Competing use of organic resources, climate variability and interactions at village scale in a communal area of NE Zimbabwe

M.C. Rufino, J. Dury, P. Tittonell, M.T. van Wijk, S. Zingore and K.E. Giller
Plant Production Systems, Wageningen University; P.O. Box 430, 6700AK Wageningen, The Netherlands; Email: mariana.rufino@wur.nl

Introduction

Mixed crop-livestock systems support the livelihood of the largest number of poor people in sub-Saharan Africa. These rural people are exposed to a variety of risks such as recurrent droughts, political instability, failure of markets for inputs and products. Livestock provide food (milk and meat) and other services to the household, such as animal traction for cropping, but also fulfil a financial role. In places with low population density, livestock may feed on grasslands. As population pressure and competition for natural resources increases, some of the feed for livestock is produced in the cropland, and because of the continuous cultivation of the land, the removal of nutrients from the soils needs to be compensated by adding fertilisers, or making use of animal manure. As population pressure and competition for natural resources increase further, grasslands tend to disappear, more feeds need to be produced in cropland, and some feed is imported to the farm.

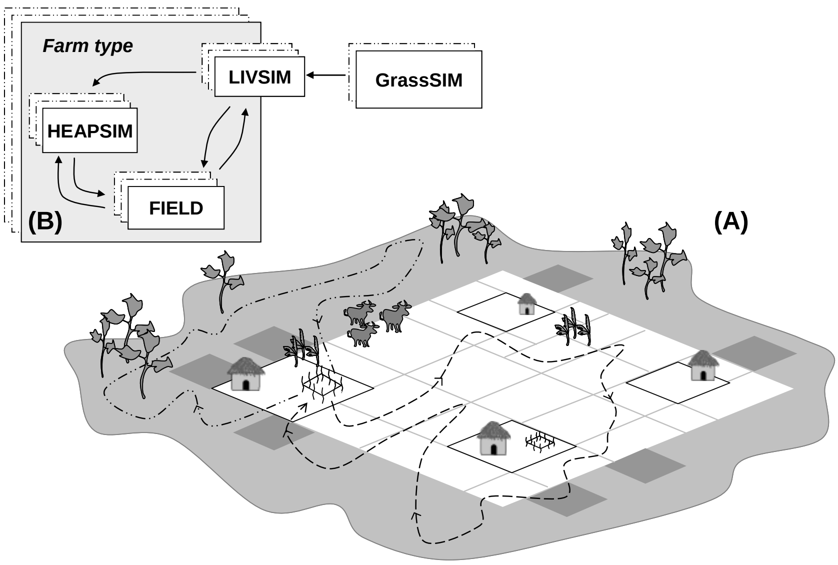

Figure 1: Schematic representation of the virtual village (A), and of the integrated tool FARMSIM (B), with the models FIELD (simulates crop production and nutrients dynamics in the soils), LIVSIM (simulates animal production and reproduction), HEAPSIM (describes decomposition of manure and other organic resources), GrassSIM (describes the availability of grass in the different grazing units).

The objectives of this study were i) to understand the dynamics of crop-livestock interactions under climate variability ii) and to identify opportunities for intensification. To achieve these objectives, we developed and tested an analytical tool to analyse crop-livestock interactions at the scale of the village using a communal area of NE Zimbabwe as example.

Methods

We combined information available for the area of study, collected through interviews, observations, experiments, and literature. We used the NUANCES-FARMSIM modelling framework (Giller et al., 2006; Figure 1) adapted and tested for the conditions of smallholder farming in Majonjo, Murewa, NE Zimbabwe. We constructed a simplified 'virtual' village using the farm typology developed by Zingore et al. (2007) which distinguishes four farmer resource groups (RG) based on cattle ownership, farm size, production orientation, hiring labour, and food self-sufficiency. Feeding strategies, herding patterns, crop residues, and manure management were studied during the dry season of 2006 and the rainy season of 2007 (Dury, 2007). Additionally, the communal grasslands were characterised. The tool includes different levels of detail: it simulates crop production at plot scale, grass production for different grazing units, animal production at individual level, while management decisions at considered at both farm and village scales by using rules. The most important transfers of nutrients: from grasslands to cropland, and between different farms within the village territory, are kept track of by integrating the different scales in which the different models operate. Climate variability is accounted for by simulating scenarios using data from the locality, which includes contrasting rainfall series.

Results and discussion

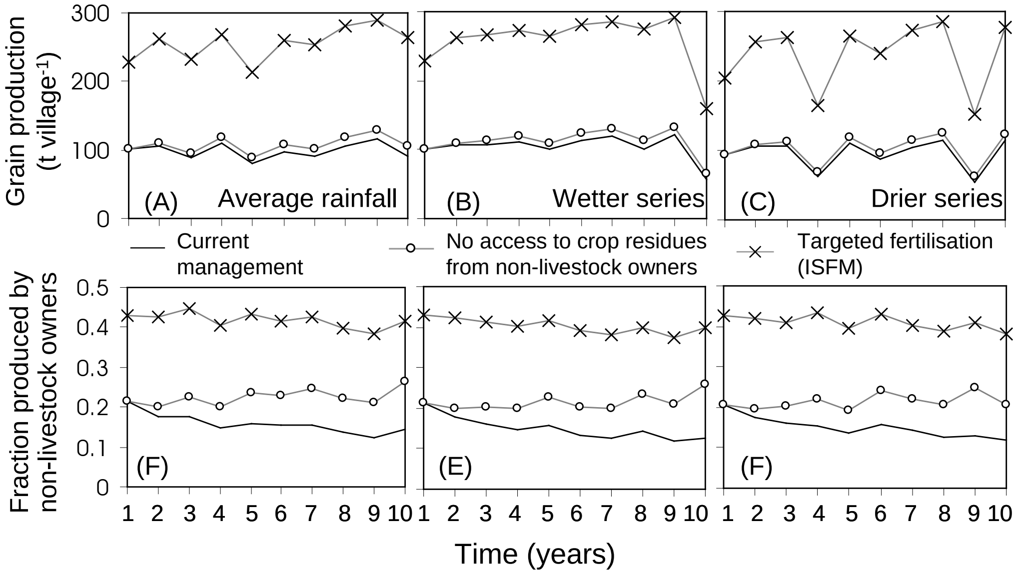

Figure 2. Simulated grain production for the whole 'virtual' village under three management scenarios (baseline, no access to cattle to crop residues of the non-cattle farmers (RG3 and RG4), and targeted fertilisation), and using three different rainfall series: (A) average series, (B) a wetter series and (C) a drier series, and the share of the non-cattle farmers grain production to total production of the whole village for (D) average rainfall series, (E) a wetter rainfall series and (F) a drier rainfall series.

The interaction between farmers determines who benefits from integration of crop and livestock. The removal of C by cattle leads to lower crop yields in the poor fields of these farmers, and has relatively smaller effect on the fields of the cattle owners that receive animal manure and fertilisers (Fig. 2). Rainfall variability intensifies the interactions, when the start of the rains is delayed, the low availability of crop residues during the dry season may lead to loss of animals from the herd. In years of good rainfall the removal is relatively unimportant. Crop-livestock integration at village scale results in concentration of nutrients in the farms with larger herds and increases dependency of the poorer smallholders on external inputs, and other types of exchanges within the village such as labour for food, cash or manures. In the targeted fertilisation scenario, fertilizer compensated for the negative effect of the interactions, though it may be an unrealistic scenario for a smallholder community in Zimbabwe, certainly under the current economic and political circumstances.

References

Dury, J., 2007. MSc thesis, Wageningen University, 133 pp.
Giller, K.E et al., 2006. Agric. Sys. 88, 8-27.
Zingore, S. et al., 2007. Agric. Ecosyst. Environ. 119, 112-126