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SWEETCLOVER IN GREAT PLAINS FARMING

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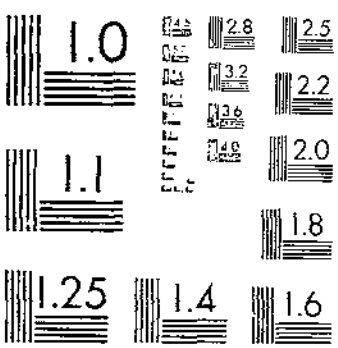

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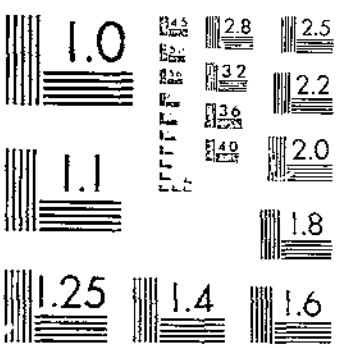

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Technical Bulletin No. 380 September 1933

SWEETCLOVER IN GREAT PLAINS FARMING

BY

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Bureau of Agricultural Economics

United States Department of Agriculture, Washington, D.C.

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UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

SWEETCLOVER IN GREAT PLAINS FARMING

By M. A. CROSBY, *Assistant Agricultural Economist, Division of Farm Management and Costs, Bureau of Agricultural Economics*

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INTRODUCTION

Sweetclover has become increasingly important during the last 10 years in many sections of the Great Plains area. Because of its adaptability to a wide range of soil and climatic conditions it is better suited to the cropping systems of that area than are any of the true clovers. It is being used to restore productiveness in many of the older farming sections in which grain farming has depleted soil fertility, and has become an important pasture and hay crop in more recently developed sections in which native pastures and meadows have been broken up and destroyed during the great expansion in small-grain production.

Accurate figures on the acreage of sweetclover for all purposes in this area are not available. Census data on the acreage pastured and

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the acreage cut for hay are available for the year 1929, and estimates of the Crop Reporting Board of the acreage cut for hay and the acreage harvested for seed are available for some States. These figures do not present the true picture, however, since they do not take into consideration the acreage plowed under for soil improvement. Moreover, there probably is considerable duplication in the acreages given since in many instances a seed crop is harvested from a field that was pastured early in the season, or from the second growth following the removal of a hay crop.

The acreage reported as harvested for seed has decreased during the last few years, largely as a result of rapidly declining prices. It is obvious that in some States the total acreage of sweetclover for all purposes has increased rapidly during the last 10 years. Nebraska, for example, reported 54,000 acres in 1921 and 1,126,000 acres in 1930, an increase of over 1,000,000 acres in 10 years. The acreage in South Dakota increased more than 50 percent from 1927 to 1930.

PURPOSE AND SCOPE OF THE STUDY

This study is a continuation of a cooperative effort of the Division of Farm Management and Costs, Bureau of Agricultural Economics, and the Division of Forage Crops and Diseases, Bureau of Plant Industry, to determine the most effective practices in the production and utilization of sweetclover and the place this crop occupies in the farm organization of different regions. Results of the first of these regional studies, which was completed in 1930, are given in a mimeographed preliminary report,[1] and in Farmers' Bulletin 1653 (*1*).[2]

In the present study particular attention was given to seeding methods and practices, cost and quantity of seed used and labor and power requirements in seeding under different methods; the amount of pasture provided by sweetclover; hay-making practices and yields of hay; harvesting practices and yields of seed; effect of sweetclover on crop yields; and the place sweetclover occupies in the cropping systems of different sections. Attention was also given to the matter of bloat trouble from pasturing the crop, and the so-called "sweetclover disease" or "sweetclover poisoning" from feeding sweetclover hay.

Information was obtained in selected sections from 500 farmers who had had several years' experience with growing and using sweetclover on their farms.[3] The location of the sections in which the study was made is shown in figure 1. The number of farm records obtained in each State is shown in table 1.

[1] CROSBY, M. A. COST OF PRODUCTION AND EFFECTIVE UTILIZATION OF SWEETCLOVER ON CORN-BELT FARMS. U.S. Dept. Agr., Bur. Agr. Econs. 25 p. 1930. [Mimeographed.]

[2] Italic numbers in parentheses refer to literature cited, p. 53.

[3] Officials of the State agricultural colleges and experiment stations in each State helped to plan the field work and selected the areas in which the study was to be conducted, and the county agents in each of the counties in which data were obtained rendered invaluable assistance in making contacts with sweetclover growers.

TABLE 1.—*Method of utilizing sweetclover on 500 farms, by States*

State	Farmers reporting use of sweetclover for—											Farms included	Farms using sweetclover for—					
	Pasture only			Pasture and hay	Pasture and hay, seed	Hay only		Seed only	Hay and seed	Soil improvement only			Pasture		Hay		Seed	
	Fall	Spring	Fall and spring			Pasture, hay, and seed	First year	Second year										
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	Pct.	No.	Pct.	No.	Pct.
North Dakota	----	22	7	37	7	17	----	4	3	1	2	100	90	90	59	59	28	28
South Dakota	----	4	7	5	5	5	----	1	2	4	2	35	26	74	19	54	16	46
Montana	----	3	1	15	----	16	----	8	1	3	----	47	35	74	42	89	20	43
Wyoming	----	8	3	5	1	2	----	2	1	3	2	27	19	70	12	44	7	26
Nebraska	4	15	14	14	11	3	5	1	10	1	3	81	61	75	24	30	25	31
Colorado	3	15	5	9	4	6	----	4	----	1	3	50	42	84	20	40	11	22
Kansas	2	7	18	9	23	22	1	2	5	5	7	101	81	80	39	39	55	54
Oklahoma	1	3	7	3	18	5	----	----	1	----	1	39	37	95	8	21	24	62
Texas	----	4	7	5	1	1	----	----	----	----	2	20	18	90	6	30	1	5
Total	10	81	69	102	70	77	6	22	23	18	22	500	409	81.8	229	45.8	187	37.4

In the cost data herein presented only "cash costs" and quantities of man labor and horse work are considered. Materials like seed,

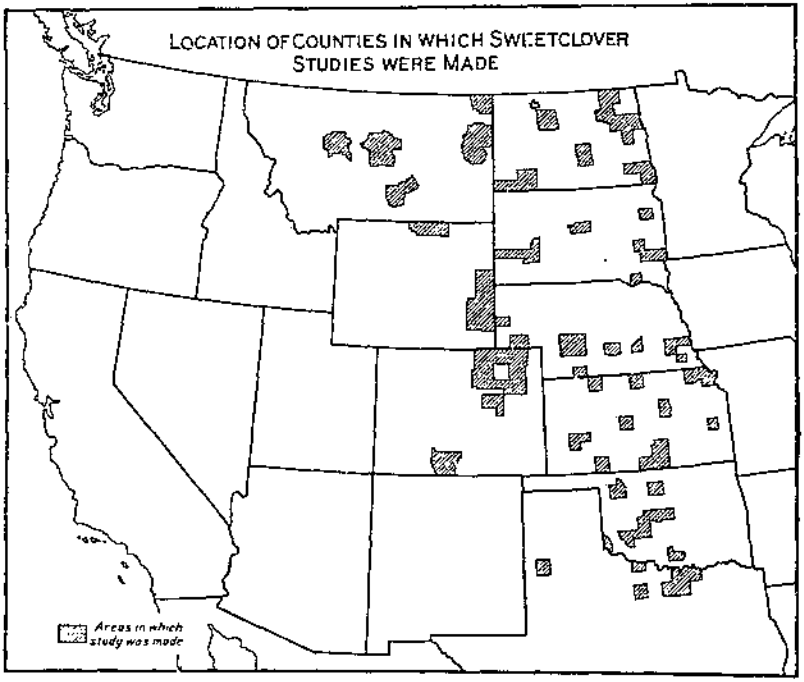

FIGURE 1.—Sweetclover is well distributed over the Great Plains area. The sections studied are representative of conditions of soil, climate, and type-of-farming existing in different parts of the various States.

lime, and inoculating culture are given at cost if bought and at farm value if furnished by the farm. The quantities of man labor and horse work required for seeding are given in hours. In cases in which sweetclover was seeded with small grain no attempt has been made to

allocate the labor between the two crops, only such additional labor as was required for seeding sweetclover being charged to that crop. No charge for depreciation or interest on investment in equipment has been included. Such charge would be difficult to determine and so small as to be negligible.

All data relative to seeding costs, carrying capacity of pasture, acreage and production of hay, and acreage and production of seed are for the year 1930 unless otherwise indicated.

HOW SWEETCLOVER IS USED

Sweetclover has a wide range of uses. In the more humid eastern portion of the Great Plains and in the irrigated sections it is used to maintain or restore soil fertility, as a pasture, as a hay crop, and as a seed crop. In the subhumid to semiarid sections it is more generally grown for pasture and for hay, soil improvement being a minor consideration.

Records from 500 farms show sweetclover being used more generally for pasture than for any other purpose (table 1). In combination with other uses, it was utilized for pasture on more than four fifths of the farms, and was used exclusively for this purpose on approximately one third of the farms. The practice of using the crop for hay was more general in the northern Great Plains States—the Dakotas, Montana, and Wyoming—where proportionately more roughage is needed for carrying livestock through the winter. Although used incidentally for soil improvement on the majority of farms, it was used exclusively for this purpose on less than 5 percent of the farms studied.

From more than one third of all the farms was the harvesting of some seed reported, but on relatively few was seed production an important phase of sweet-clover production. On many farms seed was harvested principally for home use or to supply local demand. The largest percentage of farms harvesting seed were reported from Kansas and Oklahoma respectively, and the smallest percentage from Texas.

VARIETIES GROWN

Two species and one botanical variety of sweetclover are grown on Great Plains farms. Biennial white (*Melilotus alba*) the common white blossom, and biennial yellow (*M. officinalis*) the common yellow blossom are the species, and Hubam, an annual variety of the biennial white, is the botanical variety. Grundy County white, Essex, and Arctic are smaller and earlier maturing varieties of the biennial white, and Albotrea and Switzer are varieties of the biennial yellow.

Biennial white, usually called "common white", "large white", or "common" sweetclover is most widely grown and was reported from 356 or 71 percent of the farms studied (table 2). Biennial yellow, usually referred to as "yellow blossom", or "yellow", was grown on 117 or approximately 23 percent of the farms. Grundy County white was reported from 25 farms, and Hubam from 2 farms. On 13 farms a mixture of biennial white and biennial yellow was grown.

TABLE 2.—*Varieties of sweetclover grown on 500 farms in the Great Plains, by States, 1930*

State	Farms included	Farms growing—							
		White biennial		Yellow biennial		Grundy County		Hubam	
	Number	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
North Dakota	100	61	61.0	23	23.0	16	16.0		
South Dakota [1]	35	28	80.0	1	2.9	7	20.0	1	2.9
Montana [1]	47	21	44.7	29	61.7	1	2.1		
Wyoming	27	16	59.2	11	40.7				
Nebraska [1]	81	72	88.9	7	8.6	1	1.2		
Colorado	50	11	22.0	38	76.0			1	2.0
Kansas [1]	101	89	88.1	8	7.9				
Oklahoma	39	39	100.0						
Texas [1]	20	19	95.0						
Total	500	356	71.2	117	23.4	25	5.0	2	.4

[1] More than 1 variety was grown on some farms.
[2] On some farms a mixture of white biennial and yellow biennial was grown.

The kind of sweetclover grown depends, to some extent, on the use to be made of the crop. Many farmers were growing a certain kind because it best suited them for some special use; others expressed no preference and were growing a certain kind because they first started with it and had never grown any other.

In general, those growing the common biennial white preferred it because its larger growth and longer growing season provides a greater quantity of pasture and a longer grazing period, and because it is generally considered best for soil improvement. This species predominates in the more humid, eastern part of the area, and in the irrigated sections of Montana and the North Platte Valley in Nebraska and Wyoming. Growers of the biennial yellow prefer it because it is more persistent in reseeding in pastures, because it makes a finer quality of hay than the common white, and because it is easier to handle as a hay or seed crop. This species is in most common use in Colorado, and in the dry-farming sections of Montana and Wyoming. Grundy County white was found principally in the Dakotas. This variety is preferred because it makes a finer hay, and because its shorter growth and more uniform seeding habits make it easier to harvest for seed. Growing a mixture of common white and yellow blossom in some instances was accidental, but in some cases it was intentional because the growers regarded the mixture as superior for pasture to either sort when grown alone. As compared with biennial white or biennial yellow, Hubam is inferior as a pasture, hay, or soil-improvement crop and has little to recommend its more extensive use. Its greatest usefulness is as a green-manuring crop for plowing under in the fall and as a fall pasture crop for bees.

PRODUCTION REQUIREMENTS

The principal physical and biological requirements for the successful production of sweetclover are an alkaline or neutral soil, the presence of phosphorus in the soil, and inoculation. Fortunately, over most of the vast area of the Great Plains the soils are found to meet these requirements, and in only comparatively few districts is liming or inoculation found to be necessary for sweetclover production. An

exception is found in southwestern Kansas, where many soils will not successfully grow sweetclover without liming. In other districts in the eastern third of Kansas and in southwestern Nebraska the soils of certain limited areas have become deficient in lime through continuous cropping, washing, and leaching; they need an application of lime in order to produce sweetclover economically. Long-continued cropping to corn and small grain has greatly depleted some soils of their phosphorous content; where this condition exists an application of superphosphate in addition to lime has brought highly satisfactory results. Most soils of the Great Plains are naturally supplied with the bacteria required for inoculating sweetclover, and in no part of the area except in the eastern half of Kansas and central Oklahoma was it found that artificial inoculation was considered essential for sweetclover production.

LIMING

Data relative to the quantity of lime used and the amount of labor required in hauling and spreading lime were obtained from six farms, all located in Anderson County, Kans. An abundant supply of lime rock is available for crushing in this locality, and with one exception the limestone used was obtained on the farm on which it was applied. The crusher was hired, but the tractor for operating the crusher and the crew used in crushing were furnished by the farmer. The usual crew used was 4 men for crushing and 3 men and 4 horses for hauling and spreading. In most instances the operations of crushing, hauling, and spreading were performed at the same time, and exchange labor was used to make up the crew.

The average application on these farms was 2.54 tons per acre, and the average amount of labor required for hauling the rock to the crusher, crushing, hauling the crushed rock to the field, and spreading, was 4.5 man-hours and 2.8 horse-hours per acre. The average short haul in getting the limestone to the crusher and the crushed limestone to the field is reflected in the relatively small amount of horse work required. The limestone was crushed in a portable crusher, and the only cash outlay was a charge of $1 per ton for the use of the crusher. In localities where crushed limestone has to be purchased and hauled from town or railway siding, both the cash outlay and the expenditure of labor would undoubtedly be much greater than on these farms. In a study of liming costs on 31 Corn Belt farms on which an average of 2.65 tons of lime per acre was applied, the average cost of lime was $4.83 per acre, and the average amount of labor required for hauling and spreading was 4.4 man-hours and 8.2 horse-hours per acre (*1*).

PHOSPHORUS

In many of the older farming sections it has been found that applications of superphosphate are as essential to successful sweetclover production as are applications of lime. This is particularly true of land on which alfalfa has been grown for several years. Several instances were reported in Oklahoma and Kansas in which failure to obtain a stand of sweetclover was first attributed to the exhaustion of lime in the soil and later found to result from phosphorous deficiency. Field experiments conducted by County Agent J. A. Hendricks in Anderson County, Kans., show that applications of lime alone are seldom sufficient to insure a satisfactory stand but that

when both lime and superphosphate are applied a stand is practically assured. Cooperating farmers who applied 150 pounds of 16 percent superphosphate per acre when seeding sweetclover in 1930 succeeded in holding their stands, while in practically all instances in which no superphosphate was applied stands were lost because of the severe drought in that year. The Kansas Agricultural Experiment Station recommends an application of 150 pounds of superphosphate per acre when sweetclover is seeded (*10*). Farmers in central and west-central Oklahoma were obtaining satisfactory results from the use of 400 pounds of lime phosphate per acre applied at the time sweetclover was seeded.

INOCULATION

Data on the cost of inoculating sweetclover seed were obtained from 34 Kansas farms and 7 Oklahoma farms. On many of these farms sweetclover could have been grown without the use of artificial inoculation, but the farmers had found that inoculation was good economy even when the required bacteria was already present in the soil and that when inoculation was resorted to the growth of sweetclover was thriftier and better stands were obtained. In Kansas, most of the inoculating culture was obtained through the farm bureau, the average cost being 47 cents for a quantity sufficient to inoculate 1 bushel of seed. In Oklahoma, the average cost was 80 cents for culture for 1 bushel of seed. Part of the culture was obtained through the county agents and part bought from dealers. The average cost of inoculation for 1 acre was 11.2 cents in Kansas and 19.24 cents in Oklahoma. The amount of labor required for inoculating was insignificant and amounted to only 0.03 man-hour per acre in Kansas and 0.05 man-hour per acre in Oklahoma.

It is usually advisable to inoculate when seeding sweetclover on a particular tract of land for the first time. The cost is relatively small, and inoculation may mean the difference between success and failure. Should the first seeding in a field be thin and scattering, it is advisable to let it stand and reseed, for farm experience teaches that once sweetclover has been grown on land, later seedings are more likely to succeed.

SEEDING METHODS

Seeding methods vary in different sections and appear to be governed to a considerable extent by the kind of seeding equipment available on the farm, by weather conditions, and by cultural practices most likely to result in obtaining and holding a satisfactory stand under existing conditions. Seeding was usually done with such equipment as was available on the farm. In most instances this was a grain drill; in others an end-gate seeder, a wheelbarrow seeder, a seeder attachment for a harrow, cultipacker, or roller, or a hand seeder was used. The manner of seeding was to some extent determined by the annual rainfall and the amount of soil moisture available at seeding time, by the likelihood of midsummer drought, and by the danger of loss of stand from weed competition or soil blowing. Many farmers change their seeding practices to meet varying weather conditions or changes in their cropping systems.

SEEDING WITH A NURSE CROP

The most common method of seeding sweetclover is with a nurse crop in the spring (table 3). This practice is the usual rule in the more humid, eastern, portion of the area and in the irrigated sections. It is most economical in the use of labor and permits of greatest effectiveness in the utilization of land. Approximately 80 percent of the farms included in this study were seeding in this manner; about 70 percent were seeding with spring grain—oats, barley, spring wheat, or flax—and 10 percent were seeding on winter grain in the spring.

TABLE 3.—*Acreage seeded, seed required, cost of seed, man labor, and horse work used, according to method of seeding sweetclover on 482 farms* [1]

Method of seeding	Farms reporting	Acreage seeded	Seed used			Man labor per acre	Horse work per acre
			Average per acre	Average cost per pound	Average cost per acre		
	Number	*Acres*	*Pounds*	*Cents*	*Dollars*	*Hours*	*Hours*
Seeded with nurse crop:							
Seed broadcast ahead of drill	143	6,921	11.1	7.5	0.83	0.05	0.12
Seed drilled in with grain	118	7,395	11.1	7.0	.78	.02	.....
Seed broadcast behind drill and covered, or drilled in after grain is seeded	55	1,741	12.7	7.3	.92	.72	1.66
Seed broadcast on winter grain and left uncovered	25	837	13.3	7.2	.96	.35	.11
Seed broadcast on spring grain and left uncovered	21	574	13.3	8.2	1.09	.41	.05
Drilled in winter grain in spring or broadcast and harrowed in	18	541	13.7	8.1	1.11	.05	2.14
Seeded with grain in fall	3	181	10.1	6.2	.63	.12	.33
Seeded alone:							
Drilled or broadcast and harrowed in on prepared land	58	1,392	14.2	8.0	1.14	1.83	6.23
Drilled in row-crop or small-grain stubble without preparation	36	937	13.8	7.8	1.08	.69	2.06
Drilled in rows	2	13	9.2	9.3	.86	3.23	6.92

[1] The method of seeding on 18 farms did not fall within any of these groups.

Method of seeding	Farms reporting located in—								
	North Dakota	South Dakota	Montana	Wyoming	Nebraska	Colorado	Kansas	Oklahoma	Texas
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
Seeded with nurse crop:									
Seed broadcast ahead of drill	42	13	12	12	29	21	7	7	.....
Seed drilled in with grain	47	10	27	3	11	13	6	.....	1
Seed broadcast behind drill and covered, or drilled in after grain is seeded	4	10	1	5	18	2	14	1	.....
Seed broadcast on winter grain and left uncovered	1	.....	.....	.....	5	4	5	7	3
Seed broadcast on spring grain and left uncovered	.....	.....	.....	1	8	2	13	.....	.....
Drilled in winter grain in spring or broadcast and harrowed in	.....	.....	1	.....	1	1	7	5	3
Seeded with grain in fall	3	.....	.....	.....	.....	.....	.....	.....	.....
Seeded alone:									
Drilled or broadcast and harrowed in on prepared land	.....	.....	3	3	7	5	23	8	9
Drilled in row-crop or small-grain stubble without preparation	.....	.....	.....	3	.....	.....	24	9	.....
Drilled in rows	.....	.....	.....	.....	.....	.....	.....	.....	2

Two methods were outstanding when the sweetclover was seeded with a nurse crop in the spring: (1) Broadcasting the seed ahead of the drill at the time of seeding the grain and (2) drilling the seed in with the grain. Another common method in some sections was to seed immediately after the grain was put in by drilling the clover seed in or by broadcasting the seed and covering with a harrow, cultipacker, or roller.

Several different practices were followed when the seed was broadcast ahead of the drill. Those using a grain drill with a seeder attachment allowed the clover seed to fall ahead of the drill disks or shoes. Others broadcast the seed ahead of the drill with a hand seeder, a wheelbarrow seeder, or an end-gate seeder. Broadcasting the seed ahead of the drill was usually satisfactory where ample spring moisture was available. It was a common practice in the eastern part of the Dakotas and Nebraska and in the irrigated sections of Nebraska, Colorado, and Wyoming.

Two practices were followed when the clover seed was drilled in with the grain. If a grain drill equipped with a seeder attachment was available the clover seed was run in the same spout with the grain. If the drill had no seeder attachment the clover seed was mixed with the grain and both were drilled in together. An advantage of this method is that all the clover seed gets covered. A disadvantage is that the clover seed is sometimes covered too deeply for satisfactory results. Many farmers obviate this difficulty by drilling the grain only about an inch deep and following with a cultipacker or roller.

Broadcasting the seed behind the drill and covering with a weeder, harrow, cultipacker, or corrugated roller was practiced mostly in South Dakota, central Nebraska, and central Kansas. Aside from requiring more man labor and horse work than the foregoing methods this practice has some advantages and usually brings satisfactory results. The operation of drilling in the grain tends to make a firmer seed bed for the clover seed, and the latter is not covered so deeply as when broadcast ahead of the drill. In one Nebraska community most of the seeding was done with a seeder attachment which dropped the seed ahead of a cultipacker or double corrugated roller; no difficulty in obtaining a satisfactory stand was reported when this method was followed.

The practice of broadcasting the seed on winter grain and leaving it uncovered was confined mostly to the winter-wheat sections. The seeding was usually done during the winter in order that the alternate freezings and thawings of early spring might cover the seed.

The method of seeding sweetclover in winter grain is confined mostly to the winter-wheat territory of southern Nebraska, Kansas, and northern Oklahoma. Some follow the practice of broadcasting the seed in winter and letting the alternate freezings and thawings cover the seed, and others practice seeding in early spring by drilling or by broadcasting the seed and covering it with a harrow.

SEEDING ALONE

Seeding sweetclover alone—that is, without a nurse or companion crop—was reported from approximately 20 percent of the farms studied. This practice was most common in the drier sections of western Nebraska, Kansas, and Oklahoma, in eastern Colorado, and

in northwestern Texas—sections in which a shortage of spring moisture usually occurs. In these normally dry sections a nurse crop usually is detrimental to sweetclover, robbing the young plants of moisture and shading them so that they perish when exposed to the hot sun after the nurse crop is removed. Under such conditions stands are obtained with greater certainty if sweetclover is seeded alone early in the spring. Spring freezes may occasionally injure the stand, but this risk is more than offset by the advantage gained from an early start which minimizes the danger of damage from weed competition and from hot, dry, summer weather.

On some farms the land was plowed or disked and harrowed before being seeded, and on others the sweetclover seed was drilled in row-crop or grain-stubble land with little or no previous preparation. Because of the firm seed bed thus provided, more satisfactory stands usually were obtained where seedings were made on reasonably clean row-crop stubble land, on summer-fallow, or on land that had been

FIGURE 2.—This 5-acre field on a Texas farm was seeded to sweetclover in 3-foot rows the 1st of April and furnished pasture for 18 cows on alternate weeks from June 1 to November 15.

plowed long enough before seeding time to permit the soil to become thoroughly settled and packed. Satisfactory stands were obtained on some farms where grain stubble was burned off and the land lightly disked before seeding.

On two Texas farms sweetclover seed was drilled in rows in the spring on specially prepared land. This method has some advantages for northern and northwestern Texas and similar sections in that weeds and grass may be controlled by one or two cultivations and so make it possible for the sweetclover to utilize all the moisture (fig. 2).

MISCELLANEOUS SEEDING PRACTICES

Aside from the usual seeding methods mentioned, a number of farmers were found who were following other practices to suit certain conditions of climate or soil, or certain uses of the crop. In some sections sweetclover seeded alone is likely to be crowded out by aggressive weeds, such as the Russian thistle. Under such conditions a satisfactory practice followed by many farmers was to seed with a

light seeding of oats and then pasture off both oats and sweetclover. Another practice was to drill the seed in winter rye early in the spring and pasture off both rye and clover. The oats and rye hold weeds in check, and, being pastured off, are not so exhaustive of soil moisture and do not leave the young clover plants suddenly exposed to the hot sun as is the case when the oats or rye are harvested for grain. When moisture conditions are unusually favorable, and especially in sections in which the soil is exceptionally fertile, it is not unusual for sweetclover to grow so rank as to be troublesome in the grain at harvest time. Under such conditions farmers have found it advantageous to delay sowing sweetclover until 2 or 3 weeks after the grain is seeded.

SEEDING IN PERMANENT PASTURE

Many farmers reported having tried seeding sweetclover in native pasture, but in the majority of cases these attempts met with failure. This practice is rarely successful except when the seeding is made on low, moist land, or at a time when soil-moisture conditions are exceptionally favorable to seed germination and to giving the young plants a good start. Several reported fairly satisfactory results from seeding in salt-grass pasture, or in sloughs and draws, or on bottom land where considerable moisture was available. Best results were obtained where the native sod was burned over and scarified with a disk either before or after being seeded. When fairly satisfactory stands were obtained the sweetclover reseeded to some extent and lasted from 3 to 7 years.

Satisfactory results from seeding sweetclover with bromegrass (*Bromus inermis*) were reported by several farmers. If the sweetclover was not grazed too closely the first year, and was allowed to mature some seed the second year, it usually reseeded itself for 3 to 5 years, or until the bromegrass formed a heavy, tight sod. What appears to be a satisfactory method of handling such pasture is to plow up and reseed the pasture to sweetclover when the bromegrass becomes sodbound. This combination of bromegrass and sweetclover makes a highly satisfactory pasture.

Several farmers in the Dakotas reported satisfactory results from seeding sweetclover on land that was badly infested with quackgrass. This combination makes a good pasture for 3 to 4 years, and the practice appears to be one that might well be adopted on a considerable acreage of quack-infested land in the northern Great Plains States.

SEEDING COSTS

The out-of-pocket costs of seeding sweetclover are determined by the rate of seeding and the cost per pound of seed. The amount of man labor and horse work required is governed by the method of seeding and to some extent by the equipment used. Data relative to the acres seeded, rate of seeding, and the amount of man labor and horse work used in seeding were obtained from 492 farms (table 4).

TABLE 4.—*Acreage seeded, seed used per acre, cost of seed, and the hours of labor required for seeding sweetclover on 492 farms, by selected States, 1930*

State	Farms reporting	Acreage seeded	Seed used per acre	Cost of seed		Man labor		Horse work	
				Per pound	Per acre	Total	Per acre	Total	Per acre
	Number	*Acres*	*Pounds*	*Cents*	*Dollars*	*Hours*	*Hours*	*Hours*	*Hours*
North Dakota	100	6,902	10.7	6.4	0.68	309	0.04	452	0.07
South Dakota	33	1,603	11.1	7.2	.80	338	.21	932	.58
Montana	45	2,383	10.2	8.6	.88	352	.15	1,004	.42
Wyoming	27	770	10.3	8.1	.83	254	.33	536	.69
Nebraska	79	2,330	12.6	8.4	1.06	710	.31	1,724	.74
Colorado	50	2,298	13.1	7.5	.98	286	.12	640	.28
Kansas	101	3,052	14.2	7.6	1.08	2,349	.77	6,706	2.20
Oklahoma	30	1,308	14.7	6.9	1.01	1,016	.78	2,760	2.11
Texas	18	397	13.0	8.3	1.08	587	1.48	1,338	3.37
Total or average	492	21,052	11.9	7.4	.88	6,210	.29	16,094	.76

RATE OF SEEDING

Although the rate of seeding varied widely between different farms —ranging from 4 to 25 pounds per acre—the average for the different States does not show a striking difference.

The rate of seeding was influenced to some extent by the use to be made of the crop. Heavier seedings were the rule where the crop was used mainly for pasture, or for hay, and lighter seedings where the crop was grown primarily for the production of seed, or where it had been grown on the farm through one or more rotation periods, and more or less volunteering had occurred. The quantity of seed sown per acre was also governed to some extent by the method of seeding (table 3). Where the crop was seeded alone the rate of seeding averaged higher than where it was seeded with a nurse crop, and slightly heavier seedings were made where the seed was broadcast and left uncovered on winter grain, or after spring grain had been drilled in, than where the seed was drilled in with the grain or broadcast ahead of the drill.

COST OF SEED

The cost of seed was rather uniform in each section, but varied considerably between different sections, the range being from 5 to 10 cents per pound. The former figure usually represented the farm price and the latter the price the farmer had to pay when buying the seed from a seed house or local dealer. Lower seed costs prevailed in sections in which considerable seed was produced for sale, and in which farmers who produced seed made a practice of supplying their neighbors with seed at the same price they would receive from brokers or wholesalers.

The average price of seed in North Dakota was low because the production of sweetclover seed is an important enterprise in that State. The higher price level in Montana was undoubtedly caused by the severe drought, which greatly reduced seed production. Prices in Wyoming, Nebraska, and Texas were above the average because in those States most of the farms from which information was obtained were located in sections in which relatively little seed was produced.

The cost of seed used in seeding an acre to sweetclover shows a spread of 40 cents. A relatively low rate of seeding, coupled with low price of seed, is responsible for the low seeding cost per acre in

North Dakota, and higher seeding rates, together with higher than average prices, are reflected in the higher acre costs in Kansas and Texas.

LABOR USED IN SEEDING

Man-labor and horse-work requirements for seeding sweetclover vary widely and depend principally on the method of seeding (tables 3 and 4). Where the seed was sown with a nurse crop, only the labor in excess of that required for putting in the grain was charged to sweetclover. For example: Where the clover seed was distributed with a seeder attachment on the drill the only additional labor used in seeding sweetclover was that of hauling the seed to the field and filling the seed box, and this was too small to measure. Where the seed was broadcast ahead of the drill with some implement other than the seeder attachment on the drill, or was drilled in winter grain in the spring, these operations required additional labor, all of which was charged to the sweetclover crop. Where the crop was seeded alone all labor used in preparing the land and in seeding was charged to sweetclover.

Where sweetclover was drilled in with spring grain, and where the seed was broadcast ahead of the drill when seeding grain, both man-labor and horse-work requirements were relatively insignificant. This is reflected in the small amount of labor used in the Dakotas and Montana, in which States 85 percent of the seeding reported was by these two methods.

Broadcasting the seed and leaving it uncovered after seeding spring grain, and broadcasting without covering on winter grain in the spring required but a small amount of man labor and horse work. Broadcasting and covering the seed after drilling in spring grain, drilling the seed in winter grain, or broadcasting in winter grain in the spring and covering the seed with a harrow, required considerably more man labor and horse work than drilling the seed in with the grain or broadcasting ahead of the drill.

Labor requirements were highest in Kansas, Oklahoma, and Texas. This was mainly due to the fact that the majority of the farms on which sweetclover was seeded alone were located in these three States.

FACTORS AFFECTING THE STAND

Where ample moisture normally is available there usually is little or no difficulty in obtaining a stand of sweetclover, but where rainfall is limited or falls below normal—as is likely to be the case over a large proportion of the Great Plains area—considerable difficulty is likely to be encountered in holding a stand. Seasonal distribution of rainfall and the amount of evaporation are important factors in maintaining stands of sweetclover. As loss of soil moisture by evaporation increases as one goes southward, less difficulty is encountered from this source in sections in North Dakota, in which the annual precipitation is from 15 to 20 inches, than in sections of Kansas having an average of 20 to 25 inches or in sections of Texas having an average of 25 to 30 inches.

During the last few years, and particularly in 1930 and 1931, many farmers in the northern Great Plains States experienced considerable difficulty in holding satisfactory stands of sweetclover. This was especially true in drought-stricken sections of North Dakota and South Dakota, and special inquiry was made in these States in an

effort to determine the factors that contribute to loss of stand as well as the practices most likely to result in maintaining a satisfactory stand under unfavorable conditions.

Although relatively few complete failures were reported, a considerable number reported partial failure or stands too badly damaged to be worth saving. In the majority of instances in which complete or partial failure was reported the trouble was attributed to extremely dry weather in the summer and early fall. The usual practice in these States is to seed with a nurse crop; although in most cases the clover came up to a good stand, the young plants could not compete with the grain crop for mositure, and when the latter was harvested the clover seedlings were weak and unable to survive the burning sunshine and dry weather which followed. In a few instances stands were reported to have been injured by soil blowing or by cutworms.

EFFECT OF NURSE CROP ON STAND

Inquiry failed to reveal any significant relation between the kind of nurse crop with which sweetclover was seeded and the stand of clover obtained. As a rule sweetclover is considered of secondary importance to the grain crop with which it is sown. It is usually seeded wherever wanted, regardless of the nurse crop, and on many farms was seeded with several different crops in one year. The majority of farmers interviewed expressed no special preference as to the nurse crop and stated that the supply of moisture at seeding time and in midsummer following the removal of the grain crop had more to do with obtaining and holding a stand than did the kind of crop with which the clover was seeded. Where ample moisture is available satisfactory stands are usually obtained by seeding with any of the usual nurse crops, but in sections in which a shortage of moisture is likely to occur it is advisable to reduce the rate of seeding of the nurse crop from one third to one half, and to use early-maturing rather than late-maturing varieties of grain. However, several farmers expressed a preference for seeding with certain nurse crops, provided it was convenient and expedient to do so. Of these, 34 percent preferred seeding with flax, 31 percent with wheat, 17 percent with oats, and 17 percent with barley.

EFFECT OF METHOD OF SEEDING

The method of seeding sweetclover, especially when coupled with weather conditions, appears to bear some relation to the stand obtained. Data showing the relation of method of seeding to the percentage of stand of the 1930 seeding remaining in 1931 were obtained from 118 farms (table 5). These data show that the percentage of stand was appreciably better where the seed was drilled in with the grain than where it was broadcast either ahead of or behind the drill. It will be observed, however, that method of seeding had less influence on the percentage of stand maintained in the more humid eastern sections than in the drier central and western sections.

One of the principal requirements for obtaining and holding a stand of sweetclover was found to be a firm seed bed with just enough loose surface soil to enable the seed to be well covered. This is important in the more humid sections and doubly necessary in dry-farming sections. An over-loose seed bed dries out quickly and is one of the

main causes of failure to hold a stand. For this reason freshly plowed, mellow land should be thoroughly packed before it is seeded to sweetclover. A striking example of this was observed in a drought-stricken district of North Dakota. On three farms sweetclover had been seeded on land that was thoroughly packed before seeding. On two farms the clover seed was mixed with flax, and on the other it was mixed with spring wheat and the grain and clover seed drilled in together. On each of these farms an excellent stand of sweetclover was maintained through the severe drought, whereas on other farms in that district seedings were a partial or total failure.

TABLE 5.—*Relation of method of seeding sweetclover in 1930 to the stand in 1931 on 118 farms in North Dakota and South Dakota*

Area	Seed drilled in with grain		Seed broadcast ahead of drill		Seed broadcast behind drill		Seed drilled in winter grain in spring	
	Farms reporting	Stand in 1931	Farms reporting	Stand in 1931	Farms reporting	Stand in 1931	Farms reporting	Stand in 1931
Eastern:	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
North Dakota	26	73	25	69	3	50	.....	.....
South Dakota	7	79	6	71	3	83	.....	.....
Total	33	74	31	69	6	66	.....	.....
Central and western:								
North Dakota	20	65	15	38	.....	.....	5	44
South Dakota	1	25	6	71	1	0	.....	.....
Total	21	63	21	4	1	0	5	44
Total for both areas	54	70	52	61	7	57	5	44

In dry-farming sections where seeding alone is practiced, and where soil blowing is likely to occur, some protection is needed for the young plants until they become firmly rooted. Under these conditions drilling the seed in rather high stubble of sorgo, sudan grass, or grain increases the chances of holding a stand of sweetclover.

SWEETCLOVER PASTURE

Sweetclover is in more general use for pasture than for any other purpose. On 409, or 82 percent, of the 500 farms from which data were obtained it was used for pasture, and on 160 of these farms it was used exclusively for grazing purposes. Sweetclover will carry from two to four times as many head of livestock per acre as will bluegrass or other tame pasture, and in the Great Plains States it is variously estimated that an acre of sweetclover will provide as much grazing as will 4 to 15 acres of native pasture.

In the more humid sections of the Great Plains, as well as in the irrigated areas, sweetclover pasture is usually grown in rotation with other crops. Under these conditions the crop provides the pasture needed and also is used to maintain soil fertility. In the drier sections it is the common practice to keep a field in sweetclover pasture as long as a stand can be maintained.

Although sweetclover is of outstanding value as a pasture crop it has some disadvantages, particularly on farms on which little or no other pasture is available and sweetclover is the main dependence for

grazing. There is the threat of trouble from bloat, although the danger is less with this crop than with alfalfa, red clover, or alsike clover. In the northern part of the Great Plains there is a lack of balance between the amount of grazing supplied by a given acreage of the first-year crop and that of the second-year crop, and a proportionately larger acreage of the former is required to carry a given number of livestock. In the southern Great Plains States the first-year and second-year crops are more evenly balanced as regards the quantity of grazing furnished. Earlier seeding enables the first-year crop to make sufficient growth to provide an abundance of fall pasture. In districts in which a disparity in carrying capacity between the two crops exists, many farmers overcome the difficulty by seeding a much larger acreage than will be necessary to meet the pasture requirements the second year. The entire acreage of new seeding is pastured in the fall, usually in connection with grain stubble and cornstalk fields. By having this large acreage, an abundance of fall pasture is supplied, and the danger of injuring the stand of sweetclover by close grazing is reduced to a minimum. The following spring an acreage sufficient to

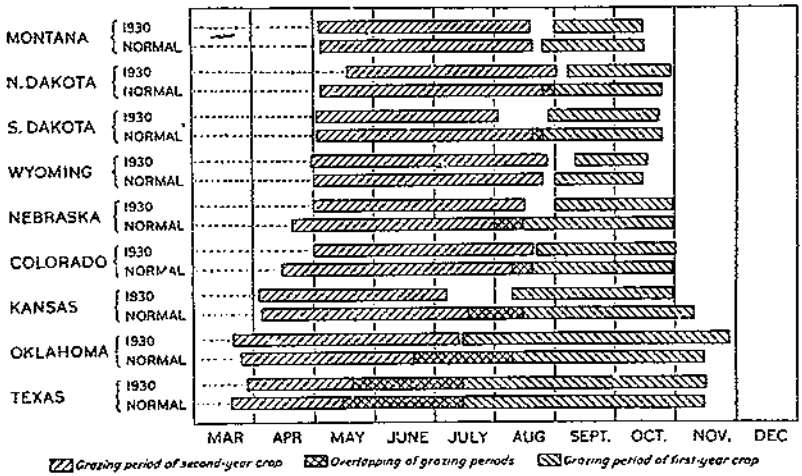

FIGURE 3.—SWEETCLOVER GRAZING PERIODS BY STATES, SEASON OF 1930 AND NORMAL SEASON.

In the northern Great Plains there is likely to be an interval of 1 to 3 weeks between the end of the grazing period of second-year sweetclover and the time the new seeding can be grazed. In the southern Plains States new seedings can be pastured earlier, and under favorable conditions continuous sweetclover pasture throughout the growing season is possible. In 1930 the severe drought lengthened the period of pasture shortage in some sections, particularly in South Dakota and Kansas.

meet the farm's pasture requirements is retained, and the remainder is cut for hay, harvested for seed, or plowed under for soil improvement.

A further drawback is the period of pasture shortage that is likely to occur between the end of the grazing period of the second-year crop and the time when the new seedings will supply the required amount of pasture. Under normal conditions this gap extends over a period of 1 to 3 weeks in the northern States, and in time of severe drought it may be considerably longer. Many farmers avoid this difficulty by having a supplemental pasture of annual grazing or soiling crops, or by having a reserve pasture of native grass. In the southern part of the Great Plains, especially in sections in which sweetclover is seeded along, the new seeding can be pastured much

earlier, and under favorable conditions the two crops will provide continuous grazing for 6 to 8 months. The average length of the grazing periods in 1930 on the farms studied, and the estimated normal or usual grazing periods by States, is shown in figure 3.

On the majority of farms studied sweetclover was grazed in connection with other pasture. For this reason data on the length of the grazing period and the number of animals pastured exclusively on sweetclover were obtained from only 82 farms on which the first-year crop was pastured, and 172 farms on which the second-year crop was pastured (table 6).

TABLE 6.—*Grazing period and number of animal units [1] pastured on sweetclover on 82 farms on which the first-year crop was pastured, and 172 farms on which the second-year crop was pastured, by States, 1930*

FIRST-YEAR CROP

State	Farms reporting	Sweetclover pastured	Grazing period			Animal units on pasture		Animal-unit days on pasture	
			Beginning date	End date	Total	Total	Per acre	Total	Per acre
	Number	*Acres*			*Days*	*Number*	*Number*	*Number*	*Number*
North Dakota	4	235	Sept. 9	Nov. 6	59	188	0.8	11,036	47
South Dakota	6	317	Aug. 27	Oct. 22	57	271	.85	14,930	47
Wyoming	3	42	Sept. 10	Oct. 18	39	45	1.07	1,550	37
Nebraska	17	486	Sept. 1	Oct. 31	61	671	1.38	42,973	88
Colorado	3	43	Aug. 22	do	71	45	1.05	3,975	92
Kansas	22	720	Aug. 10	do	83	621	.86	44,563	62
Oklahoma	19	689.5	July 15	Nov. 28	137	637.6	.92	74,889	109
Texas	8	231	May 20	Nov. 17	182	248.6	1.08	52,124	226

SECOND-YEAR CROP

North Dakota	33	1,412	May 19	Sept. 2	107	1,403.3	0.99	138,183	98
South Dakota	10	330	May 3	Aug. 3	93	333.5	1.13	34,450	102
Montana	6	134	do	Aug. 20	110	146.9	1.1	13,008	97
Wyoming	9	131	Apr. 27	Aug. 26	122	142	1.08	18,260	136
Nebraska	32	681.5	May 1	Aug. 17	109	1,061.5	1.56	111,803	164
Colorado	23	956	do	Aug. 20	112	1,018.5	1.07	104,505	109
Kansas	27	539.5	Apr. 4	July 7	95	791.1	1.41	67,103	120
Oklahoma	23	725	Mar. 21	July 14	110	827.7	1.14	88,462	122
Texas	9	271	Mar. 28	July 16	111	258.5	.95	24,110	89

[1] An animal unit is 1 horse, mule, or cow; or 2 yearlings; or 4 calves or colts; or 5 hogs; or 10 pigs; or 7 sheep or goats; or 14 lambs or kids.

FIRST-YEAR PASTURE

In the Dakotas, Montana, Wyoming, and Colorado the practice of pasturing new seedings of sweetclover is less common than in the southern part of the Great Plains. Frequently new seedings are pastured in connection with native pasture or stubble, or cornstalk fields, but the first-year growth often fails to provide much pasturage in the northern Great Plains except in localities favored with considerable rainfall or in irrigated sections. Moreover, farmers generally realize that heavy grazing of new seeding in the fall tends to restrict root development and is likely to injure the stand for the following year. Although new seedings of sweetclover were being used along with other pasture on many farms the first-year crop was used for grazing, exclusive of other pasture, on only 16 out of the 81 farms in the Dakotas, Montana, Wyoming, and Colorado on which the second-year crop of sweetclover was pastured (table 6). The majority of these

16 farms were located in the eastern part of the Dakotas, and on irrigated land in Wyoming and Colorado where moisture conditions were favorable to a maximum first-year growth.

In Nebraska more than one half the farms on which sweetclover was pastured were grazing the first-year crop. The relatively high carrying capacity of first-year sweetclover in this State was due to the fact that several of the pastures were on irrigated farms and on many of the nonirrigated farms moisture conditions were exceptionally favorable in 1930.

In Kansas, Oklahoma, and Texas the practice of pasturing the first-year crop is general. In these States the longer growing season, the earlier seeding time, and a more general practice of seeding sweetclover alone—particularly in the drier sections—enable the crop, under normal conditions, to make growth sufficient to provide considerable pasture the first year. In fact, in both central Oklahoma and northern Texas, the first-year crop was pastured for a greater number of days than was the second-year crop (fig. 3). In Kansas, because of drought, the first-year crop was pastured for an average of only 83 days, whereas the usual grazing period in that State is about 100 to 110 days. The average grazing period in Oklahoma was 137 days. However, of the 19 records obtained in this State, 17 were from the more humid central part of the State where the usual grazing period is considerably longer than in the western part of the State. The exceptionally long period over which the crop was grazed in Oklahoma and Texas was partly due to the fact that on many farms sweetclover was seeded alone and pasturing began at a much earlier date than would have been possible had it been seeded with a nurse crop. In fact, on several farms the clover was overgrazed and the stand so injured that the capacity of the second-year crop was reduced. This was particularly true on some of the Texas farms on which there was a shortage of other pasture.

The length of the period during which the first-year crop of sweetclover may be pastured increases gradually from the northern to the southern part of the area and, under normal conditions, ranges from 50 to 60 days in the Dakotas, Montana, and Wyoming to approximately 150 days in Oklahoma and Texas. The total amount of pasture furnished by an acre of sweetclover is about 140 animal-unit days in the southern Great Plains, as compared with 45 to 50 days in the northern Plains States. These differences in the length of the grazing period and the total amount of pasture provided are mostly due to the difference in the length of the growing season. The carrying capacity per acre during the pasture period was greatest in the central part of the area, chiefly because many of the pastures were on irrigated land.

SECOND-YEAR PASTURE

The length of the grazing period of second-year sweetclover depends on the character of the stand, weather conditions, the variety grown, and the effectiveness with which the pasturing is conducted. Obviously, a thin stand, if pastured to anything like its maximum carrying capacity, is depleted more quickly than a thick stand would be. Extremely dry weather in July or August will materially shorten the grazing season. The biennial white has a longer grazing season than either of the earlier maturing varieties, biennial yellow and Grundy County white. Overgrazing shortens the life of the pasture,

and undergrazing has a similar effect because the plants become woody and unpalatable if not kept rather closely grazed.

Best results in pasturing second-year sweetclover are obtained when the plants are kept grazed reasonably close rather early in the season as this checks the upright growth and causes the plants to branch more freely. Farmers who are pasturing second-year sweetclover most effectively attempt to maintain a proper balance between the number of livestock and the amount of pasture available. To do this it is sometimes necessary to clip the early growth so as to cause new shoots to put out from the joints, and in other instances it may become necessary to have other temporary or permanent pasture which can be grazed alternately with the sweetclover.

Normally the second-year crop furnishes grazing for approximately 110 days. There was some variation in the length of the grazing season reported in the different States, but for the most part the length of time the crop was pastured was relatively uniform. The shortest average grazing periods were reported from South Dakota and Kansas, and the longest from Wyoming (fig. 3). The length of the grazing season in South Dakota and Kansas was shortened by drought, while that of Wyoming was increased by exceptionally favorable weather conditions.

In Texas the carrying capacity of the pastures was lessened by dry weather, and also by having been overgrazed the first year. The greater carrying capacity of the Nebraska pastures may be accounted for by the fact that several were on irrigated farms, and others were located in sections in which summer moisture conditions in 1930 were exceptionally favorable.

All classes of livestock are grazed on sweetclover, but it is in more general use for cattle and sheep than for other farm animals. Its milk-producing qualities make it especially valuable for dairy cows and for ewes with lambs. On the majority of farms from which information was obtained two or more classes of livestock were pastured at the same time, and data were obtained from only 100 farms on which one class of livestock was grazed exclusively on sweetclover (table 7). While these figures show that an acre of sweetclover furnished 29 more animal-unit days of grazing when pastured with hogs than when pastured with cattle, and 57 more animal-unit days than when pastured with sheep, the relatively small sample for hogs and sheep precludes the drawing of definite conclusions. Other factors may have had more to do with these differences than did the class of livestock pastured.

TABLE 7.—*Sweetclover pasture: Acreage and grazing period, by animal units, animal-unit days, and class of livestock*

Class of livestock	Farms reporting	Acreage grazed	Average grazing period	Animal units		Animal-unit days	
				Total	Per acre	Total	Per acre
	Number	*Acres*	*Days*	*Number*	*Number*	*Number*	*Number*
Cattle	87	2,536.5	104	3,077.0	1.21	320,008	126
Sheep	8	333.0	98	334.3	1.00	32,761	98
Hogs	5	59.0	117	78.0	1.32	9,126	155

FOR DAIRY COWS

Dairymen who have used sweetclover for pasture generally regard it as exceptionally valuable for dairy cows. Under favorable conditions it furnishes more feed per acre than any other pasture. It is more drought-resistant than most pasture plants and provides an abundance of succulent grazing at a time when other pastures are dried up and unproductive and dairy cows are likely to suffer from lack of green feed. Dairymen are generally agreed that cows maintain a better flow of milk on sweetclover than on any other pasture, but relatively few keep production records from which comparisons can be drawn. One dairyman in Canadian County, Okla., reported an increase of 33.3 percent, or 1 gallon of milk per cow per day, from a herd of 20 cows when changed from dry roughage and silage to sweetclover pasture. Others reported a falling off that ranged from 20 to 25 percent in production when cows were shifted from sweetclover pasture to native pasture.

In 1930 a farmer operating a sandy, dry-land farm in Washington County, Colo., pastured eight cows on 20 acres of second-year sweetclover through May. The first of June the cows were moved to a native pasture, and the sweetclover was cut for hay. The cows were on the native pasture through June and July, and then on new seeding of sweetclover through August. Cream sales from the eight cows for May and August (while the cows were on sweetclover) were $50.50 and $54.48, respectively, and for June and July (while the cows were on native pasture) the sales totaled $37.45 and $37.48 respectively. The cash return was $30.05, or 40 percent greater while the cows were on sweetclover than for the same length of time on native pasture.

FOR BEEF CATTLE

Few of the farmers who were interviewed relative to pasturing beef cattle on sweetclover were able to furnish data on gains made on this pasture. The majority were either using sweetclover in combination with other pasture, or were having the crop grazed through the pasture season and finishing the cattle in a dry lot, and kept no record of actual gains made on pasture. Sweetclover is considered an excellent maintenance pasture but is not generally regarded as a satisfactory finishing pasture for beef cattle unless a supplementary grain ration is used. Sweetclover pasture tends to promote growth rather than fat; best results are usually obtained when the animals carry considerable flesh when turned on pasture in the spring. Cases are on record of daily gains of 2 to 3.5 pounds per head from sweetclover pasture supplemented with corn (*1*).

Several cattle-feeding demonstrations in which sweetclover pasture was used have been conducted in Rio Grande County, Colo., under the direction of the Colorado Agricultural College Extension Service.[4] One of these, in which a comparison was made of the feed requirements, daily gains, and feed cost per 100 pounds of gain for the same lot of steers on sweetclover pasture for 123 days and in the dry lot for 107 days, is summarized in table 8.

[4] San Luis Valley steer feeding demonstration. Monte Vista, Colo., May 8, 1928 to Dec. 30, 1928.

TABLE 8.—*Feed required to make 100 pounds of gain and average daily gain made by 26 steers in a summer-feeding period of 123 days on sweetclover pasture, and in a dry-lot feeding period of 107 days on a ranch in Rio Grande County, Colo., 1928*

Feed		Feed used per 100 pounds of gain	
		On sweet clover pasture 123 days	In dry lot 107 days
Barley	pounds	283.20	379.60
Sweetclover pasture	acres	.31	
Corn (46 days)	pounds	41.16	316.00
Alfalfa hay (24 days)	do	75.80	147.00
Cottonseed meal	do		11.40
Cull potatoes	do		507.00
Feed cost per 100 pounds gain [1]	dollars	9.54	12.47
Average daily gain	pounds	2.47	2.52

[1] On the basis of 1928 prices.

There was little difference in the average daily gain. The feed cost per 100 pounds of gain was $2.93 more while on dry lot than when on pasture, sweetclover pasture being charged at $8 per acre and feed at market prices in computing these costs. Prices for barley, corn, and alfalfa hay were slightly higher during the pasture period than during the dry-lot feeding period.

In a similar demonstration on another Rio Grande County ranch a mixed lot of long yearlings, 19 steers and 13 heifers, were fed for 123 days, May 8 to September 7, inclusive. The pasture consisted of 30 acres of yellow-blossom sweetclover. Owing to a poor stand, cold weather, and cutworm damage, this acreage was not sufficient to provide continuous grazing, and the cattle were removed from June 4 to June 23, thus making the pasture period 103 days. The average daily gain was 1.84 pounds for 123 days, and the feed cost per 100 pounds of gain was $12.17. In this case sweetclover pasture was charged at $6.66 per acre.

FOR SHEEP

Sweetclover appears to be especially valuable as a pasture for sheep, and on many farms on which the production of lambs is an important enterprise, it is the main dependence for grazing. This was found to be particularly true in the Red River Valley of North Dakota and in irrigated sections in Colorado. A study of sheep production on 200 farms in northeastern North Dakota and northwestern Minnesota in 1925 showed that more than one half of the sheep growers in that area were using sweetclover for pasture and an average of one lamb per ewe was grown to 80 pounds on pasture in about 6 months (*4*).

At the Scotts Bluff Station, Mitchell, Nebr., broken mouthed ewes and April-dropped lambs made gains of 13.1 and 39.5 pounds per head, respectively, on sweetclover pasture for 60 days, as compared with gains of 4.3 pounds per head for ewes and 28.7 pounds per head for lambs when fed on corn silage and alfalfa hay. The sweetclover pasture and the corn silage and alfalfa hay were supplemented with dried beet pulp, corn, and cottonseed cake. On the basis of the quantity of feed required to make 100 pounds of gain one acre of sweetclover pastured for 60 days had a feeding value equal to 2.32 tons of corn silage, 1.33 tons of alfalfa hay, 793 pounds of dried beet pulp, 183 pounds of corn, and 154 pounds of cottonseed cake (*3*).

In the present study more than one fifth of the farms from which pasture data were obtained were pasturing sheep on sweetclover, but

in the majority of cases the sheep were grazed with other livestock and no record was kept of weights or gains. Data were obtained from seven widely scattered farms on the number of ewes and lambs grazed, the number of days they were grazed on sweetclover, and the average weight of the lambs when sold, or at the end of the pasture season (table 9). In most instances the ewes and lambs were run on winter wheat or rye, or native grass, previous to being turned on sweetclover. Data from only seven farms is a relatively small sample but they show the possiblity of producing 5- to 6-month lambs weighing 80 pounds or more where sweetclover pasture is available.

TABLE 9.—*Lambs on sweetclover pasture: Number of ewes and lambs grazed, number of days on sweetclover pasture, and average weight of lambs at the end of pasture, period, on 7 farms, 1930*

State	Grazing period on sweetclover			Ewes grazed	Lambs grazed	Approximate date lambs were dropped	Average weight of lambs at end of pasture period
	Beginning	End	Total				
			Days	*Number*	*Number*		*Pounds*
North Dakota	June 15	Sept. 15	93	150	150	May 1	90
Montana	May 1	July 15	76	200	150	Mar. 10	80
Nebraska	May 10	Sept. 30	144	100	110	May 1	82
Colorado	May 1	Aug. 15	107	250	250	Apr. 1	99
Colorado	May 15	do	93	200	200	do	85
Kansas	Apr. 15	July 20	97	32	40	Mar. 1	85
Kansas	do	Aug. 20	128	24	30	do	85
Total or average			105	956	930		87

FOR HOGS

Sweetclover is a valuable and economical pasture crop for hogs. Grown in a 3-year or 4-year rotation, it provides a clean pasture and an abundance of succulent green feed, both of which are essential for promoting rapid growth and lessening the danger of loss from parasites and filth-borne diseases.

The first-year crop, when it makes sufficient growth to be grazed, is generally regarded as equal to alfalfa as a hog pasture, but the second-year crop is not usually so satisfactory unless the grazing is properly managed. Unless the second-year crop is kept closely grazed the growth becomes tough and woody and is not relished by hogs. This may be overcome by clipping the sweetclover when the growth begins to get too large or by limiting the size of the pasture to the number of animals. Some farmers follow the practice of dividing their pastures into two fields and pasturing each field alternately for periods of a week or 10 days.

Data were obtained from only five farms on which hogs were pastured exclusively on sweetclover (table 7). This is a small sample, but the results obtained indicate that, from the standpoint of carrying capacity, sweetclover can be as effectively grazed by hogs as by cattle or sheep. No data relative to gains made on pasture on these farms were obtainable, but experiments conducted by the Kansas Agricultural Experiment Station show sweetclover to have practically the same value as alfalfa as a pasture for hogs (*10*). Moreover, in a dry year the sweetclover remained more succulent through July and August and produced slightly better gains than did alfalfa.

FOR BEES

Sweetclover produces an abundance of honey of excellent quality and has long been recognized by beekeepers as the best crop that can be grown for honey production. It is roughly estimated that 50 percent or more of the honey produced from clovers in the Great Plains comes from this crop.

Sweetclover has a long blooming season and the period of nectar secretion usually extends considerably beyond that of the true clovers and other early-blooming, honey-producing plants. By having both early and late maturing sorts of the biennial species followed by the annual Hubam a succession of bee pasture is provided from June until late in the fall.

BLOAT FROM PASTURING SWEETCLOVER

Special inquiry was made relative to the prevalence of bloat from pasturing sweetclover; the losses of livestock from this trouble; the conditions under which bloat is most likely to occur; and precautions to be taken to prevent or minimize the danger of loss from bloat.

Data were obtained from 431 farms on which sweetclover had been used for pasture for an average of approximately 9 years (table 10). It was estimated that during that time 9,884 head of cattle and 15,721 head of sheep were grazed on these farms. On only 35 of the total number of farms, or nearly 9 percent, had there been any losses from bloat. Losses of both cattle and sheep were relatively small, and in most cases no greater than would have been expected from other causes.

TABLE 10.—*Sweetclover bloat: Number of farms from which loss of livestock from bloat was reported, number of cattle and sheep pastured, and number and percentage of animals lost, by States*

State	Farms reporting	Farms reporting losses	Period covered	Cattle pastured	Cattle lost		Sheep pastured	Sheep lost	
	Number	*Number*	*Years*	*Number*	*Number*	*Percent*	*Number*	*Number*	*Percent*
North Dakota	92	10	8	1,259	11	0.9	6,300	28	0.4
South Dakota	31	3	10	510	5	1.0			
Montana	40	2	6	1,100	6	.5	3,500	0	0
Wyoming	22	2	9	156	6	3.8			
Nebraska	65	6	12	1,736	21	1.2	2,400	6	.2
Colorado	41	4	11	1,415	15	1.1	3,350	0	0
Kansas	84	6	8	2,013	14	.7			
Oklahoma	38	2	3	1,274	7	.5			
Texas	18	0	6	421	0	0	171	0	0
Total	431	35	8.8	9,884	85	.86	15,721	34	.22

The percentage of loss was greatest in the irrigated sections of Wyoming, Nebraska, and Colorado, and in the more humid eastern part of the Dakotas, where conditions were favorable for the production of a quick, rank, and sappy growth of the second-year crop. Bloating generally was more prevalent in the northern than in the southern Great Plains States. Approximately 10 percent of the farms in the northern Plains States reported losses, while but 7 percent of the Kansas farms, 5 percent of the Oklahoma farms, and none of the Texas farms reported losses. Few cases of bloat were reported from pasturing the first year's growth. This fact may account in part for

the more frequent occurrence of bloat in the northern Plains States, where the practice of pasturing the first-year crop is less common than in the southern Plains States.

The general opinion expressed by the interviewed farmers was that there is less danger of bloat from pasturing sweetclover than from pasturing red clover, alfalfa, or alsike clover. Cattle and sheep are likely to bloat if permitted to gorge themselves on any lush herbage, and in the winter-wheat region more bloat trouble was reported from grazing wheat in the spring than from grazing sweetclover. In many instances in which losses had occurred from bloating on sweetclover the animals were chronic bloaters, or the trouble was largely the result of carelessness. The danger of bloat exists, however, and all possible precautions should be taken to guard against it.

Conditions generally credited with contributing to the danger of bloat were:

Turning livestock on sweetclover for the first time when animals are hungry.
Turning livestock on for the first time when the sweetclover is wet with dew or rain.
A period of 3 or 4 days of hot, damp, cloudy weather, while sweetclover is being pastured.
An abnormally rank, sappy growth of sweetclover.

Precautions recommended to prevent or minimize the danger of bloat were:

Be sure the animals have all the dry roughage they will eat before they are turned on sweetclover for the first time.
Have dry roughage—hay or straw— accessible to the animals when on pasture.
When possible, have some grass pasture—bluegrass, bromegrass, or native grass—where it can be grazed in conjunction with sweetclover.
If practicable, turn the animals on sweetclover early in the spring—as soon as they can get a good "bite"—and then leave them on. Some slight bloating is likely to occur when they are first turned on, but this will usually disappear as soon as they become accustomed to sweetclover. If the farmer becomes panicky and removes the animals as soon as a little fullness is evident, he is more than likely to have the same trouble each time they are put back on the pasture.

SWEETCLOVER HAY

Sweetclover is the principal hay crop in many sections of the Great Plains States. It is produced more extensively in the northern part of the area where forage requirements for wintering livestock are greater and where conditions are more favorable to the production of the crop, than in the southern Great Plains. North Dakota leads in the production of sweetclover hay by a wide margin, and for the years 1929–31 accounted for more than one half the total production of eight Great Plains States. Nebraska, South Dakota, and Montana alternate in second, third, and fourth place in production (table 11). In 1929, according to census data, sweetclover ranked second in North Dakota among all tame-hay crops as to both acreage and production, being exceeded in acreage by "small grain cut for hay" and in total production by alfalfa. In North Dakota, sweetclover constitutes approximately 30 percent of all the tame hay produced, and in South Dakota, Montana, and Nebraska it makes up about 4.5 percent of the tame-hay production.

TABLE 11.—*Sweetclover hay: Acreage harvested, yield per acre, and production in selected States, 1929–31*

State	Acreage			Yield per acre			Production		
	1929	1930	1931	1929	1930	1931	1929	1930	1931
	1,000 acres	*1,000 acres*	*1,000 acres*	*Tons*	*Tons*	*Tons*	*1,000 tons*	*1,000 tons*	*1,000 tons*
North Dakota	248	200	237	1.30	1.20	1.00	322	247	237
South Dakota	59	56	39	1.20	1.10	.90	71	62	35
Montana	70	65	42	.94	.80	.80	66	52	34
Wyoming	10	10	7	1.35	1.25	1.05	14	12	7
Nebraska	60	54	29	1.55	1.50	1.00	93	81	29
Colorado	12	11	9	1.45	1.40	1.15	17	15	10
Kansas	18	21	15	1.35	1.30	1.35	24	27	20
Oklahoma	7	7	7	1.14	1.00	1.00	8	7	7
Total	484	430	385	1.27	1.17	.99	615	503	379

Crops and Markets, December 1932.

Both first-year and second-year crops of sweetclover are utilized for hay. The practice of using the second-year crop for hay is common to all parts of the area, but production of hay from the first-year crop is confined largely to certain sections of Nebraska and to the southern part of the Great Plains, where the longer growing season and a more general practice of seeding the crop alone are conducive to a larger growth the first year (table 12). Owing to the short growing season in the Dakotas, Montana, and Wyoming, it is seldom that new seeding makes sufficient growth to provide a cutting of hay, and it is only under exceptionally favorable conditions that the first year's growth is cut for hay in these States.

TABLE 12.—*Sweetclover hay: Acreage harvested, yield per acre, and production on 40 farms harvesting the first-year crop in 1929 and 131 farms harvesting the second-year crop in 1930, by States*

State	First-year crop				Second-year crop			
	Farms reporting	Acreage harvested	Yield per acre	Total production	Farms reporting	Acreage harvested	Yield per acre	Total production
	Number	*Acres*	*Tons*	*Tons*	*Number*	*Acres*	*Tons*	*Tons*
North Dakota					40	2,435.0	1.22	2,977.0
South Dakota					14	350.0	1.36	484.0
Montana:								
On dry land					21	785.5	.71	561.0
On irrigated land					3	155.0	2.00	310.0
Wyoming:								
On dry land					8	127.5	1.00	128.0
On irrigated land					1	60.0	1.00	60.0
Nebraska:								
On dry land	4	63	0.98	61.5	8	146.0	1.09	158.5
On irrigated land	11	402	.68	274.5	1	10.0	.75	7.5
Colorado:								
On dry land					5	178.0	1.60	284.5
On irrigated land	2	14	1.14	16.0	11	402.0	2.08	961.5
Kansas	18	278	1.27	353.2	10	172.0	1.23	211.0
Oklahoma	1	10	.60	6.0	6	117.0	1.46	170.5
Texas	4	31	.98	30.5	3	21.5	1.33	28.6
Total	40	798	.93	741.7	131	5,025.5	1.26	6,342.1

When the growth is sufficient the first-year crop makes the best quality hay. It is finer stemmed, leafier, and easier to handle in harvesting. Except in the drier sections, sweetclover seeded without a nurse crop usually produces a good crop of hay the first season.

Such hay is usually clean and has practically the same value as alfalfa. Hay from first-year sweetclover that was seeded with a nurse crop is likely to contain considerable grain stubble and trash, but this is not a serious objection if the hay is for home consumption.

HAY-MAKING PRACTICES

Hay-making practices vary widely between individual farms and under different conditions, depending on whether it is the first-year or second-year crop, on weather conditions, and on the equipment available for handling the crop.

If the first-year crop is cut for hay it is usually handled the same way as alfalfa and as a rule is not difficult to cure. The usual practice is to cut with a mower, rake into windrows as soon as the leaves are wilted, and cure in the windrow or cock.

The second-year crop is more difficult to handle, and greater care in curing is needed to minimize waste and produce a good quality of hay. To make the best quality of hay, the second-year crop should be cut early, preferably before the first blossom buds appear. Cutting early is particularly important if any considerable acreage is to be harvested. The second-year crop develops rapidly, and a delay of a week or so may find the plants well past the stage for making good-quality hay. At the proper stage for cutting, the growth is sappy and rather difficult to cure, but if cutting is delayed much beyond this stage the product is likely to be coarse, woody, and unpalatable. Because of the difficulty in curing, or of a delay in cutting, or of careless or improper methods of harvesting, a large percentage of second-year sweetclover hay now produced is relatively poor in quality.

Inquiry into harvesting practices on 158 farms showed that two general methods were being followed. On approximately 80 percent of the farms the crop was cut with a mower, and on 18 percent of the farms a grain binder was used for cutting; a windrower was used on 3 farms (table 13).

TABLE 13.—*Sweetclover hay: Method of harvesting second-year crop, by States*

State	Farms reporting	Farms harvesting with—		
		Mower	Binder	Windrower
	Number	*Number*	*Number*	*Number*
North Dakota	46	34	11	1
South Dakota	13	11	2	
Montana	42	30	11	1
Wyoming	9	9		
Nebraska	10	10		
Colorado	17	16	1	
Kansas	11	8	2	1
Oklahoma	8	7	1	
Texas	2	1	1	
Total	158	126	29	3

Where a mower was used in cutting the second-year crop the most successful producers were following the practice of raking the hay into windrows before the leaves were dry enough to shatter. Those having left-hand side-delivery rakes found this implement far superior to the ordinary dump rake in handling sweetclover. This implement picks the hay up and rolls it into a cylindrical windrow with most of

the leaves on the inside and the stems on the outside, thus insuring a more uniform curing of stems and leaves and a minimum shattering of leaves. A few were using a hook-up of general-purpose tractor, two mowers, and left-hand side-delivery rake, thus accomplishing the mowing and raking in a single operation. Where this outfit was used, the freshly cut clover lay in the swath only while a "round" of the field was being made. This is probably the most effective outfit for handling large acreages of the crop economically and for making a high-quality hay.

Two methods were followed where the crop was cut with a grain binder. Some were following the practice of letting the clover fall in bunches (untied bundles) on the high stubble and leaving it undisturbed until cured. The high stubble holds the clover up off the

FIGURE 4.—If a windrower is available it may be effectively used in cutting sweetclover for hay. The implement saves labor, and the loss of leaves from shattering is small as compared with that in hay windrowed with a rake.

ground and permits the air to circulate underneath the bunches, thus hastening the curing. A more common practice was to tie the clover in rather loose bundles which were immediately set up in long shocks like grain, and stacked or stored in the barn when cured. This bundled hay is easily handled in hauling and feeding, but if a considerable acreage is to be harvested the cost or twine may make this method more expensive than harvesting with a mower and rake. One advantage of cutting with a binder is that the clover may be cut as high as desired, and another is that it contains no old stubble or trash as it is likely to if a mower and rake are used.

Where a windrower or swather was used for cutting, the clover was run directly into windrows where it cured out with relatively small loss of leaves from shattering (fig. 4). The use of this implement eliminates the labor of raking, and the hay is relatively free from old stubble or other trash likely to be taken up with the hay when a rake is used. Farmers who were using this method of cutting sweetclover for hay preferred it to either the mower or binder.

YIELDS OF HAY

Yields of sweetclover hay as reported from different farms ranged from 0.5 to 2 tons per acre for the first-year crop, and from 0.5 to 3 tons per acre for the second-year crop. Yields reported from 40 farms on which the first-year crop was harvested averaged 0.93 ton per acre, and from 131 farms on which the second-year crop was harvested the average yield was 1.26 tons per acre (Table 12).

Yields of first-year sweetclover were highest in Kansas, the high yield being due to the fact that on the majority of these farms the crop was seeded alone and the growth was not restricted by a nurse crop.

Highest yields of the second-year crop were reported from irrigated farms in Colorado and Montana. Nonirrigated farms in Montana reported an average of but 0.71 ton per acre. This relatively low yield was largely due to the severe drought. Yields from other States were relatively uniform.

SWEETCLOVER POISONING

Sweetclover poisoning is a specific disease in cattle, resulting from molded or spoiled sweetclover hay or silage. The disease manifests itself by loss of clotting power of the blood, and affected animals may bleed to death from dehorning, castration, or minor wounds, such as wire cuts, or from internal hemorrhage. As the disease cannot be detected until considerable loss has occurred, precautionary measures are likely to be neglected until the trouble is evident.

The disease occurs more commonly in young cattle than in mature animals. Under ordinary conditions horses and sheep are rarely if ever affected with the disease. An attempt to produce the disease in sheep was made by the department of veterinary science of the North Dakota Experiment Station. After a long period of feeding sweetclover hay that possessed the disease-producing qualities to a high degree, the disease was produced in only one animal. There appears to be no authentic record of the disease affecting sheep under ordinary farm conditions (*7*).

Results of an inquiry relative to this trouble indicated that farmers have learned to use caution in feeding hay made from second-year sweetclover, and none of those interviewed had had a second occurrence of the poisoning. Data were obtained from 228 farms on which sweetclover hay was fed and are shown in table 14. No difficulty was reported from feeding hay made from the first-year crop.

TABLE 14.—*Poisoning from feeding sweetclover hay: Number of farms from which such feeding was reported, number and percentage from which poisoning was reported, and losses, by States*

State	Farms reporting	Farms reporting poisoning		Farms reporting losses	
	Number	*Number*	*Percent*	*Number*	*Percent*
North Dakota	64	7	10.9	5	7.8
South Dakota	22	1	4.5	1	4.5
Montana	37	3	8.1	2	5.4
Wyoming	9	3	33.3	1	11.1
Nebraska	32	1	3.1	1	3.1
Colorado	19	0	0	0	0
Kansas	31	3	9.7	3	9.7
Oklahoma	8	0	0	0	0
Texas	6	0	0	0	0
Total	228	18	7.9	13	5.7

The method of minimizing the occurrence of the disease by feeding sweetclover hay with 2 or 3 times as much other roughage, or by feeding sweetclover hay for a week or 10 days and then feeding other roughage for 2 weeks or more, is now well understood, and those who have once experienced trouble from sweetclover poisoning usually adopt these precautionary methods.

SEED PRODUCTION

Data on the acreage of sweetclover harvested for seed are not available for the years prior to 1925. It is well known, however, that the rapid expansion in the use of sweetclover which took place from 1915 to 1920 resulted in a greatly increased demand for seed. This increased demand is reflected in the relatively high price that growers obtained for the 1918 and 1919 seed crops (table 15). Prices for the 1920 and 1921 seed crops fell precipitously but increased gradually from 1922 to 1926. Since 1926 prices have gradually declined. Seed production appears to have reached the peak in 1927, when 300,000 acres were harvested, the total production being 1,223,800 bushels. Both acreage and production have declined steadily since 1927, the acreage harvested for seed in 1931 being 247,600 acres, a decrease of 18 percent from the 1927 acreage, and production being 837,700 bushels, a decrease of 32 percent. This decrease in acreage was mainly due to the decline in price, and the resulting decline in production was further augmented by a falling off in the yield per acre, due to unfavorable weather conditions.

TABLE 15.—*Sweetclover seed: Average price per bushel paid to growers for crops, 1918–31* [1]

State	1918	1919	1920	1921	1922	1923	1924
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Illinois	15.00	14.40	9.76	6.09	4.26	5.82	6.12
Minnesota	10.50	12.60	4.80	2.70	4.11	5.49	4.89
North Dakota	10.80	13.80	5.76	2.64	4.41	5.40	5.01
South Dakota	10.20	12.60	5.70	3.00	4.20	5.82	4.83
Nebraska	10.80	15.00	7.56	3.93			
Kansas	9.84	14.10	4.89	3.06	4.65	5.46	5.28
Oklahoma	12.00	13.20	5.40	3.00			
Montana	11.40	13.95	6.90	3.00	4.20	5.49	5.01
Colorado	8.40	12.96	5.94	2.55	2.73	5.16	4.95
Idaho	10.80	14.85	6.00	3.90			
Utah	10.80	15.60	5.10	1.80		6.00	6.12
Average [2]	10.96	13.91	6.16	3.24	4.08	5.58	5.28

State	1925	1926	1927	1928	1929	1930	1931
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Ohio	7.70	8.00	6.20	5.80	4.80	4.70	3.50
Indiana	8.00	8.30	6.50	5.80	5.30	4.70	3.80
Illinois	8.30	8.50	7.00	5.30	5.10	4.70	3.80
Wisconsin						4.05	3.70
Minnesota	3.30	6.10	3.50	3.40	3.30	3.55	2.90
Iowa	7.10	8.00	5.70	5.30	4.95	4.00	4.10
Missouri	7.10	8.00	6.00	5.40	4.50	4.00	3.60
North Dakota	4.30	7.00	4.25	3.50	3.55	3.35	2.50
South Dakota	4.50	7.30	4.20	3.00	3.30	3.10	2.50
Nebraska	5.00	5.80	5.00	3.90	3.10	3.10	3.20
Kansas	5.50	6.70	4.35	3.30	3.40	3.30	2.60
Montana	6.70	8.60	6.00	4.30	4.30	3.70	3.90
Colorado	5.70	7.30	4.50	3.70	3.55	3.90	3.70
Average [2]	4.87	6.99	4.67	3.75	3.57	3.49	2.67

Compiled from U.S. Department of Agriculture Yearbooks.

[1] Prices for 1925–31, are of December.
[2] Average prices for years 1918–24 are average of the State averages, and for 1925–31 are weighted averages for the United States.

The Great Plains States normally produce approximately 65 percent of the reported production of sweetclover seed of the United States (table 16). North Dakota, with an average annual production of 274,500 bushels for the 3-year period 1929–31, leads, and produces approximately 30 percent of the total United States production. For the same period Minnesota and South Dakota ranked second and third of the Great Plains States with average annual productions of 195,833 and 186,233 bushels respectively. Nebraska and Kansas ranked fourth and fifth, with average annual productions of 83,667 and 58,867 bushels, respectively.

Sweetclover is difficult to harvest for seed, even under favorable conditions. This is particularly true of the biennial white which grows to a height of 5 to 8 feet and is exceedingly troublesome to handle with a binder or other machinery. Farmers who make a practice of producing seed of this species usually clip the first growth of the second-year crop or keep it pastured down until about the first of June. Either of these treatments causes the plants to branch more freely and the seed to mature more uniformly, and makes the crop easier to harvest. The clipping is done when the plants are 12 to 20 inches high, and only the tops are clipped off. Clipping is done, with a binder, a header, a windrower, or a mower equipped with attachments to raise the cutter bar the required distance from the ground.

TABLE 16.—*Sweetclover seed: Acreage harvested, yield per acre, and total production, by States, 1929–31*

State	Acreage			Yield per acre			Production		
	1929	1930	1931	1929	1930	1931	1929	1930	1931
	Acres	*Acres*	*Acres*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*
Ohio	6,000	4,000	5,000	2.5	2.9	2.4	15,000	11,600	12,000
Indiana	2,000	2,000	2,000	3.0	3.0	3.0	6,000	6,000	6,000
Illinois	17,000	14,000	13,000	3.5	3.3	2.6	59,500	46,200	33,800
Wisconsin		5,000	1,600		4.5	3.7		22,500	5,900
Minnesota	53,000	32,000	41,000	4.5	4.5	5.0	238,500	144,000	205,000
Iowa	8,000	10,000	10,000	3.0	3.9	3.5	24,000	39,000	35,000
Missouri	8,000	2,000	2,000	3.0	3.0	3.0	24,000	6,000	6,000
North Dakota	80,500	64,000	70,000	4.6	3.8	3.0	370,300	243,200	210,000
South Dakota	60,000	43,000	59,000	4.3	3.7	2.4	258,000	159,100	141,600
Nebraska	18,000	16,200	24,000	4.3	4.2	4.4	77,400	68,000	105,600
Kansas	14,000	18,000	14,000	3.9	3.9	3.7	54,600	70,200	51,800
Montana	5,000	5,000	2,500	4.0	3.0	3.0	20,000	15,000	7,500
Colorado	4,000	3,500	3,500	5.0	5.0	5.0	20,000	17,500	17,500
United States	275,500	218,700	247,600	4.24	3.88	3.38	1,167,300	848,300	837,700

Crops and Markets, December 1932.

A comparatively thin stand is desirable for seed production. The plants are inclined to branch more, are not so tall, are more easily harvested, and usually are more heavily set with seed, than when the stand is thick. In some of the drier sections seed producers make a practice of disking their sweetclover fields in the spring to conserve moisture, and to thin out some of the plants where the stand is thick.

HARVESTING THE SEED

Special machines for harvesting sweetclover seed are not manufactured, and the crop usually is harvested with such equipment as is found on the farm. The bulk of the crop is harvested with ordinary grain binders (table 17). Some farmers have binders equipped with pans to catch the seed that shatters off in harvesting.

TABLE 17.—*Sweetclover seed: Acreage harvested, yield per acre, and production on 85 farms, by method of harvesting, 1930*

Method of harvesting	Farms reporting	Acreage harvested	Yield per acre	Production
	Number	*Acres*	*Bushels*	*Bushels*
Grain binder	55	1,565	4.77	7,463
Combine	14	371	2.71	1,006
Header or windrower	8	208	2.92	608
Beater	8	156	1.92	299

Several practices were in vogue where the crop was harvested with grain binders. If the crop was to be threshed within a week or 10 days after harvest some followed the practice of letting the bundles lie untouched on the stubble until ready to thresh; others set the bundles up in shocks like grain and threshed from the shock. When it was impracticable to thresh within 10 days the usual practice was to stack the bundles and let them go through a sweat before being threshed. To minimize the loss of seed from shattering, many were using tractor-drawn binders and cutting from midnight until after the dew was off in the morning. Farmers who were obtaining the highest yields were following this method of cutting, and then putting the bundles in small stacks. These stacks were built by placing 3 or 4 bundles flat on the stubble and building a stack about 5 or 6 feet high on these bundles. Seed that shatters off collects on the lower bundles; there is a minimum loss when this practice is followed.

Harvesting with a straight combine was not generally reported as satisfactory. A combine works best when the crop is dry and at that time there is heavy loss of seed from shattering. If harvesting is done at a time suitable for saving the most seed, a considerable quantity of leaves, broken stems, and immature seed will be mixed with the ripe seed. Considerable labor is likely to be required in drying to prevent the seed from heating and spoiling, and in cleaning the seed after it is dried out.

Harvesting with a header and with a windrower are grouped together because both the quality of seed and the yields obtained by these methods were about the same. Where sweetclover was harvested with a header, it was usually put in shocks, one header-box load in each shock, and was later threshed. By this method the sweetclover cures out readily, and the shocks may be placed close together to facilitate threshing. When cut with a windrower, the clover cures out quickly and is threshed with a pick-up and combine.

On eight farms beaters, made from old grain binders, were used for harvesting seed. The advantages of this method are that practically all the seed gathered are mature and that it eliminates the cash outlay for twine and threshing and the labor of shocking and stacking. Disadvantages are the lower yield and the labor required for spreading the seed out to cure in order to prevent heating and spoiling brought about by the presence of green leaves, broken stems, and other trash collected with the seed.

YIELDS OF SEED

Yields of sweetclover seed vary widely, depending on the method of handling the crop prior to harvest, weather conditions, time of harvesting, and method of harvesting. Where the growth is permitted

to become overrank and is harvested with a binder, or where the crop is cut during the heat of the day when the stalks are dry and brittle, a large percentage of seed frequently is lost by shattering.

Sweetclover matures its seed over a considerable period. Both green and ripe seed are found on the plant from the time the first seed ripen until the plant is fully mature. To obtain maximum yields the most favorable time to harvest the crop is when from one half to two thirds of the seed pods are brown. This period is usually only a few days in length, and delay in harvesting, due to unfavorable weather, press of other work, or other circumstances, is likely to materially reduce the yield.

Data from 94 farms on which 2,443 acres were harvested for seed show an average yield of 4.03 bushels per acre (table 18). This is slightly above the average yield for the United States for 1930. A wide variation in yield was reported from different farms, the range being from 1 to 18 bushels. The high yields reported on the 2 Montana and 3 Wyoming farms are considerably above the average and are mainly due to the highly effective harvesting practices followed on these farms. A larger sample from these States would undoubtedly show a considerably lower average yield.

TABLE 18.—*Sweetclover seed: Acreage harvested, yield per acre, and production on 94 farms, by States, 1930*

State	Farms reporting	Acreage harvested	Yield per acre	Production
	Number	*Acres*	*Bushels*	*Bushels*
North Dakota	7	677.5	4.71	3,193
South Dakota	9	262.0	3.29	861
Montana	2	37.5	11.20	420
Wyoming	3	29.5	10.71	316
Nebraska	15	209.0	3.13	655
Colorado	9	307.0	4.42	1,357
Kansas	28	488.0	3.27	1,596
Oklahoma	19	419.5	3.35	1,406
Texas	2	13.0	2.54	33
Total	94	2,443.0	4.03	9,837

YIELDS BY VARIETIES

Yields of the shorter growing varieties, biennial yellow and Grundy County white, usually average higher than those of the common white biennial, probably because the larger growth of the latter is more difficult to handle and a larger proportion of the seed is lost in harvesting. If the crop is pastured down in the spring, or is clipped to prevent the growth from becoming too tall, the yield of seed of biennial white is usually equal to that of the smaller growing sorts.

Of the 94 farms from which data on 1930 yields of seed were obtained, 71 were growing white biennial, 18 were growing biennial yellow, 4 were growing Grundy County white, and 1 was growing Hubam (table 19). These data show biennial yellow producing the highest yield per acre; Grundy County white, next; and biennial white was third. A yield of 3.28 bushels per acre was reported for Hubam.

That comparatively higher yields were reported for biennial white in North Dakota was probably due to the fact that much of the supposedly biennial white grown in this State in reality was a mixture of biennial white and Grundy County white, with the latter predominating in many instances. Farmers who prefer the biennial white complain of inability to procure unmixed seed of this sort.

TABLE 19.—*Sweetclover seed: Acreage harvested, yield per acre, and production on 93 farms, by States and by variety, 1930*

State	Farms reporting	Acreage harvested	Yield per acre	Production
		WHITE BIENNIAL		
	Number	*Acres*	*Bushels*	*Bushels*
North Dakota	2	320.0	5.10	1,633
South Dakota	7	202.0	3.01	608
Montana	2	37.5	11.20	420
Wyoming	1	7.5	7.33	55
Nebraska	11	161.0	2.70	434
Colorado	1	35.0	2.86	100
Kansas	26	438.0	3.39	1,486
Oklahoma	19	419.5	3.35	1,406
Texas	2	13.0	2.54	33
Total or average	71	1,633.5	3.78	6,175
		YELLOW BIENNIAL		
North Dakota	2	77.5	4.99	387
Wyoming	2	22.0	11.86	261
Nebraska	4	48.0	4.60	221
Colorado	8	272.0	4.62	1,257
Kansas	2	50.0	2.20	110
Total or average	18	469.5	4.76	2,236
		GRUNDY COUNTY WHITE		
North Dakota	3	280.0	4.19	1,173
South Dakota	1	20.0	6.00	120
Total or average	4	300.0	4.31	1,293

THRESHING

The bulk of the sweetclover seed crop in the Great Plains States is threshed with ordinary grain separators, equipped with special clover screens or huller attachment. In a few localities regular clover hullers are used, and where the crop is harvested with a windrower, the threshing is done with a pick-up and combine.

There appears to be little or no uniformity in the charge for threshing, the rates varying from 50 cents to $1 per bushel. In some localities the rate varies according to the yield of seed per acre and the size of the job.

SWEETCLOVER FOR SOIL IMPROVEMENT

One of the important functions of sweetclover in the more humid areas and in irrigated sections of the Great Plains is to increase and maintain soil fertility. It is less important for this purpose in the newer farming areas and in dry-farming sections where depletion of soil fertility is less rapid, or where moisture conditions make impracticable the use of green manures.

Considered from a soil-improvement standpoint, the uses of sweetclover are manifold. It appears to increase soil fertility more rapidly and more effectively than any other legume; it will materially improve the physical condition of heavy clays, "gumbos", and soils that have a tight, impervious subsoil; and it will grow on many soils that are too wet, or too deficient in fertility, or too alkaline, to produce other crops.

Sweetclover is unexcelled as a soil-improvement crop and will quickly restore fertility to soils that are unproductive because of a

deficiency of organic matter or nitrogen. Experiments in Ohio show that a single crop of sweetclover contains from 75 to 250 pounds of nitrogen per acre, and when plowed under, it returns approximately as much nitrogen to the soil as 20 tons of barnyard manure (*9*). Besides adding organic matter and nitrogen to the soil, the deeply penetrating roots enable the plants to draw upon relatively insoluble forms of phosphorus, potash, and lime in the subsoil, and when the crop is plowed under, these elements of fertility are left in the soil in a form readily utilized by subsequent crops.

The crop is not generally used for green manure in the Great Plains except in the irrigated sections and under favorable conditions in some of the more humid sections in the eastern part of the area. Sweetclover draws heavily on soil moisture after it starts growth the second year, and if it is plowed under for green manure, the succeeding crop is likely to suffer for moisture unless conditions are exceptionally favorable. Although it is used to some extent as a green manure in the more humid sections, it is more commonly grown in various rotations and used for pasture, cut for hay, harvested for seed, or plowed under in June or July; then the land is summer-fallowed. In the drier sections it is frequently grown about once in 5 or 6 years as a pasture or hay crop in rotation with small grains. When grown under semi-arid conditions, it is generally utilized for pasture or hay, and the same land is seeded to the crop as long as possible.

The physical condition of heavy soils is greatly improved by growing and turning under sweetclover. The increased supply of organic matter renders heavy clay and gumbo soils less tenacious and more easily worked. The large, fleshy roots penetrate deeply, tending to break up tight, impervious subsoils and thus improve drainage and aeration. This combination of increased organic matter and improved drainage increases the ability of the soil to absorb and retain moisture and decreases the amount of run-off from heavy rains. This is an important consideration in many sections in which considerable sheet erosion occurs and moisture is lost through inability of the soil to absorb heavy precipitation.

Many areas of poor and unproductive land, when seeded to sweetclover provide considerable grazing, and eventually become sufficiently fertile to produce satisfactory yields of other crops. Sweetclover will grow on land too strongly alkaline for other crops and in time will reduce the alkalinity to a point at which alfalfa and grain crops may be grown.

INCREASING CROP YIELDS

Where moisture conditions are favorable, yields of practically all crops that follow sweetclover are likely to be increased; but in dry years and in sections that have a low annual precipitation the reverse is frequently true. Where there is a shortage of moisture the first crop that follows sweetclover is likely to yield no better, or may even be below the average; but the second crop usually more than makes up for any decrease in the yield of the first crop. For example: Where it is the practice to follow a crop of sweetclover with two successive crops of corn, it frequently happens that the first crop of corn will show a yield below the average, whereas the second crop will yield from 25 to 100 percent above the average.

As a rule farmers do not keep accurate record of crop yields in the individual fields; hence, it is not always possible to obtain data from

which increases or decreases in production resulting from certain practices may be determined. With the exception of those in some of the drier sections, a large majority of the farmers interviewed in this study reported that, in the long run, practically all crops yield better if sweetclover is included in the cropping system. However, only 156 of the 500 farmers interviewed were able to give accurate figures on yields of crops following sweetclover as compared with yields from land on which no sweetclover had been grown. Many of those from whom data were obtained were led to record the comparative yields because of the striking difference that was evident, whereas in instances in which the difference in yield was less apparent no record had been kept. For this reason the data obtained are probably more nearly representative of maximum than of average increases.

On many of the farms sweetclover had been seeded on land that originally was highly productive but that had been reduced to a relatively low level of productivity by long-continued cropping with corn or small grain. The increase in yields of corn or wheat following sweetclover on such land was proportionately much greater than that obtained on land in a relatively high state of productivity.

No data were obtainable which would indicate to what degree, if any, yields of crops following sweetclover were decreased because of the exhaustion of soil moisture or other conditions resulting from the use of sweetclover.

CORN

Data were obtained from 57 farms on which records had been kept with respect to corn yields following sweetclover as compared with yields on land on which no sweetclover had been grown (table 20). As four of the Nebraska farms were irrigated, data from these farms are tabulated separately. From the number of records obtainable, it is evident that cropping systems in which corn follows sweetclover in the rotation are more common in Nebraska and Kansas than in other Great Plains States. The fact that the largest increase per acre was reported from the irrigated farms is indicative of the importance of an ample supply of moisture if best results from the use of sweetclover are to be realized.

TABLE 20.—*Effect of sweetclover on corn yields, by States*

State	Farms reporting	Average yield of corn—		Increased yield per acre due to sweetclover	
		After sweetclover	No sweetclover		
	Number	*Bushels*	*Bushels*	*Bushels*	*Percent*
South Dakota	3	55.0	37.0	18.0	48.6
Nebraska	25	45.0	27.7	17.3	62.5
Nebraska (irrigated land)	4	60.8	38.2	22.6	59.2
Kansas	21	46.5	27.0	19.5	72.2
Oklahoma	4	45.0	32.5	12.5	38.5
Average	57	47.1	29.0	18.1	62.4

The relatively high percentage of increase in Nebraska and Kansas was partly due to exceptionally favorable moisture conditions in the western corn-producing sections of these States in 1930. Moreover, on several of the Kansas farms a longer period of cropping to corn

and small grain had resulted in greater depletion of soil fertility before sweetclover was used.

It was the consensus of opinion that corn following sweetclover matured better, contained a smaller percentage of soft corn, and generally was of better quality than were corn crops not following sweetclover.

WHEAT

That yields of wheat are materially increased by the use of sweetclover in the cropping system is indicated by data obtained from 32 farms (table 21). With the exception of the one farm in Wyoming all were located in the hard winter wheat belt, a majority being in south-central and western Kansas.

TABLE 21.—*Effect of sweetclover on wheat yields, by States*

State	Farms reporting	Average yield of wheat—		Increased yield per acre due to sweetclover	
		After sweetclover	No sweetclover		
	Number	*Bushels*	*Bushels*	*Bushels*	*Percent*
Wyoming	1	52.0	35.00	17.00	48.6
Kansas	25	26.78	14.27	12.51	87.7
Oklahoma	5	25.60	11.60	14.00	120.6
Texas	1	35.00	20.00	15.00	75.0
Average		27.6	14.7	12.9	87.8

In practically all instances the sweetclover was used for pasture, or cut for hay or seed the second year, or allowed to mature before being plowed under. On several of the farms the sweetclover had been seeded on badly depleted land and allowed to remain for 3 to 4 years before being plowed under. This practice usually resulted in a greater proportionate increase in yield than when the sweetclover was seeded on fairly productive land.

An outstanding example of the residual effect of sweetclover as a means of increasing wheat yields is indicated in a 3-year demonstration conducted by the county agricultural agent in Sumner County, Kans., (table 22). Fifteen farms were selected for this demonstration. On these farms part of the land seeded to wheat in the fall of 1927 had been in sweetclover for 2 or more years, and part had been in wheat for 1 or more years.

TABLE 22.—*Residual effect of sweetclover on wheat yields: 3 years of continuous wheat following sweetclover compared with continuous wheat with no sweetclover, Sumner County, Kans.*

Year	Farms reporting	Yield per acre, continuous wheat	After sweetclover		Increased yield per acre	
			Period	Yield per acre		
	Number	*Bushels*	*Years*	*Bushels*	*Bushels*	*Percent*
1928	15	14.20	1	22.60	8.40	59
1929	14	5.58	2	9.40	3.82	68
1930	3	11.42	3	19.24	7.82	68
Average		10.17	3	16.51	6.34	62

In 1929 one farm dropped out of the demonstration. This was a poor wheat year. In 1930, owing to shifts in cropping systems, all but three farms discontinued the demonstration. Although the increased yield in bushels ranged from 3.82 to 8.4, the percentage increase was more uniform and remained constant the second and third years.

OATS

Planting oats immediately following a crop of sweetclover is not as common a practice as planting wheat, but where this practice was followed yields were increased in about the same proportion as were wheat yields. Data obtained from 20 farms show an average increase of 28.2 bushels per acre or 97 percent.

SUGAR BEETS

In irrigated sections of the Great Plains sweetclover is used effectively as a means of increasing yields of sugar beets. Many farmers are using it regularly in their cropping systems and find that one crop of sweetclover pastured through the second year has approximately the same fertilizing value as 4 years of alfalfa. When sweetclover is used in a sugar-beet rotation, it is usually pastured the second year and is seldom plowed under green. Data were obtained from 17 irrigated farms on which yields of sugar beets grown after sweetclover are compared with those of beets grown after other crops (table 23). On several farms on which sugar beets were grown as the second crop after sweetclover, the average gain in yield was approximately 20 percent. Even better results were obtained at the Scotts Bluff Experiment Station, Mitchell, Nebr., where a yield of 21.2 tons of sugar beets was obtained following second-year sweetclover that had been pastured, as compared with 19.3 tons following alfalfa, and 12.1 tons in the check field where no sweetclover had been grown (*3*). In this experiment the yield of beets following sweet clover was 75 percent greater than the yield on the check field, and nearly 8 percent more than when beets followed alfalfa.

TABLE 23.—*Effect of sweetclover on sugar-beet yields, by States*

State	Farms reporting	Average yield of sugar beets		Increased yield per acre due to sweetclover	
		After sweetclover	No sweetclover		
	Number	*Tons*	*Tons*	*Tons*	*Percent*
Wyoming	2	22.25	16.25	6.00	36.9
Nebraska	6	17.5	12.75	4.75	37.3
Colorado	7	18.9	14.10	4.80	34.0
Montana	2	21.0	15.00	6.00	40.0
Average		19.05	13.98	5.06	36.2

POTATOES

Sweetclover is eminently satisfactory as a fertilizing crop for potatoes on both irrigated and nonirrigated farms. It is used as a green manure or is allowed to go through the second year before being plowed under. If the latter practice is followed, the crop is sometimes used for pasture and sometimes plowed under just before making seed or when it is approximately at its maximum growth.

Records from 24 irrigated farms show that the use of sweetclover increased yields of potatoes from 55 to 122 bushels per acre (table 24). The Wyoming and Nebraska records are all from the North Platte Valley, where the usual practice is to plow under the second-year crop of sweetclover for green manure during the latter part of May. Of the 15 Colorado records, 12 are from the San Luis Valley, where sweetclover usually is pastured through the second year, or allowed to reach approximately its maximum growth before being plowed under (fig. 5). Two of the eleven growers who qualified for Colorado's "600-bushel Potato Club" in 1929 used only sweetclover for fertilizer; they produced yields of 646 and 631.4 bushels per acre respectively (*6*). As a rule the largest yields of potatoes are obtained when a

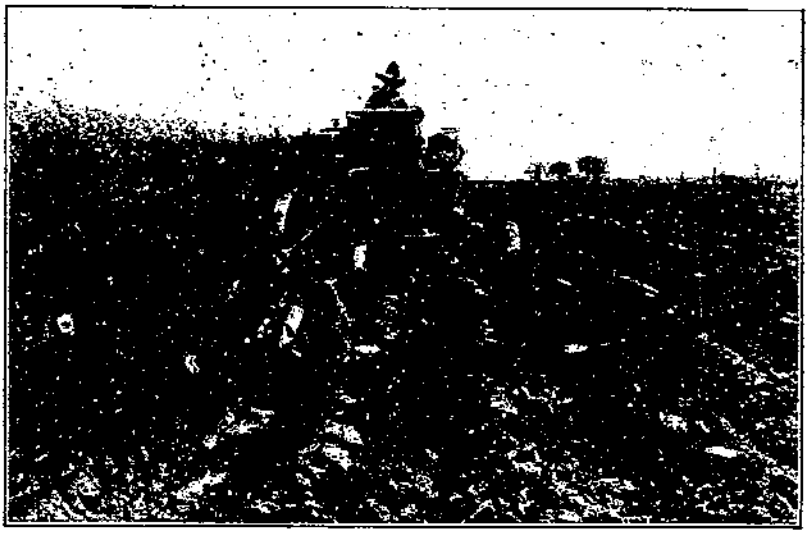

FIGURE 5.—In the San Luis Valley, Colo., yields of 300 to 600 bushels of potatoes are obtained by plowing under a heavy growth of sweetclover.

4-year or a 5-year crop of alfalfa is plowed under, but growers generally are agreed that potatoes are grown with less labor after sweetclover than after alfalfa, and that they are smoother, more uniform in size, have a smaller percentage of hollow heart, and have better keeping qualities than when grown after alfalfa or other crops.

TABLE 24.—*Effect of sweetclover on potato yields in 3 States*

State	Farms reporting	Average yield of potatoes		Increased yield per acre due to sweetclover	
		After sweetclover	No sweetclover		
	Number	*Bushels*	*Bushels*	*Bushels*	*Percent*
Wyoming	2	270.00	215.00	55.00	25.6
Nebraska	7	267.80	171.40	96.40	56.2
Colorado	15	341.00	219.00	122.00	55.7
Average		313.73	204.78	108.95	53.2

[1]

COTTON

Data were obtained from six farms on which cotton was grown after sweetclover. On these farms the average yield of cotton following sweetclover was 320 pounds of lint per acre, as compared with a yield of 170 pounds per acre in the check fields. This is an increase of 150 pounds per acre, or a gain of 88 percent resulting from the use of sweetclover. Since on some farms the yield of cotton following sweetclover was compared with the yield obtained from a field far more productive than was the sweetclover field prior to being seeded to this crop, the actual gain in some instances may have been greater than indicated in the above figures.

On none of the farms from which data were obtained was sweetclover grown in regular rotation with other crops. In most instances it was sown on land that had been badly depleted by continuous cropping, and was used for pasture, or left unmolested and allowed to reseed for 3 to 4 years. For example: On one Oklahoma farm a 10-acre tract, which produced but one fourth bale of cotton to the acre, was seeded to sweetclover, which was allowed to reseed and occupy the land for 4 years. The land was then planted to cotton and produced a bale to the acre. The sample obtained is too small to permit its use as a basis of definite conclusions, but it serves to indicate the possibility of economically increasing cotton yields in those sections in which sweetclover can be grown.

SWEETCLOVER IN GREAT PLAINS CROPPING SYSTEMS

The place that sweetclover occupies in the organization of Great Plains farms depends on the type of farming and on prevailing moisture conditions. The crop is adaptable to a wide range of soil and climatic conditions and can be fitted into almost any cropping system common to those sections in which a rotation of crops is practicable. In the more humid eastern portion of the area and in the irrigated sections in which a more or less diversified system of farming is followed, it is usually grown in regular rotation with other crops. In sections in which the rainfall is limited or uncertain it is more commonly grown for pasture for several years on the same land, and is shifted to another part of the farm only when a satisfactory stand can no longer be maintained; or it is grown once every 4 to 7 years in rotation with small grain.

The relation of the acreage of sweetclover to the total farm acreage and the percentage of sweetclover acreage used for different purposes on 401 farms is shown in table 25. The groupings in this table are based partly on crop production and practices, and partly on rainfall, with allowance for evaporation of soil moisture. For example: The first group includes the more humid eastern parts of North Dakota, South Dakota, Nebraska, and Kansas, areas in which, for the most part, corn is of outstanding importance and production practices are more or less similar. The Dakota areas have an average annual precipitation of 20 to 25 inches, with a relatively low rate of evaporation, while the Nebraska and Kansas areas have an average annual rainfall of 25 to 35 inches but a considerably higher rate of evaporation.

TABLE 25.—*Relation of acreage in sweetclover to total acreage in farms, and percentage of sweetclover used for pasture, hay, seed, and soil improvement on 401 farms in the Great Plains*

Area	Farms reporting	Land in farms		Acreage in sweetclover		
		Total	Average	Total	Average per farm	Percentage of farm area
	Number	*Acres*	*Acres*	*Acres*	*Acres*	
Eastern North Dakota	46	29,621	643.9	3,996	86.9	13.5
Eastern South Dakota	22	8,967	407.6	1,063	48.3	11.9
Eastern Nebraska	13	4,823	371.0	703	54.1	14.6
Eastern Kansas	20	5,182	259.1	803	40.2	15.5
Total or average	101	48,593	481.1	6,565	65.0	13.5
Central North Dakota	18	14,635	814.2	1,432	79.6	9.8
Central South Dakota	6	4,860	810.0	208	34.7	4.3
South central Nebraska	17	5,035	296.2	479	28.2	9.5
North central Kansas	15	6,650	443.3	378	25.2	5.7
South central Kansas	34	14,017	412.3	993	29.2	7.1
North central Oklahoma	15	5,385	359.0	478	31.9	8.9
Total or average	105	50,602	481.9	3,968	37.8	7.8
Western North Dakota	10	6,610	661.0	450	45.0	6.8
Eastern Montana	15	11,330	755.3	818	54.5	7.2
Central Montana	20	10,123	506.2	849	42.4	8.4
Eastern Wyoming	9	3,420	380.0	251	27.9	7.3
Western Nebraska	7	3,102	443.1	175	25.0	5.6
Northeastern Colorado	10	5,404	540.4	348	34.8	6.4
Central Colorado	5	3,960	792.0	142	28.4	3.6
Western Kansas	18	9,120	506.7	465	25.8	5.1
Northwestern Oklahoma	7	3,120	445.7	344	49.1	11.0
South central and southwestern Oklahoma	15	3,328	221.9	461	30.7	13.9
North Texas	9	3,068	340.9	341	37.9	11.1
North central Texas	3	399	133.0	18	6.0	4.5
Total or average	128	62,984	492.1	4,662	36.4	7.4
Montana, irrigated	6	1,187	237.4	203	40.6	17.1
Wyoming, do	11	2,902	263.8	373	33.9	12.9
Western Nebraska, do	18	4,166	231.4	600	33.3	14.4
Northeastern Colorado, do	15	4,074	271.6	503	33.5	12.3
San Luis Valley, Colo., do	18	6,861	381.2	1,414	78.6	20.6
Total or average	67	19,190	286.4	3,003	46.2	16.1

There is considerable variation between the different sections in each group as regards the acreage of sweetclover per farm, but for the most part the percentage of the farm area in this crop is comparatively uniform within each group. The fact that sweetclover is more generally used in the regular cropping systems in the more humid eastern sections and in the irrigated sections is indicated in the rather striking uniformity between these groups in the percentage of farm land in this crop. Also, there is considerable uniformity between these two groups in the percentage of the sweetclover acreage used for different purposes.

Sweetclover is not well adapted for use as a green manure in the Great Plains except on irrigated farms and in some of the more humid sections where moisture conditions are exceptionally favorable. The second-year crop draws heavily on subsoil moisture, and unless it is plowed under soon after it starts growth in the spring the succeeding crop is likely to suffer from lack of moisture. The plant contains approximately its maximum quantity of nitrogen when it is from 20 to 24 inches tall, but if allowed to attain this height before it is plowed under it is likely to have so exhausted the soil moisture that difficulty is encountered in preparing a satisfactory seed bed for the crop that

TABLE 25.—*Relation of acreage in sweetclover to total acreage in farms, and percentage of sweetclover used for pasture, hay, seed, and soil improvement on 401 farms in the Great Plains*—Continued

Area	Utilization of sweetclover [1]							
	Pasture		Hay		Seed		Soil improvement	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Eastern North Dakota	40	44.4	33	36.7	7	7.8	10	11.1
Eastern South Dakota	22	37.9	11	19.0	12	20.7	13	22.4
Eastern Nebraska	37	67.3			4	7.3	14	25.4
Eastern Kansas	14	28.0	10	20.0	6	12.0	20	40.0
Total or average	113	44.7	54	21.3	29	11.5	57	22.5
Central North Dakota	44	51.2	30	34.9	2	2.3	10	11.6
Central South Dakota	26	50.0	15	28.9	6	11.5	5	9.6
South central Nebraska	19	46.3	5	12.2	5	12.2	12	29.3
North central Kansas	21	58.3	8	22.2	7	19.5		
South central Kansas	16	43.3			10	27.0	11	29.7
North central Oklahoma	25	61.0			14	34.1	2	4.9
Total or average	151	51.5	58	19.8	44	15.0	40	13.7
Western North Dakota	35	77.8	9	20.0			1	2.2
Eastern Montana	20	36.4	30	54.5	2	3.6	3	5.5
Central Montana	32	50.1	20	35.1	5	8.8		
Eastern Wyoming	18	58.1	8	25.8	5	16.1		
Western Nebraska	15	46.9	14	43.7	3	9.4		
Northeastern Colorado	20	46.5	17	39.5	6	14.0		
Central Colorado	28	73.7			10	26.3		
Western Kansas	24	77.4			6	19.4	1	3.2
Northwestern Oklahoma	26	50.0	16	30.8	9	17.3	1	1.9
South central and southwestern Oklahoma	28	87.5	1	3.1	3	9.4		
North Texas	37	74.0	10	20.0	2	4.0	1	2.0
North central Texas	6	100.0						
Total or average	289	61.2	125	26.5	51	10.8	7	1.5
Montana, irrigated	6	14.0	35	81.4	2	4.6		
Wyoming, do	12	34.3	6	17.1	2	5.7	15	42.9
Western Nebraska, do	9	20.0	20	44.4			16	35.6
Northeastern Colorado, do	18	51.4	2	5.7	7	20.0	8	22.9
San Luis Valley, Colo., do	28	33.3	24	28.6	9	10.7	23	27.4
Total or average	73	30.2	87	35.9	20	8.3	62	25.6

[1] Totals of average acreage of sweetclover used for different purposes do not check with average acreage per farm because in most instances the acreage harvested for seed was also pastured or cut for hay.

is to follow. Moreover, if a large growth is plowed under in dry weather it may not readily decay and is likely to form a layer of dry vegetable matter underneath the furrow slice, thus destroying capillarity and rendering the surface soil incapable of drawing on the supply of subsoil moisture.

CROPPING SYSTEMS FOR CORN AND SMALL-GRAIN FARMS

In the more important corn-producing sections of southeastern South Dakota, eastern Nebraska, and eastern Kansas, sweetclover has come into general use as a part of the regular cropping system. Usually it is seeded with small grain in the spring and is either used as a green manure or allowed to go through the second year, when it is used for pasture or harvested for seed. Where moisture conditions are favorable a common practice is to plow sweetclover under in the spring of the second year and follow with corn. This practice produces satisfactory results if the clover is plowed under by the time it reaches a height of 6 to 10 inches. At this stage the plants have not used up any considerable quantity of soil moisture; the

succulent top growth decays quickly, and little difficulty is encountered in preparing a satisfactory seed bed. Probably a more general practice, especially in southeastern Nebraska and eastern Kansas, is to cut the first year's crop for hay and utilize the second-year crop for pasture or seed, and follow with corn the next year. This method of handling the second-year crop is preferable to plowing it under green, in districts in which moisture conditions are likely to be unfavorable.

In this corn and small-grain section cropping systems in which sweetclover is grown once every 3 to 6 years are not uncommon. The length of the rotation period appears to be governed by the type of farming, by the fertility of the soil, and by the use that is made of sweetclover. The shorter rotations are more common in South Dakota and Nebraska, and on livestock and dairy farms on which pasture and forage needs are greatest. All rotations are subject to various changes and modifications to suit special conditions existing in a locality or on an individual farm. The longer the rotation period the greater the number of possible crop combinations.

THREE-YEAR ROTATIONS

Three-year cropping systems are confined largely to the smaller farms on which some phase of livestock production is important and on which an abundant supply of forage and feed grain is required. The following system is probably one of the most common:

First year	Corn.
Second year	Small grain—oats, barley, or wheat—seeded to sweetclover.
Third year	Sweetclover.

When this system is used in the Dakotas and in northeastern Nebraska it is the usual practice to pasture part of the second-year crop of sweetclover and cut part for hay. With proper management two cuttings of hay can be obtained. Under favorable conditions the new seeding of sweetclover may be pastured lightly for 3 to 4 weeks late in the fall. In southeastern Nebraska and eastern Kansas, where the first-year growth of sweetclover is larger, it is a common practice to harvest this crop for hay and pasture the second-year crop. In fertile sections and on farms on which the pasture and hay requirements are limited, it is the practice of some farmers to plow under the second-year growth early in May and follow with two successive crops of corn.

FOUR-YEAR ROTATIONS

A 4-year rotation common to a considerable portion of this area is as follows:

First year	Corn.
Second year	Corn.
Third year	Small grain—oats, barley, or wheat—seeded to sweetclover.
Fourth year	Sweetclover for pasture or seed.

Modifications of this cropping system are varied and numerous. On some of the more fertile farms 3 successive crops of corn are grown after a crop of sweetclover has been plowed under for green manure. On other farms a crop of sweetclover plowed under for green manure

is followed by 2 crops of corn, which in turn are followed by 2 crops of small grain. On still others a crop of corn following sweetclover pasture is followed by 2 small-grain crops. On one of the better-than-average farms in northeastern Kansas the rotation was:

First year	Corn.
Second year	Corn.
Third year	Oats, seeded to sweet clover.
Fourth year	Wheat, seeded to sweetclover.

In this system the sweetclover seeded in oats is plowed under in August and the land sown to wheat, and the sweetclover seeded in the wheat is cut for hay in the fall and plowed under early the following spring for corn. Thus two crops of sweetclover are plowed under in 4 years.

FIVE-YEAR ROTATIONS

Five-year rotations are more common in southeastern Nebraska and eastern Kansas, the one which appeared to be in most general use being:

First year	Corn
Second year	Corn.
Third year	Small grain.
Fourth year	Oats, seeded to sweetclover.
Fifth year	Sweetclover for pasture and seed.

Where this system is followed it is the usual practice to cut the first-year crop of sweetclover late in the fall for hay. The second-year crop is pastured off, or pastured until the last of June or first of July and then left to mature seed. The sweetclover stubble is usually plowed under in the fall.

Several variations of this cropping system were noted. On some farms in southeastern Kansas, kafir—because of its drought-resistant qualities—is substituted for corn for the first crop following sweetclover. On other farms soybeans are substituted for all or a part of the second crop of corn. Another 5-year rotation that has some advantages is:

First year	Corn.
Second year	Corn.
Third year	Oats, seeded to sweetclover.
Fourth year	Sweetclover for pasture and seed.
Fifth year	Wheat, seeded to sweetclover.

In this system both corn and wheat obtain direct benefits from a crop of sweetclover—corn from a crop plowed under green and wheat from a crop that has been pastured off or harvested for seed. Yields of wheat are said to be increased 10 to 15 bushels per acre by this system. Only a light seeding of sweetclover is necessary in the wheat since there is considerable volunteering after the seed crop is taken off.

SIX-YEAR ROTATIONS

In general, 6-year rotations are similar to the 5-year cropping systems except for an additional year with corn or some other intertilled crop. One of the most common systems found in the better corn-producing areas is:

First year	Corn.
Second year	Corn.
Third year	Corn.
Fourth year	Oats, seeded to sweetclover.
Fifth year	Sweetclover for pasture and seed.
Sixth year	Wheat.

In this system the sweetclover seeded in oats provides a hay crop in the fall. A volunteer stand of sweetclover usually comes up in the wheat, and this is plowed under early the following spring for corn.

Another rotation which probably is more suitable for less productive soils or for drier areas is as follows:

First year	Corn.
Second year	Soybeans.
Third year	Small grain.
Fourth year	Wheat, seeded to sweetclover.
Fifth year	Sweetclover for pasture and seed.
Sixth year	Kafir.

This system provides for two legume crops in 6 years; soybeans preceding small grain and sweetclover ahead of kafir. Where conditions warrant, sweetclover may be seeded in the small grain and plowed under in August for wheat, thus adding another leguminous crop to the rotation. Kafir follows sweetclover pasture because it is more likely to succeed than is corn in years when soil moisture is depleted by the sweetclover. A similar rotation is recommended for southeastern Kansas by the Kansas State Agricultural College Extension Service (*10*).

CROPPING SYSTEMS FOR SMALL-GRAIN FARMS

Regular cropping systems are less common on small-grain farms than on farms on which intertilled crops predominate and a more diversified system of farming is practiced. Usually the crops are "changed about" but this is done more as a matter of convenience than with any thought of following a definite cropping system. However, many small-grain producers now include sweetclover as one of their regular crops and rely on it to provide pasture and forage, to assist in weed control, and to maintain soil fertility. This is especially true in the older farming sections in which yields have declined and weed problems have become more serious as a result of long-continued cropping with small grain.

On the larger farms the acreage of sweetclover needed is comparatively small, and many farmers follow the practice of seeding their least-productive land to this crop for 2 or more years and then shifting the crop to another part of the farm. In some instances a relatively short rotation which includes a crop of sweetclover is used on part of the farm, and when the rotation period has been completed the cropping system is shifted to other fields.

The practicability of using sweetclover in small-grain cropping systems varies widely between the northern and southern portions of the Great Plains, and largely depends on rainfall and the percentage of soil moisture lost by evaporation. Cropping systems in which sweetclover is used are in more general use in Dakota and Montana areas having an average annual precipitation of 15 to 20 inches and in which loss of moisture by evaporation is relatively slight, than in Kansas and Oklahoma sections which have an average annual rainfall of 20 to 25 inches but where a tremendous amount of moisture is lost by evaporation. Because of this difference between the two sections cropping systems for small-grain farms for the northern Great Plains and for the southern Great Plains will be considered separately.

On the Northern Great Plains

Because of more favorable soil and moisture conditions a more diversified system of farming is followed in the Red River Valley of North Dakota than in other parts of the northern Great Plains. In this section the usual cropping systems are those in which sweetclover occupies the land every 4 to 6 years, depending on the diversity of crops grown and the need for pasture and forage. In those sections in which potatoes are an important crop one of the usual rotations is as follows:

First year	Potatoes and corn.
Second year	Small grain—wheat, flax, or feed grains.
Third year	Feed grains, seeded to sweetclover.
Fourth year	Sweetclover for pasture, hay, or seed.

One modification of this system is to follow sweetclover with wheat and follow the wheat with corn and potatoes. Where a considerable acreage of sweetclover is grown it is a common practice to plow under part of the crop in June and summer-fallow the land the rest of the season. This is an excellent practice on farms on which sow thistles are troublesome.

On the more typical small-grain farms in the northern Great Plains it is practicable to have a crop of sweetclover on the land every 4 to 7 years, the frequency of its use being largely determined by variations in the supply of moisture. Definite cropping systems are the exception rather than the rule, and there is little uniformity in the order in which the various small-grain crops follow sweetclover, although probably wheat is used more than any other crop. It is impossible to designate a typical cropping system for this section, but one of the most common in the Dakotas and northeastern Montana, where the normal rainfall is between 15 and 20 inches, is as follows:

FOUR-YEAR ROTATION

First year	Wheat, or corn and wheat.
Second year	Wheat, or wheat and flax.
Third year	Feed grains, seeded to sweetclover.
Fourth year	Sweetclover for pasture, hay, or seed.

Practically all possible combinations of this system are to be found. On farms on which the need for pasture is limited it is the usual practice to plow under the second-year crop of sweetclover in June and summer-fallow the land for wheat. Others cut the second-year crop for hay, then plow immediately and summer-fallow.

Longer rotations, with a minimum of plowing to reduce the labor in preparing the seed bed and to lessen the danger of soil blowing, are the rule in some sections of Montana in which wheat is the principal crop. A 5-year rotation followed by a leading farmer, which appears to be well adapted to central Montana conditions, is as follows:

First year	Summer fallow.
Second year	Winter wheat.
Third year	Corn.
Fourth year	Spring wheat and oats, seeded to sweetclover.
Fifth year	Sweetclover for hay and pasture.

In this system the land is plowed but once in 5 years, that being for corn following winter wheat. Following sweetclover, the land is summer-fallowed with duck-foot cultivators; and following corn, the land is disked in preparation for spring wheat and oats. Corn is

grown for both fodder and grain, and the cultivation given this crop is considered the equivalent of summer-fallow in controlling weeds.

In a 6-year rotation in which the land is plowed but once the same sequence of crop is maintained except that oats are stubbled in after winter wheat. This allows for a larger acreage of spring wheat and more feed grains. A similar 6-year rotation in which the land is plowed twice is suggested by the Montana experiment station (*5*). This is as follows:

First year	Winter or spring wheat or flax in which sweetclover is seeded.
Second year	Sweetclover, for hay or pasture only.
Third year	Corn.
Fourth year	Spring wheat or flax.
Fifth year	Feed crops, such as oats cut for hay, stubbled in.
Sixth year	Summer fallow.

The land is plowed for corn following sweetclover, and for summer fallow following the year in feed crops. Under favorable conditions corn does exceptionally well after sweetclover, and the cultivation given tends to conserve moisture for the grain crops that follow.

On the Southern Great Plains

Cropping systems on small-grain farms in the southern Great Plains States are radically different from those found in the northern part of the area. This is largely owing to climatic conditions which call for different types of secondary crops and to different production practices. Because of moisture conditions corn is largely replaced by the more drought-resistant grain sorghums, and sweetclover usually is seeded alone instead of with a nurse crop. Sweetclover is used to some extent in cropping systems in central Kansas and north-central Oklahoma, but in the drier sections of eastern Colorado, the western third of Kansas, western Oklahoma, and northwestern Texas it rarely enters into any definite cropping system and is seldom grown except on low, moist land, or land that has been especially prepared for it.

In sections in which moisture conditions will warrant using sweetclover in a regular cropping system, a 5- year or a 6-year rotation appears to be more practicable than one of shorter duration. One of the most usual rotations found in the hard winter wheat section of central Kansas and north-central Oklahoma was as follows:

SIX-YEAR ROTATION

First year	Sweetclover, seeded alone.
Second year	Sweetclover, for pasture and seed.
Third year	Wheat or other small grain.
Fourth year	Wheat.
Fifth year	Grain sorghum.
Sixth year	Corn or grain sorghum.

In this system sweetclover is seeded alone on corn or grain-sorghum land. It usually makes considerable growth the first year and may be cut for hay in the fall. On many farms in this area sweetclover is replacing alfalfa as a hay crop. The second-year crop of sweetclover is pastured or cut for hay and the land is plowed in midsummer and prepared for wheat, or plowed in the fall and seeded to small grain the following spring. Many variations of this system were noted. On some farms sweetclover is seeded in spring grain, used for pasture and seed the second year, and followed with oats the next spring.

Usually a volunteer stand of sweetclover comes up in the oats; this is plowed under in June and the land is prepared for wheat. Another method is to seed sweetclover after wheat by burning off the wheat stubble and drilling the seed in without further preparation of the land.

On some of the straight grain farms sweetclover is seeded in wheat stubble and left for 2 or more years. It may be pastured, or harvested for seed, or left unmolested. The land is then brought back into cultivation and devoted to continuous wheat production for several years.

CROPPING SYSTEMS FOR IRRIGATED FARMS

Definite crop rotations are followed more regularly in the irrigated sections than in any other part of the Great Plains, and sweetclover is particularly well suited to most of the cropping systems in vogue on irrigated farms. Sweetclover usually is seeded with spring grain and is either plowed under for green manure or used for pasture or for hay. The place it occupies in the cropping system largely depends on the type of farming and the cultural requirements of the crops that follow it in the rotation.

Alfalfa is a crop of considerable importance on a majority of irrigated farms. Although used in relatively short rotations on some farms, it usually is left for 5 to 7 years, or as long as satisfactory yields are produced, and a regular cropping system which includes sweetclover is followed on the rest of the farm. When the alfalfa has to be plowed up a new field is seeded, and the crops are shifted to include the old alfalfa field in the regular cropping system.

In most irrigated sections of the Great Plains sugar beets and potatoes are the most important money crops. On some farms only one of these crops is grown, while on others both crops are of considerable importance. As land that is to be planted to sugar beets must be prepared early in the spring, it is seldom practicable to have beets follow a green-manuring crop. Potatoes, on the other hand, are planted much later and respond exceptionally well to the use of green-manuring crops where the latter can be plowed under early enough to permit of planting at the required time.

In the North Platte Valley in Nebraska, and in irrigated sections of northeastern Colorado, it is a common practice to use sweetclover as a green manure for potatoes. In Montana, in Wyoming, and in the San Luis Valley of Colorado, owing to the relatively short growing season, sweetclover is seldom used as a green manure but usually is pastured or cut for hay the second year and then followed with potatoes or sugar beets.

Cropping systems on Montana sugar-beet farms are varied, one of the most customary being as follows:

First year	Small grain, seeded to sweetclover.
Second year	Sweetclover for pasture or hay.
Third year	Sugar beets.
Fourth year	Sugar beets.

This system is sometimes extended over 5 to 6 years by including another crop of beets, or by following sweetclover with potatoes or beans and then growing two or more crops of beets before reseeding to sweetclover.

More or less similar cropping systems are followed in the North Platte Valley of Wyoming. In this section, however, several farmers were using 3-year rotations of which the following is a sample:

First year	Barley, seeded to sweetclover.
Second year	Sweetclover for pasture, hay, or seed.
Third year	Sugar beets and corn.

In some instances part of the sweetclover is plowed under green and followed with late barley or corn. This is particularly likely to be the case when a larger acreage is seeded than is needed for pasture and hay. Late barley is said to do especially well following a green-manuring crop of sweetclover.

Definite cropping systems appear to be in more general use in the North Platte Valley in Nebraska than in the irrigated sections of either Montana or Wyoming. Cropping systems vary widely in this section, depending upon soil and the relative importance of the major crops. Sweetclover usually is plowed under for green manure if it is to be followed with potatoes or beans, or is used for pasture if beets are to follow. When used for green manure the crop is irrigated about the middle of May, unless there has been ample rainfall, and is plowed under during the last of the month. Potato planting takes place the first week in June, and the sweetclover should be plowed under at least a week or 10 days before planting so that a satisfactory seed bed may be prepared. Where potatoes and beets are the major crops one of the usual cropping systems is:

First year	Barley, seeded to sweetclover.
Second year	Potatoes.
Third year	Sugar beets.
Fourth year	Sugar beets.

Where this system is followed it is the usual custom to irrigate the young seeding of sweetclover soon after the grain has been removed. This stimulates a rapid growth of the first-year clover crop, which is cut for hay late in the fall. On some farms beans instead of beets are used for the fourth year. When potatoes are not included, beans are usually grown as the first crop after sweetclover; and when neither potatoes nor beans are grown, the second-year crop of sweetclover is used for pasture and is followed with two or more successive crops of beets.

An extensive potato producer in the Scotts Bluff locality has adopted a 5-year cropping system in which potatoes and barley are alternated as follows:

First year	Barley, seeded to sweetclover.
Second year	Potatoes.
Third year	Barley, seeded to sweetclover.
Fourth year	Sweetclover for pasture.
Fifth year	Potatoes.

Potatoes are alternately grown after a green-manure crop of sweetclover and after a crop that is pastured through the second year by sheep and lambs. Slightly better yields are reported for the crop following green manure.

A leading bean grower in this locality uses the following 5-year rotation:

First year	Barley, seeded to sweetclover.
Second year	Beans.
Third year	Potatoes.
Fourth year	Beans.
Fifth year	Beans.

Three crops of beans and one of potatoes are grown after a crop of sweetclover has been plowed under for green manure. This man reports an average yield of 40 bushels per acre for each of the three bean crops. This is more than double the average yield for the county. Potato yields are said to average 300 bushels per acre.

In general, cropping systems in the irrigated sections of northeastern Colorado are quite similar to those in the North Platte Valley of Nebraska. In the potato sections this crop usually follows sweetclover that is plowed under green, and beets, potatoes, or corn follow sweet clover that has been pastured the second year. In some sections canning peas are of considerable importance. The simplest and probably the most common cropping system followed in this section is:

First year	Barley or canning peas, seeded to sweetclover.
Second year	Potatoes.
Third year	Sugar beets.
Fourth year	Sugar beets.

This system calls for a crop of sweetclover being plowed under green for potatoes. Where potatoes are not grown, some farmers plow under the first-year crop of sweetclover in September and plant the land to sugar beets the following spring; others plow under the second-year crop of sweetclover as soon as it starts growth in the spring and follow with beets. On some farms corn is grown as the first crop following sweetclover that has been pastured. For farms on which canning peas or field peas are of sufficient importance to occupy a regular place in the cropping system the following rotation is recommended by the Colorado extension service (*8*):

First year	Corn or potatoes.
Second year	Sugar beets.
Third year	Small grain.
Fourth year	Canning peas, seeded to sweetclover.
Fifth year	Sweetclover for pasture.

In recommending this system it is assumed that approximately one-sixth of the crop land is in alfalfa. When this is to be plowed up, a new field is seeded to alfalfa, and the rotation is shifted so that corn and potatoes follow the old alfalfa. The acreage of potatoes or beets can be increased by reducing the acreage of corn.

SWEETCLOVER IN THE SAN LUIS VALLEY

The San Luis Valley of Colorado is not in the Great Plains proper but is included in this study because sweetclover probably is more important and is used more effectively in this district than in any other district of the State. A rather unique agriculture has been developed in this valley. The soils are naturally deficient in organic matter and contain considerable alkali. Sweetclover corrects both these difficulties to a considerable degree. It has become a common practice to grow sweetclover as the first crop on raw land before planting to other crops, and then use this crop in the regular cropping system thereafter. The importance of sweetclover in this valley is indicated by the fact that on the farms studied an average of 78.6 acres per farm, or slightly more than one fifth of the total farm area, was in sweetclover. (See table 25.) Approximately one third of the acreage of sweetclover was used for pasture, and nearly as much was harvested for hay. The feeding of beef cattle and lambs are impor-

tant enterprises in this district; hence the need of abundant pasture and forage.

In general the cropping systems are simple and comparatively uniform. Three-year systems predominate, although on some farms 4-year and 5-year rotations are followed. The most common rotation practiced on the farms studied was as follows:

First year	Barley or peas, seeded to sweetclover.
Second year	Sweetclover for pasture, hay, or green manure.
Third year	Potatoes, or potatoes and sugar beets.

Barley and field peas are the principal grain crops. The second-year crop of sweetclover is used for pasture or hay, and the second growth is plowed under, or the first growth is plowed under as a green-manure crop about the time it begins to bloom, to be followed by potatoes or sugar beets. On some farms barley is followed by peas with sweetclover seeded in the latter crop, thus making a 4-year rotation. On other farms potatoes and then sugar beets follow sweetclover.

Alfalfa is an important crop in this district and usually is left to occupy the land for 4 to 6 years. When plowed up, it is followed by potatoes for 1 or 2 years, and then the regular rotation is continued.

DISADVANTAGES OF SWEETCLOVER

In spite of its many desirable qualities sweetclover has its disadvantages under certain conditions. The danger of bloat from pasturing sweetclover and the matter of sweetclover poisoning from feeding damaged sweetclover hay have been discussed.

In a few instances farmers reported some difficulty in getting cattle to graze sweetclover when turned on the crop for the first time. This is not generally considered a serious disadvantage, however, as cattle usually overcome their first dislike for the plant after a few days.

As sweetclover seed will remain viable for several years, when a crop has been allowed to mature seed some volunteering is likely to occur in succeeding crops on that land over a period of several years. This may not be particularly detrimental in general farming, but on farms on which seed of alfalfa, red clover, or millet is produced for market it is highly objectionable. This is particularly true in sections in which certified alfalfa seed is being produced.

Sweetclover plowed under late in the fall of the first year is not killed and usually volunteers from the crowns the following spring. This is a serious objection in many sections in which farmers prefer to fall-plow land that is to be occupied by corn or small grain the following year. Some farmers claim that if the first-year crop is plowed under about September 1 no difficulty will be encountered. This claim is substantiated by the Iowa Agricultural Experiment Station, where "* * * it was found that plowing September 1 was effective in killing practically all of the clover but at a great sacrifice in organic matter and nitrogen" (*2*).

Objection is sometimes raised to sweetclover volunteering on canal and ditch banks in irrigated sections. This is not a serious matter, however, since sweetclover is merely replacing various weeds which might become far more serious.

In dry-farming sections sweetclover is sometimes detrimental to the next succeeding crop because of its propensity for exhausting soil moisture, but this usually is more than offset by later benefits

if it is not grown too frequently on the same land. Farmers in the drier sections state that for most satisfactory results sweetclover should not occupy the land more frequently than once in 5 to 7 years.

Wild hay is an important crop on low, moist land in many sections of Nebraska and the Dakotas, and volunteer stands of sweetclover often become a nuisance in the native meadows. The second-year growth of sweetclover matures by the time the native grasses are ready to cut, and the rank, coarse, woody clover stems are highly objectionable in the native hay. Farmers who are confronted with this difficulty find that mowing their meadows early for several years tends to eradicate most of the sweetclover by preventing it from maturing seed.

SUMMARY

Because of its many uses and its adaptability to a wide range of soil and climatic conditions, sweetclover is better suited for use on Great Plains farms than are any of the true clovers. It is resistant to extremes of both temperature and moisture, and will thrive on most soils of the area. It will grow on land that is too wet, or too deficient in fertility, or too alkaline, to produce other crops successfully.

In the more humid sections and in irrigated sections sweetclover usually is seeded with a nurse crop of oats, barley, flax, or spring wheat in the northern part of the Great Plains, and with spring grain or in winter wheat in the southern sections. In the drier sections, seeding with a light seeding of grain, or without a nurse crop on clean, well-firmed land is more likely to result in obtaining and holding a stand.

Seeding costs are relatively low. Since the seeding usually is done with the regular farm equipment the only "cash cost" is for seed, and at present low prices the seed cost should not exceed 50 to 75 cents per acre. If the sweetclover is seeded with spring grain the amount of man labor and power used is negligible. Seeding alone on specially prepared land requires from 1 to 3.5 hours of man labor and from 4 to 7 hours of horse work per acre.

Sweetclover is an extremely valuable pasture crop and during the grazing season will carry more livestock to the acre than will any other pasture plant common to the area. It is pastured with all classes of livestock, but is more generally used for cattle and sheep. It noticeably increases the flow of milk and for this reason is especially valuable for milk cows and for ewes with lambs.

Cattle and sheep sometimes bloat when pasturing on sweetclover, although the danger is less with this crop than with alfalfa, red clover, or alsike clover. The danger of bloat exists, however, and precautions should be taken to guard against the trouble. Bloating is more likely to occur in the more humid sections and in irrigated pastures where moisture conditions are favorable for producing a rank, sappy growth of clover.

Sweetclover is an important hay crop in many sections of the Great Plains. In North Dakota about 30 percent of the total production of tame hay is sweetclover. In the southern part of the area it is the usual practice to use the first-year crop for hay; but in the northern Plains States the first-year crop seldom attains sufficient height to be cut for hay, and the second-year crop is utilized for this purpose.

Sweetclover has about the same feeding value as alfalfa when properly handled, and in some sections it is a more dependable hay crop.

A disease known as "sweetclover poisoning" sometimes develops in cattle, particularly young animals, that are fed on spoiled or moldy sweetclover hay over an extended period. This usually may be avoided by alternating other roughage with sweetclover hay over periods of a week or 10 days.

The production of sweetclover seed for market has decreased since 1927, largely as a result of a sharp decline in prices. North Dakota leads all States in seed production and normally produces approximately 30 percent of the total United States crop. South Dakota, Nebraska, and Kansas, in the order named, rank next as important seed-producing States of the Great Plains.

Most of the seed is harvested with a grain binder and threshed with an ordinary grain separator equipped with a special huller attachment. On some farms a straight combine is used for harvesting, but this implement is not generally satisfactory because of the heavy loss of seed from shattering and the large percentage of broken stems, immature seed, and other green material that is mixed with the seed. Cutting with a windrower and threshing with "pick-up" and combine is reported as a satisfactory method when such equipment is available.

Seed yields vary widely and range from 1 to 18 bushels per acre, the average being between 4 and 5 bushels per acre.

Sweetclover improves soil fertility by adding quantities of nitrogen and organic matter to the soil. It also improves the mechanical condition of heavy clay and gumbo soils, making them friable and more easily tilled. The large, deeply penetrating roots tend to break up tight, impervious subsoils, thus improving aeration and drainage and increasing the ability of the soil to absorb and retain moisture.

When moisture conditions are favorable, yields of practically all crops are increased by the use of sweetclover in the cropping system. Records show that the use of sweetclover increased corn yields from 38 to 72 percent; wheat yields from 48 to more than 100 percent; and oats yields about 100 percent. Cotton yields have been increased from 50 to 150 percent by having the land in sweetclover from 2 to 4 years. In irrigated sections sugar-beet yields have been increased 35 to 40 percent, and potato yields 25 to 56 percent, through the use of sweetclover.

Sweetclover may be fitted into almost any cropping system common to the Great Plains, and may be grown in either long or short rotations. In sections in which a diversified system of farming is followed, it usually is grown in regular rotation with other crops and is used for pasture, hay, or soil improvement. In sections in which the rainfall is limited or uncertain, it is more commonly grown for pasture or for hay for several years on the same land, or it is grown once every 4 to 7 years, in rotation with small grain.

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