



**HAL**  
open science

## Contextualization of on farm ex-ante evaluation of the sustainability of innovative cropping systems in viticulture, using a multiple criteria assessment tool (DEXi)

Sylvestre Delmotte, Christian C. Gary, Aude Ripoche, Jean Marc J. M. Barbier, Jacques Wery

### ► To cite this version:

Sylvestre Delmotte, Christian C. Gary, Aude Ripoche, Jean Marc J. M. Barbier, Jacques Wery. Contextualization of on farm ex-ante evaluation of the sustainability of innovative cropping systems in viticulture, using a multiple criteria assessment tool (DEXi). AgSAP Conference 2009, Mar 2009, Egmond aan Zee, Netherlands. hal-02754127

**HAL Id: hal-02754127**

**<https://hal.inrae.fr/hal-02754127>**

Submitted on 3 Jun 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



**Integrated Assessment of Agriculture and  
Sustainable Development;  
Setting the Agenda for Science and Policy  
(AgSAP 2009)**

**10 – 12 March 2009  
Hotel Zuiderduin, Egmond aan Zee  
The Netherlands**

**PROCEEDINGS**

# **AgSAP Conference 2009**

## **Egmond aan Zee**

## **The Netherlands**

### Editorial Committee of these Proceedings:

Martin van Ittersum Coordinator SEAMLESS, Wageningen University, Plant Production Systems (NL)  
Joost Wolf Wageningen University, Plant Production Systems (NL)  
Gon van Laar Wageningen University, Centre for Crop Systems Analysis (NL)

### Local Organizing Committee

Martin van Ittersum Coordinator SEAMLESS, Wageningen University, Plant Production Systems (NL)  
Floor Brouwer LEI, Wageningen UR (NL)  
Joost Wolf Wageningen University, Plant Production Systems (NL)  
Theo Jetten Wageningen University, C.T. de Wit Graduate School PE&RC (NL)  
Marcel Lubbers Wageningen University, Plant Production Systems (NL)  
Charlotte Schilt Wageningen University, Plant Production Systems (NL)

### Corresponding address:

AgSAP Office  
Plant Production Systems  
Wageningen University  
P.O. Box 430, 6700 AK Wageningen  
The Netherlands  
Website: [www.conference-AgSAP.org](http://www.conference-AgSAP.org)  
E-mail: [office.PP@wur.nl](mailto:office.PP@wur.nl)

### Suggested citation:

Van Ittersum, M.K., J. Wolf & H.H. Van Laar (Eds), 2009. Proceedings of the Conference on Integrated Assessment of Agriculture and Sustainable Development: Setting the Agenda for Science and Policy (AgSAP 2009). Egmond aan Zee, The Netherlands, 10-12 March 2009. Wageningen University and Research Centre, Wageningen, 560 pp.

Printing: GVO, Ede, The Netherlands  
Publisher: Wageningen University and Research Centre, The Netherlands

ISBN: 978-90-8585-401-2

Sauer, T., P. Havlík, U.A. Schneider, G. Kindermann, M. Obersteiner: Agriculture and natural resources in a changing world: The role of irrigation .....	156
Smaling, E.M.A., R. Roscoe, J.P. Lesschen, A.F. Bouwman, E. Comunello: The fate of nitrogen in the Brazilian soybean chain .....	158
Van der Straeten, B., J. Buysse, S. Nolte, F.L. Marchand, L. Lauwers, D. Claeys, G. Van Huylenbroeck: Spatial planning of livestock production and manure abatement.....	160
Van Meijl, H., T. Jansson, M. Banse, G.B. Woltjer: The impact of modulation: Modelling first and second pillar CAP policies .....	162
Westhoek, H., B. Eickhout, N. Hoogervorst, T. Rood, E. Stehfest, G.B. Woltjer: Environmental impacts of the European livestock sector on different scales, and prospects for reduction .....	164
Woltjer, G.B.: Agricultural policy and land use .....	166
Zimmermann, A., T. Heckelei: Farm structural change in European regions .....	168

### **Session B2: Indicators for integrated assessment**

**171**

Binder, C.R., A. Schmid, J.K. Steinberger: Sustainability Solution Space: An indicator based tool for assessing the sustainability of agricultural systems .....	172
Adamowicz, M., A. Smarzewska: Model and indicators of sustainable development in rural areas from the local perspective .....	174
Bockstaller, C., N. Turpin, L. Stapleton, M. Van der Heide, O. Therond, T. Pinto-Correia, V. Voltr, M. Raley, I. Bezlepina, J.P. Bousset, J. Alkan Olsson, F. Ewert: A structured set of indicators for integrated assessment of future agri-environmental policies.....	176
Bockstaller, C., L. Stapleton, M. Van der Heide, G. Geniaux, S. Bellon, E. Josien, M. Raley, J. Alkan Olsson: From a disaggregated set of indicators to a synthetic, composite assessment of sustainability: Paths and pitfalls .....	178
Delmotte, S., C. Gary, A. Ripoche, J.M. Barbier, J. Wery: Contextualization of on farm <i>ex-ante</i> evaluation of the sustainability of innovative cropping systems in viticulture, using a multiple criteria assessment tool (DEXi) .....	180
Giannoccaro, G., J.M. Pistón, J. Berbel: Assessing the environmental sustainability of the CAP: A DPSIR framework approach.....	182
Leip, A., F. Weiss, W. Britz: Agri-environmental nitrogen indicators for EU27.....	184
Meul, M., S. Van Passel: Sustainability of Flemish farms: Advising farmers and policymakers.....	186
Scholz, J., S. Herrmann: Rural regions in Europe: A new typology based on a multi-sectoral point of view .....	188

### **Session B3: Cropping systems modelling**

**191**

Keating, B.A., M.J. Robertson, P.S. Carberry, D.P. Holzworth, N.I. Huth: Cropping systems modelling: Past performance and future prospects .....	192
Adam, M., H. Belhouchette, E. Casellas, O. Therond, J. Wery: APES, an agricultural production and externalities simulator evaluated for two main crops in Midi-Pyrenees ..	194
Belhouchette, H., M. Adam, E. Casellas, F. Celette, M. Corbeels, J. Wery: Performances of two crop models in various conditions: The importance of underlying assumptions .....	196
Casellas, E., J.E. Bergez, H. Belhouchette, O. Therond, M. Adam, A. Metay, J. Wery: A methodology for the evaluation and improvement of a generic biophysical Soil-Plant-Atmosphere crop model based on ‘Mini-Application’ .....	198

**Session B5: Integrated assessment methods for regional and landscape levels 283**

Stoorvogel, J.J.: Integrated assessment modelling: How to assess regional impacts?..... 284

Bobojonov, I., E. Berg, C. Martius, J.P.A. Lamers, J. Franz: Integrated Assessment of crop and water allocation under conditions of uncertain water supply in the Khorezm Region of Uzbekistan, Central Asia ..... 286

Brady, M., K. Kellermann: An agent-based model for assessing the impacts of decoupled agricultural support on landscape values..... 288

Breukers, A., W. Van der Werf, M. Mourits, A. Oude Lansink: Generic bio-economic modelling of plant diseases: An exploration ..... 290

Bulatewicz, T., X. Yang, J.M. Peterson, S. Staggenborg, D.R. Steward, S.M. Welch: Integration of agriculture, groundwater and economic models using the Open Modeling Interface (OpenMI): Application to the Ogallala Aquifer..... 292

Gary, C., J.M. Barbier, P. Rio, P. Andrieux, J.M. Blazy, X. Louchart, M. Bonin, J.L. Diman, F. Causeret, H. Ozier-Lafontaine: How to design technical and organizational innovations to promote sustainable development in catchments with intensive use of pesticides ..... 294

Griffon, S., D. Auclair: Visualizing changes in agricultural landscapes ..... 296

Kros, J., T.J.A. Gies, J.C. Voogd, R. Smidt, W. De Vries: Integrated analysis of the effects of agricultural management and spatial planning on environmental quality at landscape scale ..... 298

Osterburg, B., T.G. Schmidt: Assessment of nitrogen balances at farm and regional level.. 300

Schleyer, C., I. Theesfeld, O. Aznar: Assessing the institutional compatibility of new policies ..... 302

Shahbazi, F., A.A. Jafarzadeh, M.R. Shahbazi: Assessing sustainable agriculture development using the MicroLEIS DSS in Souma area, Iran..... 304

Streifeneder, T., C. Hoffmann, F.V. Ruffini: Assessing and predicting agro-structural change in the Alpine Region..... 306

Uthes, S., C. Sattler, A. Osuch, K. Happe, A. Piorr, P. Zander: Sustainability impact assessment of EU policies at regional level: An analysis of land use dynamics and environmental effects with the MEA-Scope tool ..... 308

Wagner, S., O. Beletskaya, U. Kummer, J. Theloke, E. Angenendt, R. Friedrich, J. Zeddies: Assessment of mitigation measures for air pollutants and greenhouse gases from agricultural systems in Germany at high spatial resolution..... 310

Warnecke, S., M. Biberacher, G. Broll: Regionally optimized animal farm manure transports in an area with high intensity animal farming systems ..... 312

**Session B6: Software infrastructures and tools for integrated assessment 315**

Moore, R.V., J.J.F. Wien: Integrated modelling tools, mass collaboration and the opportunities ahead..... 316

Antle, J.M., J.J. Stoorvogel, R.O. Valdivia: The Trade-off Analysis software: Modelling tools to support informed policy decision making ..... 318

Athanasiadis, I.N., S. Janssen, E. Andersen, A.E. Rizzoli, J.J.F. Wien: Granular ontologies for integrated assessment of agricultural systems ..... 320

Botreau, R., I. Veissier, P. Champciaux, J.-P. Brun, A. Lamadon, P. Perny: A software tool to support multi-criteria-based assessment of animal welfare..... 322

Carlson, J., O. David, J. Ascough, F. Geter, L. Ahuja: The role of the Object Modelling System (OMS) for integrated assessments of conservation on agricultural land in the United States..... 324

## **Contextualization of on farm *ex-ante* evaluation of the sustainability of innovative cropping systems in viticulture, using a multiple criteria assessment tool (DEXi)**

S. Delmotte, C. Gary, A. Ripoche, J.M. Barbier, J. Wery  
INRA, UMR System, 2 place Pierre Viala,  
34060 Montpellier Cedex 2, France  
Contact: gary@supagro.inra.fr

### **Introduction**

Grape producers face an economic and environmental crisis, the latter relating to the generally high use of pesticides in vineyards. In relation to them, various stakeholders expect some environmental improvements. Researchers are proposing novel cropping systems that should be evaluated *ex ante* with respect to their contribution to sustainable development, meaning both their environmental impacts and their economical and social adoptability by farmers. Farms producing grape are very diverse in terms of size, soils, availability of staff and equipment, and objectives of production (wine grade). In this context, we hypothesized that the evaluation of a candidate cropping system should be carried out in the farm context, taking into account information in relation with its adoptability.

### **Methods**

To evaluate and compare cropping systems, Multiple Criteria Decision Aiding (MCDA) methodologies seem to be relevant (Sadok *et al.*, 2008). A decision support tool called DEXi (Bohanec, 2008) was adopted; it enables to design decision trees based on a hierarchy of criteria. The qualitative classes (such as ‘low’, ‘medium’ and ‘high’ for example) of criteria are aggregated into a single note, which is in the present case the contribution of the cropping system to sustainable development. It is necessary to define scales to convert values of indicators into classes of criteria. The criteria are then aggregated using ‘if... then...’ decision rules to obtain final classes for the overall criteria. Some criteria and indicators were derived from a list proposed for field crops (MASC v.1.0, 2008) and adapted to viticulture by a group of four experts. Two theoretical farms were defined, with contrasting production objectives (low vs. high grade wine) and availability of labour and equipment. A process of aggregation was then proposed to take into account these characteristics in the evaluation, and several cropping systems were compared.

### **Results**

The impact of cropping systems on environment was evaluated through five attributes (Figure 1): the pressure on biodiversity, the energy use and the impacts on the soil, water (both surface and below ground) and air compartments. The economic adoptability of cropping systems was evaluated through (i) the satisfaction of production objectives on average, and the stability of production over the years, (ii) the total cost of implementation of the cropping system. It indirectly reflected the efficiency of production and the productivity of labour. For the social and human dimensions of sustainability, four attributes were considered: the difficulties to implement the candidate system, the task overlap, the health risk, the social recognition and the free time left to the farmer.

One parameterization of the decision tree was obtained for each farm context. It differed on five points: (i) the calculation of the indicators of performance depended on the yield and quality objectives of the farmer, (ii) some of the indicators were calculated in reference to the actual system practiced by the farmer (iii) some qualitative criteria could take values that reflected the opinion of the farmers (Figure 1 in grey), (iv) the scale to convert an indicator value into a class of criteria could be fixed by them and reflect their objectives and

constraints, (v) the aggregation of the criteria had to be set up by stakeholders for the environmental criteria and by the farmers for the social and economics criteria, in order to represent their priorities among the attributes (Figure 1 in dotted lines).

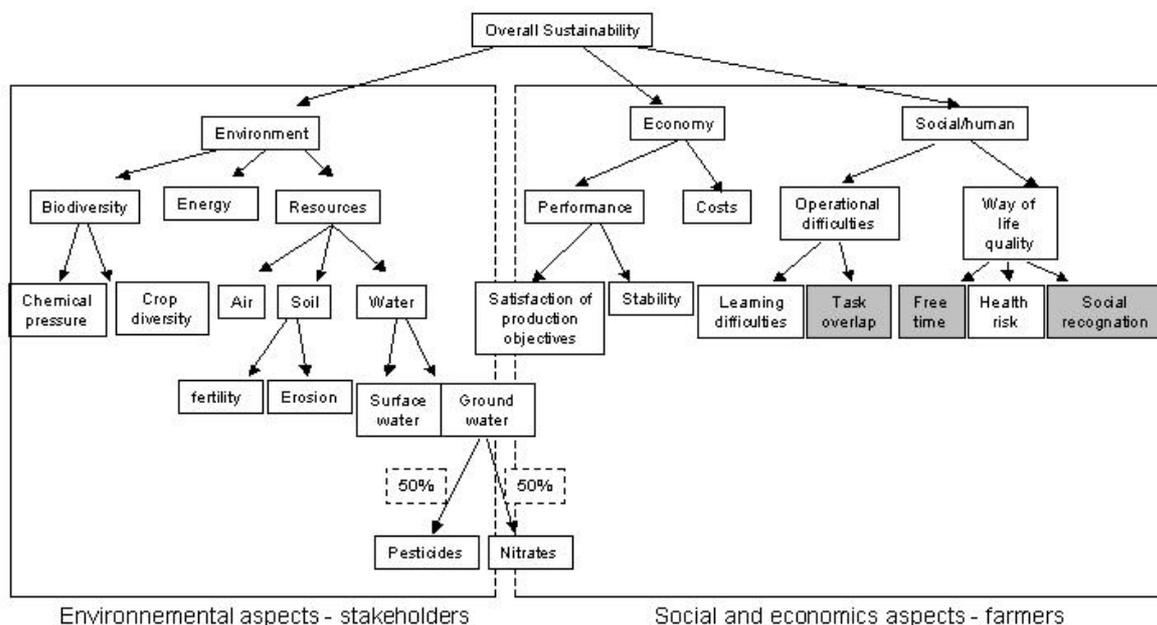


Figure 1. Splitting up of the sustainability of cropping systems into environmental, economical and social/human criteria.

It resulted that the economical and social performances of some cropping systems differed among the two farms (e.g., integrated farming with non-permanent cover cropping had a lower social score and a higher economical score in the farm with low availability of labour and equipment).

### Discussion

In the present research, we aimed at developing a tool that could be used by extensionists, farmers and stakeholders. The contextualization of the evaluation of cropping systems was tested for the two theoretical farms by using role games with experts, mainly researchers and extensionists. It proved to be powerful for discussing the decision tree and considering the local and farming contexts. The evaluation outputs appeared sound to the experts, particularly with respect to the adoptability of innovations, that is a crucial dimension of sustainability.

The method must now be tested in a real case and participatory methods must be chosen. We propose to consult stakeholders of the area where the evaluation takes place to define the utility functions for the environmental criteria. Independently, farmers would be consulted to define scale and utility functions for social and economical criteria.

### Acknowledgements

The authors thank A. Biarnès, L. Bouchet and C. Clipet for their expert contribution.

### References

- Bohanec, M., 2008. DEXi: A Program for Multi-Attribute Decision Making, version 2.0. <http://www-ai.ijs.si/MarkoBohanec/dexi.html>.
- MASCV1.0, 2008. IDDN.FR.001.040014.000.R.P.2008.000.30100.
- Sadok, W., *et al.*, 2008. *Agronomy for Sustainable Development* 28: 163-174.

## **How to design technical and organizational innovations to promote sustainable development in catchments with intensive use of pesticides**

C. Gary, J.M. Barbier, P. Rio, P. Andrieux, J.M. Blazy, X. Louchart, M. Bonin,  
J.L. Diman, F. Causeret, H. Ozier-Lafontaine  
INRA, 2 place Pierre Viala, 34060 Montpellier Cedex 2, France  
Contact: gary@supagro.inra.fr

### **Introduction**

The sustainable development of agriculture in regions where perennial crops such as grapevine in south France and banana in the French West Indies dominate is questioned in relation to their high use of pesticides. The resulting degradation of the environment generates damages for various activities including agriculture. The cost of adopting alternative crop protection strategies and/or restoring water quality is high. The consequences on human health and environment generates conflicts with other stakeholders with feedback consequences on agriculture in terms of policy (regulations), market and social recognition. The observed low diffusion of low-input cropping systems results from technical, economic and organizational limitations at several scales, from field and farm to catchment and region. Then any proposal of alternative technologies should be embodied in sets of consistent innovations of different natures and at different scales.

In terms of research methodology, the challenge is to design novel agricultural systems and carry out *ex-ante* their assessment in a way that connects various scales and balances all dimensions of sustainability (Van Ittersum *et al.*, 2008). Various methods of integrated assessment have been proposed; they are all based on systems analysis, they mobilize in a concerted way several disciplines and use models as a mean to explore the effectiveness of various scenarios (Parker *et al.*, 2002).

In the present project, skills in human (economy, geography, sociology) and biophysical (agronomy, hydrology, engineering) sciences were gathered to (i) design innovative farming systems that would reduce the use and diffusion of pesticides, (ii) evaluate their ecological effectiveness and likelihood of adoption by farmers and (iii) identify the organizations and regulations that would favour sustainable development in the studied catchments.

### **Methods**

A generic framework was adopted to organize the various scientific disciplines and approaches (Figure 1). The focus was more on the integration and consistency of these approaches than on the formal connection of a set of models differing in various ways: static/dynamic, mechanistic/empirical, biophysical/decisional, field/farm/catchment.

The influence of the institutional context was examined in two ways. First, a typology of mechanisms of incitation or repression was built and their potential impact on farming systems assessed with linear programming. Second, the role of networks of information among farmers in relation with the diffusion of innovations was studied and modelled with Multi-Agent Systems.

The design of innovative farming systems was made according to two approaches. In the grapevine catchment, surveys were carried out to analyse the diversity of farmers' strategies of weeding, soil management and crop protection. Some of these existing strategies were identified as innovative. In the banana catchment, it was considered that an input of novel techniques had to be introduced. To this end, a process of prototyping was engaged with experts (agronomists, geneticists, nematologists) after the typology of farming systems. It produced innovative cropping systems and bio-economic modelling was used to select those potentially fitting with the various types of farming systems.

The economic and environmental performances of the innovative farming systems were

assessed with biophysical models and/or indicators. This assessment focused on farm scale in the case of banana (the innovation resulting from the adoption of novel cropping systems by farmers) and on catchment scale in the case of grapevine (the innovation resulting from new distributions of performing types of farming systems within the population of farms). At last the adoptability of the most effective farming systems was evaluated with new surveys and the conditions of adoption were identified with an econometric model.

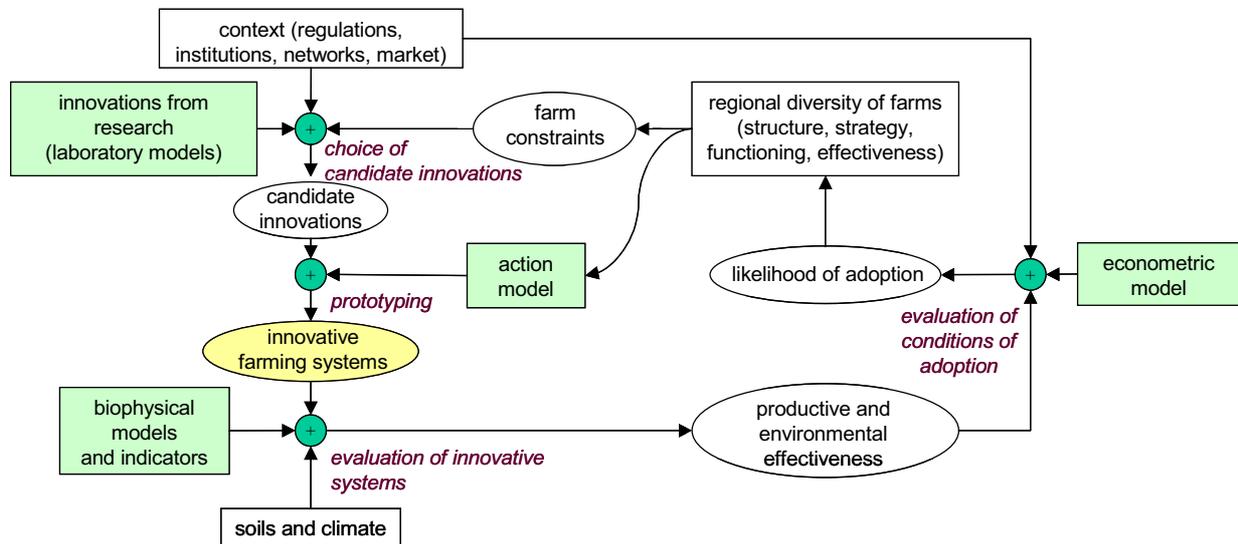


Figure 1. Scientific framework for the integrated assessment of innovative farming systems (grey rectangles are models, white rectangles, the real world, and ovals outputs).

## Results and discussion

Government and farmers' institutions recently introduced new instruments and, in some cases, their theoretical effectiveness could be assessed. The fluxes of information within farmers' networks appeared to limit the diffusion of innovation. Yet the process of design of innovative farming systems differed among grapevine and banana catchments, this social context was considered as a forcing variable in both cases. The economic and ecological crisis was more severe in banana catchments, which justified the interest for radical technical innovations and for their thorough assessment at farm scale.

A set of assessment tools were produced, from field to farm and catchment, including breakthroughs such as the coupled simulation of the dynamics of crop and nematode development in banana fields, or the coupled simulation of cultivation techniques and resulting surface transfer of water and pesticide distributed within a grapevine catchment.

Attention was paid to the likelihood of adoption of innovative systems by farmers, in relation to the economy and organization of their farm and to the innovation and policy attributes. Combined with the evaluation of crop production and externalities, it provided a framework for an appraisal of the contribution to sustainable development of existing and alternative farming systems. The coupling of various scales and criteria of evaluation should facilitate the analysis of the consequences of specific policies designed to promote novel farming systems. In this perspective, the interaction with stakeholders, including policymakers, will have to be more formalized.

## References

- Parker, P., *et al.*, 2002. *Environmental Modelling & Software* 17: 209-217.  
 Van Ittersum, M.K., *et al.*, 2008. *Agricultural Systems* 96: 150-165.