MINNESOTA

LEGISLATIVE RESEARCH COMMITTEE

BANG'S DISEASE CONTROL PROGRAM IN MINNESOTA

Publication No. 2

November 1947

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The Research Department of the Legislative Research Committee is organized to provide an unbiased, factual source of information with regard to problems which may be acted upon by the legislature. This department is engaged in objective fact finding under the general supervision of members of the Committee.

M I N N E S O T A

LEGISLATIVE RESEARCH COMMITTEE

Bang's Disease Control Program

In

Minnesota

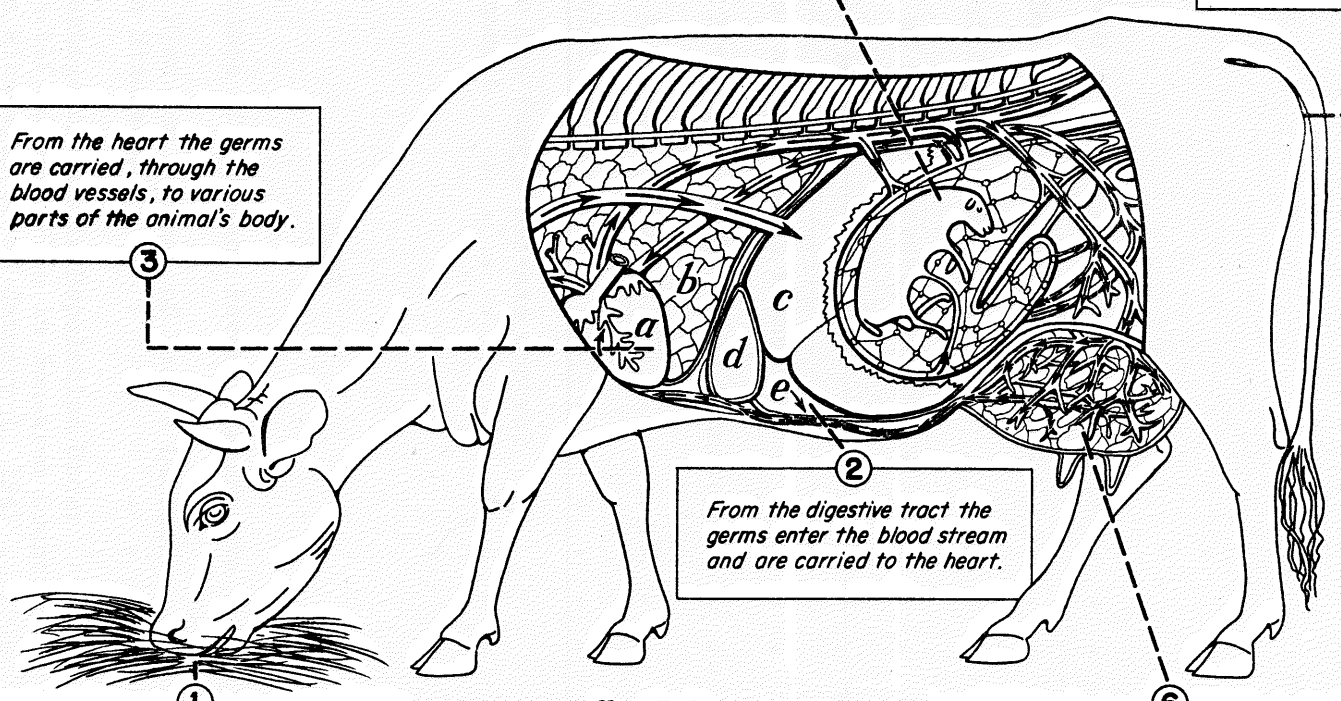
Research Report issued pursuant
to Proposal No. 2:

A PROPOSAL relating to a course
of legislative policy with respect
to the control and elimination of
Bang's disease in cattle.

Publication No. 2

November 1947

ROUTE OF BRUCELLOSIS GERMS IN THEIR ATTACK ON CATTLE



The presence of numerous germs in the pregnant uterus frequently results in death and premature expulsion of the fetus.

④

Millions of brucellosis germs pass from the uterus with the dead fetus and subsequent discharges.

⑤

From the heart the germs are carried, through the blood vessels, to various parts of the animal's body.

③

From the digestive tract the germs enter the blood stream and are carried to the heart.

②

① *The consumption of feed and water, soiled with brucellosis organisms, is the greatest single factor in the spread of the disease.*

⑥ *The udders of a large percentage of infected cows harbor brucellosis germs and discharge them more or less continuously with the milk.*

a HEART
b LUNG
c RUMEN
d RETICULUM
e ABOMASUM

Prepared in Bureau of Animal Industry, United States Department of Agriculture.

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B R I E F L Y . . .

Brucellosis is the name of a disease common to man and some domestic animals. In man it is called "undulant fever", and in cattle - "Bang's disease". Undulant fever is on the increase in Minnesota; and since no cure has yet been discovered, emphasis must be placed upon prevention. There is a definite necessity for controlling the disease from a public health standpoint.

Since the principal sources of human infection are the consumption of raw milk from infected animals and contact with infected animals or carcasses, it follows that pasteurization or boiling of all milk intended for human consumption, together with the elimination of the disease in animals, to prevent exposure due to unavoidable contacts with them, would remove the sources of human infection. In view of the importance of pasteurization as a means of reducing human exposure to the Brucella organisms, it may be advisable to require the pasteurization of all milk sold at retail.

Undulant fever causes serious economic losses through lost man-hours and the expense of medical treatment. It is classed as a compensable occupational disease under the Minnesota Workmen's Compensation Laws with both loss of wage benefits and medical benefits.

It is estimated that brucellosis causes an annual economic loss of $50,000,000 to cattle owners and $10,000,000 to swine owners each year in the United States, and Minnesota farmers being in a recognized dairy and livestock state will continue to suffer high economic losses unless the disease is controlled.

The nature of brucellosis is such that if action is delayed until an attack occurs, the owner usually sustains heavy losses, regardless of any assistance which may be given him; the objective should be to locate the infection before conditions favoring its spread occur.

The present control program with emphasis on test-and-slaughter is definately handicapped by the lack of veterinarians who will accept public employment. There are indications that the control program would benefit if laymen were trained to aid veterinarians in conducting tests. It should also be pointed out that the rules and regulations of the Minnesota Live Stock Sanitary Board provide that vaccination be done by veterinarians.

About one-fifth of the cattle in the State located in 29 counties containing slightly more than half the area of the State are under the area plan of control. In the 58 non-area counties only 4.8% of the cattle are under the certified herd plan. Both of these plans are essentially test-and-slaughter programs. Vaccination against brucellosis is not widely employed

in Minnesota. Thus, about three-fourths of the cattle in the State are not under any positive program for the control and elimination of Bang's disease. Based on the number of cattle covered by the area plan and by the certified herd plan, the test-and-slaughter program in Minnesota cannot be called successful.

From the beginning of organized Bang's disease control measures in Minnesota in 1934 until August 26, 1947, the State expended a total of $1,403,538.47 of which $941,416.16 was for indemnities and $462,122.31 for operating costs.

The present high prices of cattle furnish no incentive for farmers to participate in the certified herd or area plans for eliminating brucellosis, as the continuing high demand and high prices for dairy products make farmers reluctant to dispose of any dairy animals. In periods when cattle prices were relatively low, the indemnity payment acted as a subsidy and furnished such an incentive.

Calfhood vaccination will provide a serviceable immunity for three to five years in about 80% of the cases and protect against abortion in 95% of the cases for the same period. Uncontrolled vaccination is not encouraged by the Minnesota Live Stock Sanitary Board or the legislature as evidenced by the fact that only 19,957 calves were vaccinated in the fiscal year of 1946. The Live Stock Sanitary Board, while providing for a controlled vaccination program, is reluctant to emphasize or push an uncontrolled vaccination program. Accepted scientific evidence indicates that a controlled vaccination program is successful enough to receive wider application.

Because the United States Bureau of Animal Industry cooperates with the states in the control of Bang's disease, almost all states employ the test-and-slaughter method with the payment of indemnities. In the country as a whole there is a definite trend toward the wider use of vaccination.

It is held by some livestock disease control experts that control measures, including vaccination, must be conducted at public expense if the program is to be successful. Vaccination control measures could perhaps be facilitated if part of the funds now appropriated for indemnity payments were used for vaccination. Furthermore, there is evidence to indicate that the Bureau of Animal Industry will furnish and administer some vaccine if the vaccination program is expanded in this State.

Fundamental to the control of the disease in cattle is the observance of sound sanitation methods by the cattle owner or caretaker. The success or failure of any control program is conditioned upon the understanding and cooperation of the owners themselves. While county agents advocate and teach farm sanitation, an extended campaign of this nature could point out that brucellosis control measures are not effective unless proper sanitation procedures are observed.

INTRODUCTION

Brucellosis infects human beings, cattle, swine, goats, sheep and horses. It is a fairly common disease in the United States as well as throughout the world. Through research and study both here and abroad, scientific information has been accumulated, but to date no certain means of eliminating the disease has been discovered. However, scientific methods make possible accurate diagnosis of the disease in people and cattle and form the basis for control measures. In the United States, brucellosis apparently is of lesser importance in swine, sheep, goats and horses, both economically and pathologically, and therefore attention has been directed to control measures for human beings and cattle.

In man the disease is known as undulant fever. It not only causes suffering and sometimes death, but economic losses through reduced efficiency of infected persons, lost man-hours of work, and in some cases loss of the bread winner.

In animals the disease is of most importance in cattle for two reasons: first, the human health problem, and second, the econimic losses to livestock owners. In cattle brucellosis is commonly called "Bang's disease", and its outstanding symptom is abortion.

It is only in the last half century that the importance of brucellosis as a public health and economic problem has been recognized. These two factors have directed attention to the study of brucellosis and its effects.

BRUCELLOSIS AND MAN

Undulant fever, sometimes called Malta fever, is said to have been recognized by Hippocrates (460-357 B.C.). In 1887 Sir David Bruce, a British Army surgeon stationed at Malta proved that undulant fever is acquired by human beings through the consumption of raw milk from infected animals. Ten years later Bernard Bang, a Dane, reported finding the micro-organism causing contagious abortion in cattle. In Baltimore, in 1924, Keefer reported the first case of undulant fever in man proved to be due to the organism causing contagious abortion in cattle.

THREE SPECIES OF BRUCELLA ORGANISM

There are now usually recognized three closely related species of the Brucella organism which may cause undulant fever in man. Usually these three organisms are acquired from different sources: (1) Brucella melitensis from goats, (2) Brucella abortus from infected cows, and (3) Brucella suis from infected swine. Each of the three species, however, has been acquired on occasion from each one of the three animal hosts named. All three organisms have been isolated from blood cultures from Minnesota cases of undulant fever. The porcine (swine) organisms are usually more virulent for man than are the bovine organisms.

These three closely related micro-organisms cause undulant fever in man and contagious abortion in cattle and hogs. The infection in goats seldom causes abortion. "Bang's disease" is the term commonly applied to contagious abortion in cattle. "Brucellosis" is a more proper generic term applicable to the diseases caused by the three species of Brucella organisms.

Undulant fever is usually difficult to diagnose from clinical symptoms alone. The disease, ordinarily gradual in onset and lacking distinctive features, may easily be mistaken for influenza, tuberculosis, typhoid fever, or malaria. However, diagnostic tests, partly laboratory and partly clinical, will identify the disease with a high degree of certainty.[1]

INCIDENCE OF UNDULANT FEVER IN MINNESOTA

Undulant fever was first reported in Minnesota in 1927. From 1927 to December 31, 1936, 621 cases and 11 deaths were reported in the State. From 1937 to 1946, inclusive, 2,312 cases, including 17 deaths, were reported. There was a significant increase from year to year during the latter decade, reaching a total of 398 cases and 1 death in 1946.[2] This increase in the number of reported cases of undulant fever must be interpreted with caution. The reported cases do not represent the real total; nor does the apparent increase in recognized cases necessarily mean that the disease is on the increase. It means only that more cases are being diagnosed.

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1. Illinois Department of Public Health, Undulant Fever, What Can Be Done About It, Educational Health Circular No. 49, March 1947, p. 7.

2. Minnesota Department of Health, Section of Preventable Diseases, Undulant Fever, mimeographed statement issued January 1, 1947, p. 2.

The actual incidence of the disease is unknown.[1] The incidence of undulant fever in Minnesota, based on cases from January 1, 1936, to August 1, 1947, and 1940 population figures to obtain a rate per 1,000 population, is shown on Map I. (page 3) The figures for each county are listed in the Statistical Appendix. The rates of the counties range from zero in Pennington and Red Lake counties to 7.29 per 1,000 population in Mower County. The rates of 7.29 and 2.90 in Mower and Dakota counties, respectively, are partially explained by the fact that the State's meat packing industry is concentrated in those counties. The relatively high rates of infection in Isanti, Kanabec and Lac Qui Parle counties may be partially attributed to vigilance on the part of local physicians in diagnosing cases of undulant fever.

SOURCES OF HUMAN BRUCELLOSIS INFECTION

There is no record of the transmission of undulant fever directly from person to person in spite of the fact that the Brucella organisms are discharged in the urine and feces of infected persons.[2]

It is estimated that half of the total cases of undulant fever are contracted by drinking raw milk of infected cows or goats. Human susceptibility varies; not all people who drink contaminated milk get undulant fever. The remaining cases are of occupational origin - farmers, slaughterhouse workers, veterinarians, and laboratory workers - those who by the nature of their work are in contact with infected animals, especially hogs and cattle, or carcasses.[3]

Two routes of human infection have been established: (1) through the digestive tract; and (2) through the skin - especially if cut or abraded. It appears to have been well shown by Otero that the latter route is the easiest for infecting man.[4]

ECONOMIC LOSSES DUE TO BRUCELLOSIS

It is impossible to estimate accurately the economic losses caused by undulant fever, because its true incidence is not known. Some authorities estimate that 10% of the entire population of the United States is infected; with 1% of those infected being clinically ill with the disease - that is, sufficiently ill to have recognizable symptoms.[5] If this estimate is reasonably accurate, the economic losses occasioned by medical treatment and lost man-hours are indeed great.

UNDULANT FEVER - A COMPENSABLE OCCUPATIONAL DISEASE

In Minnesota, undulant fever is classified as a compensable occupational disease under the Workmen's Compensation Laws with both loss of wage benefits and medical benefits payable. During the fiscal years of

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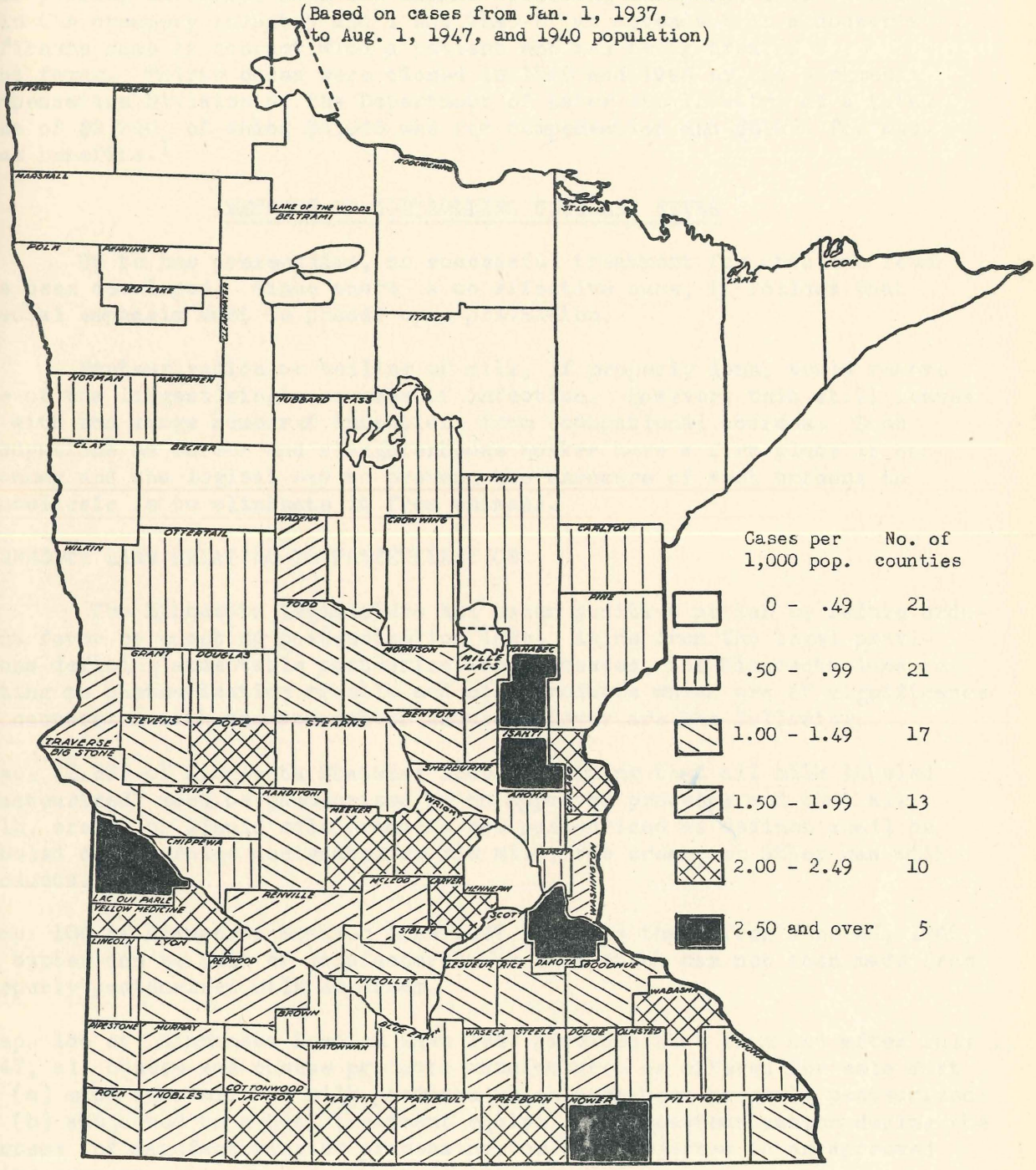
1. Alice C. Evans and T. Arthur Turner, Crippler in Disguise, p. 7
2. Illinois Educational Health Circular No. 49, op. cit. p. 6
3. Evans and Turner, op. cit., p. 9
4. Lucy S. Heathman, A Survey of Workers in Packing Plants for Evidence of Brucella Infection, p. 21 f
5. Evans and Turner, op. cit., p. 7

MAP I

INCIDENCE OF UNDULANT FEVER IN MINNESOTA
(Based on cases from Jan. 1, 1937,
to Aug. 1, 1947, and 1940 population)



Cases per 1,000 pop.	No. of counties
0 - .49	21
.50 - .99	21
1.00 - 1.49	17
1.50 - 1.99	13
2.00 - 2.49	10
2.50 and over	5

Source: See Table II - Statistical Appendix

1945 and 1946, undulant fever cases accounted for 5.3% of the total benefits paid for occupational disease cases. Of 51 undulant fever cases closed during the fiscal years 1943-46, including 10 cases in which denials of liability were filed and no benefits were paid, 45 were in the meat packing industry, 2 in the animal rendering industry, 2 in farming, 1 in the creamery industry and 1 was that of an attendant in a doctor's office who came in contact with a patient who was being treated for undulant fever. Thirty cases were closed in 1945 and 1946 by the Workmen's Compensation Division of the Department of Labor and Industry at a total cost of $9,990, of which $6,036 was for compensation and $3,954 for medical benefits.[1]

METHODS OF CONTROLLING UNDULANT FEVER

Up to the present time, no successful treatment for undulant fever has been developed. Since there is no effective cure, it follows that special emphasis must be placed upon prevention.

Pasteurization or boiling of milk, if properly done, would remove one of the largest single sources of infection. However, this still leaves us with the large number of infections from occupational sources. Such occupations as farmer and slaughterhouse worker have a firm place in our economy and the logical way to prevent the exposure of such persons to brucellosis is to eliminate it from animals.

MINNESOTA LAWS RELATING TO PASTEURIZATION

The Minnesota Legislature has taken positive action to reduce undulant fever by enacting pasteurization laws. Aside from the legal provisions defining acceptable pasteurization processes, the Minnesota laws relating to pasteurization of milk and milk products which are of significance in connection with the control of undulant fever are the following:

Chap. 32.393 of Minnesota Statutes 1945, providing that all milk labeled "pasteurized" must be pasteurized by an approved process; and that all milk, cream, or liquid milk products not pasteurized as defined shall be labeled or otherwise designated as raw milk, raw cream, or other raw milk products.

Chap. 104 of Minnesota Session Laws 1947 requires that after June 30, 1948, no butter can be sold or manufactured for sale which has not been made from properly pasteurized milk or cream.

Chap. 184 of Minnesota Session Laws 1947 provides that from and after July 1, 1947, all cheese and cheese products manufactured or offered for sale must be (a) made from milk or milk products which have been properly pasteurized; or (b) subjected to a heat treatment equivalent to pasteurization during the process of manufacturing or processing; or (c) subjected to an approved aging process.

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1. Minnesota Department of Labor and Industry, 30th Biennial Report for 1945-46, p. 113.

The Minnesota laws do not require the pasteurization or boiling of liquid milk intended for human consumption. Such a law may be impracticable because pasteurization is not always economically suited to rural areas, and it would be impossible effectively to enforce a requirement that each family boil milk intended for its own use.

In addition to the general provisions relating to pasteurization of milk and milk products, the Live Stock Sanitary Board has issued rules requiring that all milk and milk products produced by cattle maintained under quarantine for Bang's disease shall be pasteurized before being used by the owner or sold or disposed of by him excepting milk or milk products sold or delivered to points where such milk or milk products are properly pasteurized before further distribution. It should be noted that the above regulation applies only to quarantined herds which are relatively few in Minnesota.

The United States Census for 1940 indicates that 43.7% of the population of Minnesota is living on farms, in unincorporated territory, and in incorporated places having a population of less than 1,000. Places having a population of less than 2,500 are classified as rural in the Census, and 50.2% of the people in Minnesota live in such places. Most farm people and many people living in villages and small towns drink raw milk regularly, and it does not seem likely that this situation will change materially in the near future.

Twenty-six Minnesota municipalities containing 8.3% of the State's population have adopted ordinances requiring the pasteurization of all milk sold within their confines. These communities range in size from the 436 people in Woodlake to the 101,065 in Duluth.

Two first class cities, Minneapolis and St. Paul, do not require pasteurization, although most of the milk sold in these cities is pasteurized. Local health departments of these cities inspect farms furnishing milk for consumption in the Twin Cities, but it is generally conceded that such inspection does not protect consumers of raw milk from exposure to Brucella organisms.

Although only twenty-six municipalities require the pasteurization of milk, in all the larger cities and in many of the smaller communities pasteurized milk is readily available to the consumer. A list of pasteurization plants is contained in the Statistical Appendix.

Not only are many people drinking unpasteurized milk, but pasteurization does not protect persons handling infected animals against contact exposure. Pasteurization, although an important and a desirable practice, is not the final answer. "Protection of our people from exposure to Brucella abortus can come only through the elimination of infected animals."[1]

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1. B. T. Simms, Report on the Cooperative Brucellosis Control and Eradication Program, issued December 6, 1946, p. 5.

BASIC PRINCIPLES OF BANG'S DISEASE CONTROL

The necessity of eliminating brucellosis in animals because of its effect on human health has just been pointed out. In addition to its effect on human health, brucellosis is a cause of serious economic loss to livestock owners.

"Since 15 to 20 per cent of all herds are believed infected with brucellosis, the annual national cattle loss stands at approximately $50,000,000; for hogs at $10,000,000. Bang's disease not only causes abortion among domestic animals, it also seriously reduces milk production, and eventually produces sterility of either sex in cattle and hogs. It may affect mares."[1]

Dr. A. K. Kuttler, in an outline issued July 28, 1947, on "Brucellosis Eradication" stated that there are certain well established facts which are basic to understanding the brucellosis control and eradication program. Among these are:

"1. Brucellosis can be economically eradicated from any herd when the procedures most adaptable to the particular herd are followed through under the direction of those trained in livestock disease control, provided the owner or caretaker of the cattle gives his full cooperation. When brucellosis can be eradicated in a single herd, it can be eradicated in an area by the application of the same principles followed in the single herd.

2. No livestock disease has ever been controlled until the carriers have either been destroyed or restricted in their movement. Permanent identification and quarantine or slaughter of infected cattle should be recognized as a basic requirement in any infectious and contagious disease eradication project. ...

3. The demand for livestock disease eradication and control must come from the producers themselves. ...

4. The nature of brucellosis is such that if we wait until an attack occurs, the owner usually sustains heavy losses, regardless of any assistance we may undertake to give him; therefore, the objective should be to locate the infection before conditions favoring its spread occur. To do this we must depend on the agglutination test. Prevention, and not treatment should be our aim.

5. The character and self-limiting nature of brucellosis lend themselves to more misinformation than any of the livestock diseases we have thus far undertaken to eradicate.

6. Strain 19 Brucella vaccine produces a serviceable resistance in a high percentage of calves vaccinated, or softens the attack in those which fail to develop serviceable resistance.

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1. Illinois Department of Public Health, "Brucellosis (Undulant Fever)" Illinois Health Messenger, June 15, 1947, p. 46.

7. In eradication of infectious and contagious disease, we have always had to continue our efforts long after the owner feels the job has been completed. For this reason the expense, except for handling the cattle, should not be placed on the owner, lest he exercise the prerogative that would more naturally be his if he were paying the bill, of discontinuing the work short of eradication.

8. The infected cow or heifer is the principal source of infection. Such animals are especially dangerous at the time of calving or aborting, as large numbers of Brucella organisms may escape from the uterus at that time. Milk from infected cows may contain the organisms.

9. No successful method of treating the disease has been found.

10. The agglutination test is an accurate but not perfect method of diagnosis.

11. Heifers under 10 to 12 months old are quite resistant to the infection, but they become more susceptible when they reach breeding age. Pregnant heifers and milking or pregnant cows are easily infected.

12. 10 to 12 months old heifers usually develop good resistance, but not complete immunity following vaccination with Strain 19 vaccine. This resistance decreases somewhat with time. A few (up to 5 per cent) of vaccinated heifers may become permanent reactors.

13. Non-infected heifers of breeding age and cows also develop marked resistance following vaccination. A fairly high percentage of animals of this category become permanent reactors to the agglutination test after vaccination.

14. No method of differentiating between reactions which follow vaccination and those which follow infection with virulent Brucella organisms has been found.

15. Vaccination has not been shown to have any curative properties.

16. All available evidence supports the statement that injection of Strain 19 vaccine does not set up a transmissible infection."[1]

THE AGGLUTINATION TEST

"The agglutination blood test has an efficiency of more than 95%, which is as near perfect as is necessary for its successful and practical use as a diagnostic method."[2] It is based on the presence of anti-bodies in the blood stream. These anti-bodies are produced as the result of either vaccination or infection, and this causes the difficulty in determining whether a positive reaction is due to vaccination or to a field infection.

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1. Dr. Kuttler is in charge of the Tuberculosis Eradication Division of the U. S. Bureau of Animal Industry which administers the brucellosis control program.
2. University of Minnesota Agricultural Experimental Station, Brucellosis or Bang's Disease of Farm Animals, Bulletin #348, June 1940, p. 18

Although most abortions (about 85%) are due to Bang's disease, it is well to remember that all animals that abort do not have Bang's disease; also that all animals having a positive reaction to the test do not abort. An occasional diseased animal will have a negative test if the blood sample is obtained either a few days before or after calving or abortion. The explanation of this negative phase is not known, but in such cases it often causes persons to question unjustly the accuracy of the agglutination blood test.[1]

PRESENT MINNESOTA PLAN

The Minnesota programs for the control and elimination of brucellosis in animals are based on statute law and the rules and regulations promulgated by the Live Stock Sanitary Board. The plans as outlined by the Live Stock Sanitary Board on April 30, 1947, are quoted as follows:

"PROGRAMS FOR CONTROL OF BANG'S DISEASE (BOVINE BRUCELLOSIS)

I. THE AREA PLAN

A. Petitions signed by 67% of cattle owners in county required before this plan can be put into effect.

B. All owners required to submit cattle to testing.

C. All tests conducted at state and federal expense.

D. Reactors disclosed must be:

1. Sold for slaughter within fifteen days (in which case indemnity is paid) or

2. Isolated separate and apart from all other cattle until sold for slaughter (no indemnity if held over fifteen days) or

3. Entire herd including infected animals maintained in quarantine provided owner adopts vaccination program and provides for proper protection of neighboring herds (no indemnity paid).

E. Importations restricted to:

1. Cattle originating in Modified Accredited Bang's disease-free areas.

2. Cattle originating in Certified Bang's disease-free herds.

3. Cattle which have been tested and found free from Bang's disease within 30 days prior to importation and are quarantined for retest 30 to 60 days following importation.

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1. Ibid. pp. 17 and 31

F. All herds in which reactors disclosed quarantined until retested and found negative. All infected herds retested at intervals until they have passed three consecutive negative tests.

G. Vaccination of calves and adults as explained in following paragraphs may be employed under the Area Plan.

II. CERTIFIED HERD PLAN, TESTING AND ELIMINATION OF REACTORS

A. Available in Area or Non-area counties.

B. Owners sign agreement placing herd under supervision for Bang's disease control.

C. All tests in Non-area counties at owner's expense.

D. Reactors immediately sold for slaughter and indemnity paid.

E. No additions to herds except from clean herds, unless cattle tested and found negative.

F. Infected herds retested at 15 to 90 day intervals. Clean herds retested at six month intervals until three consecutive negative tests.

G. Bang's disease-free certificate issued after third negative test; annual test thereafter.

III. CERTIFIED HERD PLAN INCLUDING CALFHOOD VACCINATION

A. Available in Area or Non-area counties.

B. Herd placed under supervision as in (II) above.

C. Owner also required to sign vaccination agreement which provides that vaccinated animals will remain on the premises until they have been tested and found negative at least 30 days following vaccination or until permit is obtained for their removal.

D. All vaccination conducted by practising veterinarian at owner's expense.

E. Vaccinated animals to be included in tests and retests of herd but not identified as reactors unless positive at one year or more following date of vaccination.

F. Vaccinated animals still showing suspicious reaction more than one year following date of vaccination may be retained in herd as other suspects.

G. Herds may be continued indefinitely under supervision where vaccination is employed without segregation of vaccinated animals.

H. In order to secure a Bang's disease-free herd certificate provisions must be made to isolate vaccinated animals separate and apart from remainder of herd until tested and found negative.

IV. TESTING, RETENTION OF REACTORS AND VACCINATION

A. Available in Non-area counties and in area counties in problem herds.

B. Owner required to sign vaccination agreement as in III above.

C. Tests at owner's expense except in Area counties. Vaccination by veterinarians at owner's expense.

D. Reactors identified in Area counties by branding and tagging; in Non-area counties on owner's option by tagging and ear punch.

E. Herds in Area counties quarantined; in Non-area counties no quarantine established if all provisions of vaccination agreement complied with.

F. No indemnity paid for any reactors disclosed and herd not accepted for supervision under certified herd plan until all reactors except recently vaccinated animals have been sold for slaughter.

V. CALFHOOD VACCINATION WITHOUT TESTING

A. Available in Non-area counties only.

B. Owners required to sign vaccination agreement as provided in III above.

C. All vaccination to be conducted by a veterinarian at owner's expense.

D. No tests required unless owner wishes to remove vaccinated animals from the herd for purposes other than slaughter.

VI. VACCINATION OF ANIMALS OVER EIGHT MONTHS OF AGE

A. Available in infected herds in Area and Non-area counties.

B. Owners required to sign vaccination agreement as in III above.

C. Veterinarian required to obtain special permit to administer vaccine to each herd under this plan after stating his opinion that vaccination of animals over eight months of age is advisable.

D. Permits issued only after record of test of entire herd showing infection to exist, owner's agreement and veterinarian's application on file in office of the Board.

E. No indemnity paid in any herd where adult vaccination is employed until herd tested subsequent to vaccination and all reactors sold for slaughter.

VII. SALE OF CATTLE

A. No cattle over six months of age except steers may be sold at public auction unless tested and found negative to Bang's disease.

B. No cattle over six months of age except steers not owned by the seller since birth can be sold at private sale for purposes other than immediate slaughter or consigned to a public stockyard, unless tested and found negative to Bang's disease.

C. Vaccinated animals raised by the owner since birth may be sold at private sale to other owners employing vaccination or for export to states where entry of such animals is permitted, under permit from the Board allowing their removal from premises where vaccination is conducted."

Two basic approaches to the control of brucellosis are test-and-slaughter and vaccination. From the above outline, it is apparent that the Minnesota program for the control of Bang's disease is based upon an acceptance of the premise that, as yet, no one method has proved effective or is likely to be effective in eradicating brucellosis under all conditions; and it recognizes the importance of giving the livestock owner some freedom in the selection of a program adaptable to his own particular situation.

TEST-AND-SLAUGHTER EMPHASIZED IN MINNESOTA

The Minnesota Area Plan and the Certified Herd Plan are both based fundamentally on test-and-slaughter of reactors and are favored by the Live Stock Sanitary Board. The latter applies the method to a single herd and the former to all herds in an area. This method has been in use in the United States for 25 years. Since 1934 this plan has been given impetus by the Federal government and thousands of brucellosis-free herds have been established by following it.

Test-and-slaughter has the advantage of removing the primary sources of infection. Many lightly infected herds may be freed and remain free of the infection after a few tests. "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, thorough cleaning and disinfection of barns or buildings in which reactors have been kept, and retests at frequent intervals not to exceed 30 days until the disease has been eradicated."[1]

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1. Dr. A. K. Kuttler, Brucellosis Eradication, p. 10

The area plan is the extension of the test-and-slaughter plan to its logical conclusion; that is, the testing of all cattle within a given area, generally a county, and the slaughtering or placing under quarantine of all reactors. It is apparent that an attempt to free an individual herd from brucellosis will be hindered by the existence of infected herds in the neighborhood as is possible under the certified herd plan in non-area counties. Many authorities agree that the area plan is the most desirable single plan.

AREA PLAN NOT EFFECTIVE IN MINNESOTA

In Minnesota the area plan has been adopted and is in the process of being put into effect by the livestock owners in 29 counties. These counties are shown in Map II. (page 13) They contain slightly more than half of the area of the State but only one-fifth of the cattle. Thus, 58 counties containing slightly less than half the area and four-fifths of the cattle are outside the area plan. Considering the extent of the adoption of the area plan in the State as a whole, it is not an effective means of control. Furthermore, it is admitted that the adoption of the area plan was encouraged in the northern part of the State because testing throughout the State had indicated that the percentage of infection was low in the region.[1] Thus in Minnesota the area plan is not in effect in the region wherein is concentrated the bulk of the cattle population with the higher rates of infection.

It must be recognized that the operation of the area plan is hindered by the lack of veterinarians who are willing to accept public employment either on a full-time or per diem basis. Efforts to recruit veterinarians are meeting with little success because, under present conditions, private practice is much more attractive than the public service.

As of August 1, 1947, twenty-one counties were certified as modified accredited Bang's disease-free areas; six counties were in the process of accreditation, and two counties were awaiting tests. The lack of veterinarians hinders the conduct of tests which are especially needed in the latter two groups of counties. It can be anticipated that rapid expansion of the area plan in the immediate future, at least, will be handicapped by the present high price of cattle. During the period of relatively low prices when the area plan was inaugurated in Minnesota, there was a definite incentive for farmers to join in this movement to obtain indemnity payments over and above the market price for animals. In fact, some people contend that the original test-and-slaughter program inaugurated by the Agricultural Adjustment Administration had for its main purpose the killing off of surplus cattle, and it was decided to get rid of diseased animals in order to achieve that end.

A further obstacle to the successful operation of the area plan in Minnesota is the fact that once an area is declared to be a modified accredited Bang's disease-free area, an area-wide retest is not made until three years or more have elapsed. There is evidence which indicates that this is too long an interval between tests. When tests are conducted at intervals of three years or more, the rate of infection of the herds and cattle shows a large increase over the last area test. There is an improvement when a two-year interval is used, and when a one-year interval is

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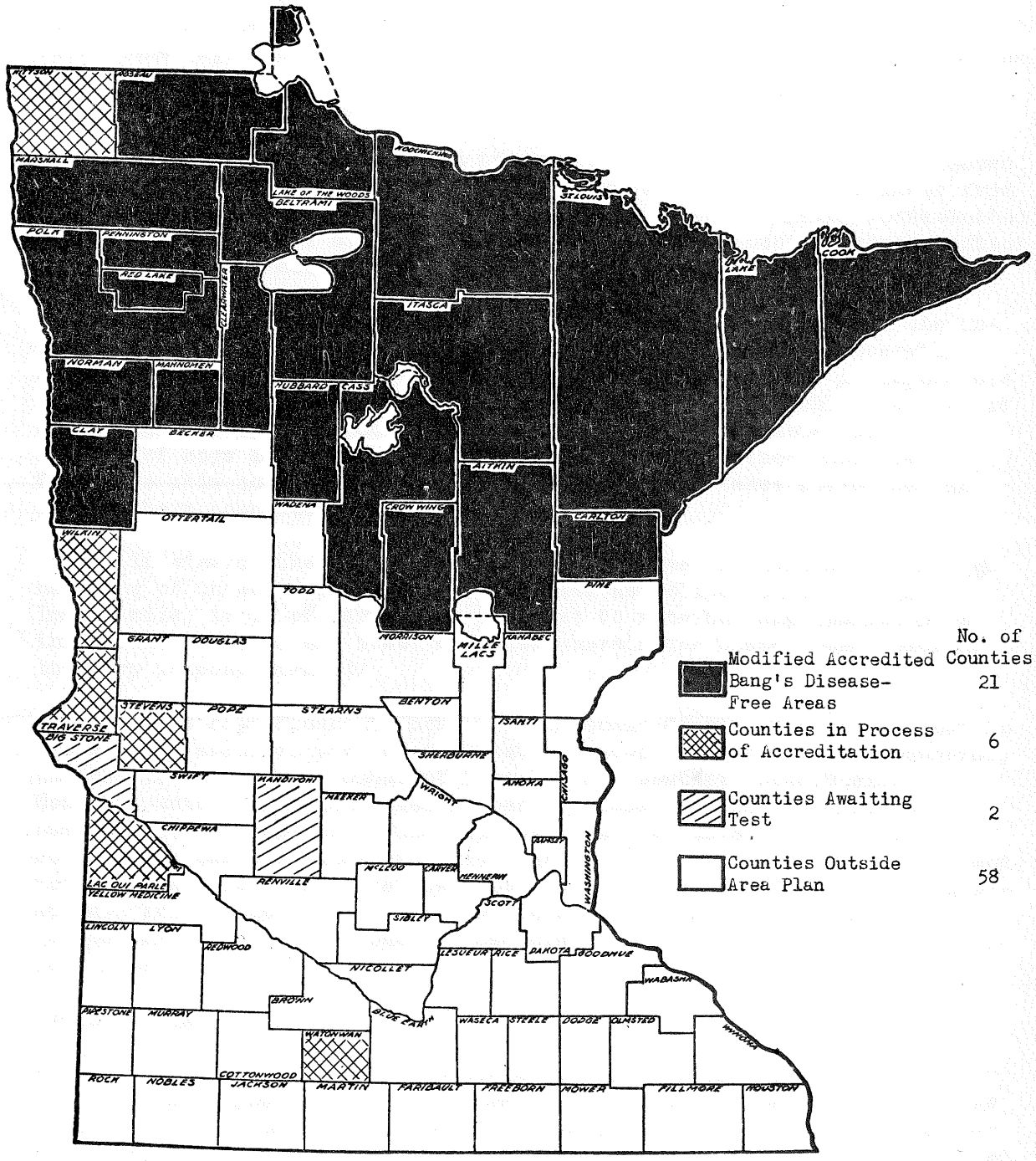
1. Minn. Live Stock Sanitary Board, Annual Report for 1940, p. 70f.

MAP II

AREA PLAN FOR CONTROL OF BANG'S DISEASE IN MINNESOTA



	No. of Counties
Modified Accredited Bang's Disease-Free Areas	21
Counties in Process of Accreditation	6
Counties Awaiting Test	2
Counties Outside Area Plan	58

Source: Statement of Minnesota State Live Stock Sanitary Board issued February 1, 1946, and corrected to August 1, 1947.

substituted the rate of infection on the retest is generally lower than on the previous test.[1] It is important that testing be frequent in order to remove sources of infection from the herds. Present rules of the Minnesota Live Stock Sanitary Board permit counties under the area plan to be reaccredited on the basis of a partial retest which must include all herds found to contain reactors during the last area-wide test. There are indications that better results would be obtained if reaccreditation were conditioned upon the results of a complete retest of all herds in the area.

AREA PLAN APPEARS TO REDUCE EXPOSURE TO UNDULANT FEVER

The area plan operates in two ways to reduce the exposure of human beings to the Brucella abortus: (1) the removal of infected animals from herds and counties reduces the chances of residents' drinking contaminated milk; and (2) it will also reduce the chances for exposure through contact with infected animals.

A comparison of Maps I and II (pages 3 and 13) shows that the incidence of undulant fever tends to be lowest in the counties operating under the area plan of Bang's disease control. However, it is impossible to state definitely that there is a cause-effect relationship although it would seem likely that such is the case. It should be noted that the raising of hogs is not of great importance in the northern counties. Therefore this source of infection is of less importance there than in the southern counties.

In view of the fact that undulant fever may be contracted through handling of infected animals and carcasses as well as through drinking impure milk, it is of particular interest to note the high incidence of infection in Dakota and Mower counties wherein the State's meat packing industry is concentrated.

It is significant to note that Watonwan County, the only county in the extreme southern part of the State to adopt the area plan of control, has the lowest rate of undulant fever of any southern county except Hennepin which is predominately urban with most of the milk sold being pasteurized. Furthermore, the only two counties in the State which had no reported cases of undulant fever during the period were Pennington and Red Lake counties, the first two counties to put the area plan into operation. This supports, but does not necessarily prove, the premise that the control of Bang's disease is associated with a low incidence of undulant fever.

CERTIFIED HERD PLAN NOT EFFECTIVE IN MINNESOTA

The certified plan is in operation both in counties under the area plan and those outside it. Testing in connection with this plan is conducted at the owner's expense in non-area counties. In area counties testing under both the area plan and the certified herd plan is conducted at the expense of the State and Federal governments. A valid criticism of the certified herd plan is that the certified herd is not protected from exposure to possibly infected neighboring herds in non-area counties.

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1. Based on field evidence gathered by Dr. Fred C. Driver, U. S. Bureau of Animal Industry, Room 1419 Post Office, St. Paul, Minnesota.

The percentage of the cattle population under the certified herd plan in Minnesota as of January 1, 1947, is shown on Map III. (page 16) The figures for each county are shown in the Statistical Appendix. In Minnesota, only 4.8% of the cattle in non-area counties are under the certified herd plan. The percentages within those counties range from 0.3% in Rock County to 13.5% in Kanabec County. In the overall picture of control on a statewide basis, the certified herd plan is not effective in Minnesota. The extent of the adoption of this plan in area counties is of little significance, because all herds in those counties are tested and the reactors are either slaughtered or placed under quarantine.[1]

EXPENDITURES FOR BRUCELLOSIS CONTROL IN MINNESOTA

From the beginning of organized Bang's disease control measures in Minnesota in 1934 until August 26, 1947, the State expended a total of $1,403,538.47 of which $941,416.16 was for indemnities and $462,122.31 for operating costs. While the indemnity payments are a result of the test-and-slaughter approach under the area and certified herd plans, most but not all of the operating costs are chargeable to these two plans.[2]

Indemnity payments have been 67.1% of the total expenditures by the State for Bang's disease control. Such payments are based on the difference between the salvage value of the carcass and the appraised value of the living animal not to exceed $125.00 for a grade animal and $225.00 for a purebred animal. The difference between the salvage value and the appraised value is split three ways - one-third borne by the owner and one-third each by the State and Federal governments. If the Federal government makes no payment to the owner, the State pays two-thirds of the difference, but in no case shall the State's payments exceed $25.00 for a grade female or $50.00 for a purebred animal. Payments are conditioned upon the owner's compliance with all laws and rules and regulations of the Live Stock Sanitary Board.

Expenditures by the Federal government for the control of Bang's disease in Minnesota fall into two categories: those for indemnities, and those for operating costs. The former are approximately equal in amount to indemnities paid by the State. When a farmer receives indemnity for a slaughtered animal, he receives two checks: one from the State, and one from the U. S. Bureau of Animal Industry.

The Federal government also expends considerable amounts in the operation of the joint Federal-State cooperative program for the control of brucellosis in cattle; however, the State pays its own operating costs in connection with the program.

VACCINATION: AS A METHOD OF CONTROL

In addition to the test-and-slaughter approach to brucellosis control, a second basic method is vaccination which is receiving greater acceptance. There is much confusion and misunderstanding about the merits

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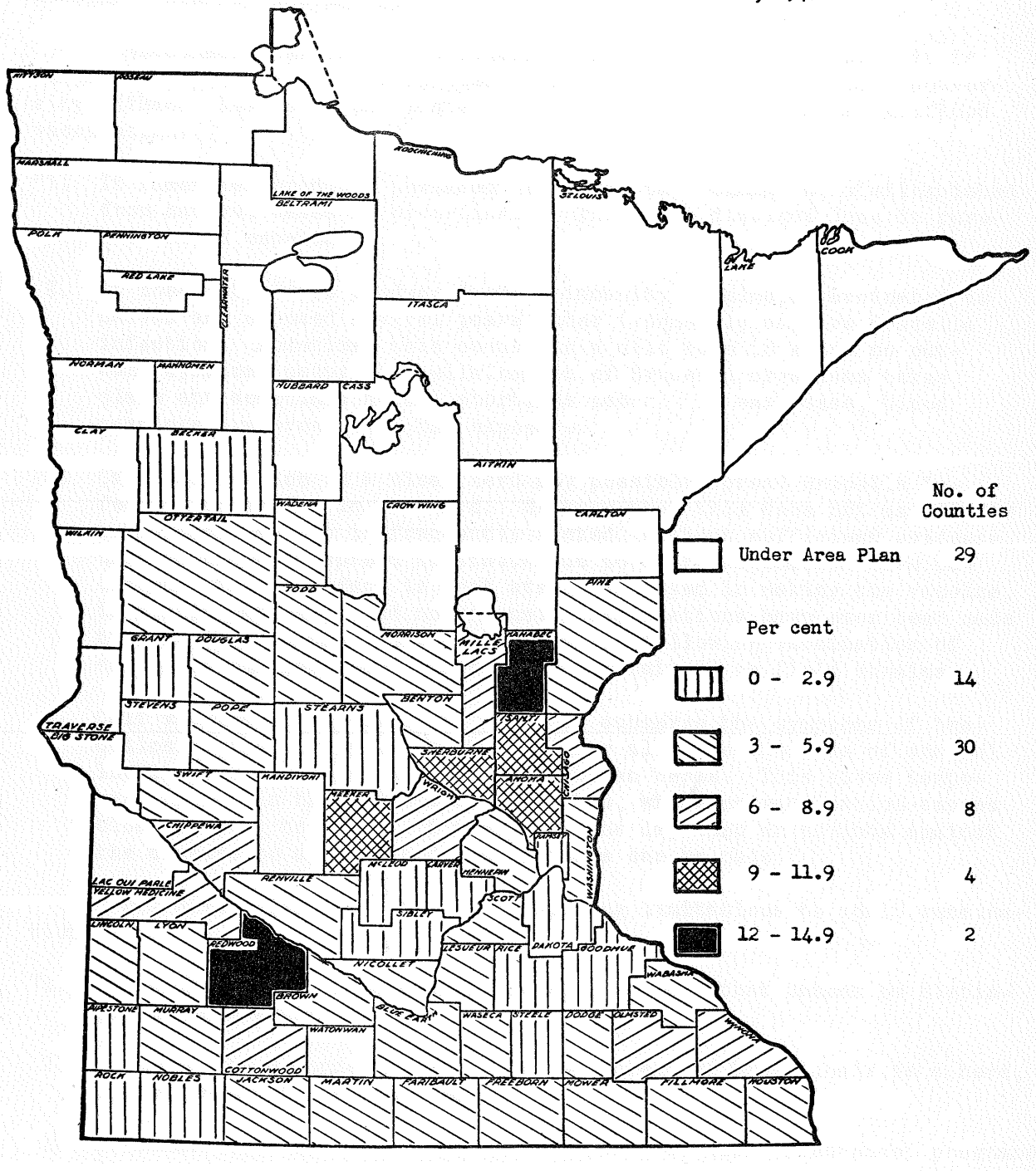
1. These percentages are based on the number of cattle under certified herd agreements and the estimated total cattle population. A breakdown of the population figures into beef and dairy cattle was not available.
2. Special report from Minnesota Live Stock Sanitary Board, Aug. 26, 1947.

MAP III

PERCENTAGE OF CATTLE POPULATION UNDER CERTIFIED HERD PLAN
IN NON-AREA COUNTIES IN MINNESOTA AS OF JANUARY 1, 1947



	No. of Counties
Under Area Plan	29
Per cent	
0 - 2.9	14
3 - 5.9	30
6 - 8.9	8
9 - 11.9	4
12 - 14.9	2

Source: See Table X - Statistical Appendix

of vaccination against brucellosis because there are many valid arguments both for and against it.

ARGUMENTS AGAINST VACCINATION

Vaccination against brucellosis is not a panacea; in fact, it is subject to rather severe limitations. Dr. R. R. Birch of Cornell University, Ithaca, New York, has listed the following limitations of calfhood vaccination:

"1. It sometimes produces permanent reactors that cannot be distinguished from natural cases of brucellosis. This is a distinct loss in purebred herds especially.

2. It does not always produce lasting immunity. Animals vaccinated as calves and exposed several years later frequently acquire Brucella infection. Sometimes this occurs in a mild form in which no outward symptoms occur, but elimination of Brucella organisms takes place and sometimes actual abortions occur. In each case, blood reactors are created by the exposure.

3. Calf vaccination in a clean herd may possibly spread Brucella infection to adults in the herd. We know that this does not usually take place, and it is frequently stated, without sufficient evidence, that no cases of spread to adults due to calf vaccination have occurred. The real fact is that strain 19, used in making the vaccine, is a mild pathogen, and no extensive examinations have ever been made to determine whether outbreaks in adults following vaccination of calves in the same herd are caused by strain 19 or field strains.

4. Calf vaccination, because it tends to submerge the symptoms of brucellosis, frequently is substituted for all other methods of control looking toward the establishment of clean herds. This gives temporary relief in the individual herd, but, whenever vaccination causes blood testing to cease, it postpones the day when an advance against the disease on a broad and secure basis can be made."

Dr. Birch also indicated the following limitations to adult vaccination:

"1. It tends strongly to create permanent reactors that cannot be distinguished from natural reactors.

2. It cannot be depended on to check the spread of brucellosis in a herd, though it may do so sometimes.

3. It causes some abortions when administered to cows in advanced pregnancy.

4. It postpones for a long period the time when the herd can be freed from brucellosis through the use of the agglutination test.

5. It creates a serious sanitary problem where milk from the herd is not pasteurized.

6. Used widely, and indiscriminately (as it actually is used), it leads away from the establishment and maintenance of clean herds."[1]

Strain 19 vaccine has no curative power as is incorrectly believed by some. Furthermore, difficulties may arise from the fact that there is a lag period of possibly two to three weeks between vaccination and the production of a serviceable immunity.[2] It is necessary to recognize that the resistance produced by Strain 19 vaccination may be overwhelmed by exposure to massive field infections.

Strain 19 cannot be considered an ideal immunizing agent. As a suspension of live organisms in physiologic saline solution, the vaccine is a fragile product subject to deterioration.[3] It is necessary to keep it under refrigeration up to the time of administration in order to prevent such deterioration. This complicates the use of the vaccine in the field, and makes it extremely important that the use of the vaccine be strictly controlled as is provided by law in Minnesota.

ARGUMENTS FOR VACCINATION

While it is important to be aware of the limitations of vaccination against brucellosis with Strain 19 vaccine, it is equally important to recognize the practical benefits to be derived from it.

1. When vaccine is properly administered, only about 5% of the treated animals may become permanent reactors. In the use of Strain 19 vaccine, one is faced with the choice of either calfhood vaccination with a shorter period of immunity and a relatively early negative reaction to the agglutination test, or adult vaccination with a longer period of immunity and a relatively persistent titer in the agglutination test. Common practice calls for calfhood (4 - 8 months) vaccination, with adult vaccination only used as a means of reducing the intensity of an abortion storm.

"When Buck and Cotton were developing the use of strain 19 as a vaccinal agent, they decided upon the age of 4 to 8 months as the preferable time for calf vaccination because of the more rapid recession of the blood titer during this period. It has been shown subsequently that the effectiveness of vaccination with strain 19 tends to increase with the age of the animal up to breeding age. It has also been noted that the degree and persistence of immunity are less in animals vaccinated at 4 months of age than at 8 months. It would appear desirable, therefore, to increase the age limits for vaccination to 6 to 10 months. This step has already been taken in the states of California and New York."[4]

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1. R. R. Birch, D.V.M., "Limitations of Vaccination in Brucellosis", Journal of the Am. Vet. Med. Ass'n., Feb. 1947, p. 98
2. A. B. Crawford, D.V.M., "Summarization of Discussions on Vaccination Against Bovine Brucellosis", same issue as above, p. 99 f.
3. Haring, Traum & Maderious, "Vaccination Against Brucellosis", same issue as above, p. 107.
4. Crawford, op. cit. p. 100f

2. While Strain 19 vaccine does not always produce a lasting immunity, it does produce a serviceable immunity. When used during calfhood, it will protect about 80% of the animals for a period of three to five years, and it will prevent abortion in about 95% of vaccinated animals for the same period. Reasons for variation in the duration of immunity are: the condition of the vaccine at the time of injection, residual infection in the herd which causes sufficient exposure to result in increased resistance, and the fact that natural resistance is bound up very closely with heredity.[1]

   Dr. A. K. Kuttler of the U. S. Bureau of Animal Industry has stated that Strain 19 Brucella vaccine softens the attack of those animals which fail to develop a serviceable immunity. He also says that the percentage in favor of vaccination is sufficient to justify its wider use. "Other diseases have been eradicated with no greater percentage in their favor than is afforded through calf vaccination".[2]

   Since vaccination with Strain 19 does not produce permanent immunity, the revaccination, as adults, of animals previously vaccinated as heifers seems worthy of further consideration.[3]

3. It is also contended that vaccination with Strain 19 vaccine sets up a transmissible infection. In this connection, Dr. Crawford stated, "So far as we know, there has been no authentic report of Strain 19 causing an infection that can be transmitted from animal to animal. The work of Mingle and Manthei at the Animal Disease Station was very definite in this connection. ... It would seem that if such spread took place, at least one authentic occurrence would have been reported in the many years that strain 19 has been used as a vaccine."[4] This statement is corroborated by Dr. B. T. Simms, Chief of the Bureau of Animal Industry, Agricultural Research Administration, United States Department of Agriculture.[5]

4. In answer to the charge that vaccination with Strain 19 may cause sterility, it is replied that unlimited evidence is available to prove that Strain 19 has no tendency to cause sterility.[6]

5. "We have no reason to believe that strain 19 is more virulent for man than field strains of Brucella. By analogy, we have more reason to believe that strain 19, owing to its reduced virulence for cattle, should be of correspondingly reduced virulence for man, and if available evidence relative to the very slight susceptibility of man to virulent Brucella abortus in milk is true, I believe we may dismiss any serious consideration of strain 19 as a public health factor."[7]

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1. Ibid. pp. 99 and 101
2. Dr. A. K. Kuttler, Brucellosis Eradication, p. 4 and 10f
3. Haring, Traum, and Maderious, op. cit. p. 107
4. Crawford, op. cit. p. 100
5. Dr. B. T. Simms, "Brucellosis (Bang's Disease)... A National Control Problem", Hoard's Dairyman, August 10, 1947, p. 627
6. Crawford, op. cit. p. 100
7. Ibid. p. 102

6. While Strain 19 is not an ideal immunizing agent, it is the best available at the present time.[1] Dr. I. F. Huddleson of Michigan State College has developed a new Brucella mucoid vaccine for the immunization of cattle against Bang's disease. During the past two and a half years, the vaccine has been used on approximately 3,000 head of cattle. When adult animals are treated with the vaccine, they do not retain an agglutination titer longer than 90 days as a result of the vaccinal reaction. Pregnant as well as non-pregnant adult animals may be treated with safety.[2] However, in view of the relatively limited field trials of the mucoid vaccine, results from its use should be interpreted with caution.

7. Vaccination is useful in establishing resistance in heifer calves in infected herds against active brucellosis during their first pregnancies. It is the only safe and effective means of establishing immunity in replacements for clean herds, and is a means of reducing abortions and other symptoms when the disease is actively progressing among adult animals.[3]

8. In order to derive full benefits from vaccination, it must be employed with due regard to its limitations. "We cannot hope to eradicate brucellosis in any herd by vaccination alone. The proper program must consist of a combination of vaccination, sanitary procedures, and immediate or ultimate removal of all animals showing a titer of 1:100 or higher."[4]

Minnesota, as was noted in the programs for control of Bang's disease listed previously in this report, makes provision for vaccination. Owners choosing to vaccinate are required to sign an agreement which provides that all vaccines used shall be administered by a registered veterinarian at the owner's expense; to allow all cattle vaccinated with Brucella abortus vaccine to be identified as vaccinates as provided by the regulation of the Live Stock Sanitary Board (vaccinated animals showing a positive reaction to the official agglutination test one year following vaccination are classified as reactors); to keep complete records on forms provided by the Board for all cattle vaccinated; restricting vaccinated cattle showing a positive reaction to the premises not to be removed therefrom without written permit from the Board; agree that no indemnity shall be paid for positive reacting cattle if any animal over 8 months of age has been vaccinated; and that any violation of the rules and regulations of the Board constitute sufficient cause for cancellation of the agreement, and upon cancellation all cattle vaccinated or exposed thereto shall be placed in quarantine.

Vaccination may be employed in area or non-area counties under the certified herd plan for calfhood vaccination, in problem herds and in infected herds. Calfhood vaccination without testing is available in non-area counties only.

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1. Ibid. p. 102
2. Dr. I. F. Huddleson, letter to Minnesota Legislative Research Committee dated August 18, 1947.
3. Dr. L. A. Dykstra, "Advantages of Vaccination Against Bovine Brucellosis", Journal of the American Veterinary Medical Association, Feb. 1947, p. 97f.
4. Crawford, op. cit. p. 102.

While provisions made by the Live Stock Sanitary Board for vaccination appear to be comprehensive and readily available to cattle owners, it can be stated that the Board has not encouraged the adoption of vaccination as a method of controlling Bang's disease. In carrying out its program the Board operates through practicing veterinarians, and in its instructions on Bang's disease vaccination issued on January 18, 1946, it stated:

"Vaccination should be discouraged in negative herds and herds in which Bang's disease may be readily controlled by the elimination of positive animals. Owners should be informed that vaccination is only an accessory to other methods of control and when used should be combined with other recognized methods for eventually establishing a negative herd. Your clients should be informed of the advantages of the Certified Herd Plan in the control of the disease so that they may take advantage of the law authorizing the payment of indemnity under this plan."

The payment of indemnities under the test-and-slaughter method of control initiated by the Agricultural Adjustment Administration in 1934, and now administered by the Bureau of Animal Industry in the Department of Agriculture is in effect a grant-in-aid program. This basic Federal plan provides for test-and-slaughter with payment of indemnities on an area and a certified herd basis. Test-and-slaughter was the first approach to controlling brucellosis in cattle and since part of the cost of this program is paid by the Federal government, almost all states have this program in effect. This original program was conceived in the days of cattle surpluses, and there is evidence to indicate that it is not well adapted to present conditions resulting from relatively high prices. An examination of current programs in other states reveals a trend toward the wider use of vaccination as a means of controlling brucellosis in cattle.

The Committee has been in touch with the agencies administering brucellosis control programs in the various states. It is the concensus that no one method of controlling brucellosis is satisfactory under all conditions, and that the method adopted depends to a large extent upon the particular situation. Proper sanitation methods are stressed without exception in all states.

Generally speaking, the test-and-slaughter program has not been popular in areas devoted to raising beef cattle, because in many cases herds would be seriously depleted if such a program were adopted. Another factor is the cost of rounding up large herds of cattle to be tested. In the earlier years of the program, test-and-slaughter was widely accepted in states where dairying is predominant among cattle raisers. Recently there has been a trend away from test-and-slaughter toward vaccination. This is due to a number of factors:

1. Greater realization that brucellosis is a public health problem has placed emphasis from a new source upon the necessity for controlling Bang's disease in cattle.

2. The poor results shown from test-and-slaughter and the large indemnities paid have led to criticism. For this reason Rhode Island discarded test-and-slaughter entirely and instituted vaccination as its only method of controlling Bang's disease.

3. It has been difficult to obtain veterinarians to conduct testing.

4. There is growing realization that the promised results of test-and-slaughter are difficult to achieve. The Federal-State cooperative program has been in operation almost 14 years and North Carolina is still the only state in which all counties have been declared modified accredited Bang's disease-free areas.

5. The present high prices of cattle furnish no incentive for farmers to participate in the certified herd or area plans for eliminating brucellosis, as the continuing high demand and high prices for dairy products make farmers reluctant to dispose of any dairy animals. In periods when cattle prices were relatively low, the indemnity payment acted as a subsidy and furnished such an incentive.

6. The recognition that the economic losses due to brucellosis are even higher in times of high prices than in periods of relatively low prices, emphasizes the need for control measures.

7. The present high demand and prices for dairy products have forced farmers in milkshed areas to go into other areas for replacement stock when they can't raise enough replacements themselves. This has made control under test-and-slaughter difficult, as one of the chief sources of infection is the introduction of infected animals into a clean herd.

8. Scientific evidence points to greater success from vaccination. This is in itself an incentive for its adoption.

9. Calfhood vaccination provides a serviceable immunity in 80% of the cases, and in only 5% of the cases do the animals become permanent reactors to the agglutination test.

10. Scientific evidence indicates that through consistent calfhood vaccination eventually a disease resistant herd may be built up.

11. Admitted failure of test-and-slaughter programs due to varying factors together with the acknowledged necessity for control of this disease has furnished impetus for vaccination.

To encourage vaccination, a number of states now furnish vaccine free, and in addition, a number of the states also pay for the cost of vaccinating animals. California at its recent legislative session went so far as to provide for compulsory vaccination of all dairy calves and optional vaccination of beef cattle as of January 2, 1948. This is the first positive control program enacted in California and is based on a two-year study by interested groups, with the legislation being sponsored by the Dairy Department of the California Farm Bureau Federation.

Wisconsin, at its 1947 legislative session, placed greater emphasis on vaccination by providing a free vaccination program. Monies formerly appropriated only for indemnities now finance both the indemnities and the vaccination program.

Illinois, at its recent legislative session, placed greater emphasis on calfhood vaccination, and like many states emphasizing vaccination programs, it extended the age to 30 months under which an animal could be declared a vaccinal reactor under the agglutination test.

New York has not expanded its test-and-slaughter program since 1941 and places emphasis on voluntary calfhood vaccination as an immunizing factor.

SANITATION ESSENTIAL TO CONTROL

Fundamental to the success of any control program is the observance of sound sanitation methods by the owner or caretaker. It is important that clean animals be prevented from coming in contact with animals which abort or with the discharged feti. Furthermore, the place where an abortion occurs should be properly disinfected before clean animals are permitted to enter it. The Minnesota law setting forth the conditions of payment of indemnities for slaughtered cattle requires that the stables and premises be disinfected and rendered in a sanitary condition within 15 days from the time of removal of the reactors, unless extenuating circumstances warrant an extension of the time limit.

While attention has been directed mainly at the control of Bang's disease, it should be remembered that brucellosis is also a problem in other domestic animals, especially hogs. There is a considerable economic loss due to brucellosis in hogs. Furthermore, diseased hogs are a source of infection to both man and cattle. Cattle may become infected with and become carriers of Brucella suis, the most virulent strain of the organism from the standpoint of human infection.

It must be recognized that hogs, sheep, goats, and horses may be reservoirs of infection on a farm. All the cattle on a farm may be tested and the reactors removed, but if some of these other domestic animals are infected, the cattle may become infected from them.

Sanitation and wise herd management are both necessary to protect a clean herd from exposure to infected additions to the herd and reservoirs of infection which may exist on the farm.

CONCLUSIONS AS TO THE BANG'S DISEASE CONTROL PROGRAM IN MINNESOTA

1. There is a definite necessity for controlling this disease from a public health standpoint.

2. In view of the importance of pasteurization as a means of reducing human exposure to the Brucella organisms, it may be advisable to require the pasteurization of all milk sold at retail.

3. Minnesota farmers being in a recognized dairy and livestock state will continue to suffer high economic losses unless the disease is controlled.

4. The present control program with emphasis on test-and-slaughter is definitely handicapped by the lack of veterinarians who will accept public employment. There are indications that the control program

would benefit if laymen were trained to aid veterinarians in conducting tests. It should also be pointed out that the rules and regulations of the Minnesota Live Stock Sanitary Board provide that vaccination be done by veterinarians.

5. Based on the number of cattle covered by the area plan and by the certified herd plan, the test-and-slaughter program in Minnesota cannot be called successful. About one-fifth of the cattle in the State located in 29 counties containing slightly more than half the area of the state are under the area plan of control. In the 58 non-area counties only 4.8% of the cattle are under the certified herd plan.

6. Present laws still permit the sale of infected animals at private sale when not under quarantine and infected cattle are still permitted under the law to intermingle in public pastures.

7. The Live Stock Sanitary Board and the legislature, while providing for a vaccination program, are reluctant to emphasize or to push an uncontrolled vaccination program. Accepted scientific evidence indicates that a controlled vaccination program is successful enough to receive wider application.

8. Vaccination control measures could perhaps be facilitated if part of the funds now appropriated for indemnity payments were used for vaccination. Furthermore, there is evidence to indicate that the Bureau of Animal Industry will furnish and administer some vaccine if the vaccination program is expanded in this state.

9. While county agents advocate and teach farm sanitation, an extended campaign of this nature could point out that brucellosis control measures are not effective unless proper sanitation procedures are observed.

STATISTICAL APPENDIX

TABLE I

Reported Cases of Undulant Fever in Minnesota

Year	Cases	Deaths
1937	89	5
1938	85	0
1939	92	3
1940	137	3
1941	177	1
1942	260	1
1943	325	2
1944	393	1
1945	352	0
1946	402	0
* 1947	241	0

* To August 1, 1947

Source: Minnesota Department of Health, Section of Preventable Diseases, typewritten statement "Undulant Fever (by residence)", May 23, 1947, p. 2 (corrected to August 1, 1947)

TABLE II

Incidence of Undulant Fever in Minnesota

County	Cases of Undulant Fever 1-1-37 to 8-1-47	Population 1940	Cases Per 1,000 Population
Aitkin	12	17,865	.67
Anoka	21	22,443	.94
Becker	4	26,562	.15
Beltrami	3	26,107	.11
Benton	17	16,106	1.06
Big Stone	11	10,447	1.06
Blue Earth	20	36,203	.55
Brown	21	25,544	.82
Carlton	21	24,212	.87
Carver	43	17,606	2.44
Cass	13	20,646	.63
Chippewa	12	16,927	.71
Chisago	32	13,124	2.44
Clay	1	25,337	.04
Clearwater	4	11,153	.36
Cook	1	3,030	.33
Cottonwood	19	16,143	1.18
Crow Wing	15	30,226	.50
Dakota	115	39,660	2.90
Dodge	21	12,931	1.63
Douglas	17	20,369	.83
Faribault	43	23,941	1.80
Fillmore	18	25,830	.70
Freeborn	79	31,780	2.48
Goodhue	42	31,564	1.33
Grant	6	9,828	.61
Hennepin	136	568,899	.24
Houston	20	14,735	1.36
Hubbard	1	11,085	.09
Isanti	33	12,950	2.54
Itasca	3	32,996	.09
Jackson	36	16,805	2.14
Kanabec	34	9,651	3.51
Kandiyohi	32	26,524	1.21
Kittson	4	10,717	.37
Koochiching	1	16,930	.06
Lac Qui Parle	41	15,509	2.65
Lake	3	6,956	.43
Lake of the Woods	1	5,975	.17
LeSueur	21	19,227	1.09
Lincoln	8	10,797	.74
Lyon	29	21,569	1.34
McLeod	42	21,380	1.96
Mahnomen	2	8,054	.25
Marshall	3	18,364	.16

Table II - Cont'd.

County	Cases of Undulant Fever 1-1-37 to 8-1-47	Population 1940	Cases Per 1,000 Population
Martin	53	24,656	2.15
Meeker	40	19,277	2.07
Mille Lacs	31	15,558	1.99
Morrison	28	27,473	1.04
Mower	263	36,113	7.29
Murray	28	15,060	1.85
Nicollet	15	18,282	.82
Nobles	36	21,215	1.70
Norman	10	14,746	.68
Olmsted	27	42,658	.63
Ottertail	41	53,192	.77
Pennington	0	12,913	.00
Pine	21	21,478	.98
Pipestone	25	13,794	1.44
Polk	9	37,734	.24
Pope	29	13,544	2.15
Ramsey	171	309,935	.55
Red Lake	0	7,413	.00
Redwood	44	22,290	1.97
Renville	40	24,625	1.63
Rice	46	32,160	1.43
Rock	16	10,933	1.47
Roseau	5	15,103	.33
St. Louis	31	206,917	.15
Scott	25	15,585	1.60
Sherburne	14	10,456	1.33
Sibley	23	16,625	1.39
Stearns	44	67,200	.65
Steele	19	19,749	.96
Stevens	13	11,039	1.18
Swift	19	15,469	1.23
Todd	35	27,438	1.28
Traverse	15	8,283	1.81
Wabasha	37	17,653	2.09
Wadena	20	12,772	1.56
Waseca	23	15,186	1.51
Washington	52	26,430	1.97
Watonwan	6	13,902	.43
Wilkin	3	10,475	.29
Winona	26	37,795	.69
Wright	67	27,550	2.43
Yellow Medicine	42	16,917	2.49
Total (state)	2,553	2,792,300	.914

Source: Data furnished by Minnesota Department of Health, Section of Preventable Diseases, Aug. 7, 1947, and U. S. Census 1940.

TABLE III

Minnesota Municipalities Which Require Pasteurization
Of All Milk Sold Within Their Confines

Municipality	1940 Population	Municipality	1940 Population
Albert Lea	12,200	Melrose	2,015
Blue Earth	3,702	Montevideo	5,220
Buffalo	1,695	Monticello	1,076
Clarkfield	965	Moorhead	9,491
Dawson	1,646	Mora	1,494
Duluth	101,065	Rochester	26,312
Elbow Lake	1,150	Sauk Centre	3,016
Fairfax	1,116	Sleepy Eye	2,923
Fosston	1,271	Tracy	3,085
Granite Falls	2,388	Winona	22,490
Hastings	5,662	Woodlake	436
Henning	948		
Mankato	15,654	Total	232,680
Mapleton	1,070		
Marshall	4,590		

The total of 232,680 is 8.3% of the population of the State in 1940

Source: Minnesota Department of Health letter to Legislative Research Committee dated September 11, 1947, and U. S. Census 1940

TABLE IV

Location of Pasteurization Plants - 1946

(In Minnesota 208 Municipalities in 78 counties contain 332 pasteurization plants)

County	Town	No. of Plants	County	Town	No. of Plants
Aitkin	Aitkin	2	Fillmore	Lanesboro	1
Anoka	Anoka	2		Preston	1
Becker	Detroit Lakes	3		Spring Valley	1
	Frazee	1	Freeborn	Albert Lea	4
Beltrami	Bemidji	1		Freeborn	1
Benton	Sauk Rapids	1		Hartland	1
Big Stone	Ortonville	2		Twin Lakes	1
Blue Earth	Amboy	1	Goodhue	Cannon Falls	1
	Good Thunder	1		Lake City	1
	Lake Crystal	1		Pine Island	1
	Mankato	2		Red Wing	4
Brown	New Ulm	3	Grant	Elbow Lake	1
	Sleepy Eye	2	Hennepin	Excelsior	1
	Springfield	2		Hopkins	2
Carlton	Barnum	1		Long Lake-Wayzata	1
	Cloquet	2		Loretto	1
	Esko	1		Minneapolis	10
	Moose Lake	2		Minnetonka Beach	1
Carver	Excelsior	2		Oak Terrace	1
	New Germany	1		Robbinsdale	2
	Norwood	1		St. Louis Park	1
	Waconia	1		Wayzata	2
	Watertown	2	Houston	Caledonia	3
Cass	Ah-Gwah-Ching	1		Houston	1
	Cass Lake	1		Spring Grove	1
	Walker	1	Hubbard	Nevis	1
Chippewa	Montevideo	4	Isanti	Cambridge	1
Chisago	Lindstrom	1		Stanchfield	1
	Rush City	1	Itasca	Bovey	1
Clay	Barnesville	1		Deer River	1
	Hawley	1		Grand Rapids	3
	Moorhead	2	Jackson	Jackson	2
Clearwater	Bagley	1		Lakefield	1
Cottonwood	Mountain Lake	1	Kanabec	Mora	1
	Westbrook	1	Kandiyohi	Willmar	4
	Windom	1	Koochiching	Int'l. Falls	2
Crow Wing	Brainerd	1	Lac Qui Parle	Dawson	1
	Deerwood	1		Madison	1
	Nisswa	1	LeSueur	Le Center	1
Dakota	Farmington	1		LeSueur	1
	Hastings	3		Montgomery	1
Douglas	Alexandria	2		New Prague	1
Faribault	Blue Earth	2		Waterville	1
	Bricelyn	1	Lincoln	Hendricks	1
	Elmore	1		Ivanhoe	1
	Wells	1		Tyler	1
	Winnebago	1			

Table IV - Cont'd.

County	Town	No. of Plants
Lyon	Garvin	1
	Marshall	2
	Minneota	1
	Tracy	4
McLeod	Brownton	1
	Glencoe	1
	Hutchinson	3
	Silver Lake	1
	Winsted	1
Marshall	Warren	1
Martin	Fairmont	2
	Sherburn	1
	Triumph	2
	Truman	1
Meeker	Litchfield	2
Mille Lacs	Milaca	1
	Onamia	1
	Princeton	1
Morrison	Little Falls	2
Mower	Austin	4
Murray	Slayton	2
Nicollet	Courtland	1
	Lafayette	1
	Nicollet	1
	North Mankato	1
	St. Peter	1
Nobles	Worthington	3
Norman	Ada	1
Olmsted	Rochester	7
Ottertail	Fergus Falls	3
	Henning	1
	New York Mills	1
	Pelican Rapids	1
Pennington	Thief River Falls	2
Pine	Hinckley	1
	Pine City	1
	Sandstone	1
Pipestone	Pipestone	3
Polk	Crookston	3
	East Grand Forks	1
Pope	Glenwood	1
	Starbuck	1
Ramsey	St. Paul	8
	White Bear Lake	2
Redwood	Lamberton	1
	Redwood Falls	2
	Wabasso	1
	Walnut Grove	1
Renville	Buffalo Lake	1
	Danube	1
	Fairfax	1
	Franklin	1
	Hector	1
	Olivia	2
	Renville	1
	Sacred Heart	1
Rice	Faribault	3
	Northfield	2
Rock	Hills	1
	Jasper	1
	Luverne	1
Roseau	Roseau	1
St. Louis	Chisholm	1
	Duluth	10
	Ely	2
	Eveleth	1
	Hibbing	2
	Nopeming	1
	Virginia	1
Scott	Belle Plaine	1
	Jordan	1
Sibley	Gaylord	1
	Gibbon	1
	Henderson	1
	Winthrop	1
Stearns	Cold Spring	1
	Melrose	1
	Richmond	1
	St. Cloud	5
	Sauk Centre	3
Steele	Owatonna	4
Stevens	Chokio	1
	Hancock	1
	Morris	1
Swift	Appleton	2
	Benson	1
	Kerkhoven	1
Todd	Bertha	1
	Long Prairie	1
	Staples	1
Traverse	Browns Valley	1
	Wheaton	1
Wabasha	Lake City	2
	Plainview	1
	Wabasha	2
Wadena	Wadena	1
Waseca	New Richland	1
	Waseca	3

Table IV - Cont'd.

County	Town	No. of Plants
Watonwan	Madelia	1
	St. James	2
Wilkin	Breckenridge	2
Winona	Altura	1
	Rollingstone	1
	St. Charles	1
	Winona	4
Wright	Annandale	1
	Buffalo	1
	Cokato	2
	Delano	1
	Howard Lake	2
	Maple Lake	1
	Monticello	1
Yellow Med.	Canby	1
	Clarkfield	1
	Granite Falls	2
Total 78	208	332

Note: The following counties do not contain pasteurization plants:

Cook	Lake	Red Lake
Dodge	Lake of the Woods	Sherburne
Kittson	Mahnomen	Washington

Source: Minn. Department of Agriculture, Dairy and Food, Bulletin of Information 1946, pp. 54-59.

TABLE V

State Expenditures for Bang's Disease Control in Minnesota

Fiscal Year	Indemnity	Operating Costs	Total
1935	None	385.00	385.00
1936	None	5,057.80	5,057.80
1937	None	19,355.53	19,355.53
1938	None	43,653.43	43,653.43
1939	13,210.83	38,829.89	52,040.72
1940	118,537.78	22,395.07	140,932.85
1941	135,339.86	29,994.36	165,334.22
1942	95,598.73	30,739.16	126,337.89
1943	62,891.99	59,181.76	122,073.75
1944	68,461.00	44,781.13	113,242.13
1945	88,087.65	50,878.89	138,966.54
1946	263,433.71	58,423.33	321,857.04
1947	95,854.61 (Paid to Aug. 26, 1947) (Est. amt. still to be paid 14,501.39)	58,446.96 (To Aug. 26, 1947)	154,301.57 (To Aug. 26, 1947)
Total	941,416.16 (67.1% of total)	462,122.31 (32.9% of total)	1,403,538.47

Source: Special Report from Minn. Live Stock Sanitary Board, Aug. 26, 1947

TABLE VI

Federal Expenditures for Bang's Disease Control in Minnesota

Fiscal Year	Indemnity	Operating Costs	Total
1943	59,250.85	102,595.96	161,846.81
1944	58,023.27	86,367.48	144,390.75
1945	75,805.90	84,822.78	160,628.68
1946	207,730.98	81,068.43	288,799.41
1947	82,469.51	127,779.83	210,249.34

Source: Bureau of Animal Industry, U. S. Department of Agriculture, St. Paul Office, Letter Dated September 23, 1947. Data for earlier years not readily available.

TABLE VII

Minnesota Livestock Population
Estimated Numbers of Livestock on Farms Jan. 1, 1947, by Counties

County	All Cattle 1947	County	All Cattle 1947	County	All Cattle 1947
*Aitkin	26,500	*Itasca	21,000	Pope	45,500
Anoka	20,000	Jackson	49,000	Ramsey	4,500
Becker	48,500	Kanabec	31,000	*Red Lake	18,500
*Beltrami	24,000	*Kandiyohi	49,000	Redwood	45,500
Benton	35,000	*Kittson	20,500	Renville	61,500
*Big Stone	21,500	*Koochiching	10,500	Rice	48,500
Blue Earth	48,500	*Lac Qui Parle	41,000	Rock	41,000
Brown	39,500	*Lake	1,500	*Roseau	29,000
*Carlton	26,500	*Lake of Woods	7,500	*St. Louis	43,000
Carver	47,500	LeSueur	34,500	Scott	31,000
*Cass	25,000	Lincoln	36,500	Sherburne	22,000
Chippewa	29,500	Lyon	50,000	Sibley	51,500
Chisago	37,500	McLeod	58,000	Stearns	111,500
*Clay	38,000	*Mahnomen	17,000	Steele	41,500
*Clearwater	21,500	*Marshall	36,500	*Stevens	29,000
*Cook	500	Martin	53,000	Swift	37,500
Cottonwood	40,500	Meeker	50,000	Todd	65,500
*Crow Wing	19,000	Mille Lacs	32,500	*Traverse	19,500
Dakota	43,500	Morrison	61,500	Wabasha	49,500
Dodge	47,500	Mower	63,000	Wadena	24,500
Douglas	59,000	Murray	47,500	Waseca	33,000
Faribault	49,000	Nicollet	34,500	Washington	33,500
Fillmore	91,500	Nobles	52,500	*Watonwan	31,500
Freeborn	62,500	*Norman	39,000	*Wilkin	29,000
Goodhue	77,500	Olmsted	71,500	Winona	53,500
Grant	29,500	Otter Tail	127,500	Wright	71,500
Hennepin	42,000	*Pennington	23,000	Yellow Med.	41,500
Houston	51,500	Pine	50,000		
*Hubbard	14,000	Pipestone	32,500	Total	3,527,000
Isanti	27,000	*Polk	68,500		

* Area Counties

	Number	Percentage
Cattle in 29 Area Counties -	751,000	21.3
Cattle in 58 Non-area Counties -	2,776,000	78.7
Total Cattle in the State	3,527,000	100.0

	Sq. Miles	Percentage
Area in Area Counties	41,715	52.1
Area in Non-area Counties	38,294	47.9
	80,009	100.0

Source: State-Federal Crop and Livestock Reporting Service, Room 351 State Office Bldg., St. Paul, Minn.

TABLE VIII

Minnesota Counties Under Area Plan of Bang's Disease Control

County	Date Testing Started	County	Date Testing Started
Red Lake	Nov. 13, 1939	Carlton	Oct. 1, 1940
Pennington	Nov. 27, 1939	Watonwan	Oct. 30, 1940
Beltrami	Dec. 19, 1939	Cass	Nov. 15, 1940
Hubbard	Dec. 4, 1939	Cook	Mar. 10, 1941
Itasca	Jan. 30, 1940	St. Louis	May 19, 1941
Lake of the Woods	June 10, 1940	Crow Wing	Sept. 1, 1941
Roseau	Mar. 4, 1940	Clay	Sept. 15, 1941
Marshall	Mar. 16, 1940	Aitkin	Jan. 26, 1942
Clearwater	June 10, 1940	Stevens	Dec. 6, 1943
Lake	June 10, 1940	Lac Qui Parle	Mar. 12, 1945
Koochiching	June 10, 1940	Traverse	Apr. 30, 1945
Polk	Apr. 22, 1940	Kittson	June 25, 1945
Mahnomen	Aug. 5, 1940	Big Stone	Awaiting Test
Norman	Aug. 5, 1940	Kandiyohi	Awaiting Test
Wilkin	Sept. 3, 1940		

Source: Based on Data furnished by Minnesota Live Stock Sanitary Board as of Aug. 1, 1947.

TABLE IX

Bang's Disease Testing in Minnesota

Fiscal Year	Herds Tested	Cattle Negative	Cattle Positive	Cattle Suspect	Total Cattle Tested	% Infection Overall	% Infection Area Plan
1940	- -	567,286	14,692	5,645	587,623	2.84	1.42
1941	- -	866,051	19,458	4,994	890,503	2.185	1.12
1942	- -	1,678,171	25,304	6,233	1,709,708	1.48	1.001
1943	29,139	527,136	14,603	3,640	545,379	2.677	.79
1944	22,955	403,303	16,365	4,618	424,286	4.057	1.35
1945	19,756	361,718	18,860	5,668	386,246	4.88	2.25
1946	26,478	429,446	36,035	8,373	473,854	7.604	2.788

Source: Annual Reports of the Minnesota Live Stock Sanitary Board

TABLE X

Percentage of Cattle Population Under Certified Herd Plan
In Non-area Counties in Minnesota as of January 1, 1947

County	Total Cattle	Under Plan	%	County	Total Cattle	Under Plan	%
*Aitkin				Lincoln	36,500	1,293	3.5
Anoka	20,000	1,903	9.5	Lyon	50,000	1,842	3.7
Becker	48,500	710	1.5	McLeod	58,000	1,396	2.4
*Beltrami				*Mahnomen			
Benton	35,000	1,319	3.8	*Marshall			
*Big Stone				Martin	53,000	2,652	5.0
Blue Earth	48,500	2,177	4.5	Meeker	50,000	4,506	9.0
Brown	39,500	1,616	4.1	Mille Lacs	32,500	2,715	8.4
*Carlton				Morrison	61,500	3,075	5.0
Carver	47,500	1,087	2.3	Mower	63,000	2,585	4.1
*Cass				Murray	47,500	1,927	4.1
Chippewa	29,500	1,915	6.5	Nicollet	34,500	1,695	4.9
Chisago	37,500	2,531	6.7	Nobles	52,500	1,425	2.7
*Clay				*Norman			
*Clearwater				Olmsted	71,500	4,845	6.8
*Cook				Otter Tail	127,500	6,876	5.4
Cottonwood	40,500	2,508	6.2	*Pennington			
*Crow Wing				Pine	50,000	2,502	5.0
Dakota	43,500	1,087	2.5	Pipestone	32,500	520	1.6
Dodge	47,500	2,666	5.6	*Polk			
Douglas	59,000	3,493	5.9	Pope	45,500	2,501	5.5
Faribault	49,000	2,534	5.2	Ramsey	4,500	90	2.0
Fillmore	91,500	3,862	4.2	*Red Lake			
Freeborn	62,500	2,018	3.2	Redwood	45,500	5,638	12.4
Goodhue	77,500	2,219	2.9	Renville	61,500	2,608	4.2
Grant	29,500	777	2.6	Rice	48,500	1,276	2.6
Hennepin	42,000	2,176	5.2	Rock	41,000	126	0.3
Houston	51,500	2,977	5.8	*Roseau			
*Hubbard				*St. Louis			
Isanti	27,000	3,008	11.1	Scott	31,000	1,254	4.0
*Itasca				Sherburne	22,000	2,008	9.1
Jackson	49,000	2,691	5.5	Sibley	51,500	939	1.8
Kanabec	31,000	4,196	13.5	Stearns	111,500	2,988	2.7
*Kandiyohi				Steele	41,500	1,192	2.9
*Kittson				*Stevens			
*Koochiching				Swift	37,500	1,379	3.7
*Lac Qui Parle				Todd	65,500	2,435	3.7
*Lake				*Traverse			
*Lake of Woods				Wabasha	49,500	2,470	5.0
LeSueur	34,500	1,843	5.3	Wadena	24,500	1,378	5.6

Table X - Cont'd.

County	Total Cattle	Under Plan	%
Waseca	33,000	1,192	3.6
Washington	33,500	1,021	3.0
*Watonwan			
*Wilkin			
Winona	53,500	4,112	7.7
Wright	71,500	6,153	8.6
Yellow Med.	41,500	2,550	6.1
** Total	2,776,000	134,477	4.8

* Area Counties
**For Non-area Counties

Sources: Cattle Pop. - State-Federal Crop and Livestock Reporting Service.
Cattle Under Certified Herd Agreements - Bureau of Animal Industry, Room 1419 Post Office, St. Paul (based on files of Minn. L.S.S.B.)

TABLE XI

Vaccination Against Bang's Disease in Minnesota

Fiscal Year	Herds Vaccinated	Calves Vaccinated	Adults Vaccinated
1939	160		
1940	251		
1941	431		
1942	235		
1943	458	2,223	0
*(1944 - 1st half)	(552)	(958)	
*(1944 - 2nd half)	(940)	(4,960)	(4,379)
*1944 - total	*1,492	5,952	4,379
1945	2,722	13,279	7,211
1946	4,358	19,957	7,503

*Note: Vaccinations prior to January 1, 1944, were under agreement B. D. 35 and after that date under B. D. 28 and 41. Since herds under vaccination agreements the first half of 1944 were probably continued under the new agreements introduced the second half, the total herds vaccinated in 1944 must be interpreted with caution. Also, since the type of agreements for vaccination changed Jan. 1, 1944, the figures prior to that date are not strictly comparable to those following.

Source: Annual Reports of the Minnesota Live Stock Sanitary Board.

SOURCES

1. Dr. R. R. Birch, "Limitations of Vaccination in Brucellosis", Journal of the American Veterinary Medical Association, Februaay, 1947, p. 98. Dr. Birch is on the staff of Cornell University, Ithaca, New York.

2. Dr. A. B. Crawford, "Summarization of Discussions on Vaccination Against Bovine Brucellosis", Journal of the American Veterinary Medical Association, February 1947, pp. 99-102. Dr. Crawford is on the staff of the U. S. Animal Disease Station at Beltsville, Maryland.

3. Dr. Fred C. Driver, U. S. Bureau of Animal Industry, Room 1419 Post Office, St. Paul, Minnesota.

4. Dr. L. A. Dykstra, "Advantages of Vaccination Against Bovine Brucellosis", Journal of the American Veterinary Medical Association, February 1947, pp. 96-98. Dr. Dykstra is from Aurora, Illinois.

5. Alice C. Evans and T. Arthur Turner, Crippler in Disguise, published by The National Society for Crippled Children and Adults, Inc., Elyria, Ohio. Dr. Evans is Senior Bacteriologist in the National Institute of Health in the U. S. Public Health Service and Mr. Turner is a professional writer on the staff of the Society.

6. Dr. C. M. Haring, Dr. J. Traum, and Dr. W. E. Maderious, "Vaccination Against Brucellosis", Journal of the American Veterinary Medical Association, February 1947, pp. 103-107. All are on the staff of the University of California at Berkeley.

7. Lucy S. Heathman, A Survey of Workers in Packing Plants for Evidence of Brucella Infection, a study made in Minnesota. Reprinted with additions, from the Journal of Infectious Diseases, Nov.-Dec., 1934, Vol. 55, pp. 243-265.

8. Dr. I. F. Huddleson, letter to Minnesota Legislative Research Committee dated August 18, 1947. Dr. Huddleson is a research professor at Michigan State College, East Lansing.

9. Illinois Department of Public Health, "Brucellosis (Undulant Fever)", Illinois Health Messenger, June 15, 1947, pp. 45-46.

10. Illinois Department of Public Health, Undulant Fever, What Can Be Done About It, Educational Health Circular No. 49, March 1947.

11. Indiana Department of Public Health, Indiana University Medical Center, and the Bureau of Animal Industry, U. S. D. A., Proceedings of Regional Conference on Brucellosis, September 26 and 27, 1946.

12. Dr. A. K. Kuttler, Brucellosis Eradication, July 28, 1947. While Dr. Kuttler is not listed as the author on the mimeographed copies of the outline, in a letter to the Legislative Research Committee from the U. S. Bureau of Animal Industry dated August 14, 1947, he is credited as being the author. Dr. Kuttler is in charge of the Tuberculosis Eradication Division of the Bureau of Animal Industry which administers the brucellosis control program.

13. Minnesota Department of Agriculture, Dairy, and Food, Bulletin of Information 1946.

14. Minnesota Department of Health, Section of Preventable Diseases, typewritten statement, Undulant Fever, (By Residence), May 23, 1947, corrected to August 1, 1947.

15. Minnesota Department of Health, "Undulant Fever Increasing in State", Minnesota Health, August 1947, pp. 2-3.

16. Minnesota Department of Labor and Industry, 30th Biennial Report for 1945-46.

17. Minnesota Live Stock Sanitary Board, Programs for Control of Bang's Disease (Bovine Brucellosis), April 30, 1947.

18. Minnesota Live Stock Sanitary Board, Annual Reports from 1939 through 1946.

19. Minnesota, State Laws and Rules and Regulations of the Minnesota State Live Stock Sanitary Board Relating to the Control of Bang's Disease (Bovine Brucellosis) in the State of Minnesota, January 18, 1946.

20. Dr. B. T. Simms, "Brucellosis (Bang's Disease)... A National Control Problem", Hoard's Dairyman, August 10, 1947, p. 627-f. Dr. Simms is Chief of the Bureau of Animal Industry, U. S. Department of Agriculture.

21. Dr. B. T. Simms, Brucellosis Control and Eradication, paper presented at meeting of American Dairy Science Association at Guelph, Ontario, June 25, 1947.

22. Dr. B. T. Simms, Report on the Cooperative Brucellosis Control and Eradication Program, paper presented at the 50th Annual Meeting of the United States Livestock Sanitary Association at Chicago, Illinois, December 6, 1946.

23. U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Animal Industry, Uniform Methods and Rules for the Establishment and Maintenance of Modified Accredited Bovine Brucellosis-Free Areas Including Amendment No. 1, January 10, 1946.

24. U. S. Department of Agriculture, Bureau of Animal Industry, Regulations Governing Appraisal of and Compensation for Cattle Destroyed on Account of Tuberculosis, Paratuberculosis, or Bang's Disease (Brucellosis), (B. A. I. Order 375), issued August 13, 1942.

25. University of Minnesota Agricultural Experimental Station, Brucellosis or Bang's Disease of Farm Animals, Bulletin #348, June 1940.

26. Wisconsin College of Agriculture, Bang's Disease Conference, June 21, 1945.

In addition to the above, pertinent sections of Minnesota Statutes 1945 and Minnesota Session Laws 1947 were examined. Inquiries were made of all states' agencies administering brucellosis control programs and replies were received from all but eight states. Many replies expressed opinions as to what was considered the best means of controlling brucellosis.

In addition to obtaining information from written material, conferences were held with people familiar with the problem.