Aspects of Applied Biology 79, 2006
What will organic farming deliver? COR 2006

Economic sustainability and risk efficiency of organic versus conventional cropping systems

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Summary

Environmental, social and economic attributes are important for the sustainability of a farming system. Resilience is also important yet has seldom been directly considered in evaluations of economic sustainability. In economic terms, resilience has to do with the capacity of the farm business to survive various risks and other shocks. A whole-farm stochastic simulation model over a six-year planning horizon was used to analyse organic and conventional cropping systems using a model of a representative farm in Eastern Norway. The relative economic sustainability of alternative systems under changing assumptions about future technology and price regimes was examined in terms of financial survival to the end of the planning period. The same alternatives were also compared in terms of stochastic efficiency. The results illustrate possible conflicts between pursuit of risk efficiency and sustainability. The model developed could be useful in supporting farmers' choices between farming systems as well as in helping policy makers to develop more sharply targeted policies.

Keywords: Sustainability; resilience; risk assessment; whole-farm stochastic simulation; stochastic efficiency

Introduction

Although there is wide agreement that sustainability is a good thing, in agriculture and generally, there is no general agreement on how to assess sustainability.

In this paper we focus on a particular aspect of agricultural sustainability which, while not comprehensive, seems relevant to the decision problem of interest. We start from a suggestion by Conway (1985) that 'sustainability is the ability of a system to maintain productivity in spite of a major disturbance, such as caused by intensive stress or a large perturbation'. Such a definition focuses on the resilience of the system. Applying this notion to the choice between alternative farming systems, we view sustainability as the ability of the system to continue into the future (Hansen & Jones, 1996). At the level of the individual farm, we take this to mean primarily that the farm business must remain financially viable while providing an acceptable livelihood for the farm family. Naturally, the ability to survive financially will be compromised if the farming system leads to the degradation of the farm resources, chiefly the land itself.

Sustainability, as we have chosen to view it, involves future outcomes that cannot currently be observed between alternative farming systems. Evidently, to compare the sustainability of farming systems it is necessary to model the stochastic and dynamic nature of the systems. That implies that sustainability can only be assessed in terms of the probability of persistence to some future moment in time. Moreover, although sustainability is usually argued to be about the long-term future, it is hard to model the inherent uncertainty far into the future because predictions about the distant future are too unreliable.

In this study we have chosen to investigate sustainability to a relatively near time horizon of six years using a whole-farm model which allows the risk of financial failure to be assessed. However, to compensate to some extent for the short time horizon, we have used stochastic simulation to examine each technology evaluated under a range of possible uncertain futures.

Materials and Methods

Expanding on the framework described by Hansen & Jones (1996), we measured sustainability of a farm system by the probability of financial survival to the planning horizon. Failure was defined as a negative value of the equity at the planning horizon.

Our sustainability criterion should not be the only economic criterion used to make a choice between farming systems. The measure focuses only on the lower tail of the distribution, implying an extreme aversion to risk, and may produce misleading results. Two risky farm systems with similar downside consequences may have very different upside outcomes, so that one would be acceptable and the other not.

To supplement the sustainability criterion we used stochastic efficiency with respect to a function (SERF) (Hardaker *et al.*, 2004). The SERF method ranks the alternative risky farming systems in terms of the certainty equivalent (i.e. risk-discounted value) of current wealth (NPV) over a plausible range of risk aversion levels.

To apply the approach proposed above, a whole-farm stochastic simulation model was developed to compare the economic sustainability and risk efficiency of organic versus conventional farming for a typical arable farm in Eastern Norway. The model evaluates the financial performance of the farm business over a six-year time horizon using equations linking farm production activities, subsidies, capital transactions, household consumption, financing arrangements and taxes.

Stochastic features were incorporated by specifying probability distributions for key uncertain variables. Both stochastic dependency between variables and increasing uncertainty with time were taken into account. Private consumption was assumed fixed every year in the planning period, independent of bad or good years. For further details of the stochastic simulation model framework see Lien (2003).

Experimental arable cropping system data with grains and potatoes (1991–1999) from Eastern Norway were used (Lien *et al*., 2006), supplemented with data on prices and labour requirements from other sources. The data were used to specify two cropping systems: conventional crop production (CON) and organic crop production (ORG). Two farm models were constructed, one for each farming system, each with 40 ha of arable land. The farms with CON cropping systems were assumed to grow barley, oats, spring wheat, and potatoes. The ORG crop systems consisted of barley, oats, spring wheat, potatoes, and annual grass-clover (for silage). The stochastic yield variables were based on the experimental cropping data. The general level of grain prices can be regarded as non-stochastic in Norway. However, variability in quality parameters causes some unpredictability in the farm-gate price for wheat. These quality parameters were recorded in the experiment and used to model stochastic wheat prices. Further, the potato price has been quite unpredictable, and was also stochastically modelled.

The models can be used to compare the two cropping systems under various scenarios, two of which are analysed here:

1. For the first we assumed that the prevailing yield and price levels (2004), the existing payments available to all farmers (but without the current additional area payments for organic farming) and the current market price premiums for organic produce continue to apply.

2. The price premium may decrease with increased supply of organic product as more farmers convert to organic production. Hence, in scenario two, we in addition to the assumptions for scenario one also phased out the organic price premiums.

Results

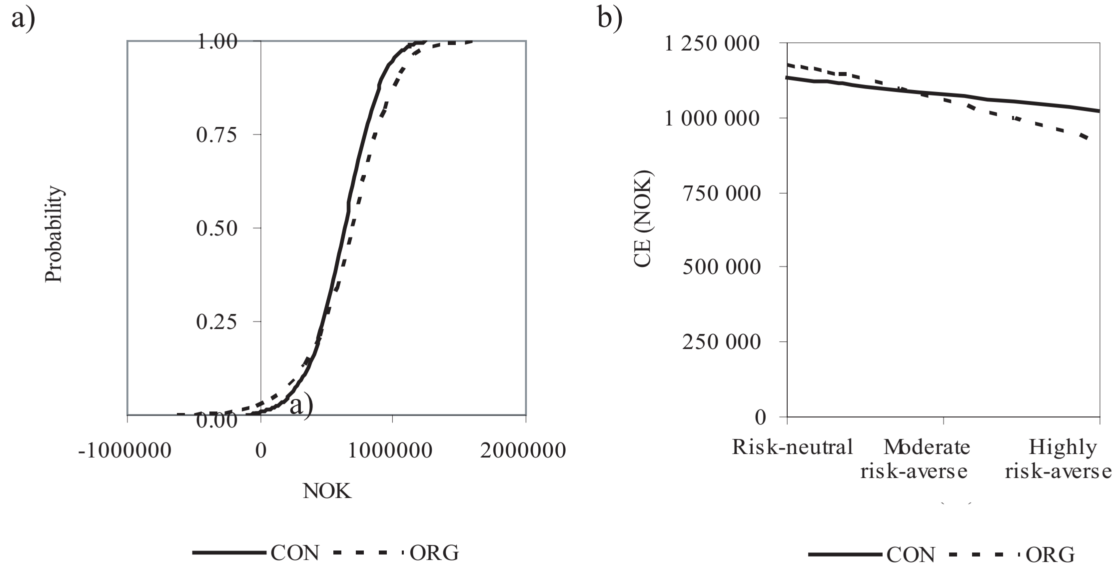

Fig 1. Simulated cumulative distribution functions (CDFs) of terminal equity in Norwegian kroner (NOK) (a) and certainty equivalent (CE) curves of NPV in NOK (b) for conventional (CON) and organic (ORG) farming systems.

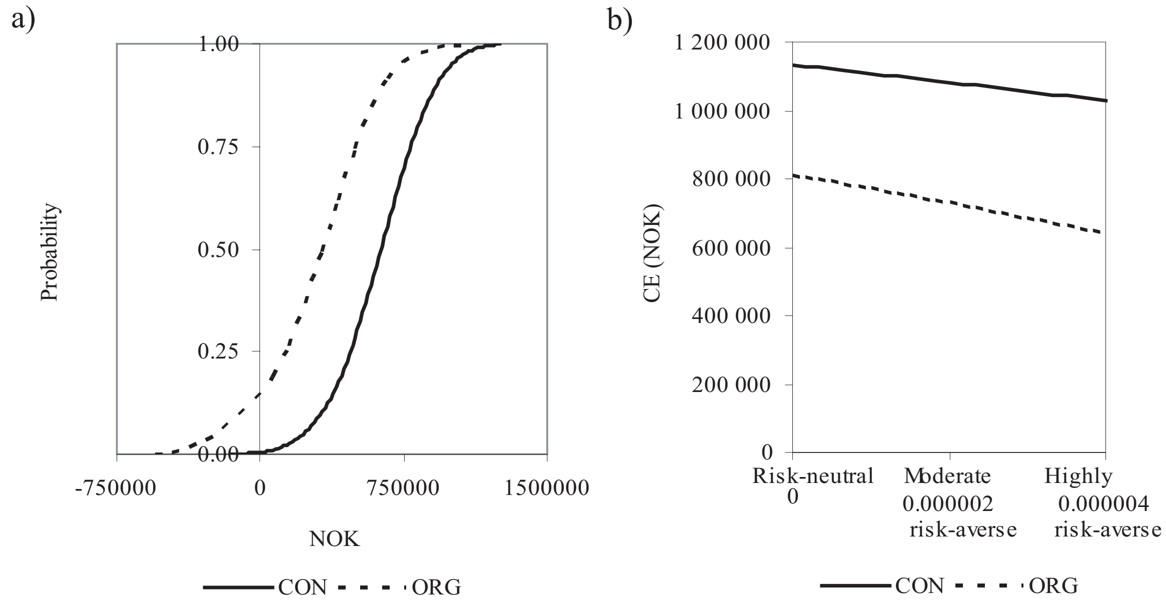

Fig 2. Simulated CDFs of terminal equity in NOK (a) and certainty equivalent (CE) curves of NPV in NOK (b) for conventional (CON) and organic (ORG) farming systems, under the assumption of declining ORG price premiums.

Scenario one – the "current" situation

The economic sustainability (Fig 1a) of the CON system is superior to that of the ORG, yet only a moderate to highly risk-averse farmer would prefer CON to ORG (Fig 1b).

Scenario two – reducing organic price premiums

It is assumed that organic price premiums follow a yearly linear decreasing trend, so that by 2009 the organic producer receives the same prices as the conventional farmer.

The economic sustainability and risk efficiency of ORG is substantially reduced compared to the CON (Fig 2).

Discussion

On the basis of the above results, it seems that the organic farming system is somewhat less sustainable than the conventional system, under the cases examined with the organic area payment removed.

This conclusion must be qualified for various reasons. First, the definition of sustainability used is narrow. Second, possible long-term differences between the two systems were unavoidably omitted. Third, no account was taken of differences in externalities of the two systems. Fourth, the model was confined to two fixed farming systems, while in practice farmers are likely to change cropping plans in the light of evolving expectations about yields and prices.

However, the model illustrated above could be useful to support decisions by farmers on whether or not to shift out of conventional production and into organic farming. Use of the above model could also be helpful to policy makers seeking to encourage organic farming methods.

An important point illustrated in the results is the difference between the particular measure of sustainability used and risk efficiency. Farm advisers and policy makers should be aware of the costs to farmers and society of recommending or requiring the uptake of farming methods that may appear technically more sustainable but that are less economically efficient.

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