



Workshop 2.1: Methods and procedures for building sustainable farming systems

Convenors: **Ana Alexandra Marta-Costa** and **Emiliana L. Soares da Silva**

X-Farm: A model for sustainable farming systems simulation

Francesco Danuso, Franco Rosa,
[Alvaro Rocca](#) and Elena Bulfoni

University of Udine, Italy

This paper illustrates X-farm, a model to manage farming systems under energetic, economical and ecological perspective, using the dynamic simulation approach. The farm is targeted to achieve the energetic self-sufficiency by using a quota of the crop biomass to produce energy as oil, biogas or heat. X-farm is composed by modules representing the farm activities and the main centres of farming costs: soil management, crop production and processing, energy production and administration. The dynamic simulation is expected to help in improving the farm management performance with the simultaneous achievement of the three perspectives.

Multilevel sustainability assessment of farming systems: A practical approach

[Steven Van Passele](#) and Marijke Meul

Faculty of Business Economics, Hasselt
University, Belgium

Sustainability assessment is needed to build sustainable farming systems. A broad range of sustainability concepts, methodologies and applications already exists. Instead of trying to construct the ideal and complete sustainability assessment tool, we suggest to combine existing methods. A smart combination of methods with different purposes makes sustainability assessment more profound and broadens the possible applications. To illustrate the multilevel sustainability assessment, a combination of the sustainable value approach (SVA) and MOTIFS is made using data of specialised dairy and arable farms in Flanders. SVA is used to support policy makers, while MOTIFS is used to support farmers towards sustainability.

Normative, systemic and procedural aspects: A review of indicator-based sustainability assessments in agriculture

[Claudia R. Binder](#) and Giuseppe Feola

Institute for System Science, Innovation and
Sustainability Research, University of Graz,
Austria

This paper develops a framework for evaluating sustainability assessment methods by analyzing their normative, systemic and procedural dimensions and applies it to indicator-based sustainability assessment methods in agriculture. The reviewed methods are categorized into three types: (i) top-down farm assessment methods; (ii) top-down regional assessment methods with some stakeholder participation; (iii) bottom-up, integrated participatory or transdisciplinary methods with stakeholder participation. The results show the trade-offs between the methods. A clear, standardized, top down procedure allows for potentially benchmarking and comparing results across regions and sites. The bottom-up methods with high stakeholder involvement support the application and implementation of the results.

Assessing the sustainability of activity systems to support agricultural households' projects

Médulline Terrier, [Pierre Gasselín](#),
and Joseph Le Blanc

UMR951 Innovation, INRA, France

This paper aims to show why an evaluation tool assessing the sustainability of activity systems could support farming households, particularly at the establishment stage, and how such a tool could be set up. It analyses three methods used to appreciate the farm sustainability and identifies their limits but also their contributions to our own methodology, at the level of complex activity systems in which farming production is combined to transformation, sales or outside activities. The evaluation tool recognizes two different contributions to sustainable agriculture, a farm-focused sustainability and an extended sustainability at a regional scale.

Towards sustainable livestock production systems – Outline of a Learning and Experimentation Strategy (LES)

[Boelie Elzen](#) and Sierk Spoelstra

Livestock Research, Wageningen University,
The Netherlands

To stimulate development of sustainable livestock systems, two broad approaches have evolved, notably top down and bottom up. Top down approaches are usually research-led while bottom up initiatives are taken by farmers who develop and try out innovations to meet challenges as they see them. Currently, the links between these two processes are relatively weak although both are needed to develop sustainable systems. A major challenge is to make a fruitful combination between the two processes. To this end we have developed what we call a "Learning and Experimentation Strategy" (LES) that we will elaborate in the paper.



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Assay of a sustainable farming model for the Montemuro mountains (Portugal)

Alexandra Marta-Costa,
Filipa Manso, Luís Tibério,
and Carlos Fonseca

Centre for Transdisciplinary Development
Studies, University of Trás-os-Montes and Alto
Douro, Portugal

This study constitutes an assay of a sustainable farming model for the Montemuro mountains (Portugal) that must integrate a strategy to reverse the trend of abandonment of such spaces, be economically viable, socially attractive and conducive to more environmental gains. The planning of the farming system was carried through the Multiobjective Programming. Although the open nature of the obtained solutions to the developed models, it was evidenced that the balance between the considered objectives is established with the selection of particular activities. Some of them assure the profitability of the farm and the others obey to more friendly environmental parameters.

Adapting a European sustainability model to a local context in semi-arid areas of Lebanon

Elias Ghadban, Salma Talhouk,
Issam Bashour, Mabelle Chedid,
and Shady K. Hamadeh

Environment and Sustainable Development
Unit, American University of Beirut, Lebanon

The agriculture sustainability assessment model (IDEA) is structured around three sustainability scales: agro-ecological, socio-territorial and economic scale translated into measurable indicators. This model was modified to fit the Lebanese agriculture context by adjusting seven indicators, and was used thereafter to assess 34 farmers over one year. The modified model proved to be useful in assessing agriculture sustainability of small farms in semi arid areas and showed high sensitivity within the Lebanese context. It also gave farmers suggestions for possible ways of intervention in order to improve the sustainability of their farms.

Trade-off analysis for agro-ecological indicators: Application of Sustainable Solution Space to maize cropping systems in northern Italy

Nicola Castoldi, Alfons Schmid,
Luca Bechini, and
Claudia Rebecca Binder

Department of Plant Production, Università
degli Studi di Milano, Italy

We applied Sustainability Solution Space approach (SSP) to analyse the sustainability of cropping systems and trade-offs among indicators of 125 maize crops. The sustainability range was defined for nine economic, nutrient, energetic, and pesticide management indicators. This led to a nine-dimensional hyper-volume, including possible combinations of indicators; correlations between indicators were used to shrink the hyper-volume, defining the SSP. Only seven crops were very close to SSP, while 23 had all indicators within the initial sustainable hyper-volume, but not in the final SSP. Finally, a sensitivity analysis was done to analyse the robustness of the SSP approach.

Systematic identification and selection of indicators for farming system diagnosis and design

G. Cesare Pacini, Jeroen C.J. Groot,
Franca Bacigalupe, Concetta Vazzana
and Santiago Dogliotti

Department of Plant, Soil and Environmental
Science, Florence University, Italy

Indicators of farming system performance are pertinent for the diagnosis of the sustainability of farming systems and to evaluate alternative options in a systems design context. However, methodologies to define, to prioritize and to select indicators in a systematic way in projects are scarce. In this paper a conceptual approach to systematically identify and select indicators for building sustainable farming systems is presented and its possible application is discussed by analysing and evaluating two indicator frameworks used for farming system design (MESMIS and AESIS) within the new approach.

Factors affecting the implementation of measures for improving sustainability on farms following the RISE sustainability evaluation

Christian Thalmann and Jan Grenz

Plant Sciences and Agroecology, Bern
University of Applied Sciences, Switzerland

The Response-Inducing Sustainability Evaluation (RISE) is a method for rapid yet holistic sustainability assessment of agricultural production at farm level. Over 600 farms in 18 countries have been analysed using RISE. We report on lessons learned from RISE application, with a focus on practical impact. The analysis as such, despite being comparatively farmer-oriented and transparent, at best induces reflection. It can serve as a "door-opener" and an instrument to structure discussion where results are shared with farmers. Farmers will only engage for more sustainable production if the analysis is an integrated part of a process generating sustainable yet practicable solutions.



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Are organic suckler cattle farming systems more sustainable than conventional systems? Productive, environmental and economic performances assessments: A model-based study

Patrick Veysset, Michel Lherm,
and Didier Bébin

INRA, UR1213 Herbivores, France

The conversion to organic farming was simulated for three suckler cattle farms by coupling an economic assessment model with an environmental assessment model. The reduced use of inputs results in a 5-20% drop in non-renewable energy consumption per ton of live weight produced. Methane production means the shift to OF does not significantly affect gross greenhouse gas emissions, but taking carbon sequestration under pastures into account, the net GHG emissions could be lower under OF systems. In economic terms, unless specific premiums are given, the switch to OF will lead to over a 20% drop in farm income.

Assessing multifunctionality in relation to resource use – A holistic approach to measure efficiency, developed by participatory research

Johanna Björklund,
and Börje Johansson

Centre for Sustainable Agriculture, Swedish
University of Agricultural Sciences, Sweden

In this study, energy analysis and footprinting were combined to assess and illustrate the total resource use caused by a dairy farm. Total efficiency was defined as a function of the resource use and the multifunctionality of production. Three scenarios with different degrees of input intensity and milk production were constructed. The ratio of local renewable resource use to total resource use differed greatly, being 1:3 for a self-sufficient organic farm and 1:14 for a conventional farm with maximum milk yield. Milk production was five-fold higher on the conventional farm, while generation of ecosystem services increased with increasing self-sufficiency.

Designing sustainable crop rotations using Life cycle Assessment of crop combinations

Frank Hayer, Emmanuel Bonnin,
Benoît Carrouée, Gérard Gaillard,
Thomas Nemecek, Anne Schneider,
and Christophe Vivier

Agroscope Reckenholz-Tänikon Research
Station ART, Switzerland

The introduction of grain legumes in crop rotations might reduce their environmental impacts. As the assessment of a several crop rotations with Life Cycle Assessment (LCA) is extensive we use a new approach of crop combinations i.e. for each crop a LCA is calculated for the reliable preceding crops and in a second step the rotations are composed using the combinations. The procedure facilitates a fast assessment of several rotations. In this presentation the authors show preliminary results which indicate that the introduction of a spring pea in a standard rotation reduces the GWP and the eutrophication potential.

Appropriate method to assess the sustainability of organic farming systems

Mohamed Gafsi,
and Jean Luc Favreau

National School of Agronomic Training (ENFA),
France

A lot of methods for assessing the sustainability of farms have been produced last decade; but most often these methods take little account of the specificity of organic farming. In this communication we propose a method for assessing farm's sustainability suitable for organic farming. The results of application of this method on 15 farms in the region of Midi-Pyrenees region show that it takes into account very well the agro-ecological and socio-territorial specificities of organic farming. But improvements are required in terms of taking into account the variability of production systems in organic farming.



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Method for the evaluation of farm sustainability in Quebec, Canada: The social aspect

Diane Parent, Valérie Bélanger,
Anne Vanasse, Guy Allard,
and Doris Pellerin

Faculté des sciences de l'agriculture et de
l'alimentation, Université Laval, Canada

In Quebec the number of dairy farms has declined and the sustainability of the farms and their communities has been questioned. In order to be sustainable a farm should be viable, liveable, transmissible, and ecologically reproducible. Thus the assessment of farm sustainability should be based on its economic, environmental and social aspects. A holistic method, named DELTA, was developed for these three aspects. To identify the indicators, we used a multiple stakeholder perspective (researchers, farmers, advisors). We report on the 20 social indicators grouped in four components: quality of life, social integration, farm succession and entrepreneurial skills. Indicators were validated on 40 farms.

A multicriteria decision method assessing the sustainability of new crop protection strategies

Patrik Mouron, Bart Heijne, Andreas
Naef, Andrea Patocchi, Jörg Samietz,
Heinrich Höhn, Esther Bravin, Joan
Solé, Jesus Avilla, Benoit Saupanor,
Aude Alaphilippe, Claire Lavigne,
Jörn Strassemeyer, Frank Hayer,
Gabriele Mack, José Hernandez,
Ursula Aubert, Marko Bohanec,
Gérard Gaillard, and Franz Bigler

Research Station ART, Switzerland

Apple crop protection mainly relies on pesticides although several alternative pest management strategies being available. This is largely caused by the problem that multiple environmental and economic aspects are to consider simultaneously, hiding if one strategy is more sustainable than another. We derived a multicriteria tool based on a hierarchical attribute tree, which uses qualitative ratings to rank results retrieved from LCA, SYNOPS and full cost calculations. Results from a case study of 5 European countries being partners of the EU-FP6 project ENDURE demonstrate the feasibility to identify crop protection strategies with improved overall sustainability applying our new tool.

Evaluating socio-economic and environmental sustainability of the sheep farming activity in Greece: A whole farm mathematical programming approach

Alexandra Sintori,
Konstantinos Tsiboukas,
and George Zervas

Department of Agricultural Economics and
Rural Development, Agricultural University of
Athens, Greece

Ruminant livestock farming is an important activity for depressed areas but also a significant source of greenhouse gas emissions. In this study, a whole-farm optimization model is used to assess the socio-economic and environmental performance of the sheep farming activity in Greece. The analysis is undertaken in two sheep farms that represent the extensive and the semi-intensive farming systems. The issue of the marginal abatement cost is also addressed. The results indicate the sustainability of the semi-intensive system, which yields a higher gross margin/ewe compared to the extensive system, causes fewer emissions/ewe and has a higher marginal abatement cost.

Managing socio-ecological systems to achieve sustainability: A study of resilience and robustness

Stephanie Eileen Domptail,
Marcos Easdale and Yuerlita

Institute for Agriculture and Market Research,
Giessen University, Germany

The paper considers a conceptual framework to analyse the success of management of socio-ecological systems at the scale of the land user and of the government in achieving sustainability. The conceptual framework considers four system properties (stability, durability, resilience and robustness) and distinguishes resilience as the maintenance of structure and function from robustness as the change in structure to maintain the function of the SES. The approach is applied to three case studies in developing countries. Results indicate that the distinction between resilience and robustness is useful but that issues of degradation were difficult to address.

Tendency of production decisions of the farmers under uncertainty conditions in Argentina

Mirna Mosciaro and Carlos Iorio

Instituto Nacional de Tecnología Agropecuaria
(INTA), Argentina

This paper analyses the productive strategies of a representative farm in the southeast Pampa Region, Argentina, to infer resource allocation tendency in these systems. The analysis incorporates market and production risk considerations through two MOTAD models, one of them including soil conservation restrictions. Results can improve the discussion about the ecological sustainability of the productive systems of the region. While pastures, corn and sunflower play an important role in the current representative farm, efficient plans tend to be less diversified. Furthermore, relaxation of land restriction allows obtaining similar expected profit at a lower risk.