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Review and meta-analysis of the determinants of ruminant production in the tropics

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Introduction

Livestock production systems currently face a challenge because of increasing food demands and environmental issues. In this context, the multi-function of grazing systems (production, environmental and social/cultural objectives) is a way to achieve sustainable production. Over the last few decades, many studies have analysed plant-animal interactions in a temperate context and have resulted in a better understanding of the processes involved in plant-animal interactions. Up to now, no quantitative synthesis has ever been conducted under tropical conditions to assess the influence of various plant, animal and environmental factors on ruminant production. This would however be essential to highlight the contribution of these studies in order to propose models for the management of animals and grasslands in tropical environments. The aim of our work is to perform a meta-analysis of data from a literature review, in order to quantify the animal, vegetation and environmental factors, and their mutual interactions, explaining production levels variations in diverse climatic conditions and their relation with nutrition.

Material and methods

This quantitative review is focused on grazing trials carried out between 37°S and 37°N on all continents and under various climatic conditions, offering C4 forages to ruminant at pasture: 75 papers have so far been referenced (80% refer to cattle, 5% to sheep, 6% to goats and 7% to mixed grazing). The studies mainly report Average Daily Gains (ADG, 84% of the papers) and intake levels (48%). The major studied factors were stocking rate and pasture fertilisation (respectively 29 and 28% of the papers). Currently, we decided to focus on studies with grazing cattle receiving any supplement, reporting both ADG and intake values (20 papers, 249 treatments). Analyses of variances were performed to assess the determinants of ADG variations and their interactions with animal management, vegetation characteristics and dry matter intake (DMI) included as covariates.

Results

Animals' physiological states and types of climate were the main factors explaining ADG variations (Table 1): not surprisingly, growing animals gain weight whereas lactating cows tend to lose weight, and ADG are lower for hot and arid environments. Pasture fertilisation, as a binary factor (fertilised or not), appears significant in the model ($P < 0.05$) but explain only 1% of ADG variations. Focusing on growing animals ($n = 202$), ADG decreased with increasing stocking rates (kgLW/ha) for semi-arid environments (ADG $= 11258 - 0.33 \times$ SR, $n = 30$, steers only); in this analysis the data available for other climates were too limited. Biomass (gDM/m^2, $n = 41$) and allowance (another way to assess stocking rates, gDM/kgLW/d, $n = 17$) did not influence significantly weight gains. In contrast, ADG increased with DM intake (gDM/kgLW/d, $n = 119$) for the three climates with no difference between steers and heifers (ANOVA with a significant climatexDMI interaction: semi-arid: ADG $= 222 + 17 \times$ DMI, tropical humid: $-529 + 36 \times$ DMI, warm arid: $-328 + 19 \times$ DMI; Figure 1). The determinants of the important residuals scattering for semi-arid and warm arid climates will have to be detailed to improve the models.

Table 1 *Mean average daily gains (g/d) for the different animals' physiological states (PS) and climatic (Cl) conditions*

Variable	*n*	Mean ± S.E.	*P*	R^2
ANOVA (PS × Cl)	187	461 ± 35	<0.001	0.52
Physiological State			<0.001	0.30
Growing Steers	144	590 ± 35[a]		
Growing Heifers	15	334 ± 25[b]		
Lactating Cows	28	−134 ± 75[c]		
Climate			<0.001	0.22
Humid Tropical	28	528 ± 56[a]		
Semi-Arid	125	536 ± 45[a]		
Warm-Arid	34	130 ± 57[b]		

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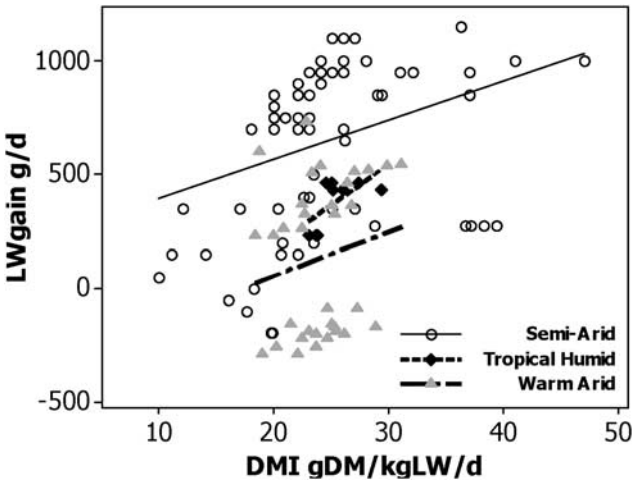

Fig. 1 Average daily gain variations for growing cattle related to DM intake levels in various climatic environments.

Conclusion

These preliminary results emphasize the influence of animal and environmental factors on average daily gains. Further analyses should now explore the influences of various climatic factors like temperatures, rainfall and photoperiod. Production levels of growing cattle appear to be well modulated by animals' management and, maybe even more, by nutrition. Measurements of vegetation structural features (biomass, allowance) do not seem to be major determinants of live weight gains. However, this result will have to be further analysed considering all the other papers giving ADG levels (without intake values). Moreover, pasture nutritional characteristics (nitrogen, fibre) should be integrated in future models. This work will contribute to a better understanding of ruminant production in the tropics and should offer the opportunity to identify appropriate strategies for animal management in tropical pastures.

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The evaluation of activated dietary charcoal from Canarium schweinfurthii Engl. seed and maize cob as a toxin binder in broiler chickens

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Aim

One hundred and twenty 3-week old male broiler chickens were used to evaluate the effects of dietary charcoal from *Canarium schweinfurthii* (charcoal A) and maize cob (charcoal B) on aflatoxin B_1 toxicosis in broiler chickens.

Materials & Methods

The individually caged birds were randomly allotted to 8 groups of 15 birds and fed in a completely randomised design a diet with either fresh groundnut meal (C−), groundnut meal infested with 22.02 ppb of aflatoxin B_1 (C+) or diet C+ supplemented with either 0.2 or 0.4% of charcoal A ($A_{0.2}$ and $A_{0.4}$ respectively), charcoal B ($B_{0.2}$ and $B_{0.4}$ respectively) or a 1/1 mixture of A and B ($M_{0.2}$ and $M_{0.4}$ respectively).

Results

The results indicated that the inclusion of charcoal either individually or as a mixture significantly ($P < 0.05$) improved feed intake (4166.66 to 4679.16 g) as compared with that of birds fed diet C+ (4075.00 g). At 0.2% inclusion, the highest feed intake was recorded with the birds fed $M_{0.2}$ (4679.16 g) as compared with $A_{0.2}$, $B_{0.2}$, C− and C+. In general, there was a drop in weight with increasing level of charcoal in the diet.

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