Applying a systems approach to the analysis of the benefits of conversion to organic production

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Abstract

Although the current level of organic production in industrialised countries amounts to little more than 1-2 percent, it is recognised that one of the major issues shaping agricultural output over the next several decades will be the demand for organic produce (Dixon et al. 2001). In Australia, the issues of healthy food and environmental concern contribute to increasing demand and market volumes for organic produce. However, in Indonesia, using more economical inputs for organic production is a supply-side factor driving organic production.

For individual growers and processors, conversion from conventional to organic agriculture is often a challenging step, entailing a thorough revision of established practices and heightened market insecurity.

This paper examines the potential for a systems approach to the analysis of the conversion process, to yield insights for household and community decisions. A framework for applying farming systems research to investigate the benefits of organic production in both Australia and Indonesia is discussed. The framework incorporates scope for farmer participation, crucial to the understanding of farming systems; analysis of production; and relationships to resources, technologies, markets, services, policies and institutions in their local cultural context. A systems approach offers the potential to internalise the external effects that may be constraining decisions to convert to organic production, and for the design of decision-making tools to assist households and the community. Systems models can guide policy design and serve as a mechanism for predicting the impact of changes to the policy and market environments.

The increasing emphasis of farming systems research on community and environment in recent years is in keeping with the proposed application to organic production, processing and marketing issues. The approach will also facilitate the analysis of critical aspects of the Australian production, marketing and policy environment, and the investigation of these same features in an Indonesian context.

Introduction

Organic production has increased substantially in many countries over recent years (Yussefi and Willer 2003). However, compared to total agricultural production, the volume of organic production in each country is still relatively low. Despite the low percentages of production overall, existing trends indicate that the demand for organic produce will be one of the major issues shaping agricultural output over the next few decades (Dixon et al. 2001). Moreover, the Food and Agriculture Organization (FAO) 'promotes organic agriculture as a means to reconcile food production and environmental conservation' in implementing Agenda 21 Chapter 14, Sustainable Agriculture and Rural Development (FAO, 2002a, p.2).

One of the factors in increasing demand of organic produce is public consternation associated with problems such as mad cow disease, while organic standards hold promise for consumers that products are produced under a healthier management regime. The concerns for health and the degradation of environmental quality caused by excess of chemicals have also contributed to the expanding demand and market value of organic produce in Australia (Hudson, 1996). For developing countries such as Indonesia, the high price of chemical inputs is a factor driving organic production, where low labour costs provide a comparative advantage.

This paper aims to analyse the process of the conversion from conventional to organic farming and the changes associated with increasing overall levels of organic production. For individual growers and processors, the conversion process is often a challenging step, entailing a thorough revision of established practices and heightened market insecurity. Implementing new management systems and facing the risk of failure and loss of financial viability are issues that place a burden on farmers, even though the wider society may benefit from the change of social, environmental and economic conditions. Therefore, this study examines both the impacts at the individual farm level from the producer's viewpoint and broader social impacts; predominantly socio-economic, taking into account farm management and industry concerns, including the environmental consequences of conversion to organic farming.

The paper presents a framework of ongoing work to model the impacts of policy changes related to the conversion process to organic farming at the individual and society levels. These impacts are examined using a systems approach at both levels. The systems approach is suited to consideration of complex problems, multiple interests and spans both 'hard' and 'soft' science.

The design of systems model is based on farmers' decisions to convert to organic farmer. This entails both financial and beliefs-based submodels. A modified cost-benefit analysis is proposed as the central element of a systems model to examine impacts at the social level, incorporating relationships to resources, technologies, markets, services, policies and institutions. The model is intended to serve a simulation role in testing policies designed to achieve desired changes to the system.

This paper begins with a brief analysis of organic farming in terms of market share and government involvement. The literature dealing with systems approaches is examined as generally and in a search for evidence in systems literature specifically relating to the evaluation of conversion to organic farming and its impacts on society. The systems model proposed is designed to analyse critical aspects of Australian organic food production, marketing and policy. The international application of such a model will be later tested in an Indonesian context, hence consideration of both Australian and Indonesian contexts for the framework.

The development of organic farming

In 2001, the worldwide market for organic products was estimated at US$19 billion, with a projection of US$23 billion for 2003 and a total area of at least 22 million hectares (Yussefi and Willer 2003). Yussefi and Willer (2003) argue that although 90% of the market for organically produced foods is in Europe and North America, there are indications of a growing organic market in other countries. Indeed, organically farmed areas in Australia are the largest in the world, at 10.5 million hectares, but in terms of the value of marketed products, the value is small, at US$125-150 million per annum (Burch et al. 2002). With estimated growth rates up to 20% per year in the period 2003-2005 (Yussefi and Willer 2003), organic farming stands poised to make a substantial contribution to agricultural development in many countries.

The interest of governments in the development of organic food is also increasing (Yussefi and Willer 2003, Burch et al. 2002, Hermansen et al. 2003). Before 1990, private certifying institutions actively regulated the production and marketing of organic products (Burch et al. 2002). In the 1990s more governments were involved in the development of organic industries through regulation of trade, certification, and financial support in the conversion process and production (Lampkin 1994, Burch et al. 2002, Yussefi and Willer 2003). Australia launched the National Standard for Organic and Biodynamic Production in 1992, while Indonesia introduced its national standard in 2002. Organic farming has also been incorporated in the agricultural and environmental policies of both countries (Hermansen et al. 2003), largely reflecting concerns for health and the environment (Mc Coy and Parlevliet 2000). In 2000 Indonesia initiated the national organic program, *Go Organic 2010*, under the Sub-Directorate of Environmental Management of Ministry of Agriculture.

The farming systems approach

Systems approach development

Farming Systems Research emerged as a reaction to the perceived limitations of reductionist science and the transfer of technology approaches characteristic of agricultural science and extension respectively. This research emphasised the importance of humans to agricultural production and the need for new technologies to be developed within this context. For the last few decades, systems approaches and simulation modeling have been progressively applied in the analysis of agricultural production (Kropff et al. 2001a, Bouma and Jones, 1999). A variety of approaches and refinements to systems research in agriculture have emerged since that time. The increasing emphasis of farming systems research on communities and the environment in recent years is in keeping with the proposed application of organic production, processing and marketing issues.

Definition and characteristics

The Natural Resources Institute (NRI, 2002, p.1) defines farming systems as 'a complex combination of inputs, managed by farming families, influenced by environmental, political, economic, institutional and social factors.' It shows that external aspects, such as policy and market condition, have an effect on the farm management, which is to be analysed in this study. The systems approach used in this study is in line with the definition proposed by Kropff et al. (2001b, p.371), 'the systematic and quantitative analysis of agricultural systems, and the synthesis of comprehensive, functional concepts of them.' They argue that in a systems approach, the assessment of the biophysical production system should be complimented by socio-economic analysis, to analyze the benefits of systems at field, farm and regional levels, which are also examined in the study. According to Keating and McCown (2001), the biophysical production system includes the inputs, crops, pastures, animals, soil and climate; while socio-economic analysis focuses on the management system of values, knowledge, resources, monitoring opportunities and decision-making.

Following the above definitions, some key concepts of farming systems research are proposed by Sands (1986) and Mettrick (1993). They are farmer orientation, systems orientation, problem solving approach, interdisciplinary, on-farm testing and a continuous, iterative approach, which the central research is on-farm research and the research provides feedback from farmers.

Levels in systems approach

In line with the approach, the 'real world of agricultural systems' is perceived from the *lowest-level unit system* of a field or paddock (APSRU 2003). Kropff et al. (2001b) claim that at the field level the interactions of genotype, the environment and management can be modeled to achieve the objectives of farmers and society. A model to reach a specific target such as yield improvement, water and nutrient management and/or crop protection can be developed by taking into account factors such as the condition of the farm environment (soil, climate), inputs such as seeds, fertilizers and pest control, and framing practice. See Table 1.

Table 1: Systems approaches at field level

Level	Key issue	Approaches
Field	To achieve different goals with respect to food supply, income and protection of the environment – This requires an understanding of the interactions among genotype, the environment and management	To increase the efficiency of breeding efforts; To determine yield potential in different environment; To optimize water and N use at the field level; To improve protection (through prevention and the use of natural enemies to minimize pesticide requirements (Kropff 1997 in Kropff et al. 2001b).

Source: Kropff et al. 2001b

The *higher-order farming system* is the farm enterprise itself and the wider catchment area. While the analysis of farm enterprise concentrates on issues such as costs, returns and risk, analysis at the catchment level focuses on environmental impacts such as leaching of nutrients to groundwater, soil erosion and dryland salinisation (APSRU 2003). Kropff et al. (2001b) presents three different approaches for farm and regional levels: future land use prediction, an exploratory approach and identification of policy instruments. These applications are summarized in Table 2. A model of agricultural systems with interactive multiple goal optimization for the farm can be developed, but socio-economic studies, including market issues and policies, are required to implement a broader level study. In effect, two stages of the modeling process are required, firstly to conceptualise the system at the farm level, and then to link to a broader level model of the socio-economic and environmental system reflecting the interests of the community as a whole.

Table 2: Systems approaches at farm and regional levels

<table>
<tr><th>Level</th><th>Key issue</th><th>Approaches</th></tr>
<tr><td>Farm</td><td>To consider the trade-offs between different biophysical and socio-economic objectives</td><td rowspan="2">The prediction of future land use based on extrapolation of existing trends;
The exploratory approach that defines a number of realistic land use options for the area to be considered;
Identification of policy instruments to realize particular land use options.</td></tr>
<tr><td>Regional</td><td>Using a systems model to analyze data supported by tools for organizing and utilizing huge databases</td></tr>
</table>

Source: Kropff et al. 2001b

The application of farming systems research

Pacini et al. (2003) point out that that scientists and managers tend to be interested in very detailed indicators and information at the field and farm level, whereas policy makers and the general public prefer condensed data relating to broader policy objectives. The separation of interests, combined with the site specificity of agro-ecosystems, presents a huge challenge in devising an analytical framework capable of encompassing individual farm level decision-making, a social perspective for environment-economic analysis and a tool for modeling policy. This is the challenge for a systems approach in moving from site-specific models of processes and decisions, through to the analysis of general impacts affecting society and the environment on a wide scale.

Other relevant approaches falling within the broad label of systems research have included work by Brethour and Weersink (2003), which examined the on-farm benefits of reducing pesticide use in Canada through average net farm returns. Benoit and Veysset (2003) employed linear programming to assess the economic consequences of the conversion of conventional livestock systems to organic farming in France. Their study was based on simulation models and optimising technical efficiency in an economic sense. The authors acknowledge that their analysis was limited to economic arguments, even though 'the shift to organic farming is a complex process taking into account the environment in a very broad sense (physical, technical, ecological, social)' (Benoit and Veysset 2003 p.11). Earlier work by de Koeijer et al. (1995) employed linear programming in conjunction with multiple goal programming to conduct environmental-economic analysis of mixed crop livestock farming. In so doing they accounted for organic matter balance, nutrient flows and chemical inputs.

Each of these studies and the methods employed has prospects for application to organic farming systems. However, none has the capacity to step up to an analytical perspective encompassing the full spectrum of socio-economic and environmental concerns that drive policy-making.

A framework for applying farming systems research in conversion process to organic farming

The systems approach previously described is applied in this study for analysing the conversion process from conventional to organic farming. The process of conversion from conventional to organic farming involves implementing new farming practices, which in turn affect whole systems. In respect to production systems, the methods of yield improvement, nutrient management and crop/animal protection change as biological and physical processes replace chemical inputs. The effect of this conversion is not only on the physical performance of the farm, but also on the management systems of the farm, involving the knowledge of the farmer, risk management and decision making processes. These influences cannot be separated from production systems.

The systems approach is applied because it is argued that belief systems are an important aspect in the analysis of producer and consumer preferences in relation to organic farming. From the producer side, it is supported by Rickson et al. (1999) finding that the ability to deal with the problems of implementing organic farming are not separable with the beliefs of the farmers. On the other side, consumers believe that the price paid for organic produce may represent a package of health and environmental benefits, ethical production, taste and nutritional qualities. Therefore, a systems approach is considered to be applicable to the analysis of the social impacts of the conversion process.

The proposed framework of the study is illustrated in Figure 1, a modified diagram from the model of the FARMSCAPE (Farmers, Advisors and Researchers, involved in Monitoring, Simulation and

Communication, and Applying Participative Evaluation) methodology (Keating and McCown 2001). As farming systems research is farmer-oriented, understanding of the farmers in the conversion process is an initial step of the analysis. Reasons behind the conversion, experience during the conversion period, including problems and lesson learnt, and expectations of the future are some aspects of the examination of decision-making process. These aspects are modeled using a case study approach involving farmers undergoing conversion or with recent experience of the conversion process. The model envisaged will have both financial and beliefs based components.

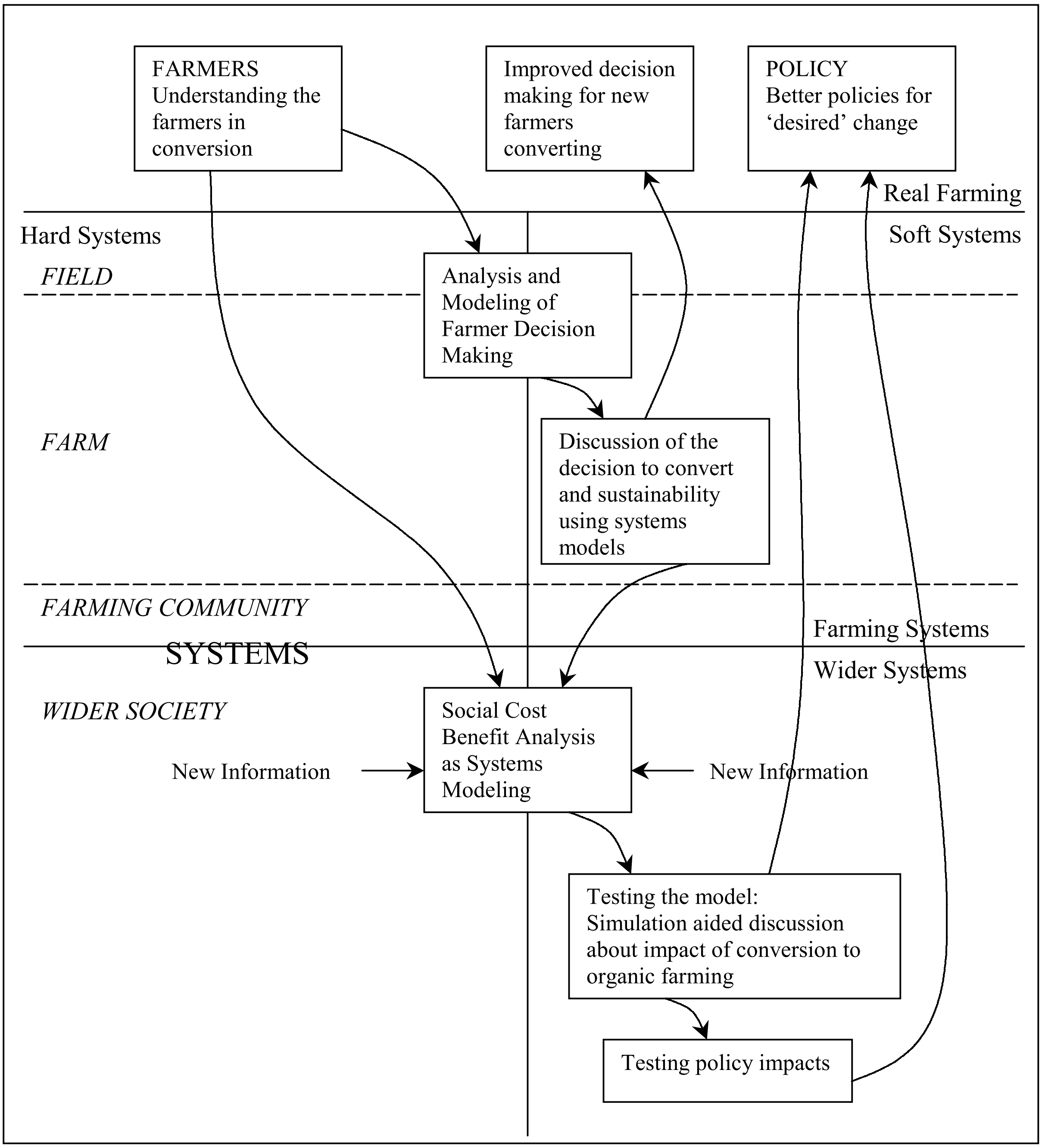

Figure 1. Conceptual map of research process

Results from the first step are analyzed and modeled in the farming systems level. As the data are both quantitative (financial) and qualitative (beliefs), spanning both physical and human elements, the model incorporates aspects of both 'hard' and 'soft' systems. The key to a systems approach is the engagement of the 'hard' systems of agricultural science and related fields, and the 'soft' systems involving humans both socially and physically (ASPRU 2003). The model of decision-making at the farm level will be discussed with the farmers engaged in the study to validate the model. In this discussion, the feedback from farmers is considered essential to improved decision-making for new farmers wishing to convert to organic farming.

The above steps are required for farming systems research ‘to elicit a better understanding of farm households, family decisions and decision-making processes’ (Collinson 2000, p.1). Collinson (2000) then argues that this limited basis for understanding is a potential base for higher-level application such as technology development and policy formulation. This is parallel with recent shifts in the farming systems approach in agricultural development, particularly in respect to the level, focus on stakeholders and target of beneficiaries (Hart 2000, Dixon et al. 2001). Therefore, the research area in Figure 1 is expanded to examine the impacts of organic conversion for wider society, as the target group is broader than farm level. The issue of scaling up is considered for wider systems. Collinson (2000) suggests six approaches in scaling up; aggregation, coverage, diffusion, externality, extrapolation and hierarchy. In this study, extrapolation for wider systems modeling is the selected approach and is conducted through social cost-benefit analysis (CBA).

CBA is usually not considered as a systems tool, but in this study CBA is used as a tool for systems modeling. In building the CBA, data collected from farmers are validated by dialogue with stakeholders. New information is required to quantify social, environmental and economic impacts of the conversion process for the wider society. The sources of information should incorporate the various actors involved in the development of organic industries, such as producers, certifying bodies, processors, marketers, consumers and government. The externalities associated with organic agriculture at the enterprise level are incorporated in the social analysis. Rahayu et al. (2003) have previously discussed a number of production externalities from agricultural production and identified prospects for reducing external costs and increasing external benefits through conversion to organic farming. An example of an external benefit is less chemical residue contained in effluent water, thereby reducing the water treatment cost for domestic and industrial purposes. This information required could be based on the farmers’ data on the reduction in the use of chemicals. The tools considered in incorporating the social aspects of farming systems are systems modeling tools (specifically SIMILE, “a software tool for computer simulation of complex dynamic systems in the earth, environmental and life sciences” (Simulistic, 2003)).

As is proposed for the farm level stage of modeling, the community level model is to be discussed with the various actors concerned for validation. For this purpose, focus groups can be applied. The impacts of selected policy changes are also to be tested to identify better policies for ‘desired’ change.

Predicting the impacts of policy and market change

The FAO (2002b) states that policies are needed to encourage farmers implementing sustainable agriculture to prevent further environmental degradation. The background to this statement is the fact that economic pressure contributes to farmers’ decisions in implementing farming systems more than the environmental consideration. An example of policy encouragement of organic farming is found in some European countries, where the governments provide financial supports for the conversion process to organic farming (Lampkin 1994). However, Lampkin (1994) argues that although these policies contribute to the development of organic farming, some farmers are still reluctant to convert due to the risk of failure and future market segmentation. It could be that the subsidies were not sufficient or that the policy has no linkage to the market.

Policies may be designed to intervene directly in the market. The organic market itself is a niche market where the consumers may be aware of the internalized costs embedded on the price premium of the organic products. This premium indicates their willingness to pay for organic produce (Rigby et al. 2001). It is predicted that intervention in markets could contribute to an increase in demand, when more consumers become aware of the advantages of organic production for health and the environment. Growers can also be encouraged to make the conversion process to organic farming by supporting policies and the creation of market opportunity. However, any increase in the volume of organic production can result in a lower price. The consequences of such a price reduction will vary for each of the parties involved. Consumer surplus is likely to be increased, as a result of reduced prices (increasing the gap between willingness to pay and price). On the other hand, producers might suffer from these changes as their incomes fall. The wider society may benefit from health, environmental and economic aspects. In order to help organic growers in this condition and prevent them from reverting, it has been proposed that subsidies for organic growers should continue after the conversion process (Rigby et al. 2001). However, this form of intervention creates a market distortion

and a requirement for plentiful sources of funds. It is unlikely that such conditions will exist in developing countries.
Brethour and Weersink (2003) have previously studied the effectiveness of policy and investment in pesticide reduction research, but all benefits were calculated from partial budgets and on-farm benefits. In the study proposed in this paper, a similar policy step will be tested, incorporating the full span of costs and benefits both on- and off-farm. A policy to increase the numbers of organic farmers through assisting certifying bodies in their support for farmers in conversion process will also be examined. This policy is selected considering that certifying agencies play an important role in facilitating farmers following through the process of transition and developing market opportunities including export. Impacts of this policy on the main actors associated with organic production and wider society will be examined using links between individual farmer, social CBA and policy submodels.
A paper dealing with interdependencies in natural resource management by Ravnborg and Westermann (2002, p.43) provides an example of empathy in approach to the research proposed as the subject of this paper. They state that farmers' resource management is…

> *not determined by external structural forces such as the market or the state, or by farmers' belonging to specific ethnic group, class or community. Rather, it is shaped by the interplay between such factors and relationships, and individual farmers' own experiences and perceptions.*

This is important to farmers in negotiating collective management of natural resources. It is also critical to the definition of the research in terms of a systems approach. There are linkages between system elements dealing with individual decision-making, institutional factors and the policy environment.

Conclusions

As the growing organic development in many countries, the analysis of organic framing and food systems are topics of definite interest in the systems literature. In common with other farming systems studies, the step from the field to the farm level of analysis has been bridged by prior research. The next step in the research challenge is to extend beyond the farm level to the catchment or the community, and to increase the level of participation in the processes of research. This is indeed, a huge challenge.
This study proposes something rather different, evolving from farming systems research to soft-systems methodologies, although it remains to be proven. However, as previously described, the social aspects are considered from the lowest level. Production systems are not separated from management systems. For analysis of decision making in the farm level, financial sub-model is an inadequate representation. It is for this reason that the study proposes to augment the financial sub-model with a beliefs based sub-model. Such a model is inescapably constructivist in nature, drawing us into the realm of soft systems methodology.
Beliefs of the producers and consumers on the invisible advantages of the organic produce are greatly considered in the model. The commitment of the growers can support the continuity of implementing organic farming since they cannot depend solely on the price premium, which is still unpredictable. Consumers' perception on the organic produce is also appreciated, whether they purchase organic products for improving health and environmental quality, ethical production, or taste.
However, in assessing the effects of increasing rates of conversion to organic farming and increasing total organic food production and consumption, prices serve as useful indicators of social preferences. In the absence of any better indicator of society's understanding and attitudes of production and consumption, the price premium for organic produce serves as a versatile indicator. As it is moved to the level of society as a whole, prices, demand estimates and the cost structures of firms to estimate the aggregate consumer and producer surpluses associated with various levels of organic production and consumption can be used. These techniques allow estimation of the welfare effects of any changes to the system associated with policy direction or market trends.
It is argued that at the current levels of organic production, say 2% of total agricultural production, the environmental and health benefits of organic production are mainly limited to the producers and consumers directly involved. That is, at current levels of production it is assumed that the price premium is paid for organic produce and its associated package of benefits as private goods (allowing for the possible existence of altruistic production and purchase decisions). Although it is recognised

that there will be external effects of both the production and consumption of organic produce, the small volumes of produce entailed renders the public effects almost negligible. Even if organic production and consumption figures are doubled, the general environmental and health effects will probably continue to be very small and almost impossible to measure at this scale. Whilst it might be pointed to the existence of external effects of organic food production and consumption in theory, from a practical viewpoint and at the level of marginal changes to the very low existing levels, the public good element of organic production can largely be ignored. This assertion is on the grounds that such benefits are likely included in the package of benefits that consumers are paying for. It will be possible to test the validity of this assumption by exploring consumer preferences on the part of consumers of both organic and non-organic produce, looking for the sources of the utility associated with organic purchases and for evidence of free riding amongst consumers of non-organic produce. Provided these assumptions stand up to the rigours of theoretical debate, it is contended that the use of social cost-benefit analysis as a tool for systems research is valid. In addition, the tool is consistent with a constructivist approach, arguing that this tool allows us to aggregate the various understandings and preferences of individuals at a social level, without the necessity of cataloguing and comprehending the many constructions involved.

Systems approaches are not defined by the conventions of the tools employed. This proposal to combine the use of a simulation modelling tool (SIMILE) with a cost benefit framework is an unusual match for our contention to be working within the boundaries of soft systems. It is the use of these tools in conjunction with participatory methods, allowing for reference back to the various stakeholders and subsequent modifications to the model that may justify the combination of these strange bedfellows and the transitions across methodological boundaries.

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