Effect of rainfall variability on grassland herbage production and ruminant livestock productivity in the Accra plains of Ghana

J. E. FLEISCHER & S. ABENNEY-MICKSON
(J. E. F.: Department of Animal Science, University of Ghana, P. O. Box 226, Legon, Ghana; S.A-M.: Department of Agricultural Engineering, University of Ghana, P. O. Box 28, Legon, Ghana)

SUMMARY

Although rainfall amount influences herbage production, there is a wide range outside which there can be depression of forage dry matter yield on the Accra plains. Low rainfall amount does not seem to depress livestock numbers, but may affect the performance of individual animals. However, very heavy rainfall may affect the animals in various ways, leading to an eventual reduction in their numbers.

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RÉSUMÉ

FLEISCHER, J. E. & ABENNEY-MICKSON, S.: *L' effet de la variabilité de la pluie sur la production d' herbage de savane et la productivité du bétail ruminant dans les plaines d' Accra du Ghana.* L' effet de la quantité de pluie sur la production de biomasse herbacées et la productivité du bétail ruminant dans les plaines d'Accra du Ghana étaient enquêtés. Malgré le fait que la quantité de la pluie influence la production d'herbage, il y a un pâturage varié hors duquel il pourrait y avoir une dépression du rendement de la matière sèche du fourrage sur les plaines d'Accra. La basse quantité de la pluie, ne semble pas à dépresser les nombres du bétail mais elle pourrait avoir un effet sur le rendement des animaux individuels. Toutefois, la pluie torrentielle pourrait avoir un effet sur les animaux dans de diverses façons menant à une réduction de leurs nombres.

Introduction

In Ghana, ruminant livestock contribute about 54 and 100 per cent of the internal meat and milk production, respectively (PPMED, 1991). The productivity of the ruminant livestock, however, depends on the natural grassland which, in turn, is largely influenced by the rainfall (Fleischer, Allotey & Heathcoate, 1996). On the Accra plains, Lansbury, Rose Innes & Mabey (1965) estimated that the composite dry matter yield of *Veteveria fulvibarbis - Andropogon canaliculatus - Schizachyrium schweinfurthii* association on the clayey and sandy soils were 2.78 and 3.36 t ha^{-1} yr^{-1}, respectively. Fleischer, Allotey & Heathcoate (1996), on the contrary, reported that the dry matter yields on the clayey and sandy soils of the Accra plains were 4.67 and 5.03 t $ha^{-1}yr^{-1}$, respectively. Ottichilo *et al.* (1991), as quoted by Ojwang *et al.* (1995), reported that in Kenya the 10 per cent driest years coincided with reduction in forage yield of 15-60 per cent. No such study has been undertaken in Ghana. Furthermore, such analysis of the impact of drought and flood has not been related to livestock numbers. Thus, it is not clear how excessive rainfall influences herbaceous biomass production and ruminant livestock numbers, and also how mild drought influences the animal numbers.

This study examines the effect of rainfall amount on herbaceous biomass production, and how it

may affect ruminant livestock productivity in the Accra plains of Ghana.

Materials and methods

Data on rainfall, radiation, temperature, humidity, sunshine hours, and wind speed for 1990/91 and 1991/92 at the Legon Meteorological Station, Accra were provided by the Ghana Meteorological Services Department (GMSD). In estimating evapotranspiration, these were taken as typifying that of the Accra plains, because data from all the other stations located in the Accra area were not up to date, i.e., many values were missing. The Penman (1948) method was used to calculate monthly evapotranspiration values. The pooled herbaceous biomass yield of the Accra plains as reported by Fleischer, Allotey & Heathcoate (1996) were used.

The evapotranspiration data were superimposed on the rainfall and biomass data. Again, the herbaceous biomass yield were related to the moisture deficit (i.e., evapotranspiration values less those of rainfall). The ruminant livestock population data for the Greater Accra Region, where the Accra plains are located, were obtained from the Livestock Planning and Information Unit of the Ministry of Food and Agriculture (MOFA) for the period between 1990 and 1993. The data were then related to the rainfall.

Results

Fig. 1 shows the climatic characteristics of the Accra plains during the experimental period. Monthly temperatures were relatively high in both years, ranging between 18.9 and 25.7 °C for minimum, and 21.7 and 33.5 °C for maximum. In both years, the maximum and minimum temperatures were lowest in July and August, respectively; the values were highest in either February or March. Evapotranspiration was high throughout the years, being 1804 mm in 1990/91 and 1629 mm in 1991/92. Total rainfall was 568.6 mm in 1990/91 and 1008.0 mm in 1991/92.

Fig. 2 shows the herbage dry matter yield as it is related to rainfall and evapotranspiration. Except for February where the dry matter yield differed, the trends were the same for both years. Total annual herbage dry matter yields were 5.27 and 4.99 t ha^{-1} in 1990/91 and 1991/92, respectively. Thus, the dry matter yield in 1991/92, i.e., the heavy rainfall year, was only 5 per cent lower than that in 1990/91, the low rainfall year.

Fig. 3 shows the relationship between herbage dry matter yield and moisture deficit in the Accra

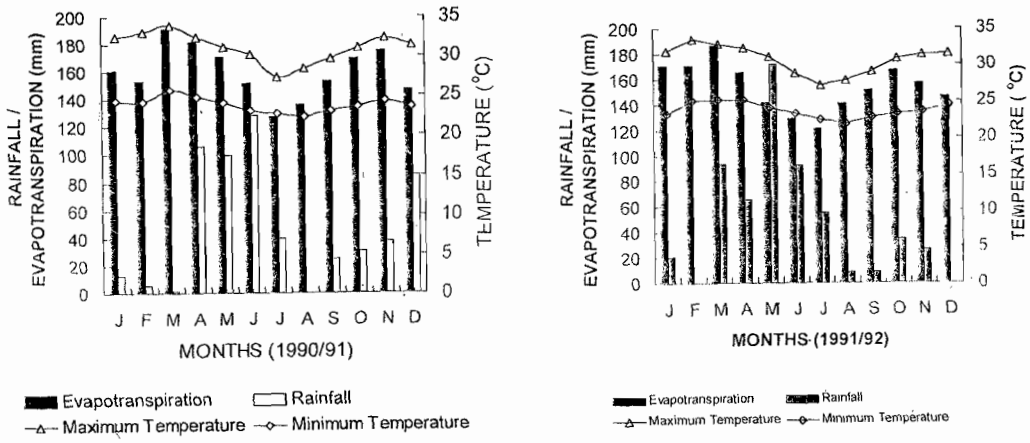

Fig. 1. Climatic characteristics of the Accra plains.

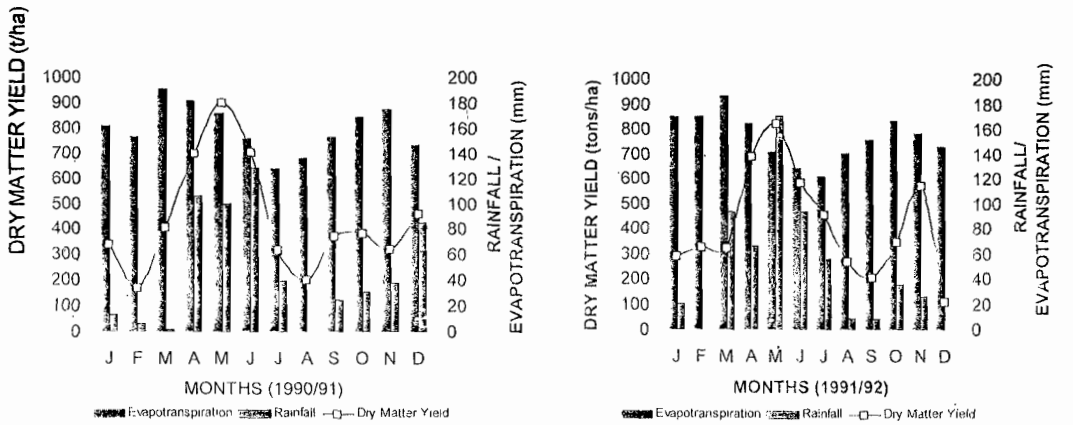

Fig. 2. Herbage dry matter yield, rainfall, and evapotranspiration in the Accra plains.

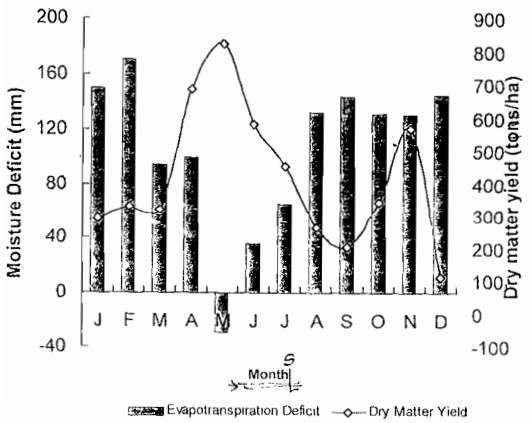

Fig. 3. Moisture deficit and herbage dry matter yield.

plains. Herbage dry matter yield increased gradually from March, reaching a peak in May. This can be explained by observing the rainfall pattern (Fig. 1). The rains usually start in March, reaching a peak in May/June (Fig. 3), a surplus of moisture in May. The other peak in November coincides with the minor rainy season, which though not comparable to the major rainy season, is sufficient to raise the herbage dry matter yield.

Table 1 shows the ruminant livestock population in the Greater Accra Region. Cattle population consistently increased throughout the years. On the contrary, the population of small ruminants varied between 1990 and 1993. For livestock units (i.e., when the livestock are equated to a matured bullock weighing 300 kg live weight), the livestock population increased between 1990 and 1991, stabilized between 1991 and 1992, and increased again between 1992 and 1993.

Table 2 shows the proportional rate of change in the two experimental years. Though the data used in the study were limited, they indicated the impacts of two contrasting rainy periods on the livestock population. In the low rainfall year of 1990/91, there was an increase in all the species. However, in the heavy rainfall year of 1991/92, there was a decrease in all species, but largely in the small ruminants.

Discussion

Many factors influence the herbage dry matter yield. These include soil (Fleischer, Allotey & Heathcoate, 1996), climatic factors such as temperature, relative humidity, and rainfall as well as other management factors such as cutting interval, fertilizer application, stocking rate, intensity of grazing, pasture husbandry, and plant species. Doppler (1980), in Avetonou, Togo, noted that temperature and relative humidity seem insignificant in semi-humid West Africa, because they hardly vary throughout the year. On the

TABLE 1

Ruminant Livestock Population in the Greater Accra Region

Year	*Cattle*	*Sheep*	*Goats*	*Livestock units*[1]
1990	63844	52767	52439	48337
1991	67298	53933	57092	50960
1992	68043	52361	50399	50907
1993	70483	59759	57628	53444

Source: Livestock Planning and Information Unit, Ministry of Food and Agriculture.

[1]) Calculated on the assumption that one livestock unit is a mature animal weighing 300 kg liveweight.

TABLE 2

Change of Livestock Population in the Greater Accra Region

Year	*Cattle*	*Sheep*	*Goats*	*Livestock unit*
1990/91	5.4	2.2	8.9	5.4
1991/92	1.1	-2.9	-13.3	0.0

contrary, rainfall seems to be the most dominant climatic factor influencing plant growth (Doppler, 1980; Fleischer, Allotey & Heathcoate, 1996). The rainfall in 1990/91 was 22 per cent lower while that of 1991/92 was 38 per cent more than the 70-year average of 732 mm for Accra. It was, however, within the extreme minimum and maximum of 333 and 1124 mm per annum, respectively (Walker, 1962). These extremes were 55 per cent less and 54 per cent more rainfall, respectively, compared to the mean value of 732 mm per annum.

In spite of the differences in rainfall amounts, the herbage dry matter yields were similar, even though the patterns differed. Although it has been reported that in Kenya the 10 per cent driest years coincided with a 15-60 per cent reduction in dry matter yield of forage (Ojwang *et al.*, 1995), the dry matter yields of 1990/91 observed in this study suggest that the minimum amount of soil moisture required to support a reasonable level of herbage biomass production was not exceeded. Furthermore, unexpected showers at certain times of the year may have contributed to the overall annual dry matter yields. The results also seem to suggest that flooding lasting between 2 and 4 weeks, as observed in 1991/92, probably does not have much effect on the overall annual dry matter yield.

The increase in animal numbers during the period of low rainfall may have been influenced by many factors. Many farmers allow the males to run together with the females; and so all year round breeding is possible. However, the animal may survive on low quality roughage by increasing its consumption of browse. Thus, the effect of low rainfall, unless very severe and extended, as was observed in the Sahel in the mid 1970s to 1980s and compounded by bush fires which may remove the dry herbage mass entirely, may not be very significant. Rose Innes (1977) has reported that cattle lose between 5 and 11 per cent of their body weight during the dry season. Similarly, Otchere *et al.* (1977) have also reported that sheep and goats lose up to 15 per cent of their live weight during the dry season. These weight losses are a combination of low production of herbaceous biomass which could fall to about 30-50 per cent of the growth rate of the rainy season (Fleischer, Allotey & Heathcoate, 1996), and the attendant fall in quality (Lansbury, Rose Innes & Mabey, 1965).

In the 1991/92 high rainfall year, the cause of the decline observed in animal numbers was not immediately apparent. It could, however, be that the times when the animals ovulated and were crossed coincided with the times when they were unable to go out grazing, and so were either on a low plane of nutrition or were even starved. Rhind *et al.* (1989), working with sheep, reported that low ovulation rate and higher embryo wastage are characteristics of animals on low plane of nutrition. Furthermore, during the period of heavy rainfall, animals are more pre-disposed to diseases such as pneumonia and gastroenteritis as well as the cold humid environment which would easily lead to death (Boniwell, 1979; Canacoo, 1989). Kabuga & Akowuah (1989), working with sheep in the derived savanna zone, reported that pre-weaning mortality doubled in the rainy season compared to the dry season. These factors, coupled with

the generally poor management practices which lack supplementary feeding of the animals indoors, may account for the decline in stock numbers.

Conclusion

Although rainfall influences herbage production, there seems to be a wide range of rainfall amounts outside which depression of forage dry matter yield on the Accra plains may become apparent. It also appears that low rainfall may not depress livestock numbers, though it may influence individual animal performance. On the contrary, very heavy rainfall may affect the grazing pattern of and also predispose the animal to diseases and parasites, thereby leading to death; and hence reduce animal numbers.

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