SCAB OF SMALL GRAINS AND FEEDING TROUBLE IN INDIANA IN 1928[1]

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Cause. In Indiana, the disease of cereals known as scab[2] is chiefly caused by the fungus, *Gibberella saubinetii* (Mont.) Sacc. (*Fusarium graminearum* Schw.). On small grains, it is most serious as a head blight. This first becomes evident by the loss of green color of some of the spikelets. Such spikelets turn yellow (fig. 1) and later brown, followed by the development of a reddish mold. If wet, humid weather prevails, the fungus spreads in the head causing the newly infected portion also to turn yellow, then brown with accompanying development of the reddish mold.

Fig. 1—Effect of scab on wheat. Four heads to the left from Marquis showing different degrees of infection before maturity as indicated by prevalence of light colored spikelets. Head to the right from Little Club showing perithecia development at maturity.

[1]Contribution from the Departments of Botany, Animal Husbandry and State Chemistry Agricultural Experiment Station, Purdue University.

[2]James G. Dickson and E. B. Mains. Scab of Wheat and Barley and Its Control. U. S, Dept. Agr. Farmers Bul. 1599. 17 p. 1929.

The effect on the grain depends upon the stage at which infection occurs. Early infection just following blossoming often completely prevents the development of the kernel, leaving nothing but the glumes covered by the mycelium of the fungus. Kernels infected later are penetrated and enveloped by the fungus and their development stopped. Such kernels are overgrown by a reddish fungus growth and are fragile and easily reduced to a powdery mass. Still later infection may result principally in more or less shrivelling and various degrees of moldy development.

Some seasons, as in 1928, another stage of the fungus develops on the heads before harvest. This is the perithecial stage which appears as small black bodies scattered over the infected heads (fig. 1). This stage also usually develops in the spring on plant rubbish such as straw, corn stalks, etc.

The fungus may also cause a seedling blight. This may develop from scabbed seed or when grain is planted in infected soil. Under such conditions the seedlings are attacked and frequently killed even before emergence. The fungus may also spread to adjacent plants, causing a yellowing and often death, resulting in thin stands. Seedling blight of wheat is favored by high temperatures at planting time.[3] [4]

As mentioned above the fungus lives over winter in rubbish such as infected straw and corn stalks.[5] [6] [7] [8] The perithecial stage, which is developed on such material discharges, its ascospores about the time that the small grains are blossoming. If weather conditions are favorable the heads become infected, with resulting spread and loss in yield and quality.

Situation in 1928. The winter of 1927-1928 was unusually severe for winter wheat in Indiana. In summarizing the situation, Borum and Justin[9] point out that twice in December 1927, following rain storms, temperatures dropped in a short time as much as 50 degrees to points near zero. Snow cover was scanty throughout the winter and the loss in winter wheat acreage was the greatest in the history of the state. It was estimated that 1,500,000 acres of seeded crops were lost. This resulted in the planting of such land with other crops. Barley was one of the crops used and as a result the acreage increased from 35,000 in 1927 to 94,000 in 1928.

The prolonged wet weather in May and June, during and following the blossoming of small grains, was very favorable for the development of scab and as a result reached epidemic proportions such as had not been attained since 1919. Although wheat was probably as severely infected as in 1919, the greatly reduced acreage was responsible for less loss than in 1919. Barley, however, was much more severely infected and the increased acreage made the disease much more of a factor in this crop than in 1919. It is estimated that in Indiana, scab caused a reduction in yield 15% in wheat, 20% in barley, and 3% in oats.

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[3]James G. Dickson and James R. Holbert. The Relation of Temperature to the Development of Disease in Plants. American Naturalist **62**:311-333. 1928.

[4]Jean MacInnes and Raymond Logelman. Wheat Scab in Minnesota. Univ. Minn. Tech. Bul. 18: 32 p. 1923.

[5]G. N. Hoffer, A. G. Johnson and D. Atanasoff. Corn-Rootrot and Wheat Scab. Jour. Agr. Research **14**:611-612. 1918.

[6]J. R. Holbert, J. F. Trost, and G. N. Hoffer. Wheat Scabs as Affected by Systems of Rotation. Phytopathology **9**:45-47. 1919.

[7]D. Atanasoff. Fusarium-Blight (Scab) of Wheat and Other Cereals. Jour. Agr. Research **20**:1-32. 1920.

[8]B. Koehler, J. G. Dickson and J. R. Holbert. Wheat Scab and Corn Rootrot caused by Gibberella Saubinetii in Relation to Crop Successions. Jour. Agr. Research. **27**:861-879. 1924.

[9]C. J. Borum and M. M. Justin. Crop Summary for Indiana, 1928. Indiana Crops and Livestock No. 39:182. 1928.

Feeding trouble. Not only was there a reduction in yield of these cereals but shortly following harvest numerous reports were received from farmers in different parts of the state concerning trouble feeding such grain. These reports increased in number as the season advanced.

In most cases barley was causing the trouble. Fewer reports were received of trouble with oats and only a few cases of trouble with wheat screenings were reported. Most farmers were attempting to use their barley for hog feed and generally they complained that hogs refused to eat the feed or ate very little. In some cases it was stated that hogs were made sick, vomiting after eating the feed apparently after having been forced to it by starvation. In a few cases death of hogs following feeding was reported. A few farmers reported attempting to feed scabby grain to horses and mules. Both refused to eat such grain.

Distribution of the trouble. Over 89 reports of trouble feeding barley were received from the following counties: Adams, several; Allen, 15; Benton, 1; Blackford, 1; Carroll, 6; Cass, 7; Clinton, many; Dekalb, several; Elkhart, 1; Fountain, several; Grant, 2; Hamilton, 4; Hancock, 1; Henry, many; Howard, 1; Huntington, many; Kosciusko, 3; Lake, 1; Laporte, several; Madison, 6; Miami, 2; Monroe, several; Montgomery, 2; Newton, several; Owen, 1; Parke, several; Porter, 3; Pulaski, 4; Randolph, 2; Rush, 1; St. Joseph, 1; Sullivan, 1; Tippecanoe, several; Tipton, 2; Vermillion, 1; Warren, 1; Washington, 1; Wells, 1; White, 2; Whitley, 4. These represented only a portion of the farmers having trouble. In several cases county agents reported the trouble as "general," "many," etc. and several farmers stated that all their neighbors were also having trouble.

In Carroll County, one farmer had 2,000 bushels which his hogs refused to eat but no difficulty was experienced with cattle. In Howard County a farmer reported having 1,000 bushels which hogs refused even when only making up 1-3 of a mixture with other feed. A number of farmers reported having 100 to 800 bushels of barley which they were unable to feed hogs.

Reports of trouble in feeding oats were received from Clinton and Union counties. County Agent V. J. Mann of Clinton County reported that one farmer had trouble feeding horses and mules oats which cows ate. County Agent L. J. Reynolds reported that a group of farmers around Liberty, Union County, were having trouble feeding their oats to hogs. One of these farmers had 3,200 bushesl which he was not able to feed hogs or horses.

A number of samples of the barley and oats causing trouble, were received. In all cases there was a large proportion of kernels infected with scab. These contained from 16 to 65% of infected kernels. Several farmers reported being able to feed barley from one field and not from another. In one case samples were received and the barley causing feeding trouble contained 65% infected kernels and that successfully fed had 9%.

That this trouble was not confined to Indiana was soon evident from reports from neighboring states, especially Ohio, Illinois, Wisconsin and Iowa. Similar trouble with barley shipped from United States was also experienced abroad, especially in Germany.[10] [11] [12] [13]

[10]Stang. Ungeklarte Schadlichkeit amerikanischer Gerste. Deutsche Landw. Presse **39**:564 1928. Abstract. Rev. App. Myc. **8**:98. 1929.

[11]Opperman and Doenecke. Futterungsversuche mit amerikanischer Giftgerste. Deutsche tierarztl. Wochenschr. **37**:165-167. 1929. Abstract Rev. App. Myc. **8**:440. 1929.

[12]H. Miessner and G. Schoop. Uber den Pilzbefall amerikanischer 'Giftgerste' Deutschetierarztl. Wochenschr. **37**:167-170. 1929. Abstract Rev. Appl. Myc. **8**:440. 1929.

[13]Die Ursache der Giftigkeit der amerikanischen Gerste. Mitt. Gesellsch. Vorratsschutz **4**:66-67. 1928. Abstract Rev. App. Myc. **8**:439. 1929.

A search of the literature did not reveal any reference to previous trouble in the United States. An examination of the files of the Department of Animal Husbandry, however, resulted in finding several letters from farmers in 1919 complaining of a similar trouble in feeding barley. The year 1919 was also a severe scab year. Dr. J. G. Dickson in answer to inquiries concerning the situation stated that some trouble had also been experienced in Wisconsin in 1919. Closely related species of Fusarium have been credited with toxic action on man and other animals[14 15 16 17] in Russia causing dizziness, etc.

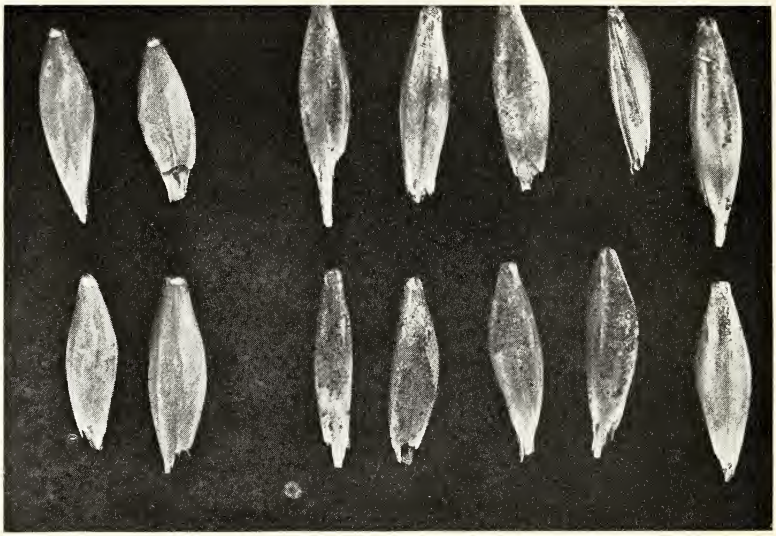

Fig. 2—Scab on Barley. Ten kernels to the left severely scabbed as indicated by light colored mycelium and conidia and black perithecia. Four kernels to the right free from the fungus.

Experiments with Hogs. The widespread trouble in feeding and the number of inquiries resulting made it desirable to obtain more information concerning the situation. Consequently Director J. H. Skinner called a meeting of members of the departments of Chemistry, Animal Husbandry, Dairying, Veterinary, Soils and Crops, Poultry and Botany of the Purdue Agricultural Experiment Station and arrangements were made to study the situation under the chairmanship of Dr. H. R. Kraybill. In these studies the writers have been fortunate in having the advice of Dr. J. G. Dickson of the Department of Plant Pathology of the University of Wisconsin and of the Office of Cereal Crops and Diseases, United States Department of Agriculture, who has made a special study of this disease for a number of years and who freely furnished information concerning his own extensive feeding experiments.

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[14]J. Eriksson. Fungoid Diseases of Agricultural Plants. p. 153-154.
[15]A. Pomaskii. Regarding the Changes in Chemical Composition of Rye Resulting from the Activity of Certain Fusarium Forms. Abstract. Exp. Sta. Record **35**:845. 1916.
[16]A. Pomaskii. Changes in the Chemical Composition of Rye under Influence of Species of Fusarium. Abstract Exp. Sta. Record **36**:635. 1917.
[17]N. A. Naumov. Intoxicating Bread. Abstract Exp. Sta. Record **36**:747. 1917.

Experiment 1. A series of feeding tests were conducted to verify the reports which had been received and to determine whether the objection could be overcome. In the first experiment, six thrifty shoats having a total weight of 695 pounds were changed from a full feed of corn and tankage on a clover pasture to a full feed of dry ground scabby barley and tankage in a dry lot. The barley (lot A) used was a mixture of several varieties of the 1928 crop from the Soils and Crops Department and a count showed 58% of the kernels were more or less scabbed. (Fig. 2). Two of the pigs were fed this barley without modification. For two of the pigs, the barley was cleaned removing the lighter kernels with the idea that this might remove most of the objectional material. About 35% of scabbed kernels still remained. The other two pigs were feed the screenings which consisted largely of scabby kernels.

None of the pigs ate much. At the end of the first three days their total weight was 611 lbs., a loss of 84 lbs. The ration of each lot of two pigs was changed to include one-half ground corn. This stimulated the appetite of all the pigs temporarily and in the next two days the total weight of the six pigs increased from 611 to 626 lbs. However, during the next four days the two pigs fed the mixture of uncleaned barley and corn just maintained their weight, the two fed cleaned barley and corn lost 1 lb. and the two with screenings and corn lost 2 lbs., the total weight of the six being 608 lbs.

The preceding rations were then modified by adding water to the feed at feeding time. This also temporarily stimulated the appetites of the pigs and the weight of the six increased from 608 to 621 lbs. in the next two days. However, at the end of six days the two having uncleaned barley had lost 3 lbs., the two with screened barley had gained 2 lbs. and the two with screenings had maintained their weight, the total weight of the six pigs falling back to 607 lbs. At this time some of the pigs were so weak and emaciated that they were unable to walk with a steady gait.

The rations were then again changed to one-third ground scabby barley, one-third ground oats, one-third ground corn plus tankage for the pigs with the uncleaned and cleaned barley. The pigs which had been fed screenings were changed to a ration of two-thirds ground corn, one-third ground oats plus tankage. These changes stimulated the appetites in each case. At the end of the first three days, the two pigs having one-third uncleaned scabby barley had gained 12 lbs., the two with one-third cleaned scabby barley, 17 lbs., and two without barley had also gained 17 lbs. These rations were continued for 14 more days. At the end of this time, the two pigs fed one-third uncleaned scabby barley had lost 5 lbs. The two with one-third cleaned scabby barley had gained 14 lbs. and the two without barley had gained 27 lbs.

During this experiment, the feeds were kept fresh and were fed according to the appetites of the pigs. The results agreed with most of the reports which had been received. The pigs were not sick. They apparently found the feed disagreeable and reduced their consumption of it. A change in the method of feeding stimulated consumption temporarily after which apparently the effect of the scabby barley again resulted in reduced consumption. Cleaning the barley did not sufficiently reduce the amount of scabby grain of the lot used. It was necessary to reduce this to less than one-third of the ration with other grain before it could be fed with any success. This would indicate that scabbed kernels should be reduced to 10% or less but even this probably depends upon the degree to which such kernels are invaded.

Experiment 2. In connection with the preceding experiment, it was suggested that the sudden change from corn, tankage and clover pasturage to barley might have been responsible for the refusal of the new ration. Consequently another feeding experiment was started September 15, 1928, in which six shoats with a total weight of 723 lbs. were changed from a full feed of corn, tankage and clover pasturage to a ground feed consisting of 9 parts of barley and one part of tankage in a dry lot. The barley used was from the 1927 crop and was practically free from scab. The six pigs ate this ration readily but the change in feed resulted in a temporary loss in weight, the total weight dropping from 723 to 718 lbs., a loss of 5 lbs. in the first two days.

After the first two days, they started to gain in weight, the next day weighing 719 lbs. Three days later (after Sept. 17), they weighed 732 lbs., gaining 13 lbs.; after 5 days, 738 lbs., gaining 20 lbs.; after 8 days, 754 lbs., gaining 36 lbs.; after 11 days 808 lbs., gaining 89 lbs.; after 14 days 825 lbs., gaining 107 lbs. The average daily gain per pig during the period from Sept. 17 to Oct. 1 was 1.27 lbs. The feed was eaten with a relish and all the animals were thrifty. The change to barley had only a slight two day check upon the development of the animals.

It was found possible to divide this lot of six pigs into three groups, each group of two pigs weighing 275 lbs., Group A containing pigs weighing 131 and 144 lbs.; group B, pigs weighing 136 and 139 lbs., and group C, pigs weighing 133 and 142 lbs. Group A was continued on the ration of ground, 1927, scab-free barley and tankage. Group B was changed to a ration consisting of 9 parts of ground, scabby barley and 1 part tankage. A different lot of scabby barley from that used in experiment 1 was fed. This barley (lot B) was obtained from a farmer of Tippecanoe County who had had trouble feeding it to hogs. It contained 51% of kernels showing more or less scab infection. Since some reports had been received that scabby barley had been successfully fed when blackstrap molasses was added, group C was fed 9 parts of ground, scabby barley (B), 1 part tankage and blackstrap molasses diluted with 10 parts of water was poured over the rations at feeding time.

Scabby barley with molasses was fed to group C for 24 days during which time their weight dropped from 275 to 235 lbs., a loss of 40 lbs. Group B fed scabby barley without molasses, dropped from 275 to 260 lbs., a loss of 15 lbs. during the same time. Group A fed scab-free barley increased from 275 to 347 lbs., an increase of 72 lbs.

With the idea that cooking might destroy the objectional principal of the scabby barley, the molasses was left out of the ration of group C and the feed was cooked. This ration was fed for 9 days with a resulting increase from 235 to 241 lbs., an increase of 6 lbs. However, group B on the same ration not cooked also increased from 260 to 271 lbs., an increase of 11 lbs. Group A showed a considerably greater increase, going from 347 to 380 lbs., an increase of 33 lbs.

Group C was then changed to a cooked ration of 9 parts whole scabby barley and 1 part tankage. There was a temporary increase in weight since they increased from 241 to 250 lbs. during the first three days. However, at the end of twelve days, they weighed 240 lbs., a loss of 1 lb. Group B on ground, uncooked scabby barley remained at practically the same weight throughout this period, only changing from 271 to 272 lbs. an increase of only 1 lb. Group A with scab-free barley increased from 380 to 416 lbs. an increase of 36 lbs. These results agree with the reports from several farmers who unsuccessfully tried cooking scabby barley.

To more directly determine the effect of the scab fungus, it was decided to artificially inoculate some of the scab-free 1927 barley. This was done by placing moistened 1927 barley in cotton stoppered quart Mason jars and autoclaving to destroy all saprophytic organisms. A pure culture of *Gibberella saubinetii* which had been isolated from scabbed barley was used to inoculate this material. In order that the material in the jars might be as uniformly penetrated as possible a three-quarter inch glass tube was placed in each jar before filling. The culture of Gibberella had been carried on autoclaved barley in preparation dishes and the glass tube in each Mason jar was filled with the inoculated barley. The tube was then withdrawn leaving a central core of barley with Gibberella from which the fungus spread uniformly through the jar.

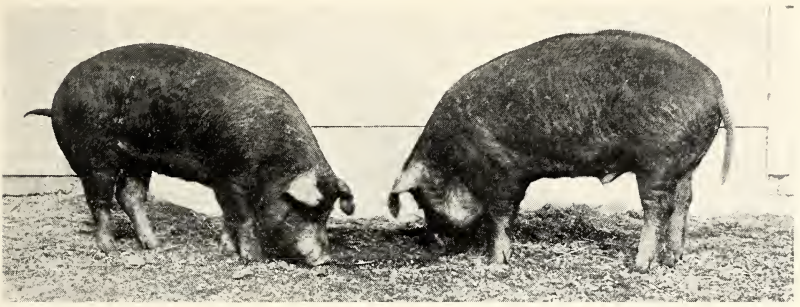

Fig. 3—Two hogs fed scab-free barley. These weighed 275 lbs. at the beginning of the test and at the end, 60 days later, weighed 442 lbs. an increase of 167 lbs.

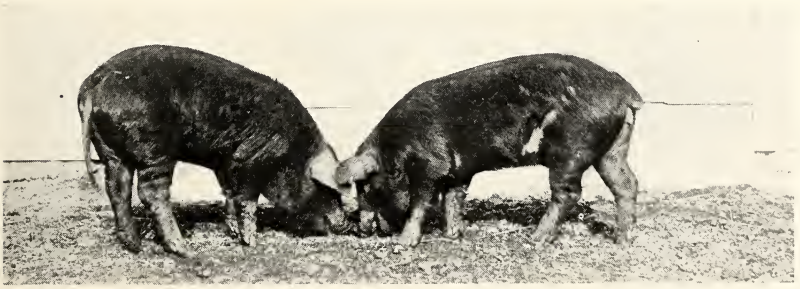

Fig. 4—Two hogs fed scabby barley. These weighed 275 lbs. at the beginning of the test and at the end, 60 days later, weighed 274 lbs. a decrease of 1 lb.

It took the culture about 9 days to thoroughly penetrate the barley. The barley was then removed and rapidly dried at a temperature of about 70° C. Since the development of the fungus in this material was much more extensive than in any of the cases under field conditions, this artifically scabbed material was mixed with the original scab-free barley so that the ration consisted of 1 part artifically scabbed barley, 8 parts scab-free barley and 1 part of tankage.

This ration was then fed for six days to Group A which had been carried for 39 days on scab-free barley with an average gain of 3.6 lbs. per day for the two pigs. These pigs immediately lost appetite and dropped from 416 to 412

lbs., a loss of 4 lbs. Group B on naturally scabbed barley during the same time showed a slight increase from 272 to 273 lbs. Group C on scabby cooked barley dropped from 240 to 235 lbs., a loss of 5 lbs.

Group A was then changed back from the artifically scabbed barley to their original scab-free barley ration and in the next 9 days increased from 412 lbs. to 442 lbs., an increase of 30 lbs. Group B on scabby ground barley increased from 273 to 274 lbs., an increase of only 1 lb. and Group C on scabby whole cooked barley increased from 235 to 244 lbs. or 9 lbs.

During the 60 days of this experiment, group A on scab-free barley (including 6 days on artificially scabbed when weight was lost) increased from 275 to 442 lbs., (fig. 3) an increase of 167 lbs. or an average daily increase per pig of 1.39 lbs. During the same period, the two pigs of group B on ground scabby barley were just about able to maintain their weight (fig. 4) since they weighed 274 lbs. at the end of the experiment. Group C fed on scabby barley with various treatments dropped from 275 to 244 lbs., a reduction which was produced mostly while feeding molasses with the ration.

This experiment shows that pigs are able to make good gains on barley when it is free from scab. However, when such scab-free barley was artificially scabbed and fed, the pigs immediately ceased gaining and finally lost in weight. While the scabby barley did not make the pigs sick, there was a reduced consumption of such barley. These pigs made no gain in weight. Modification of the scabbed barley ration with molasses and cooking did not make such barley more edible.

Experiment 3. Experiments with Rats. On September 9, an experiment was started using 9 young white rats. These were divided into three groups. Group A consisting of three rats weighing 67, 40 and 40 grams totaling 147 grams was fed ground scab-free barley from the 1927 crop. Group B containing three rats weighing 68, 34 and 52 grams totaling 154 grams was fed ground barley (lot A same as used in experiment 1 with pigs) containing 58% of scabby kernels. Group C, containing three rats weighing 70, 36 and 45 grams totaling 151 grams was fed ground scabbed barley of another lot (C) containing 64% of scabby kernels which however were not as thoroughly penetrated by the fungus as in lot A.

A decided difference in the consumption of the feed was immediately noted. During the first seven days the rats of group A on scab-free barley ate 205 grams while rats of group B on scabby barley (A) only ate 83 grams and the rats of group C on scabby barley (C) ate 96 grams. The three rats of group A at the end of the seven days weighed 196 grams, an increase of 49 grams. Group B weighed 120 grams, a decrease of 34 grams, and one rat of this group died on the seventh day. The rats of group C weighed 150 grams, a decrease of 1 gram.

The scabby barley of lot A had much more pronounced results since one rat of group B died on the seventh day, the second on the tenth day, and the third on the twenty-first day. In group C on scabby barley C, one rat died on the eleventh day while the other two lived until feeding was discontinued at the end of the twelfth week. The rats of group A on scab-free barley were fed for 15 weeks and were all alive at the end of the experiment.

The average weekly consumption of food per rat for the rats of group A on scab-free barley was 81 grams, for rats of group B, 30 grams and for group C, 43 grams. The rats of the group on scab-free barley averaged a gain of 11 grams per week per rat for fifteen weeks. The rats of group B lost on the average 8

grams a week per rat during the period they were alive. The rats of group C averaged a gain of 4 grams a week per rat during the period they lived.

The results in this experiment are very similar to those obtained with pigs except that the scabby barley was more toxic and brought about death in several cases. Such rats were examined in the veterinary department and no signs of disease were noted.

Experiment 4. On October 16, another experiment was started using older rats. Two rats weighing 164 and 137 grams averaging 150 grams, constituting group F, were fed scab-free barley. Group G containing three rats weighing 148, 154 and 158 grams, averaging 153 grams, were fed scabby barley of lot B used in feeding pigs. This feeding test ran for three weeks. The rats of group F consumed an average of 126 grams of feed per week per rat while those of Group G consumed 104 grams per week. The rats of group F showed an average gain in weight of 47 grams while those of group G averaged 12 grams.

Experiment 5. On October 25, an experiment was started using barley artificially inoculated with scab as described in experiment 2. This was fed to a group D of three rats weighing 126, 114 and 98 grams, totaling 338 grams. Another group E of three rats weighing 113, 126, 118 grams totaling 357 grams was fed scabby barley of lot B which had been cooked. At the end of the first week group D had consumed 173 grams of feed and group E 155 grams. During the same period group A on scab-free barley had consumed 278 grams. The weight of rats of group D decreased 49 grams. The weight of the rats of group E decreased 37 grams while the weight of rats in group A fed scab-free barley increased 34 grams during the same period. One rat of group D died at the end of the first week. The other two, for another week, gained some in weight but were still 4 grams below their original weight. Artificially scabbed barley therefore produced similar results and cooking did not destroy the objectionable principal.

Experiment 6. Experiment with Guinea Pigs. One experiment with guinea pigs was also tried. One group A, containing two pigs weighing 223 and 232 grams, totaling 455 grams was fed ground scab-free barley. A second group B containing two guinea pigs weighing 262 and 198 grams, totaling 460 grams was fed ground scabby barley B. A third group containing two guinea pigs weighing 206 and 278 grams totaling 484 grams was fed ground scabby barley C. At the end of the first week group A had consumed 275 grams of the scab-free barley, group B only 55 grams of scabby barley A, one dying on the third day and the other on the fourth and group C, 175 grams of scabby barley C. Group A had increased 22 grams in weight. Group B decreased 87 grams and group C decreased 27 grams. After the first week, all of the guinea pigs lost in weight. One guinea pig of group C died at the end of 17 days and the other after 21 days, and in group A after 21 days and 22 days.

Although the guinea pigs in this experiment were not able to develop even on the scab-free barley, the scabby barley was still less favorable.

Experiments with Dairy Cattle. Through the kindness of Prof. H. W. Gregory and Prof. J. H. Hilton of the Dairy Department we are allowed to quote some of the results obtained in feeding experiments with dairy cattle. A ration consisting of 5 lbs. of the scabby barley A used in the previous experiments, 2 lbs. of oats, 1 lb. of bran, 1 lb. linseed oilmeal together with alfalfa hay and silage was fed. This was fed to three cows for 10 days. The cows ate the mixture

readily and no effect was noted on weight, physical condition, milk production or milk quality as compared with the previous ten days. These results agree with reports of farmers who were able to feed cattle scabby barley which they were not able to feed to hogs.

Experiments with Poultry. Through the kindness of Prof. C. W. Carrick and Prof. R. E. Roberts of the Poultry Department we are allowed to summarize the results obtained in feeding experiments with poultry. Scabby barley A made up 20% of a ration with yellow corn, wheat bran, wheat middlings, meat scraps and cod liver oil. This was fed for 5 weeks to 15 eight-week old chicks and to 10 pullets in comparison with a similar ration containing 20% of scab-free barley. There was no reduced palatability due to the scabby barley. The feed consumption of the scabby barley as compared with scabbed-free was slightly greater for the pullets while slightly less for the chicks. There was very little difference in increase in weight between those fed scabby and scab-free barley, the pullets increasing slightly more on the scabby and the chicks slightly more on the scab-free.

SUMMARY. In these studies, hogs found scabby barley distasteful. The consumption was decreased, only enough being eaten to keep from starvation. No cases of vomiting were noted. It seems likely that vomiting probably occurred when hogs ate excessive amounts of the scabby barley with resulting excessive digestive disturbances.

Scabby barley can be fed to hogs as a small part of the ration. The proportion will depend upon the amount of scab in the grain. Since barley containing 35% of moderately scabby kernels had to be reduced to one-third of the ration before the pigs gained in weight, probably it can not successfully be fed when more than 10% of the ration. Since lots of barley differ widely in the amount of scab, the proportion of mixture can best be determined by trial.

Scabby barley can be utilized with cattle. Barley containing up to 58% of scab being successfully fed as 50% of the grain ration. It may also be utilized as 20% of the grain ration for poultry.

While there is no method known by which scab can be completely controlled in Indiana, the disease may be greatly reduced. As already stated the fungus is carried over winter on rubbish, specially corn stalks, straw, etc. It is, therefore, much more severe when wheat is planted in standing corn or where such material is imperfectly plowed under and can be reduced by thoroughly plowing under all crop residues before planting to small grains.

There is considerable evidence accumulating that a choice of varieties may greatly reduce losses from this disease. The varietal susceptibility of winter wheats have not been studied long enough under Indiana conditions to justify recommendation.[18] Among spring wheats, Illinois No. 1, Norka and Progress [19] [20] have shown outstanding resistance[21] (1. c. 2). Among the barleys several strains of Manchuria and Oderbrucker have been very promising. Hooded varieties should be avoided since they are very susceptible.

[18]The relative susceptibility of winter wheat varieties in Missouri has been reported by I. T. Scott. Varietal Resistance and Susceptibility to Wheat Scab. Mo. Agr. Exp. Sta. Res. Bul. 111. 1927.

[19]E. B. Mains. Observations Concerning the Disease Susceptibility of Cereals and Wild Grasses. Proc. Ind. Acad. Sci. **34**:289-295. 1925.

[20]J. G. Dickson, E. B. Mains, and Helen Johann. Progress Report on Cereal Scab Development During the Season of 1928. Phytopath. **19**:108. 1929.

[21]The relative susceptibility of spring wheat varieties in Minnesota has been reported by J. J. Christensen and E. C. Stakman. Susceptibility of Wheat Varieties and Hybrids to Fusarial Blight in Minnesota. Univ. Minn. Agr. Exp. Sta. Tech. Bul. 59, 24 p. 1929.