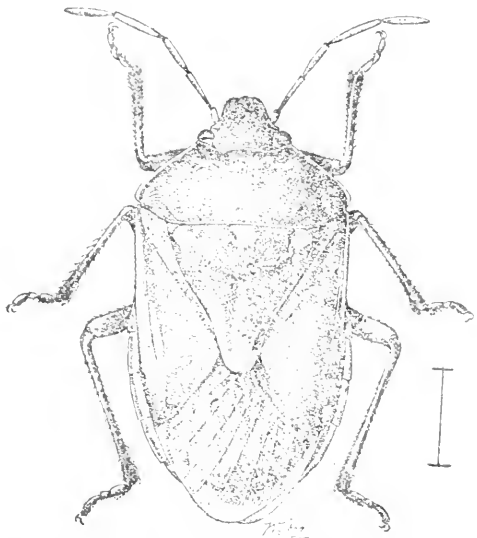
O. 294 DECEMBER, 1934

Montana Insect Pests for 1933 and 1934

The Twenty-Fifth Report of the State Entomologist of Montana

BY

A. L. STRAND, STATE ENTOMOLOGIST



SAY'S PLANT BUG, (CHLOROCHROA SAYI STAL.) A SERIOUS WHEAT PEST IN NORTH-CENTRAL MONTANA. BY MEANS OF A LONG BEAK IT SUCKS THE PLANT SAP FROM DEVELOPING GRAIN. THE DAMAGE IS OFTEN OVERLOOKED UNTIL HARVEST WHEN THE PLANTS ARE FOUND TO YIELD ONLY CHAFF AND SHRIVELED KERNELS. (FROM U. S. D. A. BUL. 779.)

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

LETTER OF TRANSMITTAL

Bozeman, Montana,
December 31, 1934

To His Excellency,
Governor Frank H. Cooney
Helena, Montana.
My Dear Sir:

I present herewith the Twenty Fifth Report of the State Entomologist.

By law the entomologist of Montana State College and Agricultural Experiment Station is the State Entomologist. It is his duty to direct control measures against destructive insect pests. In the thirty-two years since this office was created there has never been a time when it was more badly needed or served a greater number of the people of Montana than in 1934.

In November, 1933, the worst grasshopper outbreak in the history of the state was predicted. The State Entomologist, cooperating with the entomologists of other western states that were facing the same predicament, and especially with the U. S. Bureau of Entomology, prepared the estimates on which a federal appropriation was obtained for grasshopper control. As shown in the body of the report he acted as state leader in charge of the campaign. The following summary shows somewhat the extent of the work:

Number of counties engaged in grasshopper control	51
Carload shipments of poisoned bait	940
Tons of bait moved into the counties	19,509
Tons of bait actually used	16,254
(This means 67,000,000 pounds of finished bait)	
Minimum number of farmers using bait	20,805
Number of mechanical bait spreaders used	2,665
Acres of land treated	3,320,105

The actual amount of crop destroyed by grasshoppers was very small when you consider the extremely heavy infestations which had to be combated. In the non-drought counties it is estimated by the great majority of farmers themselves that nearly total loss of crop would have resulted if the grasshoppers had not been poisoned. A most conservative valuation on the crop saved is $7,500,000.

There is in storage in the state now enough poisoned bait to take care of the expected grasshopper infestations in 1935. There is this important consideration which should not be overlooked. In 1934 the State Entomologist had three assistants on federal salary and federal expense to aid in the supervision of the work. Needless to say, with an appropriation of $300 no

help could be employed at state expense. But in 1935 there will be no federal aid in this respect. With grasshoppers still requiring a great deal of time from this office, and with the expected widespread Mormon cricket outbreak, to say nothing of the many other insect problems of the state, your attention as well as that of the legislature is called to the need of adequate support for insect control work. We venture to remark that there is no other state activity which pays a higher dividend on the money invested.

Respectfully yours,

A. L. STRAND

State Entomologist

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Twenty-Fifth Report of the State Entomologist

THE CONTROL OF INSECT PESTS IN MONTANA

The original law providing for a State Entomologist, passed in 1903, includes the following statement:[1] "When it becomes known to the State Entomologist that an outbreak of an insect has occurred in any part of the State, it shall be his duty to go to the scene of the outbreak or send a suitably qualified assistant. The State Entomologist or said assistant shall determine the extent and seriousness of the outbreak and when necessary publish or make public demonstration of the best remedies to be employed."

The county insect pest law, passed in 1921, contains the following statement:[2] "The board of commissioners of any county in the state where there are any insect pests are hereby authorized and empowered to appoint some suitable person or persons whose duty it shall be, *acting under the direction of the state entomologist*, to poison, kill, catch, and exterminate insect pests within such county."

From the above quotations it is plain that it is the duty of the State Entomologist or his assistants not only to keep in touch with and to control minor insect outbreaks all over the state but also to direct the larger control campaigns in which county funds are used to wholly or partly meet the cost of field operations in actually fighting the insects.

HOW THE LAW WORKS OUT IN PRACTICE

In the past these two laws have worked out very well in practice. Instances of insect damage, if at all severe, have been discovered either by the State Entomologist or his assistants or are quickly reported by county agricultural agents or individual farmers. If the damage is restricted to a single farm or community, control measures are recommended to the owner, who puts them into operation at his own expense. If control operations on a larger scale are needed the county authorities are appealed to and the county pest law is used. Sometimes that is not enough. In 1934 most counties in the state could not have financed the intensive grasshopper campaigns which were required. The State Entomologist, in this case, presented the

[1]Chapter 72, Revised Codes of the State Entomologist Law, No. 914.

[2]Revised Codes of the County Insect Pest Law, No. 4503.

necessary facts and estimates on which were based a federal appropriation for this work.

In addition to field work in connection with insect outbreaks, surveys must be conducted to determine whether unusually dangerous insects like the alfalfa weevil are already within the state. To wait until their presence is indicated by damage to crops might be very disastrous. Other surveys connected with the prediction of coming insect outbreaks are of immense value to the agricultural interests of the state.

WHO DOES THE WORK AND HOW SUPPORTED

The entomologist of the Experiment Station is by law the State Entomologist; he also gives nearly half his time to teaching entomology at Montana State College. Since he receives no pay from the state-entomologist fund his first duty is to the Experiment Station and to the College, one of which pays sixty per cent and the other forty per cent of his salary. It is, then, obvious that the State Entomologist cannot satisfactorily perform his duties in the Experiment Station, teach classes in the State College, and at the same time devote the necessary time to demonstrating insect control. The actual field work—until 1931—was carried on to a large extent by an assistant working under the direction of the State Entomologist. In 1931 the State Entomologist's appropriation was reduced to $450 and still further cut in 1933 to $300. Now, of course, there is no assistant. Furthermore, the Agricultural Extension Service does not employ an entomologist but depends on the State Entomologist to direct and furnish the information for the insect work carried on under the immediate supervision of the county agents.

In 1934, with the state facing a great grasshopper outbreak, the Agricultural Experiment Station and the College gladly overlooked the usurpation of the entmomologist's time. That is right and proper in the case of an emergency but should not go too far. Their entomologist is no doubt in the best position to direct the work assigned to the office of State Entomologist but he should be given the necessary assistance so that other work, which is just as important, may not be neglected.

The State Entomologist is asking for an appropriation of approximately $3,000. That will provide for the employment of a qualified assistant and the necessary expenses connected with the fulfillment of his duties. We believe that the farmers of the state

realize the importance of this work. The savings made to them through the activities of this office in 1934 are very real. Although the grasshopper bait was supplied by the federal government, the prosecution of the work, the consignment and diversion of hundreds of carloads of bait, the directions under which it was used, the training of the personnel in charge of county campaigns, and a host of other functions necessary to the success of the work, fell to this office. In 1935 not only grasshoppers but Mormon crickets will demand very full attention.

The State Entomologist appropriation is not to be confused with the appropriation for the State Board of Entomology. Under the latter organization rodent control, as an important factor in the control of Rocky Mountain spotted fever, is carried on in Ravalli and Missoula counties. The work of the State Entomologist covers the entire state but, in spite of that fact, his appropriation in the past two bienniums has been about one-tenth that of the State Board of Entomology.

GRASSHOPPERS IN 1933

Fifteen counties carried on organized grasshopper control campaigns in 1933. The infested areas conformed very closely to the prediction made in the Twenty-Fourth Report of the State Entomologist, issued in December, 1932. The important outbreaks as noted at that time were to be expected in Pondera, Toole, Hill, Valley, Daniels, Roosevelt, Richland, Dawson, Wibaux, and Fergus counties. As will be seen in table 1 these were the counties where the large acreages were treated. Cascade County was somewhat under-estimated. Roosevelt and Wibaux counties, although grasshoppers caused considerable damage there, left the control work to individual farmers.

In addition to the counties listed and for which some data are given, there were many other counties where farmers were required to devote much time and money to grasshopper control. The total area poisoned probably reached nearly 500,000 acres. In spite of the fact that in some cases protected crops dried up and produced no profit, as in parts of Valley County, in other districts fair yields of grain made the grasshopper work pay for itself many times. Such was the case in Hill County where it was conservatively estimated that from 20,000 to 30,000 acres in crop were saved from the 'hoppers.

TABLE 1.—GRASSHOPPERS IN 1933

County	Funds expended	Acres poisoned
Cascade	$ 6,500.00	26,880
Custer	158.00	4,400
Dawson	4,000.00	16,000
Fergus	2,800.00	83,000
Gallatin	550.00	3,000
Glacier	750.00	3,000
Hill	15,461.31	51,000
Lake	300.00	1,200
Pondera	3,082.30	24,000
Richland	7,200.00	36,370
Sanders	03.69	500
Stillwater	500.00	2,000
Teton	350.00	1,500
Toole	1,500.00	6,000
Valley	13,921.36	177,200
Totals	$57,136.66	436,050

NOTE: The funds extended in some cases do not agree with the acreage poisoned. This is due to using up old supplies of arsenic and molasses, and special arrangements with farmers relative to furnishing bran.

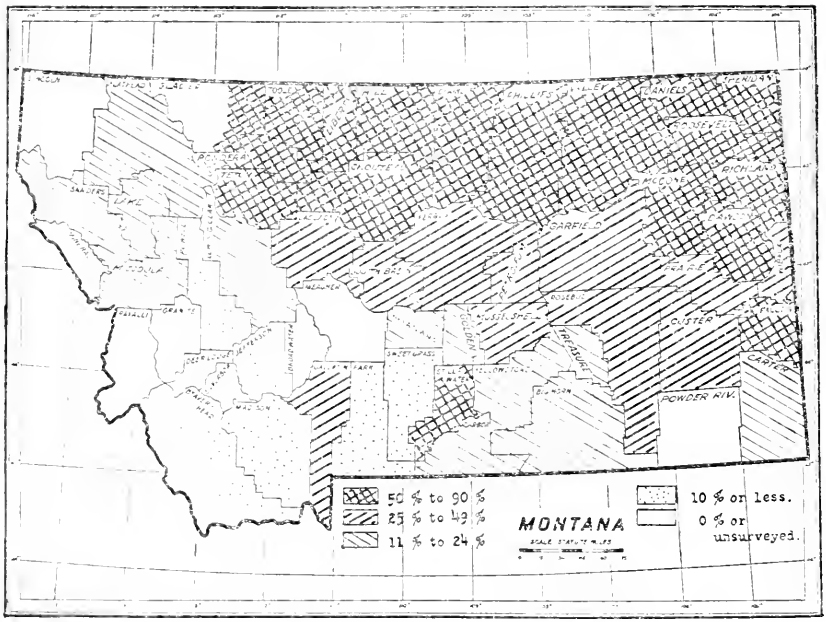

Figure 1.—The 1933 grasshopper-egg survey. Where grasshoppers were predictd for 1934.

GRASSHOPPERS IN 1934

By November 1, 1933, it was established beyond any doubt that Montana would experience in 1934 the worst grasshopper outbreak in its agricultural history. Eighteen counties were so infested with eggs (see figure 1) that from 50 to 90 per cent of the total acreage in grain and hay crops would have to be treated with poisoned bran mash. Eleven other counties showed infestations ranging from 25 to 50 per cent. Furthermore, these twenty-nine counties were the ones which produce in most years 90 per cent of our spring wheat and nearly 50 per cent of our tame hay. In many of these counties the eggs of the lesser migratory grasshopper (*Melanoplus mexicanus*) were so abundant that as high as 30 egg pods, each containing about 20 eggs, could be found per square foot of stubble. The estimated cost of combating such an extensive outbreak was beyond the financial resources of the state.

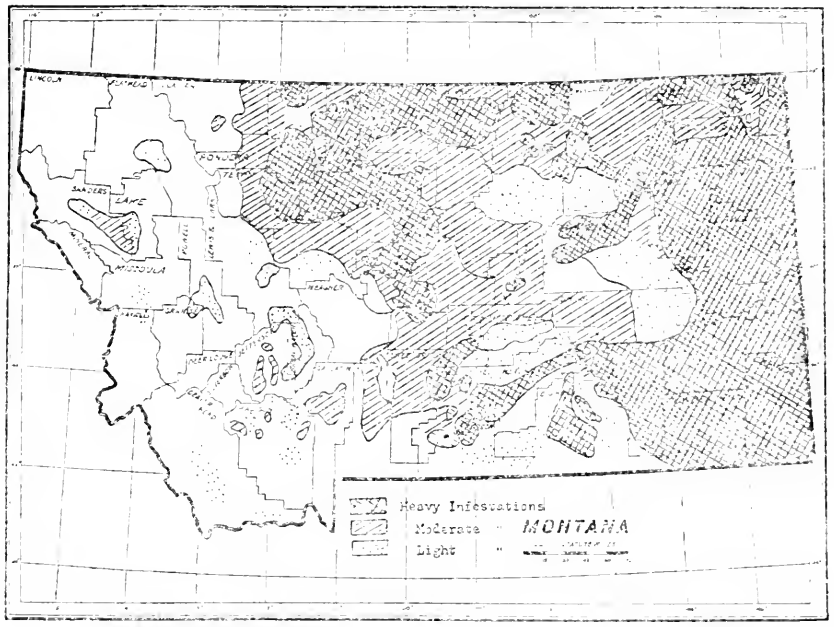

Figure 2.—The intensity of the 1934 grasshopper outbreak. This indicates where the grasshoppers actually were.

Inasmuch as states lying to the east and south of us as well as the Canadian provinces of Alberta and Saskatchewan to the north were facing the same situation, a well organized campaign embracing all the states in the Western Great Plains area seemed essential. Accordingly, a regional conference on grasshopper control, attended by official representatives from seven states and three Canadian provinces was held at Fargo, North Dakota, on November 21-22, 1933. Represented also at the conference were the railroads, grain and elevator interests, and the Northwest Crop Improvement Association.

After two days of careful consideration, the conference prepared and unanimously approved the following report:

The conference members respectfully request that this question of the grasshopper situation be given most serious consideration by Federal authorities.

1—It should be realized that as early as 1928, grasshoppers appeared in sufficient numbers to cause some apprehension and alarm. They have steadily increased in numbers until the agriculture of this region is now facing a situation which may amount to a calamity. Not only have the insects become more numerous, but only in the past season a species called the "Migratory" grasshopper has appeared. This is a close relative of the old Rocky Mountain locust, the species which ruined crops over wide areas from 1873 to 1876. The migratory grasshopper is a more destructive type than the species which predominated in the early years of the present outbreak.

2—Carefully prepared statements were presented at the conference, by entomological leaders and agricultural authorities from the states of North Dakota, South Dakota, Minnesota, Wyoming, Wisconsin, Idaho, Montana, and the provinces of Alberta, Manitoba, and Saskatchewan, Canada. Their reports were based upon accurate egg surveys of the grasshopper egg infestation this past fall. They were emphatic and positive in declaring that in the entire area grasshopper population has steadily increased since 1928, (since 1931 for Montana).

The joint survey of conditions in the Great Plains area made by the Bureau of Entomology of the U. S. D. A. in cooperation with entomological agencies during September and October of the present year, predicts, in all probability, one of the worst grasshopper outbreaks in 1934 in the history of American agriculture.

The following table summarizes the statements of the different state authorities. It indicates the number of counties that are apt to have serious grasshopper damage in 1934; the number of acres that may need poison, and the approximate cost of bait material. This sum does not include the cost of transportation and distribution of the bait, nor the administrative expense.

SUMMARY OF 1933 GRASSHOPPER SURVEY BY STATES

State	No. of counties likely to have serious grasshopper damage in 1934.	Acres that may need poison	Cost of bait at $25 per ton
Idaho	10	120,000	$ 15,000.00
Minnesota	20	279,834	41,676.00
Montana	51	3,787,316	448,400.00
Nebraska*	10	200,000	25,000.00
North Dakota	53	5,377,520	679,980.00
South Dakota	68	2,667,396	320,623.00
Wyoming	12	841,600	105,200.00
Wisconsin	35	320,060	40,000.00
Total	256	13,393,666	$1,675,879.00

*Estimate made without survey.

Report submitted by:

Claude Wakeland, Idaho
A. G. Ruggles, Minnesota
M. H. Swenk, Nebraska
Fred D. Butcher, North Dakota
A. L. Ford, South Dakota
C. L. Corkins, Wyoming
E. L. Chambers, Wisconsin
A. L. Strand, Montana

3—It has been conclusively demonstrated that with proper organization and financial assistance, grasshopper outbreaks can be controlled. Experience has shown this to be a fact in the control of small infested areas in the past and with the infestation of 1931-1933, it has been thoroughly proven in Manitoba and Minnesota.

4—The grasshopper menace which has been increasing and spreading in the northwest for the past five years has now reached a point where it is completely beyond control of the individual counties and states. The problem has become one of not only interstate, but international scope because of the recent rise to major importance of a species of grasshopper with pronounced migratory habits.

The conference believes, and strongly recommends, that an extensive control program, interstate in character, be inaugurated at once. It is absolutely necessary that a comprehensive campaign be immediately developed in order to save a large part of the 1934 crop.

The grasshopper control program should be so organized that it deals with the present emergency and it should also be permanent in character in order to prevent recurrence of the present situation.

5—(A) The conference suggests that the following brief outline should serve as a basis for organizing the emergency program. The U. S. Bureau of Entomology, and state grasshopper control committees, should be charged with the responsibility of the direction of the campaign, including allocation of funds to the different states, methods of state, county and township or

ganizations for control, spreading of poison materials, and all other details necessary for an efficiently conducted campaign.

The various states should cooperate with the Federal Bureau and should immediately form a state grasshopper control committee, the chairman of which should, in most cases, be the director of the State Agricultural Extension Service. All matters of policy and administration should be handled through the state control committee and the Federal Bureau.

Each county desiring to conduct a grasshopper campaign should make their contacts directly with the state committee, and in a like manner, township organization should be handled through the county committee.

(B) A preliminary educational campaign should be started immediately for the purpose of informing producers and business men as to the location of possible outbreaks. At the same time, the plan of organizing the program should be thoroughly explained as well as other details necessary for a successful campaign. During the conference it was emphasized repeatedly that the full cooperation of farmers and local business men was imperative for satisfactory results.

(C) Thorough plowing of the land before the grasshoppers hatch in the spring of 1934 will materially reduce their numbers, greatly increase the possibilities of effective control and will reduce the amount of poison bait required. Every effort should be employed to induce such practice.

(D) The conference believes it is necessary to make an egg survey in the fall of 1934 in order to locate those areas where there might be a possibility of continued damage in 1935. This survey should be made under the direction of the Bureau of Entomology of the Federal Government in cooperation with state officials. The funds for such work should be included in the amount made available for the emergency grasshopper campaign of this coming season.

C—The conference gave careful attention to the financial requirements for emergency grasshopper control in 1934. Considering the fact that the entomologists declare over 13,000,000 acres will need application of poison bait, it is conservatively estimated that the sum of two and a half million dollars is needed.

It was further unanimously agreed by those attending the Regional Conference that this money must be made available not later than January 1, 1934. Delay in securing this money will seriously jeopardize the thorough and early organization which is so necessary among farmers and local business groups.

Because of the impoverished condition of many of the worst infested counties, and the practical, if not legal impossibility of raising large sums of money in the counties for the purchase of bait, therefore it is reluctantly concluded that the federal government must be asked to step into this emergency as they have in other regional insect invasions, and provide adequate funds for the purchase of grasshopper bait. It was unanimously concluded that states and counties could and would find means for financing local organization expense and the cost of transportation and distribution. In proposing this method of financing, we advance the sound argument that the most equitable spread of the cost of a campaign covering many states,

and with ramifying national effects, is to be found in present forms of federal taxation.

The Federal Government has invested, and has outstanding loans to the farmers in those areas, sums of money totaling many millions of dollars. This heavy investment on the part of the Government, combined with the inability of the individual states and counties to provide funds, makes it a sound business policy for the National Government to make such funds available to protect its investment. Vast amounts are being expended in the form of relief in these districts and it is the opinion of the conference that without a curtailment of grasshopper damage next year, even more extensive relief measures will be required in 1935.

7—The conference does not contemplate more than one year of this emergency work. But it does recommend that a long-time program of grasshopper control be worked out between the federal government and the state entomological organizations, with the idea of eliminating the recurrence of such extensive outbreaks as the present one. Since surveys are fundamental prerequisites for efficient control campaigns, it is recommended that the contribution of the Bureau of Entomology be an annual grasshopper survey. It is expected that the individual states will take advantage of this survey and stamp out local outbreaks before they reach major proportions.

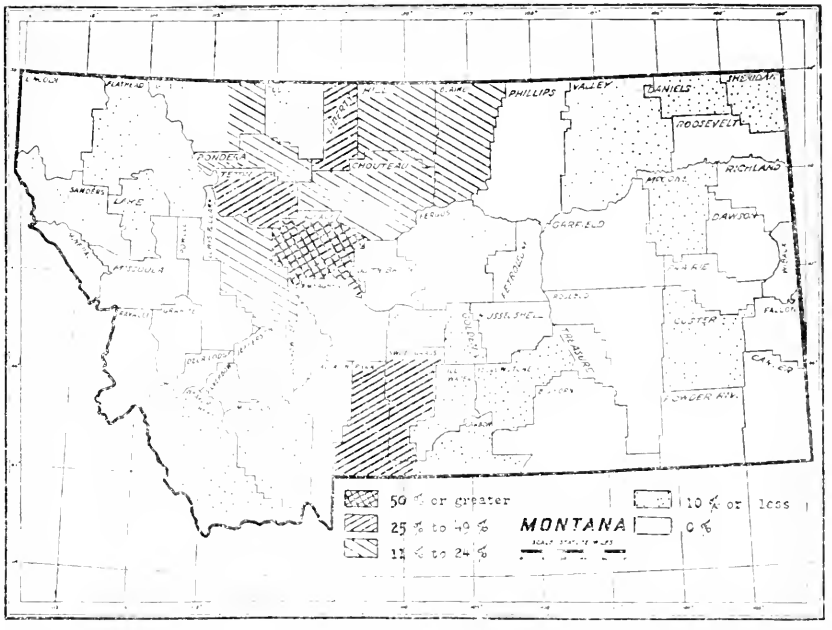

Figure 3.— The 1934 grasshopper egg survey. Where grasshopper outbreaks are predicted for 1935.

8—The members of the conference were impressed with the activity of many Northwestern congressmen in their efforts to secure funds for grasshopper control in 1932. They wish to commend such work and they request continued support for the program outlined in this report.

9—The Regional Conference was impressed with the close cooperation and exchange of ideas that exists between Canadian and United States scientific workers and officials. It is also impressed with the fact that Canada already has under way an extensive campaign to control grasshoppers next year and will carry out this campaign regardless of what is done in the United States. Such action places upon states and Federal Government the responsibility of controlling grasshoppers south of the International Boundary to prevent re-infestation of Canadian farms.

10—It is recommended the conference appoint an executive committee to be charged with the responsibility of making every effort to carry out these policies outlined in this report. This committee should be given the authority necessary to appoint additional or supplementary committees when they deem it necessary.

11—The members of the conference believe that there is no problem which so seriously jeopardizes the harvesting of a satisfactory crop in the infested regions in 1934, and since it is so definitely linked with present day relief work, it was unanimously voted that a copy of this report be sent to the President of the United States and to the Secretary of Agriculture.

Respectfully submitted,

H. R. Sumner, Northwest Crop Improvement Association
A. G. Ruggles, State Entomologist, Minnesota
J. C. Taylor, Montana Agricultural Extension Service
B. E. Groom, Greater North Dakota Association
H. L. Walster, Dean of Agriculture, N. D. A. C.
Fred Riebe, Kellogg Commission Co., Minneapolis
Walter Mills, Washburn Crosby Co., Minneapolis
Berry Akers, The Farmer, St. Paul
Evan Hall, the Milwaukee Railroad

Montana's representatives at this conference were J. C. Taylor, Director of the Montana Agricultural Extension Service, and A. L. Strand, State Entomologist.

As a direct result of this conference and the effective work of western senators and congressmen, to say nothing of the tireless efforts of Mr. H. R. Sumner, secretary of the Northwest Crop Improvement Association, a federal appropriation of $2,354,893 became available March 28, 1934, for grasshopper control. In the initial allocation of bait Montana's share in this appropriation became $469,690. However, before the season was over additional allotments of bait

brought the amount of federal money as represented in bait shipments to Montana to $496,834. However, all of this was not used and a carry-over of bait valued at $74,230 is now in storage for the 1935 work.

ORGANIZATION OF THE 1934 GRASSHOPPER CAMPAIGN

As authorized under the federal regulations, a state grasshopper control committee was set up. This consisted of the following persons:

J. C. Taylor, Director Montana Agricultural Extension Service, Chairman
Alfred Atkinson, President of Montana State College
F. B. Linfield, Director Montana Agricultural Experiment Station
A. H. Stafford, Commissioner of Agriculture
A. L. Strand, Entomologist, Montana Agricultural Experiment Station, and State Entomologist

At the first meeting of this committee, A. L. Strand, as State Entomologist, was appointed state leader. His duties were as follows:

1. Acting for the committee, to receive applications for federal grasshopper bait from the counties.
2. To cooperate with the federal headquarters at Minneapolis in directing the consignment of bait to Montana points.
3. To act as a clearing house for all reconsignments and diversions of bait within the state.
4. To organize the state into districts and to see that counties securing bait were properly organized to use it in the most effective manner.
5. To arrange for the appointment of county leaders in such counties where no county agents were already available.
6. To conduct the campaign in the most effective manner possible. To issue printed circulars on methods of using the bait as well as all other phases of the work.

Accordingly the state was divided into five districts, three of which had assistant state leaders to act as supervisors. The districts and personnel were as follows:

District 1. W. B. Mole, Assistant State Leader

County	County Leader
Blaine	E. G. Ferguson
Daniels	Chas. L. Eichhorn[1]
Phillips	H. M. Oerstos
Roosevelt	A. W. Warden
Sheridan	O. A. Lammers
Valley	C. H. Willson

[1] Under special federal appointment for grasshopper control work.

District 2. F. E. MacSpadden, Assistant State Leader

County	County Leader
Cascade	R. E. Cameron
Chouteau	G. A. Rassley
Fergus	W. H. Jones
Glacier	A. L. White
Hill	E. Sandberg
Judith Basin	Basil Asheraft[1]
Liberty	Harold Gunderson[1]
Pondera	A. C. Peterson
Teton	Fred S. Willson
Toole	Harold Gunderson[1]

District 3. W. Ellis Westlake, Assistant State Leader

Carter Fallon	Keith Sime
Custer Powder River	W. H. Lamphere
Dawson	T. B. Holker
Garfield	Carl Sloan[2]
McCone	Thos. S. Hunt[1]
Prairie	Fred A. Finch
Petroleum	Carl Sloan[1]
Richland	O. P. Roberts
Rosebud	Ralph D. Mercer
Treasure	Roy Ward, County Commissioner
Wibaux	M. P. Ostby

District 4. No district leader

County	County Leader
Big Horn	Geo. W. Gustafson
Broadwater	R. E. Ward
Carbon	F. Gordon Westlake[1]
Gallatin	G. A. Woolley
Golden Valley	F. B. Peterson
Jefferson	I. C. Mayfield[1]
Lewis & Clark	R. E. Ward
Madison	Jno. F. Ruppe[1]
Meagher	H. M. Brady, County Clerk
Musselshell	F. B. Peterson
Park	H. W. Knox, County Clerk
Stillwater	C. J. Spaulding
Sweet Grass	Laurence Lyall[1]
Wheatland	Laurence Lyall[1]
Yellowstone	R. B. McKee

[1]Under special federal appointment for grasshopper control work.
[2]Smith-Hughes Instructor, local High School.

District 5. No district leader

County	County Leader
Beaverhead	Bernard Williams[2]
Flathead	R. G. Newell
Granite	— — —
Lake	J. C. Paisley
Missoula	M. M. Oliphant
Powell	A. W. Johnson
Sanders	H. R. Armeling

[2]Smith-Hughes Instructor, local High School.

The law passed by congress carrying the grasshopper appropriation stated specifically that bait was to be furnished only to such counties and such communities as were properly organized to carry on the work in the most efficient manner. The type of organization recommended was exactly that which had been in use in grasshopper campaigns in Montana as early as 1917 and rather extensively used in the large grasshopper outbreaks in this state from 1920 to 1923. The method is described in detail in a Montana Agricultural Experiment Station leaflet entitled "How to Kill Grasshoppers," published in 1923.*

Briefly, each county was divided into communities by the county leader. In each community a leader was appointed although in some cases a committee of three farmers acted for the community. Every district had from one to several mixing stations where the required amount of water was added to the bait. The community leaders and the foremen of the mixing stations had specific duties to perform. Further organization came about through four or five farmers who lived near each other, combining their efforts in the important work of spreading the bait. (See later section on the use of mechanical bait spreaders.) Large scattering crews, in some cases financed through relief money, were organized to treat important stretches of unoccupied land.

Grasshopper control by means of poisoned bait was nothing new to thousands of Montana farmers. Many community chairmen and foremen of mixing stations had acted in the same capacity during the grasshopper outbreaks of the early '20s. In spite of this general familiarity with the methods to be employed, 18,171 farmers attended the organization meetings and many hundreds more the various demonstrations held a little later in the season.

*Probably nothing new in the way of application. A very similar method was used in China for the collection of [illegible] A. D.

From the experience of the 1934 campaign it can be said very definitely that the results in any county or community are directly proportional to the amount of supervision available. Better work was done in the three districts where district supervisors were employed than in the other two districts. With a few notable exceptions, better results were obtained in counties where the county leaders could devote all their time to the control of grasshoppers.

CONTROL OF GRASSHOPPERS BY POISONED BAIT IN 1934

Table 2 gives the amount of grasshopper bait supplied under the federal appropriation to each of 51 counties of the state. The total bait from this source was 19,109 tons. In addition to the federal bait ten counties received a total of 340 tons of bait from an appropriation made for this purpose by the Montana Relief Commission, and Fergus County purchased sixty tons. Consequently there was available altogether 19,509 tons. The formula used by the federal government and followed also in preparing the relief bait was as follows:

Bran	50 per cent
Sawdust	30 per cent
Cane molasses	15 per cent
Crude arsenic	5 per cent
(90 per cent arsenious oxide)	

All the bait was mixed in feed mills located in Billings and Livingston, Montana, and at several different points in Minnesota. The bran, sawdust, and arsenic, in correct proportions, were fed into continuous mixers which, by means of mechanical agitators, beat these ingredients together thoroughly before the hot molasses was sprayed on to them. Contrary to popular belief, the molasses was used primarily as a binder, for otherwise much of the dry arsenic would have separated from the bran and sawdust during shipment. Although the formula used could have been cheapened somewhat and still would have given as good results in most localities, the necessity of providing a bait which would give the very best results under a wide variety of conditions prevented the officers in charge from taking any such chances. Their judgment in this regard was certainly beyond reproach and had the backing of every entomologist in the various states concerned in the campaign.

It is very difficult to predict exactly when grasshopper eggs are going to hatch. This is solely on account of our not being able to

TABLE 2.—GRASSHOPPER BAIT SUPPLIES

County	Bait received: Federal (tons)	Bait received: State relief (tons)	Total bait (tons)	Bait used (tons)	Estimated 1933 survey (tons)	Bait on hand (tons)
Beaverhead	40	0	40	40	27.4	0
Big Horn	280	20	300	274.4	137.8	25.6
Blaine	570	0	570	502	541	68
Broadwater	20	0	20	20	20.5	0
Carbon	213	0	213	202	153.9	11
Carter Fallon	736	40	776	722.4	586	53.6
Cascade	750	0	750	610	496	140
Chouteau	1355	0	1355	1141	1591.5	214
Custer Powder River	420	0	420	368.7	216	51.3
Daniels	705	0	705	605	891	100
Dawson	620	0	620	421.4	660	198.6
Fergus*	780*	40	880	753	437	127
Flathead	20	0	20	12	59.5	8
Gallatin	233.6	0	233.6	163.8	239	69.8
Garfield	180	0	180	180	156	0
Glacier	30	0	30	18.2	123	11.8
Golden Valley	80	0	80	50	54	30
Granite	10	0	10	10	0	0
Hill	1660	0	1660	1527.8	1614	132.2
Jefferson	65	0	65	28.8	12.8	36.2
Judith Basin	440	40	480	414	395.5	66
Lake	100	0	100	58.6	109.1	41.4
Lewis & Clark	70	0	70	48	44	22
Liberty	630	0	630	522	382.5	108
McCone	460	0	460	402	622	58
Madison	46.4	0	46.4	46.4	38.9	0
Meagher	5	0	5	5	—	0
Missoula	20	0	20	13.5	26.4	6.5
Musselshell	60	0	60	40	117.4	20
Park	36.6	0	36.6	32.9	20	3.7
Petroleum	60	0	60	60	60.5	0
Phillips	680	0	680	593.2	668	86.8
Pondera	700	0	700	515.8	721.6	184.2
Powell	20	0	20	10	26.5	10
Prairie	400	0	400	292.5	288	107.5
Richland	730	20	750	635	664	115
Roosevelt	1210	0	1210	1122	1182	88
Rosebud	340	0	340	319.2	149	20.8
Sanders	50	0	50	26.1	19.4	23.9
Sheridan	1465	0	1465	1339	1456	126
Stillwater	340	40	380	248.1	397	131.9
Sweet Grass	40	0	40	40	16	0
Teton	510	60	570	434	404	136
Toole	450	0	450	278	395.4	172
Treasure	50	20	70	57	34	13
Valley	765	0	765	411.2	1293	353.8
Wheatland	120	20	140	124	46.6	16
Wibaux	320	40	360	329.8	237	30.2
Yellowstone	223.4	0	223.4	186.6	187.5	36.8
Totals	19,109	340	19,509	16,254.4	18,017.7	3,254.6

*60 tons of county bait also.

predict the weather. In some years hatching may begin during the first part of April and again there may not be any economic species of young grasshoppers out until late May or early June. It was highly desirable in this campaign to have supplies of bait on hand before the hatching of the eggs had proceeded very far. Consequently with the appropriation not available until March 28, and with the federal officers not able to purchase any supplies until that time, there was necessarily a great rush at the mixing plants to get the first supply of bait to the counties before the hatching of the grasshoppers started. This haste in the purchasing and handling of tremendous quantities of materials accounted for some of the first shipments containing lumpy arsenic and occasionally such high moisture content that heating occurred in transit. However, the method of shipping ready-mixed bait containing everything but the requisite amount of water, especially in a case like this when thousands of tons of poisoned material had to be handled, was very satisfactory. With but very few exceptions, the bait gave excellent results.

The rate at which the bait was laid down at Montana points may be seen from the following tabulation:

Date	Total number of carloads received (20 to 25 ton cars
Up to April 28	30
" " May 1	50
" " " 5	199
" " " 9	290
" " " 13	310
" " " 17	385
" " " 21	410
" " " 25	430
" " " 29	480
" " June 2	610
" " " 6	660
" " " 10	680
" " " 14	790
" " " 18	810
" " " 22	865
" " " 26	890
" " " 30	910
" " July 4	910
" " " 8	920
" " " 12	923

From table 2 it will be seen that 3,254.6 tons of bait was left over from the 1934 campaign. Offhand it may appear that our calcula-

tions were very faulty. It must be remembered, however, that about the first week in July the inevitable loss of practically all dry-land crops in the eastern half of the state was finally realized. No miracle in rainfall could have made much difference after that time. But as late as Friday, July 6, we had every reason to believe that we were going to be several hundred tons short in spite of the additional allotments of bait from the federal government and 340 tons furnished by the Montana Relief Commission. Up to that very day thousands of farmers were using bait to protect what crops they had from grasshopper invasion and were putting out poison even where no crop remained, in order to remove that hazard for the coming season. As long as this was going on district and county leaders did not wish to release any bait to other sections where crops were good. Only a few days prior to this time, farmers in Fergus County had themselves purchased additional bait and the county commissioners had furnished sixty tons to meet the apparent shortage.

Then suddenly it all changed. The spreading of bait in eastern Montana stopped dead. By Tuesday, July 10, we knew the campaign was over there and instead of a bait shortage we had a large surplus. From that time on the demand for bait came mostly from irrigated sections and for the protection of fall wheat, for which latter purpose several hundred tons was used.

USE OF MECHANICAL BAIT SPREADERS

There are two conditions which must be met if the best results are to be obtained with poisoned bran mash. The first is that the bait must be thinly and evenly scattered over the areas where the grasshoppers are, and the second is that the bait must be applied during that part of the day when the grasshoppers are feeding. Under the best conditions one man can spread satisfactorily only about 200 to 300 pounds of bait during the most favorable period in the morning. Of course he can get rid of much more but we are not speaking of wasted bait. In previous campaigns it was well known that farmers, faced with covering a large acreage, would continue to spread bait throughout the entire day which resulted in a great waste of material and dissatisfaction over the results obtained. In other cases when they realized that they could not possibly cover the infested areas they became discouraged and stopped poisoning. Montana farms are larger and operated with much lower man-power

than farms in the more heavily populated states to the east of us. And so, with necessity being the mother of invention, it was in Montana that the first successful mechanical devices for spreading grasshopper bait were developed. Of course end-gate seeders have been used for many years but most of these seeders were not satisfactory and very few of them were ever available.

Figue 4.—A mechanical grasshopper-bait spreader mounted on a truck and operated by belt from rear wheel.

Credit should go to some Hill County farmer (or farmers), who, in 1933, rigged up a combine straw spreader for distributing grasshopper bait. There have been dozens of variations in the design of this type of spreader but the general idea of all of them is shown in figure 4. Fed from a hopper, or by hand, on to a revolving plate possessing four baffles, the bait is thrown out into a swath some 30 to 50 feet wide. In the true straw spreader type the plate does not revolve but only the four paddles. The only essential mechanism, which can not be made by the farmer himself, is a set of beveled gears.

TABLE 3.—NUMBER OF FARMERS USING BAIT, ACRES TREATED, AND NUMBER OF MECHANICAL SPREADERS IN OPERATION

County	No. farmers using grasshopper bait	Acres treated	No. mechanical spreaders
Beaverhead	35	8,000	0
Big Horn	120	51,880	—
Blaine	500	100,100	—
Broadwater	50	1,000	0
Carbon	300	40,202	0
Carter Fallon	925	128,000	30
Cascade	1000	125,000	322
Chouteau	1264	202,780	282
Custer	490	89,260	—
Daniels	580	96,000	280
Dawson	450	70,000	—
Fergus	1232	173,655	223
Flathead	45	2,000	0
Gallatin	558	51,846	2
Garfield	360	36,000	—
Glacier	120	4,000	15
Golden Valley	120	9,000	—
Granite	15	2,000	0
Hill	1027	267,200	250
Jefferson	80	4,800	0
Judith Basin	587	73,282	225
Lake	350	10,000	0
Lewis & Clark	200	6,492	—
Liberty	283	84,497	123
McCone	341	76,000	25
Madison	96	12,683	0
Meagher	20	900	0
Missoula	45	2,500	0
Musselshell	160	7,000	0
Park	82	6,009	1
Petroleum	122	12,620	25
Phillips	978	100,000	77
Pondera	820	88,382	147
Powell	25	1,800	0
Powder River	30	2,800	—
Prairie	381	61,440	76
Richland	750	108,000	24
Roosevelt	1250	235,000	300
Rosebud	347	44,304	—
Sanders	75	4,800	—
Sheridan	1345	306,180	—
Stillwater	290	79,500	40
Sweet Grass	134	7,509	—
Teton	906	72,545	60
Toole	277	49,749	90
Treasure	125	10,500	8
Valley	845	175,668	40
Wheatland	90	22,000	—
Wibaux	—	52,000	—
Yellowstone	500	36,000	—
Totals	20,805	3,320,105	2,665

*2,000 others in towns to protect gardens.

In 1934 a new development took place. The transmission of old cars, especially those of Model-T Fords, became very much in demand. By properly cutting off the drive shaft and drive shaft housing, the essential beveled-gear device is obtained. A disk fitted with four stationary blades is mounted fast to the shaft which operates in a vertical rather than its accustomed horizontal position. The end of the shaft extends upward into the hopper used for holding the supply of bait and there, with the proper fitting, acts as an agitator to keep

Figure 5.—A battery of grasshopper-bait spreaders constructed from the transmissions of Model-T Fords.

a steady flow of bait falling on the revolving plate below. A battery of such spreaders is shown in figure 5.

Whereas a man spreading bait by hand can cover but five or six acres an hour, most of the mechanical spreaders will cover from forty to sixty acres per hour and do a very much better job. The bait is spread so well and so evenly that it is difficult to find. But the grasshoppers find it and seem to prefer the fine individual flakes of poisoned bait for extraordinary kills were obtained by as little as six to eight pounds of the wet bait per acre.

The third column of table 3 shows that 2,665 such spreaders were in use during 1934. Data are lacking from some counties where we know large numbers of spreaders were employed so that the total number in use was close to 3,000.

GENERAL RESULTS OF GRASSHOPPER POISONING CAMPAIGN IN 1934

By August 28, 1934, twenty-five counties of Montana had been assigned to the "primary drought areas." All of these counties had been carrying on grasshopper control work. Such counties as Sheridan, Roosevelt, Daniels, Valley, Phillips, and Richland were some of the very largest users of grasshopper bait. Data on bait received and bait used in the twenty-five primary drought counties as compared with the twenty-six other counties engaged in control work, are given below:

	Percentage of state's total bait supply received	Percentage of state's total bait supply used
25 primary drought counties	51.9	44
26 non-drought counties	48.1	39.2
Balance or unused bait		16.8

It will be seen that more than half of the bait received went to counties which later became part of the primary drought zone. Furthermore, these counties used up more bait than the twenty-six non-drought counties. From this it is reasonable to believe that grasshopper infestations were reduced in drought counties fully as much as in the other counties where good crops were produced. In fact, on account of its being somewhat easier to kill grasshoppers where crops are sparse than where crops are good, one can safely conclude that even a higher percentage of the grasshoppers was destroyed in the dry counties. This reasoning is borne out by the 1934 egg survey. (See figure 3, page 13). No doubt part of the decrease in the number of grasshopper eggs laid in 1934 was due to the extreme drought, for the examination of hundreds of female 'hoppers collected in eastern Montana showed that very few eggs were developed. But dead grasshoppers don't lay eggs either and without much doubt the tremendous reduction in grasshoppers in the eastern half of the state was due primarily to the poisoning campaign.

Some of the drought counties got back their seed and, in the irrigated sections of these counties, much crop was saved from the grasshoppers by the strenuous baiting campaign. So even though one can not say that the work there was a great success, neither can he say that it was a total loss. By and large with all factors considered, the general belief prevails that it was worth while.

No such involved reasoning need be applied to the north-central counties. In Toole, Liberty, Hill, Teton, Chouteau, Cascade, Judith

Basin, and Fergus, where the great part of our 27,000,000 bushel wheat crop was produced in 1934, the great majority of farmers are convinced they would not have raised a tenth of a crop if they had not controlled the grasshoppers. It was in these counties that the very heaviest infestations occurred. Approximately $200,000 of federal money was spent in the non-drought counties. Suppose we disregard entirely the large acreages in tame hay, oats, barley, and rye, and also the hundreds of gardens in urban as well as rural sections protected from severe if not total loss. And suppose we discount the word of hundreds of farmers and set down only half of the wheat crop in the worst infested counties as being saved from the grasshoppers. Even that conservative method of estimating shows a saving of $7,500,000 at current wheat prices. It would seem that the investment of $200,000 was rather amply repaid.

PLOWING AS A SUPPLEMENT TO THE BAIT METHOD IN GRASSHOPPER CONTROL

By late summer, 1933, it was realized that grasshoppers were going to be so thick in Montana during 1934 that all possible ways of controlling them should be put to use. The dominant species present was the lesser-migratory grasshopper (*Melanoplus mexicanus* Sauss.). Whereas other common species deposit their eggs in sod, along ditch banks, roadsides, etc., the eggs of this species are to be found mostly in stubble fields. Experience in the past had taught us that the poisoned bait method of control would be very seriously handicapped if much "stubbling in" of grain crops was practiced. The poison method is most effective when directed against the invasion of grasshoppers into a field. When the 'hoppers hatch out all over a field poisoning is inefficient and often ineffective. For these reasons a special effort was made to encourage the plowing of all heavily infested fields before the hatching period of the grasshoppers.

Fortunately, on account of heavy rains which fell over most of the state in September, 1933, plowing conditions were very good and many counties showed an increase in fall plowing of as much as 50 per cent above average years. Considerably more than the usual amount of spring plowing was also done, although the "stubbling in" idea was far from eliminated.

Plowing as a method of destroying the eggs, however, did not give uniformly good results. In some cases it was very effective; in others grasshoppers still hatched out successfully. The moisture con-

ditions in the soil seemed to determine the effectiveness of plowing. Moist soil, well worked down after deep plowing, killed the hoppers. Poor plowing in soil which was rather dry did not prove very satisfactory.

THE VALUE OF GRASSHOPPER EGG SURVEYS

One of the greatest aids toward promoting successful grasshopper campaigns in all the western states has been the grasshopper-egg survey conducted each fall since 1931 under the general direction of the Bureau of Entomology, United States Department of Agriculture. Although by far the greater part of the cost of these surveys has been borne by the federal government, in this state the Montana Agricultural Experiment Station and the Montana Agricultural Extension Service have contributed either travel expense or the time of one or two employees during September and October in every year since 1932.

By finding the grasshopper egg pods in the fields, roadsides, ditch banks, pastures, or waste land and determining the approximate number per square foot, a standard system has been developed by which abnormal grasshopper abundance can be predicted with surprising accuracy. The survey data are converted into terms of "percentage infestation" for each county. This means the percentage of total crop area (including hay land) which will have to be poisoned to avoid losses from grasshoppers.

When warning of a coming grasshopper outbreak can be given during the fall prior to the season when trouble is expected, it is very evident how valuable this information can be. For instance a county can decide if farmers themselves can cope with the difficulty or if it will be necessary to provide county money, as provided for under the county insect-pest law. In some instances the impending outbreak may be so great that counties themselves can not support the work. As in the case of the prediction for 1934, it was apparent that an entire region of several states and Canadian provinces was involved in an outbreak comparable with the notorious grasshopper plague of 1875-1880. Support from the federal government seemed to offer the only possible way of prosecuting the intense campaign which would be necessary. Without some accurate basis for estimating the amounts of poisoned bait required in the various states, and in the individual counties of each state, preparations for such a great undertaking would have been next to impossible.

The actual amounts of poisoned bran mash (dry weight) used in fifty-one Montana counties during the 1934 season, together with the amounts estimated (November 1933) for these counties are given in table 1. The figures for the whole state are of some interest:

	Estimated Nov. 1933	Actual
Number of counties requiring bait	51	51
Tons of dry bait	18,017.7	16,254.4
Acres treated	3,613,058	3,320,405

Had it not been for the extreme drought in eastern Montana which stopped all poisoning operations, except on irrigated land, by the first week in July, the estimated and actual figures would have been even closer.

Figure 1, the prediction for 1934 as published in November, 1933, should be compared with figure 2 which gives the location and intensity of the grasshopper outbreak as it actually occurred in 1934. The prediction map indicates the rating given to the whole county. For instance Blaine County was rated 60 per cent infested so far as the crop acreage was concerned and as shown on the map all of it is in the dark, heavy-outbreak area. This does not mean that grasshoppers were expected to occur at this rate over the whole county. The general agreement between the two maps is good. No survey of Powder River County was made in 1933 and other southern counties were rated on very little information.

THE OUTLOOK FOR GRASSHOPPERS IN 1935

As shown in figure 3 only one county, Cascade, is given a rating of 50 per cent for 1935 whereas for 1934 (figure 1) eighteen counties were rated 50 per cent or higher. Only four counties may expect infestations from 25 to 30 per cent. These are Liberty, Teton, Park, and Sweet Grass. Infestations in other counties will be of minor importance compared with what occurred in 1934. All counties have been informed in regard to this survey and the estimated amounts of poisoned bait required.

The total amount of bait needed for 1935 is 3,073.7 tons. There is on hand at the present time in all counties 3,254.6 tons. There will have to be some shifting of bait from counties having far too much to those which have too little. The policy has been adopted, though, of leaving plenty of bait in a county long enough to make sure whether or not it will be needed.

SAY'S PLANT BUG

The first injury to grain crops in Montana by Say's plant bug (*Chlorochroa sayi* Stal.), also known as the grain bug (see front cover), evidently occurred in 1932. During that season a number of wheat fields in Hill County were severely attacked. In 1933 the damage was more severe and over a wider range. By 1934 several thousand acres of wheat were left uncut in the north-central counties because the wheat berries had been destroyed by this insect.

It is a very insidious pest for it sucks the milky juice out of the heads of grain. The field attacked may look quite normal, in fact it may appear to be a good crop, but at harvest time the heads are found to be practically empty or possessing very shrunken berries.

The grain bug is known to occur in all the Rocky Mountain states except Wyoming but its greatest abundance has been reached in Utah, Colorado, Arizona, and New Mexico. Prior to 1932 only three specimens were in the collection of the Montana Agricultural Experiment Station. All came from west of the Continental Divide. Recent correspondence with entomologists of Western states indicates that the grain bug has been of practically no importance for many years except in western Utah where great swarms occurred in 1932 and caused severe damage to grain. It is evidently one of those insects which is of very spasmodic occurrence, reaching great abundance for a few seasons and then dwindling to unimportance for many succeeding years. It is hoped that this will be the case in Montana. A point of great significance in this connection is whether it has always been in the north-central counties or has been introduced there. The former is by far the sounder of the two possibilities. But the nature of its apparent spread from Hill County during the past three years and the fact that no such damage in any degree whatever had been reported from those counties during the previous twenty years seems to lend strength to the introduction idea.

Only the adults and the last instar nymphae attack grain, the younger stages living almost entirely on Russian thistle. Hibernation of the adults takes place under weeds and any other protection which may be found in fields or along roadsides. Accordingly the best, if not the sole control measure, consists in the destruction of all weeds by burning in the late fall so as to expose any hibernating adults. The eradication of Russian thistle as a host plant is of course out of the question so that all efforts must be directed against the over wintering adults. Fortunately they do not burrow into the soil.

THE MORMON CRICKET IN 1933

The Mormon cricket (*Anabrus simplex* Hald.) which occurred in large swarms on the Crow Reservation in 1931 and then decreased rather sharply in 1932, again became very important in 1933. During that season the range in the Pryor Mountains and in the Dryhead country of eastern Carbon County was nearly ruined by these large insects. (See figure 6.) The loss to cultivated crops also increased over that of any previous year. Alfalfa, wheat, barley, oats, and gardens suffered, and in many cases fields were entirely destroyed.

The county commissioners of Carbon County appropriated money for the purchase of dusting machines, arsenic, and hydrated lime for use in the Dryhead. Some success was attained in protecting crops but the work was carried out on too small a scale to reduce the huge cricket population to any marked extent. It became only too evident that by 1934 crickets would make up one of the major agricultural problems in this territory.

In order to bring before the counties concerned and particularly the Indian Service, the magnitude of the problem and the financial support which would be necessary to control the crickets, a survey of the entire area was undertaken during July and August, 1933. Mr. Frank T. Cowan, an entomologist who had many years' experience fighting crickets in western Montana, Wyoming, and Colorado, was employed for a month on this survey. The distribution of the crickets was determined, the egg beds from which the 1934 brood would come were mapped out, and careful estimates made on the number of men, dusters, arsenic and general supplies which would be needed. Copies of these reports, with maps, etc., were transmitted to the Indian Service, through the superintendent at Crow Agency, and to the commissioners of Carbon County, in September, 1933.

THE MORMON CRICKET IN 1934

Nothing was done by the Indian Service until long after the crickets had hatched in the spring of 1934. By May 2, however, the Indian Service and the United States Bureau of Entomology had entered into an agreement relative to the prosecution of the work. Not until late May, when the crickets were practically full grown, were poisoning operations begun on the reservation and, although the work was pressed strenuously through June, July and August, the crickets were not controlled in so far as preventing them from laying eggs was concerned. Migrations from their normal habitats into the

cultivated crops were prevented for the most part but the range was destroyed over a wide territory and millions of eggs deposited for the coming season.

Figure 6.—Mormon crickets—Anabrus simplex being herded together preparatory to burning.

Carbon County furnished funds for the purchase of more dusters and large amounts of arsenic and lime. Poisoning of the crickets began in May and extended through most of the season. Relief labor was employed in the dusting operations. This may or may not have had something to do with the results obtained but the fact remains that crickets were not controlled. Millions of them were killed by burning and poisoning and the rest driven back into the mountains

but not enough of them were exterminated to alleviate conditions in 1935 to any great extent.

In addition to the Crow Reservation and three areas in Carbon County, Mormon crickets increased to alarming numbers in parts of Fergus, Judith Basin, Chouteau, Pondera, Glacier, and Lake counties. They have been bad before in Lake County but not in the other new localities where they have made their recent appearance. The logical thing to do is to wipe out these infestations before control work will become much more costly. The Bureau of Entomology, U. S. D. A. has estimated that the following acreages will have to be treated for crickets in 1935:

Crow Indian Reservation, including parts of Big Horn, Yellowstone, and Carbon counties	20,000 acres
Fergus County	500 "
Judith Basin County	1,000 "
Chouteau County	750 "
Pondera County	1,600 "
Glacier County	960 "
Lake County	200 "
Total	25,010 acres

The cost of these operations is estimated at $34,476. As several other western states are facing a similar situation in regard to the Mormon cricket, an effort will be made in the present session of Congress to obtain financial support for the work. While these estimates include the hiring of foremen in charge of the dusting crews, no general supervision by men with entomological training is provided. This is expected to come from the state.

THE PALE WESTERN CUTWORM

The prevalence of the pale western cutworm (*Agrotis orthogonia* Morr.) is determined very largely by the May, June, and July rainfall of the previous year. Following two years of low rainfall this cutworm attains such abundance that widespread destruction of grain crops is the usual result. Such was the case in 1932 as described in the Twenty-fourth Report of the State Entomologist. Some "hangover" from the large 1932 outbreak was evident in 1933 and considerable loss of wheat was experienced in Valley, Fergus, and Cascade counties. Practically no losses occurred in 1934.

In 1932 only three weather-reporting stations in Montana reported rainfall for May, June, and July of less than four inches.

In 1933 there were thirteen such stations, and in 1934, twenty-seven stations, practically all in the eastern part of the state, showed rainfall below this amount. Only three stations, Canyon Ferry, East Helena, and Ballantine, reported less than four inches of rainfall during May, June, and July, for both 1933 and 1934. An increase in pale western cutworm damage may occur in the vicinity of Clasoil (southeastern Lewis and Clark County), in the dry-land sections near Ballantine, and to some extent in eastern and northeastern Montana in 1935.

INSECT PESTS OF FIELD CROPS

The Sugar-Beet Leafhopper (*Eutettix tenellus* Baker)

In 1934 the disease known as curly top of sugar beets appeared in Montana for what is believed to be the first time in the history of our beet growing sections. The carrier and disperser of this disease is the beet leafhopper. This insect normally breeds in the foothills of arid regions and then migrates to the valleys and sugar beet fields during the early part of the growing season. The disease it carries to the beets is poorly understood at the present time but in many years is responsible for damage estimated in millions of dollars in other Western States.

From Laurel to Worden during the past summer fields of beets were found where two to ten per cent of the beets were affected by the disease. In the Bitter Root Valley less than one per cent of diseased beets occurred. None could be found in the Milk River Valley. In spite of the prevalence of curly top in part of the Yellowstone Valley and the fact that the disease never occurs without an invasion of leafhoppers, very few of these insects could be collected in the beet fields. It is believed that the few insects present at the time the disease was discovered could not have been responsible for the rather extensive infection which obtained.

It has been pointed out at various times in these reports that with shifting climatic conditions in Montana we may expect invasions of southern insects or temporary increases in the normal abundance of local species. During periods of mild weather they increase rapidly to such an abundance that they are suddenly of great economic importance. However, after the intervention of one or two severe winters or a season of high precipitation, they decline to their normal insignificance. This will probably be the case with the sugar-beet leafhopper.

Sugar-beet Maggots

A maggot of an undetermined species caused severe damage in a number of beet fields in southern Montana by cutting off the root system (1934).

The Beet Webworm (*Loxostege sticticalis* L.)

This insect was of slight, if any importance, in 1933 and 1934. Many moths emerged in May, 1933, but the number of larvae which developed was extremely small. This was a remarkable decline from the very extensive outbreak of 1932.

The Colorado Potato Beetle (*Leptinotarsa decimlineata* Say)

This destructive insect was far more abundant over the state in 1934 than for several seasons.

VEGETABLE AND TRUCK CROPS

Cabbage Maggot (*Phorbia brassicae* Bouche)

In spite of a heavy emergence of flies and the deposition of great numbers of eggs on young cabbage plants—especially in the Bitter Root Valley—this insect caused an insignificant amount of damage in 1934. For some unknown reason the eggs failed to hatch. The cabbage butterfly (*Pieris rapae* L.)and the cabbage aphis (*Brevicoryne brassicae* L.) were unusually abundant and destructive.

FRUIT INSECTS

The Black Cherry Aphis (*Myzus cerasi* Fab.)

There are now 49,466 cherry trees in the Flathead Lake region. The great proportion of these are young sweet cherry trees which have been set out during the past three or four years. One of the most injurious pests of young cherries is the black cherry aphis. It withdraws the plant sap and curls the leaves, thus devitalizing the trees, and distorts the terminal growth. (See figure 7.)

The main causes of failure to control this insect in the past have been poor spraying—due largely to lack of proper equipment—and poor timing of the sprays that were put on. It was demonstrated in 1934 that from 95 to 98 per cent control could be obtained by two sprays. The first was applied shortly after the first young aphids had hatched from the overwintering eggs and were resting on the opening buds (March 24). The second was applied April 12 to catch the late hatch of aphis. Thus the majority of the plant lice were killed before the leaves were out. After the leaves have begun to curl spraying is ineffective.

In the above spraying two combinations of materials were used. One was a nicotine sulphate, 1 to 800, with the addition of about 3 pounds of dissolved laundry soap to 50 gallons of spray. The other was a combination of nicotine sulphate, 1 to 800, together with Orthol K summer spray oil at 4 per cent strength. The former gave 95 per cent control, the latter 98 per cent. The oil could have been reduced to 2 per cent and about the same kill obtained. It is believed that a third spray is also necessary shortly before picking time to destroy stray migrants.

Further studies on control and on the life history of the black cherry aphis will be made in 1935.

Figure 7.—Young cherry tree showing a distorted terminal growth caused by a heavy infestation of the black cherry aphis the previous season.

The Cherry Fruit-Fly (*Rhagoletis fausta* O. S.)

This insect, which has occurred in relatively small numbers on the east side of the Flathead Lake for several seasons, was more of a scare than a problem in 1934. It prefers to oviposit in sour cherries and most of the orchards of the locality consist of sweet varieties. The population of flies was so small the past season that efforts at control seemed wasted. However, in 1933, they were more numerous and judging from the large number found in wild pin cherries, this insect is at least an important potential pest. Next season may throw new light on the situation.

Yellow Jackets (*Vespidae*)

This insect appeared this year after most of the Flathead cherry crop was harvested. A few attempts at control gave very poor results. These pests become very serious in some seasons and no satisfactory control method is known. Luckily there is some natural force which reduces the wasps to a minimum following a season of great abundance.

Miscellaneous Cherry Insects of Flathead Orchards

In orchards on recently cleared land various insect defoliators noticeably affect the young trees for the first two years. Several species of beetles and caterpillars were responsible. Hand-picking methods usually suffice in controlling them. Tent caterpillars, fall webworms, red-humped caterpillars, yellow-necked caterpillars, and several solitary species were found feeding on the foliage of the larger trees.

The Oystershell Scale (*Lepidosaphes ulmi* L.)

This is the predominant insect pest of apples in the Flathead region. Trees have been and are being killed or made worthless by the heavy incrustations of scale. Lime sulphur does not seem to be as effective as in the Bitter Root Valley. Many orchardists have been attempting to use lye as a dormant spray but it kills only a small percentage of the eggs. The use of dormant oils has been prejudiced by poor results obtained in the few cases where they were poorly applied.

The Codling Moth (*Carpocapsa pamonella* L.)

In warm seasons the codling moth causes heavy loss of apples in the Missoula and Kalispell districts. It does not occur in the orchards on the east side of Flathead Lake although it has no doubt been carried into that section dozens of times on apple boxes, etc.

During the summer of 1934 two colonies of *Ascogaster carpocapsae* Vier., small parasite of codling moth larvae, were liberated, one colony of about 1500 in the Orchard Homes section close to Missoula and another colony of about the same size in an orchard on Rattlesnake Creek, also near Missoula. During 1935 colonies will be released in the vicinity of Kalispell. This is one of the most effective parasites of "apple worms" and it is hoped that it will become well established in Montana. Attempts to recover the parasite as a check on the success of the introductions will be made in 1935. The Bureau of Entomology, United States Department of Agriculture, raises these small enemies of the codling moth. In 1934, 40,000 of them were shipped to various fruit districts.

INSECTS OF SHADE TREES AND ORNAMENTALS

The spruce gall-aphid, *Adelges cooleyi* Gillette, has been very abundant in western Montana on Colorado blue spruce during the past two seasons. The cottonwood leaf beetles, *Lina scripta* Fabr., and *Chrysomela lapponica (interrupta)* Fab., the cottonwood leaf miner, *Zeugophora scutellaris* Suffr., and the rough plant bug, *Brachymena arborea* Say, were very destructive to cottonwood during both 1933 and 1934.

The Virginia creeper leaf hopper, *Erythroneura vitae* Walsh, which for years has been working westward up the Yellowstone River, crossed the divide into Gallatin Valley in 1932 or 1933 and since 1933 has become extremely destructive to vines in Bozeman.

APPENDIX

A few letters received from Montana farmers relative to the success of the 1934 grasshopper campaign:

Chester, Montana, July 30, 1934.

Dear Sir:

The campaign carried on in Liberty County for the extermination of grasshoppers, has been a tremendous success. I am fully convinced that had this effort not been put forth for their extermination, Liberty County would have harvested scarcely any crop. I hope the good work will be continued in 1935.

Yours truly,
G. A. Isaacs, President
Liberty County Wheat Production Control Association

Coffee Creek, Montana, July 20, 1934.

Dear Sir:

In regards to the grasshopper bait want to say it has surely been a crop saver for us in this community. We haven't killed them all by any means but have kept them down to where the damage they have done is very slight. Expect there will be lots of eggs laid as weather conditions are just right for them, consequently I fear we will need the bait again next year.

Yours very truly,
J. H. Wilson.

Luther, Montana, Aug. 4, 1934.

Dear Sir:

I wish to thank you for your cooperation in distributing grasshopper poison in this community. It has certainly saved a whole lot of crops in this neighborhood and I do not think it dangerous to stock if handled carefully. I have used a considerable amount of it and have not lost any stock. Have sown it in pastures where I had cows and horses. Have also sown it in sheep pastures but kept the sheep of for three or four days after sowing it nad did not lose any. I sow it very thin and leave no chunks. While I have no accurate way of knowing, I believe we killed from 60 to 80 per cent with one sowing.

Very respectfully
Herman E. Kuhl

Scobey, Mont., July 26, 1934.

Dear Sir:

I have been in on the grasshopper poisoning this summer in Shennum Community and we have had very good results where the poison has been put out at right time. It has resulted in 100% kills in places, and where they have not spread any the hoppers are moving in on the green feed that is left. Please do all in your power to have the government keep the poison coming next year.

Yours truly,
R. B. Henbet

Benchland, Mont., July 25, 1934.

Dear Sir:

In regard to the grasshopper poison program we worked under this season in this locality, I am satisfied that it saved many crops, basing my opinion on actual experience and observation. It is, however, an undisputed fact that the instructions given out by the ones in charge of this work were beneficial as to the results obtained in destroying the hoppers, and may I urge that this work be continued until such time that we may have the hoppers destroyed. Unless this work is continued until the hoppers are all destroyed the work and expense we had this spring would be only a temporary relief. We must keep after these hoppers until we get them all destroyed. In this I am not only expressing my opinion and belief, but this is the general opinion of all the farmers in my locality.

Yours very truly,

M. A. Harney.

Geyser, Mont., July 24, 1934.

Dear Sir:

In answer to your letter of a few days ago in regard to results of poison bait, will say we have had really good results and especially on our oats. But we do not want to forget that we still have a lot of work ahead of us this fall if we intend to be able to seed any winter wheat. Also plans for next year's battle should be laid now and not wait until it is too late next year.

Respectfully yours,

Robert J. McKenna.

Moore, Mont., July 27, 1934.

Dear Sir:

In regard to the grasshopper poison will say that I am very well pleased with the results obtained. Fields that were poisoned right had practically no damage while others that were not poisoned had much damage.

Yours truly,

Marvin Meisser.

Buffalo, Mont., July 18, 1934.

Dear Sir:

Had it not been for the grasshopper control program, I would have had very little crop this year, and if the poison is properly handled certainly kills the hoppers. Unless something happens to the eggs this winter grasshoppers will be bad next year.

Very truly yours,

R. E. Merry.

Scobey, Mont., July 24, 1934.

Dear Sir:

During this past season I have had the position of what I call "Grasshopper Boss" in one of the communities in Daniels County—that of the Silver Star District. It will probably be of some interest to you to learn of our success in this community and am taking this occasion to make a sort of report in this respect, especially since the government has furnished free all the poison bait, and a great part of the expense in getting it spread.

In our community it was spread quite freely, and without any hostile attitude, but with the spirit of cooperation. Am not so certain as to its effectiveness in entirely eliminating the grasshopper pest, but reports are that the kill has been great, the dead hoppers lying in bunches under thistle and weeds but it seems that they have been replaced to a great extent. They drift back again, undoubtedly, from off the extensive vacant lands and prairies here that have not been subject to poisoning. Think the campaign against the hoppers in this County has been conducted in an orderly way and as effective as it could have been by most any one. An appreciation is felt towards the government toward its efforts, yet it is also felt that the grasshopper menace has not been removed for another year, unless nature should take some turn to check the reproduction of the hoppers.

Yours very respectfully,

Thos. Imbs.

Lothair, Mont., July 17, 1934.

Dear Sir:

Being a member of the Lothair Community Grasshopper committee I can conscientiously say that the grasshopper campaign put on by the Government has been a grand success. I am of the opinion if we had not had this help to poison off the grasshoppers that we would have had a very short crop, and I am sure that a majority of the farmers are very thankful for this consideration from the government.

Lee Violet.

Scobey, Mont., July 26, 1934.

Dear Sir:

As a committeeman of the Julian district I want to write you a few lines in regard to the results of poisoning hoppers in our district. Will say where it was put out at the right time and right way, we had a one hundred per cent success.

Very truly yours,

Frank Getchel.