

SEASONAL VARIATIONS IN PLASMA PHOSPHORUS LEVELS OF TRANSHUMANT SHEEP IN KORDOFAN, SUDAN

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SUMMARY

Plasma phosphorus levels were evaluated for one hundred adult breeding ewes from transhumant producer flocks during the late rainy season (September 1984/1985), the mid-dry season (February 1985) and the late-dry season (May 1985). The percentage of non-pregnant/non-lactating ewes critically deficient in phosphorus increased from 9% in the rainy season to 56% in the late-dry season. In September 35% of pregnant ewes were critically deficient in phosphorus. During peak lactation (February) 87% of lactating ewes were critically deficient in phosphorus and 84% remained critically deficient until the start of the rainy season approximately 20 weeks post-lambing. The low phosphorus content of grazing rations, which varied from 0.18% in the rainy season to 0.09% in the dry season, and low forage availability, which was especially acute during the late-dry season, appeared to be the most important factors limiting phosphorus intake.

INTRODUCTION

Sudan's national sheep flock is estimated at approximately 15 million head (Booker Agricultural International, Ltd, 1981) with over 6.7 million head found in the Darfur and Kordofan Regions of Western Sudan (Fig. 1). Southern Kordofan is estimated to contain approximately 16% of this regional flock. The majority of sheep in southern Kordofan is produced by pastoralists who migrate on a seasonal basis from fixed camps in the southern parts of the region to northern grazing areas during the rainy season, returning to their southern camps in the subsequent dry season.

The breeding cycle of sheep in this transhumant production system is a result of the seasonal availability of forage (Fig. 2). Ewes generally conceive during the early stages of the rainy season (June to August) when there is an abundance of available forage and lamb during the early- to mid-dry season (November to February). The fact that ewes generally lamb once a year is a result of the unavailability of sufficient forage during the extended dry season. Preliminary flock productivity data (Cook, 1985, unpub.) indicate that traditional flocks in southern Kordofan contain approximately 75% breeding females (ewes over eight months of age) and lambing intervals range from 10 to 12 months comparable to data for sheep in South Darfur under a similar management system (Wilson, 1976).

One of the primary constraints limiting sheep productivity in the region is the unavailability of adequate nutritional resources on a year-round basis. Limited data have been published on the seasonal nutritional status of traditional livestock in the region, particularly for sheep which spend the majority of the year grazing the cracking clay ranges of southern Kordofan. However, studies (Fadlalla, 1985a

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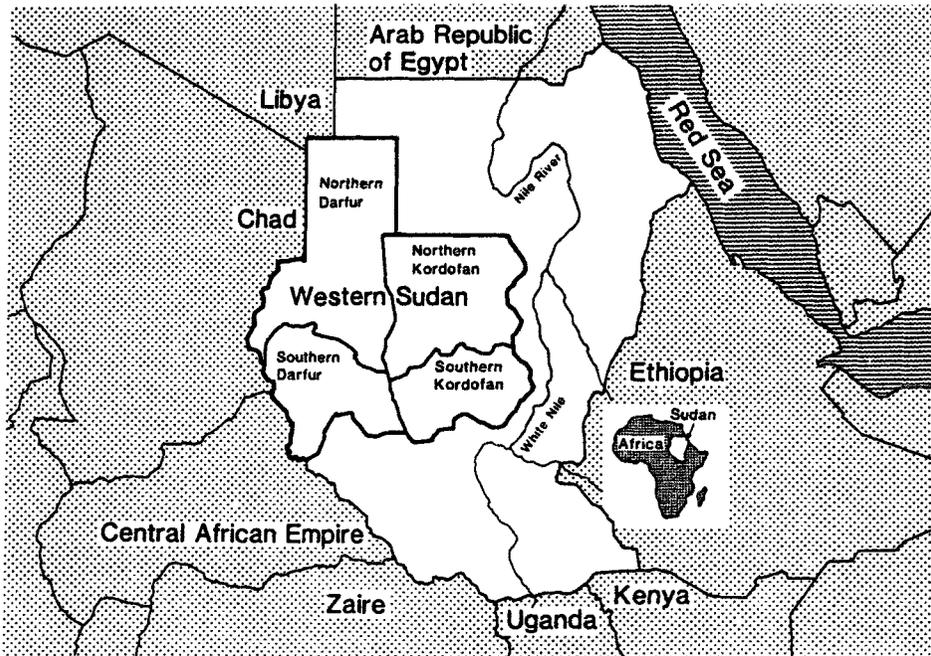


FIG. 1. Sheep study area of northern and southern Kordofan, Sudan.

and b) have shown that the low quality and quantity of available forage, especially noteworthy during the dry season, limits the intake of both energy and crude protein. Preliminary results from the chemical analysis of grazing diets indicated a seasonal phosphorus content which ranged from 0.09% during the dry season to 0.18% in the rainy season (Cook and Fadlalla, 1985). The present study was initiated to assess the seasonal phosphorus status of sheep in the transhumant production system in southern Kordofan as a preliminary stage in identifying improved nutritional management practices for traditional producers.

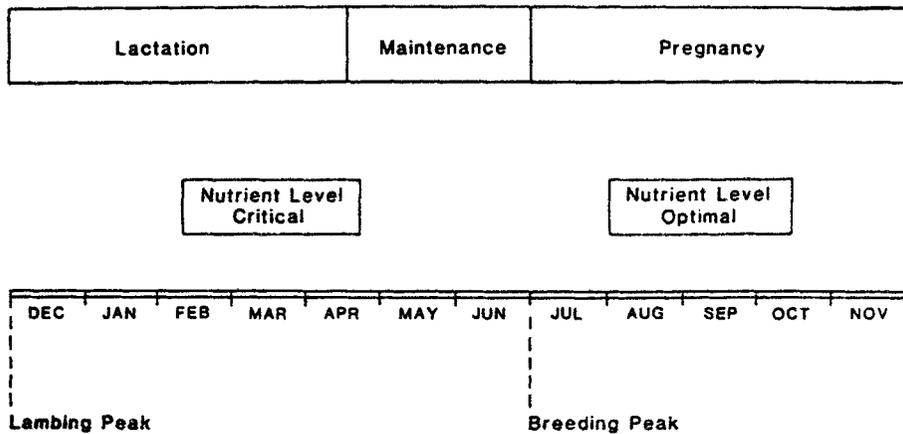


FIG. 2. Production cycle of Baggara sheep, 1985.

MATERIALS AND METHODS

Plasma phosphorus samples were collected from one hundred adult breeding-aged ewes belonging to three co-operating transhumant producers. Samples were taken during the late rainy season (September, 1984 and 1985), the mid-dry season (February, 1985) and the late-dry season (May, 1985). In order to minimise the effects of animal stress and exercise, haemolysis, temperature and plasma-separation-time on plasma phosphorus levels (Fick, McDowell, Miles, Wilkinson, Funk, and Conrad, 1979), all samples were taken early in the morning before animals left for grazing. Blood samples were collected in sodium fluoride vacutainers, centrifuged in the field and the plasma separated within 30 min of blood collection. All samples were stored in the field and transported to the laboratory at 4°C. Plasma phosphorus levels were determined using the colorimetric technique of Fiske and Subbarow (1925). The word "critical" is used in this paper to indicate plasma phosphorus levels below which are associated specific clinical signs as reported in the literature.

RESULTS AND DISCUSSION

Plasma phosphorus data are presented in Table I and graphically represented on a seasonal basis in Fig. 3. According to National Research Council (1975) requirements both ewes in maintenance and in pregnancy, on a group basis, were not critically deficient (more than 4 mg P/100 ml plasma) during the rainy season sampling (September, 1984) having group mean values of 4.9 (s.e. 0.17) and 4.1 (s.e. 0.08) mg P/100 ml, respectively. However, 35% of the pregnant ewes and 9% of the maintenance ewes were critically deficient during this period.

Dry matter intake for selected, pregnant animals grazing on cracking clay soils in southern Kordofan in 1984 were within the published range (Fadlalla, 1985a) and the phosphorus content of grazing rations averaged 0.13% (Cook and Fadlalla, 1985). Calculated phosphorus intakes amounted to approximately 0.16% of the ration, less than the 0.18% recommended for pregnant ewes

TABLE I
Seasonal plasma phosphorus levels in transhumant breeding ewes 1984-1985

Physiological state	Number of animals	Sample period	Plasma phosphorus		% of Group ¹ deficient
			mg P/100 ml (s.e.)	m moles/l (S.I. Units)	
Maintenance	28	Sept 84	4.9 (0.17)	1.9	9
Pregnant	72	Sept 84	4.1 (0.08)	1.3	35
Maintenance	28	Feb 85	3.9 (0.11)	1.3	44
Lactating	70 ²	Feb 85	3.1 (0.07)	1.0	87
Maintenance	25 ³	May 85	3.6 (0.18)	1.2	56
20 Weeks post-lambing	54	May 85	3.2 (0.13)	1.0	84
Maintenance	25	Sept 85	3.9 (0.14)	1.3	20
Pregnant	50 ⁴	Sept 85	3.4 (0.13)	1.1	60

¹ Plasma phosphorus less than 4.0 mg/100 ml plasma (NRC, 1975).

² Two animals aborted.

³ Decreased number of animals represent deaths during the period from February through May, 1985.

⁴ Four ewes were sold during 1985 rainy season.

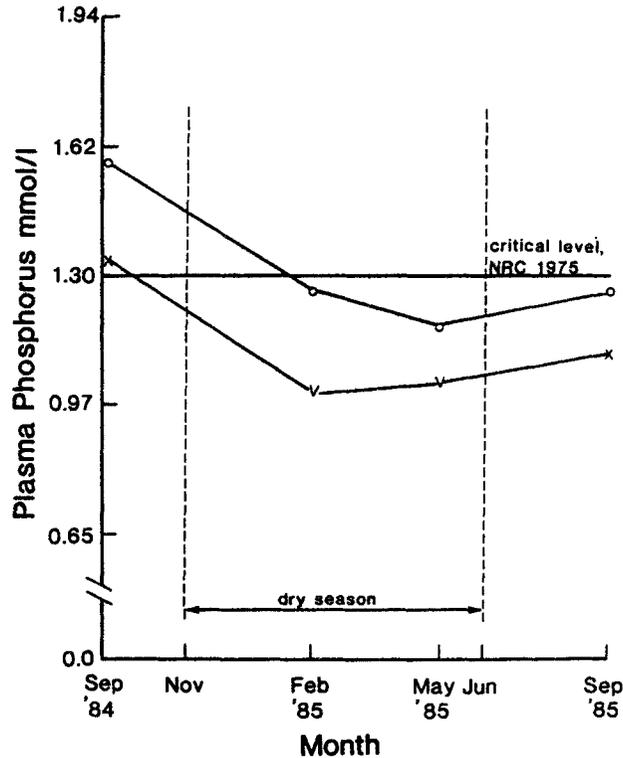


FIG. 3. Seasonal plasma phosphorus levels.
 ○ Maintenance.
 × Pregnant.
 ∇ Lactating.

(Merck, 1979). During this period forage quality rather than forage availability appeared to be the primary factor limiting the intake of dietary phosphorus.

The lower plasma phosphorus levels recorded for pregnant sheep during September 1985 were surprising considering animals were grazing northern, sandy soil ranges. The nutritional quality of the vegetation in such ecological areas has been shown superior in crude protein and mineral content when compared to ecological areas with heavier soils and higher rainfall (Breman and de Wit, 1983) such as those found in southern Kordofan. The grazing rations contained 0.18% phosphorus, although the sparseness of available grazing limited total dry matter intake.

During the mid-dry season (February, 1985) the number of critically deficient ewes significantly ($P < 0.001$) increased from 9% to 44% for maintenance animals and from 35% for pregnant ewes to 87% for lactating animals which were on the average 6.0 ± 1.2 weeks into their lactation. Group mean plasma phosphorus levels were 3.9 (s.e. 0.11) and 3.1 (s.e. 0.07) P/100 ml (Table I) for maintenance and lactating animals respectively. The increase in the percentage of critically deficient ewes in maintenance reflected both a decrease in the diet phosphorus content (0.13% to 0.09%) and in forage availability. These factors coupled with the nutritional demands of early lactation were the principal reasons for an

increase in the number of critically deficient ewes. Dry matter intake during this period was within the published normal range for lactating ewes (Fadlalla, 1985b) but the calculated phosphorus intake of approximately 0.09% of the ration was substantially below the 0.28% recommended for lactating ewes (Merck, 1979).

During the late-dry season (May) the phosphorus level in the available forage was 0.09%, the same as recorded for the mid-dry season sampling (February). However, forage availability within grazing distance of permanent water sources became very limited. Plasma phosphorus levels in both physiological groups were not significantly different from those recorded in the mid-dry season, i.e. 3.6 (s.e. 0.18) and 3.2 (s.e. 0.13) for maintenance and lactating ewes respectively. There was, however, an increase in the number of maintenance animals which were critically deficient during the late-dry season, from 44% to 56%, likely a reflection of this decreased forage availability. The slight decrease in critically deficient lactating ewes, from 87% to 84%, even in the presence of limited quantities of forage could have been the result of reduced nutritional stress of late lactation when compared to that of the mid-dry season. During the late-dry season sampling period lactating ewes were on the average 20 ± 3.4 weeks into their lactation.

The impact of the generally low plasma phosphorus levels found for ewes in this study on overall flock productivity was difficult to assess in isolation from other concurrent, nutritional and disease factors. In addition to a phosphorus deficiency which extended from the late rainy season to the end of the subsequent dry season, pregnant and lactating ewes were also found to have energy and/or protein intakes below maintenance levels. Pica was most commonly observed in pregnant ewes during the late rainy season and in lactating ewes during the mid-dry season, indicating that energy and/or protein intake was perhaps a more important nutritional consideration during the late dry season when the scarcity of available forage became a limiting factor. The greater weight loss and higher incidence of gastro-intestinal and respiratory disease problems noted during the dry season for lactating ewes when compared to maintenance animals were likely a reflection of the greater nutritional stress experienced by lactating animals. As a result the mortality rate for lactating ewes during the 1985 dry season was 23% compared to 11% for maintenance animals during the same period (Table I).

Phosphorus appears to be one nutrient which is critically deficient for most classes of productive ewes throughout the year being most deficient during the period of early lactation. Dry season forage, providing it is available in sufficient quantities, may be adequate to maintain animals; however, the supplementation of ewes with phosphorus during late pregnancy and early lactation, coupled with the early weaning of lambs, would appear to be one management strategy which should be evaluated to improve the condition and performance of breeding ewes. However, at present animal phosphorus supplements are not widely available in the Sudan.

ACKNOWLEDGEMENTS

The authors acknowledge the support of Dr D. A. Dafalla, Director of the Western Sudan Agricultural Research Project and the Agricultural Research Corporation for support of this study and permission to publish these results. Appreciation is also extended to Mr Ahmend Hashim and Mr Mohamed Sulieman for their technical assistance.

The Western Sudan Agricultural Research Project is sponsored by The Government of The Sudan, The World Bank and The United States Agency for International Development.

Accepted for publication June 1986

REFERENCES

- BOOKER AGRICULTURAL INTERNATIONAL LTD & THE CENTRE FOR TROPICAL VETERINARY MEDICINE, EDINBURGH. (1981). Regional Animal Disease Control Project, Sudan and Ethiopia. Volume IV, London, UK. p. 9.
- BREMAN, H. & DE WIT, C. T. (1983). *Science*, **221**, 1341-1347.
- COOK, R. H. & FADLALLA, B. (1985). Dry Season Supplementation of Baggara Sheep. In Transhumant Production System Research Program Results, 1984/85, Volume 3. Washington State University, Pullman, Washington (in press).
- FADLALLA, B. (1985a). The Seasonal Nutritional Status of Transhumant Sheep. 1. Pregnant Ewes During the Rainy Season. In Transhumant Production System Research Program Results, Volume 3. Washington State University, Pullman, Washington (in press).
- FADLALLA, B. (1985b). The Seasonal Nutritional Status of Transhumant Sheep. 2. Lactating Ewes During the Mid-Dry Season. In Transhumant Production System Research Program Results, Volume 3. Washington State University, Pullman, Washington (in press).
- FICK, K. R., MCDOWELL, L. R., MILES, P. H., WILKINSON, N. S., FUNK, J. D., & CONRAD, J. H. (1979). *Methods of Mineral Analysis for Plant and Animal Tissues*, 2nd edn. University of Florida, Gainesville.
- FISKE, C. H. & SUBBAROW, Y. (1925). *Journal of Biological Chemistry*, **66**, 2, 375-400.
- MERCK AND COMPANY, INC. (1979). Merck Veterinary Manual, 5th edn. Merck and Company, Inc., Rahway, New Jersey, USA p. 1301.
- NATIONAL RESEARCH COUNCIL. (1975). Nutritional Requirements of Sheep, 5th edn. National Academy of Sciences, Washington, DC, USA.
- WILSON, R. T. (1976). *Tropical Animal Health and Production*, **8**, 103-114.

VARIATIONS SAISONNIERES DU TAUX DU PHOSPHORE PLASMATIQUE CHEZ LES MOUTONS TRANSHUMANTS DU KORDOFAN (SOUDAN)

Résumé—Les taux du phosphore plasmotique sont évalués pour 100 brebis adultes provenant de troupeaux transhumants d'élevage pendant la dernière saison des pluies (Septembre 1984), la saison sèche intermédiaire (Février 1985) et la dernière saison sèche (Mai 1985). Le pourcentage de brebis non gestantes et non allaitantes atteintes d'une carence critique en phosphore est passé de 9 p 100 en saison des pluies à 56 p 100 pendant la dernière saison sèche. En Septembre, 35 p 100 des brebis gestantes présentaient une carence inquiétante en phosphore. Pendant le pic de la lactation (Février), 87 p 100 des brebis allaitantes présentaient la même carence et 84 p 100 restaient dans une situation jusqu'au début de la saison des pluies, environ 20 semaines, identique après la mise-bas des agneaux. La faible teneur en P des rations prises au pâturage, qui varie de 0,18 p 100 en saison des pluies à 0,09 p 100 en saison sèche ainsi que les faibles disponibilités fourragères particulièrement accentuées pendant la dernière saison sèche, semblent être les facteurs les plus importants dans la limitation de l'absorption orale du phosphore.

VARIACION ESTACIONAL EN EL NIVEL DE FOSFORO PLASMATICO DE OVEJAS TRANSHUMANTES EN KORDOFAN SUDAN

Resumen—Se evaluaron los niveles de fósforo plasmático en cien ovejas adultas en edad de concebir, pertenecientes a pastores transhumantes, durante el final de la estación lluviosa (septiembre 1984/1985), mitad de la estación seca (febrero de 1985) y final de la estación lluviosa (mayo 1985). El porcentaje de ovejas no preñadas/ no lactantes, críticamente deficientes en fósforo plasmático, se incrementó de 9% durante la estación lluviosa a 56% al final de la estación seca. En septiembre, 35% de ovejas preñadas presentaban deficiencias críticas de fósforo. Durante el punto más alto de lactación en febrero, 87% de ovejas de esta condición estaban críticamente deficientes en fósforo plasmático, permaneciendo el 84% deficiente hasta el principio de la estación lluviosa, aproximadamente 20 semanas después del parto. El contenido bajo de fósforo en los pastos, el cual varió de 0.18% en la estación lluviosa a 0.09% en la estación seca y la baja disponibilidad de forraje, la cual fue especialmente baja o aguda al final de la estación seca, parece ser el factor limitante más importante en la ingestión adecuada de fósforo.