What modelling methods are used by researchers in agronomy?

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INTRODUCTION

Modelling is fast becoming the means to integrate and even produce knowledge in agricultural research. But a quick overview of the scientific publications about modelling shows that the researchers mainly describe their models as a series of equations or as software. They thus focus on the model itself, saying few things about their way of designing the agronomic models. But, it is well known in the field of design that design methods deeply orient the nature as well as the use of a model. Our purpose is to investigate the methods used to design agricultural models and better identify how the agronomic research community exchanges information about modelling methods and develops new ones. More specifically, we are interested in better characterizing the extent to which such methods are use- and users- dependent. In fact some researchers make claims about the potential use of their model, but they rarely explain how they get information about use and users and take it into account in the model itself as pointed out by different authors (e.g.Sinclair et Seligman 1996; Meinke et al. 2001; McCown, Brennan, et Parton 2006).

MATERIALS AND METHODS

To address these questions, we used a bibliometric approach. We chose to search for the papers that focus on the design of new models in the agronomic literature. Eight well-acknowledged journals amongst the agronomic researchers, and available in the ISI WoS data base were chosen to run a search procedure over a ten-year period (Agricultural Systems, Agronomy Journal, Agriculture Ecosystems & Environment, Agronomy for Sustainable Development, Australian Journal of Agricultural Research, Crop Science, European Journal of Agronomy, Field Crops Research). This procedure was built using a list of descriptors to look for in the titles and abstracts of the papers published in these journals. We built a request in which the word “model” and all derived words appear in the same sentence as words belonging to the lexical field of design (like create, build, new, develop, design etc).

All the abstracts of the selected papers were read to check the relevance. We finally obtained a database of about 600 papers on which we then run our analysis. We identified keywords to systematically and automatically glean firstly the objectives the authors give to their models, secondly the designing methods used by these authors. We then analyzed the eventual link between the diversity of objectives and the diversity of designing methods. We finally focused on the role given to the future users in the design process, especially when the authors explicitly define an operational objective and a use for their models by non-researchers.

RESULTS AND DISCUSSION

In our bibliometric search, we did not choose to investigate only so called crop models. Therefore, a first result is a description of the diversity of models which are published in the 8 selected journals.

Secondly, our analysis shows a strong standardization of the modelling steps described by the researchers: description of the objective, definition of input and output variables and the relations that link them, parameterization and evaluation. These steps describe what seems to be an implicit norm about design methods or most probably an implicit norm about the way the design methods have to be described

in publications. This standardization contrasts sharply with the diversity of objectives the authors define for their models. More precisely, the lack of in-depth descriptions of these steps does not allow us to link the design methods and the objectives. Parameterization and evaluation are the most discussed steps but from a statistician point of view mostly, which does not help to link design methods and objectives of the models. And yet, various authors working in social sciences showed that design methods should take into account and reflect the given objectives (Bodker et Gronbaek 1991; Akrich 1993, 1995; Béguin 2003; Béguin et Cerf 2004). Moreover the authors mostly describe the standardized steps as separated and not as forming a whole method. Quite often, the different steps are even described in two or more distinct papers. It is a good clue that modelling methods are not handled in publications as a research object per se. Whereas publications about a model are well accepted, it is still not so common to publish by focusing on the design methods of the models.

As well, few authors acknowledge the use of participatory methods while they are numerous to make claims about the use (most often defined vaguely) of their models by non-researchers. Finally, when potential users are involved in the design of agronomic models, it is mainly as sources of information for parameterization or evaluation thanks to the experimental databases they own.

To conclude, we can say that the modelling methods are not much debated in agricultural research whereas the growing development of modelling could justify it. This could partly explain the poor use of agronomic model outside research. From our point of view, this confirms that modelling methods are still to be searched, especially to better link the model content and its future use.

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