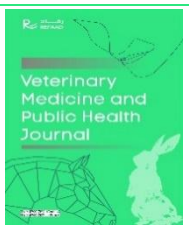
www.refaad.com

Veterinary Medicine and Public Health Journal (VMPH)

Journal Homepage: https://www.refaad.com/Journal/Index/7

E-ISSN 2707-7195 | P-ISSN 2707-7187

Vol. 7, No. 1, 2026, pp. 19 - 26



Economic Impact of Dairy Cattle Diseases in Jordan: A 2-Year Observational Study Based on A Single Intensively Managed Dairy Farm

Musab M Muhffel[1], Zuhair B Ismail[1*], Iyad Alzoubi[2]

[1] Department of Veterinary Clinical Sciences, Jordan University of Science and Technology, Irbid, Jordan.
[2] Bani Kinanah Private Veterinary Clinic, Bani Kinanah District, Irbid, Jordan.
[*] Corresponding Author: Zuhair B Ismail (zuhair72@just.edu.jo)

Original Research Article
https://doi.org/10.31559/VMPH2026.7.1.3
Received: 25 Sept 2025
Revised: 20 Oct 2025
Accepted: 9 Nov 2025

How to cite this article: Muhffel, M., B Ismail, Z., & Alzoubi, I. (2026). Economic Impact of Dairy Cattle Diseases in Jordan: A 2-Year Observational Study Based on A Single Intensively Managed Dairy Farm. *Veterinary Medicine and Public Health Journal*, 7 (1), 19-26. https://doi.org/10.31559/VMPH2026.7.1.3

Abstract:

Objectives: This study reports the economic impact of common dairy diseases in Jordan.

Methods: Data on disease diagnoses and treatments were extracted from electronic farm records of a single, large-scale, intensively managed dairy farm located over a two-year period (2015-2016). During the same period, monthly expenses were obtained and categorized into therapeutic classes, such as antibiotics, anti-inflammatory drugs, hormones, vaccines, disinfectants, and miscellaneous items. For the economic analysis, only variable costs including veterinary fees, medication costs, and estimated discarded milk due to treatment withdrawal periods were considered.

Results: Lameness, acute mastitis, endometritis, acute metritis and clinical ketosis were the most significant ($p < 0.05$) contributors to the disease burden, with prevalence rates of 25%, 20%, 18%, 15%, and 15%, respectively. The most significant ($p < 0.05$) contributors to the disease economic impact were dystocia with cesarean section (200 JOD, or 282 USD), followed by dystocia without cesarean section (160 JOD, or 225 USD), displaced abomasum (158 JOD, or 222 USD), and acute mastitis (143 JOD, or 201 USD). The average monthly farm expense was 8,088 ± 809 JOD (11,404 ± 1,140 USD), with antibiotics being the most significant ($p < 0.05$) contributor (2,862 ± 350 JOD, or 4,035 ± 493 USD), followed by vaccines (1,264 ± 150 JOD, or 1,782 ± 211 USD) and disinfectants (1,000 ± 100 JOD, or 1,410 ± 141 USD).

Conclusion: These findings highlight the significant economic burden of common diseases on this specific dairy operation and the urgent need for targeted interventions to prevent various diseases affecting dairy cattle.

Keywords: *Dairy cattle; Disease prevalence; Economic impact.*

1 Introduction

The dairy industry is a critical component of Jordan's agricultural sector (Al-Atiyat, 2014). It plays a vital role in ensuring food security and contributing to the nation's economic stability (Al-Atiyat, 2014). Unfortunately, the dairy industry faces significant challenges that hinder its growth and sustainability (Al-Atiyat, 2014; Alekish & Ismail, 2022). These include resource limitations, water scarcity, and a high burden of diseases (Al-Atiyat, 2014; Alekish & Ismail, 2022).

Dairy cows are particularly susceptible to a wide range of diseases that may severely impact farm productivity and profitability (Yilmaz, 2017; Rasmussen et al., 2024). Common conditions include gastrointestinal disorders, metabolic diseases, mastitis, musculoskeletal, and reproductive diseases (Morales-Ubaldo et al., 2023). These diseases lead to reduced milk yields, increased mortality and culling rates, and poor reproductive performance, all of which directly affect farm output and income (Rasmussen et al., 2024; Morales-Ubaldo et al., 2023; Rollin et al., 2015; Puerto et al., 2021). It also imposes substantial financial burdens on farmers due to the high costs of veterinary care, medications, labor, and preventive measures (Gohary et al., 2016; McArt et al., 2015; Azooz et al., 2020; Peterson & Mitloehner, 2021; Tabe Ojong et al., 2022).

Globally, the annual losses due to dairy cattle diseases are estimated at US$65 billion (B) (Rasmussen et al., 2024). The costliest diseases in dairy cattle are subclinical ketosis (US$18B), clinical mastitis (US$13B), subclinical mastitis (US$9B), lameness (US$6B), metritis (US$5B), ovarian cysts (US$4B), paratuberculosis (US$4B), and retained placenta (US$3B) (Rasmussen et al., 2024; Gohary et al., 2016; Liang et al., 2017; Barkema et al., 2015; Thomsen et al., 2023; Rutherford et al., 2009; Krishnamoorthy et al., 2021). Despite the global recognition of the economic consequences of dairy diseases, there is a lack of comprehensive data on their financial impact in Jordan. This knowledge gap hampers the development of effective strategies to address these challenges and support the sustainability of the dairy industry. To address this gap, this study reports on the disease burden and variable economic costs observed on a single, large-scale, intensively managed dairy farm in Jordan over a two-year period.

2 Materials and Methods

2.1 Ethical Approval

Formal ethical approval was not required in this study as it involved collecting data from medical records rather than direct live animal involvement.

2.2 Study design and data collection

This study utilized data collected from the electronic records (DeLaval DelPro™ FarmManager system) of a single, large-scale, intensively managed dairy farm located in the Aldhulail region of Jordan over a two-year period (2015-2016). The farm housed approximately 500 lactating dairy cows, all of the Friesian-Holstein breed.

Data extracted included disease diagnoses, treatments administered, withdrawal period, and amount of discarded milk over the duration of the withdrawal period of treated cows. Monthly expenses were obtained from monthly purchase invoices. Monthly expenses were categorized by therapeutic class, including antibiotics, anti-inflammatory drugs, hormones, vaccines, disinfectants, and miscellaneous items. For the economic analysis, only variable costs were considered which included veterinary fees, medication costs, and estimated discarded milk due to treatment withdrawal periods. For the variable economic impact, the analysis assumed an average of 5 sick days per disease, and an average of 5 days for milk discarded due to drug residues. Variable health costs per liter of milk produced were calculated by dividing the total monthly health expenditures by the total monthly milk production. Monthly health costs were obtained from farm records and included antibiotics, vaccines, disinfectants, miscellaneous medical supplies, hormones, and anti-inflammatory drugs. Total milk production was calculated based on an average daily production of 32 liters per cow across 500 lactating cows, resulting in 480,000 liters of milk produced monthly (32 L/cow/day × 500 cows × 30 days).

2.3 Statistical Analysis

The median prevalence, range, standard error (SE), and 95% confidence intervals (CI) were reported to describe the central tendency and variability of disease occurrence. The variable economic impact per case was analyzed using the Mann-Whitney U test, as the cost data were non-normally distributed. Median costs, ranges, SE, and 95% CIs were

calculated to summarize the economic burden. Monthly farm expenses were analyzed using t-tests to compare the average expenses across different treatment categories. Analyses were performed using SPSS v27 (IBM Corp., USA). Statistical differences were determined at $p < 0.05$.

3 Results

3.1 Disease Prevalence

Table 1 presents the disease burden in a 500-lactating dairy cow farm. Lameness was the most significant contributor to the disease burden, with a prevalence rate of 25% (95% CI: 21.0-29.0%; $p < 0.05$), followed by acute clinical mastitis (20%, 95% CI: 16.4-23.6%; $p < 0.05$), endometritis (18%, 95% CI: 14.6-21.4%; $p < 0.05$), clinical ketosis, acute metritis, and pneumonia (each 15%, 95% CI: 11.9-18.1%; $p < 0.05$). Gastrointestinal diseases, including simple indigestion/acidosis (18%, 95% CI: 14.6-21.4%; $p < 0.05$) and enteritis (10%, 95% CI: 7.4-12.6%; $p < 0.05$) also contributed significantly to the disease burden. Chronic mastitis had a lower and non-significant ($p > 0.05$) prevalence (6%, 95% CI: 4.1-8.9%) compared to acute clinical mastitis. Less prevalent conditions included abomasal ulcers (4%, 95% CI: 2.2-5.8%; $p > 0.05$), vagal indigestion (3%, 95% CI: 1.4-4.6%; $p > 0.05$), tuberculosis (2%, 95% CI: 0.8-3.2%; $p > 0.05$), subcutaneous abscesses (2%, 95% CI: 0.8-3.2%; $p > 0.05$), and subcutaneous hematomas (2%, 95% CI: 0.8-3.2%; $p > 0.05$). The 95% confidence intervals reflect the variability in the estimated prevalence rates over the two-year study period for the specific diseases within this herd.

Table 1: Disease burden in a 500-lactating cow dairy farm in Jordan.

Disease	Prevalence (%)	Number of Affected Cows	SE	95% CI†
Clinical ketosis	15*	75	1.6	11.9-18.1
Milk fever	8	40	1.2	5.6-10.4
Acute clinical mastitis	20*	100	1.8	16.4-23.6
Chronic mastitis	6	30	1.0	4.1-8.9
Dystocia	10	50	1.3	7.4-12.6
Retained fetal membranes	8	40	1.2	5.6-10.4
Acute metritis	15*	75	1.6	11.9-18.1
Endometritis	18*	90	1.7	14.6-21.4
Lameness	25*	125	2.0	21.0-29.0
Pneumonia	15	75	1.6	11.9-18.1
Simple indigestion/Acidosis	18*	90	1.7	14.6-21.4
Bloat	7	35	1.1	4.8-9.2
Displaced abomasum	5	25	1.0	3.0-7.0
Enteritis	10*	50	1.3	7.4-12.6
Abomasal ulcers	4	20	0.9	2.2-5.8
Vagal indigestion	3	15	0.8	1.4-4.6
Tuberculosis	2	10	0.6	0.8-3.2
Subcutaneous abscesses	2	10	0.6	0.8-3.2
Subcutaneous hematomas	2	10	0.6	0.8-3.2

**Statistical significance ($p < 0.05$) was determined by comparing diseased cows to healthy cows within the same herd.*
† Confidence intervals reflect variability in prevalence estimates over the study period.

3.2 Economic Impact

Figure 1 presents the total variable cost per case for various diseases. Dystocia with cesarean section (c-section) was the most significant ($p < 0.05$) contributor to the total cost of diseases on the farm, costing 200 JOD (282 USD). Dystocia without c-section also incurred significantly high economic burden ($p < 0.05$), costing 160 JOD (225.6 USD), followed by displaced abomasum (DA) at 158 JOD (222.78 USD; $p < 0.05$). Acute clinical mastitis, retained fetal membranes (RFM), acute metritis, endometritis, bloat, and pneumonia shared identical costs of 143 JOD (201.63 USD; $p < 0.05$). Chronic mastitis was slightly less costly at 133 JOD (187.53 USD; $p < 0.05$), while clinical ketosis, lameness, simple indigestion/acidosis, and enteritis each had a cost of 128 JOD (180.48 USD; $p < 0.05$). Hypocalcemia was associated with lowest cost of 67 JOD (94.47 USD; $p < 0.05$).

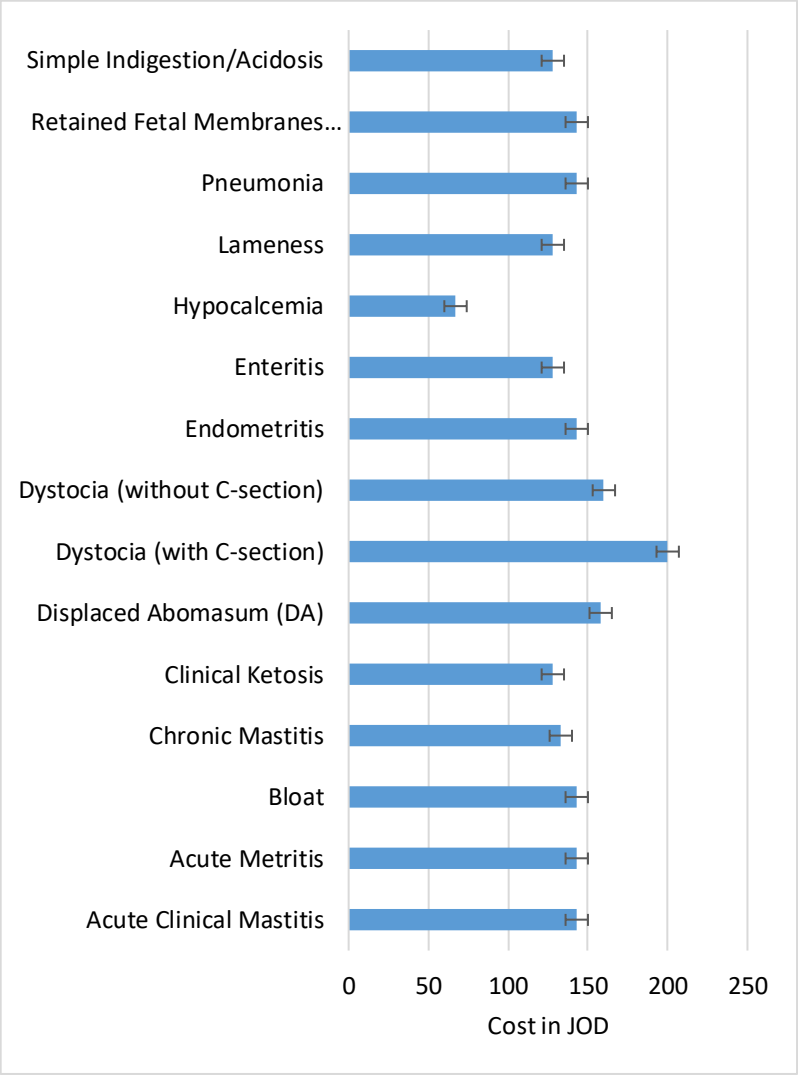


Figure 1: Variable costs per case (JOD) and per day of illness (JOD/day) in a 500-lactating cow dairy farm in Jordan.
Direct costs: Costs of veterinary consultation, medication costs, and estimated amount of discarded milk due to drug withdrawal periods. Costs per day of illness were calculated based on an assumed average of 5 sick days per case.

3.3 Monthly Farm Expenses

Table 2 presents farm expenses categorized by treatment type. The total monthly expenses averaged 8,088 ± 809 JOD (11,404.08 ± 1,140 USD), with a range of 7,279-8,829 JOD (10,263.39-12,448.89 USD).

Table 2: Average monthly farm expenses in a 500-lactating cow dairy farm in Jordan.

Expense Category	Average Cost (JOD)†	Average Cost (USD)	Range (JOD)	Range (USD)
Antibiotics	2,862 ± 350*	4,035 ± 493	2,500-3,200	3,525-4,512
Vaccines	1,264 ± 150*	1,782 ± 211	1,100-1,400	1,551-1,974
Disinfectants	1,000 ± 100*	1,410 ± 141	900-1,100	1,269-1,551
Miscellaneous‡	1,758 ± 150	2,478.78 ± 211	1,600-1,900	2,256-2,679
Hormones	700 ± 50	987 ± 70	650-750	916.50-1,057
Anti-inflammatory drugs	504 ± 50	710 ± 70	450-550	634.50-775
Total monthly expenses	**8,088 ± 809**	**11,404 ± 1,140**	**7,279-8,829**	**10,263-12,448**

* $p < 0.05$
† *Costs are presented as variable costs per month. For comparison.*
‡ *Miscellaneous: IV fluids, Calcium solutions, Magnesium solutions, Bicarbonate solutions, Injection needles and syringes, Local anesthetic, Surgical blades, Latex gloves, bandage material.*

Antibiotics were the most significant contributor to the total monthly cost, averaging 2,862 ± 350 JOD (4,035 ± 493 USD; $p < 0.05$), followed by vaccines at 1,264 ± 150 JOD (1,782 ± 211 USD; $p < 0.05$) and disinfectants at 1,000 ± 100 JOD (1,410 ± 141 USD; $p < 0.05$). Miscellaneous expenses, including IV fluids, calcium, magnesium, and bicarbonate solutions, injection needles and syringes, local anesthetics,

surgical blades, suturing materials, latex gloves, and bandaging materials averaged 1,758 ± 150 JOD (2,478.78 ± 211 USD; $p > 0.05$). Hormones and anti-inflammatory drugs were less costly, with hormones averaging 700 ± 50 JOD (987 ± 70 USD; $p > 0.05$) and anti-inflammatory drugs at 504 ± 50 JOD (710 ± 70 USD; $p > 0.05$).

Statistical analysis revealed significant differences in cost per liter of milk among different health expense categories ($p < 0.05$) (Table 3). Antibiotics represented the highest cost per liter at 0.0060 JOD/liter, which was significantly greater than all other categories except miscellaneous supplies (0.0037 JOD/liter).

Table 3: Variable disease costs per liter of milk produced (JOD and USD).

Category	Average Monthly Cost (JOD)	Cost Per Liter of Milk (JOD)	Cost Per Liter of Milk (USD)
Antibiotics	2,862	0.0060^{a}	0.0085^{a}
Vaccines	1,264	0.0026^{b}	0.0037^{b}
Disinfectants	1,000	0.0021^{b}	0.0030^{b}
Miscellaneous	1,758	$0.0037^{a,b}$	$0.0052^{a,b}$
Hormones	700	0.0015^{b}	0.0021^{b}
Anti-inflammatory drugs	504	0.0011^{b}	0.0015^{b}
Total	**8,088**	**0.0169**	**0.0239**

Values with different superscript letters are significantly different ($p < 0.05$).

The miscellaneous category showed intermediate costs and was statistically similar to both antibiotics and the lower-cost categories including vaccines, disinfectants, hormones, and anti-inflammatory drugs. Vaccines (0.0026 JOD/liter), disinfectants (0.0021 JOD/liter), hormones (0.0015 JOD/liter), and anti-inflammatory drugs (0.0011 JOD/liter) formed a statistically similar lower-cost group, with each other and with the miscellaneous category.

4 Discussion

The findings of this study describe the disease burden and variable costs observed on this single, intensively managed dairy farm in Jordan over a two-year period. Lameness was the most prevalent condition (25%), followed by acute clinical mastitis (20%) and endometritis (18%). A recent retrospective study from Jordan indicated that gastrointestinal diseases (30%), followed by udder/teat diseases (18%), reproductive and obstetrical diseases (16%), and respiratory diseases (11%) were the most commonly diagnosed diseases in cattle (Alekish & Ismail, 2022). Similar results were also reported in a recent study that examined dairy cow diseases in intensively managed dairy farms in the Mediterranean region which indicated that mastitis, lameness and metritis were the most commonly diagnosed diseases (Göncü & Sucak, 2024). Variations in disease prevalence between regions and farms can be attributed to differences in farm management practices, environmental conditions, and study methodologies (LeBlanc et al., 2006). Factors such as housing design, nutrition, hygiene protocols, and biosecurity measures significantly impact disease occurrence (LeBlanc et al., 2006). Additionally, environmental factors such as climate, humidity, and temperature fluctuations influence disease susceptibility, particularly in regions with extreme weather conditions (LeBlanc et al., 2006). Moreover, differences in study populations and methodologies, including whether data are collected from referral clinics, commercial farms, or retrospective records, can lead to variations in reported prevalence rates (LeBlanc et al., 2006). For example, the study reported by Alekish and Ismail (2022) focused on cattle presented to a referral clinic which may have presented a biased population. As this study reports findings from only one farm, it cannot be used to infer variability across different herd sizes or regions in Jordan.

In the current study, dystocia with and without cesarean section (200 JOD/case; 282 USD/case) was the costliest condition. Other reproductive disorders, such as metritis, endometritis and retained fetal membranes, also contributed significantly to the economic losses in this study. These findings are in agreement with recent studies where dystocia was reported to cost EUR 400 per case (Tsaousioti et al., 2024). In another study, the mean cost of metritis was $511 per cow, with a range from $240 to $884 (Pérez-Báez et al., 2021). Variation in reported costs in these studies could be attributed to differences in milk prices, veterinary fees and treatment costs (Rasmussen et al., 2024; Atashi et al., 2012).

Globally, mastitis has been reported to cost billions annually (Rasmussen et al., 2024; Krishnamoorthy et al., 2021; Atashi et al., 2012). In Egypt, Azooz et al. (2020) reported that the average cost of clinical mastitis per case was $931, with premature culling (77%) and reduced milk yield (13.7%) being the largest contributors. The

estimated cost of acute mastitis (143 JOD/case; 201 USD/case) in this study was much lower than those reported in Egypt (Azooz et al., 2020) and in high-income countries (e.g., $444/case in the U.S.) (Rollin et al., 2015). This disparity likely reflects differences in labor costs and material pricing.

Lameness was found to incur significant costs in this study (128 JOD/case; 180 USD/case). However, this estimate is lower than the global estimates. For instance, Robcis et al. (2023) reported that digital dermatitis (DD) was the most prevalent cause of lameness, accounting for 50% of cases, followed by interdigital dermatitis (28%) and sole ulcers (19%). The study by Robcis et al. (2023) found that the cost of a lame cow was approximately $330.00 per year. This disparity may reflect regional differences in factors such as labor costs, veterinary fees, and farm management practices.

Displaced abomasum in this study was the third costliest disease (158 JOD (222.78 USD). The main driver of the cost in DA cases was surgery as well as pre and post-operative care, and loss of milk. These results are similar to those reported in a study involving 72 lactating dairy cows with left displacement of the abomasum (Bartlett et al., 1995). The mean cost of the pyloro-omentopexy procedure was reported to be at $406.40 (Bartlett et al., 1995).

The economic analysis of this Jordanian dairy farm reveals significant concerns regarding antimicrobial use and overall disease management practices. Monthly farm expenses were predominantly driven by antibiotics (2,862 ± 350 JOD; 4,035 ± 493 USD), highlighting the heavy reliance on antimicrobials and potential overuse of these critical therapeutics. This pattern mirrors trends reported in other global regions (Rasmussen et al., 2024) and raises serious concerns about antimicrobial resistance, a growing global challenge (Ismail & Abutarbush, 2020; Obaidat et al., 2018). A recent Jordanian study found that 83.7% of dairy herdsmen have easy access to antimicrobials without prescription, with results indicating widespread misuse and significant resistance among commensal E. coli in dairy cattle (Obaidat et al., 2018). These findings underscore the urgent need for stricter regulations and educational programs on antimicrobial stewardship in Jordanian dairy operations.

The disparity in resource allocation is particularly concerning, with significantly more funding directed toward antibiotics than anti-inflammatory drugs (2,862 ± 350 JOD vs. 504 ± 50 JOD, respectively). This reactive approach prioritizes treating active infections while largely neglecting pain management during both disease and recovery phases. Such practices not only violate fundamental animal welfare principles by permitting preventable suffering but also represent a false economy - short-term savings on anti-inflammatories are ultimately offset by long-term productivity losses, increased treatment costs, and higher culling rates. The data strongly suggests an urgent need to rebalance veterinary care in these settings to address both infection control and pain management for more sustainable and ethical livestock production.

The calculated health costs per liter of milk (0.0169 JOD/liter or 2.4 fils per liter) provide valuable insight into the economic impact of disease management, with antibiotic costs comprising 35.4% of total health expenditures and reflecting the significant burden of infectious diseases such as mastitis and metritis documented in the prevalence study. The substantial allocation to the miscellaneous category (21.7%), which includes essential medical supplies like calcium solutions and IV fluids for treating metabolic disorders such as milk fever and ketosis, underscores the impact of these conditions in this herd. These findings suggest that targeted interventions addressing mastitis control, metabolic disease prevention, and optimized treatment protocols could significantly improve the economic sustainability of the farm while maintaining animal health and welfare standards.

It is important to note that this study reports only the variable costs associated with disease treatment, specifically medication, veterinary fees, and discarded milk, without accounting for additional potential variable costs such as extra feed for recovery, labor for treatment, extended time to conception, or additional barn space requirements. The number of sick days and days of discarded milk were assumed based on standard practices and withdrawal periods, representing a limitation of the study. Future research could incorporate marginal cost analysis per unit of disease, which would require collaboration with agricultural economists to provide a more comprehensive economic assessment.

5 Conclusion

This study reports the findings from a single, large-scale, intensively managed dairy farm in Jordan over a two-year period, providing insights into the disease burden and variable costs experienced on that specific operation. As data were collected from only one farm, the results cannot be generalized to

represent the situation across different herd sizes or regions in Jordan. Second, the study only considered variable costs, such as veterinary fees, medication, and discarded milk, due to difficulties in accurately estimating indirect costs, such as reduced reproductive performance, increased culling rates, and long-term productivity losses. These indirect costs can significantly contribute to the overall economic burden of diseases but were not quantified in this analysis. Additionally, the study reports variable costs per case, per day, and per liter of discarded milk, and monthly variable costs per cow, providing different perspectives on the economic impact. Additionally, the reliance on farm records for data collection may introduce biases, as underreporting or misclassification of diseases could affect the accuracy of prevalence estimates. Despite these limitations, the study offers a foundational understanding of the economic challenges posed by dairy cattle diseases on this specific farm, highlighting the need for further research with broader datasets and more comprehensive cost analyses to inform effective interventions. The study also underscores the urgent need for targeted interventions to improve the health of dairy cows on similar large-scale operations, such as improved hoof health programs, mastitis prevention strategies, and judicious antimicrobial use, which could mitigate economic losses and enhance productivity, ensuring the sector's resilience and contribution to food security and economic stability.

5.1 Acknowledgements

The authors would like to thank the Deanship of Research and the Faculty of Veterinary Medicine at Jordan University of Science and Technology for their support.

5.2 Conflict of interest

The authors declare no conflict of interest.

References:

Al-Atiyat, R. (2014). Role of small-scale dairy sector in food security and poverty alleviation. *Journal of Food, Agriculture and Environment, 12*, 427–433.

Alekish, M., & Ismail, Z. B. (2022). Common diseases of cattle in Jordan: A retrospective study (2015-2021). *Veterinary World, 15*(12), 2910–2916. [CrossRef]

Atashi, H., Abdolmohammadi, A., Dadpasand, M., & Asaadi, A. (2012). Prevalence, risk factors and consequent effect of dystocia in Holstein dairy cows in Iran. *Asian-Australasian Journal of Animal Sciences,* 25(4), 447–451. [CrossRef]

Azooz, M. F., El-Wakeel, S. A., & Yousef, H. M. (2020). Financial and economic analyses of the impact of cattle mastitis on the profitability of Egyptian dairy farms. *Veterinary World, 13*(9), 1750–1759. [CrossRef]

Bani Ismail, Z., & Abutarbush, S. (2020). Molecular characterization of antimicrobial resistance and virulence genes of Escherichia coli isolates from bovine mastitis. *Veterinary World, 13*, 1588–1593. [CrossRef]

Barkema, H. W., von Keyserlingk, M. A. G., Kastelic, J. P., Lam, T. J. G. M., Luby, C., Roy, J. P., LeBlanc, S. J., Keefe, G. P., & Kelton, D. F. (2015). Invited review: Changes in the dairy industry affecting dairy cattle health and welfare. *Journal of Dairy Science, 98*(11), 7426–7445. [CrossRef]

Bartlett, P. C., Kopcha, M., Coe, P. H., Ames, N. K., Ruegg, P. L., & Erskine, R. J. (1995). Economic comparison of the pyloro-omentopexy vs the roll-and-toggle procedure for treatment of left displacement of the abomasum in dairy cattle. *Journal of the American Veterinary Medical Association, 206*(8), 1156–1162. [CrossRef]

Gohary, K., Overton, M. W., Von Massow, M., LeBlanc, S. J., Lissemore, K. D., & Duffield, T. F. (2016). The cost of a case of subclinical ketosis in Canadian dairy herds. *The Canadian Veterinary Journal, 57*(7), 728–732.

Göncü, S., & Sucak, M. G. (2024). The most common diseases in intensive dairy cattle farms in the Mediterranean region. *MOJ Ecology & Environmental Sciences, 9*(5), 230–234. [CrossRef]

Hyperketonemia in early lactation dairy cattle: A deterministic estimate of component and total cost per case. *Journal of Dairy Science, 98*(3), 2043–2054. [CrossRef]

Krishnamoorthy, P., Goudar, A. L., Suresh, K. P., & Roy, P. (2021). Global and countrywide prevalence of subclinical and clinical mastitis in dairy cattle and buffaloes by systematic review and meta-analysis. *Research in Veterinary Science, 136*, 561–586. [CrossRef]

LeBlanc, S. J., Lissemore, K. D., Kelton, D. F., Duffield, T. F., & Leslie, K. E. (2006). Major advances in disease prevention in dairy cattle. *Journal of Dairy Science, 89*(4), 1267–1279. [CrossRef]

Liang, D., Arnold, L. M., Stowe, C. J., Harmon, R. J., & Bewley, J. M. (2017). Estimating US dairy clinical disease costs with a stochastic simulation model. *Journal of Dairy Science, 100*(2), 1472–1486. [CrossRef]

McArt, J. A. A., Nydam, D. V., & Overton, M. W. (2015).

Morales-Ubaldo, A. L., Rivero-Perez, N., Valladares-Carranza, B., Velázquez-Ordoñez, V., Delgadillo-Ruiz, L., & Zaragoza-Bastida, A. (2023). Bovine mastitis, a worldwide impact disease: Prevalence, antimicrobial resistance, and viable alternative

approaches. *Veterinary and Animal Science, 21*, 100306. [CrossRef]

Obaidat, M. M., Bani Salman, A. E., Davis, M. A., & Roess, A. A. (2018). Major diseases, extensive misuse, and high antimicrobial resistance of Escherichia coli in large- and small-scale dairy cattle farms in Jordan. *Journal of Dairy Science, 101*(3), 2324–2334. [CrossRef]

Pérez-Báez, J., Silva, T. V., Risco, C. A., Chebel, R. C., Cunha, F., De Vries, A., Galvão, K. N., & Santos, J. E. P. (2021). The economic cost of metritis in dairy herds. *Journal of Dairy Science, 104*(3), 3158–3168. [CrossRef]

Peterson, C. B., & Mitloehner, F. M. (2021). Sustainability of the dairy industry: Emissions and mitigation opportunities. *Frontiers in Animal Science, 2*, 760310. [CrossRef]

Puerto, M. A., Shepley, E., Cue, R. I., Warner, D., Dubuc, J., & Vasseur, E. (2021). The hidden cost of disease: I. Impact of the first incidence of mastitis on production and economic indicators of primiparous dairy cows. *Journal of Dairy Science, 104*(7), 7932–7943. [CrossRef]

Rasmussen, P., Barkema, H. W., Osei, P. P., Taylor, J., Shaw, A. P. M., Conrady, B., & De Vries, A. (2024). Global losses due to dairy cattle diseases: A comorbidity-adjusted economic analysis. *Journal of Dairy Science, 107*(9), 6945–6970. [CrossRef]

Robcis, R., Ferchiou, A., Berrada, M., Ndiaye, Y., Herman, N., Lhermie, G., & Raboisson, D. (2023). Cost of lameness in dairy herds: An integrated bioeconomic modeling approach. *Journal of Dairy Science, 106*(4), 2519–2534. [CrossRef]

Rollin, E., Dhuyvetter, K. C., & Overton, M. W. (2015). The cost of clinical mastitis in the first 30 days of lactation: An economic modeling tool. *Preventive Veterinary Medicine, 122*(3), 257–264. [CrossRef]

Rutherford, K. M. D., Langford, F. M., Jack, M. C., Sherwood, L., Lawrence, A. B., & Haskell, M. J. (2009). Lameness prevalence and risk factors in organic and non-organic dairy herds in the United Kingdom. *The Veterinary Journal, 180*(1), 95–105. [CrossRef]

Tabe Ojong, M. P. J., Hauser, M., & Mausch, K. (2022). Does agricultural commercialisation increase asset and livestock accumulation on smallholder farms in Ethiopia? *The Journal of Development Studies, 58*(4), 524–544. [CrossRef]

Thomsen, P. T., Shearer, J. K., & Houe, H. (2023). Prevalence of lameness in dairy cows: A literature review. *The Veterinary Journal, 295*, 105975. [CrossRef]

Tsaousioti, A., Basioura, A., Praxitelous, A., & Tsousis, G. (2024). Dystocia in dairy cows and heifers: A review with a focus on future perspectives. *Dairy, 5*(3), 655–671. [CrossRef]

Yilmaz, Ö. T. (2017). A study of milk support policies in the European Union and in Turkey. *European Journal of Interdisciplinary Studies, 9*(1), 17–33. [CrossRef]