

Chapter 6

A Conceptual Model of Grassland–Based Beef Systems

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ABSTRACT

Fulfilling the production objectives of a grassland-based beef system requires a robust management strategy to secure the best practicable use of forage resources with regard to the cattle demand. To address the challenging issue of designing such strategies, this article describes the application of an ontology of agricultural production systems to the generic conceptual model SEDIVER, which supports the representation and dynamic farm-scale simulation of specific grassland-based beef systems. The most salient and novel aspects of SEDIVER concern the explicit modeling of (a) the diversity in plant, grassland, animal and farmland, and (b) management strategies that deal with the planning and coordination of activities whereby the farmer controls the biophysical processes. By using the SEDIVER conceptual framework, part of the subjective and context-specific knowledge used in farm management can be captured and, in this way, enable scientific investigation of management practices.

INTRODUCTION

In temperate less-favored areas, beef farming involves the management of a wide range of semi-natural grasslands. Such systems are increasingly threatened by rising input/output price ratios and

the growing uncertainty surrounding production due, for example, to year-year weather variability. These problems add to the known difficulties in managing grassland-based systems. In such systems, herbage production is very heterogeneous and variable in time and space (Parsons, 1988).

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This is partly because of the variation in vegetation types in relation to management intensity and environmental factors, mainly soil conditions and topography, and partly because of weather variability within and between years. The management challenge is thus to make efficient use of grassland production, and to secure the feeding of the herd in accordance with desired, attainable and currently usable herbage production. Of primary importance for farmers is the development of greater flexibility in farm management, enabling them to take advantage of opportunities, reduce vulnerability to adverse events, or cope with their consequences, in order to preserve the sustainability of their production enterprise.

Farmers have long relied on their intuition and on lessons resulting from analyzing other farmers' experiences to make strategic decisions (Jiggins & Röling, 2000). Now, when management processes must change or be adapted, the ability to use experience and history to discern patterns is still helpful, but given the limitations of human intellect and the increase in the pace and scale of change and uncertainty, it can hardly be used to shape robust decisions that perform consistently across a range of possible situations (McCown, 2002). The traditional reductionism of agronomic analysis, which examines a production system by taking it apart and understanding its constituent elements, is also inappropriate (Antle et al., 2001). Indeed the parts interact in complex and non-linear ways in response, in particular, to the manager's actions that are inherently discrete. These interactions are highly significant in the overall functioning and performance of the system. They might give rise to phenomena such as a bottleneck on some resources. Understanding the mechanisms and consequences of these emergent phenomena is of key importance in devising a management strategy that complies with the farmer's objectives and constraints.

The idea that farming systems should take greater consideration of plant, grassland, animal, and farmland diversity, both biological and

functional, is generally agreed (e.g. Altieri, 1999; Andrieu, Poix, Josien, & Duru, 2007; White, Barker, & Moore, 2004). Such an approach encourages more flexible and efficient use of natural resources including herbage production. For instance, it enables functional complementarities and synergisms to be promoted between grassland plots that are suitable for different and sometimes multiple uses that depend on context-specific grassland production, and the feeding requirements of different animal categories (e.g. cows vs. heifers) characterized by different and fluctuating animal intake rates (Duru & Hubert, 2003; White et al., 2004). In addition, all four types of diversity constitute a potential source of flexibility that can be used in management choices to cope with uncertainty about uncontrollable factors such as weather. For instance, on a farm scale, farmland and grassland diversity bring organizational flexibility into farm management, i.e. freedom in the implementation and modification of a management strategy, e.g. a switch in the type of grassland use on a field, depending on the actual conditions encountered. On a field scale, plant species diversity makes it possible to take advantage of timing flexibility in grassland management (Martin et al., 2009a), i.e. the extent to which the use of a given grassland may be brought forward or deferred at various times of year. More generally, plant and/or animal diversity enhances operational flexibility, i.e. the farmer's ability to modify the target performance or the state of the plant and/or animal material.

The properties and behavior of agricultural production systems which exhibit such an organized complexity may be studied through modeling and computer simulation. Simulation does not replace intuition or lessons learned from other farmers' experiences but rather supplements it by revealing emergent behavior. Research has produced several simulation-oriented farm models for designing beef systems (e.g. Andrieu et al., 2007; Jouven & Baumont, 2008; Romera, Morris, Hodgson, Stirling, & Woodward, 2004). These models suffer from two main limitations. None

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