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Integrative modelling approaches for analysis of impact of multifunctional agriculture: A review for France, Germany and The Netherlands

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Abstract

This paper reviews integrative modelling approaches which were developed to analyze the impact of multifunctional agriculture, or which may be used as such. The approaches are integrative in combining multiple goals of agriculture, and confronting these with current or potential performance of agricultural land-use systems at different spatial scales. The paper focuses on France, Germany and The Netherlands, countries with a track record in quantitative systems modelling, to identify convergence of concepts and technologies applicable to assessment of multifunctional agriculture and to establish shortcomings through analysis and comparison of 15 integrative modelling cases. An analytical framework for comparison is applied, based on a conceptual model of goal-oriented evaluation of agriculture. Results demonstrate unexpectedly large differences between countries in the number of integrative models; the nature of agro-ecological or bio-economic relations used, and target audience. Common elements were a focus on methodology development rather than answering questions of specific clients, limited attention for model evaluation and impact analysis, and an imbalanced attention for economic and abiotic environmental indicators at the expense of biotic, landscape and social indicators. None of the approaches specifically addressed multifunctionality of agriculture. In the discussion we argue that to be relevant research efforts aimed at supporting policy development for multifunctional agriculture cannot concentrate on filling gaps in knowledge and technology alone, but need to concern the process of utilization of knowledge as well.

Keywords: Multifunctional agriculture; Integrative models; Goal-oriented approaches; Heuristics; Optimization; Simulation; Agro-ecology

1. Introduction

The notion of multifunctionality of agriculture emerged in the policy arena when it was referred to in the Agenda 21 documents of the Rio Earth Summit of 1992, ''particularly with regard to food security and sustainable development'' (UNCED, 1992). In 1998 the Organisation for Economic Co-operation and Development (OECD) expanded upon the concept in its Declaration of Agricultural Ministers Committee, stating that agriculture is multifunctional when it has one or several functions in addition to its primary role of producing food and fibre. Specific reference was made to contributions to landscape, environmental benefits and contributions to socio-economic viability of rural areas. In its framework for analysis of multifunctionality OECD interpreted the notion in a descriptive rather than a normative economic sense, by defining multifunctionality as a set of interlinked outputs from a production activity, where some outputs are commodities or private goods that can be marketed, and others are non-commodities or public goods (OECD, 2001). This concept of joint production which is basic to the economic interpretation of multifunctionality is explained in an early ground-breaking paper

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by Vatn (2000). A normative economic interpretation of the notion was adopted by the European Union and used in its Agenda 2000 agricultural reform, by recognizing and encouraging the range of services provided by farmers and advocating a multi-sectoral and integrated approach to the rural economy. The notion was used by the EU and others in the WTO negotiations on agricultural trade liberalization, where it was seen by the major exporting countries of the Cairns Group in particular as an excuse to continue market protection. Despite the political controversies over the economic interpretation of the notion, many organizations used and developed the term to point to the goods that are provided by agriculture without being sold in the marketplace (e.g. FAO, 1999; Boody et al., 2005).

In a number of European countries the notion of multifunctional agriculture has become embedded in legislation; in others it is used in relation with notions such as sustainable development or rural development (Kröger and Knickel, 2005). From a scientific viewpoint, multifunctional agriculture can be perceived as a concept to understand and analyze the role of agriculture in society. Also in this domain, different conceptualizations occur. In addition to OECD's market economic interpretation, conceptualizations have emerged which emphasize the spatial planning nature, the role of the farmer and the role of public regulation (Van der Ploeg, personal communication April 2005). The full variation and impact of these conceptualizations was recently described by Le Cotty et al. (2005). A basic problem in many conceptualizations is their partial nature, originating from a disciplinary viewpoint, which obscures assessment of synergies between functions of agriculture.

The policy issue at stake when discussing multifunctionality of agriculture is that the public goods provided by agriculture do not accrue automatically as inevitable outcomes of any type of farming, but vary widely based on farming practices, farm size, farm location and interactions between these variables. This leads to questions on policy incentives and regulations, their relation to multifunctional goals of society, and the way in which the outcomes of policies are affected by the locality-specific aspects of farming. These questions play a role during policy design and the associated negotiation process, as well as during monitoring and evaluation of implemented policies. During policy design, alternative policy options are assessed in terms of their contribution to goal achievement, and trade-offs between goals become topics of negotiation. During this phase investigation of a wide array of potential policies is desirable to avoid the debate becoming locked in on narrow visions. During the phase of monitoring and evaluation, predictions are needed of the degree of goal achievement over the policy planning horizon given the current state of the object of the policy.

Both during policy design and during monitoring and evaluation, indicators may be used to simplify, to quantify and to communicate consequences of actions. These indicators may be based on direct measurements as part of monitoring schemes or policy assessments. Because the scale at which information can be collected differs from the scale at which conclusions are needed, scaling up or other types of transformation of information usually occur in indicators (Dumanski et al., 1998; Dalgaard et al., 2003). During both policy design and policy evaluation, quantification of effects may be useful to evaluate consequences of alternative options. Models that integrate disciplinary knowledge enable such quantitative assessment of alternatives and have been developed and used in scientific research for some 10–15 years. An early application in agriculture was described by De Wit et al. (1988).

This paper reviews integrative modelling approaches and associated indicators which have been developed by application-oriented research to analyze the impact of multifunctional agriculture, or which may be used as such. Agro-forestry and urban planning approaches are omitted. The review is geographically restricted to agricultural research from France, Germany and The Netherlands. In view of the relative novelty of the notion of multifunctionality in agriculture and research and the long tradition of model- and indicator-based approaches in the three countries this pragmatic selection of countries, based mainly on available research capacity was considered adequate to offer a perspective of approaches that are or may be pertinent for evaluation of multifunctional agriculture without attempting to be exhaustive.

This paper does not address indicator systems as such, as reviews have appeared recently (Wascher, 2000; Roedenbeck, 2004; Halberg et al., 2005; Payreaudau and van der Werf, 2005). Instead, indicators are discussed as part of integrative modelling approaches in which land-use decisions by local actors are mimicked and evaluated using indicators. Section 2 describes the analytical framework that was developed to analyze and compare the various integrative modelling approaches, and outlines the sources of information used. Results are presented in Section 3, starting with a description of the policy context for multifunctional agriculture in France, Germany and The Netherlands, as this shapes the application-oriented research efforts. The discussion in Section 4 assesses the state of the art of integrative modelling approaches in terms of their contribution to the analysis of impact of multifunctional agriculture. It compares the results for the three countries and proposes an agenda for research and development.

2. Methodology

2.1. Conceptual framework

2.1.1. Goal-oriented versus means-oriented approaches

The role of model-based approaches for evaluation of multifunctionality of agriculture was analyzed from a goal-oriented perspective (e.g. De Wit et al., 1988; Von