TO STUDY THE IMPACT OF CONTROL SHED CONDITIONS ON MILK PRODUCTION

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Abstract

Pakistan is ranked among the top five world milk production countries in the world. However the average milk production from a single dairy animal is seven times lower than the other developed countries. Despite the genetic differences, management and technologies are the major reasons for low milk production in the country. The better management and installing the latest technologies in the shed can provide the environment which can enhance the milk production. A case study was conducted in province Punjab of Pakistan to investigate the impact of control shed conditions on relative humidity and temperature of shed and ultimate effect of relative humidity and temperature on milk production. In these two sheds, one shed was kept under normal environmental conditions whereas temperature and humidity at the other shed was controlled by cooling systems. The main components of the cooling system were exhaust, ceiling fans and sprinkler which were used to control the temperature and humidity within the shed between optimum limits of 27^0C to 33^0C and 60 to 70%, respectively. Digital hygrometer was used for measuring relative humidity and temperature. The results indicated that 60 minutes of

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watering can increase 1 liter of milk from 5 cows in one day. By an extra 60 minutes of watering, 1 liter milk per day during the summer can be achieved. Moreover the results showed that sprinklers should deliver large drops to wet cows on their skins.

Keywords: Controlled shed conditions, milk production, Pakistan

Introduction

Livestock plays an important role in the economy of many developing countries. It provides food, or more specifically milk and protein for the human diet, sources of income, and possible employment opportunities. Consumption of livestock products e.g., organic fertilizer, milk, and meat at all the scales are growing rapidly in many developing countries **(**Garcia et.al**,** 2002). In Pakistan milk production mainly managed by small-scale dairy farming which are 70 % of the total farms in Pakistan (Garcia et.al**,** 2002). Among them the milk production is considered as a livestock enterprise which provides a relatively constant stream of income to improve livelihoods of the farming community. The recent years, increase in prices has attracted the farmers to invest in this sector which resulted that 3.5 million tons milk produced during the year 2009 which was highest in the history of Pakistan (FAO, 2009). Pakistan ranked as 4^{th} largest milk production country among other milk producing countries in the world with over 30 billion liters of milk produced annually (PDDC, 2008). However, comparison of average milk yield from a single milk producing dairy animal among various countries shows that one single New Zeeland dairy animal produced as much as three dairy animals in Pakistan whereas one American cow produced as much as seven Pakistani cows (PDDC, 2008).

This small amount of milk production depends upon several factors like genetics, technology and management but the most important factor was the environmental control shed. The milk production in Pakistan not only depends on genetic and physiological factors but also fluctuation in temperature and relative humidity which have significant impact on milk production. A decrease in impregnation rate and milk yield caused by heat stress has been a great shock to dairy farmers in hot weather.

Installation of evaporating cooling in sheds cause improvements in ameliorating heat stress in cows in hot-wet environments by utilizing the low humidity conditions. The cows housed in controlled environment had both rectal temperature (39.09°C) and respiration rate (61.39 breaths/min) significantly lower than that cows which are under non controlled conditions having 41.21°C and 86.87 breaths/min, respectively. The former group also had higher milk yield and more efficient reproductive performance than the latter group (Khongdee et al. 2006). Lee et al. (2010) conducted an experiment for one calendar year from Holstein cows lactating under Louisiana ambient climatic conditions comprised a total of 264 cow-months. The authors divided the year into seasons of cool, intermediate, and hot temperatures and reported that milk production was depressed during the hot temperature-season. They further reported that rectal temperatures and respiration rates were indicative of heat stress in the hot temperature-season.

Therefore, the objective of this study was to use conditioning systems with ventilation and misting which may reduce heat stress and hence the impact on milk production is minimal.

Materials and Methods

Location of Study Area

The study area is located in district Lahore of Punjab, Pakistan. Awan Dairy Farm Khonti Border Lahore was selected to investigate the impact of controlled shed conditions on milk production (Figure 1). This site is selected due to availability of the milking buffalos, manpower on the shed, facilities to implement the control conditions and an alternate energy source of electricity generator in case of electricity shortage for smooth running of experiment.

Description of Experiment

The experiment was started on 17-03-2009. The data was collected from 23-03-2009. The data collected is as under

Two sheds were selected for the study. One shed was kept under normal environmental conditions whereas temperature and humidity at the other shed was controlled by cooling systems. The sheds were designed in a way that front side of the sheds was open which allowed the air escaped from the ventilation system to pass through and hence caused the cross ventilation. Digital hygrometer was used for measuring relative humidity and temperature. The main components of the cooling system were exhaust and ceiling fans.

The shed was 30 ft long, 8 ft high and 25 ft wide. In order to maintain friendly environment in the sheds two exhaust fans of 20 inch, two ceiling fans of 24 inch, and two sprinklers were installed. The one sprinkler covered an area of about 13 to 14 ft.

A total of 5 Buffalos in each shed were selected for the current experiment. The apparatus to control the temperature and humidity was installed at shed A. Initially the 5 buffalos were kept in the shed A whereas remaining 5 buffalos were kept in the shed B for 10 days. After 10 days buffalos are kept under normal condition for five days and then there positions were interchanged in sheds and again data was taken for 5 days.

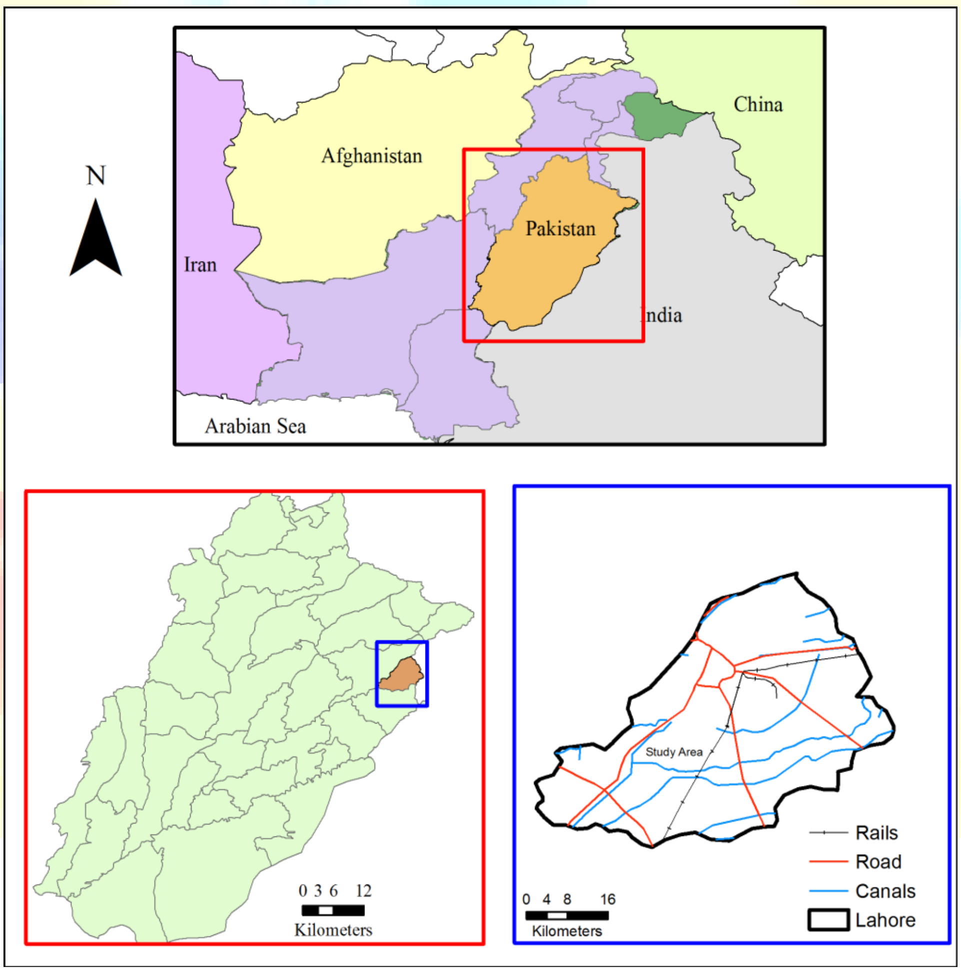

Figure 1 Location of the study area in province Punjab of Pakistan

Statistical Analysis

The data collected were statistically analyzed by using Cross over Design. In experiments where the animal/person/experimental unit remains on the treatment from the start of the experiment until the end we can call this a continuous trial. Completely Randomized Design (One-Way ANOVA), Two-Way ANOVA, Randomised Complete Block Designs) and Factorial Models are all examples of continuous trials. In a cross-over (also called a change-over trial), however, each animal will receive consecutively two or more experimental treatments during the course of the experiment; this has similarities with the Latin Square design.

To check the trend of effectiveness of milk production by temperature, the linear and quadratic equations were fitted.

Humidity is also a very important factor for the buffalos which effects the production of milk. A suitable level of humidity will lead to the higher milk production per animal. The data collected was analyzed by using cross over design and the results were discussed in the Table 1 and Table 2.

Results and Discussion

The data collected for temperature were then statistically analyzed by using Cross Over design. There is no statistically significant (p-value=0.143) linear relationship between the temperature and milk production as presented in Table 1. When the quadratic equation is fitted for the same relation, a p-value of 0.011 shows the best fit line for the relation. The quadratic relationship also shows that the optimal temperature for maximum milk production is in the range of 25^0C to 30^0C as presented in Figure 2. The upper limit of ambient temperatures at which buffalo may maintain a stable body temperature is 25 to 26°C, and that above 25°C practices should be instituted to minimize the rise in body temperature. However, in the Southeast one of the major challenges is the combined effects of high relative humidity with high ambient temperature.

Table 1: Analysis of variance of temperature effect on milk production

Equation	Model Summary	Parameter Estimates

	R Square	F	d f 1	d f 2	Significance	Constant	b 1	b 2
Linear	0.059	2.245	1	36	0.143*	3.902	-0.016	
Quadratic	0.228	5.174	2	35	0.011	0.066	0.272	-0.005

Independent variable: Temperature Dependent variable : Milk Production
Results are in-significantly different when p<0.05

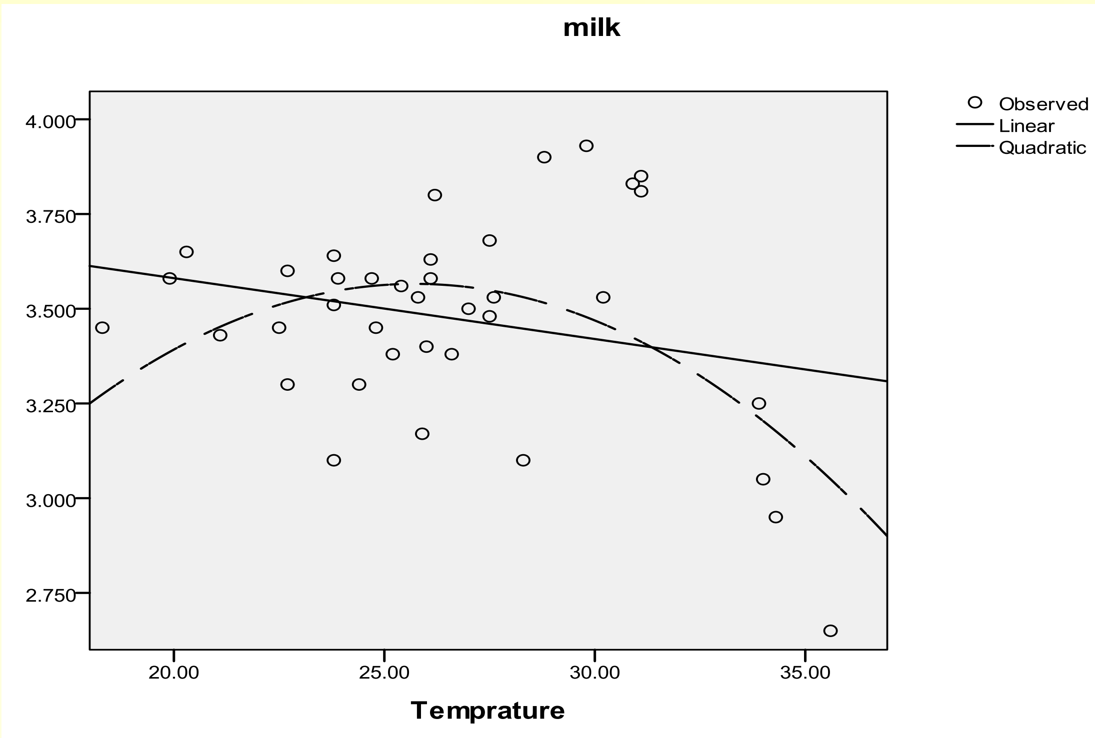

Figure 2 The effect of temperature on milk production. Temperature is in Celsius scale whereas milk production is in liters.

To check the trend of effectiveness of milk production by humidity, the results of the linear and quadratic equations show discrepancies (Table 2). The linear equation is not well fitted as p-value = 0.338 which is greater than 0.05 which means that the relationship between humidity and milk production is not linear. However the quadratic equation is fitted well as p-value is 0.024 which is less than 0.05. It is observed that the best humidity for the maximum milk production is in between 55 to 75% as indicated in Figure 3. The results also show that the required humidity level only maintained in the controlled conditions i.e. in shed with installations. West (2003) stated that high relative humidity compromises evaporative cooling, so that under hot and humid conditions, common to the Southeast in summer, the dairy cow cannot dissipate sufficient body heat to prevent a rise in body temperature. Increasing air temperature, temperature-humidity index and rising rectal temperature above critical thresholds are related to decreased Dry Matter Intake (DMI) and milk yield and to reduced efficiency of milk yield. Hagiwara et al. (2002) reported that the evapotranspiration at which the respiration rate started to increase was lower (17^{o}C) for high-producing cows (>35 kg milk/day) than that (22^{o}C) of low- producing cows. The only way to dissipate heat is to allow the environment air to reach at the same temperature as the animal's latent heat. If the environmental air is saturated, there will be no latent heat loss.

Table 2: ANOVA for the Effect of Humidity on Milk Production

Equation	**Model Summary**					**Parameter Estimates**		
	R Square	**F**	**d f 1**	**d f 2**	**Significance**	**Constant**	**b 1**	**b 2**
Linear	0.025	0.942	1	36	0.338	3.301	0.003	
Quadratic	0.077	1.461	2	35	0.024	2.625	0.030	0.005

Independent Variable: Humidity Dependent Variable : Milk Production
Results are significantly different when p<0.05

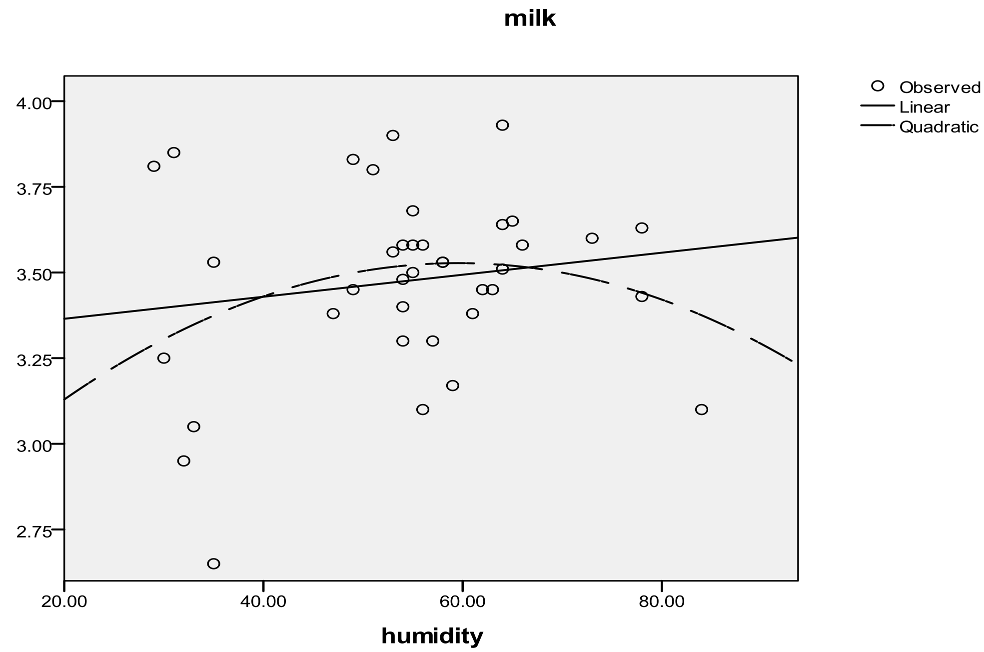

Figure 3 The effect of humidity on milk production. Humidity is in Celsius scale whereas milk production is in liters.

Milk Production in Morning and Evening

The production of milk was recorded twice a day once in the morning and then at evening. The data collected for milk production at morning is shown in the Table (3) where group I indicate that the treatments without any installations and Group II indicate the milk production data with installations. The milk production was increased within the installation is 9% per day at morning time. Bond et al., (1955) was conducted that cows in a shaded versus no shade environment had lower rectal temperatures (38.9 and 39.4°C) and yielded 10% more milk when shaded. Table 4 shows that the mean morning milk production. The F-test was applied on the data to check the significance level of the data. It indicates that the sequence and period are non-significant at 5 % level of significance 0.26 and 0.50 respectively. The mean of treatments are significant at 5 % level of significance. The d.f. of numerator's indicates the degree of freedom of treatment and d.f. of denominator's indicates the degree of freedom of error. The application ANOVA test on morning milk production indicated standard error in Table 5.

Table 3: Morning milk Production

Group-1

Period*	Treat**	Animal 1	Animal 2	Animal 3	Animal 4	Animal 5
1	1	3.405	3.841	4.375	3.922	2.534
2	2	3.283	3.466	3.533	3.772	2.155

Group-2

Period*	Treat**	Animal 1	Animal 2	Animal 3	Animal 4	Animal 5
1	2	4.232	4.465	3.795	3.434	3.725
2	1	4.522	4.512	3.755	2.683	4.083

Period* mean time and treatment
** means buffaloes with installation and without installation.

Table 4: Analysis of Variance of Morning Milk Production

Effect	Num DF	Den DF	F Value	Pr > F
Sequence	1	8	0.26	0.6219
Treatment	1	8	7.97	0.0224
Period	1	8	0.50	0.4981

Table 5: ANOVA of Fixed Effects on Morning Milk Production

Effect	Treatment	Sequence	Estimates	Standard Error	DF	T Value	Pr > t
Treatment	1		3.5538	0.2030	12.7	17.51	<0.0001

Treatment	2		2.9859	0.2030	12.7	14.71	<0.0001
Sequence		1	3.1794	0.2493	8	12.75	<0.0001
Sequence		2	3.3603	0.2493	8	13.48	<0.0001

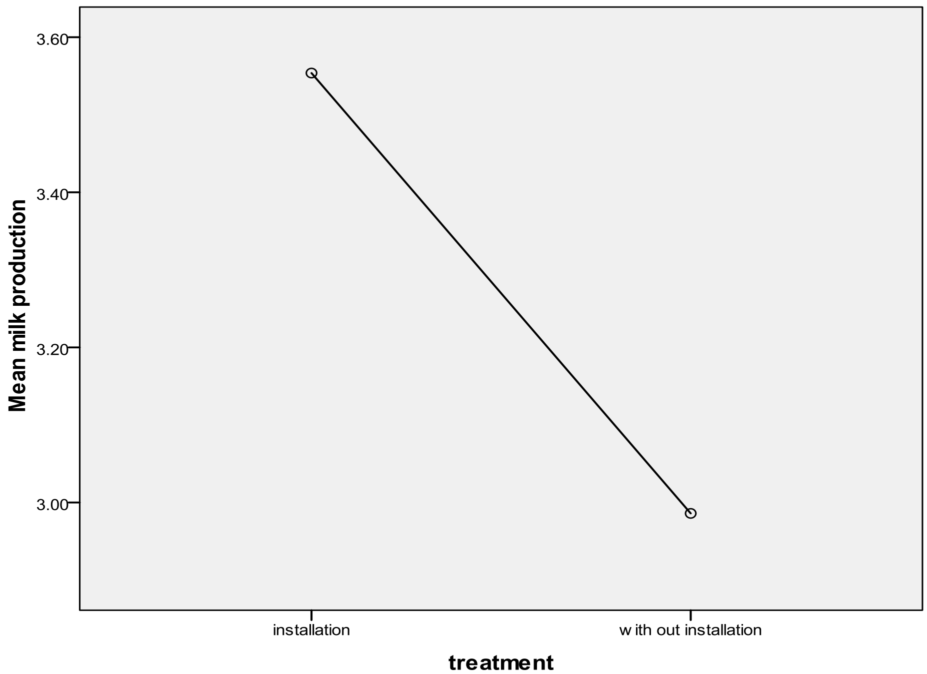

Figure 4 Milk production by treatment 1 (with installation) is greater than treatment 2 (with out installation)

The data collected for milk production at evening is shown in the Table 6 where group I indicated that the treatments without any installations and Group II indicates the milk production data with installations at both places with and without installations. Increasing air temperature, temperature-humidity index and rising rectal temperature above critical thresholds are related to decreased DMI and milk yield and to reduced efficiency of milk yield. Table 7 shows that the mean morning milk production. The F-test was applied on the data to check the significance level of the data. It indicates that the sequence and period are non-significant at 5 % level of significance 0.10 and 0.16 respectively. And the mean of treatments are significant at 5 % level of significance. The d.f. of numerator's indicates the degree of freedom of treatment and d.f. of indicates the degree of freedom of error

Table 6: Evening Milk production

Group-1						
Period*	**Treat****	**Animal 1**	**Animal 2**	**Animal 3**	**Animal 4**	**Animal 5**
1	1	2.845	3.594	3.915	3.345	2.265
2	2	3.066	2.861	3.361	3.452	2.094
Group-2						
Period*	**Treat****	**Animal 1**	**Animal 2**	**Animal 3**	**Animal 4**	**Animal 5**
1	2	3.595	3.965	2.875	2.242	3.355
2	1	3.733	3.666	3.005	2.625	3.572

Table 7: ANOVA of Evening Milk Production

Effect	Num DF	Den DF	F Value	Pr > F
Sequence	1	8	3.31	0.1066
Treatment	1	8	8.98	0.0172
Period	1	8	2.37	0.1624

Table 8: ANOVA of Fixed Effects on Evening Milk Production

Effect	Treatment	Sequence	Estimates	Standard Error	DF	T Value	Pr > t
Treatment	1		3.9606	0.1482	11.4	26.72	<0.0001
Treatment	2		3.5821	0.1482	11.4	24.17	<0.0001
Sequence		1	3.5276	0.1896	8	1861	<0.0001
Sequence		2	4.0151	0.1896	8	21.18	<0.0001

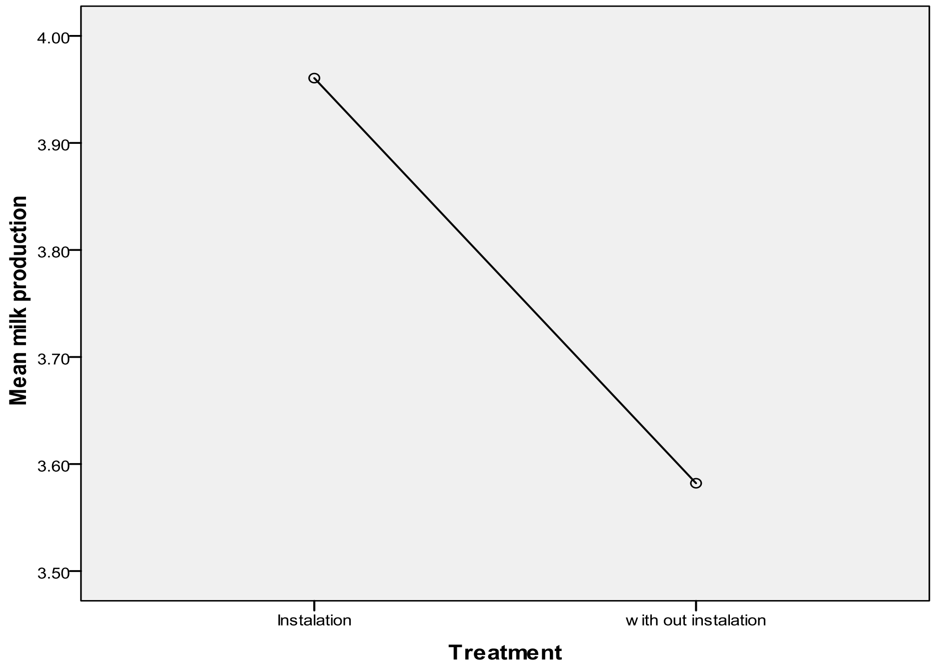

Figure 5 Milk production by treatment 1 (with installation) is greater than treatment 2 (with out installation).

Conclusions

Temperature is an important factor in the production of milk. A suitable/pleasant temperature (27^0C to 33^0C) will lead to a high yield in the milk production. Humidity is also a very important factor for the buffalos which effects the production of milk. A suitable level of humidity (60 to 70%) will lead to the higher milk production per animal Cooling cows at the dairy with shade, sprinklers or fans – before and after milking – will improve their comfort and increases milk production 1 liter/day/5 cows. Dairy trials showed that 60 minutes of wetting cows with sprinklers can produce an extra liter of milk; 120 minutes produced an extra 1 liters in hot weather. The sprinklers should deliver large drops to wet cow's skin.

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