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The National Animal Health Monitoring System in Michigan. III. Cost Estimates of Selected Dairy Cattle Diseases

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ABSTRACT

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A study was conducted to estimate costs of major dairy cattle diseases. Sixty ($n=60$) of the 6012 dairy herds in Michigan were stratified and selected randomly for participation in the National Animal Health Monitoring System in Michigan. Government and university veterinarians visited each herd once a month for a total period of 12 months. At each visit data on diseases, production, management, finance, treatments, preventive activities, animal events, and any other relevant events were collected.

Monthly and annual cost estimates of disease treatments were computed in each herd and stratum. Similarly, monthly and annual estimated preventive costs were estimated. Results were expressed as cost per head and given separately for cows, young stock, and calves. In cows, the most expensive seven disease entities (from most to least) were: (1) clinical mastitis; (2) breeding problems; (3) gastrointestinal problems; (4) birth problems; (5) multiple system problems; (6) lameness; (7) metabolic/nutritional diseases. In terms of estimated annual preventive cost, however, the ranking of the seven disease entities were (from highest to lowest): (1) mastitis; (2) breeding problems; (3) lameness; (4) birth problems; (5) multiple system problems; (6) gastrointestinal disease; (7) metabolic/nutritional problems.

In young stock, the most costly diseases were the multiple system problems, breeding problems, respiratory disease, birth problems, gastrointestinal disease, and lameness. In calves, the most costly disease problems were gastrointestinal problems, respiratory diseases, multiple system problems, birth problems, metabolic diseases, and lameness. Methodological issues, as they relate to data collection and estimation of costs as well as suggestions for improving the accuracy of these estimates, are discussed.

INTRODUCTION

In the first paper of this series, the National Animal Health Monitoring System (NAHMS) in Michigan was described (Kaneene and Hurd, 1990) in relation to the design of the project, data collection and observed frequencies

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of dairy cattle disease. In the second part of the series (Hurd and Kaneene, 1990), methodological issues in the estimation of frequencies of diseases in a prospective study of multiple dynamic populations were discussed. In the present paper, cost estimates of dairy cattle disease observed in a 12-month period will be discussed.

Interest in the economic effects of diseases and the related control/prevention activities has been increasing in the last 15 years. Many studies have focused on the economic effect of one disease entity. These have included mastitis (Janzen, 1970; Pilchard, 1972; Natzke, 1976; Dobbins, 1977; Blosser, 1979; Fetrow, 1980; Fetrow and Anderson, 1987; Kirk and Bartlett, 1988) and reproductive problems (Spiecher and Meadows, 1967; Louca and Legates, 1968; Pelissier, 1972; Esslemont, 1974; James and Esslemont, 1979; Olds et al., 1979; Holmann et al., 1984; Dijkhuizen and Renkema, 1985; Dijkhuizen et al., 1985; Bartlett et al., 1986a,b,c; Slenning, 1986; Marsh et al., 1987). Some studies have reported on the economics of a disease caused by a single agent (Goodger and Skirrow, 1986; Hallum et al., 1986; Kliebenstein et al., 1986). Only limited reports on economics of disease control and prevention have been found in the literature (Grunsell et al., 1969; Morris, 1971; Barfoot et al., 1971; James and Ellis, 1979; Goodger and Kushman, 1984–85; Alderink, 1986; Ellis, 1986; Hallum et al., 1986; Alderink and Kaneene, 1988).

The literature, however, is virtually devoid of reports where costs of production diseases (non-regulatory) were estimated using data from an active surveillance program such as the NAHMS. The objective of this paper, therefore, was to report on cost estimates of production diseases. Specific aims of the paper were to: (1) describe the methods used in estimating costs of diseases; (2) critically evaluate the results in relation to the data and methods used in the cost estimates; (3) offer some suggestions for improving the accuracy of the cost estimates.

MATERIALS AND METHODS

Design, data collection and data quality control techniques

The design, coordination, data collection, and data quality control techniques used were described in the first paper of this series (Kaneene and Hurd, 1990). Briefly, 60 dairy cattle herds were selected randomly to participate in the program. Veterinary medical officers (VMOs; veterinarians from the university, and state and federal departments of agriculture) visited the herds once a month and collected data for a period of 12 months. The top portions of the form used to collect preventive measure costs (Fig. 1) and of that used to collect other disease-related costs (Fig. 2) are shown.

4. Preventive measures (report drugs used to treat sick cattle on FORM 3 only, not on FORM 2)

I		II		III	IV			V	
Disease or condition prevented	Leave blank for code	Vaccine drug, or procedure	Leave blank for code	Purchase cost	Number of Head	A - Calves B - Young stk. C - Cow D - Bull	Hours of Labor	Hours x $/hr	Cost of Veterinary Service
				$				$ hrs	$
				$				$ hrs	$
				$				$ hrs	$

Fig. 1. Top of form used to record costs associated with preventive measures.

NAHMS V.M.O. Worksheet for Producer 22: :20:

Date Entered: __/__/__
Report Month: _____ __

V.M.O. 0

MAST - Mastitis METR - Metritis RESP - Respiratory Problems
LAME - Lameness RETP - Retained Placenta * Includes costs of culling & carcass removal

Cow ID	Calving Date	No. Born Live	No. Born Dead	Times Bred at Dryoff	Cull Reason	Diseases and/or Conditions: Last Month (N - New Case, D - Died, S - Still Sick, C - Culled, R - Recovered)			MAST 1	METR 2	RESP 3	LAME 4	RETP 5	6	7	8	9	10	Wt. Loss (lbs)	Vet Cost ($)	Drug Cost ($)	Cow/ Calf Loss *($)	Labor Hrs.	Milk Loss (lbs)	Drugs Used

Fig. 2. Top of VMO worksheet used to record animal events and associated costs.

Estimation of monthly cost of a disease in a herd

We assume that the disease in question was X in a herd i, stratum j for the month m. The monthly total cost $TC(X)_{ijm}$ was then estimated using eqn. (1):

$$TC(X)_{ijm} = \begin{array}{l}\text{drug}(X) + \text{vet}(X) + \text{labor}(X) + \text{cull}(X) + \text{dead}(X) \\ + \text{dead calf}(X) + \text{milk loss}(X) + \text{preventive}(X)\end{array} \quad (1)$$

where

drug(X) = drug cost of disease (X) treatment

vet(X) = veterinary expenses for disease (X) treatment

labor(X) = hours spent treating the disease (X) multiplied by a standard wage of \$5.50 (Nott et al., 1986)

cull(X) = net cull costs for disease (X), where net cull cost = replacement value − net salvage value
where
replacement value = replacement cost for an animal of same age and genetic potential
net salvage value = salvage price − transportation and any other related expenses

dead(X) = replacement cost (as defined under "cull") + disposal fees

dead calf(X) = value (as reported by producers) of calves born dead due to the disease (X) in the dam (this figure did not include calves that were affected with the disease and died; these figures were reported separately)

milk loss(X) = (lb loss × price per month) − (lb loss × % fed to calves) × (replacer price)

preventive(X) = monthly cost for preventing disease (X); computed as annual total for each herd then divided by number of months to give a monthly cost.

Estimation of weighted mean monthly cost of a disease per head at risk

This estimate was computed in two steps. The first step was to determine the cost of a disease per head, for 1 month, in a given herd using eqn. (2). This included preventive and treatment costs.

$$C_{ijm} = \frac{TC(X)_{ijm}}{\left[\dfrac{\text{no. of animals at risk at end of previous month} + \text{no. of animals at risk at end of this month}}{2}\right]} \quad (2)$$

where

$TC(X)_{ijm}$ = the new dollars incurred from incident and prevalent cases

C_{ijm} = cost per head in the ith herd in the jth stratum for the mth month
"at risk" = all animals of the specific age group − non-recovered cases from the previous month

The next step was to use the values estimated in eqn. (2) and estimate a weighted monthly mean cost of a disease per head using eqn. (3):

$$\bar{C}_{jm} = \frac{\sum_{i=1}^{n} (C_{ijm} \cdot m_{ijm})}{\sum_{i=1}^{n} m_{ijm}} \tag{3}$$

where
m_{ijm} = number of animals at risk in the ith herd in the jth stratum for the mth month estimated from the denominator of eqn (2)
$i = 1$ to n, n = number of herds in the jth stratum

Annual disease costs for a given disease

This figure was the sum of all the monthly means and was expressed on a per-head basis.

$$\text{Annual costs} = \sum_{m=1}^{12} \bar{C}_{jm} \tag{4}$$

Annual preventive costs

The annual costs of preventing disease (X) were computed for each herd by taking the total expenditures for 1-year preventive measures. This includes activities such as dry treatment, vaccination, and associated labor.

RESULTS

The disease problems were grouped for the expression and comparison of results, and these groupings are presented in Table 1. The estimated annual costs of disease in cows (lactating and dry females older than young stock), calves (male or female animals from birth to weaning off liquid ration), and young stock [male or female animals from weaning to first calving (females) or first use for breeding purposes (males)] are presented in Tables 2, 3 and 4 respectively. Similarly, the estimated annual costs of prevention in the three groups are presented in Tables 5–7.

TABLE 1

Disease groupings used in the NAHMS in Michigan; Round 1, 1986-87

Group name	Composition
Gastrointestinal (GI)	Bloat, coccidiosis, constipation, displaced abomasum, diarrhea, enteritis, enterotoxemia, hardware, indigestion, intestinal obstruction, intestinal hemorrhage, intestinal infections, pneumoenteritis, polyphagia, ulcers, actinomycosis
Respiratory (Resp)	Pneumonia, respiratory problems NOS[a]
Lameness	Lameness, footrot, corns
Metabolic/nutritional (MetaNutr)	Acidosis, downer cow syndrome, ketosis, low magnesium, milk fever, nutritional deficiency, overweight, polyphagia, selenium deficiency, vitamin E deficiency, white muscle disease
Mastitis	Clinical mastitis, septic mastitis, toxic mastitis
Breeding problems (Breed)	Anestrus, cystic ovaries, follicular cysts, false pregnancy, metritis, pyometria, repeat breeder, reproductive problems NOS, vaginitis
Birth problems (Birth)	Abortion, dystocia, prolapsed uterus, retained placenta, uterine torsion, vaginal tears
Multiple system (Multi)	Abscesses, accidents, agalactia, allergies, encephalitis, fever, infections NOS, injuries NOS, handling injuries, tail injuries, lethargy, no milk letdown, malignant lymphoma, navel ill, neonatal death NOS, neoplasm, disease NOS, off feed, peritonitis, poisoning, poor condition, umbilical hernia, weakness, weight loss
Integumental (Integ)	External parasites, fungal skin infections, hematomae, mycotic dermatitis
Urogenital system (UroGen)	Nephritis, Urinary tract infections NOS

[a]NOS, not otherwise specified.

DISCUSSION

Cost, defined as a measure of an amount of value released in the acquisition or creation of economic resources in production (Hepp, 1985), is made up of two components: the cost measured in terms of money spent, and the lost potential. At present, NAHMS data include only estimates of dollars spent.

Cost computation

The denominator of eqn. (2) represents the average number of animals at risk of disease during a month. This is in contrast to most economic reports that calculate the mean cost per case of disease. The cost-per-head figures reported in this paper represent the mean cost per case plus the mean risk of disease occurrence. This figure is valuable as it conveys the expected proba-

TABLE 2

Total cost (in U.S. dollars) of disease per cow per year (including cost of prevention)

Disease group	Herd size strata				Overall
	Stratum 1	Stratum 2	Stratum 3	Stratum 4	
Mastitis	38.22 (0.00-124.60)[a]	39.29 (5.65-68.19)	28.72 (1.77-154.85)	35.73 (5.29-54.94)	35.54 (0.00-154.85)
Breed	24.98 (0.00-66.13)	26.46 (4.02-61.66)	21.25 (2.30-31.67)	24.70 (0.97-33.72)	24.46 (0.00-66.13)
GI	23.23 (0.00-36.70)	6.28 (0.00-18.35)	8.09 (0.43-19.57)	13.40 (0.02-24.58)	11.13 (0.00-36.70)
Birth	10.29 (0.00-43.66)	14.92 (0.07-42.53)	1.75 (0.00-13.55)	9.89 (1.72-14.76)	9.60 (0.00-43.66)
Multi	14.55 (0.00-67.83)	7.72 (0.00-30.78)	4.46 (0.28-26.39)	8.09 (0.20-19.82)	8.01 (0.00-67.83)
Lameness	9.00 (0.00-18.22)	9.79 (0.00-30.88)	0.10 (0.00-18.41)	8.18 (0.00-14.45)	6.81 (0.00-30.88)
MetaNutr	8.27 (0.00-19.57)	6.82 (0.00-21.38)	3.12 (0.30-26.64)	6.53 (1.49-10.75)	6.03 (0.00-26.64)
Resp	2.36 (0.00-24.03)	1.65 (0.00-7.42)	10.45 (0.00-4.12)	1.56 (0.16-4.57)	3.95 (0.00-24.03)
UroGen	6.89 (0.00-38.41)	3.94 (0.00-13.12)	0.04 (0.00-48.36)	1.65 (0.005-3.97)	2.80 (0.00-48.36)

[a]Minimum and maximum values.

bility of disease occurrence and the expected cost from incident and prevalent cases.

Specific comments on various data sets that were used in cost estimations and the results

Drug and veterinary costs

These data sets were fairly accurate, as they were substantiated (for the most part) by invoices from the producer's veterinarian and/or supplier. In the future, efforts should be made to differentiate between drugs administered under the supervision of a veterinarian and those administered strictly at the discretion of the producer.

Labor data sets

There were many omissions of these data by the producer. Efforts should be directed toward educating the producers to record the time spent on various aspects of their operations. The time spent performing a task should be the preferred record instead of monetary figures, as labor wages fluctuate. The time spent then can be converted into monetary terms using an accepted labor wage factor.

TABLE 3

Total cost (in U.S. dollars) of disease per calf per year (including cost of prevention)

Disease group	Herd size strata				Overall
	Stratum 1	Stratum 2	Stratum 3	Stratum 4	
GI	24.92 (0.00-100.00)[a]	38.32 (0.00-261.53)	8.09 (0.00-150.00)	74.60 (18.01-345.92)	33.46 (0.00-345.92)
Resp	17.41 (0.00-117.00)	10.64 (0.00-119.16)	10.45 (0.00-114.86)	26.67 (0.00-36.71)	14.71 (0.00-119.16)
Multi	29.11 (0.00-236.22)	13.99 (0.00-73.88)	4.46 (0.00-20.57)	3.52 (0.00-23.78)	11.15 (0.00-236.22)
Birth	5.41 (0.00-13.53)	4.18 (0.00-12.31)	1.75 (0.00-16.03)	1.52 (0.00-11.42)	3.17 (0.00-16.03)
MetaNutr	0.13 (0.00-1.84)	0.70 (0.00-4.08)	0.08 (0.00-0.60)	6.05 (0.00-26.46)	1.39 (0.00-26.46)
Lameness	0.00	0.02 (0.00-0.17)	0.10 (0.00-1.14)	0.08 (0.00-0.44)	0.05 (0.00-1.14)
Urogen	0.00	0.04 (0.00-0.93)	0.04 (0.00-0.27)	0.00	0.01 (0.00-0.93)

[a]Minimum and maximum values.

TABLE 4

Total cost (in U.S. dollars) of disease per young stock per year (including cost of prevention)

Disease group	Herd size strata				Overall
	Stratum 1	Stratum 2	Stratum 3	Stratum 4	
Multi	5.91 (0.00-24.45)[a]	3.33 (0.00-41.40)	0.93 (0.00-11.25)	4.49 (0.00-14.52)	3.45 (0.00-41.40)
Breed	1.88 (0.00-20.84)	1.07 (0.00-3.86)	2.02 (0.00-5.03)	4.78 (0.00-11.90)	2.41 (0.00-20.84)
Resp	1.21 (0.00-4.69)	0.90 (0.00-4.94)	1.65 (0.00-3.35)	3.98 (0.70-9.25)	1.95 (0.00-9.25)
Birth	1.41 (0.00-5.56)	1.20 (0.00-2.73)	1.10 (0.00-19.06)	2.07 (0.24-5.73)	1.44 (0.00-19.06)
GI	1.21 (0.00-16.46)	0.65 (0.00-8.48)	1.14 (0.00-4.15)	0.17 (0.00-0.78)	0.71 (0.00-16.46)
Lameness	0.31 (0.00-3.21)	0.05 (0.00-0.64)	0.03 (0.00-0.14)	0.02 (0.00-0.04)	0.08 (0.00-3.21)
MetaNutr	0.01 (0.00-0.18)	0.03 (0.00-0.45)	0.02 (0.00-1.68)	0.00	0.02 (0.00-1.68)
Mastitis	0.01 (0.00-00.23)	0.03 (0.00-0.45)	>0.00 (0.00-0.02)	0.00	0.01 (0.00-0.45)

[a]Minimum and maximum values.

TABLE 5

Annual cost of preventive measures of the top 10 disease problems of cows (expressed as mean U.S. dollars per cow)

Disease group	Herd size strata				Overall
	10-49	50-99	100-199	⩾200	
Mastitis	2.45 (0.00-13.04)[a]	6.50 (0.99-28.13)	3.31 (0.19-8.70)	4.45 (1.34-6.79)	4.56 (0.00-28.13)
Breed	3.11 (0.00-15.84)	4.36 (0.00-12.86)	3.70 (0.43-6.53)	3.97 (0.00-5.92)	3.91 (0.00-15.84)
Lameness	1.38 (0.00-12.20)	1.45 (0.00-6.32)	0.64 90.00-3.81)	4.37 (0.00-10.56)	2.00 (0.00-12.20)
Birth	0.47 (0.00-6.69)	1.36 (0.00-16.86)	0.28 (0.00-1.38)	0.30 (0.00-0.71)	0.68 (0.00-16.86)
Multi	0.17 (0.00-2.79)	0.17 (0.00-1.08)	1.10 (0.00-9.91)	0.13 (0.00-0.55)	0.39 (0.00-9.91)
GI	0.43 (0.00-5.78)	0.22 (0.00-1.24)	0.15 (0.00-0.84)	0.75 (0.00-1.40)	0.38 (0.00-5.78)
MetaNutr	0.44 (0.00-2.81)	0.43 (0.00-5.88)	0.11 (0.00-0.44)	0.49 (0.00-1.85)	0.37 (0.00-5.88)
Resp	0.35 (0.00-4.45)	0.32 (0.00-1.47)	0.42 (0.00-2.61)	0.36 (0.16-1.00)	0.36 (0.00-4.45)
Integ	0.26 (0.00-2.33)	0.50 (0.00-6.32)	0.00	0.00	0.21 (0.00-6.32)
UroGen	0.14 (0.00-1.12)	0.00	0.00	0.00	0.02 (0.00-1.12)

[a]Minimum and maximum values.

Cull and death data sets

The figures used for the replacement value of an animal were those as given by the producer. These figures were assumed to be fairly accurate as the producer would know the genetic potential of the animal and current market price. It was difficult, however, to assess the accuracy of these figures. An alternative way of collecting these data has been suggested, which would involve collecting information about the animal and then using accepted standards to estimate a replacement value for the animal in question. Another problem associated with computing net cull cost was the fact that it was not possible to adjust the net cull cost to include the probability that the animal would have been culled soon regardless of her disease status. In other words, a cow may have had other problems which, when combined with disease, resulted in a culling decision. It may not be reasonable to charge the entire cost of culling to disease *X*. Further reports should focus on methods for addressing this issue.

Dead calves data sets

The figures used for the study were those given by the producer. This can

TABLE 6

Annual cost of preventive measures of the top eight disease problems of calves (expressed as mean U.S. dollars per calf)

Disease group	Herd size strata				Overall
	10-49	50-99	100-199	⩽200	
GI	0.96 (0.00-4.95)[a]	3.67 (0.00-23.37)	1.85 (0.00-27.03)	5.29 (0.00-28.04)	2.94 (0.00-28.04)
Birth	1.84 (0.00-8.73)	2.70 (0.00-10.65)	1.04 (0.00-2.74)	1.47 (0.00-8.36)	1.82 (0.00-10.65)
Resp	1.13 (0.00-10.69)	0.07 (0.00-2.53)	2.23 (0.00-9.14)	4.08 (0.00-11.40)	1.64 (0.00-11.40)
MetaNutr	0.04 (0.00-0.67)	0.37 (0.00-4.08)	0.08 (0.00-0.60)	5.34 (0.00-19.16)	1.14 (0.00-19.16)
Multi	0.55 (0.00-12.97)	0.56 (0.00-10.80)	1.69 (0.00-6.93)	0.09 (0.00-0.39)	0.82 (0.00-12.97)
Integ	0.00	0.09 (0.00-1.39)	0.00	0.02 (0.00-0.08)	0.03 (0.00-1.39)
Lameness	0.00	0.00	0.07 (0.00-0.40)	0.00	0.02 (0.00-0.40)
UroGen	0.00	0.04 (0.00-0.93)	0.00	0.00	0.01 (0.00-0.93)

[a]Minimum and maximum values.

cause problems, as seen in Table 2 for gastrointestinal disease in calves in stratum 4. For reasons mentioned under "Cull and death data", the use of a standard value for calves sold at less than 7 days of age has been suggested as an alternative.

Milk loss

In these results, the milk loss estimated was that discarded because of treatment. In some limited instances, it also included milk production lost because of an acute disease. In such cases, the loss was the producer's estimate of the difference between what the cow was producing before and during the illness.

These estimates of milk loss must be evaluated very cautiously. First, all discarded milk should not be assumed to be a loss. This is because some milk is fed to calves, in which case some money (approximately $7.00 per cwt; price of reconstituted milk replacer based on a sample of four Michigan feed suppliers, October 1987) would be saved in buying milk replacers. To correct for this discrepancy, the estimates were adjusted to account for the discarded milk fed to calves. The producers reported the percentage of discard milk fed to calves. Second, subclinical effects of disease on milk production could not be estimated with data from the conventional NAHMS data-collection procedures where identifications for individual cows are not available. Also, a decrease in milk production will cause a decrease in feed intake with a corre-

TABLE 7

Annual cost of preventive measures of the top eight disease problems of young stock (expressed as mean U.S. dollars per animal)

Disease group	Herd size strata				Overall
	10-49	50-99	100-199	⩾200	
Birth	0.90	1.20	0.48	0.68	0.86
	(0.00-5.56)[a]	(0.00-2.73)	(0.25-1.17)	(0.00-1.13)	(0.00-5.56)
GI	0.31	0.53	0.33	0.20	0.36
	(0.00-1.68)	(0.00-3.40)	(0.00-1.40)	(0.00-0.78)	(0.00-3.40)
Resp	0.37	0.24	0.30	0.22	0.27
	(0.00-2.82)	(0.00-0.92)	(0.00-2.25)	(0.00-0.75)	(0.00-2.82)
Multi	0.21	0.41	0.35	0.00	0.26
	(0.00-1.42)	(0.00-2.75)	(0.00-2.21)		(0.00-2.75)
Breed	0.24	0.24	0.10	0.10	0.17
	(0.00-2.46)	(0.00-1.37)	(0.00-0.97)	(0.00-0.38)	(0.00-2.46)
Integ	0.01	0.13	0.00	<0.01	0.05
	(0.00-0.25)	(0.00-1.10)		(0.00-0.02)	(0.00-1.10)
Lameness	0.12	0.00	0.00	0.01	0.02
	(0.00-2.42)			(0.00-0.04)	(0.00-2.42)
Mastitis	0.01	0.03	0.00	0.00	0.01
	(0.00-0.23)	(0.00-0.45)			(0.00-0.45)

[a]Minimum and maximum values.

sponding decrease in cost (savings). Further studies are being conducted to improve these estimates in the NAHMS in Michigan where identifications for individual cows were used and, in herds which were in the Dairy Herd Improvement Association (DHIA), 25% of the sample.

Preventive costs

It is felt that these estimates were underestimated. There was great difficulty in recording bulk purchases and it was not always possible for the VMO to know whether individual doses of drugs recorded in the current month might have been recorded as a bulk purchase in a previous month. Bulk purchases may not have been recorded as the VMO was anticipating collection of those costs at time of administration to the animal.

Another problem in the preventive data relates to which disease should be charged for a certain preventive measure. In the case of a multivalent vaccine against infectious bovine rhinotracheitis, bovine viral diarrhea, and five strains of leptospirosis, it was difficult to determine which disease was being prevented. Thus, the cost to vaccinate against one of these diseases was estimated as the total cost of the vaccine divided by the number of disease entities, or else the cost was attributed to the syndrome the producer was concerned about preventing. The merit of this approach may be questionable, and some standardized procedure should be agreed upon.

Specific comments on the results

Because of the grouping of disease problems used, the dollar values in this paper may not be directly comparable with those in other reports in the literature (even if values from those reports were adjusted to current monetary values). This observation illustrates our feeling that reports on cost estimates of disease should emphasize the study design, precise description of the data sets, and the methods used in estimating these costs. Results should only be used to illustrate the effects of the methods used to compute them. At this point, it is not possible to generalize the monetary figures reported and to conclude that a given amount of money could be saved on a given farm by preventing disease (X). This is true for three reasons: (1) some disease is unpreventable and this cost never can be recovered; (2) as discussed, current cost estimations are incomplete and should be used with caution; (3) whereas application of standards may improve cost estimations for extrapolation to a reference population, use of standards or population estimates on a given farm may be fraught with hazards (Lloyd et al., 1987).

The cost estimates reported here might be called gross, short-term costs of clinical disease. They are gross because revenue-increasing effects of disease, such as the savings in feed costs because of the animal being off feed, were not included. Gross costs overestimate the true net costs of disease. The costs are considered short-term as the chronic and long-term effects of disease (e.g. those on reproductive efficiency) were not included. Even though – occasionally – some registered cattle might have been overvalued, we feel that many gross costs were underestimated or omitted. The costs reported in this paper, therefore, should be considered as the lower bound of the gross costs associated with disease occurrence and prevention.

Suggestions for improving the accuracy of cost estimates

Future efforts need to focus on methodologies for estimating costs associated with lost potential because of diseases within the NAHMS program.

To be able to estimate costs of lost potential associated with disease, it is essential to have individual identification of animals, and the NAHMS program should strive to achieve such status.

Alternative methods for estimating the value of the animal, as opposed to accepting the farmer's figures, should be explored. More rigorous quantitative methods of estimating costs associated with diseases, using data from an observational prospective study of multiple dynamic populations, such as the NAHMS, should be applied.

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