INTEGRATED MANAGEMENT OF NATURAL FORAGE RESOURCES IN A TROPICAL HUMID SAVANNAH OF WEST AFRICA

Ph. Lecomte[1], Ph. Hellemans[2], A. Buldgen[2]

[1]Centre de Recherches Agronomiques de Gembloux, Station de Haute Belgique B6800 Libramont Belgium

[2]Faculté universitaire des Sciences Agronomiques de Gembloux UER Zootechnie B5030 Gembloux Belgium

ABSTRACT

In the practise of extensive cattle rearing in the Guinean low altitude savannah, coupled with a poor knowledge or appreciation of the plant communities, disturbs the natural equilibrium of vegetation. A carefully designed land management program and the establishment of indicators to monitor any changes are crucial for ensuring production capacity.

The study suggests the integration into a Geographical Information System of a set of field indicators defined for a typical savannah of the area in question. These indicators take into account throughout the seasons, data on the climate, the natural environment, the productivity value of vegetation and the risk of its degradation, as well as the type of cattle used.

A plan integrating data and field indicators into a Geographic Information System stress the interest and relevance of a global process towards a rational management of space and rearing methods in the Guinean zone.

INTRODUCTION

In the tropical humid Guinean zone of the African continent (rainfall > 750 mm, 3-5 months dry season) the forest-savannah complex got stabilised throughtime according to edaphic and biotic conditions among which fire is the most important (Hopkins, 1979). The grass growing after controlled fires which are spread through the seasons can be exploited by cattle in fencing or herding systems. Very often overstocking leads to low herd productivity and to an irreversible degradation of the natural "fire climax" vegetation. A sustainable exploitation has to be founded on sufficient knowledge of the grass productivity dynamics in space and time.

MATERIAL AND METHODS

The study applies to the Adele ranch, 16,030 hectares in the central mountain region of the Togo (Lat. 7° 80'; N Long. 00° 45' E; alt. 550 m) in the north part of the Guinean zone. It is essentially devoted to the extensive husbandry of 4000 crossbred cattle (local breed x N'dama). The climate is typical of the guinean zone; with 1100 mm rainfall, 4 months dry season from November to February and a slight decrease of the rainfall during the wet season in July and August. Pasture blocks are attributed to herds of 200 to 400 animals of a same class. The blocks are divided into 4 paddocks that should be of identical agrostological value. In late dry season a first paddock is burned to provide grass till the mid wet season. To overcome the decrease in grass quality, a second paddock is then ignited. A third one will be ignited in the early beginning of dry season to increase the area allowed to the herd and overcome the slower growth of the vegetation. The fourth paddock is left in rest for a whole year in order to preserve pastures from degradation.

The following data has been collected:

- Description of the soil profile according to texture, organic matter content, exchange acidity and cationic exchange capacity.
- Botanical composition according to abundance-dominance indices of the main grasses species.
- Sward measurement plots allowed productivity measurements every 20 days, during one year.
- Climatic data (rainfall, relative humidity) collected for the last 8 years on the ranch or in proximate stations allowed calculation of the evapotranspiration per decades.
- The pasture blocks and paddocks were identified and for each a degradation index (Di) was attributed on a scale (0 - 5) according to the progressive replacement of the climax grasses by small annuals or dicotyledon weeds, Compère *et al*., (1992).

RESULTS

The field study of the vegetation and the data treatment with a Integrated Land Water Iinformation System geographical information system software lead to a digitised agrostological map describing 11 vegetation units. Raster crossing of this one with a map describing paddocks size and repartition generated a GIS data base on the area of each unit in each paddock.

Principal Component Analysis and Clustering techniques applied to soil and botanical composition characteristics detailed four pastoral vegetation groups (Table 1) regrouping the main vegetation units.

For these groups mean sward productivity measurements were related to climatic data. The best fit parameter to predict the daily dry matter (DM) production appeared to be the actual evapotranspiration (ETR) calculated for a field capacity of 150 mm and expressed as a sum on the last four decades (4dETR). Linear models y = Ax4dETR+B were established with R^2 ranging between 73.2 and 86.5 and α vary between 1.29 and 2.31 kg DM/ha/day according to vegetation group (Table 2 and Figure 1).

The carrying capacity of the paddocks (CCpadd) are established as follows:

$$CCpadd = \sum_{i=1}^{n} Si / CC_i \text{ ; with } CC_i = CI_j / (P_i \infty VIc \infty Df)$$

S_i= area corresponding to vegetation type i and CC_i carrying capacity ha /head for vegetation i; with,: CC_{ij} : carrying capacity of vegetation i expressed in ha/head for animals of class j; CI_j : ingestive capacity of the class j kgDM /head/day; P_i : daily grassland production of the vegetation i kg DM/ha/day; VIc = voluntary intake coefficient of biomass by the UBT (Boudet, 1984); Df = degradation factor %, estimated according to a field degradation index (1 to 5) attributed to the paddock.

After generalising the results (Figure 2), a GIS map layer or tables indicates the actual pastoral potential of each paddock. This information crossed with the actual cattle numbers indicates the carriage status of the pasture.

The agrostological and pasture maps and the study of grassland productivity used jointly with information relative to zones of degradation of the grass cover provided, after generalisation of results, a geographical layer indicating the true pastoral potential of the perimeter and of each pasture. This information crossed with the actual cattle numbers indicates the carriage status of the pasture.

Expressed in maps, all this information provides a useful indicator of the size and spatial repartition of the problems of the pasture carriage and degradation stage. This could help to manage the natural ecosystem in a more rational and optimal manner.

CONCLUSIONS

Confronted with the management of large cattle numbers spread on numerous paddocks the information collected on the pedological and agrostological characteristics of a wide natural range may be associated with models describing the varying response of the vegetation regrowth to factors like the climate and degradation. Combined with cattle numbers and their potential use of the grass the data may be gathered in a geographical information system and provide a useful indicator of the size and spatial repartition of the pasture carriage. Such an approach could help to manage the natural ecosystem in a more rational and optimal manner.

REFERENCE

Hopkins, B. 1974 Forest and Savanna, ed. Longmann, London, 108p.

Compère, R, Hellemans Ph., Lecomte Ph., Gernez F., 1992, Les Savannes guinéennes du ranch de l'Adélé (TOGO) 1. Les facteurs : du milieu et la composition floristique des formations végétales pâturées, Bull Rech. Agron. Gembloux **27**: 445-71

Boudet R., 1984, Manuel sur les pâturages tropicaux et les cultures fourragères. Min coop. Franc. Paris

Lecomte Ph. (1995). Integrated management of natural forage resources and cattle rearing in the Guinean low altitude savanna. (PHD thesis) Gembloux, Faculté Universitaire des Sciences Agronomiques. 317 p.

ILWIS 1.3., The Integrated Land and Water Information System, User's Manual (1992). ITC, International Institute for Aerospace Survey and Earth Sciences, Enshede, The Netherlands.

Figure 1
Example of predicted and observed daily DM grass production along the year according to evapotranspiration (average model).

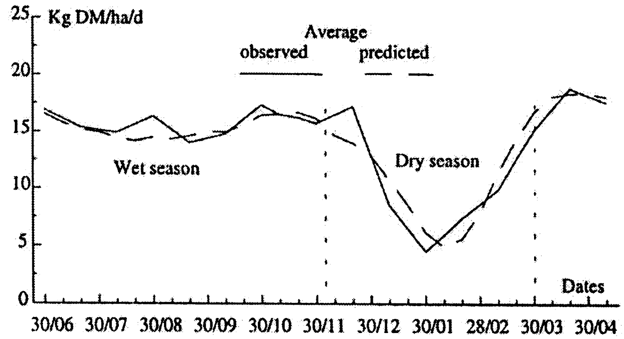

Figure 2
Integrated management of the cattle and the vegetation in an extensive ranch.

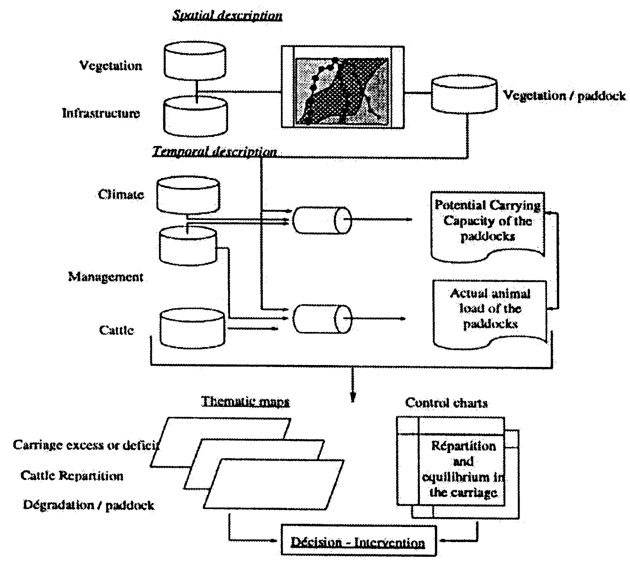

TABLE 1
Vegetation groups according to botanical composition and soil characteristics at the Adele Ranch.

Group	Description
1	Red argilous deep soils clayey sandy type with low stone charge medium exchange capacity and low acidity, colonised by the main association *Hyparrhenia diplandra, Panicum phragmitoïdes* and *Schyzachirium sanguineum*
2	Brown soils and slope colluvions; more clayey type with lower acidity, marqued by a regressive evolution with H smithiana more abundant
3	Brown superficial soils; sandy clayey soils with high stone charge and lower cationic charge; regressive evolution with *Loudetia. arundinacea* and *Andropogon schirensis.*
4	Skeleton and mineral soils or forest-savannah mosaïcs sandy clayey soils with high stone charge, more acids with *Loudetia simplex* more abundant.

Table 2
Prediction of grass production according to actual evapotranspiration for each group or in a general model.

Groups	A*	B	R^2,%	σ,kg DM/ha/d
1	0,165	-3,089	86,5	1,84
2	0,118	2,810	73,2	2,02
3	0,160	-3,491	79,8	2,31
4	0,104	0,825	83,9	1,29
average	0,132	-0,598	89,6	1,28

*y (kg DMha-1d-1) = A ∞ 4dETR+B; σ= residual standard error