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F. LeBlanc

T. Wright

J.B. Taylor

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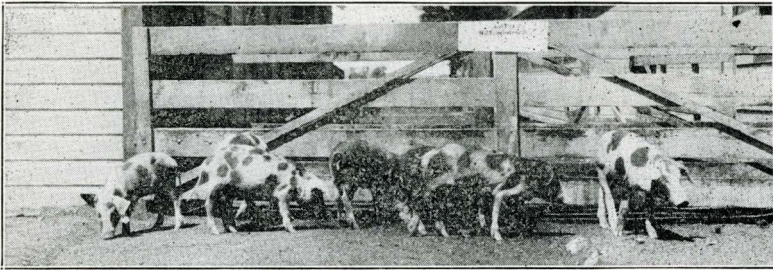
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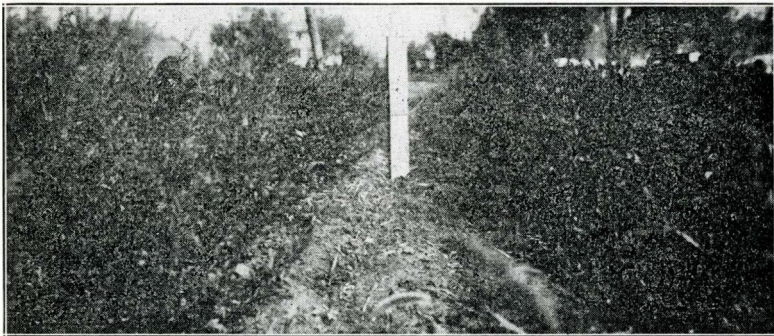
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# Oil of Chenopodium and Chenopodium Plants for the Eradication of Round Worms in Swine



Pigs at Beginning of Experiment



Chenopodium Field Before Grazing

Departments of Pharmacy, Animal Husbandry, and Veterinary  
Agricultural Experiment Station  
South Dakota State College  
of Agriculture and Mechanic Arts  
Brookings, South Dakota.

# **Oil of Chenopodium and Chenopodium Plants for the Eradication of Round Worms in Swine**

By

**Floyd LeBlanc, Turner Wright and J. B. Taylor**

The production of swine is one of the principal industries on many farms in South Dakota. On other farms, where dairying is followed, raising pigs is considered an important adjunct to a successful enterprise.

To be able to keep the pig growing and doing well from birth until a market weight is reached should be the aim of all pork producers. Having this in mind, it is necessary that attention should be given to the parasites, both external and internal, that affect the pig and avoid as far as possible their ravages.

Some five years ago an investigation along this line was planned, enlisting the research facilities of the Pharmacy, Animal Husbandry, Poultry Husbandry, Veterinary and Zoology departments. This particular investigation was conducted by the Pharmacy, Animal Husbandry and Veterinary departments.

The Pharmacy department was interested primarily in the production of oil of chenopodium under South Dakota conditions from plants originally found growing in different sections of the country; and in the proper dosage and methods of administration. The oil of chenopodium used in this experiment was obtained from plants grown in the department's medicinal garden. The Animal Husbandry department, being interested primarily in the economic return or gain from worming pigs, supplied the pigs used in the experiment and fed and cared for them. The Veterinary department made the postmortem examinations at the market and gave expert advice when called on. To date only the eradication of round worms in swine has been given consideration. Extension of the project to include similar studies of parasitic infestation of sheep and poultry will be undertaken in the near future.

Although the present phase of the investigation is not completed this progress report will furnish much valuable information to the pig raiser.

## **Ascaris Lumbricoides (Suum) in Swine**

*Ascaris suum* commonly known as round worm infestation in swine is generally considered a parasitic disease of young pigs although in some instances mature swine may be infested. The round worm has a direct life history and requires no intermediate host in the cycle of its development. The eggs of the round worm are oval in shape and 60 to 75 microns long and 40 to 55 microns wide, a micron being  $1/25000$  of an inch. When the female round worms deposit their eggs in the intestine of the hog, they are not in the infective stage because of the inhibiting effect of body temperature. Outside the animal body the development of the eggs goes on under favorable conditions of temperature, moisture, and oxygen supply until the eggs contain the embryo, in which

stage they are infective. The time varies in which the eggs reach this embryo or infective stage from a few days up to many months or even years. When these eggs containing the embryos are swallowed by pigs they pass through the stomach unharmed and are hatched when they reach the small intestine. The newly hatched larvae are about 0.25 to 0.3 m. m. in length and migrate principally by aid of the circulation. Migration from the intestinal lumen through the portal vein to the liver occurs first. The chief pathological changes in the liver are first, congestion and hemorrhage, and later, the liver shows numerous whitish in-durated areas about 1/4 inch in diameter. After leaving the liver the larvae pass to the heart by way of the hepatic veins and vena cava, and from the heart to the lungs by way of the pulmonary artery. The larvae are now five or ten times larger measuring 1.5 to 2.5 m. m. The principal changes produced in the lung are edema, petechial hemorrhages and lobar or lobular pneumonia. The larvae are coughed up and swallowed, reaching the intestinal tract where they develop into mature worms. The mature worm is cylindrical in shape and pointed at both ends, the color being yellowish brown or slightly red. The female is 6 to 12 inches long and the male 4 to 6 inches long.

The chief symptoms of hogs showing round worm infestation are loss of appetite, vomiting, unthriftiness, cough, "thumps" and difficult breathing. If the worms invade the bile ducts jaundice is produced. The skin and fat become yellow in color and convulsions and death often result. Mature worms in the intestine cause irritation and they secrete a toxin which causes intestinal catarrh. The blood becomes watery and there is an increase of a type of white cells known as Eosinophiles which is a diagnostic criterion of parasitic infestation.

Pigs which are heavily infested with worms are in poor physical condition and their vitality so lowered that they are subject to many infectious diseases. They are not in proper condition to receive vaccination against cholera, and serious losses may result from vaccinating pigs heavily infested with round worms.

In treating pigs for round worm infestation oil of chenopodium and castor oil administered in the proper dosage removes all or nearly all the worms. During this treatment for worms and during the time they are expelled pigs should be kept in a place that can easily be disinfected and cleaned to prevent reinfestation.

Prevention is one of the best means of combating round worm infestation in swine. The system of prevention known as the McLean County System is as follows:

1. Clean the farrowing quarters thoroughly and scrub with boiling water containing one pound of lye to 30 gallons.

2. Brush loose litter and mud from the sows, then wash the udder thoroughly with warm water and soap three days before farrowing and place sow in clean farrowing pen.

3. Confine sow and pigs to farrowing pens until they are moved to clean pasture, and haul—do not drive—them to pasture. Provide feed and water in the clean pasture and keep them there until the pigs are at least four months old.

Pigs kept in pens should be protected from worm infestation by eliminating hog wallows, removing manure to fields not occupied by swine, and by draining yards and pens. Badly infested lots should be plowed and pigs and other hogs kept off the lots for a year.



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If for any reason the methods of prevention outlined are not practiced or carried out efficiently the pigs often become unthrifty and show symptoms of round worm infestation. The question in the mind of the producer then is: Will it pay me to worm these pigs, and if so, what method should be used?

The object of the experiment was: (1) to determine the anthelmintic value of oil of chenopodium distilled from chenopodium plants grown in South Dakota; (2) to determine the effectiveness of different methods of worming pigs with oil of chenopodium; (3) to obtain information on the actual gain resulting from worming pigs during a four to six weeks period after weaning, and (4) to determine methods of utilizing the chenopodium plant in preventing and expelling worms.

Several varieties of chenopodium were grown namely: one from seed obtained in Maryland, one from seed collected in Kansas from a wild variety, one from seed collected in Illinois also found growing wild and one from a cross between the Maryland and the Kansas varieties. The oil obtained from these plants in normal growing years was found to be of good quality, particularly that from the Maryland and the crossed varieties.



Fig. 1.—Chenopodium plant grown in Medicinal Garden. A hybrid variety obtained by crossing *Chenopodium ambrosioides* var. *anthelminticum* with a wild variety.

Preliminary tests were made to determine the anthelmintic value of the oil. Several hundred tests were run, using varying concentrations of the oil on live ascaris contained in large test tubes and kept in a constant temperature water bath. Tests were also run on several lots of wormy pigs. These tests showed conclusively that the oil distilled from plants grown in South Dakota was of decided value as an anthelmintic.

The oil used in these experiments was the South Dakota oil of chenopodium. However, the results obtained may also be duplicated by using oil of chenopodium U.S.P. obtainable at any drug store. The chenopodium plants used in the grazing experiments were set out in the hog lots after they had been started in the greenhouse.

Cultural studies have not received the attention they should have during the past two years because of abnormal weather conditions. Hot dry years without sufficient rainfall in the spring and summer months are not the rule, but the exception in South Dakota, and more extensive cultural studies will be carried out this year. For the past three years we have had a small plot of chenopodium plants grown from seed sown directly in the ground. Chenopodium seed which fell on the ground near the still during distillation germinated and produced a fair sized plant. Chenopodium, sometimes called a weed, does not need rich soil and after it gets a start is able to withstand a considerable lack of rainfall.

The methods used, in administering oil of chenopodium to pigs are as follows:

1. Mixing oil of chenopodium and castor oil with the feed.
2. Giving the oil of chenopodium in capsules and then following with the castor oil.
3. Mixing the oil of chenopodium with castor oil and drenching the pig with this mixture.

Care must be taken in drenching pigs to prevent any oil from entering the lungs, as oil of chenopodium is then very likely to produce death. However, we have drenched several hundred pigs in this manner and have had no fatalities. Our method was to stand the pig upright and hold him between the knees of a person sitting on a chair, open the pig's mouth and allow the mixture of oils slowly to trickle down the throat.

In all of the above methods we first starved the pigs for 48 hours. This was necessary in our first method to get the pigs to eat the mixture of oils and grain. Of course, this is not the only reason for starving, as in the 48 hour period the stomach is completely emptied and the intestines partially emptied. The concentration of oil is then higher and more effective. Water was available at all times. Considerable weight was lost by the pigs, but they were not materially weakened. At first we gave 1 cc. of oil of chenopodium and 1 ounce of castor oil for each 50 pounds of weight. Later we used 1½ cc. of oil of chenopodium for each 50 pounds of weight, and the same amount of castor oil as with the 1 cc. dose. The pigs wormed were generally divided into lots of eight each.

In the first method the required amounts of oil of chenopodium and castor oil were thoroughly mixed with cracked corn and ground barley and then enough water added to moisten the mixture. Oil of chenopodium has a bitter burning taste and it was found that the pigs ate more readily a mixture consisting of half bran and either cracked corn and ground barley with the oils. Hungry pigs will usually consume the mixture of oils in from 2 to 3 hours. This method has the disadvantage in that some pigs

may not eat enough to give them a sufficiently high concentration of the oil to paralyze all of the worms. Samples of feces from each pig were examined for round worm eggs before and after worming. From these examinations it was apparent that some of the pigs retained a few worms after worming in the above manner, as eggs were found on some slides. However, the majority of slides showed no eggs, indicating that treatment was fairly successful.

The second method of administering the oil of chenopodium was to put it in a capsule and give that way, the castor oil being used as a drench. This method is very successful as examinations of feces after worming show only a few eggs on a slide occasionally. This method consumes considerably more time and has no advantage over the third method described in the following paragraph. Difficulty is sometimes encountered in getting the pig to swallow the capsule. We have found that by holding the pig in an upright position and giving a small amount of water with the capsule, it is quite readily swallowed.

In our third method the oil of chenopodium is thoroughly mixed with 1 ounce of castor oil in a small bottle and the pig drenched with this mixture. Enough oil of chenopodium, depending on the weight of pigs, and castor oil, 1 ounce per pig, for an entire lot should be mixed before worming is begun and then the correct amount of the mixture of oils administered. This method consumes very little time and in the examination of the feces after worming we have never found a single egg, indicating that the treatment must have been highly successful in eliminating the round worms.

The pigs in each lot in all the tests, except the one conducted in 1933, were fed a grain mixture consisting of shelled corn and ground barley mixed equal parts by weight, tankage, and a mineral mixture. In addition, each lot of pigs had access to pasture from the time each test was started until frost killed the forage in the fall. The kind of pasture used each year will be brought out in the discussion of the work for that year. In the 1933 trial shelled corn was used instead of the mixture of shelled corn and ground barley. The grain mixture or shelled corn, tankage and mineral mixture were each self-fed, free choice method. The mineral mixture was composed of 50 pounds ground limestone, 28 pounds steamed bone meal, 20 pounds salt, 2 pounds iron oxide,  $\frac{1}{2}$  ounce copper sulphate, and 1 ounce potassium iodide. In each test the pigs used were divided as uniformly as possible with regard to thrift, sex, and weight.

The pigs in all the feeding trials were weighed on three consecutive days at the beginning of the feeding period and again on three consecutive days at the close. The average of the first three weights was taken as the initial weight and the average of the last three weights was taken as the final weight. Individual weights of the pigs also were taken at regular two week intervals, and lot weights were taken on the alternate weeks. Thus a close check was kept on the gains made by each pig throughout each trial.

At the close of the feeding period each year the pigs were sent to the John Morrell & Co. packing plant in Sioux Falls to be killed under test at which time examination of the stomach, intestines and liver of each pig was made by Dr. J. B. Taylor of the Animal Health laboratory of South Dakota State College for evidences of round worm infestation.

The pigs used in the first test were purebred Poland-Chinas, farrowed on the college farm from April 15 to April 30, 1929. No attempt was made



to clean either the sows or pens before the pigs were farrowed. The pigs were raised on a piece of ground considered the most likely infested with worm eggs of any around the college hog plant. It should be noted, however, that a system of pasture and lot rotation to eliminate round worms had been practiced during the previous three years. For that reason, the pigs at the beginning of the experiment were not infested with worms to anything like the extent that would be found with pigs raised on farms where no attempt had been made to eradicate worms. The method used in treating the pigs in this test was to mix the oil of chenopodium and castor oil with the feed. The pigs used were divided into three lots of 9 head each. Those in Lot 1 were not wormed, those in Lots 2 and 3 were wormed on August 12 and those in Lot 3 were wormed a second time 37 days later. A sample of the feces from each pig in Lots 2 and 3 was examined on September 11. The samples from six of the nine pigs in Lot 2 showed no worm eggs while those from the other three pigs showed only a few eggs. The samples from four of the nine pigs in Lot 3 showed no worm eggs while the samples from the other five pigs showed a few eggs. Lot 3 was then wormed a second time on September 18. Samples of the feces from the pigs in this lot were examined on October 17. The samples from eight of the nine pigs showed no worm eggs and the sample from the other pig showed only a few.

The weights and gains of the pigs and the amounts of feed consumed are given in Table 1.

TABLE NO. 1—Summary 1929 Test

	Lot 1	Lot 2	Lot 3
	Not Wormed	Wormed once	Wormed twice
Number of pigs -----	9.	9.	9.
Number of days fed -----	91.	105.	105.
Average initial weight per pig --	57.8	57.0	56.9
Average final weight per pig -----	203.3	206.6	203.3
Average gain per pig -----	145.6	149.6	146.5
Average daily gain per pig -----	1.6	1.4	1.4
Feed consumed per 100 lbs. gain			
Grain -----	354.2	402.8	376.0
Tankage -----	11.4	14.1	10.5

The results in the above table show that the pigs not wormed not only made the most rapid gains but produced 100 pounds of gain on from 20 to 50 pounds less grain than the pigs which were wormed. Starving the pigs for 48 hours during the worming process stopped their gains and by the time the wormed pigs were back on feed the pigs that were not wormed weighed an average of 9 pounds a head more, thus giving them that much advantage. This advantage enabled the pigs that were not wormed to reach the final weight in two weeks less time than the pigs in the other two lots. It should be remembered, however, that these pigs were not badly infested with worms, as was shown by both the examination of the feces and the final slaughter tests, and it is quite possible that worms were not present in sufficient numbers to cause any serious retardation in the rate of growth or in efficiency in the use of feed.

It will be noted that the pigs in Lot 3 made 100 pounds of gain on approximately 25 pounds less feed than did the pigs in Lot 2. These pigs at



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the end of the second worming averaged about nine pounds to the pig lighter than the pigs in Lot 2. The Lot 3 pigs were put on a good alfalfa pasture which had not been used for hogs for three years. The alfalfa was very succulent and afforded excellent grazing. In comparing the feed consumption of the two lots it was found that the pigs on the alfalfa ate less feed than did those that remained on the rape. Pigs fed in other experiments on rape and alfalfa pasture have shown practically the same results for the two pastures. The alfalfa was the only strictly clean pasture available for Lot 3 after the second worming and it was thought that the difference in the two pastures would not cause any appreciable difference in the results. The results actually obtained, however, indicate that the fresh succulent alfalfa proved an excellent change. The decrease in the amount of feed required for 100 pounds of gain probably was due to this change in pastures rather than to the second worming .

The slaughter test at the close of the feeding period showed 20 round worms and 27 liver spots for 7 of the pigs from Lot 1, eighteen round worms and 16 liver spots for 7 of the pigs from Lot 2, and nine round worms and 21 liver spots for 7 of the pigs from Lot 3.

The second trial in this series of tests was conducted in 1930. Pigs from two sources were used. Fourteen pigs grown on the college farm and only slightly infested with worms were divided as uniformly as possible into two lots of seven head each. One of these two lots was not wormed and the other was wormed once. Twenty-one other pigs were purchased from a hog grower near Brookings and divided into three lots of seven pigs each. These pigs, although only about two weeks younger than those grown on the college farm, weighed only about half as much per pig and were badly infested with worms. These pigs were designated as Lots 1, 2, and 3, while the two lots of college pigs were designated as Lots 4 and 5. Alfalfa pasture on which hogs had not run for two years was used.

On July 28, Lot 2, 3, and 5 were wormed by mixing the oil of chenopodium and castor oil with the feed. One month after worming samples of the feces from each pig in the three lots wormed and from each pig in the two lots not wormed, were examined. The samples from six of the pigs in Lot 1, not wormed, showed many eggs, and the sample from the other pig in the lot showed only a few. The samples from four of the pigs in Lot 2, wormed once, showed no worm eggs while those from the other three pigs in the lot showed many eggs. The samples from two of the pigs in Lot 3, wormed twice, showed no worm eggs, while those from the other five pigs in the lot showed many eggs. The samples from three of the pigs in Lot 4, not wormed, showed no worm eggs, the samples from one pig showed only a few worm eggs, while the samples from the other three pigs in the lot showed many eggs. The samples from three of the pigs in Lot 5, wormed once, showed no worm eggs and the samples from the other four pigs in the lot showed only a few eggs.

On September 15 the pigs in Lot 3 were wormed a second time by the same method as used in the first worming. Examination of samples of the feces from these pigs was made on October 15. The samples from five of the pigs showed no worm eggs, the sample from 1 pig showed a few eggs and the sample from the seventh pig showed many eggs.

The weights and gains of the pigs and the amounts of feed consumed are shown in Table 2.

TABLE 2.—Summary—1930 Test

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5
	Not Wormed	Wormed Once	Wormed Twice	Not Wormed	Wormed Once
No. of pigs -----	7.	7.	7.	7.	7.
Average No. of days fed -----	193.	188.	200.	172.	160.
Average initial weight per pig--	24.1	23.6	23.7	47.6	48.0
Average final weight per pig ----	225.6	228.1	233.7	228.7	230.8
Total gain per pig -----	201.5	204.5	210.0	181.1	182.8
Average daily gain per pig -----	1.04	1.09	1.05	1.05	1.14
Feed consumed for 100 lbs. gain					
Grain -----	384.4	366.0	399.5	369.8	342.5
Tankage -----	22.4	24.8	20.8	16.7	18.1
Mineral mixture -----	0.7	0.7	1.0	0.7	1.1

When considering the data brought out in Table 2 it should be remembered that the pigs in Lots 1, 2, and 3 showed more evidence of worms at the beginning of the test than did the pigs in Lots 4 and 5. These pigs also were not only much smaller for their age than those in Lots 4 and 5, but they were of a much more blocky type. As compared with those raised at the college they were "pot bellied," runty, and decidedly lacking in thrift. When they were started it was considered doubtful if many of them would pay for the feed which would be required to bring them to market weight.

The pigs wormed only once at the beginning of the test made the fastest and cheapest gains. This was true for both groups of pigs. The difference as compared with the pigs not wormed was five days less time in one group and 12 days less time in the other group in reaching market weight. The difference in grain required for 100 pounds of gain was 18 pounds in one case and 27 pounds in the other in favor of the pigs wormed once. In each comparison, however, the pigs not wormed used slightly less tankage than the pigs wormed once. The pigs in Lot 1, not wormed, were very "pot-bellied" during the entire time they were on the alfalfa pasture and were quite paunchy even when they reached market weight. This, however, did not keep them from making almost as fast gains as the pigs in the same group which were wormed once and practically as fast gains as those wormed twice. They also were valued the same as the pigs in the other lots when sold. The pigs wormed twice required 15 pounds more grain for 100 pounds gain than the pigs not wormed and 33 pounds more grain for 100 pounds gain than the pigs wormed once. The tankage required, however, was slightly lower than for the other two lots but would not offset the larger amount of grain. The pigs that were wormed lost the "pot-bellied" appearance soon after worming, which would indicate that at least the majority of the worms had been expelled. Summing up, the results obtained in this trial indicate that with pigs badly infested with worms it will pay to worm them once even after they have reached an age of 12 to 14 weeks, but that there is no saving of feed from a second worming.

The slaughter tests at the close of the feeding period showed 9 round worms and 139 liver spots for the pigs from Lot 1, not wormed; eight round worms and 44 liver spots for the pigs from Lot 2, wormed once; six round worms and 77 liver spots for the pigs from Lot 3, wormed twice; fifty-

four round worms and 47 liver spots for the pigs from Lot 4, not wormed; and ten round worms and 23 liver spots for the pigs from Lot 5 wormed twice.

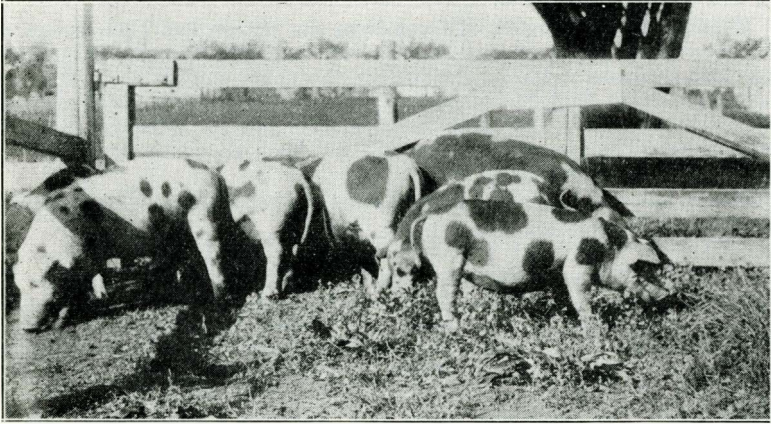


Fig. 2.—Pigs in Lot 1, not wormed, 1930. Near close of feeding period.

The third of this series of tests was conducted in 1931. The pigs used were obtained from the same source as the smaller pigs used in the 1930 trial. These pigs also were small and unthrifty when the test began. Their appearance and the examination of the feces showed they were infested with worms, but to insure a heavy worm infestation round worms were obtained from the Morrell packing plant in Sioux Falls and eggs from these worms were fed to the pigs in their feed on July 21. On August 4 one of the pigs obtained for the experiment died. Examination showed 18 large worms due to the primary infestation and innumerable small worms in the stomach, intestines and liver. This showed, without doubt, that the pigs were badly infested with worms. On August 5, thirty-two pigs were divided as uniformly as possible into four lots of eight head each. The pigs in Lots 2, 3, and 4 were then wormed, the oil of chenopodium and castor oil being given in the feed. After worming, all the lots were put on an oat and rape pasture seeded on ground where hogs had never been before. Examination of the feces from the pigs in all the lots was made on September 4. During the early part of the test several of the pigs died. Examinations showed that these losses were due to both worm infestation and necrotic enteritis. The examination of the feces of the five pigs remaining in Lot 1 showed four with many eggs and one with no eggs. Of the seven pigs remaining in Lot 2, five showed no eggs and two showed a few eggs. Of the six pigs remaining in Lot 3, four showed no eggs and two, a few. Of the seven pigs remaining in Lot 4, four showed no eggs, two showed a few eggs, and one showed many eggs.

On September 29 the pigs in Lot 4 were wormed a second time by the following method: The pigs were kept without feed for one day and then given a mixture of 1 ounce epsom salts and one-half drachm of salt in a pound of feed per pig. No additional feed was given for another day. Oil



of chenopodium was then administered in capsules to each pig, using  $1\frac{1}{2}$  times our usual average dose. This was followed by one ounce of castor oil per pig. Samples of the feces from the pigs in this lot were examined on November 2. Six of the samples showed no worm eggs and the remaining one showed only a few.

Examination of samples of feces from the pigs in Lot 2 on November 2 showed that they were still heavily infested with worms. They were, therefore, wormed a second time using the same method as in the first worming, except that the amount of oil of chenopodium given was increased by one-half. The feces samples from this lot were examined on December 4. This examination showed five with no worm eggs and two with only a few worm eggs.

The weights and gains of the pigs and the amounts of feed consumed are given in Table 3.

TABLE NO. 3—Summary 1931 Test

	Lot 1	Lot 2	Lot 3	Lot 4
	Not wormed	Wormed twice	Wormed once	Wormed twice
Number of pigs -----	5	7	6	6
Average number of days fed -----	149	166	150	166
Average initial weight per pig ---	29.3	27.2	25.1	25.7
Average final weight per pig -----	231.2	228.5	228.0	228.2
Total gain per pig -----	202.0	201.3	202.9	202.5
Average daily gain per pig -----	1.36	1.21	1.35	1.22
Feed consumed for 100 lbs. gain				
Grain -----	402.1	372.3	355.3	378.3
Tankage -----	20.6	18.8	16.7	18.8
Mineral -----	0.5	0.7	0.8	0.9

These results show that the pigs in Lot 1 (not wormed) and in Lot 3 (wormed once) made the fastest gains or 1.36 pounds and 1.35 pounds per pig per day respectively. The pigs in Lots 2 and 4 (wormed twice) made slower gains or 1.21 pounds and 1.22 pounds, per pig per day respectively. The pigs in Lot 1 not wormed and which made the fastest gains, however, made the most expensive gains. These pigs required 402.1 pounds of the corn and barley mixture, 20.59 pounds of tankage and .54 pounds of mineral for each 100 pounds gain. The cheapest gains were made by the pigs in Lot 3, which were wormed once. These pigs showed practically the same rate of gain as those in Lot 1, but required only 355.3 pounds of the corn and barley mixture, 16.67 pounds of tankage and .79 pounds of mineral for 100 pounds of gain.

The two lots of pigs wormed twice showed a feed requirement for 100 pounds gain practically midway between those wormed once and those not wormed. These results indicate that when pigs show decided worm infestation it pays to worm them once, also if the first worming is efficient it is doubtful if a second worming pays. In this experiment the pigs were given a set-back with the second worming which they did not make up by faster gains afterward. This probably accounts for the higher feed requirement for 100 pounds of gain than for the pigs wormed once.

Examination after the pigs were slaughtered showed six large round worms and 9 liver spots for the pigs in Lot 1; one large and 13 small round worms and 86 liver spots for the pigs in Lot 2; one large and 1 small round



worm and 9 liver spots for the pigs in Lot 3; and eleven large and 25 small round worms and 25 liver spots for the pigs in Lot 4. The large number of liver spots charged to the pigs in Lot 2 were due to the liver of one pig being badly spotted, it being estimated that this liver showed 75 liver spots. The large number of round worms charged to the pigs in Lot 4 was due to one pig having 32 worms.

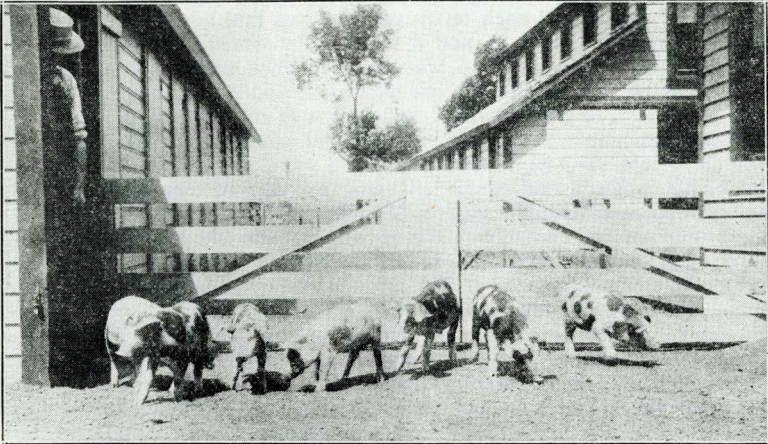


Fig. 3.—Lot 2 wormed once, 1930. At beginning of feeding period.

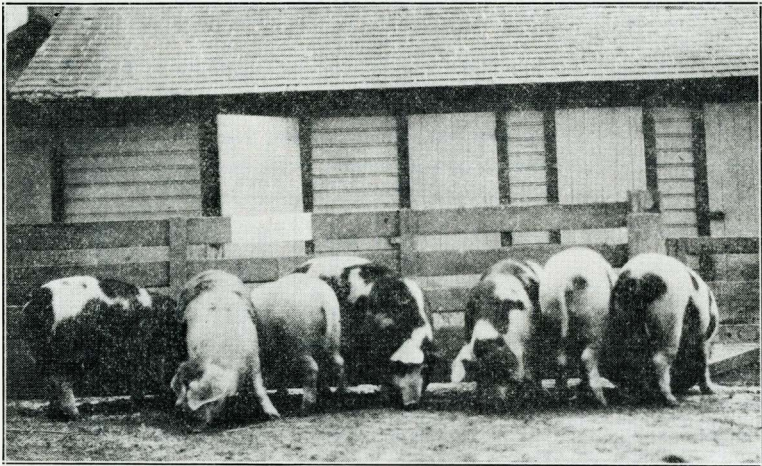


Fig. 4.—Lot 2 wormed once, 1930. At end of feeding period.

A new phase of the investigation was started with the fourth test in 1932. This new phase consisted of grazing or pasturing pigs on the grow-

ing chenopodium plants. The pigs used were grown on the college farm and consisted mainly of Duroc-Jerseys with a few Chester Whites and Poland Chinas. These pigs were farrowed between April 1 and April 20. The 50 pigs selected were kept in one lot after weaning until July 7, at which time the eight pigs showing the heaviest worm infestation as indicated by examination of the feces, were selected and wormed.

In order to insure a heavy infestation of worms 40 pigs were fed eggs obtained from round worms, on July 7. These 40 pigs were divided into five lots of eight head each on August 1, thus making six lots of pigs in the experiment. Lots 1, 2, and 3 were not wormed. Lot 4 was wormed early as stated above. Lot 5 was wormed once and Lot 6 was wormed twice. The pigs in all the lots except Lots 1 and 2 had access to oats and rape pasture. The pigs in Lot 1 had access to oats and rape pasture plus chenopodium plants. The pigs in Lot 2 had access to chenopodium plants only as forage. The pigs in Lots 5 and 6 were wormed on August 1, the oil of chenopodium and castor oil being mixed with the feed. The same method was used with the pigs in Lot 4 wormed on July 8.

Samples of the feces from the pigs in all the lots were examined for worm eggs on September 7. Five of the samples from the pigs in Lot 1 showed no worm eggs, two of the samples a few and the remaining sample many. Five of the samples from the pigs in Lot 2 showed no worm eggs and the remaining three samples showed only a few. Two of the samples from the pigs in Lot 3 showed no worm eggs, three of the samples showed a few eggs and three samples showed many eggs. Two of the samples from the pigs in Lot 4 showed no worm eggs, five showed a few eggs and one showed many eggs. Three of the samples from the pigs in Lot 5 showed no worm eggs, four samples showed a few eggs and one showed many eggs. Four of the samples from the pigs in Lot 6 showed no worm eggs, and the other four samples showed only a few.

Lot 6 was wormed the second time on September 12. The examination of the feces on October 12 showed six samples with no worm eggs and two with only a few.

The weights and gains of the pigs and the amounts of feed consumed are shown in Table No. 4.

TABLE NO. 4—Summary 1932 Test

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6
	Not wormed	Not wormed Chenopodium forage	Not wormed Control	Wormed early	Wormed once	Wormed twice
Number of pigs -----	8	8	8	7*	8	8
Average number of days fed -----	173	152	144	158	138	152
Average initial weight per pig ----	39.8	41.9	40.4	33.7	43.8	42.3
Average final weight per pig -----	224.2	225.0	229.2	227.4	226.9	227.6
Total gain per pig -----	184.4	183.1	188.8	193.7	183.0	185.3
Average daily gain per pig -----	1.07	1.21	1.31	1.23	1.33	1.22
Feed consumed for 100 lbs. gain						
Grain -----	414.3	356.8	336.0	320.1	331.9	343.9
Tankage -----	24.6	30.0	26.2	23.5	26.5	24.4
Mineral -----		1.2	1.1	0.9	0.4	1.0

\* One pig from Lot 4 died on November 26.

The results show that the pigs in Lot 1, not wormed but pastured on the standard rape and oats mixture plus chenopodium plants made the slowest gains and required the largest amount of feed for 100 pounds of gain. The chenopodium plants were not transplanted to this lot until the oats and rape mixture had gotten a good start. Weather conditions were favorable for the oats and rape to make good growth. The result was the chenopodium plants were practically smothered out. Inasmuch as the chenopodium plants have a strong, disagreeable odor and a disagreeable flavor the object of this mixture was to see if the pigs would eat the chenopodium plants when they had access to other forage. The oats and rape mixture supplied an abundance of forage at all times and the pigs apparently left the chenopodium plants untouched. The pigs in this lot did not have so good a shelter as the pigs in the other lots, also there were two especially slow gaining pigs in Lot 1, which accounts for the slower and more expensive gains.

The pigs in Lot 5, wormed once, and in Lot 3 not wormed, made the fastest gains, showing practically the same rate of gain. The pigs in Lot 4, wormed early; in Lot 2, grazed on chenopodium plants; and in Lot 6, wormed twice, class in a slower gaining group with practically the same rate of gain for the three lots. The most economical gains from the standpoint of feed consumed for 100 pounds of gain were made by the pigs in Lot 4, wormed early. The pigs in Lot 5, wormed once, ranked second, and the pigs in Lot 3, not wormed, ranked third in economy of gains. It should be noted that there was only a very slight difference between Lots 5 and 3 in the amount of feed required for 100 pounds of gain.

The results obtained from Lot 4 seem to indicate that if pigs are to be wormed the greatest advantage will be obtained by worming as soon as possible after weaning.

The pigs in Lot 2, grazed on chenopodium plants, made the most expensive gains of any pigs in the experiment. This was probably due to the fact that these pigs were practically without forage during the greater part of the feeding period as they did not learn to eat the plants or develop an appetite for them until late in the season. The examination of the feces of the pigs in this lot after they had begun to eat the chenopodium plants showed fewer worm eggs than feces from the pigs in any of the other lots. Also on postmortem examination fewer worms were found in the pigs from this lot than in the pigs from any of the other lots.

The slaughter test showed 66 large and 78 small round worms and 90 liver spots in the pigs from Lot 1; fifteen large and 28 small round worms and 32 liver spots in the pigs from Lot 2; forty-four large and 15 small round worms and 51 liver spots in the pigs from Lot 3; ten large and 31 small round worms and 31 liver spots in the pigs from Lot 4; thirty-four large and 15 small round worms and 22 liver spots in the pigs from Lot 5; and twenty-eight large and 58 small round worms and 34 liver spots in the pigs from Lot 6.

The pigs used in the 1933 test were crossbred Poland-China-Duroc-Jersey grown on the college farm. They were allowed to run in all the lots around the hog barns where it was thought there might be worm infested ground. By weaning time they were a runty, unthrifty looking lot of pigs.

Samples of the feces of these pigs were taken on July 3 and examined for the presence of worm eggs. Results were positive in almost every case. On July 7, when the pigs were 10 to 12 weeks old they were di-



vided into seven lots of eight pigs each. The eight pigs showing the most worm eggs were put in Lot 4, wormed on July 10, and immediately thereafter put on oat and rape pasture. On July 8 the remaining 6 lots of pigs were fed worm eggs to insure a heavy infestation of worms. These six lots of pigs were kept in dry lots until July 29 when Lots 5 and 6 were wormed. The method of worming this year was to mix the oil of chenopodium with the castor oil and give as a drench. Lots 1, 2, 3, and 7 were not wormed. All of these lots were put on pasture on July 30. Lot 1 had oats and rape sowed in one-half the lot and chenopodium plants in the other half. Lot 2 had chenopodium forage only. The remaining five lots had the standard oats and rape pasture.

Examination of the feces was again made on August 28. Three of the samples from Lot 1 showed no worm eggs four showed a few and one many. Two worms were found in the feces from the pig that showed many eggs. Five of the samples from Lot 2 showed no eggs and three showed a few. Four of the samples from Lot 4 showed no worm eggs, two showed a few and two showed many. No worm eggs were found in any of the samples from Lots 4, 5 and 6. Five of the samples from Lot 7 showed no worm eggs, two showed a few and one many.

The pigs in Lot 6 were wormed a second time on October 7. The examination of the samples of feces from the pigs in this lot on November 8 again showed no worm eggs.

The pigs in Lot 1, having access to both oats and rape, and chenopodium plants ate the chenopodium plants readily and grazed these plants to the ground while the oats and rape mixture remained comparatively untouched. The pigs in Lot 2 having access to chenopodium plants only, also ate the plants readily as shown by Figure No. 5. At the beginning of the



Fig. 5.—Pigs grazing chenopodium plants. Lot 2, not wormed, 1933.

test it was planned to grind green chenopodium plants and mix with the feed given the pigs in Lot 7 but owing to the dry season and the readiness with which the pigs in Lot 2 ate the chenopodium plants it was soon apparent that all of the chenopodium plants available would be needed, therefore the original plan for feeding the pigs in Lot 7 was abandoned.



CHENOPODIUM TO ERADICATE ROUND WORMS IN SWINE 17

The weights and gains of the pigs and the amounts of feed consumed are shown in Tables 5 and 6.

TABLE NO. 5—Summary 1933 Test

	Lot 3	Lot 7	Lot 4	Lot 5	Lot 6
	Control not wormed	Control not wormed	Wormed early	Wormed once	Wormed twice
Number of pigs -----	8.	8.	8.	8.	8.
Average number of days fed -----	122.	126.	145.	122.	126.
Average initial weight per pig --	41.7	40.4	33.8	38.1	39.1
Average final weight per pig -----	225.9	226.1	229.8	229.0	228.4
Total gain per pig -----	184.2	185.7	196.0	190.9	189.3
Average daily gain per pig -----	1.51	1.47	1.35	1.56	1.50
Feed consumed for 100 lbs. gain					
Grain -----	271.4	283.0	266.8	265.9	297.9
Tankage -----	44.1	42.9	37.1	42.6	40.0
Mineral -----	0.5	0.5	0.4	0.7	0.4

TABLE NO. 6—Summary 1933 Test

	Lot 3	Lot 7	Lot 1	Lot 2	Lot 5
	Control not wormed	Control not wormed	Chenopodium and rape for grazing	Chenopodium only for grazing	Wormed once
Number of pigs -----	8.	8.	8.	8.	8.
Average number of days fed -----	122.	126.	126.	119.	122.
Average initial weight per pig --	41.7	40.4	43.3	41.0	38.1
Average final weight per pig -----	225.9	226.1	231.4	226.8	229.0
Total gain per pig -----	184.4	185.7	188.1	185.8	190.9
Average daily gain per pig -----	1.51	1.47	1.49	1.56	1.56
Feed consumed for 100 lbs. gain					
Grain -----	271.4	283.0	281.4	268.8	265.9
Tankage -----	44.1	42.9	41.2	44.7	42.6
Mineral -----	0.5	0.5	0.4	0.5	0.7

The most apparent result shown in these tables is the low grain requirement for 100 pounds of gain. However, the tankage eaten for 100 pounds of gain is higher than in former years. This, no doubt, was due to the prevailing dry weather and the forage not being so succulent as in better growing seasons. The comparative results with the different lots were practically the same as in previous years. The pigs in Lots 5 wormed once, and Lot 2, not wormed, but grazed on chenopodium plants made the fastest gains. The pigs in Lot 4, wormed once, but wormed early, made the cheapest gains with Lots 5 and 2 ranking second and third. The pigs in Lot 2, not wormed but having access to chenopodium plants only for forage, made faster and cheaper gains than the pigs in Lot 3, not wormed but having access to oat and rape pasture for forage. The pigs in Lot 6, wormed twice, made slower and more expensive gains than the pigs in any of the other lots.

The slaughter test showed 13 large and 21 small round worms and 128 liver spots in the pigs from Lot 1; seven large and 19 small round worms and 45 liver spots in the pigs from Lot 2; twenty-three large and 7 small round worms and 18 liver spots in the pigs from Lot 3; three large and 8

small round worms and 20 liver spots from the pigs in Lot 4; seventeen large and 21 small round worms and 114 liver spots in the pigs from Lot 5, fifteen of the large and 9 of the small round worms being in one pig; one large and 3 small round worms and 29 liver spots in the pigs from Lot 6; Twenty-two large and 11 small round worms and 98 liver spots in the pigs from Lot 7.

A summary of the results obtained from the strictly comparable lots of pigs not wormed, wormed once, and wormed twice fed in 1930, 1931, 1932 and 1933 are shown in Table 7.

### Pigs Not Wormed Compared with Pigs Wormed Once and with Pigs Wormed Twice

TABLE NO. 7—Summary of 1930, 1931, 1932, and 1933 Tests

	Pigs not wormed	Pigs wormed once	Pigs wormed twice
Number of pigs -----	28	29	30
Average number of days fed -----	151.	148.	160.
Average initial weight per pig ----	34.7	33.5	33.6
Average final weight per pig -----	227.7	227.4	229.4
Total gain per pig -----	193.1	194.5	195.8
Average daily gain per pig -----	1.28	1.31	1.23
Feed consumed for 100 lbs. gain -----			
Grain -----	343.4	327.8	352.8
Tankage -----	29.1	28.3	25.9
Mineral mixture -----	0.7	0.7	0.8

These results show that the pigs wormed once made the fastest gains, those not wormed ranked second, and those wormed twice ranked third. From the standpoint of the lowest feed requirement for 100 pounds of gain the pigs wormed once ranked first and those not wormed second, those wormed twice ranked third.

The results of the 1932 and 1933 work in which pigs not wormed, but grazed on oats and rape; pigs wormed once, but wormed early and grazed

### Pigs Not Wormed Compared With Pigs Wormed Early, Pigs Wormed Once At A Later Date, Pigs Wormed Twice At Later Dates, And Pigs Not Wormed But Grazed On Chenopodium Plants

TABLE NO. 8—Summary of 1932 and 1933 Tests

	Pigs not wormed grazed on oats and rape	Pigs wormed early grazed on oats and rape	Pigs wormed once grazed on oats and rape	Pigs wormed twice grazed on oats and rape	Pigs grazed on chenopodium plants but not wormed
Number of pigs -----	16.	15.	15.	16.	16.
Average number of days fed -----	133.	151.	130.	139.	136.
Average initial weight per pig ----	41.0	33.7	41.0	40.7	41.5
Average final weight per pig -----	227.5	228.7	227.9	228.0	225.9
Total gain per pig -----	186.5	194.9	187.0	187.3	184.5
Average daily gain per pig -----	1.40	1.29	1.44	1.35	1.36
Feed consumed for 100 lbs. gain -----					
Grain -----	304.1	291.5	298.2	320.7	312.5
Tankage -----	35.1	30.5	34.7	32.3	37.4
Mineral mixture -----	0.8	0.6	0.6	0.7	0.9

on oats and rape; pigs wormed once at a later date and grazed on oats and rape; pigs wormed twice and grazed on oats and rape; and pigs not wormed but grazed on chenopodium plants only are compared in Table 8.

These results show that when compared for rate of gain the pigs wormed once at a later date ranked first, the pigs not wormed and grazed on oats and rape ranked second and the pigs not wormed but grazed on chenopodium plants ranked third. When compared as to feed required to make 100 pounds of gain, or economy of gain, the pigs wormed once but wormed early and grazed on oats and rape ranked first, those wormed once at a later date and grazed on oats and rape ranked second, the pigs not wormed but grazed on oats and rape ranked third, the pigs not wormed and grazed on chenopodium plants ranked fourth while the pigs wormed twice and grazed on oats and rape ranked fifth.

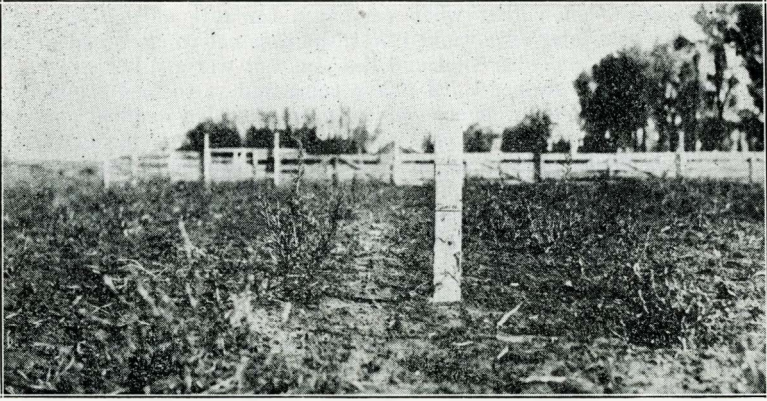
### Summary

1. The results of this series of tests indicate that if pigs are badly infested with worms, worming them once by an efficient method as soon as possible after weaning will reduce feed costs during the subsequent feeding period.

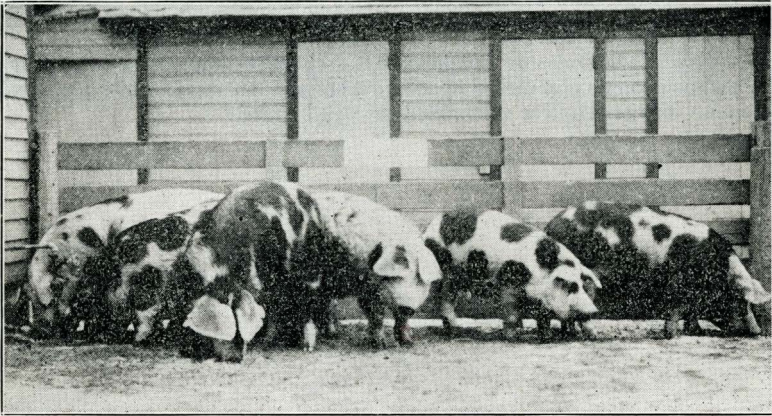
2. Worming the pigs a second time resulted in increased rather than decreased feed costs as compared with pigs wormed only once.

3. The results of two tests indicate that chenopodium plants may be used as a forage crop to eliminate worms and reduce grain and supplements required to produce 100 pounds of gain.

4. Cultural methods for development of chenopodium are now in progress, and as soon as completed specific recommendations as to its practical value as a forage crop for worming pigs will be made.



**Chenopodium Field After Grazing**



**Pigs at End of Experiment**