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U. S. DEPARTMENT OF AGRICULTURE.

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FARMERS' BULLETIN No. 8.

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RESULTS

OF

EXPERIMENTS WITH INOCULATION

FOR THE

PREVENTION OF HOG CHOLERA.

BY

Dr. D. E. SALMON,  
CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

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PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

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WASHINGTON:  
GOVERNMENT PRINTING OFFICE.

1892.



LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
BUREAU OF ANIMAL INDUSTRY,  
*Washington, D. C., May 7, 1892.*

SIR: I have the honor to submit herewith for publication a report upon the results of experiments with inoculation for the prevention of hog cholera.

Very respectfully,

D. E. SALMON,  
*Chief of the Bureau of Animal Industry.*

Hon. J. M. RUSK,  
*Secretary of Agriculture.*

## TABLE OF CONTENTS.

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	Page.
Introductory remarks.....	5
Inoculation as used for the prevention of swine diseases.....	6
Examination of the claims and inoculations made by Dr. Billings, 1887 to 1889.....	9
Protection by inoculation.....	21
Insurance of inoculated hogs.....	23
Failure of inoculation as a private enterprise.....	24
An experimental test of inoculation.....	27
Failure of inoculation in Nebraska during 1891.....	34
The financial aspect of inoculation.....	37

# RESULTS OF EXPERIMENTS WITH INOCULATION FOR THE PREVENTION OF HOG CHOLERA.

## INTRODUCTORY REMARKS.

In the following pages is given a review of the efforts which have been made to discover a method of inoculation that would prevent hog cholera, and also a statement of the tests which have been made to demonstrate the value of inoculation. This evidence is given with considerable detail, and an array of facts is presented which should satisfy any reasonable man of the correctness of the conclusions.

It has been apparent for some time that inoculation as a preventive of hog cholera was a failure. But in spite of this it has been advocated by interested parties for their own purposes, and has been indorsed by a portion of the agricultural press in terms which are inexplicable to those who know the facts. The cases in which inoculation has been performed with little or no loss have been published as proving the success of the operation, while those in which heavy losses have occurred have not been mentioned until the information reached the public in other ways, and then there has been an attempt to explain them away.

It is due to our farmers that they should have all the facts—that they should know all the losses and failures which occur. To hold these back and advocate inoculation is to practice misrepresentation and deception, and to lead farmers to try a method, alleged to be protective, but which is liable to destroy their entire herds and force them into bankruptcy. It has not been a pleasant matter to take up these wrongs which have been practiced on our farmers and to expose them, but they have been carried on with such persistency that this has become necessary.

Inoculation for hog cholera was shown to be of no practical value by the experiments of this Department made in 1886. It proved a failure in the experiments made by the Nebraska Experiment Station in 1888 and 1889. As a private enterprise, there was a failure to carry out the promise to inoculate and to insure the farmer against loss from disease among inoculated hogs. The attempt to establish a business of inoculating hogs at 50 cents a head was a financial failure.

The attempt to protect hogs by inoculation when fed in distilleries was a failure. The attempt to feed hogs on glucose refuse and protect

them by inoculation was the most disastrous failure of all, only because it was attempted on a larger scale. The attempt to show the value of inoculation in the Ottawa experiment was a failure. The attempt to protect hogs by inoculation on the State farm of Nebraska was a failure. The inoculations in Nebraska for the year 1891, taken as a whole, are a failure, and have been followed by nearly or quite three times the average loss which has prevailed among uninoculated herds in the State at large. The whole history of inoculation from beginning to end has been a series of failures. It has caused terrible and disastrous losses to farmers who have been led to test it in their herds. It has been demonstrated to be a means of spreading the disease. Its protective influence has never been conclusively demonstrated, but in many cases it has been proved that inoculated hogs were not protected.

Why, then, should farmers practice inoculation as a preventive against hog cholera? Why should they give the time and trouble and expense which it involves? Why should they take the risk of disease, of stunting their hogs, of loss of weight? There certainly can be no reason for their doing this when the losses among the inoculated hogs are greater than those among hogs in the same State that have not been inoculated.

This Department does not recommend inoculation. It believes it to be injurious and unsafe for the hogs operated upon, dangerous to other hogs in the communities where practiced, and that its protective power is uncertain and of very little effect, even if it exists at all.

With the facts and legitimate conclusions given in this bulletin the question of inoculation is left in the hands of the farmers. Those who decide to test it will do so knowing the consequences which are liable to follow. This Department does not oppose inoculation or attempt to prevent its use, but it believes that the farmers should know all the facts in order that they may decide intelligently whether it is to their interest to adopt inoculation or to avoid it.

#### **INOCULATION AS USED FOR THE PREVENTION OF SWINE DISEASES.**

Inoculation with hog-cholera virus was first tested as a preventive of this disease in the experiments of the Bureau of Animal Industry in the year 1886. The method of inoculation was discovered at that time, but the results were unsatisfactory, as the animals were not sufficiently protected, and the experiments have been repeated under various conditions from that time to the present to learn if any modification of the operation would make it more effectual.

Prevention by inoculation depends on the well-known principle that one attack of a contagious disease generally protects the individual from subsequent attacks of the same contagion. The amount of protection received varies greatly with different diseases and different animals. In no case are all individuals protected in this way from any disease, and in many cases the immunity lasts only for a short period of time.

Inoculation in practice consists in injecting under the skin as much of the strong virus of hog cholera as can be given without producing a fatal attack of the disease. Inoculation is very different from vaccination. The virus used in inoculation is the same in variety and strength as that found in animals dying with the plague, while for vaccination a weakened virus is used, which can not cause a fatal disease. Although vaccination with attenuated virus prepared in several different ways has been tested in the experiments of the Bureau, no method of successfully preventing the disease known as hog cholera by vaccination has ever been introduced or discovered.

Some breeders have advocated inoculation on the ground that vaccination has been found efficacious in preventing smallpox in the human subject, and that, consequently, inoculation should be an equally reliable preventive of hog cholera. In reaching this conclusion they overlook two very important facts. In the first place, there are communicable diseases, such as tuberculosis, from which no immunity can be acquired either from vaccination, inoculation, or an attack of the disease contracted by ordinary exposure. It is therefore impossible to decide such a question by reasoning from one disease to another. The matter of immunity must be determined by observations with each particular disease. In the second place, the effects of inoculation and vaccination are radically different. The vaccine virus, as used in the prevention of smallpox, is not the virus of smallpox, but of a different and distinct disease. It produces a mild disease in cattle and an equally mild disease in people. It never assumes a malignant and fatal character either in cattle or people. For this reason it can be used with safety. Before vaccination was discovered, however, inoculation with smallpox virus was sometimes used, but its results were uncertain and often fatal.

Inoculation is now being advocated as a preventive for hog cholera, and it should be remembered that this means the introduction into the animal's body of the strong virus of the malady, and it is a question of the size of the dose whether the disease produced by this operation is mild or fatal in its character.

The dose is not the only factor which influences the result that follows inoculation. The strength of the virus varies so much in different outbreaks of the same disease that a perfectly harmless dose obtained from one outbreak will be certainly fatal when obtained from another.

There is another influence which has an even greater effect in varying the results of inoculation, and that is the wide difference in the susceptibility of the animals. A dose of virus that will scarcely affect one animal will kill another in the same herd, and there is also such a great difference in the susceptibility in different herds that the dose which might be used on one herd without producing any noticeable effects would set up a disease in another herd and cause the loss of a majority of the animals.

With these varying conditions, which in many cases can neither be foreseen nor controlled, inoculation is an operation which is attended with more or less danger of producing the very disease which we are seeking to avoid. In our experiments we found that a dose of 1 cubic centimeter, i. e., from 15 to 20 drops of the strongest cultivated virus, would occasionally kill an animal. From one-quarter to one-half this quantity, i. e., from 4 to 10 drops, have been given without serious consequences in any case.

Such doses generally produce a swelling where injected, which is at first warm and more or less painful, and later becomes encysted. The center softens, disintegrates, and becomes a purulent mass, which may remain encysted or may force an opening through the skin and discharge for several weeks. An inoculation of this kind produces a slight degree of immunity, because a second inoculation can then be made with 2 or 3 cubic centimeters of virus, i. e., with four to twelve times the first dose, and still no fatal effects result.

The second inoculation increases the immunity, but still the animals are not able to resist the effects of feeding with strong virus or exposure in pens where sick animals are kept. We inoculated about 50 animals in this way in our first experiments, varying the doses somewhat, and only 5 of them resisted the first exposure. By giving two inoculations we of course get a greater degree of protection than can possibly be obtained from one inoculation, with safety to the animals, but the expense of two inoculations is so great that, in order to make the method practical, the inoculator gives only one dose, and generally increases that beyond the limit of safety. Thus, in some experiments that have been made in the West, I am informed that a dose of 1 cubic centimeter, i. e., from 15 to 20 drops, was given, and many herds contracted the disease and died, as should have been anticipated from the experiments previously made by the Bureau of Animal Industry.

In view of these facts, which have been developed by careful and unbiased scientific inquiry, it is scientifically and economically of the greatest importance to thoroughly investigate and consider the evidence brought forward by those who assert inoculation to be a great success before their claims are admitted to be correct.

If inoculation does not protect in a majority of cases from the disease, this alone should be a sufficiently serious objection to prevent its adoption. And if, in addition to a failure to protect, there is a grave danger of stunting the hogs that are inoculated, of producing a fatal form of the disease, and of spreading the contagion to hogs that are not inoculated, then to advocate or adopt this method would be so absurd and preposterous that it could not be expected of sensible and reasonable men.

The question of the value and success of inoculation must, therefore, be decided by an examination of the results of this operation where it has been practiced and tested. It can not be decided by unsupported

assertions nor by plausible arguments which ignore the failures and losses, and take into account only the cases where the animals survive the operation.

The question has become a specially important one. Inoculation has been so persistently and unqualifiedly recommended during the past four years by Dr. Billings, of the Nebraska Experiment Station, and he has been so firmly sustained by the chancellor and regents of the University of Nebraska and by a portion of the agricultural press, that the operation has been adopted and practiced on a scale of considerable magnitude. A widespread interest in the matter has been excited, and many farmers are anxiously inquiring whether the claims that have been put forth are or are not well founded.

The general adoption of inoculation by our farmers either means protection from hog cholera or it means great loss from the cost of the operation and the spread of the disease. Whether one or the other of these results is demonstrated to follow the practice, it is the duty of this Department to collect the facts, to consider them, and to present them to swine growers with the legitimate deductions to which they lead. The time has come when this can be accomplished in a sufficiently complete manner to leave no doubt as to the conclusions which must be reached. An extended correspondence with those who have tested inoculation has brought out many facts of the greatest interest and most direct bearing on the subject. In addition to this an experiment made on a sufficient scale to insure reliable and decisive results, and with every precaution that could be suggested, confirms the conclusion reached from an examination of the practical tests. In fact all the evidence, from the first experiments made by this Bureau early in 1886 to the latest inoculations in Nebraska, is harmonious and points unquestionably to the same general conclusion.

#### **EXAMINATION OF THE CLAIMS AND INOCULATIONS MADE BY DR. BILLINGS, 1887 TO 1889.**

The chief advocate of inoculation has undoubtedly been Dr. F. S. Billings, of the Nebraska Experiment Station, and when others have advocated this practice they have based their opinions upon his experiments. To fully understand the value and bearing of the evidence brought out by his tests, it is consequently necessary to take them up with some detail and examine them with care.

In the Nebraska State Journal, January 21, 1887, he said:

Under the auspices of the State University I have been successful in demonstrating that this disease can be almost absolutely prevented by means of artificial inoculation, and we are prepared to make any test that may be desired with the small number of hogs at our command. \* \* \* As it is, we have as sufficiently demonstrated the fact that vaccine prevention is practical and possible, as we have done it in a large number of hogs, for the tests have been far more severe than could possibly occur to hogs in any infection under natural conditions.

In the same paper for January 25, 1887, he said: "All we now need is the means to make one grand test experiment, which I propose to do as soon as the funds you have so kindly asked for are at our disposal."

Being requested to make this experiment by the State veterinarian, in order that the method might be adopted in the field, if successful, by the State live stock sanitary commission, he replied in a long article, from which the following quotation is made:

I leave it to every practical farmer in Nebraska whether he considers another test necessary to show that prevention by inoculation can be done. Then why is it not practical as well as practicable?

First. Because it stunts the hogs in their growth.

Second. Because the method used consists of a virus which contains the germs or specific cause of hog cholera.

(So long as we use such a virus as that, so long will it be possible for every hog thus inoculated to infect the earth or pens where it is placed, and hence make pestiferous centers where none may previously have existed. As the earth is the natural abode of the germs of this disease, it is self-evident they would again acquire their natural virulence in course of time.)

We have not been engaged to spread this disease, but to prevent it.

These two circumstances were doubtless unknown to the State veterinarian of Nebraska when he suddenly displayed such extraordinary interest in the welfare of the swine breeders of the State. They show the utter folly of continuing this line of experimentation and the test demanded by him.—(Nebraska State Journal, October 9, 1887.)

The above quotation shows that thus early in his investigations the investigator recognized three conclusions as the result of his experiments: First, that inoculation stunted the hogs; secondly, that it spread the disease; and, thirdly, that the method is not practical, and that it is utter folly to continue this line of experimentation.

The experimentation was nevertheless continued, for at the meeting of the National Swine Breeders' Association, November 14, 1888, Dr. Billings said:

I would say to you that there is no question but that we are eventually going to prevent swine plague by inoculation. My tests are more severe than any that have ever been made by Pasteur or anybody else in the line of experiments, and there has been no failure. This year I received word from my assistants that they have inoculated 1,000 hogs. They would have inoculated more, but I myself am opposed to it for the simple reason that the method does not suit me.

Within two weeks after this public announcement that there had been no failure and that 1,000 hogs had been inoculated, the Breeders' Gazette (November 28, 1888) contained the following statement:

Mr. H. H. Hess, Surprise, Nebr., writes: "For the interest of the readers of the Gazette I would like to give my experience with inoculation as a preventive of hog cholera. I had Dr. Billings inoculate 260 head of hogs for me, and he just killed all but 40, and they will die. I consider it the greatest humbug ever heard of. My hogs were perfectly healthy when inoculated."

This and other newspaper articles on the subject brought out a statement by the originator of the experiments, from which the following table is compiled:

Name of owner.	No. inoculated.	No. lost.
Surprise Nebr.:		
D. L. Sylvester.....	93	73.
Ed. Hinkley.....	163	No information.
F. W. Luddon.....	52	None.
L. E. Luddon.....	46	Nearly all.
H. H. Hess.....	260	220.
C. W. Walker.....	11	None.
Gibbon, Nebr.:		
W. A. Rogers.....	10	
L. C. Bassett.....	22	
H. A. Lee.....	154	
Humphrey & Harris.....	34	
D. P. Ashburn.....	18	
Lincoln, Nebr.:		
State Farm.....	30	
Falls City, Nebr.:		
Mr. Steele.....	121	Large number.
Total.....	1,014	

Mr. Walker has since stated that in L. E. Luddon's herd all but 6 died, and that some of Mr. Hinkley's were lost, but the number was not given. An article in the Omaha Bee at the time stated that Mr. Steele lost 110 within thirty days. Mr. Hess states that his total loss was 240. This would make the loss from the information at hand 463 out of the 1,014 inoculated, or 45½ per cent. This does not include Mr. Hinkley's loss, which is unknown.

When it is considered that the experimenter had asserted for nearly two years that he could prevent the disease by inoculation, that during this time the question had been contested and he had been perfecting his method, and that these experiments were made to demonstrate the value of the method, such a complete and disastrous failure in the results is certainly surprising. Under such circumstances it is self-evident that more than ordinary care would be observed in preparing the virus, and in having the conditions as favorable as possible for success.

An attempt has been made to explain these losses on the theory that the herds were infected before they were inoculated, and that the inoculation had nothing to do with the production of the disease. It is said that in one herd several had died before the inoculation; that the two Luddon brothers, who were among those that inoculated, lived side by side, the road only separating their dooryards; that their hogs were inoculated at the same time and in every particular alike, using virus out of the same bottle, yet not one out of the larger herd sickened perceptibly, while with the other herd all but six died; that another brother had a dozen or more hogs that were not inoculated and were kept in a tight pen on the premises with the latter herd, to which they were in no way exposed, "but simultaneously with them sickened and died in about the same ratio." From this it was argued that no poison could

work that way, "fatal or harmless according to the side of the highway on which it was administered."

In considering this explanation, we can not lose sight of the fact that the virus of contagious diseases is exactly the one poison which does act in an unequal and apparently erratic manner. When a roomful of school children are exposed to one of their number affected with measles or scarlet fever, every child does not contract the disease, though all are equally exposed. The children of some families will contract the disease, while those of other families will remain free from it. This is not the result of living on different sides of a street or in different parts of a town, but it is due to the difference in susceptibility, which varies both with individuals and with families.

The observation of natural outbreaks of hog cholera also shows that, with animals equally exposed, some will contract the disease and die while others will be unaffected. Of two herds in adjoining fields one may be affected and the other remain healthy. In the same herd the young pigs may all die and the older hogs may not show signs of disease. Such observations, repeated in innumerable instances, are sufficient to demonstrate that the action of the virus of contagious diseases can not properly be compared with other poisons. A poisonous dose of strychnine will affect all animals of the same species and size in substantially the same manner. The same dose of hog-cholera virus may kill a portion of the animals to which it is administered, while the other portion may show no effects from it. In the experiments made by this Bureau concerning inoculation this has been incontestably demonstrated. A few examples will illustrate this.

Of 4 hogs inoculated with  $1\frac{1}{2}$  cubic centimeters each, of culture liquid, 1 died in seven days, 1 in eleven days, and 2 survived.

Of 8 hogs inoculated with one-half cubic centimeter each, of culture, 1 died in six days and the remainder survived.

Of 16 hogs inoculated with a like dose of the same culture, 1 died and the rest remained well.

Of two lots of hogs containing 21 and 27 animals, respectively, and together exposed to the same contagion 4 died from one lot, and none from the other.

Of two lots of hogs containing 16 and 14, respectively, and together exposed to the same outbreak of disease, the larger lot resisted, while 11 of the 14 in the other lot died.

These instances are sufficient to show the unsoundness of the argument that because a part of the herds resisted, the others could not have contracted the disease from the inoculation.

To determine whether the disease was produced by the inoculation, the most important evidence is the time at which the first sickness was observed in the inoculated herds. If about the usual period of incubation elapsed after inoculation before sickness or deaths occurred, that is a very strong indication that the disease was caused by the inocula-

tion. If there were deaths in one herd before the inoculation was performed, that herd should be left out of consideration. Unfortunately, no clear statement of the facts has been made to the public by the inoculator, and what has been written is conflicting and contradictory. At the meeting of the National Swine Breeders' Association above referred to it was stated that no failure had occurred. Afterwards it was stated that about 400 had died, but that this was not the result of the inoculation. Still later it was stated that over 1,000 hogs had been inoculated in Nebraska since 1886, most of which had been exposed and reexposed to infection in very severe outbreaks of the real swine plague, with a reported loss of but 11 hogs out of the whole number.\*

It has not been asserted that there had been any sickness among L. E. Luddon's hogs before inoculation. It is only said that his brother's hogs, across the road, did not become sick, and that another brother's hogs, on the same premises, sickened simultaneously and died in about the same proportion. This proves nothing. As has already been shown, one lot of hogs may resist an exposure that will be very fatal to another lot. If the date of inoculation and the date of the first death in the lot of 46 had been given, as well the first death among the hogs in the pen, this would be a better indication from which to judge. But this information has never been given.

What is meant by the two lots sickening simultaneously? Was the first sick animal in each lot observed within the same hour, the same day, or the same week? This makes an important difference. If they were observed the same day, it would not show that the disease was not the result of the inoculation. In making an inoculation, the owner is liable to infect his clothing and to carry the contagion on that or on his shoes to another lot of hogs on the same premises. If the first sickness or death occurred between five and thirty days after inoculation, it probably was caused by the inoculation. That is as much as can be said.

If this were the only herd that sickened out of a large number, we should be disposed to admit that the infection was accidental. But if, on the other hand, it can be shown that disease in other cases has frequently followed inoculation, and that the sickness appeared from five to thirty days after the operation was performed, it would not be logical to conclude that this was in all such cases an accidental coincidence, and that the inoculation was harmless.

Fortunately, we have the facts in regard to the last herd inoculated at that time. The owner, in reply to an inquiry, made the following statement:

SURPRISE, NEBR., *February 2, 1892.*

SIR: Yours of the 28th ultimo received, and I will try and give you my experience with inoculation. The fall of 1888, some time in October, as near as I can remember, Dr. Billings, of Lincoln, sent Dr. Thomas here to inoculate my hogs, which numbered 260. In about eight or ten days after they were inoculated they all took sick. Within

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\* Prevention of Swine Plague by Inoculation. Frank S. Billings & Co., p. 5.

four weeks 230 died, and between that time and spring 10 more died. Only 20 survived out of 260.

My hogs were perfectly healthy when inoculated.

That, in brief, is my experience. If Dr. Billings had not been indorsed by the State I should never have allowed him to inoculate; but he had stated in a lecture that it was no more an experiment, but a settled fact; that it was a preventive. I do not believe that making the virus out of a cholera hog and putting it into a healthy hog will work.

I could not recommend inoculation.

Very respectfully,

H. H. HESS.

Hon. J. M. RUSK.

The following correspondence, brought out by a circular of inquiry from this Department, shows that many herds were inoculated during 1888 and 1889, and that many losses from inoculation occurred during those years, of which the public, up to this time, has had no information. They also indicate most emphatically that the sentiment among the farmers in the districts where inoculation has been most thoroughly tested is overwhelmingly against the practice.

Dr. H. N. Hall, Ayr, Adams County, Nebr.:

The last outbreak of hog cholera in this vicinity was in 1889. Two herds were inoculated. One belonged to W. Lowman, of Hastings, Nebr. The owner says 1 died while testing it, and the rest never did well and were hard to fatten. The other herd contained 10 animals, and in this none died from inoculation. The popular opinion on inoculation in this part of the State is not very favorable. We are waiting for a chance to test it more thoroughly.

Edward Creager, Juniata, Adams County, Nebr.:

Inoculation has been practiced to a certain extent. It was tested in four herds that I know of, an average of 5 in each herd being inoculated. I can not say positively how many deaths occurred before thirty days or how many afterwards, but most of the deaths occurred before that period had elapsed. I would not recommend inoculation.

J. W. Coulter, Hastings, Adams County, Nebr.:

Inoculation has been practiced in this vicinity, and particularly in one herd of about 300 head; the number in the other herds not known. In the large herd a few died in about twelve to fifteen days after the inoculation; exact number not known. I am a strong believer in inoculation, but I would advise care in its use. All the hogs on the place should be inoculated at one time that have not been previously inoculated. Everything said in regard to this should be taken with a grain of allowance, for in 1883, 1884, and 1885 my neighbors' hogs had the cholera and large numbers of them died and mine were not affected, although they frequently intermingled. I thought this was because I treated my hogs somewhat differently, and that I had found a preventive for the cholera, but in 1886 my hogs nearly all died.

D. N. Miller, David City, Butler County, Nebr.:

Inoculation was practiced in the western part of Butler County in 1888. Eight or ten herds were inoculated. I would not recommend inoculation.

John H. Sleeper, Surprise, Butler County, Nebr.:

Inoculation has been tried in this vicinity. Mr. H. H. Hess, of Surprise, had inoculated a few years ago 260 head, and 230 died directly from the effects of inoculation,

so the owner stated. Ed. Hinckley, also of Surprise, had several hundred treated, and a great many died. Wilbur Ludden tried it with the same results; also his brother, L. Ludden, all of Surprise. I am not able to give you the number in any of the herds, except that of Mr. Hess. I never tried inoculation, although I lost nearly all my hogs a few years ago. About the only man in this neighborhood that believes in the treatment is C. H. Walker, of Surprise. He and Dr. Billings, were going through the county doing all they could toward it, but I do not know of anyone trying it since the men above named failed.

#### Lewis E. Talmage, of Surprise, Butler County, Nebr.:

In reply to yours, will say the last case that I know anything about was that of D. L. Sylvester, of Surprise. In the fall of 1890 he had 75 inoculated, and then sold them to Mr. C. H. Walker, of Surprise, to ship to Iowa. I do not know the percentage of deaths resulting from the inoculation. Miller Brothers, of Surprise, in 1890, had some 70 inoculated, and lost almost the entire herd. They also had a bunch inoculated in 1888 and lost a large percentage. Mr. Christ. Schroder, of Surprise, had 250 inoculated, and he told me he lost nearly the entire herd, and the few that did live were damaged. Mr. H. H. Hess, of Surprise, inoculated in 1888 probably 200 head, and lost 90 per cent. Wilbur and Charles Ludden, of Surprise, the same fall inoculated with the same results. The number of hogs given in each case is from memory.

#### D. P. Ashburn, Gibbon, Buffalo County, Nebr.:

Inoculation has been practiced in this vicinity by 6 or 8 persons having from 30 to 200 animals in a herd. With one single exception none were lost. H. A. Lee, of Kearney, lost 3 or 4 head out of a pen of 24 that were closely confined and had only dry corn and water to eat. He also inoculated about 125 that were running after cattle in a field or large corral at the same time and with the same virus, and the effect was not noticeable. None died or were sick. I would recommend inoculation in careful, intelligent hands, but not otherwise. It creates a mild case of cholera, from which the disease will spread if not prevented, and as the average hog-raiser is not to be relied upon in this particular, I think for general use as a preventive it would be likely to create as much loss as it would prevent. I have used it for several succeeding years with success, and if I again raise hogs shall use it if nothing better offers. I am impressed with the great need of a safer virus, and think it possible that scientific research might discover it.

#### John Reddy, Gibbon, Buffalo County, Nebr.:

In answer to your inquiries I must say none of my hogs were inoculated, but my neighbors put 8 hogs in my yard as a test that were inoculated by S. C. Bassett, the agent of Dr. Billings, of Lincoln, Nebr. Seven out of the 8 died of cholera, and the 1 that lived had a slight touch of it, but recovered. A very poor showing, as we all thought, since a greater per cent of my hogs lived that were not inoculated at all.

#### S. C. Bassett, Gibbon, Buffalo County, Nebr.:

A few hundred hogs were inoculated in this vicinity in the years of 1888 and 1889. A less number were inoculated in 1890 and 1891. According to my recollection, seven herds were inoculated, containing from 20 to 150 head in a herd. In the majority of these herds—five, as I remember—none of the inoculated hogs died within thirty days. In the other two herds, 3 in one herd of 20 inoculated and 7 in one herd of 150 inoculated died. These experiments were mostly confined to pigs ranging from six weeks to three months old. Five of these inoculated pigs were placed in a herd suffering from one of the most fatal outbreaks of cholera I have ever known, and 3 of said pigs died. On my own farm I inoculated hogs first in the spring of 1888, and with one exception have inoculated all pigs farrowed on the farm since that date. I have had no hogs die from the effects of inoculation; neither have I had inoculated hogs die with hog cholera. From my observation and experience I

am strongly of the opinion that of hogs inoculated by the Billings method as now practiced a large per cent may be prevented from contracting the disease hog cholera. I am positive that inoculation by this method does not kill, does not stunt, does not injuriously affect the hog. Its effects are hardly perceptible to those who care for hogs.

C. Dean, Gibbon, Buffalo County, Nebr.:

I can not tell just how many herds or the number of animals in each herd that were inoculated. Inoculated hogs died in all the herds so far as I know, but can not state the number. It has not proved to be a preventive for hog cholera in our part of the country.

William Welland, Gibbon, Buffalo County, Nebr.:

Inoculation has been practiced in this vicinity in seven or eight herds, from 25 to 200 in a herd, in past years. None in 1891. In one or two instances 3 or 4 head died. In several instances hogs have been taken from inoculated herds and exposed. They stood the test where the inoculation was properly done. I would not recommend inoculation in its present condition. I believe the practice and principles are right and will prevent disease, but the great liability of spreading disease by inoculation in careless hands is too great to make its general use practical. What is needed is virus that will produce the effect without starting the disease.

W. J. Davis, Fort Robinson, Dawes County, Nebr.:

Billings's inoculation has been tried in some neighborhoods. I think about six herds and about 10 in each herd. I only heard of 2 that died out of the total number. I would recommend inoculation.

R. M. Allen, general manager of the Standard Cattle Company, Ames, Dodge County, Nebr.:

We have practiced inoculation ourselves, but do not know of any other person in this county who has practiced it. We inoculated, June 9, 1889, 54 hogs; August 1, 1889, 143 hogs; and we inoculated 8 head of sucking pigs about April 1, 1891. In our first experiment 4 head died out of 54 within thirty days. In the next experiment, August 1, 1889, a violent outbreak occurred, destroying all but about 30 out of 143. The last bunch of 8 head were all sucking pigs, and died soon after inoculation. I am not able to say whether they died from the inoculation or not. The second lot of 143 were slightly infected with cholera at the time of inoculation. The outbreak which started August 7 lasted longer than thirty days. I would not recommend inoculation from my personal observation of its effects, but from my experience with hog cholera I recommend its trial in a very careful, systematic, and guarded manner by such farmers as are intelligent enough to practice it themselves. I think it is likely that the number of hogs that will survive outbreaks of cholera will be greater if inoculation is practiced, especially if practiced at several different times on the same subject.

B. W. Reynolds, Fremont, Dodge County, Nebr.:

So far as my own information goes, I am led to believe that Dr. Billings's inoculation process for the prevention and cure of hog cholera is a failure in the majority of cases. I know, however, that by adopting advanced ideas as to sanitary conditions, and adhering to them, hog raisers in this county are suffering less than formerly.

J. O. Milligan, Scribner, Dodge County, Nebr.:

The few experiments in inoculation made in this section did not prove very satisfactory. From my observation of its effects I would not want it practiced on my herd. As far as I know personally that method of treatment not only proved fatal to the hogs inoculated, but caused the disease to spread.

### G. Abell, Exeter, Fillmore County, Nebr.:

A neighbor of mine, William Sullivan, of Cordova, Seward County, had some of his hogs inoculated. I went to see him this morning. He inoculated between 20 and 25. He had on his farm probably twice that number. Three or 4 of the smaller ones died. There being no disease in the neighborhood at that time, he hardly considers it a fair test of prevention.

### Hugh Gibson, Fairmont, Fillmore County, Nebr.:

I know of only 3 men that have tried inoculation. One herd had 50 head; all died. One herd had 65 head; 35 died. The other herd of 30 head all did well. All the deaths occurred twenty to twenty-five days after inoculation. Would recommend inoculation when the animals are two or three months old. After they get older I do not think it is successful.

### John Sheridan, Grafton, Fillmore County, Nebr.:

I know of three herds that were inoculated, varying from 40 to 60 head in each. In two of them none were lost, while in the third herd about all died. I have no faith in any remedy, inoculation included. As far as these two herds are concerned I think it no proof that they were protected from the cholera. One man purchased 15 head soon after inoculation; they are all right. There are several herds that have not been inoculated and escaped the cholera. I had 130 in my herd. They got the cholera. I tried all the so-called sure cures to no effect; then changed them around to a different part of the farm in different lots, grading them according to their appearance. I think that saved 24. There was a bunch of hogs within 60 rods of mine that were not inoculated, and they did not get the cholera.

### H. C. Stoll, Beatrice, Gage County, Nebr.:

Two years ago I had 23 head inoculated by Billings's man, and all died within twenty days. I have been told that Mr. Billings had a large hog ranch at Davenport, Iowa, where he bought several hundred hogs and inoculated them; but cholera hogs came in contact with them, and then they all "went up the spout." A man told me that was there and saw them. I most decidedly would not recommend inoculation, unless the operator first pays for the hogs. Three years ago my hogs contracted the disease at the St. Louis fair, and I lost over \$5,000 worth. I then bought 23 head of fine sows, all in pig. I had a talk with Billings, and he told me to inoculate them. I told him I was afraid, because they were all in pig. He said it would not hurt them on that account. He sent a man who inoculated them. The next week he came again and repeated it. The result was that all died. The same man inoculated two herds in Iowa, and they died. When I told Billings the result, he sent out pamphlets stating that sows in pig should not be inoculated. He should have known that at first. But 2 or 3 died that were not in pig. I had a long talk with one of his men, and he said it was a good thing if 10 per cent were saved by inoculating them. I do not want any preventive that will only save 10 per cent, when I can save 50 per cent after they get the disease.

### G. D. Mullihan, Paddock, Holt County, Nebr.:

Near Creighton, where I formerly lived, there were some hogs inoculated, and there are various opinions as to its preventing cholera, but the majority are not favorable to it as near as I can learn.

### Francis C. Urban, Little, Holt County, Nebr.:

Inoculation has been tested in two herds in this vicinity. In one herd of twelve 8 were inoculated and 6 afterwards died. The other herd contained 28 head, of which 22 were inoculated, and 25 afterwards died. From what I have seen I would not recommend inoculation. These herds were inoculated according to the Billings method by a veterinarian from Lincoln, Nebr.

C. F. Sodman, Elk Creek, Johnson County, Nebr.:

My neighbor had 10 hogs inoculated out of a herd of 25, and another had 5 inoculated out of 20. All the inoculated hogs in the first herd died, and part of those not inoculated. In the second herd no hogs died. I would not recommend inoculation.

C. M. Branson, Lincoln, Lancaster County, Nebr.:

The State prison tried inoculation, and an extensive feeder of cattle and hogs tried it. It was done by Dr. Billings. There were two herds—I think about 50 in each herd. Nearly all died in one herd, and I think none in the other. Some who have had hogs inoculated have told me that they were highly pleased with it, and say they would not risk having hogs without inoculation. Dr. Billings has often assured me that it is a wonderful preventive. I know nothing of my own experience.

H. B. Musser, Lincoln, Lancaster County, Nebr.:

I have only learned of a few herds that were inoculated. In one a part were inoculated; in the others all. I do not know the number which were afterward lost, but the greater part died. I would not recommend inoculation.

E. F. Black, Raymond, Lancaster County, Nebr.:

Only one herd in this vicinity has been inoculated. This contained but 3 animals, and 1 out of the 3 died. There has been a great deal of inoculation in this county by Dr. Billings and his assistants, but reports are very conflicting as to the results.

James W. Eaton, Nebraska City, Otoe County, Nebr.:

I only know of one herd that was inoculated, and they were evidently infected before the operation. This herd belonged to John Campbell, of Nebraska City. His neighbor, Simeon Patton, has a hog yard just across the road, 4 rods distant, both being mostly in a low swale. Mr. Patton's hogs had cholera and were dying fast, when Mr. Campbell got the virus and inoculated his own hogs. Mr. Campbell inoculated 20 large hogs and 65 pigs or young hogs. Of the large hogs, 19 were kept at some distance from the others and from Mr. Patton's. None of these showed any indications of being sick. The other large hog, being lame, was kept with the pigs. He died, and so did 60 or 61 of the shotes out of the 65 inoculated. The shotes got sick in six or seven days after treatment and died soon afterward. Mr. Campbell does not believe in inoculation.

Fred. Lucas, Unadilla, Otoe County, Nebr.:

The cholera is as it has always been. I have had it on my farm about six times, but not during the last three years. The last year it paid us a visit in January, and took all but 12. An outbreak the June before left about 25. My neighbor did not have the disease at any of the times when it visited me. All there is between his hogs and mine is a common board and wire fence. Now, during the last twelve months, when my farm has been free from it, it has taken his hogs. It singles out one man and takes almost all his hogs, while his neighbor goes free. Mr. W. Rotton, of Unadilla, had about 50 head which were inoculated. After about three months he sold 8 to Mr. Avery, who had the disease some three or four months before and lost nearly all of his hogs. Of the 8 inoculated hogs bought, he put 7 in the yards that had the disease in them some months before. One was taken away to other lots. The 7 all contracted the disease in a severe form. Three died; the other 4 eventually recovered. The other 1 never took the disease nor was exposed. I have no faith in inoculation or anything else to prevent this disease.

A. E. Lane, Table Rock, Pawnee County, Nebr.:

There were two herds inoculated in this neighborhood in February, 1890. One herd was owned by D. K. Miller. It consisted of 9 animals, that had been purchased by him for the experiment and they were supposed to be free from disease. They were inoculated by S. C. Bassett, one of Dr. Billings's agents. Eight of the 9 died

within thirty days after their inoculation. Herd number 2 consisted of 13 animals. They were inoculated by the same man with virus from the same bottle as the first herd mentioned. Six of the 13 died.

Byron Street, Phelps, Phelps County, Nebr.:

A herd east of here was inoculated. About 10 or 12 per cent died from the inoculation. After a time the herd was taken into a yard where other hogs had the cholera in its worst form. Part of the inoculated hogs sickened, but none died.

John W. Tohman, Danbury, Red Willow County, Nebr.:

Two herds that I know of have been inoculated. They belonged to C. Underwood and P. P. Wright. One herd contained about 100 head, and there were 4 or 5 of them died in a few days after they were inoculated. I do not know the number in the other herd. The owners of both of these herds claim that the animals have since been exposed and no further losses have occurred.

John Tighe, Humboldt, Richardson County, Nebr.:

The parties that I know who had hogs inoculated in this county are Wesley Hummel, Dr. J. G. Cox, M. Hardy, and Fred Lewis. Mr. Lewis did the inoculating with virus furnished by Dr. Billings. I can not now say how soon after inoculation any of these hogs died, but the general impression is that it is worthless as a preventive. I do not know of a man in our county that is in favor of it. I would not inoculate my own hogs from what I understand about the way that it has acted on the hogs in this county.

John Lichty, Falls City, Richardson County, Nebr.:

Two herds were inoculated in this vicinity by Dr. Billings. Nearly all died.

John M. Brockman, Humboldt, Richardson County, Nebr.:

My neighbor, Dr. J. G. Cox, had his herd of hogs inoculated, and lost nearly the entire herd. I think the inoculation caused the disease in this herd. Inoculation has been a total failure as a preventive of hog cholera in every instance that has come under my observation.

Isaac N. Ewalt, Falls City, Richardson County, Nebr.:

Prof. Billings, of the State University, inoculated about one-half of a herd for a man in this neighborhood, and about half of them died within thirty days. This is the only herd inoculated in Richardson County that I am aware of. I would not recommend inoculation, as I have but little faith in it. I saw Mr. Steel the other day. He is the man who owned the herd inoculated here. I asked him his opinion, and if he could recommend inoculation. He said he did not know whether it was a preventive or not, as the disease was in his herd when they were inoculated, and there were as many of them died that were inoculated as of those that were not.

P. O. Avery, Humboldt, Richardson County, Nebr.:

Mr. F. L. Lewis inoculated about a dozen herds about a year ago. The herd of Dr. J. G. Cox, about 30 head, all died, or nearly all, within about two weeks. Mr. Lewis inoculated his own herd, about 25 in number. They recovered all right, and were feeding up and doing finely till about sixty days after being inoculated, when they took sick, and all, or nearly all, died, seldom living over four days after getting sick. Mr. John Holman had 25 head inoculated, which he kept on the place where he lives. After about two months he moved them to another farm where he had quite extensive feed lots, and where he had put about 80 shotes that he had just bought out west where crops had failed, and they had no cholera. The latter took sick very soon and all died but 2. None of the inoculated hogs died. The inoculation was made according to Dr. Billings' method.

### Charles Neely, jr., Humboldt, Richardson County, Nebr.:

I only know of five or six herds that have been inoculated. Two herds have lost severely after inoculation. From my very limited knowledge of inoculation, I am not very favorably impressed with it.

### A. Tynan, Stella, Richardson County, Nebr.:

Inoculation has been tried, but deemed useless, and is no longer practiced. In one herd 75 were inoculated, and all died. Those that were not inoculated lived. I would not recommend it, for in every case I know of it was a failure.

### J. S. Wilcox, Morse Bluff, Saunders County, Nebr.:

Lyons Brothers, of Lyons, Burt County, Nebr., had 20 head inoculated in 1889 by Mr. Courtney, of Lincoln, Nebr. These were placed with sick hogs at Mr. Hall's thirty days after inoculation. I went on purpose to see this lot, and have a letter from Mr. Lyons saying that he lost more than three-fourths of them; also that several of his neighbors who were testing inoculation lost theirs. Mr. Courtney claimed that the virus was not right, and proposed to make further test and guarantee the hogs. This proposition was accepted, and the hogs died again this time. Mr. Courtney has not paid for the loss as he had agreed.

### C. E. Ward, Belvidere, Thayer County, Nebr.:

I know of one herd that was inoculated in 1889. It belonged to J. H. Horneday. The herd contained 30 hogs, which were inoculated July 10. Twenty-seven died before August 15.

### J. M. Bennett, Hebron, Thayer County, Nebr.:

I began inoculating in November, 1889, since which time there has been no disease among my hogs. I once put 3 inoculated hogs in a sick bunch. Two died; the other was affected, but did not die. This is the only test I have had opportunity to make.

### E. T. Pliefke, Gresham, York County, Nebr.:

I do not know of any inoculated herds that have been exposed to hog cholera and have not afterwards suffered from the disease. Mr. Samuel F. Weaver, of Ulysses, Butler County, Nebr., had a herd of 79 inoculated. These were exposed two weeks after, and all died but 13. As far as I have noticed, it avails nothing. One herd of 48 were doing well when inoculated, and in a week began to get sick and die.

### E. J. Currier, Harlan, Shelby County, Iowa:

In the fall of 1889, November or December, F. S. Billings, by his agent, Mr. Courtney, inoculated 133 young hogs for me. The inoculation was repeated about sixty days after. Between one and two months after the hogs began to sicken, and about 70 of them died. I sent 21 to another farm, and after they had been there a month they took the cholera and gave it to the healthy hogs already on the place. There was no other case of cholera in that region, and my neighbors were not losing any at the time mine were sick. Did inoculation do it? It looks like it. At any rate, I shed no tears because Billings has shut off the supply of virus for all outside of Nebraska.

The following extracts from letters received by Frank S. Billings & Co., and published in pamphlet No. 3 on inoculation, are also of interest in this connection:

#### Thos. L. Peifer, Lincoln, Ill.:

Out of the 42 head (of which 25 were pigs, and of which 4 of the latter died and 1 of the large hogs, since inoculating), my hogs have done exceedingly well; they appear healthy, but I can scarcely attribute this to inoculation, as there has been no disease in the immediate neighborhood, so that the preponderance of evidence would not prove much yet with me.

### H. A. Lee, Kearney, Buffalo County, Nebr.:

About the 20th of October, 1888, I had 154 pigs inoculated as a preventive of hog cholera. Twenty-four of the above number were at my home farm, and the balance, 130 head, were 2 miles distant, at the stock ranch and feed yards.

During the two years previous to this I had lost the larger part of my pigs during the late fall and winter with cholera, and believing the yards to be thoroughly infected with the disease I concluded to try inoculation as a preventive. No cholera has made its appearance on my farms since.

As to its immediate effects, I will say that the 24 head at the home farm, whose feed was principally corn, were most of them affected, over one-half showing cholera symptoms. Some of them did not get over it for weeks, and 1 died. The 130 head up to the time of inoculation had been kept almost entirely on oats, and the inoculation produced no visible effect on them.

On the 24th of October, 1889, Mr. Bassett inoculated 143 head of pigs; 137 of them were at the cattle ranch and 6 small runty pigs at the farms. The operation produced no visible effect on the 137, but of the 6 head at the farm 4 died.

On the 8th of December, 1889, I took 4 of the 137 and placed them with the hogs of John Reddy, of Gibbon, whose hogs were dying with the cholera. One took the disease and died; the other 3 are still at his farm, and the last time I saw them seemed healthy and were doing well. On the 28th of December last Mr. Bassett came and wished to reinoculate those which he had before inoculated, saying he feared the virus used on the 24th of October had lost its protective principle. About 135 head were reinoculated; over half of them were sensibly affected, ceased growing, and lost flesh, and there are fully 40 head that have not yet recovered from the effects of the last operation.

### C. S. French, Chapin, Ill.:

With me inoculation has not been the success that I hoped it would be. The first lot of 74 did fairly well; 2 died soon after the operation, and 1 disappeared; do not know whether he died or not. One of that lot died a few days ago; he drooped around a few days with outward symptoms of cholera. The rest seem all right of that lot.

The last lot of 27 I would pronounce a perfect failure. They never seemed to get over the operation. They keep running down until they die. There has more than half of them died, and I think more of them will die yet.

### PROTECTION BY INOCULATION.

We will now turn for a moment to the question of the protection by the operation. To what extent were the hogs inoculated in Nebraska protected from the contagion if really exposed to it? The advocates of inoculation tell us that it has been impossible for them to give the disease to their inoculated hogs. The letters quoted above show that in several cases the inoculated hogs contracted disease when they were exposed to it in about the same proportion as those which had not been inoculated. John Reddy reports 8 inoculated hogs exposed, all of which became sick, and 7 of which died. S. C. Bassett reports 5 exposed, of which 3 died. Fred Lucas reports 7 exposed, all becoming sick and 3 dying. P. O. Avery reports a herd of 25 which took the disease sixty days after inoculation, and three-fourths of which died. J. M. Bennett put 3 inoculated hogs with sick ones; all took the disease and 2 died. E. J. Currier had 133 hogs inoculated; sixty days after-

ward they were inoculated the second time, and from this inoculation contracted the disease and 70 died. Our experiments at Washington show that nearly all inoculated hogs can be afterwards fatally infected with cholera. Did the animals inoculated in Nebraska receive any greater degree of immunity than those which were inoculated in Washington? These tests indicate that they did not.

The board of inquiry appointed by the Commissioner of Agriculture in 1888 procured a number of hogs that had been inoculated in Nebraska (about 17), and tested them by feeding them with cultivated virus of hog cholera and by inoculating them with the virus of hog cholera and swine plague. In each case a number of animals that had not received the protective inoculation were used in the experiments to determine the effect of exposure upon ordinary swine. The first test was made by feeding cultivated virus, but this did not prove strong enough to kill any of the hogs. Even those which had not been inoculated survived, but all of the hogs, including those that had been inoculated, were very sick. The inoculated hogs were not quite so sick as the others, but there was very little difference. Four of the inoculated hogs from Nebraska, and 5 hogs from Pennsylvania, which had not previously been inoculated, were then inoculated with the virus of the disease known as infectious pneumonia or swine plague. Of the 4 Nebraska inoculated hogs 3 died and 1 recovered, but this one when subsequently killed for examination proved to be very severely affected. Of the 5 hogs which had not been previously inoculated 1 died and 4 were sick and recovered. When killed for examination one of the 4 was found seriously diseased; the other 3 were either slightly or not at all affected.

Still later, 4 Nebraska inoculated hogs and 2 other hogs which had not been inoculated were fed upon the viscera of hogs which had died of hog cholera. Two of the inoculated hogs and 2 that had not been inoculated contracted hog cholera and died. Two of the inoculated hogs remained well.

As a last test the remaining 6 animals from Nebraska were inoculated by intravenous injection of the cultivated virus of hog cholera. Of these, 3 had been inoculated with hog-cholera virus, and 1 had been inoculated with the sterilized liquids in which hog-cholera germs had grown, and 2 had recovered from an attack of hog cholera. The 4 hogs which had received the protective inoculation all died. One of the recovered hogs died, and the other resisted the virus and remained well.

It is quite evident from these experiments that the animals inoculated in Nebraska were fully as susceptible to hog cholera after the operation as were those which had been inoculated in the experiments of this Bureau in Washington.

The conclusion that inoculation is not a satisfactory preventive for hog cholera is by no means inconsistent with the results obtained in investigating other diseases. Various experiments have shown that the protection which follows one attack of a disease or which is pro-

duced artificially by inoculation or vaccination is by no means absolute. It is simply an increased power to resist that particular contagion, and it may be sufficient to guard against the small doses of the virus which with most diseases are all that an animal is exposed to under ordinary conditions. But if from any cause a larger quantity of the contagion finds its way into the animal's body it will contract the disease in a fatal form in spite of the immunity derived from a previous attack or from inoculation. This was strikingly shown in the writer's experiments with fowl cholera (Report Department of Agriculture, 1881-'82, p. 289) and by the researches of Prof. Chauveau with anthrax. While, therefore, it may be perfectly practical to prevent by inoculation those diseases in which the contagion does not multiply outside of the body, and with which the attack is caused by a small quantity of virus floating in the air or adherent to the woodwork of buildings, it may be much more difficult or impossible to prevent that other class of diseases to which hog cholera belongs, and which are caused by germs that multiply freely in water, in the soil, and in moist organic matter, and which are consequently taken into the body in enormous quantities, especially by swine.

This brings the history of the attempts to prevent hog cholera by inoculation down to the year 1889. In that year Dr. Billings resigned his position in the Nebraska Experiment Station and established a laboratory in Chicago for inoculating hogs as a private enterprise. Some of the experiments mentioned in the letters published above refer to inoculations made with virus from this laboratory. As it was not possible in all cases to decide whether the virus was procured from Lincoln or Chicago, and as at both places it was prepared by the same individual, the letters giving the experience of swine-growers have been inserted together in the report.

#### INSURANCE OF INOCULATED HOGS.

When the laboratory at Chicago was about to commence operations, the impression given out was that the owners of inoculated hogs were to be insured against losses. The following appeared editorially in the *Farmers' Review*, April 10, 1889:

His newest departure is one that will doubtless create a furore of excitement in the ranks of the veterinary fraternity of the country, and indeed among the agricultural community likewise. The Billings Live-Stock Insurance Company has, we understand, declared its intention of doing business on a mammoth scale, and before many months pass will have received its final papers. This will be no clap-trap concern, founded on the visionary lines of heretofore live-stock insurance companies, which have accepted risks against death from disease and accident, and brought ruin to all concerned—excepting, of course, the sharpers running the scheme. Hogs will be insured against death from cholera on condition that the animals are inoculated with virus of the disease prepared at the laboratories of the company, which it is proposed to erect and provide with the best bacteria-poison chemist in the world, regardless of cost.

In the Nebraska State Journal, May 2, 1889, Frank S. Billings announced over his own signature that:

As regards my own experience with inoculation, there are a large number of farmers who have now made the necessary practical tests extending over a period from June, 1888, to the present time, aside entirely from my own, but what is perhaps more conclusive proof than any other is that I am prepared to "take my own medicine" and suffer the consequences.

There is a practical expression that "money talks," and my money and that of my friends will be ready to talk to the amount we may lose from hog cholera against which we are going to insure, on condition that we inoculate the animals first, and as we intend to be ready to "talk" to the tune of half a million or over, and as those interested with me are "in for the dollars," while I am in because I can not serve my country and race in any other way, under the ruling method in American politics, and as these gentlemen have investigated the preventive inoculation experiments in Nebraska, and are satisfied and anxious to go into business on that basis, it does not seem that preventive inoculation needs the indorsement of the chief of the bureau of animus intensified

These representations having been publicly made, a number of swine-growers applied to have their hogs inoculated and insured against loss, but in every instance that has been brought to our attention the projectors of the enterprise declined to insure the animals. In pamphlet No. 3, on Inoculation (p. 56), issued by Frank S. Billings & Co., it was stated:

It must be distinctly understood that we do not warrant or guarantee anything. As in vaccination the owner must accept the results, whatever they may be.

No one but an arrant fraud and quack would warrant or guarantee that which neither he nor anyone else can invariably control.

Why this sudden change of policy? If no one but an arrant fraud and quack would warrant or guarantee against loss after the company was formed, was not the same true when the announcement was made in which insurance was to be a prominent feature of the company's business? Is it not probable that the losses following inoculation were found to be too great to admit of profitable insurance, rather than that the inoculator had so suddenly experienced a radical change of sentiment in regard to the propriety of insurance in such cases? The letters given in this report detailing the heavy losses in Nebraska, losses which have never before been made public, indicate that insurance would have been a most disastrous financial operation.

#### **FAILURE OF INOCULATION AS A PRIVATE ENTERPRISE.**

Soon after this company began business in Chicago it was announced that an experiment would be made at the Peoria distilleries to demonstrate conclusively the value of inoculation. This Department sent a representative there to observe and report upon the results. As this report differs somewhat from the statement made by the company which performed the inoculation, the latter is given. It is as follows:

Much curiosity exists as to an experiment we made at the Peoria distilleries. The plain facts are these: We put in 30 single inoculated hogs; 15 of them died. We

also put 18 double inoculated hogs; none of them died. Two others got in with these by mistake which had not been inoculated; these 2 died. We did this to see what we had to do in order to meet the peculiar conditions of feeding and the sudden change of food to which hogs are subjected at such places. We found out what we have to do to be successful, and hence the experiment answered our purposes.

From this statement we learn that of the 30 hogs inoculated according to the method recommended for farmers, 15 head, or 50 per cent, died when exposed. The ones that were twice inoculated can not be taken into consideration, because it is almost universally admitted that two inoculations are impractical on account of the expense, the trouble, the time required, the added risk, and the loss of growth in the animals. It will also be seen from the experience at Davenport, Iowa, an account of which follows, that the information obtained by the Peoria experiment did not avail to prevent loss when the experiment was repeated on a larger scale.

It is not the purpose of this bulletin to go into an examination of the details of the experience of this company with inoculation as practiced on farms. The following extract from an editorial article in the *Ohio Farmer*, August 9, 1890, shows the financial result of its operations:

Dr. Billings, in another column of this issue, announces that he has decided to withdraw all his advertisements in which he endeavors to bring the inoculation of swine before the farmers as a preventive of cholera, because his efforts have been a financial failure. But, to show his faith in the process, he intends to go to farms where swine-feeding is the leading interest, purchase the hogs outright, inoculate them, and feed them at his own expense. He says: "The Government swine plague has no terrors for us."

Further particulars of this new undertaking to demonstrate the value of inoculation and to reap the pecuniary rewards which would follow from a successful method of prevention are found in the following editorial note printed in the *Farmers' Review*, August 20, 1890:

We understand that Dr. Billings and those interested with him in business have lately purchased 10 acres of land at Dubuque [Davenport?], Iowa, adjacent to the glucose works in that city. Suitable buildings for the feeding of thousands of hogs at one time are to be erected at once; pipes for carrying food from the works to the feeding troughs are to be laid in; a contract has been made for the supply of sufficient food to feed 40,000 hogs during the year. A trustworthy agent is at present busily engaged in buying and inoculating 4,000 hogs with which to commence business. From all this it becomes very apparent that inoculation as a preventive against hog cholera is not by any means defunct. While farmers have not taken a unanimous share in the benefits of the method offered them in their business, Dr. Billings proposes to reap a deserved reward by turning feeder and pocketing the profits that hogs rendered ironclad against disease must surely yield when cheaply fed.

The results of this experiment and also of other experiments in inoculation are set forth in the following communication from Mr. E. M. Crummer, of Belleville, Kans., who for business reasons made a thorough investigation of the whole subject:

My recent investigations of the merit of inoculation was prompted solely by the desire on my part to learn the real merits of it, so as to be able to recommend it to my patrons if I found it really efficient. I took considerable pains to make inquiries

of disinterested parties who had tried it, and while I found some who had implicit faith in it, the majority pronounced it an utter failure. And in all cases where it seemed (to the parties) to afford immunity, they really had not exposed it to a practical test. I have read most everything I could get treating on inoculation pro and con, and while I learned or suspected that in the main it had failed with the farmers, still I had a genuine hope that it would yet turn out to be practical, and that the failures might be overcome by learning the practical conditions under which to operate. A recent article in a Western stock paper stated that Dr. Billings had established at Davenport, Iowa, near the glucose works, a plant for feeding hogs on a more extensive scale than was ever before attempted. The plant was to represent an investment of from \$50,000 to \$100,000, and have a feeding capacity of from 5,000 to 10,000 hogs at a time; also that inoculation was to be their only protection from disease.

The article went on to state that they had already 1,600 hogs under feed, and all were doing well, and they had not lost one from disease. This statement, emanating from a stock paper which had sent their representative there, who had spent a day at the plant, caused me to think that certainly no man would invest so much money in an unproved theory, and that after all there must be some protection in it if rightly administered. I left home some three weeks since, and made a thorough investigation, to my full satisfaction. I was fully convinced of the utter failure of inoculation as at present administered, and was disappointed, as a matter of course. I found at Davenport a very extensive plant, designed for feeding the glucose refuse. Everything was pretty much as represented in the article referred to, except the immunity from cholera enjoyed from the use of inoculation. At the time I was there Mr. Billings was absent, but through the courtesy of the foreman in charge I was admitted and shown through the plant, with the exception of the quarantine department. The hogs on hand—what were left, and they were only a handful of the original number—were all down with the cholera. All the rest had already been inoculated before arriving at the plant, or after getting them there.

Instead of there being no losses from disease in the plant, they had kept right on dying until the remnants of the herd, most of which would survive the disease, were in the same condition as any other cholera herd, affected more or less with blood poisoning, etc. The only hogs on hand free from disease were a couple of carloads in the quarantine department that had not yet been inoculated, and since their arrival had been protected by disinfectants. The whole scheme of demonstrating the utility of inoculation is an abject failure. These hogs had been bought up by one of Mr. Billings's inoculators out in western Kansas. Most of them were inoculated where received, at the shipping stations, and several hundred died from the effects of cholera developed by inoculation at the places where bought, before shipping them into the plant. As you are not in so good a position to learn the inside facts, I have been thus frank and plain with you about it. The foreman and another gentleman who had helped through all the inoculations told me frankly that they had no confidence in inoculation, and advised me not to recommend it to my patrons. There is a Mr. Walker in Surprise, Nebr., who has had perfect success with inoculation, and who is going to do the inoculation of all the hogs hereafter at the plant. He was also going to ship in 200 of his own hogs that had been inoculated.

Mr. Henderson, at Junction City, Kans., whom I visited, and whom Dr. Billings quotes extensively, made no practical and conclusive test of it at all. He first inoculated a drove of hogs that were recovering from cholera. Afterwards inoculated pigs once or twice. These pigs failed to come down with cholera where the ground had been infected months before, which proves nothing. He made no actual heroic tests. The most practical test I learned of was made at Kearney, Nebr. Sixteen pigs, all healthy and free from disease, were inoculated, belonging to eight different farmers. Prof. B. sent out one of his men, Mr. Bassett, to do the inoculating and see that it was right. They recovered from the inoculation, were put in with sick hogs, and every one of them died. Then it was claimed that the virus was too weak. It seems

that the whole trouble is in not being able to adapt the strength of the virus to the condition of each individual hog or pig.

On the whole, I must say I feel like complimenting you on your good judgment and that of your associates in going slow in this matter, and not indorsing inoculation by Dr. Billings's process until you had first seen it thoroughly demonstrated. I am confident that a few words of indorsement from you would have resulted in introducing cholera where it had never been before, and in great losses to stock growers.

This same correspondent wrote as follows nearly a year later:

At the time I wrote you last winter or spring, I had returned from Davenport, Iowa, and was expecting a report from the foreman of the feeding plant on the results of the inoculation of the Wisconsin hogs which were then in the quarantine department, and which were to be inoculated by Mr. Walker, I think, of Surprise, Nebr. Well, I waited several weeks, and wrote to the foreman again. He then wrote me that the Wisconsin hogs "have got the cholera very bad now. When I see a success of inoculation I will write you." He never wrote me afterwards, although I wrote him another letter in order to get a more definite report.

After this last failure to make a success of inoculation as a private enterprise, Billings withdrew from the company and again accepted a position as investigator in the Nebraska Experiment Station. The attempt to prevent hog cholera by inoculation at the Davenport feeding establishment was abandoned. Inoculation was, however, still asserted to be a great success; an effort was made to introduce it extensively in the State of Nebraska, and this Department was repeatedly and most urgently pressed to make an investigation and satisfy itself that the claims of its advocates were not exaggerated.

#### AN EXPERIMENTAL TEST OF INOCULATION.

During the summer of 1891 there was an outbreak of swine disease in La Salle County, Ill. The farmers appealed to Secretary Rusk for relief, and, on their urgent request, Dr. E. C. Schroeder, of the Bureau of Animal Industry, was delegated to make investigations and to give such advice and assistance as were needed. An appeal was also made to F. S. Billings, of the Nebraska Experiment Station, and one of the farmers, Mr. Cadwell, had been to the laboratory of that station, where he spent some days under instruction, and returned home with the report that he had Billings's assurance that he could make the inoculations as well as any one.

On November 7, Dr. Billings gave a free lecture to the farmers at Ottawa on the subject of inoculation. The lecturer killed a diseased pig in the lecture room, and showed the farmers how to dissect it and how to make a culture of the germs for inoculating purposes, according to his method. He made such a culture, which was retained by Mr. Cadwell, already referred to as having been instructed at the Nebraska laboratory. He distinctly stated that the virus he then prepared was all right, and that it might be saved and used to inoculate hogs.

At the conclusion of this lecture, the Chief of the Bureau of Animal Industry being present, was called upon and made a short address, in

which he explained that the Billings method of inoculation was practically identical with that used by the Bureau of Animal Industry in the spring of 1886, but which was found not to afford sufficient protection and to have other disadvantages which made it unsatisfactory for general adoption. He stated that it was the same as that used in Nebraska in 1888, when 400 hogs were lost out of 1,000 inoculated, and at Peoria in 1889, where 50 per cent of the hogs inoculated died from cholera, and at Davenport, Iowa, in 1890, where the practice was attempted on a much larger scale and failed disastrously. He did not oppose inoculation, but pointed out the disadvantages and dangers connected with it which farmers should understand before they adopted it. In conclusion, he proposed to make an experiment in order to demonstrate to the satisfaction of all whether the Billings inoculation had any better effect in preventing the disease than that used by the Bureau, and to indicate whether either were of practical value as a preventive measure.

The plan he proposed was to purchase 99 healthy hogs, 33 of which should be inoculated by Billings, 33 by himself, and 33 to be left without inoculation; the entire 99 to be exposed to disease after a period of thirty days had elapsed, and the whole experiment to be under the supervision of a committee of the farmers themselves, who would report the results.

Dr. Billings promptly declined to have anything to do with such an experiment. The farmers, however, were much interested in the proposition and decided to carry it through, agreeing that Mr. Cadwell should make the inoculations on one-third of the hogs with the virus prepared during the lecture. At a meeting held in the evening the farmers decided that 20 hogs in each lot, 60 in all, would be sufficient for the experiment, and appointed a committee of five to superintend it. During the deliberations on the details, Billings affected a studied indifference, turning his back on those present and avoiding any participation in the discussion beyond a few remarks to the effect that he did not care what experiments were made in Illinois, he should continue his inoculations in Nebraska.

The hogs were purchased and ready for inoculation Saturday, November 21. The committee, the representatives of the Bureau of Animal Industry, and Mr. Cadwell were on hand, when the latter stated that Billings had written to him saying that he did not have confidence in the virus prepared by himself at the lecture and that he would send some virus, which he knew to be all right, from Chicago. This virus, however, he had failed to send and neither letters nor telegrams had brought any response from him. It was then agreed that Mr. Cadwell should go to Chicago in person to get the virus. This he did, expecting to be back and ready to make the inoculations on Monday, the 23d. Monday came, and all parties again met at the farm where the hogs were kept. Mr. Cadwell now reported that Billings declined to furnish

him with any virus, but told him that the proper way was for him to make it at Ottawa. Inasmuch as Billings had frequently asserted and repeated his assertion at the lecture referred to, that he could teach any farmer in a very short time how to prepare the virus himself and how to inoculate, and inasmuch as Mr. Cadwell had received his instructions personally and had, furthermore, received assurance that he was competent to do both, it was agreed that the experiment should be carried out, the virus prepared by Mr. Cadwell being used upon one lot, that provided by the Bureau upon another, the third to be left uninoculated. And on the 28th of November these inoculations were so performed.

In a letter published in the Omaha Bee, Dr. Billings said:

The reason I would not send virus from here was simply this: I am instructing farmers how to make their own, and am succeeding, and do it safely, for if inoculation is ever to become practical it must be a simple and cheap method.

In other words, he asserts that the success of inoculation depends upon farmers being able to do it safely themselves, and, of course, if they are not successful in doing it themselves, then inoculation must, in his opinion, be a failure.

There has been a great interest manifested by the swine-growers of all parts of the country in the results of this experiment, because it has been the first test under the direction of farmers that has been made with the necessary precautions to secure exact and reliable evidence on this subject. In this case great care was observed in arranging the details of the test, in selecting proper animals which had not been previously exposed to the disease, in locating the lots where the animals were to be kept, and in avoiding everything which would have a tendency to lessen the value of the experiment as a practical illustration of the results which may be expected to follow inoculation when performed according to the methods which have been most highly recommended.

The following is the report of the committee having the experiment in charge:

*A proposition to test Dr. Billings' alleged discoveries in preventive inoculation for hog cholera, and the value of inoculation in general for this disease.*

Sixty hogs, from four to six months old, shall be purchased and divided into three (3) lots, each hog to be marked with a numbered hog label in the ear; Mr. Cadwell to inoculate twenty (20) of these by his method; the Bureau of Animal Industry to inoculate twenty (20) of these by its method; to be inoculated once by each. The remaining animals to be kept separated from the inoculated animals, without inoculation. Immediately after the inoculation the two inoculated lots shall be turned together, and they shall not again be separated except by consent of both parties to the experiment. The farmers now present will select the farm upon which to keep the animals, and designate five (5) unbiased farmers, who shall have charge of them, and who shall, at the end of the experiment, make a written statement as to what was done and what were the final results. Both parties shall be consulted as to the management of the animals, and particularly as to any changes in location, in feed,

or in the care of the animals, and the report of the committee shall be confined to statements of fact; but the committee of farmers shall have the right to decide upon any disputed points in regard to these matters. One-half of the expenses for purchasing and keeping the hogs shall be paid by the farmers, and one-half shall be paid by Dr. Salmon. Inoculated and check hogs shall be turned together after thirty days, if possible on a farm where cholera exists.

The following committee was appointed:

Charles Eaton (chairman), Vermillionville, Ill.

A. E. Brunson, Northville, Ill.

W. H. Watts, Ottawa, Ill.

Harry Rockwood (secretary), Ottawa, Ill.

M. C. Hodgson, Ottawa, Ill.

The above proposition to test the value of inoculation as a preventive of hog cholera having been accepted, the farm of Charles L. Eaton, at Deer Park, La Salle County, Ill., was selected.

Fifty-five pigs were bought in localities free from hog cholera, and divided and inoculated as directed. The inoculations were made November 28, 1891. The inoculated hogs were kept in a 4-acre field, and the uninoculated hogs in a field, the area of which is about three-fourths of an acre. One corner of the field in which the uninoculated hogs were kept was separated only 20 feet from the field in which the inoculated hogs were confined. The water for the hogs flowed from the end of a tile draining an adjoining field in which no hogs had been kept. This tile opened in the lower corner of the field in which the uninoculated hogs were kept, and then passed into an open ditch which flowed in a curve to the lower end of the field in which the inoculated hogs were confined. The hogs were fed corn in the ear, and also received some ashes and salt. No change of consequence was noticed during the first nine days after inoculation.

December 7 two hogs were showing symptoms of disease, and December 10 the first pig died. This death was followed by others, until now only 19 hogs remain. The dates upon which the hogs died are given below, together with the method by which they were inoculated, or with the name "check," signifying that they were not inoculated. The dates are as follows:

Died December 10.....	1 hog, Cadwell.
Died December 12.....	1 hog, Cadwell.
Died December 13.....	2 hogs, Cadwell.
Died December 18.....	1 hog, Cadwell.
Died December 20.....	1 hog, Cadwell.
Died December 21.....	1 hog, Bureau.
Died December 24.....	1 hog, Cadwell.
Died December 25.....	1 hog, Cadwell.
Died December 26.....	1 hog, Cadwell.
Died December 26.....	1 hog, check.

*December 29.*—At this point in the experiment, the thirty days having expired, the time during which the hogs should be separated, the checks and inoculated animals were turned together.

Died December 31.....	1 hog, Bureau.
Died December 31.....	1 hog, Cadwell.
Died January 1, 1892.....	1 hog, Bureau.
Died January 2.....	1 hog, Bureau.
Died January 3.....	1 hog, Bureau.
Died January 4.....	2 hogs, checks.
Died January 6.....	2 hogs, checks.
Died January 7.....	1 hog, check.
Died January 8.....	1 hog, check.
Died January 10.....	1 hog, Cadwell.

Died January 10.....	1 hog, check.
Died January 11.....	1 hog, check.
Died January 12 (missing—supposed to be dead).....	1 hog, Bureau.
Died January 13.....	3 hogs, checks.
Died January 17.....	1 hog, Cadwell.
Died January 17.....	1 hog, check.
Died January 19.....	2 hogs, Bureau.
Died January 21.....	1 hog, check.
Died January 22.....	1 hog, Bureau.
Died February 5.....	1 hog, Bureau.

The condition of the remaining hogs is good, with the exception of three animals, and they will probably make a good recovery.

CHARLES L. EATON.  
H. E. ROCKWOOD.  
A. E. BRUNSON.  
WILLIAM H. WATTS.  
M. C. HODGSON.

It should be noticed that the first hogs to show sickness were those inoculated by Mr. Cadwell, and that this sickness appeared in nine days, or about the usual time which elapses between exposure and the appearance of disease. This indicates that the disease was caused by Cadwell's inoculation. Fourteen more days passed, during which 6 Cadwell hogs died before the first one of the Bureau hogs died. This indicates very clearly that the Bureau hogs contracted the disease from exposure to the Cadwell hogs. There are here two facts plainly brought out, viz: (1) the Billings method of inoculation may cause an outbreak of the disease it is designed to prevent; (2) the disease thus caused is communicated to other animals in the same manner that ordinary outbreaks of the disease are communicated.

The uninoculated hogs were turned with the inoculated ones on December 29. The object was, no doubt, to determine how many of these would die when exposed to this outbreak, and compare this number with that of the inoculated hogs which died. The final result of the experiment is that 14 of the 19 hogs not inoculated died; 12 of the 18 hogs inoculated by the Billings method died, and 10 of the 18 hogs inoculated by the Bureau died. The variation in the figures may be accidental, or it may show a slight degree of immunity conferred by the inoculation, particularly with the hogs inoculated by the Bureau, as one more of the Cadwell hogs and two checks were very sick, while all of those remaining in the Bureau lot are in good health. Practically, it must be admitted, there was no great difference in the effect of the exposure on the three bunches of hogs.

In order to explain the production of the disease by Cadwell's inoculation it has been stated by Dr. Billings and by editorials in certain papers that Mr. Cadwell had written a letter in which he asserted that "after Dr. Billings had refused to supply him with virus he was unable to secure a hog suffering from a mild attack of cholera. He could only get virus from a malignant form of disease, so he told the committee in

charge that he was not satisfied; but they told him to go ahead, and he did so, with the fatal results stated in the dispatch." (Farmer's Review, December 23, 1891; also Nebraska State Journal, December 27, 1891, and January 22 and 29, 1892.) The Department has investigated this statement, and is satisfied that it is not correct.

When it became apparent that Dr. Billings was endeavoring to delay this test and avoid responsibility for the results, Dr. Schroeder, who represented the Bureau, was instructed not to go on with the experiment if Mr. Cadwell objected to any of the arrangements. Accordingly, before beginning the inoculations, Dr. Schroeder asked Mr. Cadwell if he was fully prepared and satisfied to go ahead, and whether he was perfectly satisfied with his virus. Both of these questions he answered in the affirmative. The following statement, signed by every member of the committee, confirms this statement, and shows that Mr. Cadwell, so far from being directed to use the virus against his wishes, acted strictly in accordance with his own judgment:

We, the committee of farmers appointed to superintend the experiment of inoculating hogs at the farm of Charles L. Eaton, in Deer Park Township, La Salle County, Ill., by Dr. Schroeder, representing the Bureau of Animal Industry of the Department of Agriculture, at Washington, D. C., and Mr. George C. Cadwell, representing the so-called Billings method of inoculation, do hereby state, in regard to the report that we directed Mr. Cadwell to proceed with the inoculation on November 28, 1891, against his judgment, that we did not direct Mr. Cadwell to proceed with the inoculation on that date, but that he used his own judgment in the matter.

Dated at Ottawa, this 1st day of February, 1892.

CHARLES L. EATON.

H. E. ROCKWOOD.

A. E. BRUNSON.

M. C. HODGSON.

WILLIAM H. WATTS.

The facts appear to be that Mr. Cadwell had three flasks of virus, obtained from different sources, and he tried to get the committee to take the responsibility of saying which flask should be selected. This the committee very properly declined to do, since Cadwell had been instructed by Dr. Billings and represented him in the experiment. As a matter of fact, Cadwell made use of two of his flasks, inoculating half of his lot of hogs from one and the remainder from the other. The disease was caused by the virus from both sources.

The objection urged against this virus by Dr. Billings is that it was obtained from an outbreak where more than 50 per cent of the animals died. (Nebraska State Journal, January 29, 1892.) If this is to be the criterion in selecting the virus, it is obvious that no one can be certain as to whether or not he is using a proper virus. The virus must be obtained while the disease is in progress, whereas we can only know how many die from any given outbreak after the disease has ceased its ravages.

One flask of the virus used by Cadwell was obtained from the farm of Henry Richards, where 91 per cent of the animals died. Of the hogs

inoculated with this virus 88 per cent died. The other flask was obtained from the farm of Nicholas Shawback. There were in this herd 146 hogs, of which 50 died, and 1 was killed by Cadwell to obtain virus. Eighty-three from this farm were sold apparently healthy, and 12 remained in good health at the time inquiry was made, about February 15. As a matter of fact, therefore, but 34 per cent of this herd died. Of the hogs inoculated with this virus 4 out of 9 died, or 44 per cent. That is, in the latter case, the virus was more fatal in the inoculated animals than in the herd from which it was obtained, while in the former case there was practically no difference.

The first hog to die was one inoculated with the Richards virus. Two days later 1 inoculated with the Shawback virus died. The day following this 1 died inoculated with the Richards virus and 1 with the Shawback. There can, consequently, be no doubt that the virus from both places produced fatal results.

After these facts were given to the press Mr. Cadwell wrote a letter of explanation, in which he stated: "I was satisfied in my own mind that the virus was not what I wanted. It did not work as I would like to have it." Mr. Eaton, the chairman of the committee, also stated that "Mr. Cadwell did say that he was not quite satisfied with the way it (the virus) had worked, but nothing said about the kind of an outbreak."

It would appear from these statements that the first objection raised to the virus by Dr. Billings had not been made by Mr. Cadwell. The facts given above show that under any circumstances this objection would not be valid, since one of the outbreaks from which the virus was taken corresponded with the instructions publicly issued from the Nebraska Experiment Station. There can be no question that this virus produced fatal results, as well as that from the more severe outbreak.

The question now arises, how much consideration should be given to Mr. Cadwell's statement that the virus "did not work as he would like to have it?" By this he undoubtedly meant that the appearance of the beef broth after the germs had multiplied in it was not exactly what he thought it should be. But why should he object to a culture because of its appearance? Nothing is said by Dr. Billings, in his instructions to farmers on inoculation, as to the rejection of cultures on account of their appearance. The essentials are there said to be that the virus shall be obtained from an outbreak of disease in which less than 50 per cent of the animals die, and from an animal in the first stages of the disease. He has expressly stated that such cultures are not expected to be pure, but that this makes no practical difference. This being the case, the appearance of the culture must necessarily vary according as it is contaminated with one or another of the atmospheric germs. Everyone who has studied the question from a bacteriological standpoint knows that pure cultures of the germs of hog

cholera will also differ in appearance when obtained from different outbreaks. This objection to the virus consequently has no bearing upon the results of the experiment. No one can tell from the appearance of a culture what its effects will be when hogs are inoculated with it.

The truth is, the advocates of inoculation were opposed to making a public and carefully guarded test. They could not decline the proposition to make such a test, however, because it was exactly what the people of that section unanimously demanded. They did delay the experiment on one pretext or another as long as possible. The date of inoculation was twice postponed, and even then there was this pretense of something being wrong with the virus, although the directions for preparing it had been scrupulously followed. It may be safely said that more care was exercised in selecting this virus than is usually given to the selection of virus for farmers' use. Three weeks' time in a section of the country where the disease is thoroughly disseminated surely should be sufficient to obtain material for inoculation, if the method is a practical one.

As an illustration of the difficulty of obtaining proper virus by this method, and of the dangers attending inoculation, it may be added that according to Dr. Schroeder's reports Mr. Cadwell inoculated 4 hogs by the Billings method previous to the beginning of the test experiment. Of these 2 died. Shortly after the experimental hogs were inoculated, Cadwell inoculated 5 hogs by the Billings method. Of these 3 died. He also inoculated 14 hogs and pigs by the same method on the farm of James Mitchell, near Utica, Ill. No trouble was noticed among these until four or five weeks after inoculation, when the disease broke out, and 10 animals, or 71 per cent, died.

It may also be stated in this connection that early in October, 1891, Mr. James Richey, of Tonica, La Salle County, Ill., obtained virus from the Chicago establishment organized by Dr. Billings, and at that time conducted by his former associate. Mr. Richey at once inoculated his herd of 90 animals, which were, in the words of the owner, "a first-class lot of young, healthy hogs." Nine days after the inoculation they commenced to die, and at the time of Dr. Schroeder's visit but 2 remained alive. The loss in this case was over 97 per cent.

This was the experience with the Billings method of inoculation in La Salle County, Ill., while Dr. Schroeder was stationed in that locality.

#### **FAILURE OF INOCULATION IN NEBRASKA DURING 1891.**

Under date of January 6, 1892, Dr. Billings addressed a letter to the Omaha Bee, in which he endeavored to explain the communication of disease by the inoculations made in accordance with his method at Ottawa, Ill. The following extract from his letter is of interest in this connection:

I have inoculated some 50,000 hogs, and never in a single instance that I know of has such an accident occurred through inoculated hogs as at Ottawa, and there have

been very few cases in which inoculation has not protected. True, I failed completely in protecting hogs that were fed on glucose refuse, but that was due to the glucose and not the inoculation. Hogs fed on distillery slops can be protected by inoculation. Every one who is acquainted with the true facts knows that those herds reported as killed at Surprise, Nebr., in 1888, were all diseased at the time they were inoculated. This year over 3,000 have been inoculated in Nebraska, and to-day I sent out virus for 1,900 more, but with some regrets, as I fear for its injury and the possibility of its being frozen. Of the 3,000 I do not know of one being injured by inoculation, yet one such case in sucking pigs is reported, and one failure in the same herd; the pigs I doubt, as five other lots of pigs were inoculated at the same time with the same virus, and they all lived; the failure I know the cause of, and have learned to avoid it in the future.

In spite of this very positive statement, the Department is in receipt of information from three different correspondents of undoubted reliability to the effect that on the 12th of August, 1891, 48 head of swine were inoculated on the State farm under the direction of Dr. Billings, and four of the herd were not inoculated. August 30, 4 pigs were dead, and 2 others very sick were taken to the laboratory for examination. Within thirty days after inoculation 26 died, and before the outbreak set up by the inoculation ceased its ravages 41 of the 52 hogs on the farm died. These facts were certainly known to Dr. Billings at the time the letter quoted from above was written.

With Western Resources for February 10, 1892, was included a supplement giving a statement by Dr. Billings of the inoculations made in Nebraska from August 18, 1891, to January 1, 1892. Why the inoculation on the State farm of August 12 was not included was not stated. In this statement were given more or less complete returns from forty-four herds inoculated. These herds contained 2,952 animals. Among these herds—in a column headed “Died from cholera after thirty days after inoculation”—there is one of 50 which lost 2; one of 163 which lost 2; one of 73 which lost 30; one of 89 which lost 40. These commenced to die three weeks after inoculation. Another herd of 31 lost 2; a herd of 279 lost 38; a herd of 108 lost 77; a herd of 24 lost 7; making in these herds a loss of 198. In addition to this there were eight herds in which losses occurred where it is stated that the herds were infected before inoculation. The evidence of their infection before the operation was performed is not given except in one case. With regard to this it is stated that only those were lost which were sick at the time. In regard to one of the herds it is stated: “I inoculated sows and pigs at the same time. The pigs died; all the old hogs lived.”

In another case it is stated: “Sick at the time of inoculation, and lost 60 shotes, but none of the old ones.” In regard to another herd: “Hogs sick at the time of inoculation. Lost 15 head.” In another case: “Sick at the time of inoculation. My loss has been less than any of my neighbors.” In another case: “No fair test. My hogs were sick when inoculated.” In still another case: “Sick at time of inoculation; visibly so; 13 not sick; these 13 never got sick.”

These explanations are given so that the reader can judge for himself as to whether in any of these cases the disease was caused by the inoculation.

The Department has received the following statements from parties who had hogs inoculated in Nebraska during the period under consideration:

W. Rotton, Unadilla, Nebr.:

I had 51 hogs inoculated. I have not lost any with cholera. I have not much faith in it, as I sold 8 shotes to a neighbor that had cholera some time before, and he lost 2 with the disease. They all took it, but all the others got over it and are doing well.

Henry A. Dan, Boelus, Nebr.:

I do not think inoculation is a preventive. I inoculated on the 1st day of November 49 hogs, and from that time on my hogs have not done well, and the latter part of January the cholera broke out in my herd, and I have lost 10 up to this date, April 13. They have all been sick, and the pigs that were born came dead, or if alive they did not live twenty-four hours.

D. E. Palmblade, Axtell, Nebr.:

I had 72 hogs inoculated. Out of the 72 I sold the old ones, and out of the 55 young ones remaining, I lost about 17. None of them died from the inoculation, and they did very well before they became sick.

S. M. Geyer, Seward, Nebr.:

I inoculated 30 head in 1891 with virus prepared by Dr. Billings. It failed to produce any effect at all. I have not lost any since. As to my opinion of inoculation, I think it is more apt to spread the disease than to prevent it.

Hugh McLaughlin, Lincoln, Nebr.:

I inoculated about 50 hogs last fall, of which 20 died after inoculation. The others lived, and did well. They were all together at the time. I have not seen any sick since.

W. C. Dieterichs, Rockville, Nebr.:

I had about 40 head of shotes inoculated last fall with virus and instruments sent to me by Dr. Billings, of Lincoln, this State. Two little pigs died soon after being inoculated. Do not know if inoculation was the cause. None died of the cholera except one, and that one got amongst a neighbor's hogs and staid several days amongst them. These hogs of my neighbor's had the cholera very bad at the time, although they had been inoculated on the same day mine were. My hogs did not thrive well after being inoculated, and always looked rough and not thrifty, although they had plenty to eat and were running at large. I do not think now that inoculation is a preventive for hog cholera. Perhaps the virus has something to do with it. My neighbor and I inoculated the same day. The virus I used was in another bottle than his. He lost 5 and 6 hogs, and I lost 1, but could not positively say it died of cholera as it died at the neighbor's. I do not think I shall want to inoculate again for a while.

A. B. Wright, Diller, Nebr.:

I inoculated 75 head of swine last fall, of different ages. The large hogs were damaged. Some of them lost in weight nearly 100 pounds. The shotes from six to eight months old I could see no difference in. I inoculated 19 sucking pigs, every one of which died. There has been no cholera in the neighborhood since I inoculated. My opinion is that inoculation is of little or no benefit.

### John Campbell, Nebraska City, Nebr.:

On September 18, 1891, I inoculated 63 shotes about five months old, and 22 old hogs, with virus received from Prof. Billings, of Lincoln, Nebr. In about ten or twelve days I lost 1 shote, and a good many of the shotes were sick. In about three or four weeks I had lost 59 of the shotes, leaving me 4. The shotes and old hogs had been in separate lots, not adjoining, but after inoculating, which was all done at the same time, I moved all the old hogs farther away from the others, with the exception of 1 lame one, and it died in about 30 days after inoculation, but the other old hogs have never had the cholera. I have not much faith in inoculation.

If we deduct from the total number inoculated, as given by Dr. Billings's statement (2,952), the number contained in the herds that were said to be diseased when inoculated (394), we have remaining 2,558 as the number inoculated which had not previously been exposed. Among these it is admitted that the loss from inoculation and exposure amounted to 198, or  $7\frac{3}{4}$  per cent. This is nearly twice the average loss from all diseases of swine in the State of Nebraska for the year 1891, which is given as 4 per cent by the statistical division of this Department. If we correct this statement and make it accord with the letters received by the Department from the owners of the inoculated herds, which letters are given in this bulletin, we must add the herd of John Campbell, which evidently was not infected before inoculation, but which plainly contracted the disease from the operation. We should also add to the losses the 2 belonging to W. Rotton, which died from exposure to cholera, the 10 belonging to Henry Dan, which probably contracted the disease from the inoculation, and the 3 belonging to W. E. Dieterichs. This would give a total of 2,643 healthy hogs inoculated and a loss of 273, or more than 10 per cent. This loss is two and a half times the average loss of the State for the year from all diseases.

There are a considerable number of owners of inoculated herds in the list from whom the Department has received no replies, and it is therefore probable that full returns would considerably increase the percentage of loss as given above. It will also be noticed that no account has been made of the 48 head inoculated on the State farm, of which 79 per cent died from the inoculation. If inoculation on the State farm, where all the conditions can be controlled and where the hogs are under the personal supervision of the operator, is followed by such disastrous results, it certainly can not be safe on farms throughout the country, where such advantages are impossible.

#### THE FINANCIAL ASPECT OF INOCULATION.

It is very apparent, from the facts presented in this bulletin, that inoculation is a very dangerous operation, and that the protection from it is, at best, uncertain, and in many cases entirely wanting. With these incontestable conclusions in mind, we will give some figures on the losses from swine diseases and the cost of inoculation. Two years ago the following statement was made:

According to the estimates of the statistical division there are about 50,300,000 hogs in the United States. The inoculation of these at 50 cents per head would cost \$25,150,000. The total loss from disease during the year 1888 was 3,105,000 hogs, at an average value of \$5.79 each. This would make the total loss of swine from all diseases \$17,980,000.

In order to estimate the loss from hog cholera we must deduct from this sum the losses from ordinary diseases, such as animal parasites, exposure, overcrowding, and improper feeding, which are always acting and do not produce epizootic diseases. These losses were estimated by the statistician of the Department in 1886 to be about 4 per cent of the total number of hogs, but as this may be considered rather a large estimate we will, in our calculation, take 3 per cent as the average loss from such causes. This would amount in 1888 to 1,509,000 animals, valued at \$8,737,000, and deducting this from the total loss of swine we have remaining \$9,243,000 as the losses from epizootic swine diseases. In the present condition of our knowledge we must admit that there are at least two entirely distinct epizootic diseases of hogs, which have been referred to in the reports of this Bureau as hog cholera and swine plague. The exact proportion of the loss caused by each of these diseases is at present unknown, but if we admit for the purposes of this calculation that but one-third of the loss is caused by swine plague we have remaining a loss of but \$6,163,000 for the year 1888, which can be attributed to hog cholera. To prevent this disease by inoculation, as we have just seen, requires the expenditure in cash of \$25,150,000, or more than four times the amount of the actual losses. In addition to this expenditure there should be counted the time required of the farmer in handling the hogs at the time of the operation and in giving them such precautionary care and in practicing such disinfection as is required to make this operation at all successful.

We should reach the same conclusion if, instead of estimating the loss and expense for the whole of the United States, we should take a single hog-raising State, as, for example, the State of Illinois. According to the statistician's estimate there are 5,275,000 hogs in Illinois, and to protect these by inoculation would cost \$2,637,000. In the year 1888 the total losses of hogs in that State from all diseases was about 316,500, with an average value of \$7.45 each, which would make the loss for that year \$2,359,925. Deduct a loss of 3 per cent of all the hogs in the State as caused by ordinary diseases, and we find that this would amount to 158,250 hogs, worth \$1,178,962. Deducting the losses caused by ordinary diseases from the total losses from all diseases and we have \$1,180,963 left to represent the loss from both hog cholera and swine plague. Take from this one-third, to represent the loss from swine plague, and we have remaining, as the loss from hog cholera, about the sum of \$800,000. To prevent this loss by inoculation, as we have seen, would require \$2,637,000, or more than three times the sum to be saved.

In the above calculations we were considering inoculation when prac-

ticed as a private enterprise, with a charge of 50 cents per head for the operation. It has since been proposed that the virus and instruments should be supplied by the State experiment stations and that the farmers should perform the operation themselves. This would no doubt reduce the cost of inoculation to 25 cents a head for the time and trouble involved in the operation, the expressage on the instruments and virus, and the precautions necessary to prevent the spread of the disease to other herds. To this we must now add the loss following the operation when performed on healthy herds. This we have just seen has been with 2,643 animals inoculated the last year, and with every precaution that could be adopted, over 10 per cent. If the hogs average \$5 per head in value this would be an additional expense of 50 cents per head for each inoculated animal.

Some herds during the past year were badly stunted. In some cases animals not only stopped growing, but they lost 50 or 100 pounds in weight. Such losses are very serious and amount to much more than the cost of the operation, or even the value of the animals which die from it. The hog crop is practically an annual crop. In many cases hogs are sold at six to eight months of age. Now, it is very plain that to subject animals marketed at this age to an operation which stops the growth of all, or of a considerable proportion of them, for one or two months is to deprive the farmer of all chance of profit from this industry.

### FARMERS' BULLETINS.

The bulletins of this series may be obtained by applying to the Secretary of Agriculture, Washington, D. C. The following have been previously issued:

Farmers' Bulletin No. 1. The What and Why of Agricultural Experiment Stations. (A brief explanation of the object, origin, and development of the stations, their work in Europe and in the United States, and the operations of the Office of Experiment Stations of the Department of Agriculture.) Prepared by the Office of Experiment Stations; pp. 16. Issued June, 1889.

Farmers' Bulletin No. 2. The Work of the Agricultural Experiment Stations; (Illustrations of Station Work in the following lines: better cows for the dairy; fibrin in milk; bacteria in milk, cream, and butter; silos and silage; alfalfa; and field experiments with fertilizers.) Prepared by the Office of Experiment Stations; pp. 16. Issued June, 1889.

Farmers' Bulletin No. 3. The Culture of the Sugar Beet. (Treats of the climatic conditions, soil, fertilizers, and cultivation required by the sugar beet, cost of growing, time to harvest, and method of soiling; describes briefly the process of beet-sugar manufacture, and gives statistics of sugar production and consumption.) By H. W. Wiley, chemist of the Department of Agriculture; pp. 24. Issued March, 1891.

Farmers' Bulletin No. 4. Fungous Diseases of the Grape and their Treatment. (Describes downy mildew, powdery mildew, black rot, and anthracnose of grapes, and gives instructions for their treatment and estimated cost of remedies.) By B. T. Galloway, Chief of the Division of Vegetable Pathology; pp. 12. Issued March, 1891.

Farmers' Bulletin No. 5. Treatment of Smuts of Oats and Wheat. (Describes the smuts of wheat, oats, and barley, the damage they cause, and the various methods of treatment which have been found useful for their prevention.) Prepared by the Division of Vegetable Pathology; pp. 8. Issued February, 1892.

Farmers' Bulletin No. 6. Tobacco: Instructions for its cultivation and curing. Prepared by John M. Estes, special agent; pp. 8. Issued February, 1892.

Farmers' Bulletin No. 7. Spraying Fruits for Insect Pests and Fungous Diseases, with a Special Consideration of the Subject in its Relation to the Public Health. Prepared by the Divisions of Entomology and Vegetable Pathology; pp. 20. Issued April, 1892.