

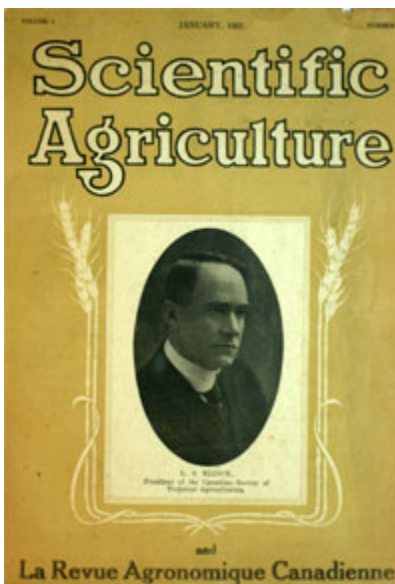


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Number 5

Shaw, AM, 1930, **The Importance of Solar Radiation in the Development of Growing Pigs**, Scientific Agriculture, Vol 11, No. 1, pp 1- 8

SCIENTIFIC AGRICULTURE

Vol. XI.

SEPTEMBER, 1930

No. 1

THE IMPORTANCE OF SOLAR RADIATION IN THE DEVELOPMENT OF GROWING PIGS

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[Received for publication June 6, 1930]

To determine if possible the effect of Solar Radiation or direct light* on young, growing pigs, an experiment was planned with light as the only variable. It has now been repeated four times, the following being a detailed account of the experiments and the results obtained.

FIRST TRIAL

Four groups of 9 pigs each were selected for the trial. Each group was made up as follows: two pigs, 4 months of age; and seven pigs 2 months of age. Pigs from 5 litters were used and distributed as evenly as possible in the 4 groups. The pigs were of Yorkshire breeding. The experiment commenced on December 23rd, 1927 and continued for a period of 126 days.

Housing

The sleeping quarters consisted of wooden buildings 9 feet x 10 feet and about 8 feet high, equipped with plank floors and straw lofts. A yard 10 feet wide and 18 feet long with walls 4 feet high was erected on the south side of each pen. Three of these yards were completely covered so that no light could penetrate into them. The fourth yard was not covered, but simply enclosed by the 4 foot fence. Feeding troughs were placed at the north end of each yard. To enable the attendant to feed the pigs in the covered pens, a drop door just above the trough was arranged so that it could be pushed inward sufficiently to allow the feed to be placed in the trough and yet not allow any light to enter.

Each pen had an opening 2 feet x 3 feet through which the pigs in each group could enter their respective yards. These outlets remained open during the entire trial so that all pigs had the same opportunity for exercise. All pens were kept clean and well bedded with straw, the attendant entering and cleaning pens through doors in the north wall.

The lighting of the pens was arranged as follows:

Pen No. 1 (With open yard) had no glass in it.

Pen No. 2 (With covered yard) had 8 square feet of ordinary window glass placed at such a height in the south wall as to flood the whole interior of the pen with light.

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*Direct light in this experiment refers to sunlight or skylight received by the animals without first being modified by transmission through glass or other absorbing medium.

Pen No. 3 (With covered yard) had 8 square feet of Vita glass (a) placed in south wall in similar position as window in Pen 1.

Pen No. 4 (With covered yard) had no glass in it and was totally dark at all times.

Feeds

All groups were fed exactly alike, the following feeds being used: oats, re-cleaned wheat screenings and wheat middlings. All grain was ground and hand fed dry twice daily with buttermilk as a protein supplement. Each group had access to a mineral mixture containing salt, lime, sulphur and charcoal.

Table 1 shows average gains made by all groups during period of 126 days. The two older pigs in each group have been listed separately from the seven younger pigs.

TABLE 1. *Showing average gains made by all groups during 126 days. First Experiment.*

Pen	Total number of pigs	Average initial weight lbs.	Average final weight lbs.	Average gain for 126 days
1. Open yard	2	82.0	251.0	169.0
2. Window glass	2	84.5	253.0	168.5
3. Vita glass	2	93.0	254.5	161.5
4. Dark	2	79.0	237.5	158.4
1. Open yard	7	41.5	144.3	102.8
2. Window glass	7	42.0	113.1	71.1
3. Vita glass	7	42.1	123.3	81.2
4. Dark	7	36.1	107.5	71.4

It will be noted from the above table that in the case of the pigs that were four months of age at the beginning of the experiment, comparatively little difference in rate of gains occurs. All of them appeared to be able to develop about equally well under their respective conditions. The gains made by these pigs, however, cannot be stressed unduly because of the limited number of animals in each group, although the results are in general agreement with those found in the second experiment. These pigs up until the time they were selected for this experiment were kept under open yard conditions and fed a well balanced ration. It would appear that a sufficient storage of Vitamin "D" had taken place before these pigs were placed on test to prevent the development of rickets during the period of the experiment. In the case of the younger pigs, however, a study of the gains made shows quite clearly that the seven pigs in Pen 1 (open yard) made decidedly better gains than those in Pens 2, 3 and 4.

Some observations made on the physical conditions of the pigs in the various groups are illustrated in the following table:

(a) The Vita glass used in this experiment was purchased from an authorized agent of the manufacturers of this product. It was also subjected to a laboratory test involving the use of the Spectrograph by which it was found to transmit the ultra violet rays down to 2600 Angstrom Units. This test was made in order to make sure that the glass used was a standard product.

TABLE 2. *Showing actual physical condition of all pigs in each group at the conclusion of the first experiment.*

Pen	Total number of pigs	Number of Normal pigs	Slightly Affected with rickets	Number badly Affected with rickets	Number Complete Cripples	Percentage of normal pigs
1. Open yard	9	9	0	0	0	100%
2. Window glass	9	4	1	3	1	44.4%
3. Vita glass	9	4	2	2	1 died	44.4%
4. Dark	9	3	2	3	1	33.33%

It is here clearly shown that some of the pigs in Pen 2, 3 and 4 were unable to develop normally; while, in Pen 1, all the pigs appeared to be normal in every way. It might be pointed out that the two oldest pigs in each group were in every case among those considered normal at the conclusion of the experiment. Only two pigs are listed as complete cripples, but it was quite evident that, had the experiment been carried much longer, most of those affected would have been listed as such.

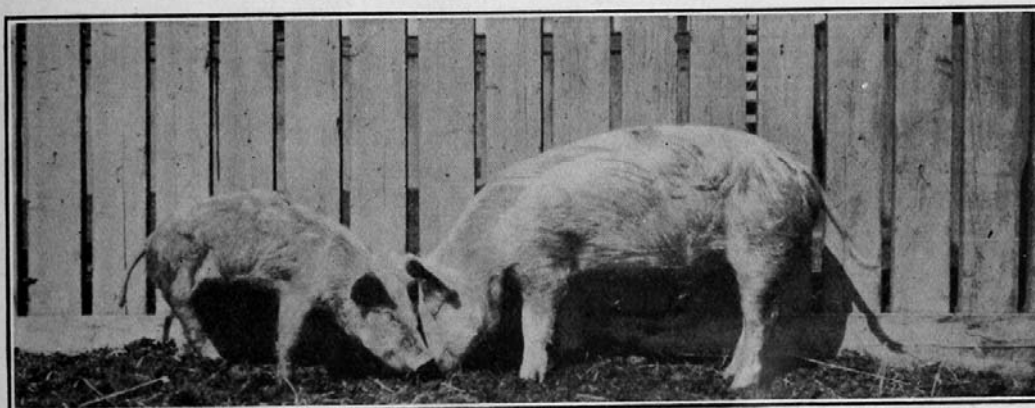


Figure 1. The pigs in this picture are litter mates. The larger one was kept in Pen 1 with access to an open yard. It is normal in every way. The smaller one was kept in Pen 4 without access to light from any source. It is a typical case of rickets. The picture was taken at the end of the first experiment.

SECOND TRIAL

So definite were the results of this trial that it was decided to repeat it the following winter. The same equipment was used. The pigs selected for the second trial were Yorkshires. Litter mates were used as far as possible and distributed evenly throughout the first three groups. The pigs selected for the fourth group and kept in the pen with the open yard were only two months of age at the commencement of the experiment, December 16, 1928. The trial had lasted for 120 days when it was decided to discontinue it on account of the very bad condition of a number of the pigs.

The following table gives a summary of the gains made by each group. No variation existed within the groups as in the previous experiment except that, in the group which was kept in Pen 4, the dark pen, one pig, somewhat older and larger than any of the others, was included.

Not only were the pigs in Pen 1 normal in each experiment, but it might be added that adjacent to the experimental pens both during the winter of 1927-28 and 1928-29 some 150 pigs of the same age and weight were kept in pens similar to No. 1 with entirely satisfactory results. Not a single case of rickets was observed among this rather large number of feeder pigs, indicating very clearly that light is of vital importance in the development of the growing pig.

Related Tests

To secure further evidence that the absence of direct light was the cause of the rickets developing in the various groups, an additional test was made at the close of the first experiment. All the pigs affected were placed in a colony house in a dry lot, fed exactly the same way, but were at liberty to go in or out at will. Immediately it was noticed that all the pigs remained outside of the pen most of the time. They gradually improved until finally even the ones that at the beginning could not stand were able to walk stiffly to the trough. Eventually all recovered sufficiently to be marketed although many bent legs and enlarged joints were still in evidence.

At the end of the second trial, the covering of the yards attached to Pens 2, 3 and 4 was removed. Immediately the pigs took advantage of the

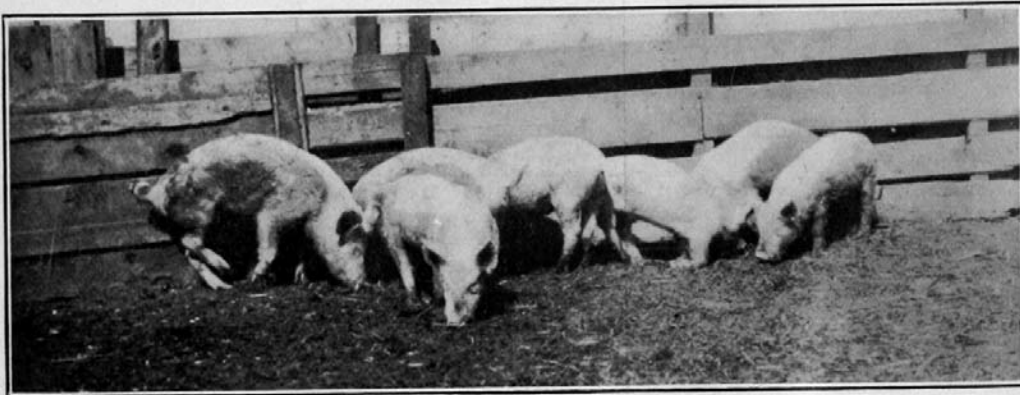


Figure 2. This picture was taken at the close of the second experiment. The pigs shown are from pens 2, 3 and 4 and all are badly affected with rickets.

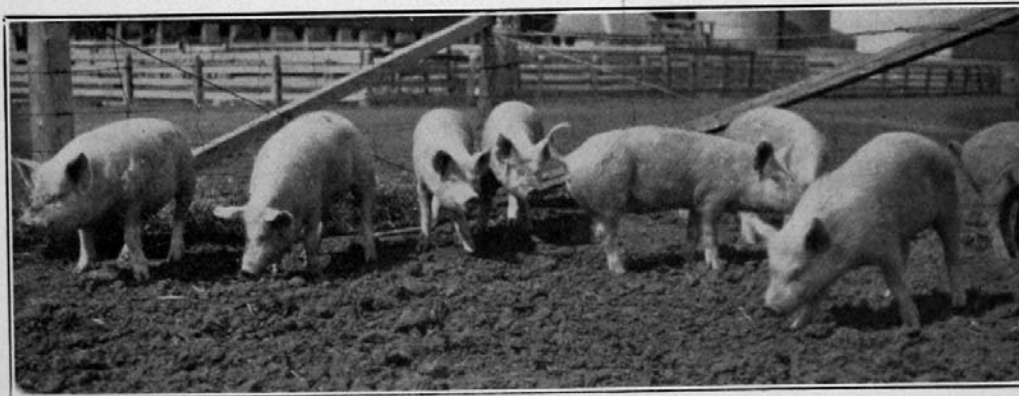


Figure 3. The same pigs as shown in Fig. 2 two months later. A marked improvement was noted very soon after they were given access to an open yard. They continued to improve gradually until they eventually reached an average weight of 200 pounds. The feeds used were exactly the same as during the duration of the experiment. The only change made was to give them free access to an open yard.

light and remained outside the pen, stretched out on their sides most of the time. The skin soon commenced to take on a ruddy hue and, in a comparatively few days, an improvement in their physical condition was noticeable.

At first, some of these pigs were unable to use their hind quarters at all, and dragged themselves about with great difficulty. Others walked on their knees while others had enlarged joints or bent legs. All of them, however, slowly recovered the use of their limbs and gradually began to thrive. Those least affected soon began to gain rapidly in weight and even some of those pigs that were listed as complete cripples at the conclusion of the experiment eventually recovered sufficiently to be marketed.

THIRD TRIAL

During the summer season of 1929, three lots of eight pigs each were placed in "A" shaped colony houses 8 feet x 8 feet square with covered yards 8 feet x 18 feet attached. In this test, the lighting of the houses was arranged as follows:

Pen 1 An opening 4 feet x 4 feet in the south wall of house covered with wire netting (no glass).

Pen 2 Windows 4 feet x 4 feet of common glass.

Pen 3 Windows 4 feet x 4 feet of Vita glass.

The experiment commenced on June 28th, 1929 and continued for 145 days. The method of feeding was similar to that used in the previous trials with the important exception that all lots were fed an abundance of fresh green alfalfa daily. The following table indicates the results obtained:

TABLE 5. *Showing average gain made by all groups during period of 145 days. Third Experiment.*

Pen	Total number of pigs	Average initial weight lbs.	Average final weight lbs.	Average gain for 145 days lbs.
1. Open window	8	28.37	185.	156.6
2. Window glass	8	25.25	166.8	141.6
3. Vita glass	8	24.9	163.4	138.5

No pigs in this test developed rickets, but the group in Pen 1 provided with the open window made decidedly better gains than the group in Pen 2 or Pen 3. Moreover the difference between Pen 2 (common glass) and Pen 3 (Vita glass) was negligible; in fact, was slightly in favor of the group housed behind common glass. The failure of the pigs in this experiment to develop rickets would seem to have been due to the presence of Vitamin "D" in the fresh green alfalfa.

FOURTH TRIAL

As this result was slightly at variance with our previous findings, it was decided to run still another test. This trial commenced on December 12, 1929. Two groups of eight (8) pigs of uniform breeding, age and weight were placed in each lot. A part of the equipment used in the previous experiment was utilized. Pen No. 1 was provided with light through an opening in the south wall 4 feet x 4 feet covered with wire netting and Pen No. 2 received

its light through a window of common glass of exactly the same size: viz., 4 feet x 4 feet. No Vita glass was used in this trial. The pigs were on test 130 days and, during the entire period, both groups were fed exactly alike. The results with regard to average gain appear in Table No. 6.

TABLE 6. Showing average gains made by each group during period of 130 days. Fourth Experiment.

Pen	Total number of pigs	Average initial weight lbs.	Average final weight lbs.	Average gain for 130 days lbs.
1. Open yard	8	39.16	148.5	109.4
2. Window glass	8	38.37	123.6	85.3

The difference in rate of gain is again very distinctly in favor of the group in Pen 1. This difference in weight, however, does not tell the whole story as will be seen by an examination of Table No. 7.

TABLE 7. Showing actual physical condition of all pigs in each group at the conclusion of fourth experiment.

Pen	Total number of pigs	Number of Normal pigs	Slightly Affected with rickets	Number badly Affected with rickets	Number Complete Cripples	Percentage of normal pigs
1. Open yard	8	8	0	0	0	100%
2. Window glass	8	0	5	2	1	0%

All pigs in Pen 2 were affected, one of them being a complete cripple, and all of the others showed unmistakable signs of rickets.

The pigs in Pen 2, by the end of the experiment, were quite definitely on the down grade, while the pigs in Pen 1 were perfectly healthy and had every indication of being in a thriving condition. Owing to the fact that this experiment was carried on during the winter months, the group in Pen 1 was exposed to a much greater extent than those in Pen 2. The temperature in Pen 1 was, at all times, practically the same as the temperature outside, on many occasions the thermometer registering as low as 30° F. below zero. In spite of this apparent handicap, these pigs remained in much better

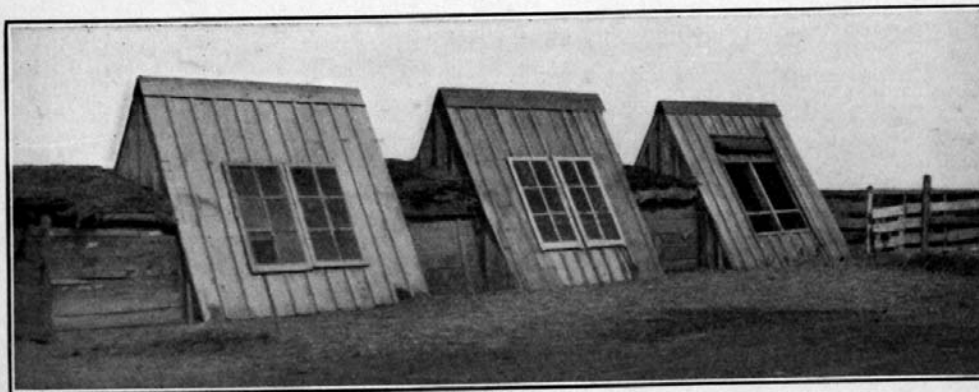


Figure 4. Southwestern exposure of the equipment used in the various experiments. On the left, Pen 3 is provided with a Vita-glass window. The window in Pen 2 (centre) is common glass while Pen 1 on right contains no glass, the opening being covered with wire netting and provided with a curtain which could be let down on particularly cold nights. All openings are of the same size to insure uniform distribution of light.

physical condition than the pigs in Pen 2, which appeared to be much more comfortable in every way.

Many experiments have been conducted in recent years on the biological effects of ultra-violet light, especially in connection with Vitamin "D" in the prevention of rickets. In the majority of these cases, rats or fowls were used; and, although the findings in several instances have some bearing upon the results obtained here, we feel that they are not quite comparable. We would be very glad to hear from anyone who has done work along similar lines using pigs and with light as the only variable.

SUMMARY

The results obtained in the foregoing experiments would seem to justify the following comment thereon:

1. That direct light is necessary for the normal development of pigs.
2. That young pigs fed what would ordinarily be called well balanced rations but deprived of light will develop rickets.
3. That similar young pigs fed in the same manner but having access to open yards or direct light will remain normal.
4. That the light secured through ordinary window glass is of little value in preventing rickets in young pigs.
5. That Vita glass is of very doubtful value. Certainly if superior at all, it is not sufficiently superior to ordinary glass to justify the great difference in price.
6. That, by furnishing an abundance of fresh green legumes or probably other green plant growth, the occurrence of rickets will be prevented.
7. That young pigs show the effect of restricted light much more quickly than older ones.
8. That pigs 3 or 4 months of age that have up to that period developed normally seem to be able to withstand comparatively long periods of restricted light.
9. That access to direct light will cause rapid improvement in affected animals and eventually restore pigs showing evidence of most advanced cases of rickets sufficiently to be marketable.
10. That entirely apart from the development of rickets, the pigs which received direct light made significantly greater gains than all other groups in the experiment.
11. That, in view of the results obtained in this experiment, it would appear that the most satisfactory system of housing for young growing pigs the year round is to provide them with comfortable sleeping quarters with open yards attached to which they can have access at all times.

ACKNOWLEDGEMENTS

The writer wishes to acknowledge the great assistance rendered by J. W. G. MacEwan, B.S.A., M.A., Assistant Professor of Animal Husbandry, University of Saskatchewan; Mr. L. T. Wilson, B.S.A., Instructor in Animal Husbandry, University of Saskatchewan; and Mr. W. G. Kirk, B.S.A., Instructor in Animal Husbandry, University of Saskatchewan in connection with the actual supervision of the experiments while in progress and subsequently with the compilation of data; also to Dr. E. L. Harrington, Ph.D., Professor of Physics, University of Saskatchewan for making laboratory tests of the glass used in the experiments and for valuable advice in connection with radiation.