Farming Systems Design 2007

An International Symposium on Methodologies on Integrated Analysis on Farm Production Systems

Field-farm scale design and improvement

September 10-12, 2007 – Catania, Sicily, Italy

sponsored by

LA GOLIARDICA PAVESE

The correct citation of articles in this book is:

authors, 2007 *title*. On: Farming Systems Design 2007, Int. Symposium on Methodologies on Integrated Analysis on Farm Production Systems, M. Donatelli, J. Hatfield, A. Rizzoli Eds., Catania (Italy), 10-12 September 2007, book 2 – Field-farm scale design and improvement, pag. *??-??*

Sponsors of the Symposium:
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Under the auspices of:
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ISBN 978- 88-7830-474-1

Printed on August 2007 by *Global Print*, Gorgonzola (MI), Italy

BIO ECONOMIC MODELING: LESSONS LEARNED ON OBSTACLES TOWARDS INTERDISCIPLINARITY

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Introduction

Farm decision models are established tools for studies of the impact of agricultural policies, technological innovation or more recently climate change, on production systems (Janssen et van Ittersum, 2007). Studying decision processes belongs clearly to social science, but it is more and more acknowledged that the relevancy of farm models strongly depends on the way they account for the biophysical processes involved in farming. Thus, farm modeling became recognized as a multidisciplinary job, as underlined by the rising, from about a decade, of the term "bioeconomic" to characterize it. This paper summarizes two case-studies involving farm modeling and draws lessons regarding issued linked to multidisciplinarity – or more properly – interdisciplinarity.

Methodology

The first case-study focused on an ex-post analysis of an agricultural revolution that occurred in central Brazil in the 90's. Indeed, many subsistence farms had turned into intensive dairy farms within a decade, their income being increased tenfold or more, whereas a significant number of other farms were left out of this development trend (Bainville et al., 2005). Our multidisciplinary team that studied this revolution considered the following hypothesis for explaining the differences between farm trajectories over time: (i) variations in risk aversion of farmers (ii) variations in market accessibility, (iii) variations in bank credit accessibility and (iv) variations in the biophysical environment of farms.

The second study was an ex-ante analysis of the feasibility of direct seeding mulch based cropping systems (DMC) in farms of a mountainous region of Vietnam. Agronomic trials had shown that return to land was generally higher and return to labor lower under DMC than under conventional management. Moreover, DMC would require changes in the management of farm's labor and cash over seasons.

In both studies we used linear programming technique to model the main types of farms identified in the studied regions. Information about farmers' goals, farm structures, and the technical coefficients of most activities was obtained through farm surveys carried out under the responsibility of farm economists. Field agronomists were in charge of providing technical coefficients specifically for crop activities, using trials in research centres and a network of monitored plots in farmers' fields. Farm models were first validated against real farms by comparing simulated with observed sets of activities, and then were run farm simulations specifically designed for testing the hypothesis at stake in each study. These simulations were in Brazil, sensitivity analysis of farm activities to market and weather variations, and in Vietnam, simulations in which DMCs were added to the list of possible activities.

Results

The study in Brazil showed that soil constraints such as low water retention capacity could be severe enough to prevent subsistence farms of the region to follow the same pathway as farms on more favorable soils towards intensive and highly specialized dairy farms. Even considering a constant, low risk aversion, an equally favorable access to market and credit in the simulations, simulated farms on unfavorable soils would not choose dairy production based on intensive corn and fodder crops, highly risky on these soils, whereas simulated farms on favorable soils would do so. This was matching actual situations (Affholder et al., 2006).

The study in Vietnam showed that the simulated choice of adopting or rejecting DMC was variable across farm types and environments, and moreover that adoption was in most cases hampered by extra requirements of DMC in labor and cash, as compared to conventional farming. Biomass available in situ for mulch establishment at the start of the rainy season had indeed to be completed with biomass collected in the neighboring environment, for the mulch to effectively control weeds and erosion. This resulted in extra labor requirements at a peak period for labor. Extra fertilizer amounts were also required under DMC.

The results of the study in Brazil were rather disappointing for social scientists of the team, whereas it was so for agronomists in the Vietnamese case. In the study in Brazil, economists were expecting economic and social constraints to be preeminent over biophysical constraints in determining the dynamics of farming systems in the studied region. Preliminary simulations using rough biophysical data were actually supporting this hypothesis which eventually proved to be erroneous. Indeed the agronomists in the team did not endorse these preliminary results especially since the simulated solution appeared to be highly dependant to changes in agronomic data within their confidence interval. But it took several years of crop modeling for the agronomists to improve the precision, up to a “satisfactory level”, of the biophysical data provided to the farm model. We must also admit that we did not define objectively this “satisfactory level”. It rather resulted from a compromise between the will of the agronomists to increase the accuracy of their crop models and the will of the farm economists to match the deadlines of the project and be available for something else.

In the study in Vietnam, field agronomists were expecting DMCs to be economically attractive to the well informed, rationale farmers that were idealized in the farm models. As the sensitivity analysis showed that increasing the accuracy of the biophysical data would not change the results of farm simulations, at least some of the agronomists involved in the research suspected the farm models built or even the linear programming method to be inappropriate. Efforts from the rest of the team to re-check the model and discuss the method as thoroughly as possible did not prevent some of the agronomists from rejecting the conclusions of the study and leaving the team.

Conclusions

First, in such bioeconomic modeling studies of farm strategies, the fact that outputs of crop models serve as inputs to farm models brings asymmetry in the way one discipline, farm economy, relies on the work of the other, field agronomy. Second, change in scale from field to farm implies changes in the hierarchy of processes to account for, but no fully objective procedure is available for doing so. In a team working under the pressure of deadlines, the farm economist is likely to impose his own views on the hierarchy of processes at stake, and to apply pressure on the crop modeler for delivering his outputs: a kind of hierarchal relationship between disciplines that jeopardizes interdisciplinarity and hence the relevance of the overall study.

In order to overcome these difficulties more research is needed, focusing on more objective procedures for shifting from field to farm scale. As for the development of any model, sensitivity analyses are expected to play a key role in identifying the components of the bioeconomic models that have to be improved for a given study. More specifically, the study of error propagation from biophysical models to farm decision models should be the major criteria for refining or not the biophysical model. It is likely, however, that advances in procedures and tools will not suppress all subjectivity from bioeconomic studies. As a consequence, their results should not be used in a prescriptive way but rather as a basis for discussions among stakeholders in order to enhance their common understanding of the studied systems, as proposed for example by Barreteau et al. (2003).

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