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On the relationship between milk yield and climatic factors

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सार — बंगलोर में अर्द्ध और उष्णकटिबंधीय क्षेत्र में व्युत्पन्न कुछ जल वायविक परिवर्तन के और मौसमी दूध उत्पादन के मध्य सांख्यिकी विश्लेषण किया गया था। इस अध्ययन से पता चलता है कि दूध के उत्पादन में परिवर्तनशीलता का कारण है ग्रीष्म ऋतु में अधिकता (9.3 लीटर/गाय/दिन) की अपेक्षा शीत ऋतु में न्यूनतम (8.5 लीटर/गाय/दिन) होती है। और दोनों मानसून ऋतुओं में बराबर होती है (दक्षिण-पश्चिम और उत्तर-पूर्व मानसून ऋतुओं के दौरान 8.7 लीटर/गाय/दिन)। इस बात पर विचार किया गया था कि ठंडी हवा इंडैक्स जैसे जलवायु घटक का नकारात्मक प्रभाव था जबकि आर्द्रता वाले इंडैक्स और फोटोथर्मल ताप एककों के मौसमी दूध उत्पादन पर सकारात्मक (ग्रीष्म और शीत ऋतुएं) और नकारात्मक (दो मानसून ऋतुएं) दोनों ही प्रकार के प्रभाव है।

ABSTRACT. Statistical analysis was carried out between seasonal milk yield and some of the derived climatic variables at a semi-arid tropical locality in Bangalore. The study revealed that the milk yields varied from the highest (9.3 lit/cow/day) in summer season to the lowest (8.5 lit/cow/day) in winter season and almost the same in both the monsoon season (8.7 and 8.5 lit/cow/day during southwest and northeast monsoon seasons). It was envisaged that the climatic components like wind chill index had negative effect while wetness index and photothermal heat units had both positive (suummer and winter seasons) and negative (two monsoon seasons) influences on seasonal milk yields.

Key words — Milk yield, Photothermal, Temperature humidity, Thermal insulation.

1. Introduction

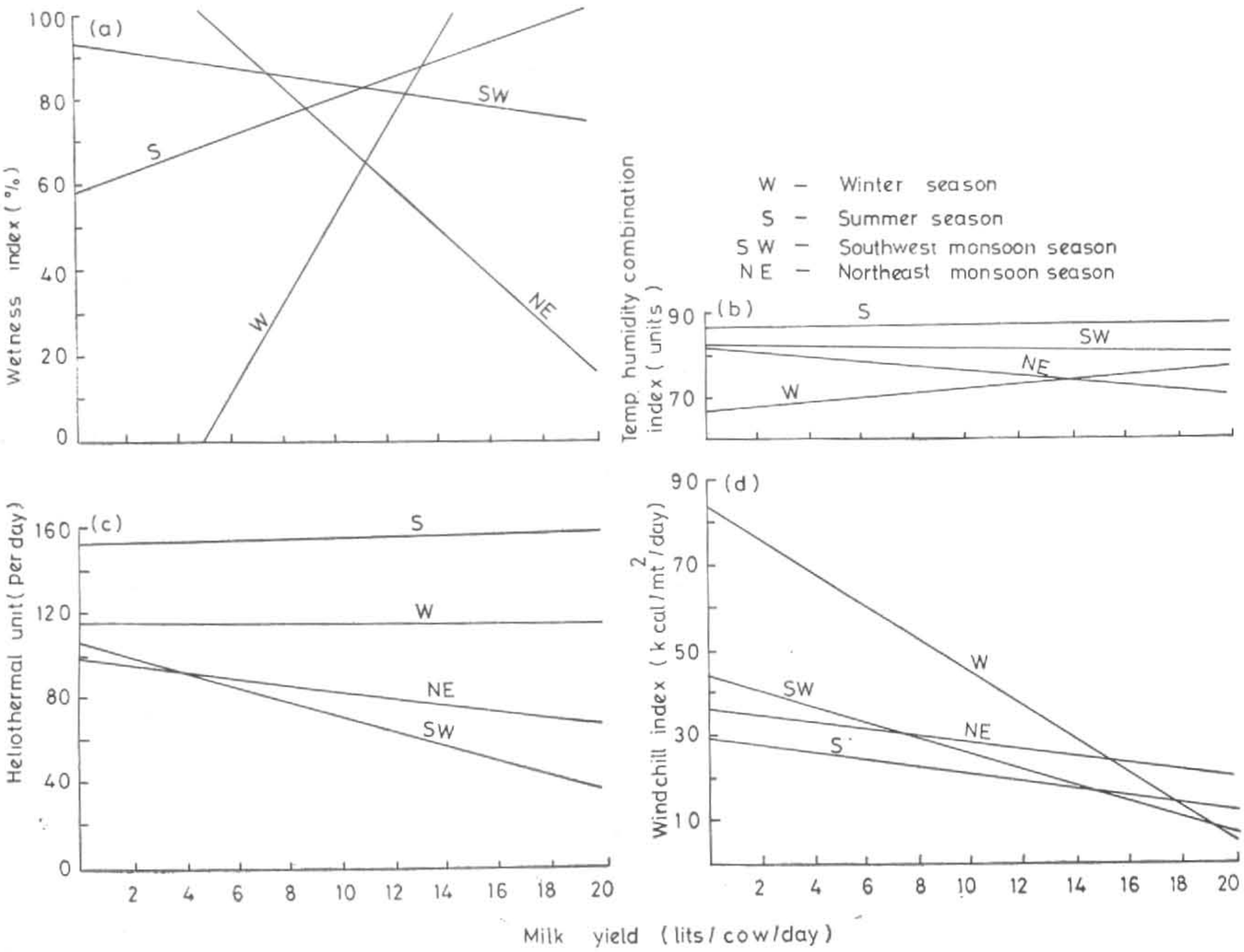
Nearly 25 per cent of variations in livestock productivity especially the typical produce like milk yield from cows (warm blooded domestic mammals) are influenced directly by various climatic factors besides certain indirect normal limitations of non-climatic seasonal factors such as shelter, feed efficiency and cattle management practices etc (Hancock 1954, Smith 1964, Bianca 1965, Thompson 1973 and Dragovich 1982).

The cows in present study consisted of a herd strength around 103 (constituted mostly Holstien Friesian crossbred with a few Jersey and Red Dane crossbreds) for which the optimum ranges of photothermo neutral zones and physiological characters were approximately the same. The cows were milked daily twice at around 0300 and 0900 GMT (0830 & 1430 IST) mechanically. Balanced feed was provided to the cows daily before milking in limited quantity and prepared mechanically by mixing locally available feed ingradients (like maize, jowar and groundnut cakes) with wheat and rice bran mineral mixture proportionately. General rationed feed like green grass (fodder maize, para and bund grasses) along with ragi and paddy hay dry matter at 2.3 kg/cow/day was also provided besides normal field grazing. The animals were sheltered at normal heat tolerency level in open air under commonly flexible loose cemented sheds attached with suitable modern sanitary parlours for daily routine animal husbandary activities.

2. Data and methodology

The daily milk yield data for 14 years (1976-89) period was collected from the dairy farm, University of Agricultural Sciences, Hebbal, Bangalore. The relevant meteorological data for the period was obtained from the Hebbal Agrometeorological Observatory (Lat. 12° 58′ N, Long. 77° 58′ E, alt. 902 m a.s.l. and tropical semi-arid climatic type), situated just by the side of the dairy farm. Linear correlation and regression analysis were carried out for the period under study to bring out the relationship between the four seasonal milk yield values (expressed in lit/cow/day) and the four derived climatic indices namely wetness index (WTI), temperature-humidity combination index (THI), heliothermal heat units (HTU), and wind chill index (WCI). The results were presented as linear regression lines in Fig. 1 and the derived regression equations in Table 1 along with mean and coefficient of variations.

The wetness index was calculated as the ratio of seasonal total rainfall to the normal rainfall expressed as percentage, the thermal stress indicator otherwise known as heliothermal heat units were enumerated



Figs. 1 (a-d). Regression lines between the four seasonal milk yields and the four derived climatic variables

TABLE 1

Statistical relationship between seasonal milk yield and derived climatic variables

Climatic parameter	Winter M (CV)	Winter RE (CC)	Summer M (CV)	Summer RE (CC)	Southwest monsoon M (CV)	Southwest monsoon (RE) (CC)	Northeast monsoon M (CV)	Northeast monsoon RE (CC)
Y	8.4 (18)	--	9.3 (26)	—	8.7 (14)	—	8.5 (14)	—
WTI	31 (144)	Y=12.6—75.1 X (0.4)	79 (33)	Y=2.2+58.6X (0.2)	86 (20)	Y=—0.9+94.3 X (—0.1)	83 (22)	Y=—5.8+132.7X (—0.4)
THC	71 (5)	Y=0.4+67.5 X (0.2)	87 (4)	Y=—0.1+87.9 X (—0.1)	81 (3)	Y=—0.2+82.3X (—0.1)	77 (4)	Y=—0.7+82.6 X (—0.3)
HTU	117 (11)	Y=—0.03+116.3 X (0.004)	155 (6)	Y=0.3+152.4 X (0.1)	77 (10)	Y=—3.4+106.7X (—0.5)	87 (11)	Y=—1.5+99.7 X (—0.2)
WCI	52 (18)	Y=— 3.9+84.8 X (— 0.5)	22 (28)	Y=—0.8+29.1 X (— 0.3)	28 (15)	Y=—1.9+44.1 X (— 0.5)	30 (18)	Y=—0.7+36.7 X (—0.2)

M — Mean, CV — Coefficient of variatio given in brackets under the column M, RE — Linear regression equation, CC — Correlation coefficient given in brackets under the column RE, *Y* — Milk yield in lit/cow/day, WTI — Wetness index expressed as percentage, THC—Temperature-humidity combination index in units, HTU — Heliothermal heat units per day, and WCI — Wind chill index in k cal/m²/day.

as the product of growing degree days (calculated assuming 10° C as base temperature) and actual hours of bright sunshine and expressed in units per day. The wind chill index defined as the rate of heat loss due to wind speed from the sweat glands of the animal (Ames and Insley 1975) was computed according to the methodology adopted by Mount and Brown (1983). The temperature-humidity combination index was derived as per the formula suggested by Maust *et al.* (1972).

3. Results and discussion

Summer seasonal conditions indirectly influenced milk yields [as indicated by positive correlations in Table 1 and Figs. 1(a & c)], since the increase in fleece temperature during summer enhances the effective vapourisation of the sweat glands in cows. This would cause an increase in feed and water intake (particularly at tropical semi-arid conditions) which increases energy intake and consequently resulting in an overall increase in production of milk apart from other limitations like breed and feed types (Bianca 1965). All the climatic factors chosen under the present study were negatively correlated with milk yields during the two monsoon seasons (Table 1). The seasonal changes in photothermal climatic indices, namely THC [Fig. 1(b)] and HTU [Fig. 1(c)], which mainly control and influence the thermoregulatory processes in cows were the predominant reasons for lower milk yields during the two monsoon seasons (Albright and Alliston 1971). The wind chill index was noticed to have an opposite affect on milk yield as indicated by negative correlation coefficients during all the four seasons [Table 1 and Fig. 1(d)]. The highest mean wind chill index of 52 k cal/m²/day was also observed in the same winter season in which the lowest milk yield obtained. This was found to be due to the enormous increase in thermal insulation during winter season (between the animal and the air above it) caused by high level of moisture evaporated by short lengths of cows fleece at moderate wind speeds (Mount and Brown 1983).

The above seasonal pattern resembled the reflected influences of the seasonal acclamatization of various reproductive functions of the animal (like pregnancy, lactation and milking) in tropical semi-arid climatic conditions (Alhassan and Buvanendran 1985). The highest mean annual milk yield of 11.0 lit/cow/day was noticed in the driest year like 1980 (due to the positive affects of THC and HTU on milk yields) while the lowest mean annual milk yield of 7.8 lit/cow/day in the wettest year namely 1988 (due to the negative affects of WTI and WCI on milk yields) during the course of study. Milk yields from each cow on an average during the morning observations were found to be comparatively higher (around 50 to 60 per cent of the evening observation) than the evening observation indicating that milk yields closely follow the sharp diurnal fluctuations in THC.

4. Conclusion

It was concluded that the thermohygric heat balance accompanied by light affect at threshold ranges influences seasonal march in milk yield status of cows while higher mangitudes of wetness and wind chill indices showed retarding influence.

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