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BRUCELLOSIS

WITH A CONTROL PLAN FOR BEEF CATTLE

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Brucellosis, commonly spoken of as Bang's disease in cattle, is, from an economic standpoint, probably, the most serious disease affecting Missouri cattle at the present time. Although the mortality rate in adult cattle is not great, the heavy loss of calves, the increase of sterility in the herd, and other associated troubles make the economic losses very heavy. In the United States it is said that approximately 5 per cent of all adult female cattle are now infected. The annual loss in this country is at least $100,000,000. This figure does not include hogs. Much experimental work has been done with this disease, but many questions still are raised by livestock owners regarding the best methods of control. Information reported in this publication has been gained from various experiments conducted at the Missouri Agricultural Experiment Station, and especially from work with a brucellosis infected beef cattle herd. This herd went through a "storm of abortions" and methods of handling and freeing this herd of infection are outlined.

ANIMALS AFFECTED

Brucellosis is a general term used to designate infection with Brucella organisms in all classes of animals and in man. There are three different strains of this organism that infect man and domestic animals. In cattle, the disease was known formerly as infectious or contagious abortion, later was called Bang's disease and now is given the name brucellosis. It has been the opinion of many beef cattle raisers that brucellosis is more often an infection of dairy cattle than of beef cattle. In some unpublished research one of the authors (Elder) found the per cent of infection in beef cattle in Missouri just as high as that found in dairy cattle. These findings were based upon the results of several hundred thousand tests and this number was considered great enough to be very significant.

Infection generally is believed highest in herds of cattle that are kept more closely confined and that probably remain in barns or sheds much of the time, or when the cattle are closely associated in small pastures. The per cent of infection in range cattle, or what might be called semi-range cattle, does not seem to be so great. Swine are commonly affected with brucellosis but the disease in cattle is seldom, if ever, transmitted to hogs. Experiments carried on at the Missouri Experiment Station indicate that the danger of spread from swine to cattle is not great when

the animals are kept under pasture conditions. Sheep are rarely, if ever, affected, but goats are susceptible. Horses are also susceptible to the disease and the infection is particularly associated with such conditions known as fistulous withers and poll evil. Man is susceptible to the infection and may contract the disease from handling the infected animals. The disease in man is known as brucellosis or undulant fever, and will be discussed later in this bulletin.

METHODS OF CONTROL

The method of control in any herd preferably is based upon the conditions in that particular herd. In 1947, 1948, and 1949, the committee on brucellosis of the U. S. Livestock Sanitary Association recommended methods of procedure for eradicating brucellosis under plans A, B, C, and D. These four plans, taken from those reports, are included in this bulletin. From them the cattle owner should choose the one best suited for his farm and herd conditions. The plans described below include some reasons given for the use of each.

Plan A. Test-and-slaughter; with or without calfhood vaccination. Test and slaughter of infected animals has the advantage of being a short-time program, since many lightly infected herds may be freed and remain free of the infection after a limited number of tests. Where negative herds are surrounded by heavy infection, the advantages of calfhood vaccination should be considered.

Test-and-slaughter is recommended for infected herds in which the immediate removal of reactors will not cause serious economic losses, provided owners appreciate fully the necessity of following recognized sanitary procedures. These procedures must include prompt removal of reactors, and thorough cleaning and disinfection of barns or buildings and pasture areas where abortions have occurred. Retests at frequent intervals not to exceed 30 days should be made until the disease has been eradicated. Test-and-slaughter is likely to be unsuccessful unless all of these procedures are followed. However, it has been successful in thousands of herds where suitable precautions have been observed.

Calfhood vaccination should be encouraged in infected herds and areas, but it should not be a substitute for sound sanitation and management. Failure to follow sound management practices, so far as replacements are concerned, accounts for most of the breaks in clean herds. Owners should be warned that, as is true in many other disease control programs, occasional herds do not respond satisfactorily.

Plan B. Test and calfhood vaccination; temporary retention of reactors until they can be disposed of for slaughter without excessive loss to the owner under provisions of the law.

The objective should be to dispose of reactors for slaughter as soon as possible. Full recognition is given to the fact that vaccinated calves

will not all be resistant. However, with a high percentage of vaccinated animals having an increased resistance to brucellosis, the percentage in favor of vaccination is sufficient to support its wider use.

Plan C. Calfhood vaccination without test of any part of the herd. This plan to be confined to those herds in which the movement of animals is restricted to special permits issued by State Livestock Sanitary Officials.

Plan D. Adult vaccination—only when approval is received in writing from state and federal cooperating agencies prior to the time of vaccination, which should be confined to herds where there is evidence of rapid spread of virulent infection indicating the need for emergency measures. This should take place only after the owner has been informed in writing that vaccinating of his adult animals may not prevent the spread of infection. In herds where adult vaccination is adopted, the herd must be subjected to the agglutination test prior to vaccination, reactors identified according to state regulations, and vaccine administered only to negative animals within 10 days after the completion of the official test.

ADULT VACCINATION

Adult vaccination has been criticized by many because it causes such animals to develop a blood agglutination titer which usually persists for long periods of time. This interferes with the movement of cattle across state lines into areas which demand a negative blood test. Further objections have been voiced because pregnant animals frequently abort when vaccinated. Unfortunately, it is impossible, by present known methods, to differentiate between blood agglutination titers resulting from vaccination, and those which are the results of actual field infection. Any adult animal which reacts to the blood agglutination test may be considered as potentially dangerous and probably infected. No adult animals were vaccinated in this particular experiment.

HISTORY OF BRUCELLOSIS IN THE UNIVERSITY BEEF HERD

An outbreak of brucellosis in the University of Missouri beef herd in 1946 made it necessary to develop some plan for the control and elimination of this disease in the herd without sacrificing valuable blood lines and with the least possible financial loss. For these reasons a variation in Plan B (refer to page 4) was used.

The source of the infection for this outbreak never has been definitely determined. Prior to 1946, there was no evidence of an active infection of brucellosis in this herd. During the period 1930-1946 several cows occasionally gave suspicious reactions of 1 to 50 or incomplete 1 to 100. At other times during the semi-annual tests in April and October, the tests on these cows were completely negative. The cows giving these

occasional suspicious reactions were placed on an isolated pasture until a clean test was obtained. Only one female was added to the herd during this sixteen-year period. She was isolated for 60 days and tested twice before being pastured with the herd. No vaccines for brucellosis were used on the herd prior to March, 1947.

PLAN OF CONTROL

A plan for control of brucellosis in the University of Missouri beef herd was started as a cooperative project between the School of Veterinary Medicine and the Department of Animal Husbandry in March, 1947, and terminated in March, 1951.

The outlined "Plan of Control" consisted of the following:

1. An initial blood or agglutination test was made on all animals in the herd over six months of age.

2. All animals reacting in dilutions of 1 to 100 or higher were removed from the herd and were isolated permanently in pastures from which drainage could not flow into pastures where disease-free cattle were kept.

3. Suspects to the test were held in isolation for 30 days and retested.

4. Retests were made on all negative cattle every 30 days until two successive clean tests were obtained. Reactors were removed and handled as previously described. After that, the interval between tests was extended to 60 or 90 days and this procedure followed for one year. After the herd was considered free of disease, the tests were made every six months.

5. Any cow in the herd that showed symptoms of aborting was isolated for at least 60 days. Two negative tests were obtained before returning her to the "negative herd" or controlled group.

6. All heifer calves, if negative to the test, were vaccinated with Strain 19 vaccine at approximately 6 months of age and were kept separate from the breeding herd until 18 months of age.

7. Vaccinated heifers were tested at 30 and 60 day intervals until they became negative. Due to the fact that the blood titer on some heifers dropped rapidly it was necessary to make the first test in 30 days and then retest every 60 days thereafter until negative. This was done in our experiment for the purpose of obtaining information on how long vaccinated calves will retain blood titers.

8. Heifers were retested again at 18 months of age and were required to be negative before breeding.

9. Heifers that remained positive after breeding age were either placed in the positive reacting herd or sold on the market.

SEPARATE UNITS USED ON THE EXPERIMENT

The reactor group referred to in the tables and discussion consisted of cattle that were found infected on the initial test and those cattle that were removed on succeeding tests.

The controlled group consisted of cows that did not react to the initial test. They remained in this group as long as they did not react to subsequent tests and did not abort.

A third group known as the vaccinated group was made up of calfhood vaccinated heifers after they had reached production age. These heifers were not kept as a separate unit but were pastured and housed with the controlled group.

PRINCIPAL RESULTS

At the beginning of the experiment in 1947, we had a total of 82 adult breeding cows. On the initial test, 16 of these were found to be reactors to the blood agglutination test.

During the first two years any cow in the controlled group that aborted before showing an agglutination reaction was immediately placed in the reactor group, but the abortion was credited to the controlled group.

Since this herd was free from infection for a long period, every animal was probably highly susceptible to brucellosis and following the outbreak a "storm of abortions" occurred, which accounted for the large number developing in the first and second years.

In addition to the original 16 reactors removed at the start of 1947, 33 additional reactors were found in the controlled group during that year. In 1948, there were four more reactors removed from this controlled group but there were no additional reactions after 1948.

As was expected the breeding performance of the controlled group improved greatly as the reactors were eliminated. In 1948, difficulty occurred in getting some cows in the controlled group to settle with calf which partially accounts for the poor calving percentage for that year shown in Table 1. These cows later settled with calf and did not become reactors or aborters.

During 1947 and 1948, five cows were sold out of the controlled group because they repeatedly failed to settle with calf. This probably was

TABLE 1 -- BREEDING PERFORMANCE IN THE CONTROLLED GROUP

Year	Number of Cows	Live Calves	Calving %	Average Number Services Per Calf	Abortions	Sold for Sterility Reasons	Sold Following Abortions
1947	42	29	69.0	2.00	9	3	0
1948	31	22	70.9	2.43	4	2	0
1949	24	20	83.3	1.80	1*	0	0
1950	21	19	90.5	1.50	1*	0	0

* Abortions not due to brucellosis.

not due to brucellosis as none of these cows showed a reaction to any agglutination test. Other cows were sold from both the controlled and reactor groups principally because of old age.

In the reactor group it will be noted that breeding efficiency was very poor during 1947-48 (Table 2). Some improvement was noted in 1949 and breeding performance was approximately normal in 1950. Some of this improvement can be attributed to the disposal of cows that were

TABLE 2 -- BREEDING PERFORMANCE IN THE REACTOR GROUP

Year	Number of Cows	Live Calves	Calving %	Average Number Services Per Calf	Abortions	Sold for Sterility Reasons	Sold Following Abortions
1947	40	20	50	1.21	16*	0	4
1948	42	22	52.4	2.90	6**	4	1
1949	37	24	64.8	1.65	6	0	0
1950	35	30	85.7	1.76	3	4	0

* Included one premature calf that lived.
** Included two premature calves that lived.

either sterile or of insufficient value to retain after one abortion. In a control program of this kind, we believe it is desirable to cull as many aged and poor producing reactor cows as is economically practical; although in some instances we retained cows of valuable breeding for as long as two years in an effort to obtain a live calf from them. The evidence we obtained after following the above procedures seems to indicate that infected herds will improve in breeding efficiency and produce a near normal calf crop after about two years.

The vaccinated group did not come into significant production until 1949. The rather low calving percentage for this group in 1949 was due to a failure of some of the heifers to settle with calf, but they later conceived and have been producing normally since. The one abortion shown in Table 3 of the vaccinated group was in a first calf heifer. She was negative to the agglutination test at the time of abortion and again 3 months later. Following abortion this animal was placed in the reactor group and rebred. She promptly settled with calf but aborted again 7 months later and showed a very strong reaction to the blood test. This would seem to indicate that in this case there was inadequate protection from vaccination when the animal was exposed to severe infection. It is

TABLE 3 -- BREEDING PERFORMANCE IN THE CALFHOOD VACCINATED GROUP

Year	Number of Cows	Live Calves	Calving %	Average Number Services Per Calf	Abortions	Sold for Sterility Reasons	Sold Following Abortions
1947	0	0	0	0	0	0	0
1948	4	3	75.0	1.00	1*	0	0
1949	17	12	70.6	2.53	0	0	0
1950	30	30	100.0	1.29	0	0	0

* Negative three months after abortion.

unfortunate that the immunity of all vaccinated calves could not be challenged, but conditions under which this herd had to be handled would not permit this approach.

During the course of the project, it was decided to calculate the cost of maintaining the 3 groups of cattle, and to make a comparison with estimated returns from calves if sold as purebreds or as grade stock. Results are tabulated in Tables 4, 5, and 6.

The cows in the controlled and vaccinated groups were dependent on pasture alone for 7 months of the year. They were fed some mixed grass and legume hay in addition to the pasture in December and April and were fed corn silage in January, February, and March each year. They were fed approximately 2.25 tons of corn silage, one-half ton of mixed hay and pasture. In estimating the feed cost based on prices in 1950, we used $10 per ton for corn silage, $20 per ton for the hay and $2.50 per cow per month for 8 months pasture.

Most of the cows in the reactor group were on pasture alone for 6 months of the year. They were pastured through the late fall, winter and early spring on a field from which mixed grass and lespedeza hay was baled and moved from about half of the field each summer. The balance of the field, which was usually coarser hay was put up in moderate size stacks that were used for wintering the reactor cows. After harvesting the hay, this field was allowed to grow up for late fall and

TABLE 4 -- COST AND RETURNS OF MAINTAINING CONTROLLED GROUP

Controlled Group	1947	1948	1949	1950	4-year total
Average Number Cows	42	31	24	21	118
Average Number Live Calves	29	22	20	19	90
Total Feed Costs	$2492.45	$1499.48	$1248.44	$ 813.36	$ 6053.73
Total Estimated Income from Calves if Sold as Purebreds	7250.00	5500.00	5000.00	4750.00	22,500.00
Total Estimated Income from Calves if Sold as Grades	3915.00	2970.00	2700.00	2565.00	12,150.00

TABLE 5 -- COST AND RETURNS OF MAINTAINING REACTOR GROUP

Reactor Group	1947	1948	1949	1950	4-year total
Average Number Cows	40	42	37	35	154
Average Number Live Calves	20	22	24	30	96
Total Feed Costs	$1572.21	$1773.68	$1656.20	$1524.11	$ 6526.20
Total Estimated Income from Calves if Sold as Purebreds	5000.00	5500.00	6000.00	7500.00	24,000.00
Total Estimated Income from Calves if Sold as Grades	2700.00	2970.00	3240.00	4050.00	12,960.00

TABLE 6 -- COST AND RETURNS OF MAINTAINING VACCINATED GROUP

Vaccinated Group	1947	1948	1949	1950	4-year total
Average Number Cows	0	4	17	30	51
Average Number Live Calves	0	3	12	30	45
Total Feed Costs	0	$463.48	$ 926.08	$1402.02	$ 2791.58
Total Estimated Income from Calves if Sold as Purebreds	0	750.00	3000.00	6500.00	10,250.00
Total Estimated Income from Calves if Sold as Grades	0	405.00	1620	3510.00	5535.00

winter pasture. The summer pasture charge for the group was $2.50 per cow per month for 6 months and $4 per cow per month for the 6 months of winter pasture and stack hay. In open winters these cows ate only 1 ton of stack hay per cow.

In order to make some comparison on costs and returns from each group only the feed costs were figured, since this is the principal cost item and labor and housing costs vary greatly from farm to farm. If at some later date the prices used are no longer applicable, a reasonable close estimate may be calculated from the data.

Income from the calves was based on estimated sale value at weaning time with purebred calves estimated at $250 and grade calves at $135 each. Likewise if these prices are not applicable to conditions prevailing at the time, other values may be substituted and calculations made from the data. The same number of bulls was used on the herd as was used prior to starting the experiment.

We were particularly interested in determining the economy of maintaining a separate reactor herd. By making extensive use of pasture and low cost roughages, a somewhat less expensive ration was provided for the reactor group as compared to the controlled and vaccinated groups. As a result of our calculations from a financial standpoint, we believe the decision to maintain a separate reactor herd depends upon whether or not one operates a grade herd or a purebred herd. While the income from calves from the grade herd more than paid for the feed cost it is questionable whether this profit would compensate for the time and labor required.

One should always bear in mind the constant danger of reinfecting the clean herd that is being developed. One should not attempt to undertake a program of this kind without a thorough realization of the additional responsibilities. Any laxity in maintaining the reactor herd separate and apart from the disease-free herd may result in total failure of the plan. It is necessary that each step of the plan be followed very carefully in order that one's efforts be carried to a successful conclusion. It is very important to eliminate all cattle in the infected herd as soon as a brucellosis-free herd has been rebuilt to the original size by the addition of vaccinated heifers. Our records show that a sufficient number of vaccinated heifers would have come into production in 1951 in numbers large enough to replace all losses incurred in the original herd of 82 had not some of them been sold as breeding stock.

Four of the heifer calves from the reactor group of cows were found to be infected as the result of nursing infected cows and could not be used for vaccination. A failure to identify these infected animals by blood test prior to vaccination could have resulted in placing virulent infection in the clean herd and jeopardizing the entire program.

As already mentioned, one of the objectives in the plan of this experiment was to preserve valuable blood lines in this herd of beef cattle. The composition of the herd in March, 1951, when the experiment was terminated, emphasizes this point. Only 21 of the original 82 cows remained in the negative herd during the four-year course of this experiment. Thirty of the calfhood vaccinated heifers, which included the 1950 heifer calves, were either from dams that were negative to the agglutination test or from calfhood vaccinated dams. Thirty-nine of the vaccinated heifers were from cows in the positive reactor group. If Plan A had been used where test and slaughter is practiced the herd would have been reduced to a point that valuable breeding cows would have been sacrificed and would have required a longer time to have been rebuilt to its original size.

Heifers that were calfhood vaccinated at 6 months of age carried a blood titer for an average of 5.8 months after vaccination when they were tested at 30 and 60 day intervals. Seven per cent of the calfhood vaccinated heifers were still carrying a low titer at 18 months of age.

HERD MANAGEMENT

Control of brucellosis is an individual herd problem. Different plans can be equally succesful. Sanitation and good herd management is an integral part in any control program but the final goal should be eradication. Approved methods of herd management include testing, quarantine and disinfection of premises. Elaborate equipment and expensive isolation quarters are not necessary, but the identification of all animals is very important.

The source of infection in a herd is often the purchase of a new cow; therefore, one should keep new additions away from the herd for a period of 60 to 90 days. All pregnant cows in an infected herd should be closely watched. If any should show evidence of impending abortion they should be immediately removed from the herd and where indicated, the barn should be cleaned and disinfected. There are other causes for the occurrence of abortions but most are due to Brucella abortus. When large numbers of animals are considered, only a very small per cent of cows that abort once will abort the second time. However, in this particular experiment eight cows aborted twice and two cows aborted or had premature calves three times. Heifers in their first pregnancy are the most susceptible to the disease. Not many cows ever recover or completely throw off the disease but if properly handled they may become good breeders. They may have trouble with retained placentae and some of them may become sterile. A small per cent of the cows on the experiment had retained placentae following abortion but there were very few such

cases in the reactor group following normal pregnancies. It has not been definitely proved that trace minerals will either prevent or cure the disease and there is no medicine which will cure brucellosis in livestock.

Calfhood vaccination, as previously outlined and used in this experiment, is very helpful in controlling the disease in a cattle herd. Calfhood vaccination is not a cure-all for Bang's disease, or brucellosis, and it should not be substituted for all other methods of control. There is no evidence to prove that vaccinated calves will spread the disease to other cattle, even though the other cattle have never been vaccinated. It is not necessary and apparently not advisable to vaccinate bull calves.

In considering a plan of control, the livestock owner should consult his local licensed veterinarian and discuss all phases of the problem with him in an effort to determine the plan best adapted to the farm. After the plan has been selected, a schedule should be carefully worked out to include all activities connected with the program. In some instances, herd owners have failed in their control programs because they were not aware of all the ways by which brucellosis germs could be spread.

The services of the veterinarian should also be employed in collecting blood samples and administering the vaccine. This not only assures the herd owner of having the work performed correctly, but also provides official recognition of the work being done on the farm and permits the movement of cattle through trade channels with proper certification.

HUMAN HEALTH ASPECT

Since people are susceptible to brucellosis, serious consideration should be given to this phase of the problem. It is the opinion of some that the human health reason is a bigger reason for the eradication of brucellosis than is the dollar and cent pocketbook reason. Unfortunately, the disease in humans has increased during and after the last war. Farmers get the disease from handling infected animals (newborn, especially), and from drinking raw infected milk. The danger from handling animals seems to be greater than from the consumption of milk. The type of infection probably depends somewhat on the predominating livestock type in the area. In 1949, the National Research Council said: "Satisfactory control and eradication of undulant fever in man are dependent on prevention of his being exposed to infected animals and animal products." Use of rubber gloves when handling newborn animals and infected cattle, and thorough washing of hands several times after handling them are precautions to be taken. Milk from an infected cow should be properly pasteurized or boiled before it is used for human consumption.