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EFFECT OF SEASONAL VARIABLES ON COW MILK PRODUCTION OF SMALLHOLDERS AT VOLTAR, GORUSINGHE AND JHOLPE VILLAGES IN NEPAL

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The seasonal variables play a significant role in milk production of cow but such study was not done yet in Nepal. This research was objectively carried out to show the variation in temperature, rainfall and humidity and find the effect of seasonal variables on milk production. Small holders of three sites particularly Voltar, Jholpe and Gorusinghe of Dhading, Syangja and Kapilwastu districts respectively were selected for this study. Primary data specifically temperature, rainfall and humidity from automatic local weather stations were recorded from July, 2013 to February, 2014 and daily milk production was noted for 244 days from three farmers of Voltar, four of each from Jholpe and Gorusinghe sites. Collected data were analyzed statistically to compare the milk production of these sites. Moreover natural log regression was used to correlate between milk yield and seasonal variables. Average temperature was 27.19 ^{0}C in June, 2013 at Voltar, maximum rainfall was 615.50 mm in July at Jholpe and humidity was recorded 94.21 % in February at Gorusinghe. Average milk production of small holders showed 9.11, 8.82 and 5.69 L at Jholpe, Voltar and Gorusinghe respectively, hence one way ANOVA and Tukey's b showed differences in milk yileds among them of these sites at 5% level of significant. The r^2 values were 0.460, 0.794 and 0.805 between temperature and milk production of small holders of Voltar, Jholpe and Gorusinghe respectively. Similarly, r^2 value was 0.733 between rainfall and milk yield of Gorusinghe. However, there was varying effect of humidity on milk production.

Keywords: cow, temperature, rainfall, humidity, production

Cattle keeping and dairy profession is the integrated discipline of agriculture system (Zonderland- Thomassen and Ledgard, 2012). This business offers a common platform for more than a billion people and thus promotes the livelihoods of the people especially of rural smallholders in developing countries (Upton, 2004, Doreau et al., 2012). This is because of overwhelming consumption of milk especially more in developing countries (FAO, 2009). Annual average global milk consumption amounts to 100 kg per capita. It is about 300 kg in Western Europe but it is only 10-30 kg in Africa and Asia. It is 30-150 kg per capita in India and less than 30 kg in Nepal (Biradar et al., 2012, NDDB, 2014).

Almost hundred years back, most of the rural people living near the forests were engaged in cattle keeping in Nepal. They had profession to keep the cows and buffalo in herd but this had changed according to modernization in agriculture system and development of infrastructure. The educational access forced people to limit to keep only one or two cows and buffaloes. However, some rural small holders have been interestingly adopted this profession as diary business for income generation. Such profession like cattle keeping is contributing about 24.8 % to the agricultural gross domestic product in total. Remarkably, more than 250 dairies are operating at various villages in Nepal (FAO, 2010, Reshma and Babu, 2014). Some enthusiastic examples

have been observed at rural areas in Kapilwastu, Dhading and Syangja districts. Here, the small holders are professionally keeping Jersey cow in their farm.

There are many factors affecting the milk production of cows. The seasonal variables are one of the major components affecting the milk production. The major variables of season are temperature, rainfall and humidity (Laird, F.C.; Barrell G.K. 2010). The USAID project has established three automatic weather stations at Gorusinghe, Voltar and Jholphe in Kapilwastu, Dhading and Syangja districts respectively to relate the seasonal variables with different traits of living beings. One of the major purposes of this was to explore the relationship between milk production and seasonal variables. In this context, the research questions raised that: a) is there any variation in temperature, rainfall and humidity at these sites and b) is there any effect of seasonal variables on milk production of cow? This research tries to find the answers of these questions.

MATERIALS AND METHODS

Study sites and data collection

Three sites were selected for the study. They were Voltar, Jholpe and Gorusinghe of Dhading, Syangja and Kapilwastu districts. There were automatic weather stations at each site. The temperature, rainfall and relative humidity have been recorded. In fact three farmers have been keeping the cow at Jholpe, four farmers each at Gorusinghe and Voltar villages (figure 1). They have been keeping the cows. At the same time daily milk production per day per cow were also recorded from June, 2013 to February, 2014.

Data analysis

The collected data were anlyzed applying the statistical tools IBM, SPSS 21. Firstly, the graph of temperture, rainfall and relative humidy were presented accoriding to the location of weather station. In detail, the minimum, maximum and average temperature were also analyzed and vairation was estimated. Secondly, the mean monthly milk production, standard error, minimum and maximum values were estimated. At the same time relationship

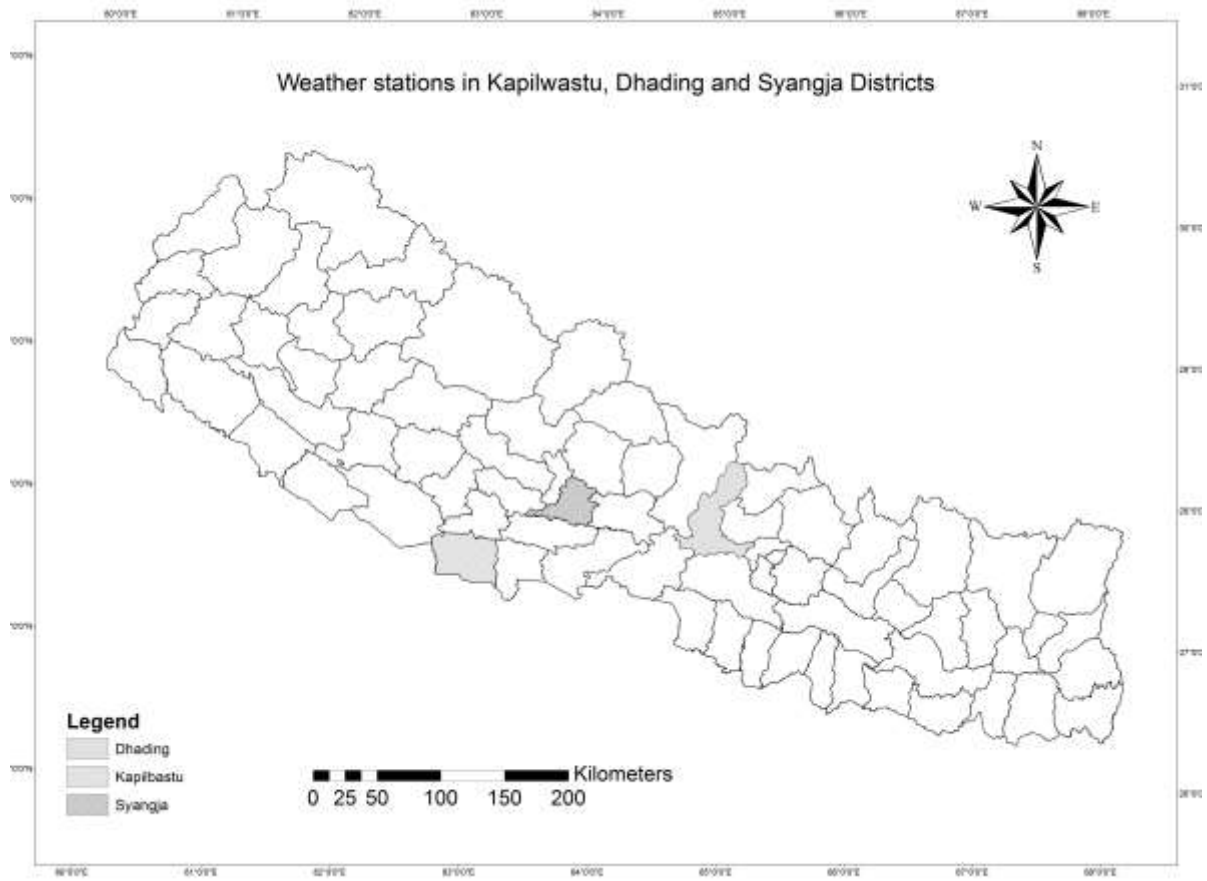

Figure 1: Map of the study area

between mean monthly milk production (dependant varible) and seasonal variables (independent) specifically temperature, rainfall and relative humidity was evaluated. Rgression of Natural log was used to show the relationship between seasonal variables like temperature and rainfall and milk production. At the same time polynominal rgression was also applied to show the relationship between cow milk and relative humidity.

$Y = a + b \ln(x)$……Log natural relation

$Y = a+bx+cx^2$……..

…Polynominal regression

RESULTS

i. Temperature variation at Voltar, Dhading

The temperature varied from June, 2013 to February, 2014. It showed that, the estimated average temperature was the highest 27.19 ^{0}C in June, 2013 and the lowest 13.16 ^{0}C in January, 2014. Similarly, the highest maximum temperature was 34.71 ^{0}C in July, 2013 and the lowest one was 22.19 ^{0}C in January, 2014. In case of minimum temperature the highest record was 23.16 ^{0}C and the lowest record was 4.77 ^{0}C. The temperature variation is due to seasonal change (figure 2). Generally June and July are very hot season and October to February months are cold season in Nepal.

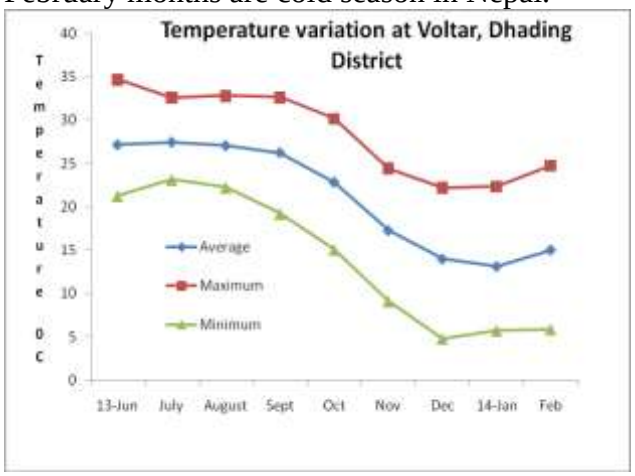

Figure 1: Map of the study area

ii. Temperature variation at Gorusinghe, Kapilwastu

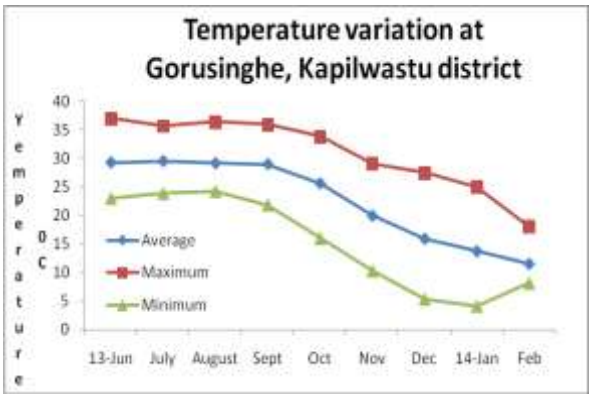

Figure 2: Temperature variation at Voltar, Dhading

Similar trend was found at Gorusinghe in Kapilwastu district too. The average temeprature was the highest in June 2013 with 29.47 ^{0}C and but it ws the least 11.54 ^{0}C in February, 2014. This trend was slightly differed in case of lowest record of maximum and minimum temperature which were 17.95 ^{0}C in February, 2014 and 4.14 ^{0}C in January, 2014 respectively. The highest records of temeperature was about 37 ^{0}C in June, 2013 in case of maximum temperature and 23.87 ^{0}C in July, 2013 of minimum temperature (figure 3).

iii. Temperature variation at Jholpe, Synagja

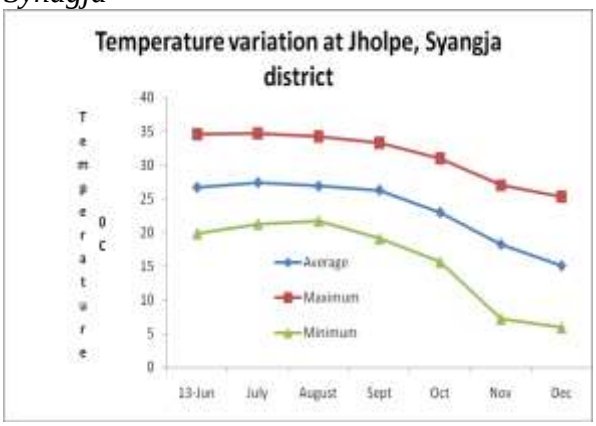

Figure 4: Temperature variation at Jhophe, Syangja district

The record of the highest and the lowest temperature was in July and December respectively. The record was the highest about 34.71, 27.36 and 21.29 ^{0}C of maximum, average and minimum resspectively. The records of the lowest temperature were 25.25, 15.05 and 5.89 ^{0}C of maximum, average and minimum respectively (figure 4).

iv. Precipitation variation in Voltar, Jholpe and Gorusinghe

The rainfall was varied according to the months. In fact, June and July are the main months of rainy season. There is low rainfall in August and some times winter rainfall may occur in Novemebr to December. So, the maximum rainfall was 615.50 mm at Jholpe which was the second highest at Gorusinghe with 615.60 mm in same month. In case of winter rain, it was the highest about 185.40 mm at Gorusinghe (figure 5).

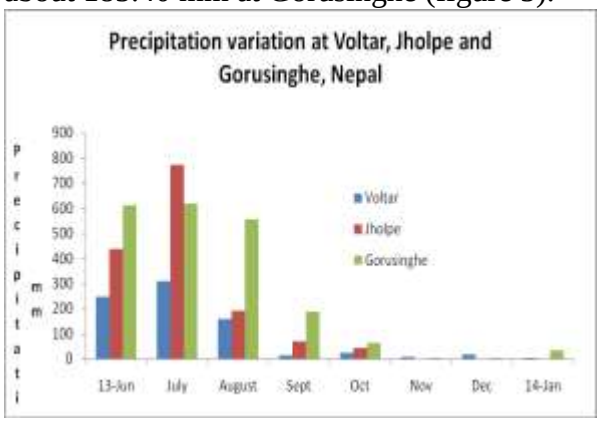

Figure 5: Rainfall variation at Voltar, Jhophe and Gorusinghe

v. Relative humidity

The relative humidity was varied in different months and season. The relative humidity was recorded between 69.19 % in February of Jholpe to 94.21 % in same month of Gorusinghe. The general curve showed it was the dry in November, for instance the the relative humidity of Jholpe and Gorusinghe was 72.55 %. The reason behind this may be, because of drought in winter season in Nepal (figure 6).

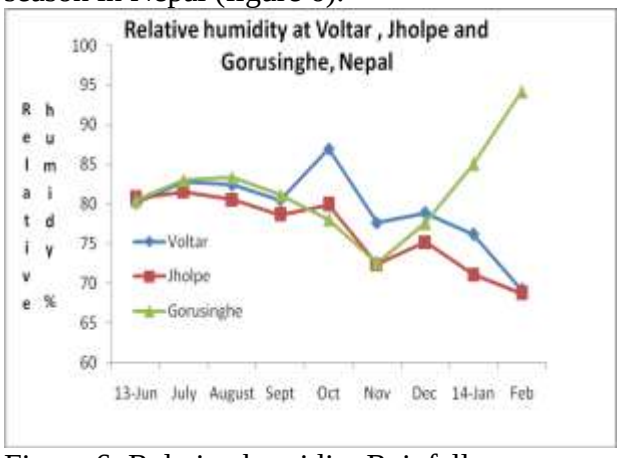

Figure 6: Relative humidity Rainfall variation at Voltar, Jhophe and Gorusinghe

Descriptive statistics of cow milk production at Voltar, Jholpe and Gorusinghe

The average milk production of cow was varied according to different sites. The mean yield of milk was 9.11 L of Voltar, 8.82 L of Jholpe and 5.69 L of small holders at Gorusinghe sites. The minimum milk production was 8.60 L and maximum was 9.90 L of small holders at Voltar.

The one way ANOVA showed that there was significant differences in milk production of cow of different sites at 5% level of significant since P-value was 0.000 smaller than 0.05.

Table 2: ANOVA showing variation in milk production at Voltar, Jholphe and Gorusinghe

At the same time the Tukey's b was applied to compare the milk production of cows at different sites. It showed that, there was significant differences at 5% level of significant in milk production of small holders of different sites since the values are in different subsets.

Relationship between milk production of cow and temperature in Voltar

There was postive relationship between milk production of cow of small holders and temperature using the natural log regression. The r^2 values were 0.460, 0.794 and 0.805 for regression of milk production and temperature of Voltar, Jholpe and Gorusingh sites od Dhading, Syangja and Kapilwastu districts respectively (figure 7, 8 and 9).

Relationship between humidity and milk production

There was no good relationship between relative humidity and milk production of small holders. The natural log regression line showed r^2 values 0.008, 0.011 and 0.000 of Voltar, Jholpe and Gorusinghe sites (figure 10, 11 and 12).

Monthly rainfall vs average milk production

The rainfall was also recorded but its effect is related to the grass production and the consequence is more milk production. The yield of cow milk of small holders was varied according to rainfall variation since relationship between them showing r^2 values were 0.574, 0.350 and 0.733 at Voltar, Jholpe and Gorusinghe of Dhading, Syngja and Kapilwastu districts respectively.

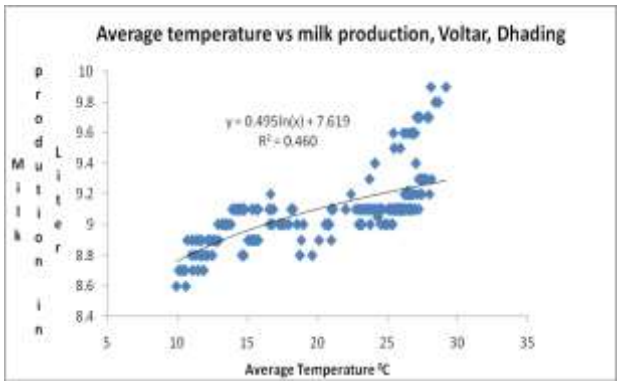

Figure 7: Relationship between milk production and temperature at Voltar, Dhading

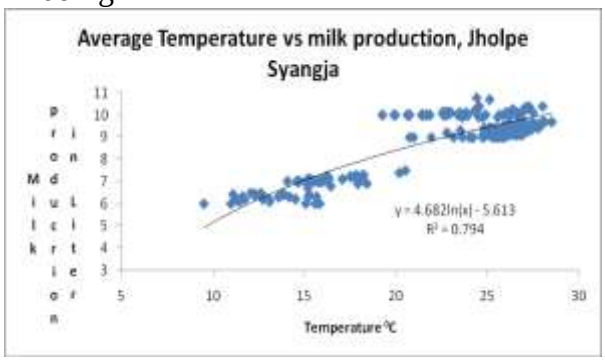

Figure 8: Relationship between milk production and temperature at Jholpe, Syangja

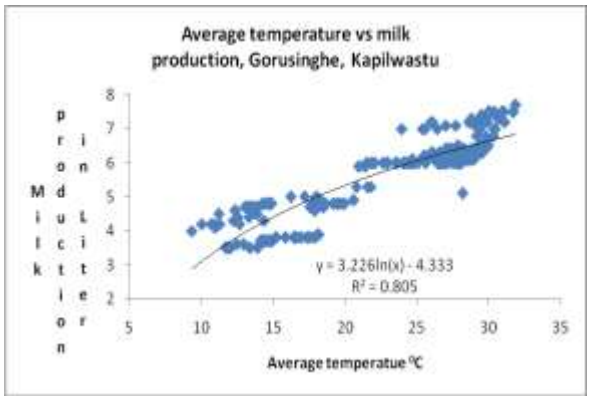

Figure 9: Relationship between milk production and temperature at Gorusinghe, Kapilwastu

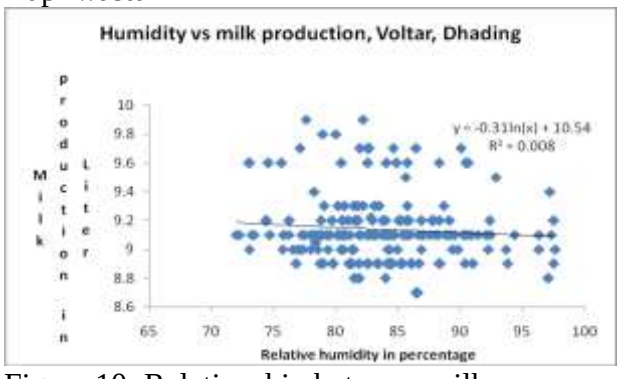

Figure 10: Relationship between milk production and relative humidity at Voltar, Dhading

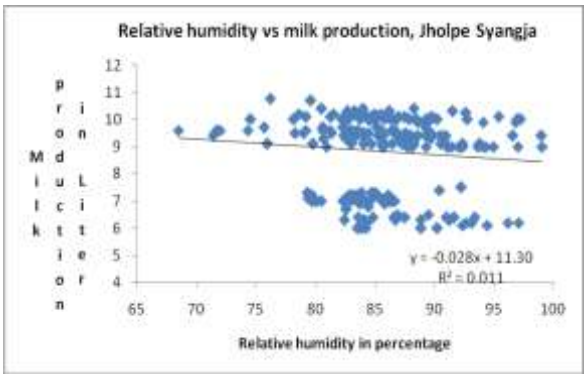

Figure 11: Relationship between milk production and relative humidity at Jholpe, Syangja

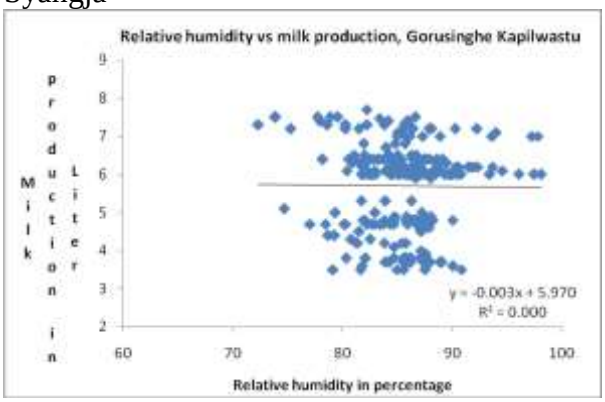

Figure 12: Relationship between milk production and relative humidity at at Gorusinghe, Kapilwastu

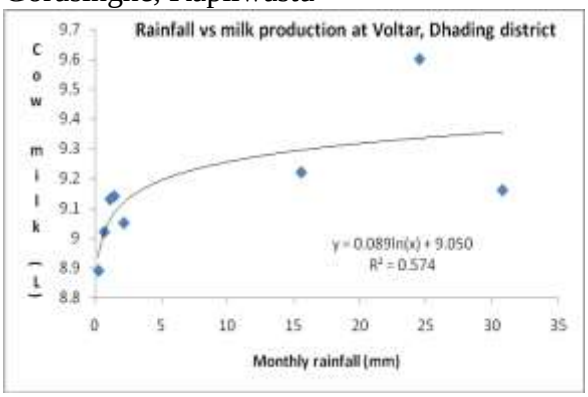

Figure 13: Relationship between milk production and rainfall at Voltar, Dhading

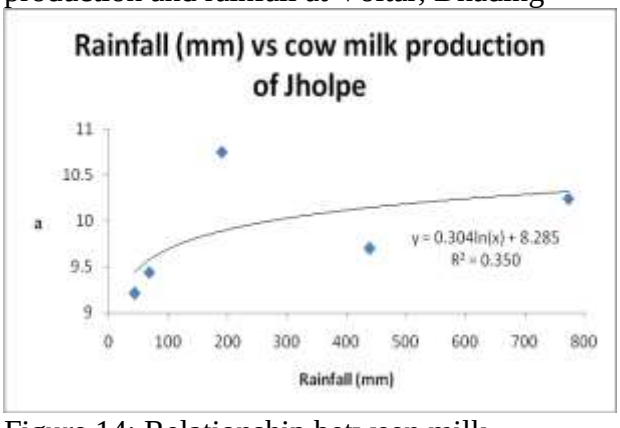

Figure 14: Relationship between milk production and rainfall at Jholpe, Syangja

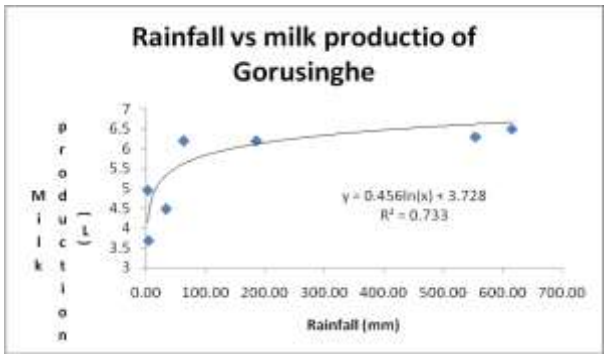

Figure 15: Relationship between milk production and rainfall at Gorusinghe, Kapilwastu

DISCUSSION

General temperature, rainfall and relative humidity vary according to the different sites. The temperature is decreased according from plain to hills. The recorded temperature showed 3 to 10 ^{0}C in high mountain, 10 to 20 ^{0}C in mid hill and 20 to 25^{0}C in plain (Tarai) (MoEST, 2007). The performance of milk production of cow is quite good 20 to 35 ^{0}C but if the temperature is increased the milk production is relatively affected (Mayer et al, 1999). This research showed that the increasing temperature is favorable for more milk production but only at certain level. This fact was also supported by Igono et al (1985). Generally the highest milk yield per day per cow was at 25 to 28 ^{0}C. the research finding was also supported by study of Berman et al, (1985), their result was around 27 ^{0}C was suitable temperature for cow to produce more milk during hot and rainy season in Thailand. In addition, Novák et al., 2000, showed that the temperature between 24 and 27°C is appropriate for maximum milk production for cow. Moreover, Dikmen and Hansen (2009) reported that upper limit temperature was 28.4 ^{0}C for more milk production of Holstein cows in subtropical environment and in housed conditions.

According to most of these studies, Summer Monsoon brings more than 80 % of the annual rainfall in Nepal during the rainy months, June to September. The remaining amount of precipitation is predominantly released by the western disturbances, which influences rest of the months from October to May (Shrestha, 2000, Nayava, 1980). The milk production is directly related to climatic parameters (Verwoerd et al, 2006, Kabuga et al, 1991) like temperature, rainfall

Table 1: Descriptive statistics of milk production at Voltar, Jholphe and Gorusinghe

Site	Mean L	Standard Error	Standard Deviation	Minimum	Maximum	Count
Voltar	9.11	0.015	0.24	8.60	9.90	242
Jholphe	8.82	0.095	1.38	6.00	10.75	213
Gorusinghe	5.69	0.073	1.13	3.50	7.70	242

Table 2: ANOVA showing variation in milk production at Voltar, Jholphe and Gorusinghe

	Sum of Squares	Degree of freedom	Mean Square	F	Significant (P value)
Between Groups	70.55	2	35.27	24.05	0.000
Within Groups	39.59	27	1.47		
Total	110.14	29			

Table 3: Tukey's b test showing differences in milk production

Sites	N	Subset for alpha = 0.05		
		1	2	3
Gorusinghe	242	5.69		
Jholpe	213		8.82	
Voltar	245			9.11

(Bouraoui et al, 2002, Vasconcelos, 2011). Upper limit of thermal stability and subsequent rise of thermoregulatory functions are affected by body temperature. So increasing temperature variation in rainfall and humidity affect the performance or milk production of cow (Rejeb et al, 2016, West et al, 2003). There is positive relationship between milk production and rainfall. This was also supported by several authors, the yield of milk production varied according to seasonal variables (Bucklin et al., 1991).

Suitable environment favors the cow to produce milk. The appropriate rainfall, temperature and relative humidity are the main parameters of the environment. Good environment is good indicator of palatable grass on which the cow feeding is depend on (Regan and Richardson, 1938).

A study done at Triângulo Mineiro in Brazil showed that milk production varied from 9.19 to to 12.31 liters/cow/day and the average daily milk production was about production of 11.17 L/cow in lactation (Gerais et al, 2012). This result is about matching with the milk production of cow of Jholphe, Syangja district and minimum yield of cow milk production was near about to the Voltar, Dhading district in Nepal. The other study done by GarciaI et al, (2015) also showed similar result.

CONCLUSION

Therefore it can be concluded that, it was variation in temperature, rainfall and relative humidity between June 2013 to February, 2014 and also in milk production at local level. There is log regression relationship between seasonal variables like temperature and rainfall with milk production of cow small holders but it was unclear effect of relative humidity on milk production of cow. Therefore, it is recommended that the further study should be focused on factors affecting the performance of milk production in different conditions and geographical sites.

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