The Relation of Brucellosis To Human Welfare[1]

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FOR MANY years, it has been a common practice for those interested in agriculture to gauge the effect of a disease of animals on the basis of economic losses, that is, the monetary income of those who own the animals and the cost to the taxpayers who supply the funds for the prevention and control of the disease. It can be argued, in all seriousness, that this criterion has virtue when efforts are being made to bring to the attention of specific groups of people the need for taking necessary measures for the prevention and control of an animal disease. However, when a disease is viewed and considered in a more embracing and far-reaching direction, namely, its direct and indirect effects on human welfare, monetary losses are dwarfed into insignificance.

Although all members of the veterinary profession are aware of the economic effects of animal diseases on the livestock industry, there are only a few who have given much thought to, or even considered, how closely their professional activities are geared to man's present way of life or improvement in his living conditions. One could find no parallel in the amount of discomfort to man's present-day routine of living, if a serious animal disease should suddenly reduce or interrupt the flow of those foods from animal sources now considered essential for the maintenance of good health. The imaginary discomforts, which many could hardly endure under wartime food rationing, would seem, by comparison, like mild irritations.

It may be stated, without reservation, that when a situation decreases the output of a very necessary and important food used in the daily diet of a large percentage of our population, such a situation becomes a problem that affects human welfare. This may involve higher costs of food for those least able to pay or insufficient food to satisfy the minimum requirements of those who should not be denied, especially children.

It is also a well-known fact that animals serve as the host or reservoir of many diseases to which humans are susceptible. These diseases are transmissible to man by direct contact with animals or through infective foods derived from them. In many cases, the animal disease continues to be a disease of humans only because of

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the continued existence of infected animals. Once the latter are removed, or a link in the infection chain from animal to man is broken, it ceases to be a major disease of humans.

Of all the diseases that might be considered in this category, brucellosis is one of the most important. One might go as far as to say that there are few animal diseases today that play as important a role, both directly and indirectly, in man's welfare. Brucellosis has become a distinguished disease because it affects the health and productivity of goats, cattle, and swine, three of man's most vitally useful food-producing livestock. In addition, the health and welfare of human beings are known to be adversely affected, either directly or indirectly, by this condition.

Human beings become involved as the result of being unfortunate trespassers on the road that the organisms travel from animal to animal. From what is known of the history of this disease in humans, it would soon cease to exist as such if all infected animals were destroyed.

During the past twenty-six years, brucellosis, or undulant fever, has been recognized in humans located in all the forty-eight states. It is now well known that, after invasion of the tissues, all three species of *Brucella* are capable of producing in humans similar febrile diseases that tend to become chronic in nature. The sources of the condition have been known for many years, but the comparative importance of the various means of its transmission to humans is just beginning to be realized.

From the epidemiological data collected by two groups of workers, it is now possible to evaluate the problem that brucellosis presents in a large populated area and, from this, set into operation plans directed towards its prevention. During the last eighteen years, Hardy and associates,[2] also Jordan,[3] have been carefully collecting epidemiological data on the occurrence of brucellosis in the population of Iowa and have tabulated, according to their occupation, the yearly morbidity rates of those affected. They have also sought to show how contact with farm animals compares with the use of raw milk as the means of transmission. In Iowa, all three species of *Brucella* have been associated with the disease in humans; their source appears to be either the cow or the hog.[4]

2. A. V. Hardy, C. F. Jordan, and I. H. Borts, Undulant fever; further epidemiologic and clinical observations in Iowa. J.A.M.A., 107:559–564, 1932.

3. C. F. Jordan, Undulant fever in Iowa. Proc. 46th Meeting of U. S. Live Stock Sanitary Assoc., p. 137, 1942; *Personal communication*, 1945.

4. I. H. Borts, Some observations regarding the epidemiology, spread, and diagnosis of brucellosis. J.Kansas Med.Soc., Dec. 1945.

TABLE 1

Morbidity Rates of Undulant Fever in Relation to Occupation[a]

Occupation	*Cases 1927–1935*	*Population 1930 Census*	*Annual Rate Per 100,000*
Packing-house employees	103	8,000	142.5
Men on farms[b]	422	324,000	14.5
Women on farms	80	250,000	3.6
Others 10 yrs. and above	371	1,375,000	3.0
Children under 10 yrs.	15	464,000	0.4
Total	991	2,471,000	4.5

[a]A. V. Hardy, C. F. Jordan, and I. H. Borts, J.A.M.A., **107**:559–564, 1936.
[b]Includes farm laborers; estimated number, 74,000.

The data covering the annual morbidity rates of human brucellosis in the State of Iowa are divided into three groups of years and are presented in Tables 1, 2, and 3. From the 3,111 known cases, studied during a period of eighteen years, one should obtain fairly conclusive evidence as to how various means compete with each other in the transmission of the disease. When the data are analyzed according to the population in each occupational group and their history of exposure, it becomes clearly apparent that contact with the infected live animal, or its carcass, plays a much more important role in the transmission of brucellosis to humans than does the use of raw milk. This fact holds true, regardless of whether the infected animal is handled on the farm by the farmer or the veterinarian, or at the point of slaughter by the packing-house worker. It is of interest to note that there is a striking correlation between the annual morbidity rates of those groups in which the rates were the highest for all three periods. Surprisingly, the occupational group showing the highest annual morbidity rate for the entire period has been the smallest user of raw milk. On the other hand, farm women, all of whom used raw milk, show an annual morbidity rate that differs in only a small degree from that found in urban groups, most of whom also used raw milk. The data presented in Tables 1, 2, and 3 give a better understanding of the modes of transmission of the disease to humans and indicate the methods that should be followed for its prevention.

The United States has not yet made clear, through epidemiological data, what effect the use of pasteurized milk has had, or is having, on the incidence of human brucellosis. When cases occur in areas

TABLE 2

Morbidity Rates of Undulant Fever in Relation to Occupation[a]

Occupation	*Area*	*Percentage of Contact with Livestock*	*Percentage Using Raw Milk*	*Cases 1936–1941*	*Population in Group*	*Annual Rate per 100,000*
Child	Rural	60	85	47	1,454,037	0.5
Farm wife	Rural	40	100	81	1,454,037	0.9
Farm worker (male)	Rural	100	100	320	311,776	17.1
Child and teen age	Urban	23	77	26	1,084,231	0.4
Housewife	Urban	3	92	36	1,084,231	0.6
Merchant-professional	Urban	25	84	154	1,621,500	1.6
Packing-house worker	Urban	98	20	118	15,000	131.1
Total	Urban			782	2,538,263	5.1

[a]C. F. Jordan, Proc. 46th Meeting U. S. Livestock Sanitary Assoc., p. 137, 1942.

TABLE 3

Morbidity Rates of Undulant Fever in Relation to Occupation[a]

Occupation of Group	*Area*	*Contact with Animals*		*Users of Raw Milk*		*Total Cases*[b] *1942–1945*	*Population in Group*	*Annual Rate per 100,000*
		No.	*Percentage*	*No.*	*Percentage*			
Child (12 yrs. and under)	Rural	19	65.6	29	100.0	29	916,768[c]	0.9
Teen age	Rural	26	72.2	36	100.0	36	916,768	0.9
Farm wife (adult female)	Rural	56	60.9	92	100.0	92	916,768	2.2
Farm worker (adult male)	Rural	611	100.0	611	100.0	611	311,776[d]	43.0[e]
Child (12 yrs. and under)	Urban	5	27.8	18	100.0	18	1,621,500[f]	0.4
Teen age	Urban	6	31.6	16	84.2	19	1,621,500	0.3
Housewife (adult female)	Urban	3	3.2	77	81.9	94	1,621,500	1.4
Merchant-professional	Urban	57	26.0	159	72.6	219	1,621,500	3.3
Packing-house worker	Urban	205	98.1	69	35.0	209	20,000[g]	271.5[e]
Veterinarian	Urban	11	100.0	8	72.7	11	800[h]	250.0[e]
Total	Rural and Urban	999	74.7	1,115	83.3	1,338	2,538,268	12.3

[a]C. F. Jordan, *Personal communication*, 1945.
[b]Through 11/15/45.
[c]Farm population, Census 1940.
[d]Male farm workers, Census 1940.
[e]Specific rate per 100,000.
[f]Urban and non-farm population, Census 1940.
[g]Estimated number.
[h]Approximate number.

where only pasteurized milk is sold, it is not always possible to rule out the use of unpasteurized dairy products or contact with infected animals. On the other hand, the low annual morbidity rate of the disease in large populated areas, where pasteurization has long been practiced and where milk has been consumed by large numbers of people, can hardly be attributed to any other factor.

While three species of *Brucella* are known to infect cattle, only one, *Brucella abortus*, has thus far been shown to be highly infectious for the cow. The other two species, *Brucella suis* and *Brucella melitensis*, have been recovered from the milk of cows in only a few instances. The effect of the latter two on the health and productivity of the cow is not yet known.

The disease, known as bovine brucellosis, or Bang's disease, is regarded as insidious in nature. This fact reflects itself in the difficulty encountered in recognizing the condition by any means except through laboratory diagnostic tests. The causative organism enters the body by way of the digestive tract or through the skin; for some unknown reason, it has a predilection for lymphoid tissue and the gravid uterus. The preference shown by the organism for the uterus and the mammary glands, as its seats of action, could hardly be more unfortunate in so far as the welfare of man is concerned.

When *Brucella* organisms invade the tissue of a cow, they often bring about changes in the gravid uterus which result in the expulsion of the developing fetus. Many infected cows become sterile for long periods of time thereafter. Valuable and productive breeding stock of rich inheritance cannot be continued when abortion occurs too often, and as a result, there is not only loss of future breeding stock but also a large amount of potential milk and meat never reaches the consuming public. It can be readily seen that the presence of the disease requires the maintenance of more breeding animals to provide meat and milk for human use than would normally be necessary.

During the present century, the dairy cow and its products have come to be as essential to man's health as the clothes that he wears or the water that he drinks. It may be said without reservation that there is no other food that so greatly influences man's well-being from the cradle to the grave as milk. Thus far, regardless of claims, no substitute which will serve the same purpose has been found.

Those who have studied brucellosis in cattle have long known, and those in the beef and dairy industries are now recognizing, that this disease not only causes a serious decrease in income on capital investment but is also responsible for a considerable reduction in the

TABLE 4

Milk Yield in *Brucella*-infected Cows Compared with Those not Infected

Author	Status of Cow	No. of Cows	No. of Lactations	Average Milk Yield in Lb.	Decrease in Lb.	Percentage Decrease
Hooper[a]	Not infected	6	6	5,949	2,147	35[b]
	Br. infected	12	12	3,802		
White *et al*[c]	Not infected	38	108	9,315	1,600	17[d]
	Br. infected	45	129	7,715		
Simms & Miller[e]	Not infected	31	31	8,542	3,832	45[b]
	Br. infected	48	48	4,710		
Fritz & Barnes[f]	Not infected	209	379	9,937	2,622	26[b]
	Br. infected	120	203	7,315		
Graham Throp[g]	Not infected	28	28	9,740	2,128	22[b]
	Br. infected	11	11	7,612		
Rich[h]	Not infected	115	115	8,100	1,450	18[d]
	Br. infected	115	115	6,650		
Minet & Martin[i]	Not infected	115	154	8,803 ± 117	666 ± 298	10[d]
	Br. infected	38	42	8,137 ± 274		
Totals & averages	Not infected	542	821	8,626+	2,063+	23+
	Br. infected	389	560	6,563		

[a]J. J. Hooper, Bull. No. 248, Kentucky Agric. Exp. Sta., 1923.
[b]Uncorrected yields.
[c]G. C. White, R. E. Johnson, L. F. Rettger, and J. G. McAlpine, Bull. No. 135, Storrs Agric. Exp. Sta., 1925.
[d]Corrected yields.
[e]B. T. Simms and F. W. Miller, J.Am.Vet.Med.Assoc., 68:455, 1925.
[f]S. Fritz and M. F. Barnes, J.Am.Vet.Med.Assoc., 76:490–504, 1930.
[g]R. Graham and F. Thorp, Bull. No. 360, Illinois Agric. Exp. Sta., 1930.
[h]L. H. Rich, Cornell Vet., 21:15–24, 1931.
[i]F. C. Minet and W. J. Martin, J.of Dairy Sc., 7:122, 1936.

amount of milk, milk products, and meat intended for human use. This situation not only reduces the supply but also tends to increase the costs of production.

It is common knowledge that cows, which abort as a result of *Brucella* infection, have shortened lactation periods and consequently have a low milk yield during the year of abortion. It is not generally known, however, that infected animals, even when they do not abort, produce less milk, on the average, than those not infected.

No one doubts any longer that the *Brucella* organism can result in extensive damage to the milk-producing tissue of the udder. Substantial proof of this has been seen in the histological sections of *Brucella abortus*-infected udders made by Runnels and Huddleson[5] and Ridala.[6] From the extensive damage found in the udder tissue, one would expect to find a lower milk production in infected animals than in those not infected.

Several investigators have made an attempt to determine the influence of brucellosis on the milk yield of dairy cows over a period of one or more years. A considerable amount of data have been collected by seven independent groups of workers on this phase of the disease and are summarized in Table 4. These investigators have compared the annual milk yield of 542 non-infected animals with 398, which were considered as infected on the basis of the results of serum agglutination tests. The former had passed through 821 lactation periods and the latter, through 560.

The smallest difference, 660 pounds, between the milk yield of the non-infected and infected was noted by Minet and Martin[7] and the largest, 3,832 pounds, by Simms and Miller.[8] The average milk yield per lactation for both groups of animals is considerably higher than that reported for the average dairy cow in most states of the United States. It is therefore presumed that the animals on which the data were collected represented above the average milk producers.

According to these investigations, the average *Brucella* infected animal produces 2,063 pounds less milk per lactation than those not infected. In their study, Minet and Martin[9] also presented data on

5. R. A. Runnels and I. Forest Huddleson, The nature of *Bacterium abortus* infection in the udder of the bovine. Cornell Vet., 15:376, 1925.
6. V. Ridala, Inquiries into the pathogenic changes produced by *Brucella abortus* in the udder and certain organs of the cow. Vet.and Milk Hyg.Inst., U.of Tarta, Estonia, 1936.
7. F. C. Minet and W. J. Martin, The influence of mastitis and *Br. abortus* infection upon the milk yield of cows. J.Dairy Res., 7:122, 1936.
8. B. T. Simms and F. W. Miller, Practical results of attempts to control abortion disease. J.Am.Vet.Med.Assoc., 68:455, 1925.
9. F. C. Minet and W. J. Martin, *op. cit.*

one group of 12 infected cows, showing that, even in the absence of abortions, infected cows produce considerably less milk than those not infected. This particular group produced 20 percent less milk per lactation than normal ones.

It is known that numerous factors, other than disease, influence the milk yield of cows. Minet and Martin[10] have so well summarized these factors that they are repeated here. "Corrections have to be made in the first place for age (as judged by the number of calvings), length of dry period, service period (interval between calving and next effective service), and month of calving. Comparisons of yield can only be made with animals of the same breed living under the same conditions of animal husbandry and being milked by the same system—by hand or machine, as the case may be. After all these conditions have been satisfied, it has to be remembered that other diseases may have a bearing on the issue."

It may be presumed that five of the groups, whose data are set forth in Table 4, failed to use correction factors in assessing milk yield losses in *Brucella*-infected cows, as these were not mentioned in their reports. In view of this, one is not justified in attributing to *Brucella* infection, alone, all of the decreases in milk yield that these five groups have reported. On the other hand, it is logical to assume that their figures are not far from being correct, since they correspond closely to those reported on cows in which correction factors were applied in assessing milk yields.

From the data presented on such a large group of animals over many lactation periods, it does not require a well-developed imagination for anyone to comprehend that the aggregate loss of market milk or milk products from this one disease alone is enormous to the dairy industry of the United States. This loss emerges with greater significance when analyzed in terms of the food that the dairy cow population of a state, such as Michigan, is capable of producing; also when viewed from the standpoint of its effect on human welfare.

According to the 1945 census of the Bureau of Economics of the United States Department of Agriculture, there are approximately 1,080,000 dairy cows of breeding age (grade and pure-bred) in Michigan. From blood test samplings of areas in this state, wherein the incidence of infection is low and high, about 10 percent of the cows of milk-producing age have brucellosis. This means that 108,000 infected animals will produce 2,063 pounds less milk per animal each year, as long as the foregoing figures are maintained. As a

10. *Ibid.*

result of brucellosis, the milk-consuming public is thus deprived of 222,804,000 pounds of market milk yearly.

According to Professor A. C. Baltzer, of the Dairy Department of Michigan State College, the people of Michigan consume, at the present time, on the average of 400 pounds of milk per person per year. On the basis of this consumption rate, the total amount of milk that is not produced by the dairy cows in Michigan, because of brucellosis, would supply a total of 557,000 persons with their needed whole milk requirements for one year.

Now let us turn to the consideration of the loss in another dairy food—butter—due to this disease. This angle has had special significance during the past winter because of the nation-wide shortage of such a valuable human food. The butter-making industry estimates that 100 pounds of milk are required to produce 5 pounds of butter. Before 1941 the average number of pounds consumed per person per year in Michigan was 17. If the 10 percent of Michigan cows now infected were free from brucellosis, they would produce 11,140,200 more pounds of butter for the consuming public than they are now producing. In other words, enough butter is being lost to supply 655,300 persons with their butter requirements for one year.

Still another important aspect of food losses caused by brucellosis is worth considering, namely, that of meat processed for human consumption. From an evaluation of the annual meat losses to the cattle industry of Michigan, one should obtain some idea of those that occur in animals in other states where brucellosis is just as prevalent. According to a voluminous amount of breeding data on *Brucella*-infected cattle, which the writer has collected over the past thirty years, approximately 15 percent of the infected animals do not produce offspring each year due either to abortion or sterility. This means that an estimated 16,240 calves are lost annually by the 108,000 infected animals of breeding age in Michigan. By multiplying the total number of calves lost each year by the dressed weight (80 pounds) of the average veal calf, it is estimated that 1,299,200 pounds of veal fail to reach the consumer each year, because of brucellosis.

One may carry this analysis still further by estimating the loss in meat, if the calves were raised and marketed as fat heifers or steers at a weight of 800 to 900 pounds. An 800-pound animal should yield a dressed weight of 400 pounds. On the basis of the dressed weight, there is a possible loss of 6,494,000 pounds of meat to the consuming public each year. It must be admitted that this figure is only relative

and only holds true where dairy cattle are sold for meat. Certainly, a large percentage of the heifer calves, had they been born, would have been raised in the herd or sold to others for replacement of mature milk-producing animals. If one should consider these from the standpoint of their potential productive capacity as dairy cows, then the additional loss in food products to the consumer would be far greater than that from meat alone.

Several published and unpublished studies on hogs on individual farms, where brucellosis was present, clearly show that the disease in this animal is of major economic importance to the farmer and a limiting factor in the production of pork for human consumption. Brucellosis reduces the potentially available meat from swine through sterility, abortion, and weak offspring that die before they are more than one week of age. At the present time, it is not even possible to guess at a figure that would represent the total amount of dressed pork lost in one of the states where hog-raising is a primary agricultural industry. This is due to the fact that no one has yet had the opportunity to make an extensive survey on the farm to determine the relative incidence of the disease. Sampling studies by means of a blood diagnostic test on hogs, delivered at the large slaughter houses, do not furnish an adequate picture of the extent of brucellosis in gilts or brood sows on the farm. The majority of the hogs sent to markets for slaughter each year is of an age in which the incidence of brucellosis is known to be low.

Substantial proof that brucellosis is a great destroyer of potentially available meat has been obtained from one large hog-raising farm, where 119 gilts and sows were bred to farrow in the spring of 1944. *Brucella* blood tests conducted on these revealed that 53, or 44 percent, were positive. If all the animals in this group had conceived and farrowed healthy pigs, the expected pig crop would have been 371. However, due to sterility, abortions, and weak offspring which died before reaching one week of age, only 70 pigs were raised to market age. In other words, 82 percent of the expected pig crop was lost. On the basis of a marketing weight of 225 pounds, the number of pigs that never had a chance to reach market age, because of brucellosis, represents 54,180 pounds less of dressed pork for the retail trade.

Now, in view of the great loss of pigs from brucellosis in 1944, the owner of the drove used all possible means to eradicate the disease during the fall and winter of 1944–45. His efforts did not go unrewarded, as the breeding and farrowing records for 1945 showed a substantial decrease in losses from brucellosis. There were 194 gilts

and sows bred to farrow in the spring of 1945. Of these, 15 were later found infected; 9 of them aborted; 6 lost 36 pigs shortly after farrowing due to unthriftiness. This group lost a total of 99 pigs, or a market weight of dressed pork amounting to 17,820 pounds. In other words, the pork loss from brucellosis on this farm for 1945 was reduced by 36,360 pounds from that of 1944. Coming from one farm alone, this figure represents a substantial increase of meat for the consumer.

It is known that the incidence of brucellosis in many large droves of hogs in those states, where hog-raising is a major farm industry, is from 20 to 50 percent. If these droves are experiencing as great a loss as the one just discussed, then the loss of consumer pork from brucellosis must be a sizable figure in this country. The full significance of the meat losses in the one drove discussed will emerge only when there is more information available as to the extent of the disease in hogs on farms in our large hog-raising states.

When considered on the basis of food losses in the entire cattle and swine population of the United States, the magnitude of the effects of this disease would appear to lead one into the realm of fantasy. If the figures quoted for both cattle and hogs are within an error of 5 to 10 percent in either direction, they still leave no doubt in one's mind as to the fact that brucellosis is a problem that can no longer be ignored by those who are trying to improve our human food position, and that of the world. It is a problem that needs the attention of all of those who are interested in the betterment of the welfare of all people.

In view of the ever-present human health hazard and the appalling losses in foods, it is pertinent to inquire whether there is hope that the situation under review may be improved or corrected in the near future. No one who has worked for any length of time with brucellosis would suggest that there is some simple solution to the problem of its control or prevention. There is one point, however, on which most students of the disease are in close agreement; it is that the infected animal, regardless of species, must be exterminated. If for no other reason, this must be done to remove the present danger to human health.

Jordan's latest report[11] on the annual morbidity rates of brucellosis in groups of various occupations presents convincing proof that the pasteurization of food products from infected animals will not alone solve this human health problem. The pasteurization of foods,

11. C. F. Jordan, *Personal communication*, 1945.

especially dairy products, should of course be continued and extended. The epidemics of brucellosis[12] in humans, traceable to unpasteurized milk from infected cows, are a sufficient warning to justify the practice. On the other hand, as long as infected cattle and hogs are maintained on farms or sent to slaughter houses, we may expect the continuance of a large number of infections among the groups who come in contact with these animals.

From our past knowledge of the prevention and eradication of other animal diseases, it may be said that there are three separate or combined roads that can be followed with respect to brucellosis. The first of these is the use of a drug, or other agent, that will cure the disease in animals. The second is the detection and rapid slaughter of all infected animals. The third approach is the utilization of an effective immunizing agent in non-infected animals and, at the same time, the slaughter of those shown to be infected by the blood serum agglutination test.

With respect to the first road, let us examine the prospect of discovering and utilizing a satisfactory therapeutic agent for animal brucellosis. First, it may be said that, thus far, all agents tried have proved ineffective in the infected cow and hog. The possibility of an agent turning up in the future does not look too bright, although the writer would be the last to say that the discovery of a suitable and inexpensive agent is beyond our reach.

During the past eleven years and in cooperation with the Federal Government, most of the states have made earnest efforts to follow the second road—that of detecting and slaughtering infected animals. Through the use of this method, much progress was made for a time in the establishment of a large number of disease-free herds of cattle. However, the lack of professional service during the war years, the necessity of adding adult animals to herds to maintain milk production, and the failure to take into consideration many of the known facts pertaining to the nature of brucellosis have served to limit the application of the eradication plan and to nullify, in many instances, the advances that were made during the first few years of its application.

It is known that in some states as high as 50 percent of the herds once accredited as free from brucellosis no longer have this status. The situation has led to much discontent among those directly concerned with the eradication program; the advisability of its continuance has been questioned by many. On the basis of our knowledge

12. C. P. Beattie and R. M. Rice, Undulant fever due to *Brucella* of porcine type—*Brucella suis*; report of milk-borne epidemic. J.A.M.A., 102:1670–1674, 1934.

of the distribution of brucellosis among farm animals, it may be said that state-wide or nation-wide eradication of bovine brucellosis will never become a *fait accompli* until some form of an area plan is adopted and employed. At the same time, the plan should be applied to all other farm animal hosts. The application of such a procedure to our large domestic animal population has been considered by many to be too laborious and too costly and, in the end, too impractical. Despite the known obstacles, there exists sufficient proof in Virginia and in Michigan to substantiate the claim that bovine brucellosis can be eradicated from large areas, or kept under control.

The third road of approach to the problem, and possibly the most practical, is the prevention of infection by immunizing susceptible animals by means of a suitable agent and at the same time slaughtering all infected ones. The prevention of the disease by immunization has had many trials with various types of vaccines and bacterins during the past forty years. The most satisfactory of these, thus far, has been calf vaccination with a culture of *Brucella abortus* of reduced virulence, developed by Cotton, Buck, and Smith.[13] It is the opinion of all those who have studied this means of immunization that it serves a useful purpose in increasing the resistance of cattle to brucellosis during the first and second years of their breeding life. It has been reported that the resistance or immunity engendered in calves by the vaccine has not always been sufficient to prevent infection, when they are exposed to aborting animals after reaching breeding age. This type of vaccine has certain defects that limit its wide use in adult animals. When it is injected into pregnant animals, they are likely to become infected from the vaccine organism and abort. Those which are treated after reaching two years of age or older will retain a positive blood reaction for two or more years. During this period, it is not possible to differentiate between the vaccinated and the infected, thus creating a complicated situation, especially when such animals are to be sold for breeding purposes or their milk is to be used for human consumption without pasteurization.

Little progress will be made in the control of brucellosis in farm animals by immunization until the agent is of such a nature that it can be used on adult, pregnant, and non-pregnant animals as well as on calves and, at the same time, meet all the objections that impede the use of other agents. It is the writer's belief that the finding of

13. W. E. Cotton, J. M. Buck, and H. E. Smith, Efficacy of an avirulent strain of *Brucella abortus* for vaccinating pregnant cattle. J.Agric.Res., 46:291, 1933.

such an agent is not an impossible task and that it may be brought to light before the end of 1946.

At the present time, the writer has under investigation for immunization purposes one of the dissociated phases of *Brucella*, known as the mucoid phase. This phase possesses no pathogenicity for experimental animals or cattle. It elicits specific agglutinins only to a slight degree, and then for only a short period of time. When injected into guinea pigs in a live state and in the proper doses, a high degree of immunity is engendered against infection from any of the three species of *Brucella*. All control guinea pigs (the number used in each experiment is the same as those treated), inoculated at the same time, are infected. Experiments designed to determine the immunizing value of this type of vaccine in cattle are in progress but are not yet of sufficient duration to warrant any analysis of its value.

In the foregoing discussion, an attempt has been made to point out some of the important major aspects of the brucellosis problem, the manner in which they affect human welfare, in general, and the cattle- and hog-raising industry, directly. It has been known for a number of years that the presence of this disease in a herd of cattle or hogs is an economic liability to the farmer. As years pass, public health authorities, and those directly affected, become increasingly aware of the fact that its continued presence in animals is a public health menace that cannot continue indefinitely. The shortages in our most essential foods for children and adults have served to emphasize the necessity of employing suitable measures that will prevent evident food losses.

It can be said without reservation that brucellosis is one of the major causes of food losses. Its elimination from animal life will benefit the public in general and bring more profit to the animal industry. It is, therefore, a disease that concerns all the people rather than a section of the people.