Herbage productivity of the Winneba plains of Ghana

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SUMMARY

The biomass productivity of the Winneba plains of Ghana was measured between January 1990 and February 1992. Ten sampling sites were chosen for the study. An area of 5.0 m × 5.0 m was demarcated and within it an area of 1.0 m × 1.0 m was harvested at monthly intervals, clipped by means of sickle at 5 cm above ground, and dried at 70 °C for more than 48 h for dry matter determination. Crop growth rate was then estimated. Dry matter yields were 5.29 and 6.31 t ha^{-1}yr^{-1} on the clayey and sandy soils respectively, averaging 5.87 t ha^{-1}yr^{-1} for the Winneba plains. The respective crop growth rates on the clayey and sandy soils were 1.935 and 2.236 g m^{-3} day^{-1} between April and August, 0.867 and 1.0779 g m^{-2} day^{-1} between September and February and 0.296 and 0.742 g m^{-2} day^{-1} respectively in March. Carrying capacity may probably be in the range of 2.18 and 3.86 ha AU^{-1} per annum.

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RÉSUMÉ

FLEISCHER, J. E., ALLOTEY, A. J. & HEATHCOTE, I.: *La productivé herbacées des plaines de Winneba du Ghana.* La productivé de biomasse des plaines de Winneba du Ghana a été évaluée entre Janvier 1990 et Février 1992. Dix endroits d'échantillonage etaient choisis pour l'étude. Une superficie de 5.0 m × 5.0 m était délimitée et à l'intérieur d'elle, une superficie de 1.0 m × 1.0 m était récoltée à intervalles mensuels, était découpée au moyen d' une faucille à 5 cm en surface du sol, sèchée à 70 °C à plus de 48 h pour la détermination de matière sèche. La proportion de la croissance culturelle était alors estimée. Les rendements de matières sèches étaient 5.29 et 6.31 t ha^{-1} par an respectivement sur le sol sablonneux et argileux, faisant la moyenne de 5.87 t ha par an pour les plaines de Winneba. Les proportions respectives de la croissance culturelle sur les sols argileux et sablonneux étaient 1.935 et 2.236 g m^{-2} par jour entre Avril et Août, 0.867 et 1.0779 g m^{-2} par jour entre September et Février, et 0.296 et 0.742 g m^{-2} par jour respectivement en Mars. La capacité de porter pourrait probablement être dans l'étendue de 2.18 et 3.86 ha AU^{-1} par an.

Introduction

Ruminant livestock production in Ghana, like that of many West African countries, is largely dependent on the natural grassland for sustenance and productivity. Consequently, inadequate feed supply, aggravated by the annual cyclic changes in the nutritive quality, severely limits stock productivity. Compounding the situation is the fact that animals are kept in restricted localities leading to scattered but widespread overgrazing (Fleischer, unpublished).

One area in Ghana where the ruminant livestock population is very low yet the potential appears to exist for a higher carrying capacity is the Winneba plains. The Winneba plains currently support about 0.7 per cent of the national cattle herd and 7 per cent of the small ruminant flock (MOFA, 1991).

The natural vegetation of Winneba plains which is characterized by grasses of varying heights interspersed with clumps of thickets on old termite mounds has been described by various workers (Baker, 1962; Rose Innes, 1977). However, Carson (1985) reviewing the conditions on the plains observed that there was no information on the net primary productivity of the grass phytomass of the plains. Though the Winneba plains bear floristic resemblance with that of Accra plains (Brand &

Brammer, 1956; Enti, 1985) an extrapolation of the grass herbage production of the latter to cover the former would be inappropriate since productivity of the natural vegetation is influenced by a combination of factors such as precipitation, soil and topography (Frost & Smith, 1991). Furthermore, there has been no estimate of the carrying capacity of the grassland of the Winneba plains.

The objective of this study was to measure the herbage production.

Materials and methods

Conditions of the plains

The Winneba plains stretch between longitude 0° 45'W and 0°35'W and between latitudes 5°20'N and 5°25'N. The plains cover a total area of some 2060 km^2. The relief is flat and gently undulating with slopes of less than 2 per cent except on scattered hills where it may vary between 3 and 6 per cent. Two main streams, the Pratu and the Ayensu, run through the plains throughout the year.

Climate

The climate of the Winneba plains is typified by that of Winneba (5°20'N 0°37'W) as shown in Fig. 1.

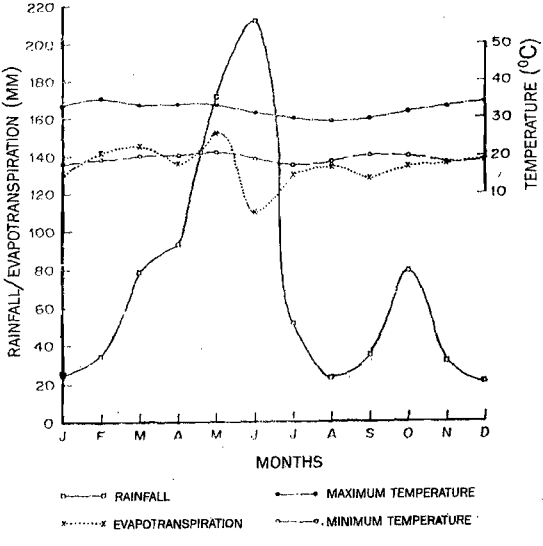

Fig. 1. Climatic characteristics of the Winneba plains

Temperatures are generally high throughout the year averaging some 25.9 °C. The average maximum monthly temperature is 32.4 °C and the average monthly minimum temperature is 19.4 °C. Rainfall averages 868 mm per annum but is very variable. Potential evapotranspiration as measured by tank evaporimeter is about 1700 mm per annum. Relative humidity is high throughout most part of the year (Walker, 1962).

Vegetation

The vegetation of Winneba plains is floristically similar to that of the Accra plains. It is made up of thickets on old termite mounds characterized by such ligneous species as *Ceiba petandra, Baphia nitida, Dichapetalum guineense, Zanthoxylon xyloides* etc. There are also climbers such *Griffonia simplicifolia, Tiliacora dinklagei* etc. and thorny species such as *Acacia pennata, Mezoneuron benthamianum* etc. In the waterlogged or floodable areas are such species as *Pentadon pentandra, Hygrophila auroculata* etc.

Among the dominant grasses are *Brachiaria falcifera, Setaria anceps, Vetiveria fulvibarbis, Sporobulus pyramidalis, Heteropogon contortus, Cymbopogon giganteus, Monocymbium sublobata, Panicum maximum* and legumes such as *Mucuna puriensis, Calopogonium mucunoides, Teramnus labialis, Centrosema pubescence* etc. (Enti, 1985).

Experimental period, sampling sites and sampling

The work was carried out between January 1990 and February 1992, i.e. two calendar years. A total of 10 sampling sites were selected based on soil type, grass association and ease of accessibility. The dominant floristic composition of each site is shown in Table 1. Grass samples were collected once every month from both shaded and unshaded areas of each site.

In each sampling site, an area of 5.0 m × 5.0 m was demarcated within which 1.0 m × 1.0 m was sampled. Sampling was done by clipping the herbage at 5 cm above ground level manually using a sickle. The

TABLE 1

Dominant Ligueous and Herbaceous Composition of the Study Area in the Winneba Plains

Area	*Ligueous species*	*Grasses and sedges graninous*
0[1]	*Baphia nitida, Azadirachta indica, Dichapetalum guinensis, Milletia thorningii*	**Panicum maximum, *Brachiaria falcifera, Conchrus echinates, Echinochloa* spp., *Rotboelia exaltata, Sorghum arundinaceum*
1	*Mezoneuron bentameanus*	**Panicum maximum, Echinochloa* spp., *Cyperus* spp., *Sorghum arundinaceum, Rotboelia exaltata, Centrosema pubescence*
2	*Azadirachta indica, Malachantha alnifolia, Milletia thorningii*	**Heteropogon contortus, Panicum maximum, *Andropogon gayanus, Pennisetum pedicelatum, Brachiaria falcifera, Sporobulus robusta*
3	*Azadirachta indica,*	*Pennisetum pedicelatum, *Panicum maximum, *Andropogon gayanus, *Heteropogon contortus, *Hyperrhenia rufa, Brachiaria falcifera, Fymbrystylis* spp., *Sporbulus repens*
4	*Azadirachta indica, Magnifera indica*	**Andropogon gayanus, *Sporobulus pyramidalis, Panicum maximum, Pennisetum pedicelatum, Imperata cylindrica, Rotboelia exaltata, Eleusine indica, Rynchelytrum repens*
5	*Elaisis guinensis, Cocos nucifera, Antiaris africana Baphia nitida, Mezoneuron bentamecanum, Xanthoxylon xyloides, Milletia thorningii*	**Andropogon gayanus, Sporobulus pyramidalis, *Imperata cylindrica, Setaria palidefusca, Pennisetum pedicelatum, Brachiaria falcifera*
6	*Azadirachta indica, Dichapetalum guinensis, Flacourtia flavesence, Cassia siamea, Azadirachta indica*	*Panicum maximum, Heteropogon contortus, Brachiaria falcifera, Brachiaria distichophylla*
7	*Milletia thorningii, Azadirachta indica*	*Heteropogon contortus, Eragrostis tenella, Panicum maximum, Andropogon gayanus, Sporobulus pyramidalis, Brachiaria falcifera, Rynchelytrum repens, Setaria sphacelala, Eleusine indica*
8	*Elaeophorbia drupifera, Azadirachta indica, Baphia nitida, Xanthonylon xyloides, Dichrostachys cenerea*	*Pennisetum pedicelatum, Heteropogon concortus, Ctenium newtonii, Brachiaria falcifera, Sporobulus pyramidalis, Fimbristyllis ovatge*
9[1]	*Baphia nitida, Azadirachta indica*	*Heteropogon contortus, Sporobulus pyramidalis*

(1) Sites were discarded in the course of project because of inaccessibility due to prolonged flooding.
* Dominant grasses at site.

samples were weighed and later dried in an oven at 70 °C for more than 48 h and weighed for dry matter (DM) determination. Dry matter yield was then estimated. Crop growth rate was calculated according to the method described by Hunt (1990).

Results

The annual dry matter yields of the various sites of the Winneba plains are shown in Table 2. Due to certain problems encountered after the commencement of the project, data on two sites were discarded. Thus, data on only eight sites were analysed. Site 1 had distinctly very high yield. Thus, its inclusion gave a higher average yield value with very large variation for the plains. Discussions with the residents of that area indicated that the area is mainly used for crop produc-

TABLE 2

Annual Total Dry Matter Yield on Different Sites in the Winneba Plains

Site	*1990/91*	*1991/1992* ($t\ ha^{-1}y^{-1}$)	*Mean yield*
1	15.104	21.690	18.397
2	6.776	5.758	6.267a
3	5.866	6.421	6.144a
4	6.143	5.223	5.683ab
5	5.232	5.853	5.588ab
6	3.107	7.704	5.406ab
7	4.346	4.280	4.313b
8	8.281	7.156	7.719c
A) Average	6.868	8.011	7.440
SE[a)]	4.020	5.630	4.530
B) Average	5.692	6.056	5.874
SE[a)]	1.670	1.157	1.033

A) is when Site 1 is included
B) is when Site 1 is excluded
a) SE = Standard error

tion. Consequently, Site 1 was separated from the rest and hence an average value of 5.87 t $ha^{-1}yr^{-1}$ with a relatively smaller error margin was obtained. There were, however, significant differences among sites. Sites 2, 3, 4, 5, and 6 were similar in dry matter yield ($P>0.05$). With the exception of Site 1, Site 8 had the highest dry matter yield and was significantly different ($P<0.05$) from the rest. Site 7 had the lowest dry matter yield and was significantly different from Sites 8, 2 and 3 but not the others.

Table 3 shows the effect of type of soil on the

TABLE 3

Dry Matter Yield of Grass Herbage on the Winneba Plains as Influenced by Type of Soil ($t\ ha^{-1}yr^{-1}$)

Year	*Soil type*		*Average*
	Clayey	*Sandy*	
1990/91	4.400	6.631	5.692
1991/92	6.135	5.998	6.056
Average	5.287	6.314	5.874

dry matter yield. In the 1990/91 project year, yield on the sandy soil was higher than that on the clayey soil. The overall average of the project period, however, showed that clayey soil had lower dry matter yield than the sandy soil. These differences were, however, not statistically significant ($P>0.05$).

The average monthly dry matter yield on sites in the Winneba plains is shown in Fig. 2. The

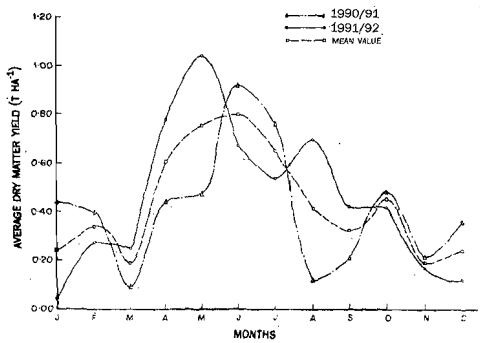

Fig. 2. Average monthly dry matter yield of the Winneba plains

pattern for both years was very similar except for few instances where, due to unexpected rain spells, abberant observations were made. That not withstanding, the peak dry matter yields were obtained in May - June (1.04 - 0.92 t ha^{-1} and in October, 0.42 - 0.48 t ha^{-1}. The value for August (0.70 t ha^{-1}) in the 1991/92 project year was unusually high compared to the monthly average of both years, i.e. 041 t ha^{-1}.

Crop growth rates of the grass herbage yield as influenced by type of soil are shown in Fig. 3. Essentially three distinct periods could be identified with both soils. These were: the period of very high growth rates which lasted between April and August with average crop growth rates of 1.935 and 2.2236 g $m^{-2}day^{-1}$ for the clayey and sandy soils respectively; the period of moderate growth lasting between September and February with an average crop growth rates of 0.867 and 1.077 g m^{-2} day^{-1} for clayey and sandy soils respectively and the period of least growth rate occurring in March with average crop growth

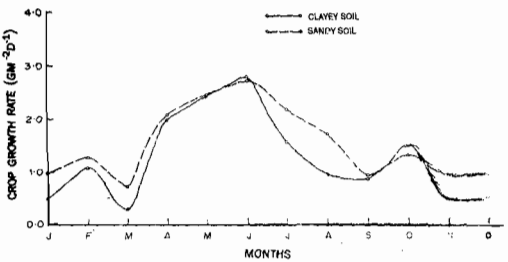

Fig. 3. Crop growth rate of the grass biomass of the Winneba plains as influenced by type of soil

rates of 0.296 and 0.742 g $m^{-2}day^{-1}$ for clayey and sandy soils respectively. The annual average carrying capacity ranged between 2.18 and 3.86.

Discussion

The dry matter yield obtained on the Winneba plains is higher than that observed for the Accra plains (Fleischer, Allotey & Heathcote, unpublished). It is also higher than yields reported for similar ecological zones (Boudet, 1975a; Piot & Rippstein, 1975; Ohiagu & Wood, 1979). The higher yield obtained in these areas may be due to the favourable rainfall regime (Walker, 1962).

Differences in yield between the sandy and clayey soils have been similarly observed on the Accra plains (Lansbury, Rose Innes & Maybey, 1965; Fleischer, Allotey & Heathcote, unpublished). The reason for this disparity was not immediately apparent. However, it is recognized that the dry matter yield was the combined product of grass association, soil type and rainfall (Frost & Smith, 1991). Of these, rainfall appears to be the dominant factor. The monthly dry matter yields show that they follow the rainfall pattern and hence any variation observed, whether on the clayey or sandy soil, is largely influenced by the variability of the rains.

The crop growth rate values obtained in this study are higher than those obtained for the Accra plains (Fleischer, Allotey & Heathcote, unpublished) and other areas of the sub-region (Hopkins, 1963; Boudet, 1975b; Ohiagu & Wood, 1979). The values, however, compare favourably with those obtained for savanna woodland type of vegetation in the Olokomeji area of Nigeria (Hopkins, 1965, 1968). The values make it possible to estimate the annual dry matter yield of the area.

In conclusion, it is found that though the area is potentially able to support a high stock population, a number of issues may have to be addressed before this is made possible.

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