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Executive Summary

Paratuberculosis (Johne's disease) is endemic in the U.S. and Kentucky cattle industry, affecting both beef and dairy cattle. The disease affects the productivity of cattle (lowering milk production, reducing the weights of calves) and eventually causes the death of infected animals. The disease spreads among cattle on farms, primarily through fecal shedding of the organism, and may be brought onto a farm through the purchase of infected animals.

Since the disease often has long incubation and subclinical stages, testing may be necessary to confirm its presence. From late 1993 into early 1994, a random sample of blood samples drawn for brucellosis testing was also examined for paratuberculosis. This analysis indicated that less than one percent of Kentucky's beef cows and about six percent of its dairy cows are infected with paratuberculosis.

Using this information about incidence, an economic analysis was conducted to measure the financial losses to the Kentucky cattle industry. Two alternative approaches were used. One, a "net present value" approach measured the impact on the current and future earnings and value of infected animals. The alternative approach, a "market value" approach, measured the impact by using market prices to assess the loss of infected animals and their productivity. The two approaches resulted in similar results: a $6 million loss utilizing the net present value method and a $5.7 million loss using the market value approach. The conclusions from both methods are conditional upon the assumptions regarding cattle costs, production levels and age of onset of disease.

Measured against the size of the dairy and beef industries separately, it is apparent that costs are much more important for the dairy industry than the beef industry. Using either method, about two-thirds of the costs are borne by the dairy industry, which is much smaller than the beef industry.

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[1] This report was prepared at the request of Dr. Wade Kadel, Director of the Breathitt Veterinary Center in Hopkinsville, Kentucky, to assess the need for and alternative policies for the control of paratuberculosis in Kentucky. The data, methods and conclusions may also be useful for herd owners, veterinarians and leaders in the industry for making on-farm and policy decisions. Dr. Kadel and Mr. Brad Summa, statistician with the Kentucky Agricultural Statistics Service, provided helpful information and advice.

Background

Paratuberculosis (Johne's disease) is an endemic disease affecting the productivity of dairy and beef cattle in Kentucky (and other states). The disease may affect cattle in a subclinical phase, but eventually becomes acute, leading to death. The disease is not highly contagious, but does spread among cattle within a herd. The disease is spread by shedding of the organism in the feces of infected animals and sometimes through other contact. The primary method of transmission is newborn calf exposure to its dam. Transplacental transfer of the etiologic agent, a bacterium, Mycobacterium paratuberculosis, does occur, yet most transfers occur when calves nurse dams with fecal contaminated udders or ingest milk contaminated with the bacteria. Some researchers believe that soil contamination may also play a role (Pennsylvania Dairy Health and Biosecurity Manual).

Paratuberculosis causes direct economic losses through the death of the infected cattle, lowered milk production of dairy cattle, lowered calf production among both dairy and beef cattle, and through increased veterinary and related medical costs. Because the mechanism of the disease affects nutrient absorption, feed consumption typically remains normal even though the body condition of infected cattle deteriorates as the disease progresses. Other economic losses come from costs of testing programs borne by government agencies and lowered value and loss of reputation of breeding stock.

The focus of this study is on the economic losses, not on alternative control measures. If it is decided that losses are great enough to consider control measures whether private, mandated and/or publicly supported, both costs and benefits (including probable effectiveness) should be carefully considered.

Methodology

The losses a farmer accrues from paratuberculosis occur over time and can affect several sources of income. A dairy will experience loss of milk revenue, loss value of calves, death of cows and reduced income from sale of infected cows. A dairy cow may be thought of as a productive asset, producing a stream of returns over time. Her value is the sum of the net (of production costs) milk revenue, value of calves and salvage value. Likewise a beef cow's value to a cow-calf operation is the sum of the net value of the cow's calves plus her salvage value when culled.

There are three methodologically sound alternatives for valuing a cow. One is to calculate her value based on the incomes and costs described above (a "net present value" approach). Another is the market value approach, utilizing reported prices for similar animals as an indicator of value. The third is "replacement cost" approach, which measures the cost of raising a comparable replacement. In this study, the first two approaches are utilized. This produces two independent measures which are useful in assessing the results of the study since the analysis requires several assumptions.

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Using the net present value approach, the economic impact of paratuberculosis can be expressed as the difference in value between an infected animal and a non-infected animal. The loss per cow is: EL = NPVN - NPVI, where: EL is the loss in value per animal, NPVN is the net present value of a non-infected cow and NPVI is the net present value of an infected cow. The total loss will equal EL * N, where N is the number of infected cows. There will be two separate equations, one for beef cows and one for dairy cows.

Using the market value approach, the economic loss is the value of the lower milk production from infected cows, the market value of the cows which die (which captures the future value of their calves and milk production) and the reduced value of the cows which are culled because of paratuberculosis.

Assumptions and Data Used in the Analysis:

The prevalence of the disease is a key coefficient. A random sample of the blood samples submitted for brucellosis testing between November 1, 1993, and February 15, 1994, to the University of Kentucky Veterinary Diagnostic Laboratory and the Murray State University Breathitt Veterinary Center (BVC) at Hopkinsville, was selected. All of the samples were tested at the BVC, using the ELISA serology method, for evidence of the paratuberculosis causative agent.

Of 1146 samples from beef cows and heifers, seven tested positive. Of 641 dairy cattle samples, 20 tested positive. The test for Paratuberculosis is only considered about 45% accurate. The test produces only about .3% false positives, but it does produce false negatives about 55% of the time. With these data, the real prevalence can be calculated[2]. For beef cattle in Kentucky the estimated real prevalence is .68%. Likewise, the estimated real prevalence for dairy cattle is 6.23%.

The calculated real prevalences are lower than those reported for other states, which range from 1.9 percent to 18.7 percent and average between seven and eight percent (Collins, et al.; Whipple). This fact, when combined with the possibility that the methodology used to provide the samples tested in Kentucky may underestimate the true prevalence of the disease, may lead one to believe that if the prevalence estimate is inaccurate, it is too low. As a result, the sensitivity of the results of the analysis to the prevalence estimate was evaluated and is discussed in the results section.

Obviously, the number of cattle in Kentucky is a key element in the analysis. The relevant data, collected by the Kentucky Agricultural Statistics Service are shown in the following table:

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[2] Various formulae are used to calculate the "real prevalence" from sample results and test false positive and negative parameters. Three cited in various scientific articles produce the same results.

Table 1. Cattle and Related Data Used in the Analysis

Cattle Inventory in Kentucky   (as of January 1, 1994)

Beef Cows	1,145,000
Dairy Cows	175,000
Beef Cow Replacement Heifers	205,000
Dairy Cow Replacement Heifers	70,000

Milk Production and Prices (1993 averages)

Average Milk Production	11,844 pounds/cow/year
Average Milk Price Received	$.134 per pound

(Source: Kentucky Agricultural Statistics Service)

The loss in milk production from Johne's disease, according to studies reported by Whipple, varies considerably from study to study. One reason for the variation may be the difficulty in measuring the impact on milk production; another is related to disease onset and the different impacts in the subclinical and clinical stages of the disease. Reductions in milk production between 7.8% and 16% have been reported; this study assumes a reduction of 12% in one lactation, after which the cows are either sold or die.

The point of onset of Johne's disease is not documented in the literature. If a first calf/lactation heifer is infected the economic impact is greater than if a cow is infected in the last stage of her productivity. The working assumption used was a disease onset in the mid-life of the cow's production. Based on published data and conversations with animal production scientists, the assumption of a four-lactation production life was used for the average dairy cow in Kentucky. Beef cows were assumed to have a six-calf average productive life.

Based on these assumptions, production scenarios were developed. For dairy cows, a healthy cow was assumed to produce at the state average milk level (11,844 pounds per lactation) for four years and then be sold at 1,200 pounds of body weight. An infected cow was assumed to have two full lactations, a third lactation with a 12% lower production and then be sold weighing 1,000 pounds. Ten percent of the infected cows were assumed to die after the reduced lactation, with no cull value. Returns over variable costs were based on the publication "Livestock Budget Estimates for Kentucky - 1993," adjusted for milk production (appendix 2). The returns data in the budget estimates were compared with data from farms in the Kentucky Farm Business Analysis program. This comparison indicated that the budget estimates were consistent with actual farmer practices. Cull cows were priced at $45 per cwt. for the healthy cows, $42 for the infected cows. (Paratuberculosis does not affect the meat, nor has it been found to be carried in the meat of infected cattle. For this reason, infected cattle may be sold for slaughter with no known health effects. Infected cattle receive lower prices, however, because they are typically thinner when sold.)

Similarly, production scenarios were developed for beef cows. A healthy cow was assumed to produce six calves, averaging $80 per year returns over variable costs (also based on the "Livestock Budgets...", appendix 2). She was then sold weighing 1,000 pounds at $45 per cwt. An infected beef cow was assumed to produce four calves, with the fourth weighing 25 pounds less than normal because of the mother's lower milk production. Ten percent of the infected cows were assumed to die; the remainder were assumed to be sold weighing 800 pounds for $42 per cwt.

For the "market value" method, average prices for July, 1994 are used. For dairy cows, that is $950 per head and for beef cows that is $600 per head. The same cull cow values are used as in the other parts of the study.

Results and Conclusions

The net present value approach yielded an economic loss figure of $6 million, while the Market Value approach estimate of loss is $5.7 million. (There is about a 5% difference is the results from the two approaches.) The present value approach results are summarized in Table 2, and the market value approach results are summarized in Table 3. (Appendix 1 shows the calculations used to derive the net present value results.)

Table 2. Summary of Results Using the Net Present Value Approach

$3,609,610	Loss of income and cull value of infected dairy cows which are culled
923,269	Loss of income and cow value of infected dairy cows which die
1,075,324	Loss of income and cull value of infected beef cows which are culled
344,227	Loss of income and cow value of beef cows which die
$5,952,430	TOTAL

Table 3. Summary of Results Using the Market Value Approach.

$2,076,398	Loss of milk revenue (at 12%)
1,035,738	Mkt value of dairy cows that die
1,177,470	Reduced cull value of infected dairy cows
132,362	Loss of beef calf revenue
467,160	Mkt value of beef cows that die (10% of those infected)
798,844	Reduced cull value of infected beef cows
$5,687,972	TOTAL

One reason for the difference in the two approaches is that markets may undervalue the types of livestock lost. In other words, the reported market prices may be for animals which are inferior to the ones lost. Alternatively, the net present value approach may over estimate the value of the cows, perhaps because less productivity is given up to the disease (its onset may occur later than assumed in the analysis, for example).

The direct cost to dairy and beef cattle operations, based on the assumptions used in this analysis, is about $6 million per year. This is an annual loss in capital value and income, not revenue. For example, if a cow dies on a dairy operation, the owner loses the value of the milk which she would have produced but also the value of the cow. The owner would not lose other revenue unless the he/she had planned on selling the cow. It is even possible that short term revenue would increase if the disease resulted in increased culling without offsetting purchases of replacement stock.

Given the importance of the assumptions on which this analysis is based, a sensitivity analysis was conducted. If the age of onset is later or earlier than assumed in this analysis, the economic costs calculated by the net present value approach will decrease or increase by 25% to 30%. This suggests that the age of onset is a critical variable. Another important assumption was the level of prevalence of the disease. The relationship of economic costs to this parameter is linear. In other words, if the actual level of prevalence of the disease is 25% higher than believed, the economic costs would be 25% higher.

To put the results of this study in perspective, one may consider the income and capital values of the dairy and beef industries. Since the losses measured are primarily capital losses, the relationship to asset value should be considered. If a beef cow is assumed to be worth $600, the loss for beef operations would be less than 1% (.4%) of cow value. For dairies (with the average cow valued at $950), the loss would equal about 2.9% of value. If, as assumed, the net returns over variable costs per beef cow is about $80 per cow, then the $1.4 million loss due to Johne's disease is about 3% of net revenue (about $60 per average 25 cow herd). Similarly, for a net returns of $198 per dairy cow, the $4.5 million dairy impact of the disease would be about 14% of revenue (or $1,600 per 55 cow dairy herd).

Because little is known about some of the on-farm aspects of the disease (such as age of onset), and because of the large variability of costs and performance on both dairy and beef cattle operations, this analysis is very dependent on its assumptions. This was one reason to use two different methodologies which use different assumptions. The similarity of results adds confidence to this study's conclusions, but should not preclude a careful examination of the underlying assumptions.

This study focused on the costs directly affecting commercial beef and dairy operations in Kentucky. The impacts on the purebred industry have not been evaluated, nor have other costs, such as veterinary costs or testing costs.

This analysis suggests that the loss to the Kentucky beef and dairy cattle industries due to paratuberculosis, while in the neighborhood of $6 million per year, is not extremely large relative to the size of these industries. The impact is much more serious for the dairy industry than for the beef industry. If the disease becomes more prevalent, it could have serious consequences. Programs to eradicate or ameliorate the disease will have to be evaluated carefully with regard to their likelihood of success as well as their costs.

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