Spring 1956

South Dakota Farm and Home Research

Agricultural Experiment Station

Richard C. Wahlstrom

SOUTH DAKOTA

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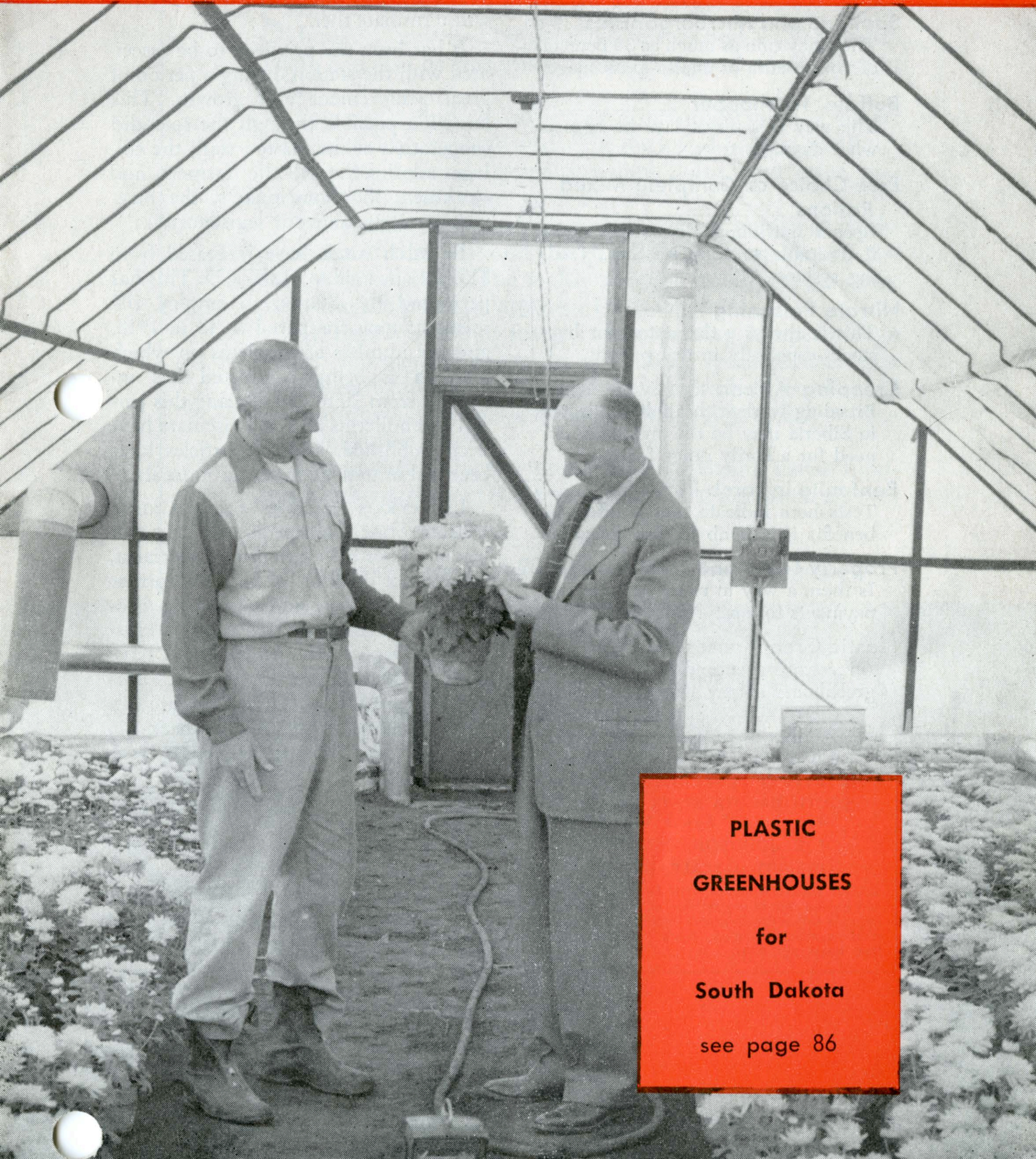

PLASTIC GREENHOUSES for South Dakota

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SOUTH DAKOTA
FARM and HOME
Research

A REPORT OF PROGRESS

Vol. VII SPRING 1956 No. 3

IN THIS ISSUE

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I. B. JOHNSON, *DIRECTOR*
EVERETT METCALF, *EDITOR*

SOUTH DAKOTA FARM AND HOME RESEARCH will be sent free to any resident of South Dakota in response to a written request to the editor, Agricultural Experiment Station, South Dakota State College, Brookings, S. D.

From the Director

With the close of the fiscal year June 30, I will have reached that required period when administrative responsibilities are to be passed on to a younger person. My 18 years as director of the Agricultural Experiment Station will terminate then.

It has been my privilege to be associated with the station during a period of great achievement and growth. This has been possible through the splendid cooperation of the Station staff, the college administrators, the farmers and stockmen, the homemakers, the business interests, and our legislators.

Research funds have increased from $157,344 in 1938 to $1,057,075. This has permitted the Station to employ 105 scientists now compared to 42 in 1938, and the number of problems on which research is being conducted has increased from 70 to 130. During this period 150 bulletins and 103 circulars have been published, and 258 articles have been submitted to scientific journals.

In previous years I have served South Dakota State College as county agent leader, livestock extension specialist, compliance director for both the former Wheat Allotment and Corn-Hog Programs, and head of the Animal Husbandry Department. In all there have been 28 years of service to South Dakota's agriculture. These represent a rich and fruitful personal experience, enhanced by the loyal support of one's many friends.

My sincerest wishes and support go to my successor.

Sincerely,

I. B. Johnson

Director

You may lose one third of your crop through

Spoilage and Microorganisms

IN ALFALFA SILAGE

GEORGE SEMENIUK

SPOILAGE OF ALFALFA or alfalfa-grass silage put up in stacks, bunkers, trenches, or pits often runs as high as 30 percent. There can also be this much spoilage in poorly built upright silos.

You might find several types of spoilage in your silage. Some is moldy or putrid and some dark and burned smelling, lacking the desirable greenish-yellow color, sour odor, and sour taste of good silage.

You usually find good silage in the lower center of stacks or center of silos. Around this good silage there may be the dark, burned silage. The moldy silage is usually in the outer parts and the putrid silage near the bottom.

By tightly packing forage when putting it up in large stacks, you can cut down the amount of spoilage, but even then there can be a lot. The best way to produce good silage and cut down spoilage is to enclose the stack tightly with a durable plastic covering.

Fermentations by the wrong microorganisms cause spoilage. Fermentations of this type result when too much air gets

The cut-away stack below shows different types of spoilage.

into the stack and there is not enough carbohydrate in the high protein forage.

Stacks, bunkers, trenches, pits, and upright silos all have a lot of surface area. Air can penetrate into the silage for short distances. This promotes the rapid growth of protein digesting and weakly acid-producing microorganisms. These are not the type of microorganisms that produce good silage.

Heat is also produced by these same microorganisms. And as the temperature goes up, new kinds of microorganisms develop that raise the temperature even higher—149 to 162° F. near the outside. Under such heat the surface rapidly becomes dry and porous, letting air get deeper into the stack. This promotes still more spoilage.

Traditionally, forages low in carbohydrates and high in protein are hard to ensile without spoilage. Therefore, various ways have been devised to correct this deficiency. One of these is to add carbohydrates, such as black-strap molasses, to help strongly acid-producing bacteria develop rapidly. This prevents the development of protein digesting or putrifying bacteria in the stack.

Another way is to add strong mineral acid to slow or stop the development of weakly acid-producing and putrifactive bacteria and promote the development of the strongly acid-producing bacteria.

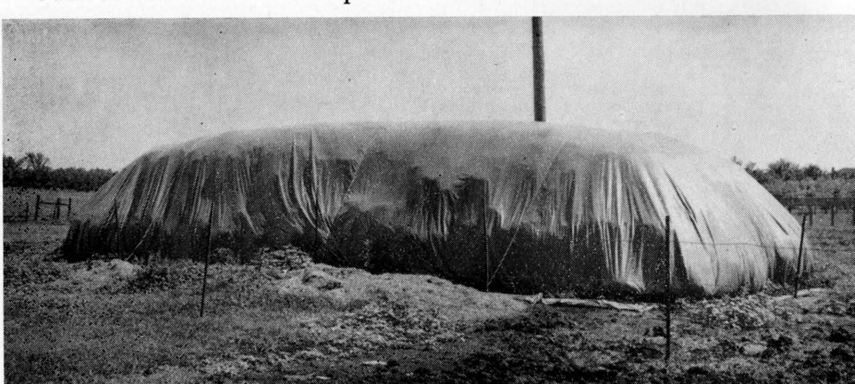
However, success has been variable, perhaps partly because not enough of the additives have been used and partly because conditions were not air-tight enough during ensiling. Nevertheless, many good silages have been obtained by these methods.

But many good silages have also shown up, seemingly by chance, when no supplement has been added. If you could get good silage with no supplement by providing the right conditions cheaply, this would be the most desirable. One way to find these conditions is to learn the progress of spoilage in the stacks.

Progress of Spoilage in Stacks

During the past summer we followed the progress of spoilage in

Outdoor stack covered with a plastic sheet and sealed at the bottom with dirt.



ensiling alfalfa put up in one large circular stack and in one large, partly-covered bunker. We took samples from these at different times to depths of 3 feet. These samples were examined for changes in color, odor, acidity, and number and kinds of microorganisms.

The large circular stack was put up June 14 to 16, 1955. It was tightly packed, 30 feet in diameter, 8 feet high, and held about 150 tons of alfalfa of about 67 percent moisture.

Within 2 days the temperature rose to around 149° F. in the outer 6 inches. After 23 days the same temperature was found in the outer 1 to 2 feet. The temperature stayed lower in the center of the stack, but even here it reached 100 to 115° F. within 20 days and 121° F. 4 to 5 feet in from the sides by 40 days.

Except for the outer portions, the temperature stayed at 80 to 90° F. across the lower 2 feet of the stack.

With such variations in temperature you can expect different kinds of fermentations in different parts of the stack. Therefore you will get different qualities of silage from the different parts.

Table 1 shows that this is true. You can consider the dark brown silage with burned or bunty odors shown in the table as spoiled. However, you can find different degrees of spoilage within these samples.

The pH readings show that the degree of acidity never got very strong in any part of the stack. From what we've said, one probably would expect large numbers of putrifactive bacteria. Yet, none were found.

Most of the microorganisms found in the stack after 2 days were nonsporing types that do not need free oxygen (faculatively anaerobic) and must have medium temperatures (mesophilic). We found them in about equal numbers at all three levels. After 2 days they rapidly disappeared, especially at 13 and 31 inches. Some nonsporing bacteria that need free oxygen (aerobic) and live at high temperatures (thermophilic) were found near the surface at first. Later we found them deeper in the stack as the temperature increased.

The bunker type stack was less tightly packed. You can see the

Continued on page 81

Table 1. Some Characteristics of Silage at Depths of 6, 13, and 31 Inches Midway Up a Circular Stack

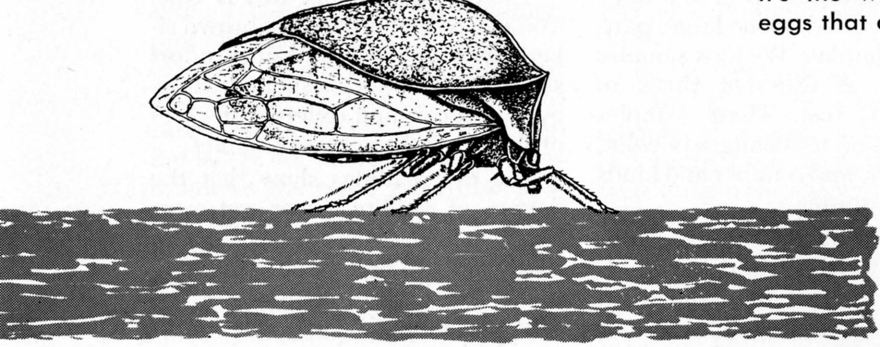
Days After	pH*			Color†			Odor‡		
Ensiling	6 in.	13 in.	31 in.	6 in.	13 in.	31 in.	6 in.	13 in.	31 in.
2	----	5.1	5.1	---------	Gr.Y.	Gr.Y.	---------	N.Fr.	N.Fr.
9	5.2	5.1	4.9	L.Br.Y.	Gr.Y.	Gr.Y.	Sl.Bur.	Sl.Ac.	Sl.Ac.
15	7.1	5.0	5.0	Br.Y.-M.	Gr.Y.	Gr.Y.	Sl.Bun.	Sl.Ac.	Sl.Ac.
23	7.3	4.8	5.0	Br.Y.-M.	L.Br.Y.	L.Br.Y.	Md.Bun.	Sl.Bur.	Md.Ac.
68	7.6	5.1	4.8	Md.Dk.Br.-M.	Md.Dk.Br.	L.Br.	Bun.	Str.Bur.	Str.Bur.
218	8.6	8.2	4.5	Dk.Br.-M.	Md.Dk.Br.-M.	Md.Dk.Br.	Bun.	Bun.	Str.Bur.

*Values progressively lower than 7 indicate greater acidity and values progressively higher than 7 indicate greater alkalinity.

†Gr.—greenish, Y.—yellow, L.—light, Br.—brownish, M.—moldy, Md.—moderately, Dk.—dark.

‡N.—nearly, Fr.—fresh, Sl.—slightly, Bur.—burned, Ac.—acid, Bun.—bunty, Str.—strongly, F.—faintly, P.—putrid.

It's the way this insect lays eggs that damages your trees



CONTROLLING THE

Buffalo Treehopper

H. C. Severin

THE BUFFALO TREEHOPPER [*Stictocephala bubalis* (F.)] is found in all parts of South Dakota. We are concerned with this insect, not because of its feeding habits but because of the way it lays its eggs.

The eggs are layed in short slits made by the female in 2- or 3-year-old twigs or trunks. You can see the result in figure 1. The twigs or trunk of the tree becomes rough and gnarled. Apple trees are most severly damaged but pears, plums, elms, poplars, and willows may also be seriously damaged.

And yet, you can control almost all of this injury through proper orchard management.

Life History and Habits

The adult treehoppers are greenish, four-winged bugs about three-eighths of an inch long. They are roughly triangular and have two short, sharp, horn-like growths on their shoulders, giving them a fanciful resemblance to the head of a buffalo.

Although the wings are well developed, the insect seems reluctant to leave the area where it was hatched.

The adult treehoppers begin to appear in early July and are abundant by the end of the month. They remain numerous until fall and then disappear with cold weather.

An ovipositor is attached under the back end of the female's abdomen. This is what she uses to cut the slits through the bark into the sapwood. She then lays her eggs in these slits.

Four to 12 eggs are layed in each slit. The paired slits are about a fourth of an inch apart. Because of the way they are made, the bark between them dies, leaving an oval or circular scar. The scar enlarges as the tree grows. If enough eggs are

layed in a twig, it becomes dwarfed, deformed, and weak. These twigs easily break off in the wind and may be readily attacked by fungous diseases.

The eggs hatch the following May. The young or nymphs are very small. They move to the ground where they feed on the sap of succulent plants. During the next 6 weeks the nymphs pass through five stages. When the nymphs are fully grown they molt once more and transform into adults.

Control

The best way to control the buffalo treehopper is to practice clean cultivation in your orchard during June. This eliminates the food supply of the nymphs and they will not be able to survive.

Should you not practice clean cultivation, do not plant such crops as alfalfa, potatoes, or a clover in your orchard. Nymphs of the buffalo treehopper prefer to feed on these plants.

If you don't cultivate the orchard, use a DDT spray. Use 3 pounds of a 50 percent wettable DDT powder per 100 gallons of water for this spray. Spray the cover crop, weeds, and grasses in the orchard and a border 100 feet wide on all sides of it. Apply the spray from about August 1 in southern South Dakota to about August 10 in northern South Dakota or the Black Hills.

Don't feed DDT-treated foliage to milk cows, poultry, or to meat animals within 90 days of slaughter. (Project 142. Leader: H. C. Severin, Entomology-Zoology Dept.)

Figure 1. Apple twigs injured by egg-laying activity of buffalo treehopper. A. Injury two years old. B. Injury several years old.

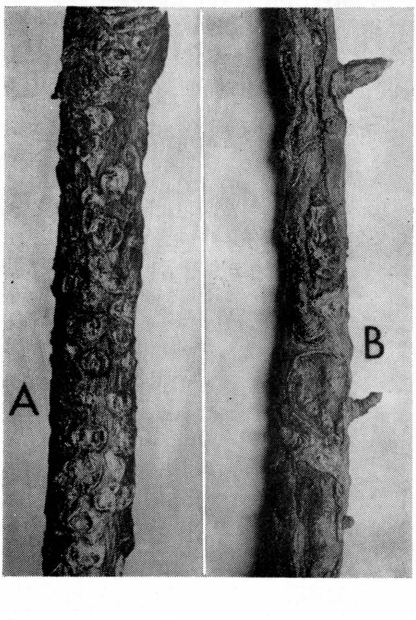
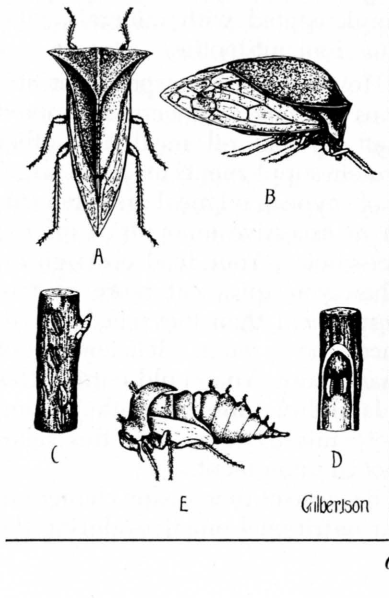
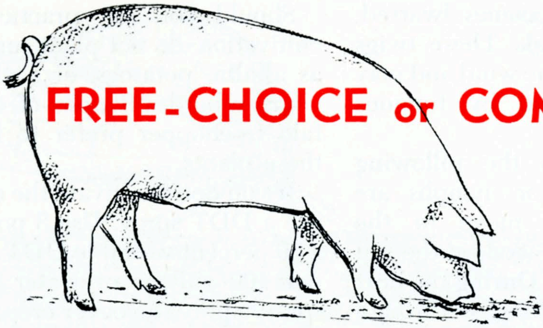


Figure 2. Life history of buffalo treehopper. A. Adult, top view; B. Adult, side view; C. Slits cut into apple twig; D. Bark cut away to show eggs in slits; E. Nymph. (After Gilbertson.)





FREE-CHOICE or COMPLETE MIXED

RICHARD C. WAHLSTROM

EXPERIMENTS OF 15 to 25 years ago have shown us that pigs fed corn and protein supplement free-choice can balance their rations in protein needs.

During recent years we have made many new nutritional discoveries. The use of B vitamins and antibiotics, in particular, have let us lower the recommendations for protein in swine rations. Also, soybean oil meal has recently become a major protein supplement for swine. We have found that it is an excellent protein supplement when properly supplemented with minerals, vitamins, and antibiotics.

However, many experiment stations and hog producers have noted that soybean oil meal and other protein supplements made up largely of soybean oil meal are often eaten in excessive amounts if offered free-choice. Your feed costs go up when your pigs eat more protein supplement than they need to balance the protein deficiencies of farm grains. You could correct this palatability problem with a complete mixed ration, but this takes special equipment.

Because of these many changes in our nutritional practices during the past two decades, we have conducted an experiment on feeding methods. The following trials were undertaken to get more information on the relative merits of free-choice feeding compared to feeding complete mixed rations both in dry-lot and on pasture.

Dry-Lot Trial

In this trial we divided 40 purebred weanling pigs as equally as possible, according to litter, weight, and age, into four groups. All lots were kept in concrete-floored pens connected with 14- by 20-foot concrete feeding floors. Each lot had a

Here Are 6 Points

Here are six points for you to consider when feeding your pigs.

1. Pigs fed in dry-lot needed slightly less feed per 100 pounds of gain when fed free-choice.
2. The main advantage of a ground and mixed ration compared to free-choice feeding seemed to be a slight increase in rate of gain.
3. Less protein supplement was consumed in the mixed rations. However, the cost of grinding

RATIONS

self-feeder and automatic waterer.

The pigs in lot 1 (control lot) were self-fed a basal ration free-choice consisting of shelled No. 2 yellow corn and protein supplement A. The composition of the protein supplement is given in table 1. We fed lot 2 in the same manner but fed the protein supplement as pellets. A complete, ground and mixed ration was fed to lot 3. This ration contained 82.5 percent ground corn, and 17.5 percent protein supplement A until the pigs averaged 100 pounds. Then it was changed to 90.7 percent corn and 9.3 percent supplement. Lot 4 was fed the same ration as lot 3 but the ration was pelleted.

s to Keep in Mind

and mixing offset this difference in feed costs.

4. The use of oats to replace one-third of the corn in the ration fed to pigs on pasture lowered the feed costs.
5. Pigs fed in dry-lot gained slightly faster and more efficiently than pigs fed on pasture.
6. There was no advantage in pelleting the ration for pigs fed in dry-lot.

Results and Discussion

You can see the results of the dry-lot trial in table 2. During the early part of the feeding period lot 4, which received the pelleted ration, did not gain as well as the other three lots. We found almost no difference in rate of gain of lots 1, 2, and 3.

From 100 pounds to market weight the pigs in lot 3, fed the complete ground and mixed ration, gained fastest. For the entire period this lot also had the fastest gain while lot 4 was the slowest.

The most efficient gains were made by lot 2, which was fed free-choice with the protein supplement pelleted. Lot 4 needed the most feed per unit of gain but we think at least part of the poor efficiency, as well as slower gains, was because they scoured while other lots did not.

We did not try to weigh the feed wasted, but pigs fed the pelleted ration seemed to waste the most. We have noticed this in other trials too, but many workers claim less feed is wasted when the feed is pelleted.

Table 1. Composition of Protein Supplements

	Supplement A	Supplement B
Solvent soybean oil meal	50	49
Tankage (60 percent protein)	45	49
Steamed bone meal	1.5	—
Ground limestone	1.5	—
Trace mineralized salt	2.0	2
Antibiotic supplement*	+	+
Vitamin supplement†	+	—

*Furnished 60 gm. of aureomycin per ton of supplement A and 60 gm. of terramycin per ton of supplement B.

†Furnished 12 gm. of riboflavin, 24 gm. of pantothenic acid, 54 gm. of niacin, 60 gm. of choline, and 45 mg. of vitamin B_{12} per ton of supplement.

You can see in table 2 that both lots fed free-choice consumed more protein supplement than we put in the complete mixed rations. This was rather surprising, as we found that a mixture of equal parts of soybean meal and tankage was not consumed in exececssive amounts in other trials.

Feed costs paralleled feed efficiency, with lot 2 having the lowest feed costs and lot 4 the highest. Feed costs were almost equal between lot 1, fed shelled corn and protein supplement free choice, and lot 3, fed the complete ground and mixed ration. The extra cost of the higher protein ration eaten by lot 1

Table 2. Results of Feeding Growing-Fattening Pigs Free-Choice or Complete Mixed Rations in Dry-Lot

	Lot No. and Method of Feeding			
	1 Free-Choice	2 Free-Choice Supplement Pelleted	3 Mixed Ration	4 Mixed Ration Pelleted
No. of pigs	10	10	10	8*
No. days fed	116	109	107	123
Av. initial wt., lbs.	30.5	30.5	30.6	29.8
Av. final wt., lbs.	207.1	206.2	208.3	206.3
Av. daily gain, lbs.				
Start to 100 lbs.	1.37	1.36	1.32	1.18
100 lbs. to final wt.	1.64	1.84	1.98	1.68
Start to final wt.	1.53	1.61	1.66	1.44
Feed/cwt. gain, lbs.				
Corn	269.2	245.6	296.6	306.6
Protein supplement	64.7	63.6	40.8	41.6
Total feed	333.9	309.2	337.4	348.2
Feed cost/cwt. gain†	$9.78	$9.32	$9.86	$11.12

*Two pigs died of causes not due to ration treatment.

†Feed prices per cwt.: Shelled corn $2.54, oats $2.01, soybean meal $3.52, tankage $4.49, trace mineralized salt $2.30, steamed bone meal $4.85, ground limestone $0.83, antibiotics $0.12 per gram and vitamin supplement $0.40 per lb. Other costs per cwt. were: grinding $0.08, mixing $0.05, and pelleting $0.30.

was offset by the cost of grinding and mixing the ration fed lot 3.

Pasture Trial

We used 48 purebred pigs weighing about 32 pounds for this trial. Twelve pigs were put in each of four 2-acre alfalfa pasture plots. Shelter and shade were provided by portable houses. We put a self-feeder and a self-waterer on each plot and small mineral feeders on the free-choice plots. The mineral supplement was made up of equal parts of trace mineralized salt, steamed bone meal, and ground limestone.

Lot 1 was self-fed shelled corn and protein supplement B free-choice. Lot 2 received a grain mixture of 2 parts ground corn and 1 part ground oats and protein supplement B free-choice. A complete mixed ration was fed to lot 3. It was composed of 88 percent ground corn and 12 percent supplement B until the pigs weighed 100 pounds and 92 percent corn and 8 percent supplement from 100 pounds to market weight. We gave lot 4 a complete mixed ration of 90 percent corn and oats mixture and 10 percent supplement B to 100 pounds and then 94.2 percent of the grain mixture and 5.8 percent of the supplement. The grain mixture was 2 parts corn and 1 part oats.

Results and Discussion

The results of this trial are given in table 3. Lot 3, fed the mixed ration with corn as the only grain, gained slightly faster during both stages of the trial. Although the differences were not great, the two lots fed the complete mixed rations gained faster than the lots fed free-choice from weaning to 100 pounds.

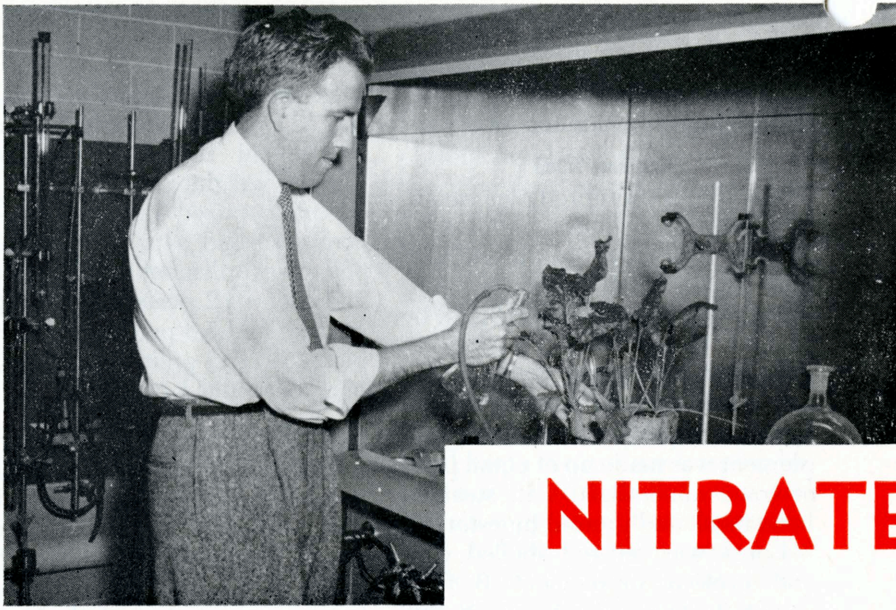
About 10 percent less feed was needed by the pigs fed the com-

Continued on page 85

Table 3. Results of Feeding Free-Choice or Complete Mixed Rations on Pasture

	Lot No. and Method of Feeding			
	1 Sh. Corn Supp. B Free-Choice	2 Corn-Oats Supp. B Free-Choice	3 Corn Supp. B Mixed Ration	4 Corn-Oats Supp. B Mixed Ration
No. of pigs*	10	12	11	11
No. days fed	124	121	117	122
Av. initial wt., lbs.	32.4	31.5	31.2	32.0
Av. final wt., lbs.	210.0	209.3	216.4	208.8
Av. daily gain, lbs.				
Start to 100 lbs.	1.23	1.19	1.29	1.27
100 lbs. to final wt.	1.59	1.72	1.85	1.61
Start to final wt.	1.43	1.47	1.58	1.45
Feed/cwt. gain, lbs.				
Corn	280.2	213.7	314.7	195.3
Oats	----	106.8	----	97.6
Protein supplement	63.4	34.5	32.8	23.3
Total feed	343.6	355.0	347.5	316.2
Feed cost/cwt. gain†	$9.89	$9.49	$10.14	$8.62

*Two pigs from lot 1 and 1 from each of lots 3 and 4 died from heat prostration.
†See table 2 for feed prices used, pasture costs not included.



NITRATE

E. I. WHITEHEAD

NITRATE POISONING is a recurring problem, especially in times of drought. Last November, 26 head of cattle fed oat hay containing 5.9 percent potassium nitrate died, and in December, 17 head fed sudan grass containing 4.9 percent potassium nitrate died—examples of the seriousness of the problem.

Nitrate poisoning of cattle and other cud-chewing animals is due to the accumulation of nitrogen in the nitrate form in forages. We consider 1.5 percent potassium nitrate (air dry sample basis) toxic for ruminant animals.

Nitrate nitrogen is changed to the nitrite form by microorganisms in the paunch (rumen). The nitrite nitrogen then changes normal hemoglobin, the red, oxygen-carrying part of the blood, to methemoglobin. Methemoglobin does not carry oxygen, so if there is enough nitrite, the animal dies of suffocation.

An animal may die within a few hours after eating high nitrate forage.

Veterinarians often use methylene blue to treat nitrate poisoning of cattle and sheep.

Nitrate Content of Plants

Nitrate is the main source of available nitrogen for growing plants. The biochemical process by which nitrogen compounds in the soil are changed to nitrates is called nitrification.

Legume crops have not caused livestock losses due to nitrate poisoning. Native grasses and hays rarely contain much nitrate. However, oats, barley, wheat, or rye hay, and corn or sorghum fodder have sometimes been found to have toxic amounts of nitrates.

Sugar beets are treated with 2,4-D to find the effect of the spray on nitrate accumulation.

An ever-present problem-- especially in dry times . . .

POISONING

In studies with oats and corn, we have found that these plants accumulate a lot of nitrate as young plants. Their nitrate content goes down rapidly as the plant shoots, flowers, and matures seed.

If the normal growth is stopped by drought, the plants are left with the large amount of nitrates. This is often the case when drought-damaged corn is cut for fodder or a green oat-hay is prepared. When you ensile corn with enough moisture to allow normal fermentation, most of the nitrate present is usually destroyed.

Plants are grown under controlled conditions.

While adequate soil nitrate and drought damage are the main causes of high nitrate forages, other factors are also involved. Short daylight periods slow down the use of stored nitrates by plants. Soil without enough available minor elements such as molybdenum, manganese, and copper, which are needed for normal function of plant enzymes, may cause nitrate accumulation.

Effect of Herbicide Sprays

If herbicides are improperly applied they can affect the nitrate contents of plants. In one case sugar beets were sprayed with a toxaphene mixture to control a late brood of web worm. However, the spray mixture had been contaminated with 2,4-D. When the sugar beet tops were fed to 70 head of cattle, 41 showed symptoms of poisoning. Of these, 19 died and 18 treated with methylene blue recovered. We found that the sprayed beet tops contained 4.5 percent potassium nitrate. Unsprayed beet tops from nearby fields contained only 0.22 percent.

We made a number of field tests with several crop and weed species, treating the plants with various herbicide sprays. Generally, the herbicide treatment produced small increases in the nitrate content of the plants, but results were far from clear-cut.

Many factors in the field can affect the nitrate content of plants. To have better control of these conditions, we grew the plants indoors, using a controlled lighting system. This way we were able to correctly determine the effect of herbicide sprays.

In all of these experiments we applied nitrate nitrogen equivalent to 50 pounds nitrogen per acre, and sprayed with 2,4-D. The spray was equal to about half that recommended for the control of mustards. The results of three experiments are given in table 1.

These figures are the average nitrate content for all plants in each group. You can see that mustard plants responded differently than sugar beets. In mustard plants nitrate seems to accumulate faster. However, mustard plants, both sprayed and unsprayed, seemed to use more of the excess nitrate than sugar beets, but the nitrate content of the sprayed plants stayed higher than the control plants.

In the treated sugar beets, the nitrate content of the tops was still high at the last sampling, but the control plants decreased in nitrate content. Trial 1 showed foxtail was not affected.

The nitrate content of all of these plants is much higher than when they are grown outdoors in full sun.

In trials 2 and 3 we studied the effect of light intensity on nitrate content. The 11-day sampling figures for trial 3 are shown in table 2. They are the average nitrate values for the three replications of each treatment.

Notice that as light intensity increased, the nitrate content of the plants decreased. The highest light intensity was only equal to about one-tenth that received by plants growing in full sunlight.

These herbicide sprays are valuable new aids in farm management and these studies are not critical of them. However, they do point out that you must follow the recommended spraying methods care-

Table 1. The Effect of 2,4-D Spray (2.5 ounces per acre) on the Nitrate Content of Mustard, Sugar Beet, and Foxtail Plants

Trial	Days After Spraying	% Potassium Nitrate (Air-Dry Basis)					
		Mustard		Sugar Beets		Foxtail	
		U*	S†	U*	S†	U*	S†
1	0	------	------	------	------	------	------
	4	10.8	17.6	7.7	8.2	2.9	3.2
	14	5.5	12.4	4.3	8.8	3.4	3.4
2	0	18.5	------	6.3	------		
	3	17.6	21.9	7.1	7.1		
	9	18.5	22.0	7.2	9.1		
3	0	17.4	------	6.8	------		
	4	18.6	21.6	8.6	8.1		
	11	14.9	19.4	7.3	8.5		

*Unsprayed.
†Sprayed.

Table 2. The Effect of 2,4-D Spray and Light Intensity on the Nitrate Content of Mustard and Sugar Beet Plants 11 Days After Spray Treatment

Plant	Light Intensity (Foot Candles)	% Potassium Nitrate (Air-Dry Basis) Unsprayed	Sprayed
Mustard	630	15.6	20.9
	940	15.5	19.1
	1240	13.7	18.2
Sugar Beet	630	8.3	9.7
	940	7.2	8.9
	1240	6.2	6.8

fully. If herbicides are not properly applied the plants may be stunted or distorted but not killed. Then there is a chance that enough nitrates may accumulate in some plant species to make the field unsafe for grazing.

Nitrates in Water

We have found several samples of farm well water which are high in nitrate, containing as much as 0.35 percent potassium nitrate. These samples were analyzed in connection with cattle deaths. Water with the equivalent of 0.35 percent potassium nitrate would provide more than one-third pound of nitrate salt per day to dairy cows.

In the fall of 1953 and again in the spring of 1954, we collected samples of water from 31 undrained ponds and small lakes in northeastern South Dakota. Nitrate nitrogen was not found in water from any of these supplies. Therefore, we do not believe that such water supplies will cause trouble.

In an experiment using sheep as test animals, we tried to determine the effects of nitrate in water on methemoglobin formation. Three sheep were used in the control group and three were given water with 0.05 percent sodium nitrate. The nitrate content of the water was raised weekly to 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, and 0.9 percent.

We took blood samples three times a week from both groups. An occasional sample showed methemoglobin but only in small amounts.

Sheep seem to be quite tolerant to nitrates in water. Some experiments have shown that the sheep's feed affects their response to nitrate nitrogen. Well-fed sheep were less affected by nitrates (supplied by stomach tubes).

However, since cattle seem more sensitive to nitrates than sheep, we are continuing work on this problem of nitrates in the water supply, particularly in connection with forages that contain less than 1.5 percent potassium nitrate. In this way we can determine the combined effects of nitrate in the water and feed.

Will Test Samples

If you want to know the feeding quality of a forage from the standpoint of nitrate content, you can have it analyzed by the Station Biochemistry Department at South Dakota State College for a small charge. The sample you send should be representative of the forage so that we can make correct recommendations.

When you are in doubt about a forage, it is a good idea to feed it to a cull animal. Watch it closely for several days for any symptoms of distress before you feed the forage to the herd. (Project 87. Leader: E. I. Whitehead, Station Biochemistry Dept.)

Here's a unique story that began in 1911. The result may be a new carpet of green for South Dakota pastures and ranges.

Creeping Alfal

M. W. Adams

Woven into the dark green fabric of the history of alfalfa is a golden yellow thread—the unique and arresting story of creeping alfalfa. In the beginning we trace this thread to a few seedbearing plants collected on the steppes of Siberia by Professor Niels Ebbesen Hansen, South Dakota's famous plant explorer of the early 1900's.

Dr. Hansen disclaimed that he was "either a prophet or the son of a prophet" when he forecast that the alfalfas brought from Siberia might be successfully introduced "as wild plants into the native ranges of the Prairie Northwest, where they will probably be able to hold their own with any plants now found there."

Dr. Hansen further stated in 1911, "To increase the carrying capacity of our present rough lands, now unfit for cultivation, by bringing in as a wild plant the yellow-flowered Siberian alfalfa, is certainly a work worthwhile."

These statements show a vision and a challenge which have become bench marks to modern alfalfa breeders. We have fallen heir not only to this vision and challenge, but also to plant materials by which they soon may be realized.

Laterally-Spreading Roots

The golden thread next appears among a few plants in the alfalfa nursery of Agronomist Sam Garver at Highmore, S. D. The time was 1912. Many of Dr. Hansen's introductions were being studied by Garver. But a number of plants of S.P.I. 28071 from Orenburg, Russia were unlike any others. Garver observed that these plants had laterally-spreading roots extending from 30 to 36 inches from the mother plant and which then produced stem buds that grew to the surface of the soil and leafed out as green shoots.

The lateral roots were 4 to 10 inches below and parallel to the soil surface, of small diameter, and marked at irregular intervals by slight swellings. New stem buds

Dr. N. E. Hansen collected alfalfa from areas of extreme drought and cold.

grew from these tuber-like enlargements and frequently roots also originated here (see figure 1).

Agronomists Garver and R. A. Oakley saw that these plants were low-growing, spreading types not suitable for hay, but they suggested in 1917 that such plants might sometime be used by breeders seeking pasture or range types for grazing purposes.

This suggestion, like Dr. Hansen's, fell on infertile soil and the golden thread seemingly disappeared for almost three decades. These were the years of Grimm, Cossack, and the hardy, productive Ladak alfalfas.

Then, in Saskatchewan, Canada, Agronomist S. E. Clarke found that the only alfalfa plants that came through the dry years in his nurseries were from the Siberian alfalfa and a few hybrids between it and Ladak.

Prominent among these hybrids were a small number of creepers like those described by Garver. This material has formed the basis of a plant breeding program in Canada and some of it has recently been reintroduced by the South Dakota Experiment Station.

Plants in Perkins County

But the thread had not been forever lost in South Dakota. In the summer of 1950 agronomists at the South Dakota Experiment Station visited an old field of Cossack alfalfa on the Henry Kruse farm in Perkins County. Beside it was a planting of Hansen's Siberian alfalfa—the yellow-flowered Semipalatinsk. Both fields dated back to 1911-12.

Among the Cossack plants, now considerably reduced in stand and inter-grown with western wheatgrass, were found eight creeping alfalfa plants (see figures 2 and 3). We now think these plants are hybrids between the Cossack and carriers of the creeping trait from the Semipalatinsk.

About this time the Experiment Station launched a program of al-

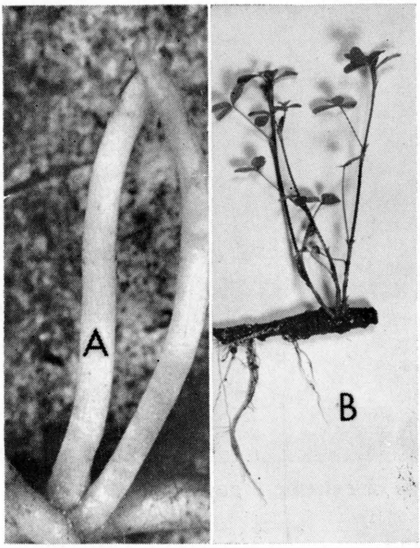


Figure 1. Portion of proliferous root showing: (A) the adventitious origin of new stem tissue at the point of enlargement, and (B) their development into sturdy stem structures.

falfa research and breeding, accepting the challenge to produce a long-lived hardy alfalfa to grow with grass for grazing on the prairies and range pastures of the northern plains.

The rediscovered root-proliferating type of alfalfa, because of its proven hardiness and ability to spread by underground roots, was selected as the foundation stock in the new program.

Parent and progeny nurseries of root-proliferating alfalfa selections

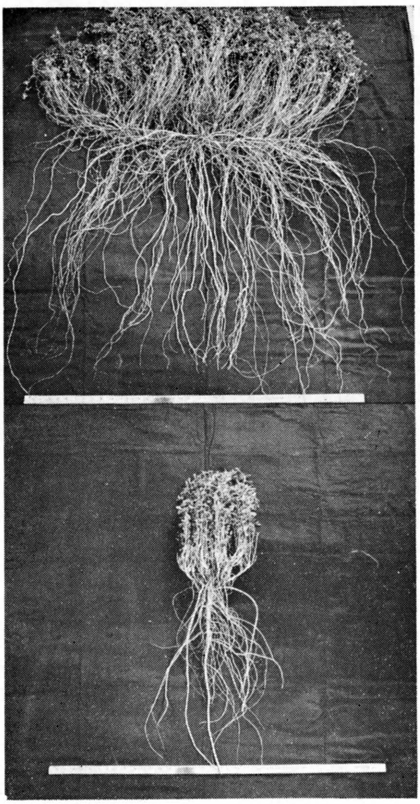
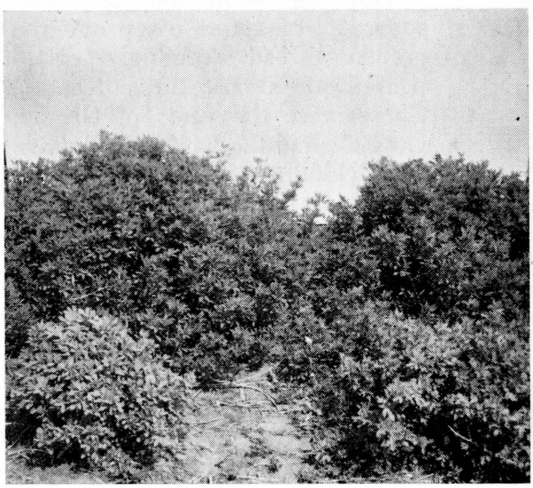


Figure 2. (Left) Upper plant—root-creeping type of alfalfa. Lower plant—standard alfalfa type. Both plants are about the same age. Note yardsticks.

Figure 3. (Below) Above ground the creeping type (background) and the non-creeping type (foreground) show distinct differences in vegetative vigor and growth form.



have now been grown at the Range Field Station, Cottonwood, and the main Station at Brookings for four years. We have selected plants which are disease resistant, strongly creeping, and whose offspring show the creeping trait most often and most pronounced.

Some families (the intercross offspring of a single female plant) have relatively few creeping-type plants. A few families are made up almost wholly of the creeping type. (See figures 4 and 5 and table 1.)

However, in the material we have worked with so far, the most widely creeping parents have not given the most aggressive offspring. This tendency can be measured as a correlation. For two nurseries involving 24

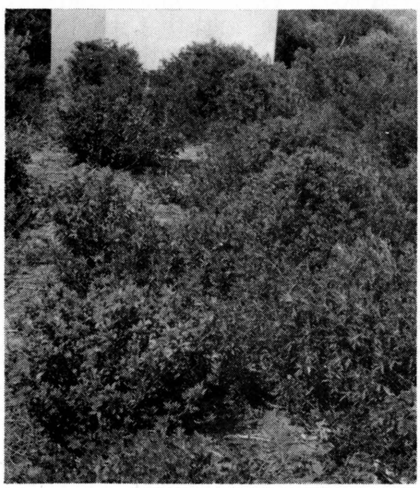
Continued on page 85

Table 1. Summary of Performance of Creeping-Rooted Alfalfa Selections and of Their Intercross Progeny for "Creep"

Selection Number	Clonal Parent Amount of Creep (In.)	Intercross Progeny Amount of Creep (In.)	% of Plants That Are Creepers (Av. of 40 Plants Ea.)
CK1	35.05	30.3	78.9
CK2	33.58	33.0	92.3
CK3	27.00	30.7	76.9
CK4	27.06	27.0	53.8
CK5	32.83	33.0	78.9
CK6	30.78	32.0	75.0
CK7	26.80	30.1	74.4
CK8	32.57	32.5	87.2
CK9	35.73	33.3	78.9
CK10	34.00	27.7	83.8
CK11	29.95	29.0	72.5
CK12	38.42	32.6	70.0
CK13	36.30	30.7	94.4
CK14	33.00	32.2	57.9
CK15	36.68	31.5	90.0
CK16	32.05	30.3	70.3
CK17	33.35	34.4	84.6
CK18	31.88	34.5	92.1
CK19	31.00	35.6	97.5
CK20	39.31	34.5	84.2
CK21	43.95	35.2	50.0
CK22	42.85	30.0	65.0
CK23	non-creeper	32.8	48.7
CK29	34.21	29.3	76.5

Figure 4. (Left) Portions of two intercross families showing mostly creeping-type plants: CK 18, right; CK 19, left.

Figure 5. (Right) Portions of two intercross families showing differences in percentage creeping plants: right, CK 15—90 percent creeping; left, CK 16—40 percent creeping.



Bentonite

IN LAMB

Leon F. Bush and R. M. Jordan

There is no apparent benefit from feeding your fattening lambs bentonite. That's the conclusion from trials involving 457 lambs at Brookings and Newell during three winters (1952-54). Differences in rate of gain, feed efficiency, and carcass grade and yield were of no practical importance.

Sodium bentonite, a natural occurring volcanic ash that swells when wet, has been used as the binding material in range pellets for some time. It absorbs nearly five times its weight in water and contributes no energy value to the ration.

Some have felt that bentonite would expand the surface of the feed when it absorbed water and digestive juices in the digestive tract. These people reasoned that this would improve feed utilization by increasing the surface on which digestive juices, enzymes, and bacteria could act.

To determine the value of sodium bentonite in lamb feeding rations, we began a series of feeding trials. In all of these trials we fed the lambs in the treated lots sodium bentonite (0.1 pound per lamb daily) mixed with the protein supplement. We fed the control lambs the same ration without bentonite.

The First Trial

We conducted the first trial at Brookings in 1952. The results of this trial are shown in table 1. We used two lots of 25 western feeder lambs and full-fed them shelled corn, brome hay, and 0.2 pounds of soybean meal. For the treated lot we mixed sodium bentonite with the soybean meal at a ratio of 1 to 2.

The bentonite was powdered and therefore very dusty. Yet the lambs ate it readily and consumed slightly more grain per day than the control lambs. The lambs receiving bentonite showed 0.27 pound more daily gain than the controls.

In this trial 26 pounds of sodium bentonite replaced 25 pounds of concentrates and 38 pounds of hay for each 100 pounds gain. Little difference was noted in carcass grade and yield.

The Second Trials

In 1953 we conducted trials at Brookings and Newell. We used a coarser, granular form of bentonite to get away from the dustiness of the powdered bentonite. A sum-

FATTENING RATIONS

mary of the results is shown in table 1.

We full-fed lambs in the Brookings trial shelled corn, brome hay, and 0.2 pound soybean meal. We used four lots of 10 lambs each. Two of these lots served as controls while the remaining lots received 0.1 pound of bentonite daily.

In this trial we obtained no benefit from adding bentonite to the ration. There was no difference in daily feed consumption, rate of gain, or feed efficiency between the

Table 1. Effect of Bentonite in Lamb Fattening Rations

	Brookings (1952)		Brookings (1953)		Newell (1953)	
Treatment	Control	Powdered Bentonite*	Control	Granular Bentonite*	Control	Granular Bentonite*†
No. of lambs	25	25	20	20	38	40
Days on feed	81	81	87	87	70	70
Av. initial wt., lbs.	71.9	70.2	70.7	71.0	80.1	80.2
Av. final wt., lbs.	100.6	101.1	103.4	103.5	99.7	101.2
Av. da. gain per lamb, lb.	0.354	0.381	0.375	0.375	0.310	0.300
Death loss	0	0	0	0	2	0
Av. daily feed:						
Grain, lbs.	1.38	1.42	1.41	1.42	0.89	0.97
Hay, lbs.	1.84	1.84	1.73	1.73	1.71	1.45
Soybean meal, lbs.	0.20	0.20	0.20	0.20	0.20	0.20
Bentonite, lbs.	-----	0.10	-----	0.10	-----	0.10
Feed per 100 lbs. gain:						
Grain, lbs.	385.0	368.0	376.1	381.0	292.0	321.3
Hay, lbs.	520.0	482.0	461.4	462.6	562.5	483.0
Soybean meal, lbs.	56.0	52.0	53.4	53.5	65.9	66.6
Bentonite, lbs.	-----	26.0	-----	26.7	-----	33.3
Carcass grade:						
Prime	-----	2	-----	-----	-----	-----
Choice	17	16	-----	-----	-----	-----
Good	8	8	-----	-----	-----	-----
Carcass yield	49.1	49.1	47.0	49.1	-----	-----

*Bentonite and soybean meal mixed in proportion of 1:2.
†The bentonite-soybean meal mixture was pelleted.

control and treated lots. However, the bentonite-fed lambs had a higher carcass yield than the controls.

The bentonite-soybean meal mixture fed to the treated lots at Newell was pelleted to aid in feeding. We fed 20 feeder lambs in each of four lots—two control and two treated lots. We full-fed these lambs barley, alfalfa hay, and 0.2 pound of soybean meal.

The bentonite-fed lambs ate somewhat less total daily feed than the control lambs, but they ate a higher proportion of grain to roughage. This type of ration suggests a more rapid rate of gain; however, the bentonite-fed lambs gained slightly less than the control lambs. The total amount of feed required per 100 pounds of gain was nearly the same for both groups.

The Third Trials

Since results of the second trials were the opposite of those obtained with powdered bentonite, we conducted trials at Brookings and Newell during 1954 in which both forms of bentonite were used. A summary of the results is shown in table 2.

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Table 2. Effect of Bentonite in Lamb Fattening Rations—Summary of Trials Conducted at Brookings and Newell (1954)

	Brookings			Newell		
Treatment	Control	Powdered Bentonite*	Granular Bentonite*	Control	Powdered Bentonite†	Granular Bentonite†
No. of lambs	47	49	50	47	48	48
Days on feed	98	98	98	116	116	116
Av. initial wt., lbs.	66.5	66.7	66.3	57.9	57.8	57.8
Av. final wt., lbs.	101.0	101.3	101.2	105.3	106.0	106.7
Av. da. gain per lamb, lbs.	0.355	0.350	0.360	0.410	0.415	0.425
Death loss	3	1	0	1	0	0
Av. daily feed:						
Shelled corn	1.24	1.24	1.21	1.25	1.30	1.28
Alfalfa hay	1.63	1.58	1.57	1.53	1.53	1.53
Soybean meal	0.10	0.10	0.10	0.15	0.15	0.15
Bentonite	------	0.10	0.10	------	0.10	0.10
Feed per 100 lbs. gain:						
Shelled corn	352.0	352.5	338.5	300.5	307.0	300.0
Alfalfa hay	464.5	448.5	441.0	368.0	361.0	356.0
Soybean meal	28.5	28.0	27.5	36.0	35.0	34.5
Bentonite	------	28.0	27.5	------	23.4	23.1
Carcass grade:						
Prime	6	3	9	------	2	------
Choice	38	39	37	36	38	42
Good	3	7	4	11	8	6
Carcass yield	52.3	51.2	51.4	51.2	51.4	50.9

*Bentonite and soybean meal mixed in proportion of 1:1.
†Bentonite and soybean meal mixed in proportion of 2:3.

Spoilage in Silage

Continued from page 63

spoilage progress of this stack in table 2. We took samples from the exposed end of the stack. Progress was similar to the circular stack but more rapid. Not much acidity developed at any of the depths, and consequently putrifactive bacteria, judged by odor, were quite active. Thermophilic bacteria were slightly more numerous in this stack.

Progress of Spoilage in Pilot Silos

In further tests of spoilage we used small experimental stacks. These were about 5 feet in diameter and 6½ feet high. Each one held about 2 tons of silage. We put them up in a shed on July 13, 1955. Two men packed them by tramping.

After 2 months we opened them and determined the extent of spoilage. Stacks enclosed in a plastic cover or metal sheet did not heat. They settled 30 percent and were good quality throughout.

Stacks left uncovered heated from the start and settled 42 percent. They showed the same type of spoilage as the large outdoor stacks, except for less yellow-green silage.

By adding chemicals to the uncovered stacks, we increased the amount of good silage in the lower center from about 3 percent to about 12 percent for those treated with sorbic acid and to 13 percent for those treated with sodium metabisulphite.

The silage enclosed by plastic or metal sheet has a clean acid odor like sauerkraut. The pH was between 4.1 and 5.1. Few mesophilic bacteria were found and none to only a few thermophilic ones were found.

The wide band of dark brown silage around the good silage in the open stacks had a pungent to flat burned odor. The pH was 4.6 (5.4 with sodium metabisulphite added). It had moderate numbers of thermophilic bacteria. A thin upper layer of brown silage between this and the outside moldy layer also possessed a pungent burned odor, but its acidity was near neutral. It carried many aerobic, spore-forming, thermophilic bacteria. The outside moldy layer, as in field stacks, was strongly alkaline, with a pH of 8.1.

The work we have done so far indicates that the best way you can insure good silage is to keep out air and prevent loss of moisture. A durable plastic cover that seals the stack completely to the ground seems to do the job. (Project 237C. Leader: George Semeniuk, Plant Pathology Dept.)

Table 2. Some Characteristics of Silage at Depths of 8, 14, and 32 Inches From the Exposed End of a Bunker Stack

Days After	pH*			Color†			Odor‡		
Ensiling	8 in.	14 in.	32 in.	8 in.	14 in.	32 in.	8 in.	14 in.	32 in.
7	5.5	5.2	5.4	Gr.Y.	Gr.Y.	Gr.Y.	F.Ac.	Md.Ac.	Md.Ac.
14	5.2	6.0	6.8	L.Br.Y.	Gr.Y.	Gr.Y.	F.Ac.	F.Ac.-Sl.P.	Sl.P.
20	6.8	5.6	6.4	Br.Y.	L.Br.Y.	Gr.Y.	Md.P.	Md.P.	Md.P.
28	8.1	5.6	6.4	Br.	Br.Y.	L.Br.Y.	Str.Bun.	Md.P.	Str.P.
73	8.0	8.5	5.0	Dk.Br.	Dk.Br.	Br.Y.	Str.Bun.	Str.Bun.	Sl.Ac.-Md.Bur.

*, †, ‡—See footnotes in table 1.

You may find your real property taxes are harder to pay some years than others. The reason this is true for South Dakota farmers is there's no connection between

Property Taxes and Farm Income

JOHN E. THOMPSON

THE FARMER IN SOUTH DAKOTA often finds it harder to pay his property taxes in one year than in another. This is true, to some extent at least, for other individuals or groups as well.

However, the farmer is especially bothered by this problem because of his changing income. Good weather and high prices may increase his production and income. In another year conditions may reverse and the farmer finds himself faced with a lower income.

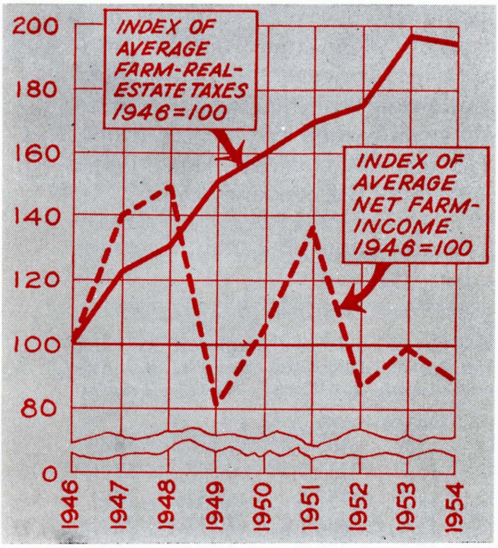
As the farm property levies are not affected by farm income, these changing conditions make the taxes much harder to pay in some years.

You are probably aware of this condition. However, you may not realize how much farm income fluctuates or what has happened to real estate taxes in relation to income in our state. We have gathered information on farm real estate taxes and farm income for 1940 and 1945-54 to find how these two are related (see table 1).

In the table you can see that taxes have risen sharply from 1946 to 1954. Only in 1954 did farm real estate taxes go down from the previous year. In contrast, the net income has been unsteady, going from a high of $471.1 million in 1948 to a low of $242 million in 1949. The 1949 net income was about one-half as large as in 1948. However, taxes increased by more than $2 million.

You can see how much harder it was to pay the taxes in 1949.

In recent years the number of farms have decreased in our state so fewer farmers shared in the farm income and in paying the taxes. We reduced the net income figures and farm real estate tax estimates to an average farm figure by dividing by the number of farms in



the state to make up for this difference.

The purchasing power of the dollar has also gone down during this time, further lowering the real value of the net income. However, no adjustment was made for this as we felt that it was not necessary to show the general relationship between net farm income and farm real estate taxes.

To make it easier to compare these figures we reduced them to index numbers with 1946 equal to 100. You can see the comparison graphically in the chart.

From the chart you can see the highly erratic net farm income pattern for our state in contrast to the increasing but more uniform farm real estate taxes for the period. You will notice that for 1947, 1948, and 1951 it was easier to pay taxes than in the other years.

You may now wonder how we can get more uniformity between net farm income and farm real estate taxes. It would be hard to suggest, with any hope of achievement, a plan that would adjust farm income to correspond more closely to farm real estate taxes. We can not control farm prices effectively, nor can we control farm production. Therefore, adjusting farm real estate taxes to our changing farm income is more practical.

The problem of reducing the difference between farm real estate tax payments and net income will tend to get worse in the future as more tax revenue is needed. The higher the property taxes go in relation to net income, the harder they will be to pay. Therefore, one solution may be to look for sources other than the property tax when more tax revenue is needed. Either an increase in the sales tax or a state income tax will tend to take more from the farmer when his income is high and less when it is low. Of the two, the income tax will usually be more effective in relating tax burden to ability to pay.

Another method that might be used is to exempt personal property from taxation. This may require substituting some other type of revenue to make up for the loss. Even so, farmers would probably be better off with the change as they are heavy personal property tax payers.

A third possibility is to change the method of school financing. Schools are the major recipients of revenue raised by property levies. Such levies can be reduced, or at least not raised, if some other source is used for school support or if schools can be operated more ef-

ficiently under the present plan. In either case the property tax burden on farmers would be reduced.

Finally, farm property tax mill rates could be tied to the farmers' parity price ratio or some other indicator of farmers' financial well-being. Such a plan would reduce stability of revenue from the property tax. However, the state could build reserves when farm income is up to use when the income drops. (Project 262. Leader: Max Myers, Agricultural Economics Dept.)

Table 1. A Comparison of Farm Income and Farm Real Estate Tax Data for South Dakota—1940, 1946-54

Year	Cash Farm Income in S. Dak. (Gross)*	Costs of Farm Production†	Net Inc. Rec. From Ag.‡	Net Inc. as % of Cash Farm Income	Farm Real Est. Taxes§	Net Inc. Before Real Est. Taxes	Av. Farm Inc. Before Real Est. Taxes‖	Av. Farm Real Est. Taxes**
	(millions)	(millions)	(millions)		(millions)	(millions)		
1940	139.5	64	75.5	54.1	9.6	85.1	$1,175	132
1946	502.8	183	319.8	63.6	11.7	331.5	4,857	171
1947	679.6	236	443.6	65.3	14.2	457.8	6,752	208
1948	655.1	184	471.1	71.9	15.0	486.1	7,217	223
1949	559.0	317	242.0	43.3	17.3	259.3	3,876	259
1950	510.3	190	320.3	62.8	18.2	338.5	5,094	274
1951	604.4	187	417.4	69.1	19.1	436.5	6,629	290
1952	565.0	311	254.0	45.0	19.6	273.6	4,193	300
1953	533.7	243	290.7	54.5	21.7	312.4	4,832	336
1954	536.7	281	255.7	47.6	21.2	276.9	4,323	331

*U. S. Department of Agriculture, *Agricultural Statistics* and recent releases of the U. S. Department of Agriculture's *The Farm Income Situation*.
†Difference between gross cash farm income (column 2) and net farm income (column 4).
‡U. S. Department of Commerce, *Survey of Current Business*.
§U. S. Department of Agriculture, *Agricultural Statistics* and recent releases of the U. S. Department of Agriculture's *Taxes Levied on Farm Real Estate* by years. Data is for Year of Levy.
‖Obtained by dividing net income by estimated number of farms in South Dakota (Bureau of Census Farm Population Estimates).
**Obtained by dividing farm real estate taxes by estimated number of farms in South Dakota (Bureau of Census Farm Population Estimates).

Bentonite

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We fed six lots of lambs at each station, 25 lambs per lot at Brookings and 24 per lot at Newell. We full-fed these lambs shelled corn and alfalfa hay. At Brookings we fed them 0.1 pound of soybean meal and at Newell 0.15 pound.

There was little difference in daily feed consumption between the control and treated lots. The lambs fed powdered bentonite ate the bentonite-soybean meal mixture as readily as those receiving the granular bentonite or those fed only the protein supplement.

The differences in daily rate of grain and feed consumed per hundred pounds of gain were in favor of the lambs fed the granular bentonite. These differences were quite small and of little practical importance. (Project 233. Leader: Leon F. Bush, Animal Husbandry Dept.)

Pig Rations

Continued from page 69

plete mixed ration containing the corn and oats mixture (lot 4). It is hard to explain why this group was so much more efficient than the others, although the amount of feed required by lots 1, 2, and 3 is somewhat high for pasture-fed pigs.

Lot 1, fed shelled corn and supplement free - choice, consumed more protein than we consider necessary to balance the ration. Including oats in the ration seemed to decrease the need for protein supplement.

Feed costs were lowest for lot 4 because of the difference in feed efficiency. The price relationship between corn and oats during the trial also favored the feeding of oats. (Project 268. Leader: R. C. Wahlstrom, Animal Husbandry Dept.)

Creeping Alfalfa

Continued from page 77

parents and almost 2,000 offspring, the parent-progeny correlation for the degree of creep was 0.34 (not significant). Therefore, we have based our selection on superior families instead of superior individuals alone.

For resistance to common leafspot of alfalfa (described in the Winter 1954 issue of *South Dakota Farm and Home Research*), we have been able to select effectively on an individual merit basis (see table 2).

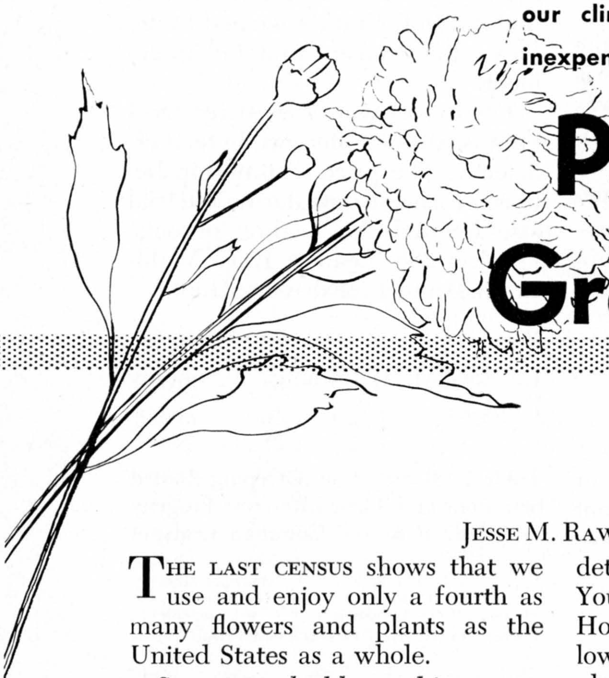
Over-all progress has been somewhat slower than where selection for all traits can be made on the individual basis. Nevertheless, satisfactory advance has been made in two generations of selection, and experimental synthetic strains are being produced now for more extensive testing.

The golden yellow thread, symbolic of the root-creeping type of alfalfa, has now led to superior selections and strains in the hands of plant breeders. The destiny of this thread may soon be a new carpet of green gold for our South Dakota ranges and pastures. (Project 74. Leader: M. W. Adams, Agronomy Dept.)

Table 2. Reaction of Creeping-Rooted Selections and Their Intercross Progeny to Alfalfa Rust and Common Leafspot

Selection Number	Rust Score 1=Resistant 5=Susceptible: Clonal Parent	Rust Score: Progeny	Leafspot Score 1=Resistant 5=Susceptible: Clonal Parent	Leafspot Score: Progeny
CK1	4.34	3.86	4.37	3.60
CK2	3.30	2.99	2.27	2.95
CK3	3.03	2.88	4.66	4.18
CK4	2.29	2.65	2.52	3.18
CK5	4.04	3.14	3.22	3.26
CK6	2.80	2.50	1.08	2.86
CK7	2.36	2.69	2.42	3.35
CK8	4.21	3.74	4.07	3.52
CK9	4.34	3.61	3.90	3.80
CK10	4.30	4.04	1.05	2.28
CK11	3.98	4.00	1.15	2.36
CK12	4.36	3.94	1.03	1.88
CK13	2.43	3.21	4.98	3.48
CK14	1.67	2.89	4.50	2.86
CK15	2.40	3.15	3.23	3.00
CK16	2.04	2.61	3.92	3.24
CK17	3.63	3.62	4.95	3.64
CK18	4.46	3.96	1.00	2.09
CK19	5.00	4.08	1.00	1.46
CK20	3.52	3.94	1.00	1.76
CK21	4.20	2.95	3.68	3.18
CK22	4.29	3.82	3.80	3.18
CK23	4.53	3.82	1.35	2.84
CK29	1.20	2.39	4.42	3.72

They proved themselves in our climate last winter—inexpensive, easy-to-build



Plastic Greenhouses

Jesse M. Rawson

The last census shows that we use and enjoy only a fourth as many flowers and plants as the United States as a whole.

Some people blame this on our weather. Others say we don't have enough interest or that the idea is still new in many areas of our state. But the main reason is simply that good flowers and plants aren't available.

Our widely scattered population has made it unprofitable to start greenhouses in all but the larger cities. The large investment needed to build a greenhouse is too much for many communities to support.

Now cost no longer needs to be a barrier to starting in the greenhouse or nursery business. We've been testing a plastic greenhouse for the last year and it grows excellent plants. You can build a plastic greenhouse for about a tenth of the cost of the glass type.

The main fault is that the plastic deteriorates during the summer. You have to replace it every year. However, the cost of the plastic is low and it is cheaper to replace the plastic annually than the glass normally broken each year. Also, except for an occasional hail storm, glass breakage is worst in the winter when replacement is difficult. You replace the plastic in the fall when the weather is still good.

For small growers or growers in small communities the value of a plastic greenhouse is apparent. However, established growers can also make good use of the new building. One or more plastic greenhouses could be built to handle the spring plant business. In addition to the low cost the plastic greenhouse also gives great flexibility. For instance, in the spring, hot beds can be attached to the house and, by changing the pipes around, they can be heated with the same burner as the house. The plastic can be

replaced in the summer with aster cloth and you can grow such flowers as asters and dahlias which benefit from partial shade.

The flexibility isn't restricted to the larger grower, though. You can use the burner to heat brooder houses, farm workshops, farrowing pens, and other buildings on your farm.

The first crop grown under the plastic was chrysanthemums. We used 400 potted plants timed to bloom in late November and early December. The clay pots were set on the ground. These plants were as good as plants grown under glass.

We are now growing calceolarias, petunias, primroses, schizanthus, and garden chrysanthemums in the house. All are growing satisfactorily. While plastic does not transmit light as well as glass, the plants have not "stretched" or shown signs of lack of light. One advantage is that light is diffused so there are no shadows in the house.

Humidity has been high all winter in the house. A film of moisture has always been present on the inside layer of plastic. This has cut watering in half. To date, we've had no trouble with mildew or other diseases which thrive under high humidity.

The October 29 storm showed us that the house can stand wind. Even though winds reached 55 miles per hour, there was no damage.

The idea for plastic greenhouses comes from the University of Kentucky. The Department of Horticulture there developed and tested the first ones. However, until now no tests had been made this far north. We adapted the original plans to fit our needs. You may want to make other changes to suit your needs.

A local grower has recently built a plastic greenhouse using these modifications. He put in a poured concrete foundation instead of the posts and 2 x 6 inch sill plate. The heater was put outside in a separate box, thus taking up no floor space in the building. He built benches around the walls in preference to ground beds. The stack from the vacuum blower was placed horizontally through the wall, thus exhausting gasses more directly.

If you run into any problems or have any questions about building a plastic greenhouse, write the Hor-

Benches can be installed around the walls of the plastic greenhouse.

To save floor space, the heating unit could be put outside in a separate box.

ticulture and Forestry Department, South Dakota State College, College Station, Brookings.

Costs

A major advantage of the plastic greenhouse is its low cost. While costs will vary somewhat in different areas, here's about what a plastic greenhouse 18 x 40 feet will cost.

Heater, blower, and thermostat	$225.00
Pipe, elbows, etc. (6" galvanized)	85.00
Installation of gas tank	25.00
Tank rent (1 year)	24.00
Tubing, fittings, etc. from tank to burner	12.00
Lumber No. 1 fir	95.00
Lath	5.00
Polyethylene plastic	45.00
Brackets, turnbuckles, and misc.	27.00
Nails and tacker staples	5.00
	$548.00

For about $150 more you can double the size of the house, as the first five items would be the same for an 80-foot house.

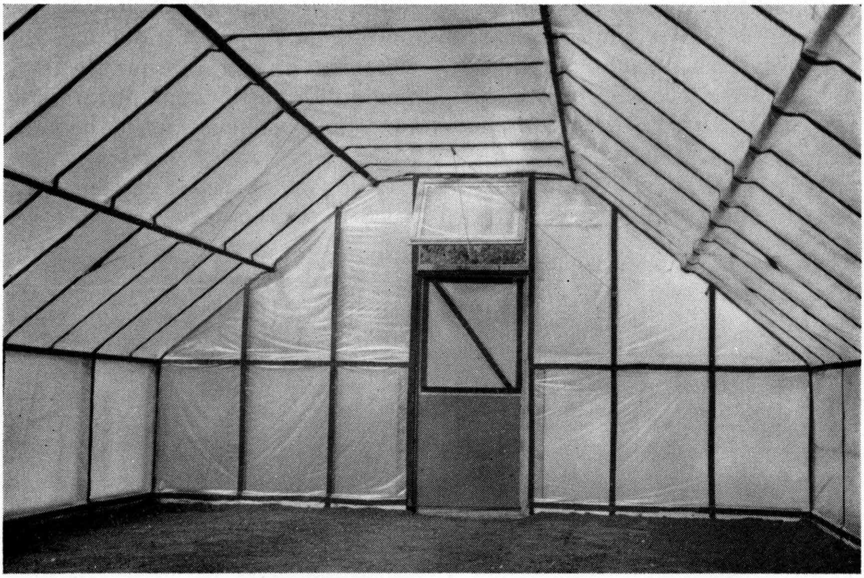
Propane (L-P) gas costs about 13½ cents a gallon. Cost of heating for the 10-week period beginning October 24 at the above rate was $1.06 per day. We consider this a good test period because November and December 1955 were extremely cold.

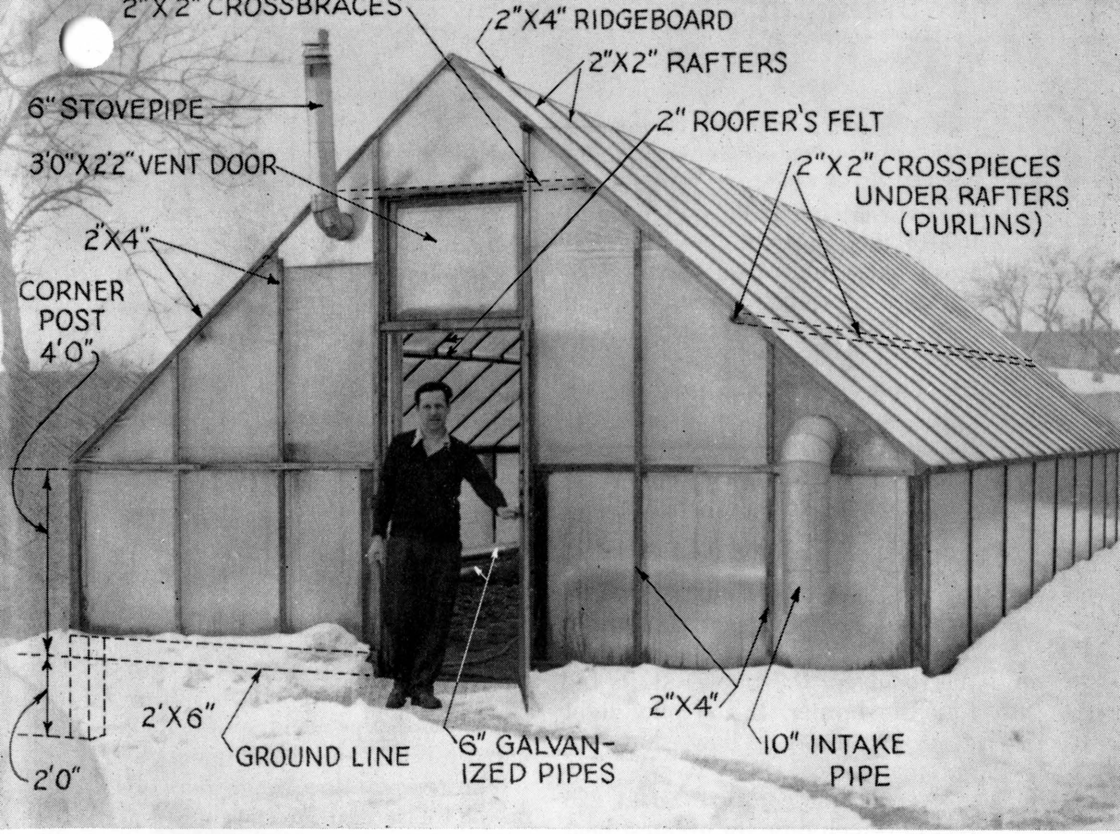
Construction

Our greenhouse was 18 x 40 feet in size. We laid out the site and dug the post holes at 4-foot intervals along the sides and ends.

At the corners, every 8 feet along the sides, and on both sides of the doors we put up 4 x 4 posts. We used a 2 x 4 post between the 4 x 4's along the sides and nailed a 2 x 4 plate at the top of each post. The plates were made by joining two 2 x 4's near the center of the house. A 2 x 6 baseboard was put around

The picture below shows how evenly the light is distributed in the plastic house.





the outside at ground level and a 1 x 6 was put on the inside. The sides and ends were pre-fabricated and raised into position as units.

All wood touching the ground was treated with a wood preservative of copper napthenate or chromated zinc chloride. One should not use pentachlorophenol or other phenolic compounds as their fumes will kill or severely injure plants.

After squaring the sides and ends we put up the 2 x 4 ridge. The ridge is held by 2 x 2 sash bars at 2 foot intervals. We gave the roof a 40-degree slope for better snow slippage. Two longitudinal purlins were put under the sash bars on each side of the roof. To give the house more strength and hold the sides together, we placed 2 x 2 cross braces across the house above the upper longitudinal purlin. For additional bracing we stretched No. 9 wire diagonally from the ridge to the plate on each side of the roof. It was held in place with large screw eyes and tightened with turnbuckles. The doors and ventilators were made of inch material.

Before putting on the polyethylene plastic we removed slivers and rough spots on the wood to reduce the chance of tearing the plastic. The outside layer was 3 mil (0.003 inch thick) polyethylene 50 inches wide. We put it on horizontally across the sash bars and lapped about 3 inches. The plastic was held in place with staples and nailed

lath. We used 6 penny, 2 headed nails so we could remove them easily.

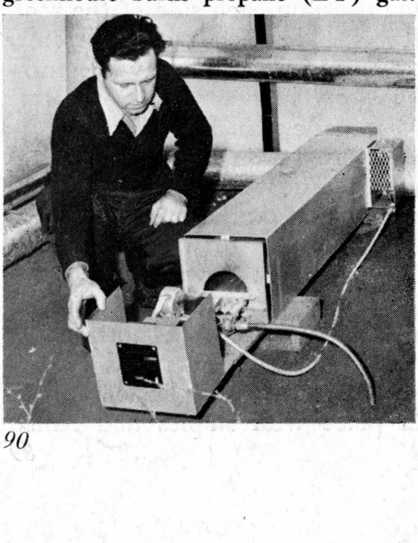
For the inner layer we used 0.0015 inch thick polyethylene. It was tacked on the inside of the sash bars and uprights, making a dead air space between the two layers of plastic. Instead of laths to secure the inner plastic we used 2-inch strips of roofing felt and tacked it to the wood.

Heating

A new type L-P bottled gas burning heater was installed after the house was covered. It has two parts, a vacuum blower and a 160,000 BTU burner with a thermostatic control. The gas can not escape into the room, for the blower starts before the burner. If the pilot light goes off, the gas flow shuts off automatically.

It is desirable to use about 225 feet of 6-inch pipe for greatest heat efficiency. In addition to length of pipe, it is recommended to run the pipe around the perimeter of the greenhouse. With an 80-foot house you would place the burner at one

The heating unit used in the plastic greenhouse burns propane (L-P) gas.



end and the blower at the opposite end. With a 40-foot house, the pipe has to run double to get in 225 feet. Then both burner and blower are at the same end.

All joints were sealed with furnace cement and asbestos paper. With the vacuum-type system the pipes don't have to be level, so we put them underground at the door. They are 8 inches from the inside wall and the bottom one is 4 inches off the floor.

By placing the pipes near the floor, cold air entering the building through the walls is warmed before it reaches the plants. As the heat slows down at the elbows, more heat is given off and the cold corners are warmed. By simply adding elbows and pipe, cold spots which may develop can be eliminated.

The temperature range depends on the thermostat. At first there was only a 3-degree spread. However, this has increased considerably as the thermostat is becoming less efficient. We think this is because the thermostate isn't well adapted to the moist air in greenhouses.

To provide the air need for combustion, we ran a 10-inch intake pipe through the wall near the burner. It is recommended that you provide 1 square inch of fresh air intake for each 1,000 BTU of heater capacity.

The advantages of this house as we see it now are low original cost, reasonable heating and maintenance costs, great flexibility, ability to withstands wind, snow, and hail, and the need for less frequent watering. (Project 286. Leader: Jesse M. Rawson, Horiticulture Dept.)