EFFECTS ON INTAKE OF SUPPLEMENTING LOW-QUALITY ROUGHAGE WITH PROTEIN-RICH FEEDS

J.J.M.H. Ketelaars[1], G.A. Kaasschieter[1] and M. Kané[2]
[1]Research Institute for Agrobiology and Soil Fertility (AB-DLO), P.O. Box 14,
NL-6700 AA Wageningen, The Netherlands
[2]Institut díEconomie Rurale (IER), B.P. 258, Bamako, Mali

ABSTRACT
Intake responses of ruminants to supplementation with protein-rich concentrates or legume hays have been related to the ratio of nitrogen (N) content and organic matter digestibility (OMD) of the basal feed. Marginal intake effect of supplements, i.e. change of organic matter intake (OMI) from the basal feed per unit OMI from supplement, decreased on average from 1.7 to 0 and -0.8 g. g^{-1} at N/OMD of 0.010, 0.016 and > 0.030 g. g^{-1}, respectively. Marginal effect of supplements defined as change of total digestible organic matter intake (DOMI) per g DOMI from supplement was 2.5, 1 and 0.3 g. g^{-1} for N/OMD of 0.010, 0.017 and > 0.030 g. g^{-1}, respectively. From these effects, marginal productivity of a protein-rich concentrate, i.e. increase in liveweight gain (kg) per kg dry matter of supplement, was estimated to decline from 0.9 kg. kg^{-1} to less than 0.2 kg. kg^{-1} when N/OMD is raised from 0.010 to values > 0.030 g. g^{-1}.

KEYWORDS
Supplementation, protein, intake, roughage, prediction

INTRODUCTION
Supplementing ruminants with protein-rich feeds has often been found to improve the productivity of animals on a basal ration of low-quality roughage. The effectiveness of supplementation, however, varies, a/o with the composition of basal feed and supplement. Detailed knowledge of this variation may help to identify situations for more efficient use of often scarce amounts of supplements. Within the framework of a research project carried out in Mali, West-Africa, opportunities were investigated for improving ruminant productivity through the strategic use of protein-rich seed cakes or legume hays. One of the research objectives was the prediction of the outcome of protein-rich supplements from knowledge of available feed resources.

Largest increases in animal productivity have been observed when supplements stimulated roughage consumption and hence, resulted in substantial increases in total daily energy intake. Therefore, accurate estimates of changes in intake are thought to be crucial for successful prediction of effects of supplementation. In order to establish predictive equations, intake responses to supplementation were analyzed.

MATERIALS AND METHODS
Data used for the analysis came from local experiments described in detail in several research reports (Kaasschieter *et al.*, 1994; Kaasschieter and Coulibaly, 1995; Kané, 1996) and from a limited number of experiments reported in the literature (Siebert en Hunter, 1977; Minson en Milford, 1967; Zemmelink *et al.*, 1991). All trials involved combinations of roughages with protein-rich concentrates or legume hays. Data from cattle, sheep and goats have been included. In all experiments animals received the basal ration (grass hay or straw) *ad libitum*.

Intake responses to supplementation were analyzed in two different ways: 1. as changes of organic matter intake (OMI) from the basal feed per unit change of OMI from supplement, and 2. as changes of total digestible organic matter intake (DOMI from basal feed plus supplement) per unit change of DOMI from supplement. Intake changes have been related to the ratio of nitrogen content (N) to organic matter digestibility (OMD) in the feed. This ratio refers either to a non-supplemented ration or to a ration receiving an extra amount of supplement in case several levels of supplementation have been tested.

RESULTS AND DISCUSSION
The magnitude of the intake response to protein-rich supplements will depend on the degree to which the ration has a protein (or nitrogen) deficit. The occurrence of a protein deficit is determined by the relative availability of protein and energy from the feed. The latter is reflected by the ratio of N and OMD of the feed. This is confirmed by Fig. 1a which relate the marginal OMI effect of supplements to the N/OMD ratio of the ration. The marginal OMI effect allows a clear distinction to be made between protein-deficient and non-deficient rations. Protein-deficient feeds can be defined as feeds from which the intake increases when the protein supply to the animal is improved, hence the marginal effect should be greater than zero. For non-deficient rations the marginal effect is negative, i.e. OMI from the basal feed decreases upon supplementation. Fig. 1a shows that N/OMD is a sensitive parameter to distinguish between both types of rations. Only when N/OMD is less than the critical value of 0.016 g. g^{-1} increases in basal intake are observed. For roughages, this value roughly coincides with a feed N content of 7 g. kg^{-1} of dry matter.

Fig. 1b shows the marginal effect of supplements defined as change of total DOMI per g DOMI from supplement, with values of 2.5, 1 and 0.3 g. g^{-1} at N/OMD of 0.010, 0.017 and > 0.030 g. g^{-1}, respectively.

From the effects on DOMI, marginal productivity of protein-rich supplements, i.e. expected increase of liveweight gain (kg) per kg dry matter of supplement, can be estimated. For example, taking a concentrate with OMD of 75%, and assuming: an energy value of DOM equivalent to 19.5 MJ. kg^{-1}, a marginal efficiency of 0.5 for the conversion of digestible energy in net energy when comparing *ad libitum* fed animals (Tolkamp and Ketelaars, 1994), and an energy content of liveweight gain of 18 MJ. kg^{-1}, marginal productivity is estimated to decline from 0.9 kg. kg^{-1} to less than 0.2 kg. kg^{-1} when the N/OMD of the ration is raised from an initial value of 0.010 g. g^{-1} to values > 0.030 g. g^{-1}.

Although only a limited number of data sets were used in the above analysis, results are encouraging: effects of supplementation appear to be quantitatively predictable from information on the composition of basal feed and supplement. Future work should test the validity of the equations established here with the help of a larger data set. Estimates of the marginal productivity can then be compared with actual observations on improvements of liveweight gain upon supplementation.

REFERENCES
Kaasschieter, G.A., Y. Coulibaly and **M. Kané**. 1994. Suppleméntation de la paille de mil (*Pennisetum thyphoides*) avec le tourteau de coton: effets sur l'ingestion, la digestibilité et la sélection. Rapports PSS no. 4, AB-DLO, Wageningen, The Netherlands, 25 pp.

Kaasschieter, G.A. and **Y. Coulibaly.** 1995. Rentabilité de l'utilisation de fane de niébé (Vigna unguiculata) comme supplément avec la paille de mil (*Pennisetum thyphoides*) par des taurillons. Rapports PSS no. 7, AB-DLO, Wageningen, The Netherlands, 37 pp.

Kané, M. 1996. SupplÈmentation de la paille de riz avec le tourteau de coton dans l'alimentation des vaches laitiéres. Rapports PSS no. 16, AB-DLO, Wageningen, The Netherlands, 146 pp.

Minson, D.J. and **R. Milford.** 1967. The voluntary intake and digestibility of diets containing different proportions of legume and mature pangola grass (*Digitaria decumbens*). Aust. J. Exp. Agric. Anim. Husb. 7: 545-551.

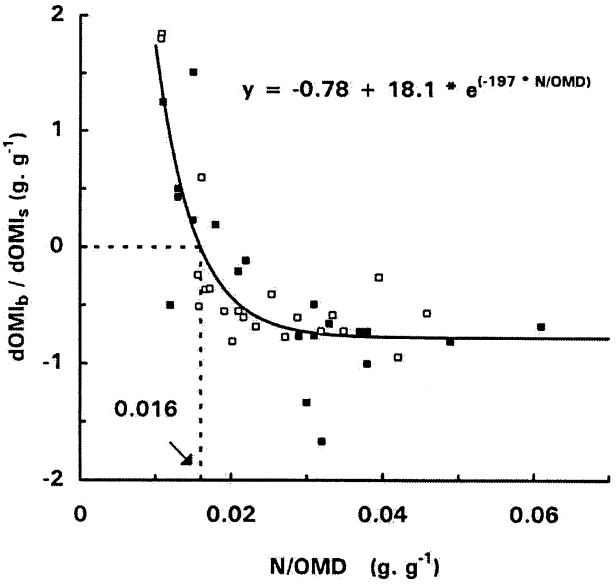
Siebert, B.D. and **R.A. Hunter.** 1977. Prediction of herbage intake and liveweight gain of cattle grazing tropical pastures from the composition of the diet. Agricultural Systems 2: 199-208.

Tolkamp, B.J. and **J.J.M.H. Ketelaars.** 1994. Efficiency of energy utilization in cattle given food ad libitum: predictions according to the ARC system and practical consequences. Anim. Prod. 59: 43-47.

Zemmelink, G., B.J. Tolkamp and **N.W.M. Ogink.** Energy requirements for maintenance and gain of West African Dwarf goats. Small Ruminant Research 5: 205-215.

Figure 1
Marginal effects of supplementing low-quality roughages with protein-rich supplements as a function of the ratio between N content and OMD of the basal feed.
(a) Marginal effect expressed as the change in OMI from the basal feed (dOMIb, g) per g OMI from supplement.
(b) Marginal effect expressed as the change in total DOMI from basal feed plus supplement (dDOMIt, g) per g DOMI from supplement.
Closed symbols refer to data from local experiments, open symbols to literature data.

(a)



(b)