Available online at www.sciencedirect.com
ScienceDirect
Agricultural Systems 92 (2007) 240–265
AGRICULTURAL SYSTEMS
www.elsevier.com/locate/agsy

IMPACT: Generic household-level databases and diagnostics tools for integrated crop-livestock systems analysis

M. Herrero [a,b,*], E. González-Estrada [a], P.K. Thornton [a,b], C. Quirós [a], M.M. Waithaka [c], R. Ruiz [b], G. Hoogenboom [d]

[a] *International Livestock Research Institute (ILRI), P.O. Box 30709, Nairobi, Kenya*
[b] *Institute of Atmospheric and Environmental Sciences, School of Geosciences, University of Edinburgh, West Mains Road, Edinburgh EH9 3JG, UK*
[c] *Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Plot 15 John Babiiha Road, P.O. Box 765, Entebbe, Uganda*
[d] *Department of Biological and Agricultural Engineering, University of Georgia, Griffin, GA 30223, USA*

Received 30 March 2005; received in revised form 23 March 2006; accepted 30 March 2006

Abstract

We outline the need for generic crop-livestock systems databases and data standards for comprehensive systems analysis in developing countries. We also indicate the type of data that such databases should contain and review how they can be collected. We describe IMPACT, a database and analysis tool that we have developed that goes some way to meeting the demands that may be made of such systems data. Analysis tools, links to models and uses of such databases are briefly described and illustrated with case studies from Kenya, Ghana and Sri Lanka. The paper concludes with a discussion of the needs for a more coherent integration of global data collection and improved sharing of data for better articulation of research and development outcomes in developing countries.

* Corresponding author. Address: International Livestock Research Institute (ILRI), P.O. Box 30709, 00100 Nairobi, Kenya. Tel.: +254 20 422 3000; fax: +254 20 422 3001.
E-mail address: m.herrero@cgiar.org (M. Herrero).

0308-521X/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.agsy.2006.03.008

Keywords: Crop-livestock systems; Livestock; Models; Databases; Livelihoods; Tools; Decision support; Poverty; Agricultural development; Household models

1. Introduction

As objects of study, the importance of mixed smallholder farming systems in developing countries is counter-balanced by their complexity. Increased integration of crops and livestock is seen in many places as a key to system intensification (Tarawali et al., 2004). In a previous paper (Thornton and Herrero, 2001), we outlined a framework for the integration of detailed biophysical crop and livestock simulation models, and highlighted the need for minimum data sets that could be used for calibration and validation. We argued that the application of robust household and crop-livestock models is critical for furthering the research agenda associated with animal agriculture in the tropics and sub-tropics. Crop-livestock smallholder systems are already of enormous importance to human welfare in these areas (LID, 1999), and these systems are under considerable stress in many countries, particularly through population increases and declining soil fertility, and in the future because of changing climates and weather patterns.

A framework for analyzing and modelling these systems is certainly required, but the basis of this has to be data sets that adequately describe or characterize the systems under study. At first sight, the data problem seems almost insurmountable. How can systems be adequately characterized for a multitude of purposes, while remaining in the realm of the feasible in terms of the amount and type of data to collect?

The concept of the minimum data set relating to crop models was first set out by Nix (1984), the basic idea being that all crop models, however designed, would require information on certain aspects of the aerial and soil environment. This "required" information would then have to be supplemented by data on the crop-soil system that would be essentially model-specific, such as genotype characteristics and management factors (Hunt and Boote, 1998). This data supplementation could be almost infinite, so in an attempt to place reasonable limits on the type of information that was needed for crop modelling, the concept of the minimum data set (MDS) was developed, in relation to a hierarchy of data sets that could be considered to be appropriate for the operation of models of differing degrees of complexity (Hunt and Boote, 1998). Nix originally drew these up in relation to the frequency with which weather data would be required: the week, the day, and the hour. After some time, it became apparent that for management-orientated crop models, the day was the appropriate level, and so the minimum data set was defined and refined through time (IBSNAT, 1993), and included information on the site, weather, soil, initial conditions, and management.

Since the end of the International Benchmark Sites Network for Agrotechnology Transfer project in the early 1990s (IBSNAT, 1993), the crop modelling software suite DSSAT (Decision Support System for Agrotechnology Transfer; Jones et al., 1998) was continued by a new consortium named ICASA (International Consortium for Agricultural Systems Applications; Bouma and Jones, 2001). The ICASA website