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Effect of ventilation, floor space allowance and cooling arrangement of cattle shed on milk yield of local and cross breed dairy cattle in Ganjam

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Key words: Breeds, Cattle, Milk yield, Microclimate.

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Abstract

Twenty farmers consisting of small and marginal Dairy Farm from 5 blocks i.e Kukudakhandi, Rangeilunda, Chatrapur, Sorada and Hinjilicut of Ganjam district were considered based on Cross Breed and Indigenous Breed of cattle population for this study. Farmers were Co-operated for collecting information on Cattle shed and milk yield aspect of dairy cattle. Subsequently farmers were grouped accordingly for both above mentioned type of cattle shed and number of cows in the shed. Data was compiled from different studies evaluating the performance of different grades of Cross Breed animals as well as Local Breeds (Singh, 2016). Data on microenvironment of Cattle shed and daily milk yield of cows were recorded besides feeding and disease occurrence (Das *et al.*, 2014). It was observed that Ventilation of cattle shed of Cross Breed Cows Shows Highly significant **(**$P < 0.01$) effect on av. daily milk yield and Indigenous Breed Cows Shows Highly significant ($P < 0.05$) effect on av. daily milk yield whereas Floor space provision inside cattle shed of Cross Breed Cows and Indigenous Breed Cows shows significant ($P< 0.05$) effect on av. daily milk yield Similarly Cooling arrangement in cattle house of Cross Breed Cows shows significant ($P < 0.05$) effect on av. daily milk yield and_Indigenous Breed Cows shows highly significant ($P< 0.01$) effect on av. daily milk yield. It was inferred that besides manual and mechanical cooling if false ceiling is made inside cattle house cow would feel more comfort with higher milk yield. Key words: Breeds, Cattle, Milk yield, Microclimate.

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Introduction

India has one of the largest livestock populations in the world. According to "Indian Dairy Industry Analysis" India is the world's largest milk producer, accounting for around 17% of the global milk production. Besides, it is one of the largest producers as well as consumers of dairy products. The Milk production in India will grow at a CAGR of around 4% during 2011-15 (Himabindu *et al.*, 2014). As per basic animal husbandry statistics (2012) total cattle population in India is 199mn, with total bovine population 304mn. Odisha constitutes 4% of the total bovine population in the country. In global scenario, Indiais thehighest milkproducer with atotal production of137.7 million tonne (BAHS, 2015). Buffalo contribute 51%, while cow produces 45% of India's total milk (2010-11). Out of cow milk major chunk (53%) is contributed by crossbred cows. It is because average milk productivity of indigenous cow in India is only 2.2kg/day. Since intensive cattle development Project-1965, crossbreeding became a national policy for cattle breeding (DAHD, GOI, 2012) for rapid improvement in milk production of indigenous cows. In today's scenario 23% of cow's population in India belongs to crossbred cattle.

Current trend indicates that crossbreed cattle population is increasing more rapidly (7.58% per annum) than indigenous cattle and buffalo (0.85 and 1.84%, respectively). It can be predicted that in future there will be further increase in high yielding crossbred cattle population in India. In one hand crossbred cows are better milk producer, efficient feed convertor, heavier and are more docile in nature. But on another hand they are comparatively more susceptible to climatic stress, management conditions and disease. Therefore, better care and management including comfortable housing and resting place is of utmost importance (Mishra *et al.*, 2017).

Odisha is one of the least developed states in India. Odisha is one of the eastern states of India having tremendous agriculture and allied opportunity. Odisha has total land area of 1,55,820sq. Km with 30 districts having population of 4.19 Cr (Panda and Mishra, 2013). Odisha is not only a Poor state but also affected with malnutrition. Therefore efficient and effective production of milk can bridge the gap of malnutrition in Odisha. Livestock as an integral component of economic and social life of the rural community. Livestock farming in India is part of a composite farming system characterised by crop–livestock interactions (Singh, 2004; Kumar and van Dam 2013). Ganjam is one of the districts in Odisha where milk is very important. In Ganjam, the total bovine population was 123mn in 2012 (Livestock census 2012). Over the two decades, ending in 2014-15 milk production in Odisha has increases from 5.8 LMT in 1994-95 to 19.0 LMT exhibiting a CAGR of 6.4%. Six districts of Odisha i.e. Cuttack, Puri, Ganjam, Jagatsingpur, Baleswar and Jajpur remain major milk sheds accounting for 40% of states milk production. In Ganjam, milk production is 2.665 kg/day and bovine milk production is 1899000 MT in the year 2014-15.

Sanitation plays a significant role in dairy farming. Sanitation is very essential for improving and protecting health of the cattle. It includes proper sewage and drainage system for disposal of waste, urinals of the animals. Sanitation is the process of keeping cattle shed and around the cattle shed clean and healthy, provision of clean water supply and disposal of hazards of contaminated water. Sanitation in cow sheds also includes the gaps of place between cows and disposal of urine and waste. In present time main focus is on cow's comfort, which will increase milk production and eliminate many animal health problems. The most common measure must be taken by the Indian farmers to reduce the temperature which will directly effect on dairy cattle.

Dairy housing systems have significant impact on the dairy production, overall health and longevity of dairy cattle. Housing management, in reality, is the manipulation of the animal environment to promote the most efficient production of milk. A better understanding of micro climate of shed will greatly enhance managerial capabilities (Das *et al.,* 2014). Ideally housing or management systems should consider animal's preference to improve welfare. Quality cows walked more when on rubber flooring

compared to concrete flooring and made more visits to an automated milking system (Ouweltjes *et al.*, 2011). It can be said that worldwide due to increased animal welfare standards, flooring of the animal house will take important position. It is related to all the aspects of livestock flooring has been found detrimental to livestock health and production (Mishra *et al.*, 2017).

In India dairy houses mostly are either of tie stall or loose housing type depending upon herd size. For smaller herd, up to 20 cows tie stall is preferred while for greater herd size loose housing is practiced. Some progressive dairy farmers also constructed free stall barns (FAO, 2010). The floor type is one of the most critical parts of the loose housing system because of the effect it has on cattle locomotion (Stefanowska *et al.*, 2001). Association between various flooring with cow behaviour and comfort has been found in several studies. In various behavioural studies it has been established that dairy cow voluntarily select the comfortable flooring (Natzke *et al.*, 1982; Jensen *et al.*, 1988; O'Connell *et al.*, 1992; Herlin, 1997). Cows show preferences between soft or hard (Norring *et al.*, 2010) and in wet or dry surfaces (Fregonesi *et al.*, 2007). Cows clearly prefer to stand and walk on rubber compared to concrete floors (Bergsten, 2010).

Kremer *et al.*, (2012) reported significantly less days to first breeding, higher conception rate, double heat detection rate and less days open in the rubber-slatted floor than concrete-slatted flooring. It is clear from animal behaviour experiments that cows do not lie on hard floors if given a choice (Norring *et al.*, 2010).

Shades can improve animal comfort, productivity and should be designed properly to reduce heat stress. Good housing systems are those that are well designed for ease of management and maintenance at all time. Thiagarajan and Thomas (1990) also found that proper housing helped in reducing the extremes in maximum and minimum air temperatures. So, this Study was taken with the object to develop suitable housing system to enhance comfort of animal and to increase the productivity of dairy cattle.

Armstrong (1994) noticed that the relative daily cows' production is constant when temperatures are low and medium, while after passing a threshold, starts to decrease. The rate of decline increases with rising temperatures. Exposition of dairy cattle to high ambient temperatures (Ta), high relative humidity (RH) and solar radiation for extended periods decrease the ability of the lactating dairy cow to disperse heat. At the same time, lactating dairy cows create a large quantity of metabolic heat. So, accumulated and produced heat joined with decreased cooling capability induced by environmental conditions, causes heat stress in the animals. Finally, heat stress induces increase of body temperature. Johnson (1980) observed that when the body temperature is significantly elevated, feed intake, metabolism, body weight and milk yields decrease to help alleviate the heat imbalance.

Beside changes in milk yield, heat stress could also cause changes in milk composition, somatic cell counts (SCC) and mastitis frequencies (Rodriguez *et al.*, 1985, Du Preez *et al.*, 1990b). Increase of relative humidity to 90% induces additional decrease of milk yield for 31, 25, and 17% of normal yield. Use of a temperature-humidity index is a one way to measure the combined effect of temperature and humidity. A mean daily THI in value of 72 is considered to be the critical point at which milk yield is reduced (Johnson, 1987). Increasing THI in the range of 71 to 81 reduced the milk yield and intake of feed and water for dairy cows (Johnson *et al.*, 1963). The effect was greatest when THI exceeded 76. Du Preez *et al.* (1990b) stated that milk production is affected by heat stress when THI values are higher than 72, which corresponds to 22°C at 100% humidity, 25°C at 50% humidity, or 28°C at 20% humidity.Kohli *et al.* (2014) also reported that in high yielding crossbred cows there was a significant decrease of milk yield when THI was above 80. The livestock has been well knit with the socioeconomic fabric of our rural economy and plays a vital role in the employment and income generation. The Majority of the farmers who are marginal and small, generally rear one or two milk animals, mainly using crop residue, by products and family labour especially women & children (George, 1996).

Milk production is growing at 5% leaving gap between demand and supply (DAHD, 2012). In order to convene the rapid growing demand and you increase the milk production as it has number of corresponding profit, weight should be given to milk production around 80% of rural households depend on livestock & draw about 30% of their annual income from livestock. According to 2012-13 information odisha's target fodder production is about 26501.00 quintals (economic survey of Odisha 2014). Milk production of Odisha was about 1.861 Mt against 137 MT in 2013-14 from 1.651 MT in 2009-10. It is observed that though the per capita availability of milk has increased from 67g /day in 2000-01 to 117g/ day in 2013-14 (Economic survey of Odisha, 2014) still far after the all India per capita availability, 290g /day in 2013-14 and worked average of 285g/day. The sector has ample scope to substantially enhance the production to meet the domestic, create employment and income generating opportunities for the rural poor and enhance their food and livelihood security. Consumers have a high price elasticity of demand formal products.

The problem is severe when milk producers are landless, small, marginal farmer lack of having scientific knowledge to boast the animal productivity. This results in increased cost of milk product. Various inputs like green fodder, dry fodder, concentrate, labour etc. are used as input resources in milk production under such situation; it is worth to examine whether milk production is profitable or not (Prusty and Tripathy, 2015). So, the object of this study is to quantify the effect of micro climatologically changes on milk production of dairy cattle (local and cross breed) in Ganjam.

1) To develop suitable housing system, to enhance comfort of animal and to increase the productivity of dairy cattle.
2) To increase the Milk Yielding of cows in Ganjam.
3) To Maintain Good Health in Dairy Cows by reducing Diseases.
4) To increase the income of small Dairy farmers of Ganjam.

Materials and methods

Study Area

Twenty farmers consisting of small and marginal Dairy Farm from 5 blocks of Ganjam district i.e Kukudakhandi, Rangeilunda, Chatrapur, Sorada and Hinjilicut.

Methods

The study is primarily based on secondary data. The data was collected from 20 Farmers having at least 10-15 Cross breed of cows each and 10 farmers having at least 3-4 indigenous breed of cows. Data were collected from farmers on housing and dairy production system such as system of management, type of cattle shed, Orientation of cattle shed, ventilation of cattle shed, roofing materials, floor space, cooling system in the cattle shed, Breed of animal, fodder and feeding procedure, Sanitation and health status of animal etc.

Apparatus Used

Digital Hygrometer, Dry Bulb- Wet bulb thermometer, Lactometer was used for measuring and recording accurate data.

Procedure

Each farmer's house was visited regularly for monitoring of milk production, reproduction and health aspect of animal. After observation for a period of six months, Milk yield of cows were recorded twice daily as per standard procedure for ten consecutive days.

Data Analysis

Data on microclimate was recorded regularly in the morning, as per IMD (1994) THI (Temperature Humidity Index) was calculated as per West (1994). Data for all variables were subjected to analysis of variance using Micro soft Excel.

Result and discussion

Effect of cooling arrangement

Cross Breed Cows

Cooling arrangement in cattle house of shows significant ($P< 0.05$) effect on av. daily milk yield and all the micro environmental parameters. While highly significant ($P< 0.01$) effect on avg. daily air

temperature, and also highly significant (P< 0.01) effect on avg. daily relative humidity index. Average daily milk yield (10.98±0.07kg) in lower air temperature (26.5±0.18°C), and lower relative humidity (73.7±0.28%) was significantly lower in cattle shed in all the micro environmental parameters. It was inferred that besides manual and mechanical cooling if false ceiling is made inside cattle house cow would feel more comfort with higher milk yield. (Table 1 & Fig. 1)

Table 1. Effect of Cooling Arrangements on Cattle Shed of Cross Breed Cows.

Ventilation of Cattle Shed	Average Daily Milk Yield (Kg)	Average Daily Air Temperature (C°)	Average Daily Relative Humidity (%)
Good	10.98±0.07(30)	26.5 0.18(30)	73.7±0.28(30)
P Value	P < 0.05	P < 0.01	P < 0.01
Normal	8.88±0.03(30)	29.6 0.02(30)	77.1±0.06(30)
F Value	1.2	2.79	1.2

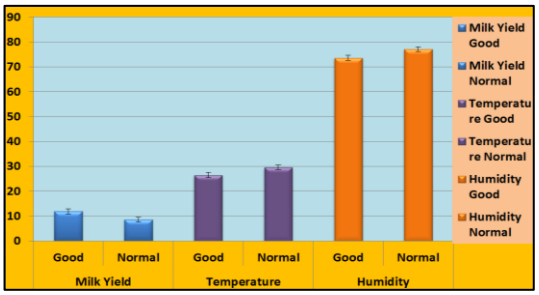

Fig. 1. Effect of Cooling System in Cross. Breed.

While highly significant (P < 0.01) effect on avg. daily air temperature, and significant (P< 0.05) effect on avg. daily relative humidity index.

Average daily milk yield (4.98±0.1kg) in lower air temperature (26.5±0.27°C), and lower relative humidity (73.7±0.28%) was significantly lower in cattle shed in all the micro environmental parameters.

It was inferred that besides manual and mechanical cooling if false ceiling is made inside cattle house cow would feel more comfort with higher milk yield. (Table 2 &Fig. 2)

Indigenous Breed Cows

Cooling arrangement in cattle house shows highly significant (P< 0.01) effect on av. daily milk yield and all the micro environmental parameters.

Table 2. Effect of Cooling Arrangements on Cattle Shed of Indigenous Cows.

Ventilation of Cattle Shed	Average Daily Milk Yield (Kg)	Average Daily Air Temperature (C°)	Average Daily Relative Humidity (%)
Good	4.98±0.1(15)	26.5 0.27(15)	73.7±0.28(15)
P Value	P < 0.01	P < 0.1	P < 0.05
Normal	3.60 ± 0.09(15)	29.6 0.03(15)	77.1±0.66(15)
F Value	2.4	2.15	0.69

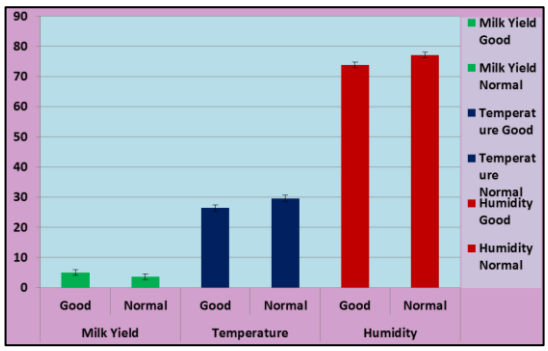

Fig. 2. Effect of Cooling System in Indigenous Breed.

Cooling arrangement in cattle house had highly significant effect on average daily milk yield and all the micro climatologically parameters. It was observed that average daily milk yield (10.69±0.33kg) was highest while average daily air temperature (26.62±0.14) were lowest in cattle shed where false ceiling was made by areca stem besides manual and mechanical cooling by electric fans (Fig.-3). So it was inferred that besides manual and mechanical cooling if false ceiling is made inside cattle house cow would feel more comfort with higher milk yield. Suriyasathaporn *et al.* (2006) reported that the use of electric fan in cattle shed operated during the day time increased milk production of cows during the first period of lactation. Appropriate technology is required to ease the impact of heat stress on dairy cows introduced to the humid tropics especially in the summer.

It was shown repeatedly that access to shade minimized radiation as much as 30% and reduced heat stress substantially (Roman-Ponce *et al.*, 1977). Alternatively, high performance fans may have great potential in improving milk yields (Igono *et al.*, 1987).

Effect of Floor Space

Cross Breed Cows

Floor space provision inside cattle shed of shows significant (P< 0.05) effect on av. daily milk yield and all the microenvironments. While highly significant (P< 0.01) effect on avg. daily air temperature, and also highly significant (P< 0.001) effect on avg.

Daily relative humidity index. Average daily milk yield (11.13±0.05kg) in lower air temperature (25.5±0.18°C), and lower relative humidity (80.0±0.34%) were observed in cattle shed where standard floor space of minimum 4m² per cattle was maintained. (Table 3 & Fig.3).

Table 3. Effect of Floor Space on Cattle Shed of Cross Breed Cows.

Ventilation of Cattle Shed	Average Daily Milk Yield (Kg)	Average Daily Air Temperature (C°)	Average Daily Relative Humidity (%)
Good	11.13±0.05(30)	25.5±0.18(30)	80.0±0.34(30)
P Value	P < 0.05	P < 0.01	P < 0.001
Normal	8.99±0.04(30)	30.1±0.11(30)	84.4±0.33(30)
F Value	1.17	3	1.6

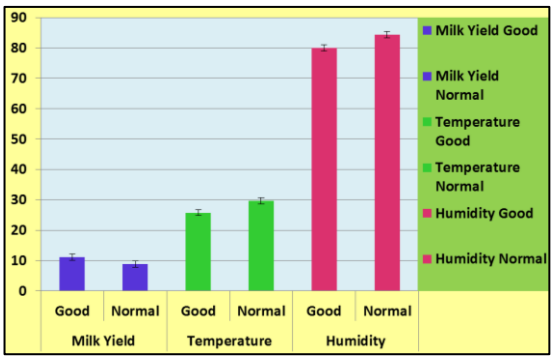

Fig. 3. Effect of Floor Space in Cross Breed.

Indigenous Breed Cows

Floor space provision inside cattle shed of shows significant (P< 0.05) effect on av. daily milk yield and all the microenvironments. While highly significant (P< 0.001) effect on avg. daily air temperature and also highly significant (P< 0.01) effect on avg. daily relative humidity index. Average daily milk yield (5.09±0.09kg) in lower air temperature (25.5±0.21°C), and lower relative humidity (80.0±0.32%) were observed in cattle shed where standard floor space of minimum 4m² per cattle was maintained. (Table 4 & Fig.4).

Floor space provision inside cattle shed had highly significant effect on average daily milk yield in all the microclimates. Average daily milk yield was significantly higher while average daily relative humidity was significantly lower in cattle shed where standard floor space was maintained. So it indicates that standard floor space of 4 m² should be maintained to get better milk yield. Meen akshisundaram *et al.* (2009) reported that in poor type of cattle house where floor space provision was 2.61m² per cow, relative humidity was found to be significantly higher than that of good type of cattle house where floor space provision was 3.84m² per cow.

Table 4. Effect of Floor Space on Cattle Shed of Indigenous Cows.

Ventilation of Cattle Shed	Average Daily Milk Yield (Kg)	Average Daily Air Temperature (C°)	Average Daily Relative Humidity (%)
Good	5.09±0.09(15)	25.5±0.21(15)	80.0±0.32(15)
P Value	P < 0.05	P < 0.001	P < 0.01
Normal	3.70±0.05(15)	29.8±0.16(15)	80.1±0.47(15)
F Value	2.6	2.6	1.8

Stergarr doe *et al.* (1986) stated that restriction of floor space adversely affected the behaviour of cows. In France, even under.

The temperate conditions, Brouillet and Raguet (1990) suggested a floor space allowance of 6m² per cow.

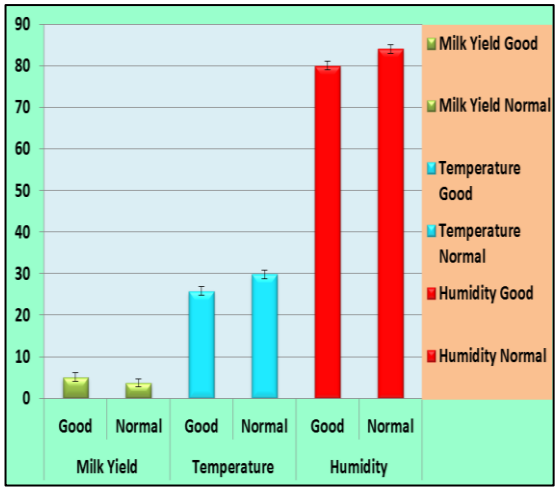

Fig. 4. Effect of Floor Space in Indigenous Breed.

Effect of ventilation on shed

Cross breed cows

Data analysis revealed that Ventilation of cattle shed of Shows Highly significant (P< 0.05) effect on avg. daily milk yield, while significant effect (P< 0.01) on avg. daily air temperature, and significant (P< 0.001) effect on avg. daily relative humidity index. Lesser heat stress and more milk yield were observed in cattle house having east–west orientation. Significantly higher milk yield (11.33±0.04kg), in lower air temperature (24.0±0.06°C), and lower relative humidity (86.7±0.23%) were observed in cattle shed with good ventilation. (Table 5 & Fig.5).

Table 5. Effect of Ventilation on Cattle Shed of Cross Breed Cows.

Ventilation of Cattle Shed	Average Daily Milk Yield (Kg)	Average Daily Air Temperature (C°)	Average Daily Relative Humidity (%)
Good	11.33±0.041(30)	24.04±0.06(30)	86.7±0.23(30)
P Value	P < 0.05	P < 0.01	P < 0.001
Normal	9.11±0.046(30)	28.27±0.03(30)	91.0±0.09(30)
F Value	0.7	3.72	1.75

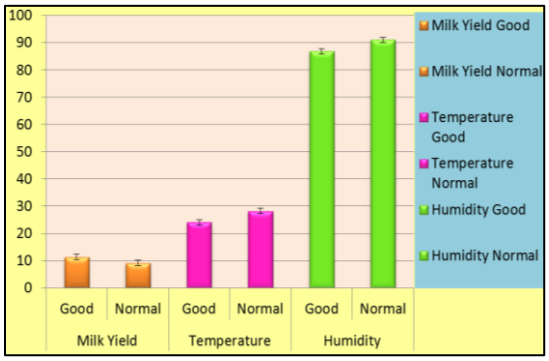

Fig. 5. Effect of Ventilation in Cross Breed.

Indigenous Breed Cows

Data analysis revealed that Ventilation of cattle shed of Shows Highly significant (P< 0.05) effect on av. daily milk yield, while highly significant effect (P< 0.05) on avg. daily air temperature, and significant (P< 0.1) effect on avg. daily relative humidity index. Lesser heat stress and more milk yield were observed in cattle house having east – west orientation.

Significantly higher milk yield (5.28±0.1kg), in lower air temperature (24.0±0.24°C), and lower relative humidity (86.7±0.33%) were observed in cattle shed with good ventilation. (Table 6 & Fig.6)

Good ventilation causes minimal interference with convective and evaporative heat loss from the animals, i.e. allowing natural air movement to carry heat and moisture away from the surface of the animals. Ventilation of shed depends on height, Width and slope of the roof (Bianca, 1965).

Table 6. Effect of Ventilation on Cattle Shed of Indeginous Cows.

Ventilation of Cattle Shed	Average Daily Milk Yield (Kg)	Average Daily Air Temperature (C°)	Average Daily Relative Humidity (%)
Good	5.28±0.1(15)	24.06±0.24(15)	86.7±0.33(15)
P Value	P < 0.05	P < 0.05	P < 0.1
Normal	3.83±0.08(15)	28.2±0.21(15)	91.0±0.14(15)
F Value	1.5	3.61	1.78

Effect of Housing on Disease and Reproductive Disorders

It was observed that mastitis is the most common disease problem whereas repeat breeding is the most acute reproductive problem in farmer's field.

Hard floor surface adversely affects hoof health and comfort, predisposes animal to pain and lameness and ultimately affect productivity. Inadequate floor surface can predispose dairy cattle to several health related issues.

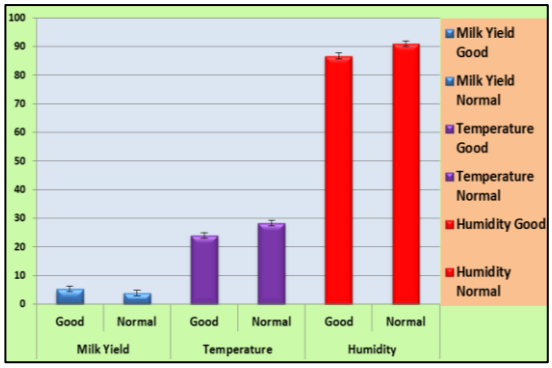

Fig. 6. Effect of Ventilation in Indigenous Breed.

The most prominent among which is the lameness. In India prevalence of lameness has been reported between 8 to 30.5% (Chawla *et al.*, 1991, Singh *et al.*, 1999, Randhawa, 2006, Sood and Nanda, 2013).

There was no association between housing and reproductive disorder. However, mastitis was more prevalent in unhygienic shed and in dairy shed where more animals were accommodated i.e. below standard space was provided to each cow.

So more concern on space provision in the shed is needed to reduce disease problem. However average daily relative humidity was lowest in shed where only manual cooling was arranged. So it was inferred that besides manual and mechanical cooling if false ceiling is made inside cattle house cow would feel more comfort with higher milk yield.

Conclusion

So it was revealed that orientation and ventilation of cattle shed, floor space provision and cooling arrangement in cattle house had significant ($P< 0.05$) effect on average daily milk yield and all the microclimates. Semi open RCC house with east- west orientation and good ventilation was found to be suitable for high milk production and less heat stress on both types of cattle breed. Standard floor space of 4.5m²/cattle was found to be most suitable for higher milk yield and comfort of animal.

False ceiling inside cattle house besides manual and mechanical cooling would render cow more comfort with higher milk yield. So it was revealed that appropriate sanitation, Ventilation and in- time feeding with adequate water plays a significant role for keeping the animal Healthy and Disease free.

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