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Rangeland Rummy to support adaptive management of rangeland systems

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Abstract. To support the development of adaptive management strategies in rangeland-based livestock systems, we developed a game called "Rangeland Rummy". It is intended to stimulate farmers' discussion and knowledge exchange around the collective design and evaluation of rangeland-based livestock systems. We present the game and its various components.

Keywords. Farm model – Rangeland system – Adaptation – Simulation – Learning.

Le Rami Pastoral : un jeu pour favoriser la gestion adaptative des systèmes d'élevage pastoraux

Résumé. *Pour favoriser le développement de stratégies de gestion adaptatives des systèmes d'élevage pastoraux, nous avons développé un jeu appelé le Rami Pastoral. Il vise à stimuler les discussions entre éleveurs et le partage de connaissances autour d'un exercice collectif de conception et d'évaluation de systèmes d'élevage pastoraux. Nous présentons ce jeu et ses différents éléments.*

Mots-clés. *Modèle de système d'élevage – Système pastoral – Adaptation – Simulation – Apprentissage.*

I – Introduction

Rangeland-based livestock systems have to deal with the significant instability and uncertainty of the agricultural context (climate change, volatility of input prices, etc.). To support the development of adaptive management strategies in grassland-based livestock systems, we had previously developed a board game including a computer model called *Forage Rummy* (Martin *et al*., 2011). It proved successful in stimulating farmers' learning about their livestock systems and the scope for their adaptation. *Forage Rummy* was unsuited to address the specific features of rangeland-based livestock systems such as heterogeneous vegetation on paddocks or the practice of delayed grazing. Then, we developed a new game called *Rangeland Rummy* intended to stimulate farmers' discussion and knowledge exchange around the collective design and evaluation of rangeland-based livestock systems.

II – Overview of *Rangeland Rummy*

1. Conceptual model of a rangeland-based livestock system

Our conceptual model of a rangeland-based livestock system represents the interactions between four system components: rangeland (divided into types of paddocks), feed stocks (conserved forage and concentrate), herd or flock (divided into animal groups) and farmer (represented by its

management strategy and practices). The farmer organizes the herd or flock into animal groups and allocates rangeland use by deciding upon grazing and feeding management. To feed his grazing animals, the farmer builds up on each paddock a type of grazable feed resource which results of previous utilizations. Over the short term, this feed resource depends on the actual state of the vegetation when it is grazed; over the long term, it depends on the vegetation type. The farmer also decides about the use of feed stocks that are allocated to animal groups.

2. Objects included in *Rangeland Rummy*

In *Rangeland Rummy*, manipulated objects are of two types (Fig. 1): (i) material objects (e.g. cards) enabling modelling, i.e. design of rangeland-based livestock systems on a board game; and (ii) a computer object, i.e. a computer model enabling simulation in order to evaluate these systems. Material objects are intended to create a connection between players. Farmers and/or agricultural consultants manipulate these material objects and the information they encapsulate to design rangeland-based livestock systems. Throughout this process, they share knowledge, opinions and discuss the pros and cons of different options. Computer objects are intended to provide integrated evaluation of rangeland-based livestock systems designed by players in order to stimulate their reflections and discussions. Such evaluation is based on relevant and objective up-to-date knowledge encapsulated in the simulation model.

A. The game board

The game board (a whiteboard marked with information; Fig. 1) was designed to address the key challenge faced by rangeland farmers, i.e. managing the feeding system in compliance with desired, attainable and accessible feed resources. Along the x-axis, the board is divided into 24 15-day periods, i.e. one year, whose starting date is not fixed. Along the ordinate, the upper part is an area axis expressed in hectares and is used to represent the rangeland and grassland paddocks (or paddock types) and the corresponding feed resources. The lower part offers space to build until four animal groups and the feeding regime allocated to each of these groups. Therefore, the game board enables to organize the system components, their dynamics and their interactions.

B. The calendar stick

The starting date of the game board corresponds to the transition between the end of winter and early spring. At this time occurs a breakpoint in biomass production kinetics on rangelands. Then, a calendar stick (Fig. 1) specifies this date and the dates of the following 15-day periods for each regional application of *Rangeland Rummy*. These dates can be defined using a France-wide database on rangeland production and use (Institut de l'Elevage, 1999) or based on expertise.

C. The feed resource sticks

Rangeland Rummy contains flattened sticks (that we call feed resource sticks, Fig. 1) referring to combinations between a vegetation type (e.g. broom moorland) and a management type (e.g. full grazing at full spring and incomplete grazing in autumn) on a paddock. Sticks are marked with the corresponding feed resources available per hectare and for given seasons (early spring, full spring, end of spring, summer, autumn, end of autumn, winter), or with the available yield (in tons of dry matter per hectare) through mechanized harvests. Colors are used to represent feed quality (low, medium, high) of the feed resources. For each new application of the game, feed resource sticks corresponding to the application situation are developed based on different sources. The main one is the France-wide database on rangeland production (Institut de l'Elevage, 1999). In order to represent climatic hazards, rangeland sticks can be produced based on expertise or using crop and grassland models.

Playing *Rangeland Rummy*, farmers can represent their rangeland and grassland paddocks and the management practices they implement on these paddocks on the game board using the feed resource sticks. They first have to select the corresponding feed resource sticks among the whole set of sticks. Then, they have to place the sticks on the upper part of the game board and decide on the area to allocate to each stick corresponding to the paddock area.

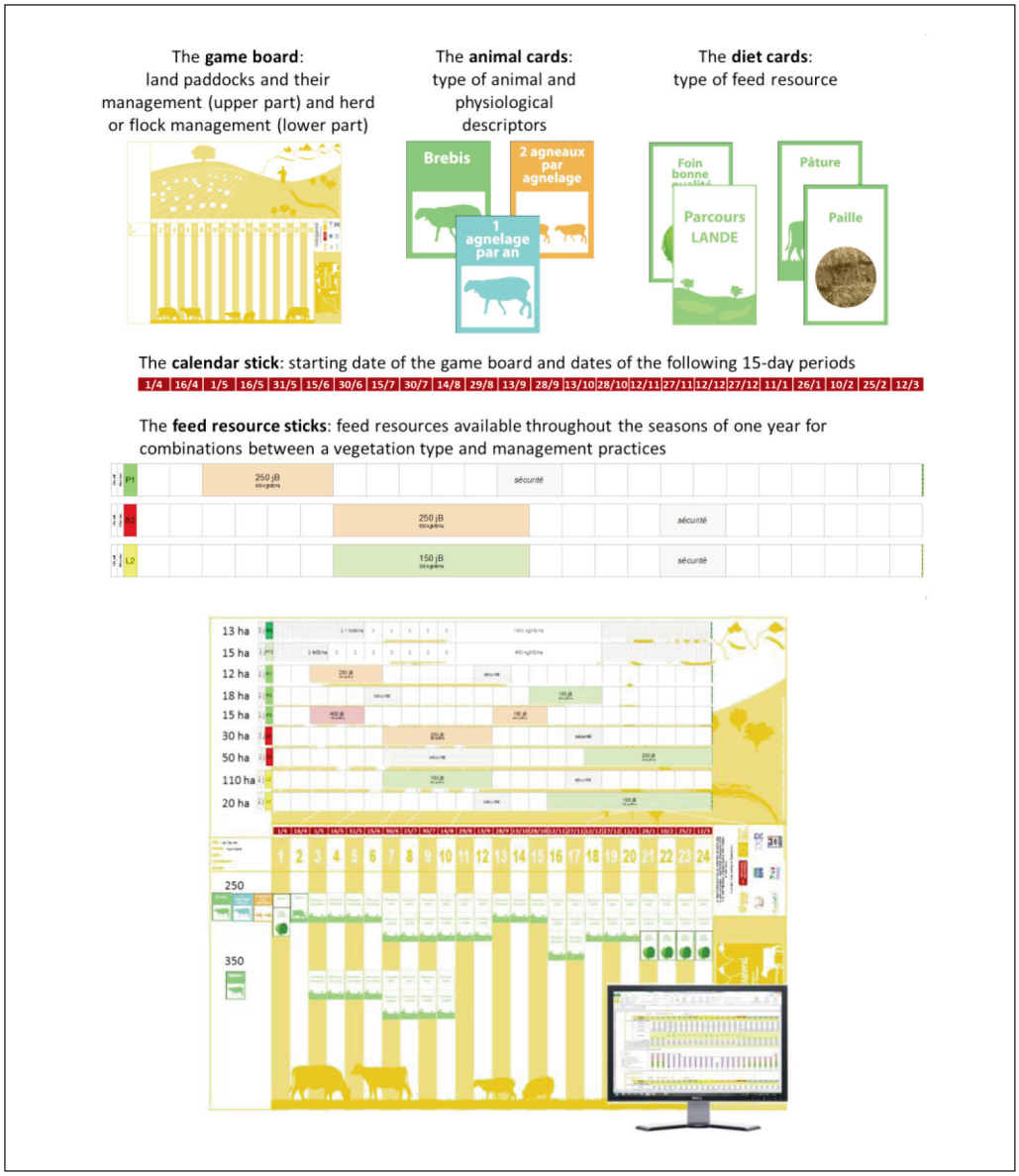

Fig. 1. Separate view of the material objects manipulated when using *Rangeland Rummy* (upper part) and aggregate view of the same objects placed on the game board together with a screen displaying inputs and outputs of the computer spreadsheet (lower part).

D. The animal cards

Herd or flock management in rangeland-based livestock systems consists of organizing the herd or flock into one to several animal groups and deciding upon animal species, breed, body condition and reproduction. Then, *Rangeland Rummy* contains animal cards displaying a type of animal (e.g. beef cow, meat sheep) and a physiological state (e.g. a calving period) descriptor (Fig. 1). Combining animal cards amounts to describe the target animal of a group. To represent herd or flock management, farmers have to combine animal cards and specify a headcount to each combination on the game board, thereby creating animal groups (at most 4). In this way, farmers explain their strategy for herd or flock management. It is not visible on the game board (only in the spreadsheet), but each combination is given a pattern of daily dry matter (in kg) and feed quality (low, medium, high) requirements of the animal across the 24 15-day periods of the year. Such patterns are developed using animal intake simulation models.

F. The diet cards

Each diet card represents a type of feed: forage (e.g. grazed woodland, grazed grassland, hay, silage) or concentrate (e.g. soya meal). Diet cards have to be combined by farmers in order to build the feeding regime of each animal group across each of the thirteen four-week periods of the calendar year (Fig. 1). While defining these regimes, farmers have to connect each card has with a given feed resource stick. This way, diet cards make a link between such a stick and the animal group grazing the corresponding feed resource(s).

G. The spreadsheet

Throughout the game, farmers' choices regarding the feed resource sticks and their area allocation, the animal groups and their size as well as their diets are entered into a computer spreadsheet (Fig. 1). The spreadsheet integrates this input information and automates the calculations of indicators and graph building used for evaluation of the rangeland-based livestock system designed. For instance, graphs illustrate the extent to which quantitative and qualitative animal feeding requirements are covered over each 15-day period. It also holds data, among other things, about residual standing biomass after grazing on the different vegetation types (e.g. shrubland, woodland) as well as self-sufficiency for forage, concentrates and straw. The spreadsheet thereby hastens the process whereby players visualize whether feed resources adequately match animal feeding requirements across seasons and eventually decide whether to continue with additional design and evaluation loops.

3. Workshop content

Rangeland Rummy is intended to be used by agricultural consultants and/or researchers with small groups of 2 to 4 farmers during workshops lasting from 2 to 4 hours. The problem situation is defined with farmers prior to the workshops or at their very beginning. Workshops include collectively and iteratively designing and evaluating rangeland-based livestock systems, while confronting them to new contextual challenges (e.g. climate change, volatility of input prices) or new farmers' objectives (e.g. being self-sufficient for animal feeding).

IV – Conclusion

Rangeland Rummy has been tested with agricultural consultants and farmers in two regions of France. It tended to stimulate farmers' discussion (e.g. about how to prevent shrub encroachment with grazing), reflective and interactive analysis and learning about rangeland-based livestock systems, their management and the scope for their adaptation. For instance, a farmer was pro-

posed by his colleagues a way to modify the timing of grazing on moorland and woodland to increase grazing pressure on insufficiently grazed paddocks. *Rangeland Rummy* is currently being tweaked to prepare its transfer into the activity of agricultural consultants.

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