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Effect of Confinement Stress on Milk Yield in Dairy Cows

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Abstract:

Response of lactating cows (LC) to methods of rearing was evaluated. Two groups of LCs were tested and compared for milk yield (MY) in a completely randomised design (CRD). A total of six (6) LCs were used, three (3) of which were randomly selected and subjected to confinement (called confined cows (CCw)) and the other three (3) were left free and raised under free grazing conditions (called free grazing cows(FGCw)).

CCws were tested for milk yield before confinement (MYBC). CCws and FGCws were tested for MY during the study period which lasted 19 days. CCws were compared for MYBC and milk yield during confinement (MYDC). Results revealed that MYBC was significantly ($p< 0.05$) higher than MYDC. MY for FGCws was significantly ($p<0.05$) higher than MY for CCws. The study revealed that confinement adversely affects MY hence loss of business for dairy farmers.

Key words: Confinement, Milk yield, Dairy animal, Free grazing, Lactating cows.

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Introduction

The dairy sector in Zambia is a viable industry that could contribute to poverty reduction especially in our rural areas. However over the years this sector has been unable to supply the much needed milk with only an annual supply of about 125 million litres. There is a 25% milk deficit in the Zambian market (Magoye Dairy Farmers Case Study 2007). GART (2011), reported that the recommended annual consumption of milk by the WHO and FAO is 200 million litres.

There are a number of challenges that the dairy industry in Zambia faces. These include the high cost of feed, poor infrastructure, lack of breeding programmes at both community and national level, poor breeds of dairy cows, poor management, lack of appropriate dairy technology to increase milk production to mention but a few (MDF Case Study 2007). This calls for intervention from government and would be well-wishers as many small scale dairy farmers do not have the capacity to find solutions to some of these challenges.

Dairying is a dynamic, changing industry that is adjusting to new technologies, price volatility, environmental concerns and a variety of other issues (Muller 2004). Most dairy farms use the grazing system mostly for economic purposes (i.e reduced input costs). A summary of 22 studies and farm management data clearly indicate that grazing results in about $100 to $200 advantage on profit per cow per year compared with confined feeding systems. The use of intensive grazing presents challenges to dairy producers and nutritionists. It is also true that supplemental feeding with pasture-based systems is more difficult to manage than with confinement systems basically because of less control of forage component with grazing system which reduces consistency of nutrient intake from day to day. Consequently, milk yield/cow/day can be quite variable and milk yield per cow is often 1700 to 2500kg/cow/year lower than obtained with confinement

systems. Milk production on pasture is economic optimization and not necessarily making the most milk per cow (Muller, 2004).

Milk yield of a cow is influenced by a number of factors. Water is one of the factors which play a very big role in milk production of a cow. GART (2011), indicated that milk contains 87% water. If the animals are not allowed to drink sufficient water, they will not be able to produce good quantity of milk. According to the Agricultural Research Council (ARC, 1980) the equation for water requirement is:

$$I_w = 12.3 + 2.15I_d + 0.73M$$

where I_w = water intake,

I_d = dry matter intake and

M = Live mass

Feed is another essential factor in milk production. It is a source of different nutrients which are essential for maintenance needs and for production in form of meat and milk (GART 2011). Temperature is another influential factor that affects milk production in cows. High temperatures can decrease milk production by as much as 50 percent (National Research Center 1987).

Abate et al 2010 reported that season of calving had no significant effect on milk yield parameters, though persistency correlated negatively with the lactation period and peak yield. These workers further indicated that calving year and calving season must be taken into consideration when evaluating the productivity of cows.

Indoor animals are more comfortable and thus need about 15% less feed per kilogram of protein produced saving still more acres of land for nature and still more carbon left in the soil (Avery 2010).

Though confinement is associated with good health, reduced feed cost and reduced methane production, the question is on whether animals are happy or not and whether

microenvironment to which they are subjected conform to species requirement.

Many other factors have been reported to affect livestock performance. Management, lactation turn or age, year and season in which lactation started are the leading environmental factors affecting performance in cattle (Mhamdi 2008). Lactation in dairy cattle also depends on genetic and environmental factors as well as the two way interaction of these factors (i.e G x E interaction). Genetic background, climate, diseases, feeding, year and season of calving have been reported to affect milk production, lactation length and dry period (Mhamdi, 2008). Andersen et al., 2007 observed that the Holstein performed better than Jersey crosses in milk yield under confinement. Average daily intake was 2.2kg/cow less for Jersey crosses than the Holsteins.

It is also important to note that numerous physiological changes occur in the digestive system acid-base chemistry and blood hormones during hot weather, some in response to reduced nutrient intake, but many changes occur as a result of strain in the cow (Lucy et al. 2003).

Outdoors, the birds suffer more from heat, cold, and stress, which retards their weight gain and productivity (Avery and Elam 2003). Indoor animals are more comfortable, and thus need about 15 percent less feed per pound of protein produced, saving still more acres of land for Nature and still more carbon left in the soil (Avery 2010). Dairy animals are considered as biological machines as they consume feed and use as a fuel to produce milk. There are certain changes in environment as well as animal physiology which create stress condition in animals. Stress may be considered as anything that is applied to an animal from an outside source that has an effect on that animal's normal physiological activity. During stress, the performance of dairy animals is reduced (Dubey and Gnanasekar 2008). Yourself (1985) defined stress as magnitude of forces external to the body which tend to displace its system

from resting or ground state.

The environmental factors have profound effects on the dairy animal's productivity through its effects on growth rate, reproduction and milk production (Stewart 2005). Some rearing methods, such as confinement, end up leading the cow into frustration. Animal psychologists have advanced the assertion that, animals, just like human beings get frustrated and are prone to stress factors. Meanwhile, when a living organism undergoes frustration different chemical substances are released in the system. Some of these chemicals may have an effect on the normal processes that occur in their bodies, for example milk production. The release of such chemicals into the blood may either reduce or completely inhibit such processes.

There is lack of information among small-holder farmers on the relationship between confinement and milk let down in dairy animals. It was against this background that a study was carried out at the Golden Valley Research Trust (GART) in Batoka Southern Province of Zambia and it was specifically designed

(a) To compare the milk yields of confined and free range dairy animals

Harmsworth, Coleman, Barnett, and Borg (2000), confirmed that stress from different sources may negatively affect welfare and productivity in animals. The welfare here would imply good health of the animal. It is however logical to conclude that a health cow will produce more of milk. High disease incidence, reduced fertility, decreased longevity and modification of normal behaviour are indicative of substantial decline in cow welfare. Improving welfare is important as good welfare is regarded by the public as indicative of sustainable systems and good product quality and may also be economically beneficial (Altenacu et al. 2010).

Many people in the livestock industry possess little

understanding of how the livestock confinement system works or appreciate how animals interact with environments. Thus they compound problems rather than contribute to solutions (King, 2010). The Animal Welfare Institute (2011), stated that not only does this prohibit cows from engaging in normal exercise and behaviour, but are unable to groom and their social needs as herd animals are frustrated. This frustration will in turn be manifest in reduction in cow's productivity.

Thicke (2010), noted that the irony of modern confinement is that it is the nature of cows to move about and the nature of grass to stand in one place, but with confinement method of animal production, we have turned it backward and made the cows stand in one place and made the grass move to the cows. The former system is referred to as pastoral farming while the latter is referred to as factory farming. Turning nature backward like that takes a lot of energy, and is only possible when energy is cheap. The aspect of energy comes about because in the houses the animals should have the forage cut and taken to where they are. Thicke further stated that when cows are kept in confinement, the cows' forage has to be mechanically harvested in the field, hauled to the confinement facility, placed in storage, and then mechanically removed from storage each day to feed the cows. And, the cows' manure must be collected into a storage facility from where it eventually must be hauled back to fields and spread. All these operations require fossil fuel energy. This would mean an unnecessary use of energy which the world is striving hard to reduce.

The feeding behaviour of group-housed cows is influenced by management practices at the feed bunk and factors associated with the physical environment. The feeding pattern of group-housed dairy cows is largely influenced by the timing of fresh feed delivery and delivery of fresh feed has a greater impact on stimulating cows to eat than does the return from milking (Botheras 2010).

Delivering fresh feed more frequently improves access to

fresh feed for all cows and reduces sorting of the TMR. This will potentially reduce variation in diet quality consumed by cows, with benefits for milk production (Botheras 2010).

Combs 2001 observed that a major factor limiting milk production from grazed pasture is low intake. Depies 1994 as cited by Combs 2001, reported that, when compared to confinement based systems, cattle consuming ever excellent quality pastures typically consume as much as 20% less feed dry matter per day as animals feed similar quality forage in confinement facilities.

Thicke (2010) further added that cows living and grazing in their natural environment are healthier than when living under confinement conditions, often on concrete. Also, a diet high in freshly grazed forage is healthier for cows than diets that are normally fed in confinement dairy systems. A cow has a rumen, which is a digestive system that evolved to digest forages. The rumen serves as a fermentation vat for bacteria that can digest the cellulose (which humans cannot digest) of forages. When a cow is fed high levels of corn or other grains as is normal in Concentrated Animal Feeding Operation (CAFO) dairies, the cows are more susceptible to health problems, especially metabolic disorders and foot problems.

Washburn, White and Green (2002), reported that confined cows had 1.8 times more clinical mastitis and eight (8) times the rate of culling for mastitis than cows on pasture.

Conditions in confinement housing are so unnatural and poorly designed that cows are more susceptible to lameness, consistently ranked as one of the most serious welfare problems for cattle (Whay 2011).

Geis (2011) advanced that cows living in confinement dairies live the good life and receive better treatment than most pets. He further pointed out that since weather is always a challenge in livestock production a confinement dairy barn allows the producer to moderate the effects of weather on the cows, something that is impossible in a pasture.

A research by the University of Arkansas (2009), revealed that hot summer weather may decrease milk production by as much as fifty (50) per cent. A cow has a temperature range within which its processes function properly and Pike (2011) calls this temperature range the cow's thermo-neutral zone ranging from 5- 25^{o}C. Nutrition and management are the two very important tasks by which we can minimize the loss caused by heat stress. Small corrections in nutrition and management during the summer can give comfort for the cows and more profit to the dairy owners (Dubey and Gnanasekar, 2008).

Intensive dairy systems impose considerable stress on cattle contained within them. In addition to confined environment, cows are regularly exposed to potentially aversive stimuli, such as human contact, milking and veterinary procedures. Stress from such sources may negatively affect welfare and productivity (Hemsworth et al 2000). Regula et al. (2004) showed that loose-housing and regular exercise throughout the year had a positive effect on lameness, teat injuries and lying-down behaviour. Loose-housing systems were generally associated with improved welfare, while welfare of these within the tie stalls was somewhat compromised. The same author also found out that welfare standards varied significantly within husbandry systems, concluding that the management skills of the farmer seemed to be of similar importance to the housing system itself in maintaining welfare standards. Management of stress is particularly important in intensive environment in which welfare is already compromised by confinement and animals are exposed to potential stresses such as human-animal interaction, veterinary procedures and milking.

According to Biasutti 2010, adoption of loose-housing systems in conjunction with stress management techniques could enhance welfare significantly while alteration of housing systems in existing dairies may not be feasible; the strategies

for stress management may be applied in any future system and even in highly confined housing may significantly enhance profitability and dairy cow welfare.

Temperature (°C)	Milk yield (ltrs)
20	26.98
25	24.99
30	22.99
35	18.01
40	12.02

Source: The National Research Council, 1981

Materials and Methods

Research site

The research was conducted at Golden Valley Agriculture Research Trust (GART) in Batoka. Batoka is about 280km from Lusaka and the research institute is situated about 2km from the Lusaka- Livingstone road. It is about 20km from Choma. It lies at an altitude of 1, 275m above sea level and has a mean annual rainfall of 723.5mm. The site lies on latitude 16^{o} 50' S and longitude 27^{o} 04' E. The mean annual temperature is 8^{o}C . The soil type is sandy loam (Mochipapa Meteorological Station 2013).

Experimental design

A Complete Randomized Design (CRD) was used in the research. Six (6) cows were randomly selected from a total of fourteen (14) lactating cows. Further randomization was done to select the three (3) that made the Confined group (CCw) and the three (3) that made the Free grazing group (FGCw). The experimental units were all cross breeds F_1 of Sussex and Friesian and these were experimented on response to confinement in relation to milk yield. The period of observation was thirty eight days.

Housing

A paddock measuring 10m by 7m was chosen to keep the confined group. A shelter inside this paddock was constructed to offer shelter from direct sunshine as temperature has a bearing on milk yield.

Six (6) lactating cows, all of the same breed, were chosen randomly from the total population by picking lots. The first three (3) were assigned to confinement treatment making up the confined group and were labelled CCws (confined cows). The other three (3) were assigned to free grazing conditions and constituted the free grazing group, labelled FGCws (free grazing cows). Milking was done twice per day, at 05:00 and 13:00. The yields were recorded in tables. The confined animals were enclosed from 29th May up to 18th June 2013 giving a total of nineteen (19) days. Before commencing data collection the confined group was given an adaptation period of nineteen (19).

Data regarding milk yield from the two groups of animals in the first nineteen (19) days was collected and recorded on daily basis.

Statistical model

$$Y_i = \mu + R_i + \varepsilon_i$$

where: Y_i = observed milk yield on the individual cow of the i^{th} rearing method

μ = overall mean

R_i = effect of the i^{th} rearing method

ε_i = random error component

Results

Average Milk Yields of Free Grazing and Confined Cows

When evaluated across groups average milk yields varied with treatment, with Free Grazing Cows having the highest yield (5.69ltrs) and Confined Cows recording the lowest (3.89) (table 2 and figure 1).

Trt	DAYS																		
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19
FGCw	5.63	5.7	6.06	5.76	6.16	5.63	6.26	5.96	5.93	5.16	5.53	5.53	5.93	5.53	5.36	5.33	5.63	5.66	5.46
CCw	4.10	4.20	4.66	4.40	4.63	4.73	4.36	4.00	4.16	3.46	3.66	3.66	3.76	3.50	3.46	3.50	3.46	3.26	2.96

	TOTAL(Y)	MEAN($\bar{Y}$)
FGCw	108.21	5.69
CCw	73.92	3.89
	∑Y=182.13	∑$\bar{Y}$= 4.79

Table 2: Average daily milk yields in litres for Free Grazing and Confined Cows

D = Day, CCw= Confined Cow, FGCw = Cow on Free Grazing,

Mean milk yields for the two treatments were significantly ($p<0.05$) different (table 3).

Source	df	SS	ms	F.Cal	F.tab
Total	37	37.14			
Trt	1	30.94	30.94	182*	4.08
Error	36	6.2	0.17		

Table 3: Analysis of Variance Table for milk yields

*means are significant, CV = 20.91%

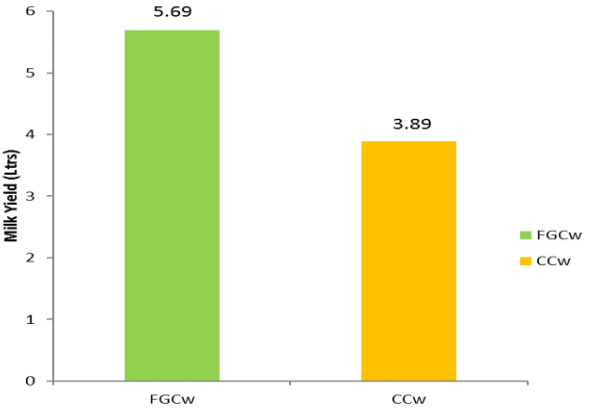

Fig. 1: Av. Milk Yield for Free Grazing and Confined Cows

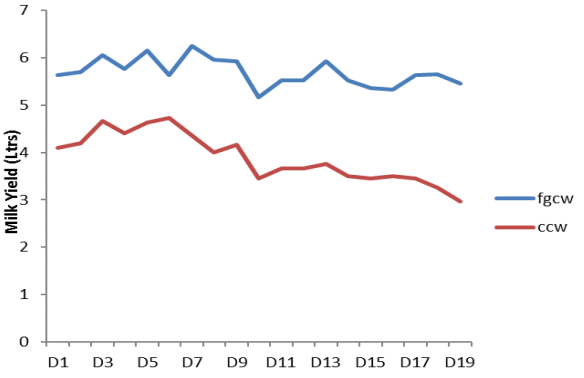

Fig. 2: Av. Daily Milk Yields for Free Grazing and Confined Cows

Milk yields of Confined Cows before and during Confinement

Average milk yields before and during confinement varied with a higher value (4.82ltrs) observed before confinement (Table 4).

Trt	DAYS																		
	1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19
MYBC	5.33	4.83	5.13	5.1	5.1	5.2	5	4.9	4.76	4.83	5.13	4.5	4.46	4.43	4.43	4.36	4.53	4.33	5.16
MYDC	4.1	4.2	4.66	4.4	4.63	4.73	4.36	4	4.16	3.46	3.66	3.66	3.76	3.5	3.46	3.5	3.46	3.26	2.96
														TOTAL			**MEAN**		
													MYBC	**91.51**			**4.82**		
													MYDC	**73.92**			**3.89**		
														∑Y=165.43			**∑$\bar{Y}$ = 4.35**		

Table 4: Milk yield before and during confinement (Ltrs)

D = Day, MYBC= Milk Yield before Confinement, MYDC = Milk Yield during Confinement

Average milk yields before and during confinement were 4.82ltrs and 3.89ltrs respectively (Table 4 and Fig 3). Mean milk yields for the confined group before and during confinement were significantly ($p<0.05$) different (Table 5).

Source	df	SS	ms	F.Cal	F.tab
Total	37	14.89			
Trt	1	8.14	8.14	43.29*	4.12
Error	36	6.75	0.188		

Table 5: Analysis of Variance Table for milk yields

*means are significant, CV = 14.6%

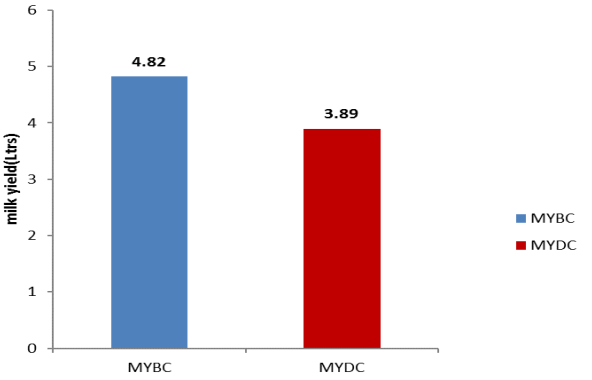

Fig. 3: Av. Milk yield in litres before and during confinement

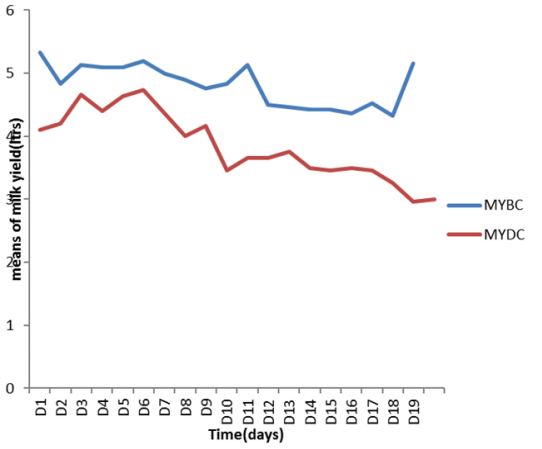

Figure 4: Milk yields for the confined group before and during confinement

Discussion

Milk Yield before Confinement (MYBC) ranged from 4.33 ltrs to

5.33 ltrs with an average of 4.82 litres (SE= ±0.15) while Milk Yield during Confinement (MYDC) ranged from 2.96 to 4.76 litres with an average of 3.89 litres (SE= ±0.15) (Table 3).
The two means differed significantly ($p<0.05$) indicating the average effect of confinement on milk yield in dairy animals.

In this study the same group of animals performed better in terms of milk yield when on free range. There was a general decline in milk yield when the same group was subjected to confinement. These results are in agreement with those reported by Harmsworth et al, 2000 who reported that stress from different sources may negatively affect the welfare and productivity of animals.

Milk yield for free grazing cows ranged from 5.16 to 6.26 ltrs per day with an average of 5.69ltrs (SE=±0.23). Milk yield among confined cows ranged from 2.96 to 4.73 litres with a mean of 3.89 litres (SE=±0.23). The two means differed significantly ($p<0.05$), reflecting superiority of free grazing method in milk yield over confinement method (table 2).

Conclusion

Results of this research show that method of rearing has an effect on milk yield of a dairy cow. This research has revealed that confining dairy cows leads to reduced milk yield. This means that confinement is a form of stress which affects the normal physiological processes among them hormone levels, milk secretion and milk let down. Lack of exercises, reduced variability of feed composition, temperature levels and deprivation of socialization are some of the factors that are associated with confinement which contribute to stress levels.

It would, however, be recommended that further research be carried out involving other breeds to see how they would perform in confinement. This particular research used the Batoka cross which is a cross of Sussex and Friesian. A further research should be carried out to ascertain whether

confined animals adapt after some time and if the milk yield improves. This could be done by increasing the adaptation period beyond what was used in the present study.

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