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Multicriteria evaluation of biomass resources for farming

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Responding to the challenges posed by global warming and the declining availability of most non-renewable resources will require a paradigm shift in the agricultural practice and in the role of live stock within the farming system. Farming systems should aim at maximizing plant biomass production from locally available diversified resources with processing of the biomass on farm to provide food, feed and energy and through recycling of all waste materials. The approach that is the subject of this paper is that the production of food/feed can be combined with the generation of electricity, thus ensuring sovereignty in food and energy for families in rural areas. The concept that facilitates this approach is the fractionation of biomass into edible (for food-feed) and inedible cell wall material, the latter being converted into a combustible gas by gasification, the gas in turn being the source of fuel for internal combustion engines driving electrical generators. The cell contents and related structures are sources of digestible carbohydrates, oil and protein which are used as human food and/or animal feed. An important byproduct from this process is "biochar" (65% carbon- 35% ash) that is both a sink for carbon, as well as a valuable amendment for the typically acid soils in tropical latitudes. The overall balance of these activities results in a farming system in which the carbon footprint is negative.

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Adaptation of a mechanistic model of intake and digestion in sheep to tropical forages

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Introduction

Numerous mechanistic models of ruminant nutrition have been published in a temperate context. Therefore, a big challenge is to adapt these models to tropical feeding situations. Sauvant *et al.* (1996) have published a mechanistic model simulating intake, chewing activities and digestion kinetics in the rumen of sheep consuming temperate roughages. The main objective of this current work was to modify this model and to adapt it to C4 grass.

Methodology

This compartmental model is structured around two submodels integrating the relationships between intake, feeding behaviour and digestive processes, with a time-step of integration of 1 minute. Simulations are performed with ModelMaker program. The decision submodel decides from activities of eating, ruminating and resting. The choice among these activities is performed according to the relative values of antagonistic functions of motivation to eat (FMI) and of satiation (FSAT). The FMI function is mainly based on forage palatability and composition, on energy balance, and FSAT. The FSAT function is determined by rumen load signals and energy balance. When the animal does not eat, the decision between ruminating and resting is related to the particles size in the rumen. The ruminal digestion submodel describes postprandial kinetics of particles (comminution and outflows), of digestion and of flows of nutrients (outflows and absorption). To adapt the model, the results of Assoummaya (2007) were the major source of experimental data. They concern measurements of intake, chewing activities, particle kinetics, outflow rates, digestion in the rumen and in the whole tract. They were obtained with sheep placed in digestibility crates and receiving chopped tropical forages.

Seven major aspects, dealing with empirical auxiliary equations of the original model were modified and applied to the new version: The calculation of the potential intake rate (PIR $= 3.50 \pm 1.29$ gDM/min) was entirely modified and is function of forage neutral detergent fibre (NDF $= 73.6 \pm 3.1$) and Crude Protein (CP $= 11.8 \pm 3.9$) contents (in % feed DM), and of body weight (BW $= 47.6 \pm 8.4$ kg): PIR $= 8.27 - 0.0794$ NDF $+ 0.110$ CP $+ 0.0764$ (BW-50) [$n = 84$, $R^2 = 0.60$, RMSE $= 0.84$].

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The initial value of PIR (PIRi) was calculated from fitting kinetics of DM intake in function of the mean PIR: PIRi = 2.0 PIR [$n = 4$, $R^2 = 0.99$, RMSE = 0.23].

The proportion of large particles (retained by screen sieves of 1.18 mm of aperture) in the swallowed bolus (PLPS, %) is a function of the forage NDF content: PLPS = −10.91 + 0.777 NDF [$n = 7$, $R^2 = 0.88$, RMSE = 1.3]. This relation was ignored in the previous model.

The *in vivo* potential digestibility of NDF (NDFd, %) is estimated by the potential degradability of forage DM estimated with long time incubations *in sacco* (ISPD, %): NDFd = 0.92 ISPD [$n = 11$, $R^2 = 0.70$, RMSE = 4.3].

The *in vivo* organic matter digestibility (OMd%) from the content in non digestible NDF (ndNDF, %DM) measured either *in vivo* (OMd = 85.6 − 0.78 $ndNDF_{vivo}$, $n = 126$, $R^2 = 0.79$, RMSE = 3.1) or *in sacco* (ndNDF = 80.4 − 0.70 NDF_{sacco}, $n = 62$, $R^2 = 0.48$, RMSE = 4.0).

The *in sacco* degradation rate of digestible NDF (kdNDF = 0.05 ± 0.02 h^{-1}) is predicted from forage NDF from a data base of C4 grass: kdNDF = 0.313 − 0.0035 NDF [$n = 74$, $R^2 = 0.53$, RMSE = 0.012].

The transit is assessed through AdLignin, as such measurement was performed. For that, a specific new sub-model of kinetic of lignin in the rumen was developed. Moreover, to evaluate digestive flows of raw materials, a second specific new submodel of kinetic was also developed for water phase.

Model evaluations

They were performed through comparisons between observed and simulated values of kinetics of rumen DM and lignin compartments, kinetics of particles and of pH after the meal, daily means of DM intake, of chewing and ruminating times, of duodenal flows of NDF and of organic matter digestibility in the whole tract. The two practical contexts for the evaluation procedure corresponded, firstly, to 4 stages of regrowth of Pangola grass (14, 21, 28 and 56d, Archimède *et al.*, 2000) and, secondly, to individual variations linked to BW. First results are globally encouraging despite predictions are not very accurate at this stage, however the model will have to be developed further particularly by integrating the nitrogen aspects which are important to explain and predict the feeding values of tropical forages (Leng, 1990). Moreover, the issue of the scale of palatability in function of the stage of regrowth was also put in evidence and will merits a specific focus.

References

Archimède H, Boval M, Alexandre G, Xandé A, Aumont G and Poncet C 2000. Anim Feed Sci and Technol 87, 153–162.

Assoummaya C 2007. PhD thesis, AgroParisTech, Paris.

Leng RA 1990. Factors affecting the utilization of 'poor-quality' forages by ruminants particularly under tropical conditions. Nutr Res Rev 3, 277–309.

Sauvant D, Baumont R and Faverdin P 1996. J of Anim Sci 74, 2785–2802.

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Ecological assessment and productivity of natural pasture in Arly National Park (Burkina Faso, West Africa)

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Introduction

In Burkina Faso (West-Africa), protected areas annually produce a high herbaceous biomass which is completely reduced to ashes when burning is used as a management tool. This biomass is an opportunity for rural populations to resolve the critical problem of forage during dry season. In 2007, the authority permitted an exceptional pilot project in the eastern area where farmers where allowed to collect biomass herbaceous for storage fodder. However this arrangement could compromise biodiversity conservation if there is no information on the floristic composition and the carrying capacity of these natural pastures. The aim of this study was to determine a typology of pasture, evaluate the net primary productivity and to analyise the effects of ecological aspects on productivity and spatial distribution of pasture. This study was carried out in Arly National Park, the site of the pilot project.

Materials and methods

Some 138 phytosociological relevés (100 m^2 plot) were identified along topographic gradients in the park. Floristic data were submitted to multivariate analysis (DCA) in order to discriminate pasture. For determination of above ground biomass of each pasture, all herb species were clipped to 1 cm above ground height and separated by gramineae and other herbs. Fresh weight of each fraction was measured.

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