Journal of Animal Health and Production 2 (3): 40 – 45
http://dx.doi.org/10.14737/journal.jahp/2014/2.3.40.45

Research Article

Investigating the Relationship between Claw Disorders and Milk Yield before and after Claw Trimming Using Modified Dutch Method in Three Egyptian Dairy Farms

Mohamed Gomaa*, Ahmed Ismail El–Azzazy*, Fathy El–Seddawy, Mahmoud Abdel–Maboud, Ahmed Behery, Abdel–Basit Abd El–Aal

Department of Surgery, Anestesiology and Radiology, Faculty of Veterinary Medicine, Zagazig University, Zagazig 44511, El–Sharkia, Egypt
*Corresponding author: a4ismail@yahoo.co.uk or gomaasurgeon@yahoo.com. (First and second author Contributed equally to this work)

ARTICLE HISTORY

Received: 2014–08–20
Revised: 2014–09–05
Accepted: 2014–09–06

Key Words: Claw disorders, Milk yield, Modified Dutch method, Lameness, Claw trimming

ABSTRACT

It is well known that treatment of foot lameness poses an enormous economic burden for milk producing farms. For this reason we herein developed a modification to *Dutch method* of claw trimming/unloading in order to treat these annoying disorders, simply and properly. Accordingly, milk yield of enrolled lame cows was evaluated following treatment. In total, 1.338 dairy cows from three Holstein–Friesian dairy farms located in *El–Sharkia Governorate*, *Egypt* were enrolled in this prospective study from January 2012 to August 2013 timeframe. Herein, prevalence of claw disorders were 4.2% for coriosis, 8.3% for white line disease 10% for underrun soles 41.7% for claw deformities, 29.2% for wall fissures, and 12.5% for sole ulcer (SU). Additionally, digital dermatitis (25%), inter–digital dermatitis (11.7%), inter–digital hyperplasia (1.7%), heel horn erosion (8.3%), inter–digital necrobacillosis (1.7%) and pedal arthritis (1.7%) were also filed out. Subsequently, milk yield data of lame cows were analyzed two weeks before treatment as well as two and four weeks after treatment. Impartially, milk yield of Farm–B and Farm–C showed significant increases at four weeks (154.35±30.44; $P<0.001$ and 130.59±22.17; $P<0.01$, respectively) and two weeks post treatment only in Farm–C (116.55±21.17; $P<0.05$) compared to pretreatment values (Farm–B: 96.25±22.94; Farm–C: 97.41±23.12). However, there were no statistical differences in milk production were noted in Farm–A. Based on these results, application of modified *Dutch Method* with claw measuring device named Claw–Check® for claw unloading/trimming might be beneficial clinically to reduce the burden of claw lameness and subsequently improves milk yield.

ARTICLE CITATION: Gomaa M, Ismail El–Azzazy AI, El–Seddawy F, Abdel–Maboud M, Behery A, Abdel–El–Aal A (2014). Investigating the relationship between claw disorders and milk yield before and after claw trimming using modified dutch method in three egyptian dairy farms. J. Anim. Health Prod. 2 (3): 40 – 45.

INTRODUCTION

Lameness in dairy cattle represents one of the major irritating problems in dairy farms that leads to poor animal welfare and substantial economic loss (Esslemont and Kossaibati, 1997). The reduced animal welfare is primarily generated due to pain experienced by lame cows (Whay et al., 1997; Dyer et al., 2007). The direct economic loss is represented by costs of treatment and cow–replacement (Kossaibati and Esslemont, 1997; Hernandez et al., 2007), while the indirect economic loss is amount by culling of chronically affected cows (Booth et al., 2004), lowered fertility and reduced milk production (Warnick et al., 2001; Green et al., 2002; Amory et al., 2008). *Kossaibati* estimated that the cost of indirect economic loss is amount three times costs more than that of direct economic loss (Kossaibati and Esslemont, 1997). More specifically, diseases of the foot accounted for 99% of the lameness cases recorded in cows in a prospective study on British dairy herds (Clarkson et al., 1996). At this regards, economic strategies related to the efficacy of preventing and treating lameness in dairy cows require definite estimates of the associated costs in comparison to herd productivity outcomes (fertility and milk production). To realize this, the accurate estimates related specifically to the effect of foot derived lameness on milk production are firstly required to be outlined. In different countries, rather than Egypt, there are number of studies reported that claw specific disorders reduced milk yield of dairy cows (Warnick et al., 2001; Green et al., 2002; Hultgren et al., 2004; Amory et al., 2008; Bicalho et al., 2008; Green et al., 2010; Singh et al., 2011; van Straten et al., 2011; Montgomery et al., 2012). Additionally, findings of most recent study indicated that the test day milk fat might be a valuable indicator for claw horn lesions (van Straten et al. 2011). While in Egypt, the effect of bovine claw specific lesions on milk yield has been reported so far by only one more recent published research article (Ahmed and Shekidef, 2012). However these studies have not investigated what about milk yield following treatment of such disorders. On the other hand, effective treatment for claw horn disease in dairy cows has been advocated for

ISSN: 2308–2801

many years using an accepted method that described first by Toussaint Raven, named the *Dutch method* of claw trimming (Toussaint Raven, 1989). Therefore, this study was fulfilled to investigate the efficacy of the *Dutch method* of claw trimming with minor modification, using claw measuring device named Claw–Check®, for treatment of claw–specific–disorders and its subsequent effect on milk yield in three Holstein–Friesian dairy herds in Egypt.

MATERIALS AND METHODS

Study Design and Animal Management

In total, 1.338 dairy cows from three Holstein–Friesian dairy farms (Farm–A: n=437, Farm–B: n=101, and Farm–C: n=800) located in *El–Sharkia Governorate, Egypt* were enrolled in this prospective study from January 2012 to August 2013. Throughout the study, cows of these farms were housed outdoor on a sandy floor and fed on concentrate and silage. These farms were visited twice a month searching for dairy cows that had claw disorders derived lameness. Before each visit, dairy cows with abnormal gait and arched back were grouped and kept in separate tracks for preliminary examination.

Foot Derived Lameness Diagnosis

On the visiting day, these separated cows were thoroughly examined searching for claw–horn disorders. Briefly, Lame animals were carefully inspected during both stance and progression. Physical clinical exploration was attentively implemented to describe site; type, cause and extent of lesion. Lactating cows suffered from claw disorders were only involved in this study. Before starting the treatment, the dataset of each cow including; ear tag identification number, affected limb/s, affected claw/s and description of claw horn lesion (site and type) associated with the lameness were recorded. Milk yield data of each examined lame cow were also captured from farm records two weeks before treatment as well as two and four weeks after treatment.

Treatment of Affected Claws

All cows suffered from claw disorders were treated similarly throughout the entire study period as follows: removal of abnormal horn, cleaning, disinfection, unloading the affected claw through claw trimming, local +/– systemic antimicrobial medication and finally thin protective bandage painted externally with medical tar.

Claw Trimming/Unloading

The claw trimming was performed according to five step *Dutch method* as described by Toussaint Raven (1989) with minor modification using a claw measuring device namely the Claw–Check® (Figure 1; Demotec, Germany) (Kümper, 2000). The all affected claws were trimmed and pared under the guidance of the Claw–Check to maintain their biomechanical dimensions and to ensure the evenly distributed weight loading. The trimming steps were as follows, the correct form of claw was initially determined using Claw–Check; Farrier's clipper was used to remove extra–horn from the anterior claw wall by a vertical cut at the toe to the sole surface using the straight edge of the Claw–Check (the anterior wall was shortened to a length of ~75mm) ; a power tool with small cutting blades located on a disc was used to remove horn only from the abaxial wall of claws; sole and heel horn was removed and axial wall modeling was carried out using a hoof knife. If it was not possible to unload the claw showing the primary lesion associated with lameness by trimming, a wooden block was applied to the sound claw in cases of non–infectious claw disorders.

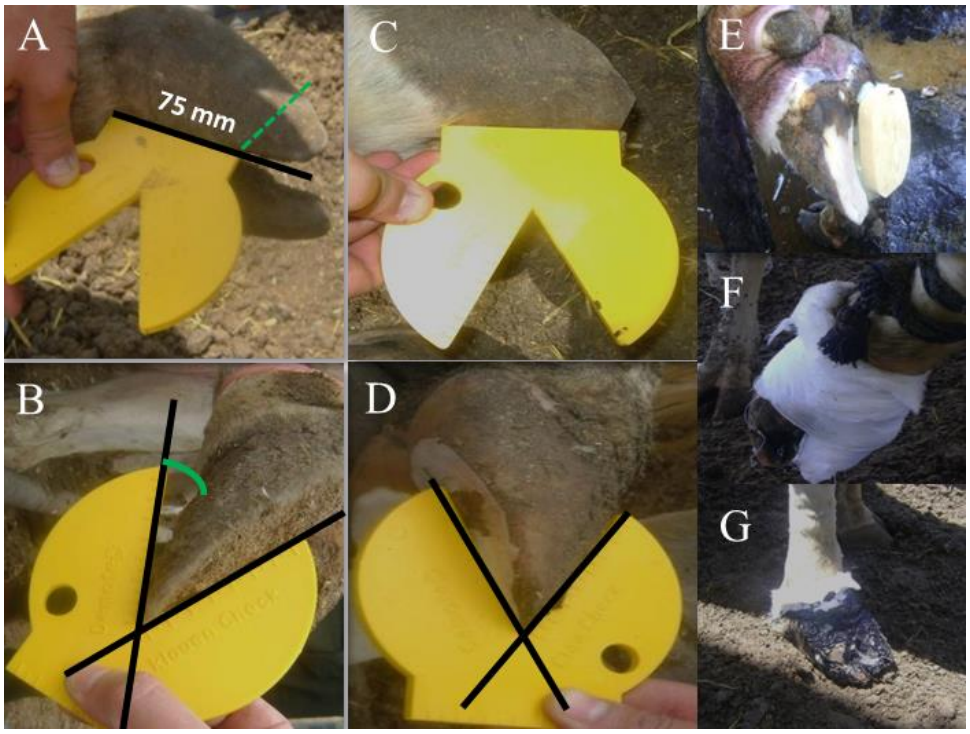

Figure 1: Application of claw check for proper claw trimming; (A, B) Untrimmed claw with an extra–unwanted horn (dashed green line, A) and wall angle (green arc, B) is displayed; Correctly trimmed claw is shown with proper wall length and angles (C, D); Afterwards, diseased claws were treated with local medication and wooden block on healthy claw (E), bandaging (F), and medical tar as water proof (G)

ISSN: 2308–2801

Statistical Analysis

For each farm, collected milk yield data, before and after treatment, were regularly transferred to Microsoft Excel spreadsheet and statistically analyzed using GraphPad Prism–4 software (La Jolla, Ca). The obtained data were expressed as mean±SD. Differences between animals before and after treatment were analyzed using a one–way ANOVA and Tukey test for post–hoc comparisons. The significance levels were defined at P<0.05, P<0.01 and P<0.001.

RESULTS

Disorders Prevalence and Lesions Identification

During the study period, one hundred twenty cases of claw disorders were diagnosed. Data describing number of lame dairy cows suffered claw affections per each herd and prevalence of such affections among affected animals are summarized in table 1 and figure 2. According to nature of lesion, the obtained affections were herein categorized into two main categories;

1. Non–infectious
2. Infectious claw disorders.

The Non–Infectious Claw Disorders

There were five cows (4.2%) suffered from subclinical laminitis (coriosis) that were incidentally discovered during regular claw trimming. Sole hemorrhages, reddish or yellow discolorations, along white line of claw were the most noticed characteristic findings of such disorder.

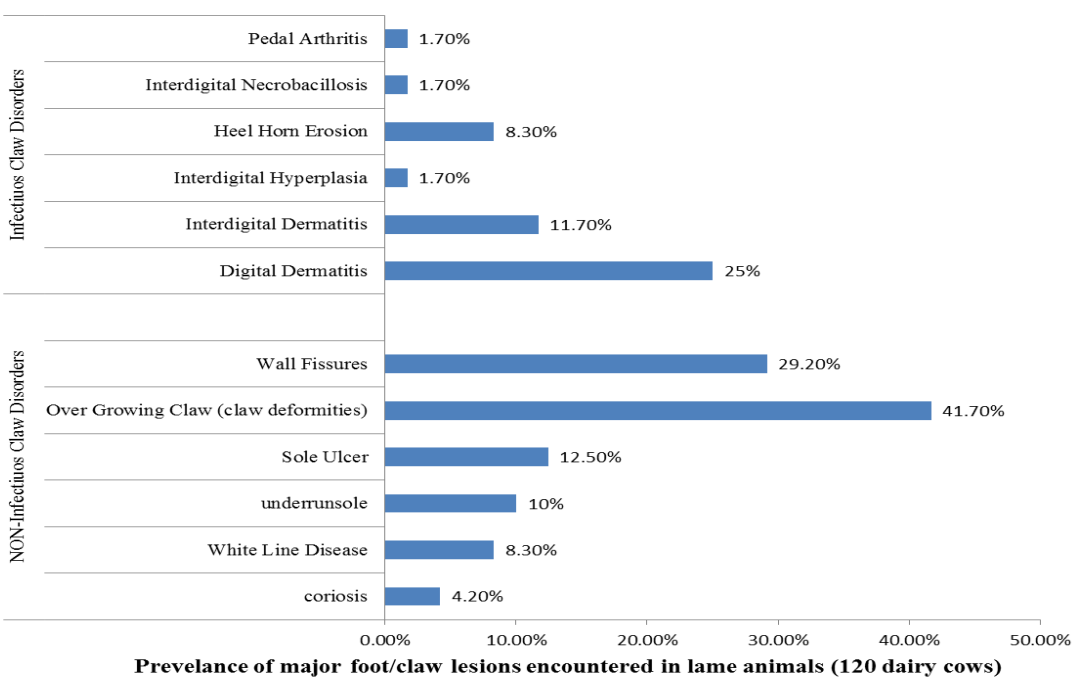

Figure 2: Prevalence of claw disorders found in the study. Some of cows had more than one claw disorders concurrently, hence total percentage of more than 100%

Table 1: Mean±SD values of milk productivity per week of foot derived lame cows before and after treatment

EXAMINED FARMS	TOTAL ANIMAL NUMBER		MILK PRODUCTIVITY OF CLAW DISEASED COWS		
	Total herd number	Claw derived lame dairy cows	2–weeks pre-treatment	2–weeks post-treatment	4–weeks post-treatment
FARM -A	437	30	210.4 ± 21.59	198.8 ± 23.99	188.6 ± 35.11
FARM -B	101	20	96.25 ± 22.94	114.45 ± 24.64	154.35 ± 30.44
FARM -C	800	70	97.41 ± 23.12	116.55 ± 21.17	130.59 ± 22.17

White line disease was observed in ten cows (8.3%) as areas of hemorrhage and necrosis of the corium with separation between wall and sole. In some cases dirties and white necrotizing horn like powder at areas of white line separation were noticed, while in rare cases, sole abscess followed by severe lameness was also evidenced. Twelve cows (10%) were recorded lame due to underrun (double) soles. During claw trimming, horn of the sole was seen stratified into two distinct layers; a superficial thicker/harder sole and a thinner/softer underlying sole with a space in between.

Sole ulcer was filed out in fifteen severely lame cows (12.5%) as a protruded granulation tissue at axial border of the sole bulb junction of affected claws. In this study, claw deformities (overgrowth) had highest prevalence (41.7%; *n*=50) compared to other non–infectious or infectious claw disorders. The most frequent types of misshapes observed were beak claw (dorsal), and scissor claw (crossed), whereas corkscrew claw was not common. Other claw disorder that noted with high prevalence was wall fissures (29.2%; *n*=35). Two forms of fissures were observed; vertical

ISSN: 2308–2801

and horizontal (thimble) wall fissures. Vertical fissures were mostly observed originating from toe to coronary band or from coronary band to toe. Moreover, varying degrees of lameness, ranged from mild to severe degree, were seen relevant to the depth of fissure.

The Infectious Claw Disorders

Digital dermatitis (DD) was the most frequent infectious disorders, whereas, the least frequent disorders were Inter–digital (ID) hyperplasia, ID necrobacillosis and pedal joint arthritis. By observation, we found that muddy accumulated manure (slurry) for long time was a main predisposing factor in generating these recorded infectious disorders. Thirty cows (25%) suffered from digital dermatitis (Mortellaro disease) which was found mostly on the plantar dermal aspect of foot adjacent to the ID cleft as well as at the skin–horn junction of heel bulbs. ID dermatitis (IDD) was represented by 11.7% (*n*=14) and appeared as moist inflammation of the ID epidermis not involving the deeper tissues. This lesion was often painful on touch. Heel horn erosion (HHE) had incidence of 8.3% (*n*=10) which was very painful either by touch or during animal progression (severe degree of lameness). Only two animals (1.7%) with ID hyperplasia was recorded which resulted mainly from old digital dermatitis. Similar to ID hyperplasia, the incidences of ID necrobacillosis (foot rot) and pedal joint arthritis were 1.7%, respectively. The former disorder was showed as necrotic lesion in ID skin and cellulitis in soft tissue of foot accompanied with swelling, typically local foul odor and lameness. While the latter disorder was invariably noticed with other concurrent ignored disorders such as sole ulcer, ID necrobacillosis, white line disease and white line abscess. Clinically, the signs reported were swelling at heel region, inflammation extended toward fetlock joint and purulent arthritis in coffin joint which was combined with marked severe degree of lameness.

Effect of Claw Trimming/Unloading on Milk Production

Differences in values (mean±SD) of milk production before and after treatment of claw horn disorder using the modified *Dutch method* are shown in Table 1 and Figure 3. During the pre–trimming period of 14 days the average of milk yield per week in all lame cows under investigation was (Farm–A: 210.4±21.59; Farm–B: 96.25±22.94; Farm–C: 97.41±23.12) liters. Later, at the day of 14 and 28 after claw trimming the mean milk yield data were collected and statistically analyzed. In Farm–A, there were no any statistical differences in milk production comparing pre–treated cows and two–time points of treatment setup. However, milk yield of the investigated animals at both Farm–B and –C showed significant increases (154.35±30.44; P<0.001 and 130.59±22.17; P<0.01, respectively) after four weeks treatment duration in addition to two weeks post treatment however the latter was only in Farm–C (116.55±21.17; P<0.05). Overall, we could speculate that efficacy of ~ 65% after claw trimming/unloading using modified *Dutch method* for reducing the lameness and relevant milk loss was clinically achieved.

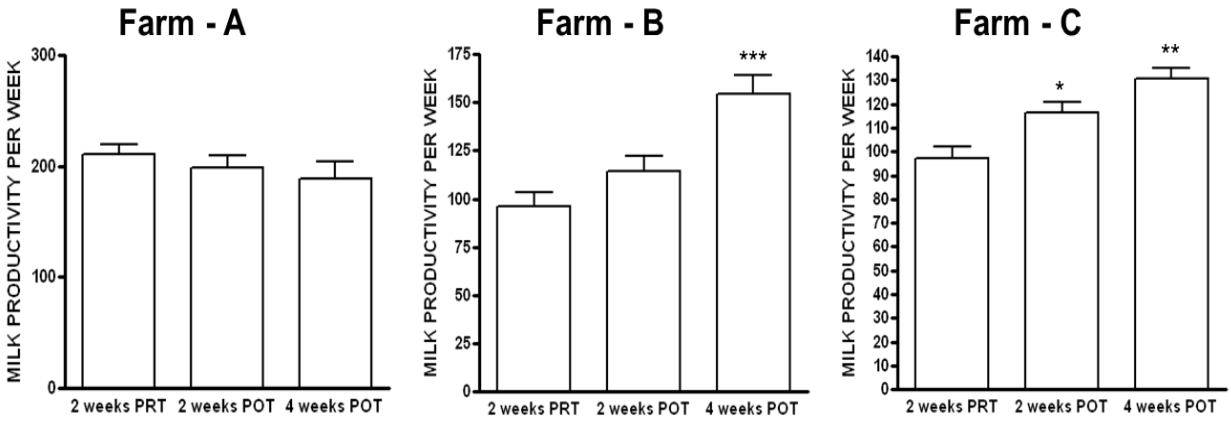

Figure 3: Claw trimming and unloading improved milk production of claw diseased animals at 2 and 4 weeks post–treatment (POT) when compared with that of pre– treatment (PRT). * P ‹ 0.05, ** P ‹0.01, *** P ‹ 0.001

DISCUSSION

The five steps *Dutch Method* of claw trimming in cattle have mainly been targeted to accelerate the cure of claw disorders, since this method correct the balance of ground surface of claws in United Kingdom (O`Callaghan–Lowe et al., 2004), Northern Europe (Nuss and Paulus, 2006) and North America (Shearer and van Amstel, 2001). During this study, 120 lame dairy cows from three different farms were subjected to treatment of infectious and non–infectious claw disorders using Modified *Dutch Method* of claw trimming with Claw–Check® as a new device developed firstly by Dr. Kümper (Kümper, 2000). Accordingly, using this device, maximum benefits of claws trimming and paring could be achieved through adjustment angle between sole and anterior claw wall, measuring length of anterior claw wall, comparing the height of lateral and medial, and achieving correct loading plane and slope of sole when contacts to ground (Kümper, 2000). Herein, the non–infectious claw disorders represented the highest rates of prevalence were claw overgrowth (41.7%) and wall fissures (29.2%). This could be attributed to lack of routine claw trimming programs in addition to sandy floors also

ISSN: 2308–2801

enhanced development of chronic laminitis which characterized by overgrowths (Somers et al., 2003). Our results showed that corkscrew claw, one of claw deformities, noticed in both medial and lateral claws (Rhebun and Pearson, 1982). Inconsistently, other previous studies showed the corkscrew claw affecting only lateral claws of the rear feet (Mc Cormack, 1978). Wall fissures, either vertical or horizontal fissure (thimble) were here in recorded (*n*=35; 29.2%). On observation, superficial fissures was not characterized by lameness while deep fissured was accompanied by severe lameness. Searching for the reasons of these fissures we found that claw wall hydration due to unhygienic condition and neglected trimming were an important predisposing factors in formation of these fissures (Clark et al., 2004). Moreover, the prevalence of DD (Mortellaro disease: *n*=30; 25%) were very high in comparison to the rest of infectious claw disorders because of noticed muddy conditions of farms. Bovine DD is an infectious and a multifactorial disease that generated by bacteria, namely treponemes, as well as environmental, managerial and individual–animal factors (Refaai et al., 2013), while the causative agents of IDD in cattle are Bacteroides nodosus (Dichelobacter nodosus) and Fusobacterium necrophorum. Therefore, IDD is commonly observed in wet and unhygienic environments (Hultgren and Bergsten, 2001). Additionally, we also observed HHE which was very painful either by touch or rarely during animal progression. On the other aspect, regarding to the milk yield, in Farm–A, there were no any statistical differences in milk production comparing pre–treated cows and two time points of treatment setup. However, milk yield of the investigated animals at both Farm–B and –C showed significant increases ($P<0.001$ and $P<0.01$, respectively) after 4 weeks treatment duration in addition to 2 weeks post treatment but the latter was only in Farm–C ($P<0.05$). Overall, we could speculate that - 65% efficiency of claw trimming using modified *Dutch method* for reducing lameness and relevant milk loss was noticed. However, there is only one published data describing the immediate effect on milk yield following treatment of claw horn disease using *Dutch method* (Montgomery et al., 2012), the results of this study indicated that correct claw trimming technique for treating digital horn lesions is most beneficial and pronounced on activity levels during the night–time period. To achieve this, effective claw trimming should shorten the length of the dorsal wall of the lateral claw in particular, and ensures the initial contact and impact force of the claw with the ground occurs more at the heel (Singh, 1993; Montgomery et al., 2012). Other benefits of claw trimming are to reduce points of maximal pressure away from the sole heel junction, and abaxial white line and adjacent sole, redistributing that pressure somewhat to the stable claw (Meyer et al., 2007). Consequently, unloading the diseased claw has been represented as a main crucial step for obtaining an effective treatment (Blowey, 1998). Ahmed and Shekidef (2012) in their study found that sole ulcer and sole abscess had the highest prevalence among the hoof lesions in dairy farms and usually associated with the greatest milk loss in dairy cows as well. High yielding dairy cows are more likely to expose to lameness due to sole abscesses and sole ulcer than average yielding or low yielding cows. Foot rot and foot warts were associated with smaller decreases in production than sole ulcers or abscesses in one herd. In the other herd, cows with foot abscesses and foot rot tended to have larger decreases in milk production (Warnick et al., 2001) while rapid treatment of claw horn disease in lame dairy cows improved their immediate health and welfare immediately and probably reduce milk lost (Montgomery et al., 2012; Green et al., 2010).

CONCLUSION

Upon our obtained results, modified *Dutch Method* and claw measuring device named Claw–Check® of claw unloading/trimming could be used as a clinically feasible approach in diseased farms to simply limit claw lameness and subsequently improves milk production.

ACKNOWLEDGEMENT:

This work was supported by a research grant K3M52011/2012 from Zagazig University and Ministry of Higher Education and Scientific Research, Egypt.

POTENTIAL CONFLICTS OF INTEREST

The authors declare there are no potential conflicts of interest.

REFERENCES

Ahmed IH, Shekidef MH (2012). Incidence and Management of Bovine Claw Affections and Their Economic Impact: A Field Study on Dairy Farms. J. of Am. Sc. 8 (6):46 – 61.

Amory JR, Barker ZE, Wright JL, Mason SA, Blowey RW, Green LE (2008). Associations between sole ulcer, white line disease and digital dermatitis and the milk yield of 1824 dairy cows on 30 dairy cow farms in England and Wales from February 2003–November 2004. Prev. Vet. Med. 83 (3 – 4): 381 – 391.

Bicalho RC, Warnick LD, Guard CL (2008). Strategies to analyze milk losses caused by diseases with potential incidence throughout the lactation: a lameness example. J. D. Sci. 91 (7): 2653 – 2661.

Blowey RW (1998). Welfare aspects of foot lameness in cattle. Irish Vet. J. 51: 203 – 207.

Booth CJ, Warnick LD, Grohn YT, Maizon DO, Guard CL, Janssen D (2004). Effect of lameness on culling in dairy cows. J. D. Sci. 87 (12): 4115 – 4122.

Clark CR, Petrie L, Waldner C, Wendell A (2004). Characteristics of the bovine claw associated with the presence of vertical fissures (sandcracks). Can. Vet. J. 45: 585 – 593.

Clarkson MJ, Downham DY, Faull WB, Hughes JW, Manson FJ, Merritt JB, Murray RD, Russell WB, Sutherst JE, Ward WR (1996). Incidence and prevalence of lameness in dairy cattle. Vet. Rec. 138 (23): 563 – 567.

Dyer RM, Neerchal NK, Tasch U, Wu Y, Dyer P, Rajkondawar PG (2007). Objective determination of claw pain and its relationship to limb locomotion score in dairy cattle. J. D. Sci. 90 (10): 4592 – 4602.

Esslemont RJ, Kossaibati MA (1997). Culling in 50 dairy herds in England. Vet. Rec. 140 (2): 36 – 39.

Green LE, Borkert J, Monti G, Tadich N (2010). Associations between lesion–specific lameness and the milk yield of 1,635 dairy cows from seven herds in the Xth region of Chile and implications for management of lame dairy cows worldwide. Anim. Welf. 19: 419 – 427.

Green LE, Hedges VJ, Schukken YH, Blowey RW, Packington AJ (2002). The impact of clinical lameness on the milk yield of dairy cows. J Dairy Sci. 85 (9): 2250 – 2256.

Hernandez JA, Garbarino EJ, Shearer JK, Risco CA, Thatcher WW (2007). Evaluation of the efficacy of prophylactic hoof health examination and trimming during midlactation in reducing the incidence of lameness during late lactation in dairy cows. J. Am. Vet. Med. Assoc. 230 (1): 89 – 93.

Hultgren J, Bergsten C (2001). Effects of a rubber–slatted flooring system on cleanliness and foot health in tied dairy cows. Prev. Vet. Med. 52: 75 – 89.

Hultgren J, Manske T, Bergsten C (2004). Associations of sole ulcer at claw trimming with reproductive performance, udder health, milk yield, and culling in Swedish dairy cattle. Prev. Vet. Med. 62: 233 – 251.

Kossaibati MA, Esslemont RJ (1997). The costs of production diseases in dairy herds in England. Vet J. 154:41 – 51.

Kümper H (2000). Controlling the shape and function of cattle claws by the help of a new measuring device. In: proceeding of 4th International

ISSN: 2308–2801

Symposium on Disorders of the Ruminant Digit. Parma Italy, 1999, 9: 3 – 7.

McCormack J (1978). Diagnosis and treatment of some common foot problems in cattle. Vet. Med. Small Anim. Clin. 73: 801 – 808

Meyer SW, Weishaupt MA, Nuss KA (2007). Gait pattern of heifers before and after claw trimming: a high–speed cinematographic study on a treadmill. J Dairy Sci. 90 (2): 670 – 676.

Montgomery JA, Forgan K, Hayhurst C, Rees E, Duncan JS, Gossellein J, Harding C, Murray RD (2012). Short term effect of treating claw horn lesions in dairy cattle on their locomotion, activity and milk yield. Vet. Sc. Dev.. 7: 25 – 30.

Nuss K, Paulus N (2006). Measurements of claw dimensions in cows before and after functional trimming: A post–mortem study. Vet. J. 172: 284 – 292.

O'Callaghan Lowe KA, Murray RD, Cripps PJ, Ward WR (2004). Working practices of cattle foot trimmers used for foot care in dairy cattle compared with those of veterinary surgeons for treatment of lameness in large animal practice. J. Vet. Med. Ass. 51: 429 – 434.

Refaai W, Van Aert M, Abd El–Aal AM, Behery AE, Opsomer G (2013). Infectious diseases causing lameness in cattle with a main emphasis on digital dermatitis (Mortellarodisease), Liv. Stock Sci. 156: 53 – 63.

Rhebun WC, Pearson EG (1982). Clinical management of bovine foot problems. J. Ame. Vet. Med. Assoc. 181: 572 – 579.

Shearer JK, van Amstel SR (2001). Functional and corrective claw trimming. Vet. Clin. North. Am. F. An. Pract. 17 (1): 53 – 72.

Singh Y, Lathwal SS, Chakravarty AK, Gupta AK, Mohanty TK, Raja TV, Dangi RL, Roy BK (2011). Effect of lameness (hoof disorders) on productivity of Karan Fries crossbred cows. Anim. Sci. J. 82 (1): 169 – 174.

Somers JGCJ, Frankena K, Noordhuizen–Stassen EN, Metz JHM (2003). Prevalence of claw disorders in Dutch dairy cows exposed to several floor systems. J. D. Sci. 86: 2082 – 2093.

Toussaint Raven E (1989). Cattle Foot Care and Claw Trimming. Ipswich, Farming Press.

van Straten M, Siani I, Bar D (2011). Reduced test–day milk fat percentage in cows diagnosed with claw horn lesions during routine claw trimming. J D. Sci. 94 (4): 1858 – 1863.

Warnick LD, Janssen D, Guard CL, Grohn YT (2001). The effect of lameness on milk production in dairy cows. J. D. Sci. 84 (9): 1988 – 1997.

Whay HR, Waterman AE, Webster AJ (1997). Associations between locomotion claw lesions and nociceptive threshold in dairy heifers during the peripartum period. Vet. J. 154: 155 – 161.

ISSN: 2308–2801