ECONOMIC IMPACT OF ALTERNATIVE JOHNE'S DISEASE CONTROL STRATEGIES: A SIMULATION APPROACH

K.D. Walker, Market Research Division, Farmland Industries, Kansas City, Missouri 64118. J.B. Kliebenstein, Department of Agricultural Economics, University of Missouri, Columbia, Missouri 65211. C. Thomas, School of Veterinary Medicine, University of Wisconsin, Madison, Wisconsin 53706.

SUMMARY Johne's disease can have a negative impact on producer profit. Prevalence rates are important in determining the level of impact. For low prevalence rates profit impacts are negliable. Costs of controlling the disease are on par with losses which are disease related. As the prevalence rate increases, profit impacts grow dramatically.

INTRODUCTION Economic analysis of animal diseases has received increased attention during the past few years. Interest in animal infection originates from at least two fronts; some animal diseases are communicable to man and disease can reduce production efficiency of the infected animals. Reduced production efficiency can lead to reduced profit levels for the producer and increased food costs to the consumer.

Animal diseases are many and varied. They range from those which are very virulent, contagious and fast spreading to those which have long latency periods, low level of contagiousness and spread very slowly. Most economic analyses of animal infections have centered on contagious diseases which can have catastrophic and devastating effects such as foot-and-mouth disease (Power and Harris, McCauley et al.) and swine fever (McCauley and Sundquist). Further, economic analysis was rather straight forward where losses associated with a disease outbreak highly outweighed their control costs. Recently other less dramatic diseases have proven to be more troublesome to control than first anticipated. Information for these diseases is limited. Types of control methods and associated benefits and costs of controlling or eradicating the infection are limited. Moreover, many producers may not be aware of the disease presence within the herd and its adverse effect on herd performance.

Paratuberculosis or Johne's disease is one such troublesome infection that has received increased attention. This chronic, debilitating infection can occur in both domestic and wild ruminants. The latency period can be quite long, thus exposing many other animals to the disease. Once infected an animal may live for as little as six months or as long as fifteen years. To further complicate the situation, carriers may appear healthy and not show any clinically detectable signs until shortly before death. For paratuberculosis, disease progression within the animal leads to a gradual decline in milk production, increase in feed consumption, increase in mastitis problems and increase in breeding problems leading to longer calving intervals. In essence, the herd life of infected animals is reduced. Infected cows may be eventually culled for reasons that are thought to be non-Johne's related such as low production or infertility.

The primary objective of this report presents the general outline for a Johne's disease simulation model that integrates the dynamic nature of the disease economics and epidemiology. The model focuses on the individual herd level. A brief overview of the results are presented. A dairy operation, representative of an average Wisconsin dairy, is used as a base.

MATERIALS AND METHODS Control methods for Johne's disease have taken two primary directions: vaccination and/or improved herd health management practices. Research has shown use of vaccination to be approximately 85 to 90 percent effective (Wilesmith). Usage of the vaccine does not provide absolute protection against infection nor does it imply that infection will not spread. To be effective it needs to be administered to calves before they reach 35 days of age (Wilesmith). Also, there may be a delayed hypersensitivity within the animal to other serologic

and allergic tests, including the tuberculin test. As a result, individual cow records must be maintained and prior approval from state and federal personnel need to be granted before releasing the vaecine to the veterinarian for administering. The vaccine is given subcultaneously and a vaccination nodule up to the size of a grapefruit can develop at the injection site. The nodule can develop draining tracts which alter the appearance and possibly reduce the market value of the animal.

Methods of control through improved herd health management strategies range from maintaining clean surroundings, to immediate removal of calves from dams at birth and raising calves separately, to testing animals for subclinical infection and immediate culling of those animals which test positive. Several types of Johne's tests are available and can be used (Riemann and Abbas). Of those available, fecal culture tests are felt to be the most reliable. However, this test does not provide immediate feedback as it takes from 12 to 16 weeks to culture the organism. With fecal culturing, all cows diagnosed as positive are in fact infected. There are not any false positive tests. However, a negative result implies either the animal is free of the disease or if infected none of the organisms were detected in the particular sample. An advantage of fecal culturing is that all other tests can render both false negative and false positive results. Remaining herd management strategies such as separating the calf from dam at birth, feeding of pasteurized colostrum where the calf is not allowed to nurse, and maintaining environments for heifer calves separate from the remainder of the milking herd have been discussed by numerous authors (Larsen, Moyle, Riemann and Abbas).

With Johne's disease, control inputs interact with the uncontrolled disease level, thus altering the production process over time. Impacts are felt in the first time period as well as in successive time periods. Thus, evaluation of disease management inputs in a Johne's infected herd should be conducted in a dynamic environment over several consecutive time periods.

In dairy operations performance measures of individual cows include milk production per year, length of time between calving and feed requirements per unit of output. Subclinical Johne's acts to adversely affect these three measures. Abbas et al., and Buergelt and Duncan report milk production levels 8 to 15 percent lower for Johne's infected over noninfected cows. Based on fecal culture test results, Abbas et al., found that the calving interval for infected cows was 15.2 months compared to 13.5 months for noninfected cows. It is also felt by those knowledgeable with Johne's that feed requirements are greater for infected animals, as these animals consume more feed to compensate for reduced nutrient absorption ability. Discussions with veterinarians and others familiar with Johne's gave estimates between 5 and 25 percent above noninfected cows.

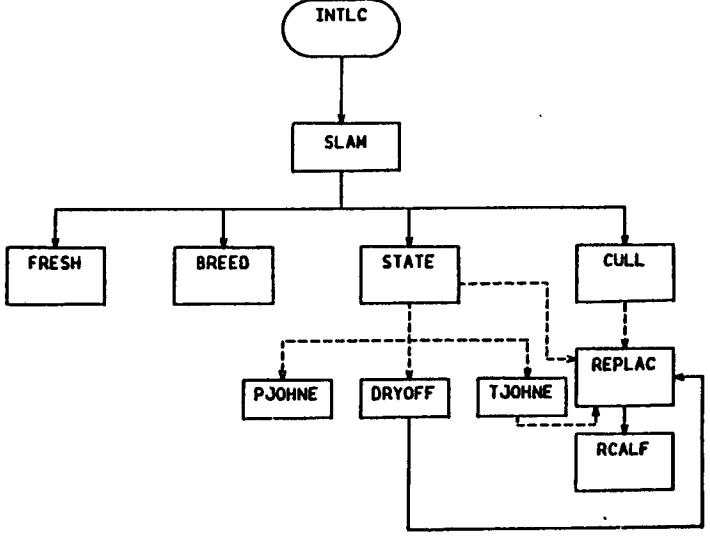

Figure 1: Overview of Simulation Model

To model Johne's disease a special purpose language, SLAM II, is used. An overview of the model is presented in Figure 1. Subroutine INTLC initializes variables which passes control to SLAM which increments time and initiates calls to the appropriate subroutines. FRESH denotes freshening of the cow and birth of the calf. BREED represents breeding. Milk production and feeding occur in STATE. Dotted lines represent calls which can be made by one subroutine to another as conditions change. Johne's disease is modeled in subroutines PJOHNE and TJOHNE. DRYOFF is called if the cow is ready to be dried off and CULL is

called to determine if the cow should be removed from the milking herd. Replacement stock enters the milking herd through the subroutines REPLAC and RCALF. The model is a combination discrete-continuous simulation.

RESULTS Discounted returns to labor and management declines as the initial Johne's disease prevalence rate increases. For six percent prevalence, if not specific disease control practice is implement, the decline in computed returns is small, less than $40 per year. However, if the prevalence increases to 12 percent, returns fall by about $1,800 per year. At 28 percent prevalence, returns fall by over $4,000 per year.

A breakdown of the returns into revenues and costs shows the major disease impact is revenue related. Revenue declines are largely a result of decreased milk production. Infection causes cows to be culled before reaching their peak lactation. On the cost side, the effects of a younger herd due to disease and an older herd from no disease tend to be off-setting. Cows infected with Johne's disease consume more feed resulting in higher herd consumption levels. However, noninfected herds are usually composed of older and higher producing cows which have higher levels of feed usage as well.

Results generated show that Johne's disease can reduce returns to labor and management and adversely affect herd performance. This is especially true if initial prevalence rate is above six percent. While the disease affects both the revenue and cost side, its major impact appears to be on the revenue side through decreased milk production. Management control practices which employ a semi-annual culture testing program are the most effective measures in minimizing the number of animals with the disease. Further, such practices are always able to eliminate the infection from the herd. However, while these practices do reduce the levels of disease occurrence and thus risk of further infection, they do not necessarily lead to the highest returns. Other practices such as vaccination can lead to higher returns over time. Such measures are generally not as effective in reducing disease occurrence. In short, when deciding which management practice is preferred, trade-offs between the levels of risk and returns of each practice must be considered. If disease is present, opting for no disease control inputs can lead to wide variations in income and high levels of risk.

REFERENCES (1) Abbas, B., H.P. Riemann and D.W. Hird. "Diagnosis of Johne's Disease (Paratuberculosis) in North California Cattle and a Note on its Economic Significance." Calif. Vet. 8(1983): 20-24. (2) Buergelt, C.D. and J.R. Duncan. "Age and Milk Production Data of Cattle Culled from a Dairy Herd with Paratuberculosis." J. Amer. Vet. Med. Assoc. 173(1978): 478-80. (3) Larsen, A.B., A.I. Moyle and E.M. Himes. "Experimental Vaccination of Cattle Against Paratuberculosis (Johne's Disease) with Killed Bacterial Vaccines: A Controlled Field Study." Amer. J. Vet. Res. 39(1978): 65-69. (4) McCauley, E.H. and S.W. Sundquist. Potential Economic Consequences of African Swine Fever and Its Control in the United States. Institute of Agricultural and Applied Economics, Univ. of Minnesota, 1974. (5) McCauley, E.H., N.A. Aulaqi, J.C. New, W.B. Sundquist and W.M. Miller. Potential Economic Impact of Foot and Mouth Disease in the United States. Conducted by the University of Minnesota under a cooperative agreement with the Animal and Plant Health Inspection Service, USDA, 1979. (6) Moyle, A.I. "Culture and Cull Procedure for Control of Paratuberculosis." J. Amer. Vet. Med. Assoc. 166(1975): 689-90. (7) Power, A.P. and S.A. Harris. "A Cost-Benefit Evaluation of Alternative Control Policies for Foot-and-Mouth Disease in Great Britain." J. Agr. Econ. (1973): 573-600. (8) Riemann, H.P. and B. Abbas. "Diagnosis and Control of Bovine Paratuberculosis (Johne's Disease)." Adv. Vet. Sci. Comp. Med. 27(1983): 481-506. (9) Wilesmith, T.W. "Johne's Disease: A Retrospective Study of Vaccinated Herds in Great Britain." Br. Vet. J. 138(1982): 321-31.