Risk and economic sustainability of crop farming systems

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Abstract

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 sustainability of the systems was examined in terms of terminal financial position.

Key words: Sustainability, resilience, risk assessment, whole-farm stochastic simulation, stochastic efficiency.

1. Introduction

Although there is wide agreement that sustainability is a good thing, in agriculture and generally, the term has been given so many meanings[1] that commentators have suggested that the concept is not definable (Pretty 1995), meaningless (Beckerman 1992), or at best is context specific (Pannell and Schilizzi 1999, Zhen *et al*. 2005). Not surprisingly, therefore, there are difficulties in getting agreement on how to assess sustainability. Many different indicators have been selected by different analysts, with limited consistency across studies. In a farming systems context, a review of the literature also reveals use of a wide range of indicators. This diversity led Pannell and Glenn (2000) to propose a framework for economic evaluation to rationalise the selection of indicators in agriculture.

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, a concept introduced by Holling (1973). 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 and Jones 1996, Kaine and Tozer 2005). 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. There is a close link, therefore, between financial survival and the trend in factor productivity, which was proposed by Lynam and Herdt (1989) as the criterion of sustainability most useful for guiding agricultural research.

Sustainability, as we have chosen to view it, involves future outcomes that cannot be observed at the time that decisions are made about how the system is to be managed. As Hansen and Jones (1996) wrote: 'Since sustainability deals with the future, it cannot be readily observed'. Conway (1994) noted the difficulty in assessing sustainability in terms of the persistence of a system because of the infeasibility of long-term experiments. It is clear that such assessments require modelling the performance of alternatives management options into the future (Pandey and Hardaker 1995, Hansen and Jones 1996). Moreover, any such models must reflect the uncertainty about what the future might bring (e.g., Payraudeau *et al*. 2005). Indeed, the uncertainty about the future, and the possibility of shocks to the system from future adverse events, are the very reasons why it is important to explore the resilience of the system as it affects sustainability.

Evidently, an investigation of the sustainability of a farming system needs to model the stochastic and dynamic nature of the system. That implies that sustainability can be assessed in terms of the probability of persistence to some future

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[1] For example, according to Rigby and Cáceres (2001), Jacobs (1995) recorded at least 386 definitions of sustainable development.

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. Lynam and Herdt (1989) suggested a time horizon greater than 3-5 years but probably less than 20 for assessing sustainability. In this study we have chosen to investigate sustainability to a relatively near time horizon of 6 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 can use stochastic simulation to examine each technology evaluated under a range of possible uncertain futures. The model is implemented to illustrate the effect of changing assumptions about future technology and price regimes.

Even with such a short time horizon, it is impossible to capture in a model all the features of the farming system and all the possible future events that might impinge on its sustainability. However, that does not mean that the task is fruitless, Box (1976) noted that ‘all models are wrong, but some are useful’. The intention of this study is not to give exact answers, but to highlight the relative consequences of alternatives, and to develop insight and understanding. The aim in developing and applying the simulation model described below is to investigate what management options appear to improve sustainability of the farming system and what curtail it, and to find out whether threats or opportunities coming from outside the system affect sustainability positively or negatively.

2. Quantifying economic sustainability

In this study we first expand on the framework described by Hansen and Jones (1996) for using stochastic simulation models to quantify the sustainability of a farm system.

Let time to failure, T_F, be represented with a cumulative probability distribution, $F_{T_F}(t)$, where t is a time variable and T is a particular time. For the time period $(0,T)$, sustainability, S, is defined as:

$$S(T) = 1 - F_{T_F}(T) \tag{1}$$

which is equivalent to the survival function in mortality studies. Following Hansen and Jones (1996), sustainability can be estimated by the relative frequency of surviving realisations, or

$$\hat{S}(T) = \frac{n(T)}{N} \tag{2}$$

where $n(T)$ is number of non-failures at time T and N is number of iterations in the simulation model.

Sensitivity analysis can be used to rank the impacts on the sustainability of the farm system of different variables. The steps in the analysis are as follows: 1) simulate the model for the base scenario and record; 2) increase or decrease the investigated input variable i by, e.g., 5 per cent, simulate the model and record; 3) repeat step 2 for each input variable tested for sensitivity; 4) use equation (2) to calculate $\hat{S}$ for the base scenario as well as for all investigated changes in variables; and 5) calculate the relative sensitivity, r_i, for all investigated variables as:

$$r_i = \left[\frac{\hat{S}_i - \hat{S}_0}{\hat{S}_o} \right] \Big/ 0.05 \tag{3}$$

where $\hat{S}_0$ and $\hat{S}_i$ are sustainability estimates for the base and alternative scenarios. Relative sensitivity, r_i, is interpreted as an elasticity indicating the percentage change in $\hat{S}$ for a one per cent change in the investigated input variable.

Failure can be measured in financial terms. For example, Hamblin (1992) suggested that agriculture in a cash economy fails to sustain if production falls below the levels necessary for profitability. Lenders may impose threshold debt-to-equity ratios above which they will force foreclosure by recalling loans. Hansen and Jones (1996) used two criteria of failure: a debt-to-equity ratio exceeding 2.0 or a negative net present value (NPV) of future cash flows. In this study we have chosen to identify failure when the farm owner's equity falls below zero, indicating technical insolvency. While our criterion is less readily triggered than the debt-to-equity ratio of 2.0 used by Hanson and Jones, we believe it is a reasonable approximation to the likely response of many lenders when a family farm faces hard times. Because it is not easy to model all the possible on- and off-farm strategies that a farm family can use to avoid financial ruin, our model may somewhat over-estimate the risk of failure, justifying a less stringent setting. The exact setting of the criterion of farm sustainability used could readily be tailored to the circumstances of an individual farm decision maker. However, in comparing the sustainability of alternative farming systems, it seems likely that the relativities will not be much affected by the variations in the setting.

The above sustainability criterion should not be the only criterion used to make a choice between farming systems. The measure focuses only on the lower tail of the distribution. This is also the case with the 'value-at-risk' (VaR) criterion, which has been widely used in finance.[2] The use of VaR as a measure of risk has been criticised by, e.g., Artzner *et al*. (1999) and Szegö (2005). As with some other safety-first criteria, considering only the lower tail of the distribution means that risks with bad outcomes are rejected, with no consideration of up-side potential. Often up-side consequences can be sufficiently appealing to offset the relatively low chances of the bad outcome. Ignoring up-side potential implies an extreme degree of risk aversion which may not be justified in reality since, while the failure of a family farm business may be judged to be very undesirable, it does not imply the extinction of the family, the members of which can move on to another life, albeit perhaps a less preferred one. In other words, while the equity invested in the farm business may be lost, the human capital of the family members is not lost.

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[2] Manfredo and Leuthold (1999) have discussed the potential for application of VaR to agriculture.

It follows that to evaluate fully the relative risks of alternative farming systems we need to consider the whole range of outcomes, good and bad, and their associated probabilities. To supplement the outlined sustainability criterion we have used stochastic efficiency with respect to a function (SERF) (Hardaker *et al*. 2004b). The SERF method ranks the alternative risky farming systems in terms of current wealth over a plausible range of risk aversion levels. Simulated empirical probability distributions of wealth, measured by NPV, for the two cropping systems are ranked using sample certainty equivalents[3] (CEs) at several risk aversion levels in the chosen range. The stochastic NPV, comprising both the discounted terminal equity and discounted consumption income in years 1 to 6, is calculated using a deterministic annual discount rate at 0.05, intended to represent the farmer's opportunity cost of the invested equity (Miller and Bradford 2001). Of course, since farmers have different opportunities, the discount rate will vary between farmers and so should be adapted to each case. The method shows which risky alternative is preferred by decision makers with different degrees of risk-aversion, leaving the final choice to the individual decision maker.

3. Whole-farm simulation model

To implement application of the approach proposed above, a whole-farm stochastic simulation model was developed to compare the 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, subsidy schemes, capital transactions, household consumption, financing arrangements and tax obligations. Stochastic features were incorporated by specifying probability distributions for key uncertain variables. The measure of sustainability used was based on the future level of equity (net assets) at the end of the last (sixth) planning year. Equity is a measure of financial solidarity; a farmer is technically bankrupt if the equity is negative.

One problem with this measure is in cases when terminal equity is positive yet in some of the years between the start and end of the period the equity was negative, and the farmer was therefore insolvent. To handle this case, the interest rate on borrowed funds was increased by 5% over the stochastic base interest rate (see below) for any years in which the equity was negative. This was to reflect the extra (direct and indirect) costs of borrowing as financial solidarity of the farm business declined, i.e. the higher interest rates typically charged by lenders in such a situation as well as management difficulties due to lack of ready funds.

Private consumption was assumed fixed every year in the planning period, independent of bad or good years. In reality, it is to be expected that consumption spending would be increased or reduced depending on the available funds, but refinement along these lines was not judged necessary for this illustrative example. It

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[3] Certainty equivalent is defined as the sure sum with the same utility as the expected utility of a risky alternative (Hardaker *et al*. 2004a).

would be possible to include an adjustment for this effect when 'tuning' the model to the conditions of a specific real farm.[4]

For this analysis the coefficients of variation of all stochastic variables were assumed to increase linearly by 2 per cent a year over the planning period, reflecting greater uncertainty with time over the planning period.

One aspect that needs to be considered in stochastic simulation is the stochastic dependency between variables (Hardaker *et al*. 2004a). To avoid biasing the results, for the stochastic variables we allowed for first-order autocorrelation (i.e. inter-temporal correlation) between years, as well as intra-temporal correlation. Details of how the stochastic dependencies were estimated and simulated are given by Richardson *et al*. (2000).

The simulation model used was programmed in Excel and simulated using the Excel Add-In Simetar© (Richardson, 2004). In the simulation model the Latin hypercube sampling technique was used with 500 iterations to get good estimates of the distribution of the objective variables for each specified scenario. For further details about the stochastic budgeting model framework see Lien (2001).

4. Data

Experimental arable cropping system data (1991-1999) from eastern Norway (Eltun *et al*. 2002) were used, supplemented with data on prices and labour requirements from other sources. Two cropping systems were included in the main data set, conventional crop production (CON) and organic crop production (ORG). Each farmlet in the experiment had eight rotation plots and an eight-year crop rotation. All of the crops in each rotation were grown each year. Inspection of the experimental data permitted the combination of some of the crops within a rotation (varieties of the same crops) without significantly reducing the information from the experiment. The consolidation resulted in five crops in the CON system and six crops in the ORG system. The stochastic yield variables were based on the experimental cropping data.

Two farm models, one for each farming system, were constructed, each with 40 ha of arable land, a typical crop farm size in the region. The farms with CON cropping systems were assumed to grow 15 ha barley, 10 ha oats, 10 ha spring wheat, and 5 ha potatoes. The ORG crop systems consisted of 10 ha barley, 5 ha oats, 10 ha spring wheat, 5 ha potatoes, and 10 ha annual grass-clover (for silage). These crops mix proportions are about the same as were used in the experiment. For more details about the data used and empirical results of differences in risk between conventional and organic cropping systems in Eastern Norway, see Lien *et al*. (2006).

Norwegian farmers receive quite substantial government support, chiefly through price support measures and area payments for crops. Under the annual agricultural agreement between Norwegian farmers and the government, target prices (maximum average prices) are set for most commodities, including wheat, barley and oats (NILF 2003: 5-30). Hence, 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

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[4] In so far as sustainability is about the conflict between current and future consumption, it could be interesting to explore the trade-offs in future work.

recorded in the experiment and this information was used to model stochastic wheat prices.

The potato price has been quite unpredictable, and was stochastically modelled. Deflated historical potato prices in NOK (Norwegian kroner, AUS\$ 1.00 ≈ NOK 5.00) per kg for 1991-1999 from the Agricultural Price Reporting Office (LP 2000) were used to specify the empirical potato price distribution. Based on organic potato price premiums in Norway in 2003/2004 and price premiums for organic potatoes in other European countries, organic potatoes were initially assumed to be sold at prices 50% above conventional prices, and with the same relative risk (hence higher absolute risk).

Deterministic product prices (reduced for the yield-dependent hauling cost and ensilage cost for clover grass), input prices and prevailing area payment schemes (2003/2004) were taken from NILF (2004).

The following initial mean rates of interest per year were assumed: short-term loan interest rates 6%, long-term loan interest rate 5%, deposit interest rate 4%. The probability distributions and trends over the planning horizon in the stochastic interest rates on financial assets and liabilities were forecasted with an autoregressive model. The forecasting model was estimated using annual average rates on 10-year Government bonds for the period 1985 to 2003. Using the hierarchy of variables approach (Hardaker *et al*. 2004a), interest on Government bonds was assumed to be the macro-level variable affecting all interest rates. The interest rates on short- and long-term loans and deposits were all assumed to be perfectly correlated. The forecast values and their standard deviations from the estimated first-order autoregressive model AR(1) equations were used as indexes for the stochastic distribution and stochastic trends of all interest rates used in the budgeting model.

5. Illustrations

By way of illustration, the model was used to compare two cropping systems, CON and ORG, under three scenarios. For the first we assumed that the prevailing yield and price levels, the existing subsidy payment system for conventional farming (but with the current special area payments for organic farming excluded[5]) and the current organic price premiums continue to apply.

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

In scenario three, we opted to illustrate the effects of crop failures in one year on the sustainability and risk efficiency of the two farming systems.

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[5] Lien *et al*. (2006) showed that the current organic area payments and price premiums make organic farming significantly more profitable than conventional farming. If organic area payments were removed, the same study showed that the expected economic return from organic cropping was slightly higher than under conventional management. There is a widespread belief, at least among crop farmers, that organic area payments and price premiums will soon be reduced or removed (Koesling *et al*. 2004). Hence, we have chosen to illustrate the sustainability of the organic system without special government support.

5.1 Scenario one: the ‘current’ situation but organic area payments excluded

Figure 1 shows the means and limits of the distributions of the equity of the two farm systems for each year in the planning period.

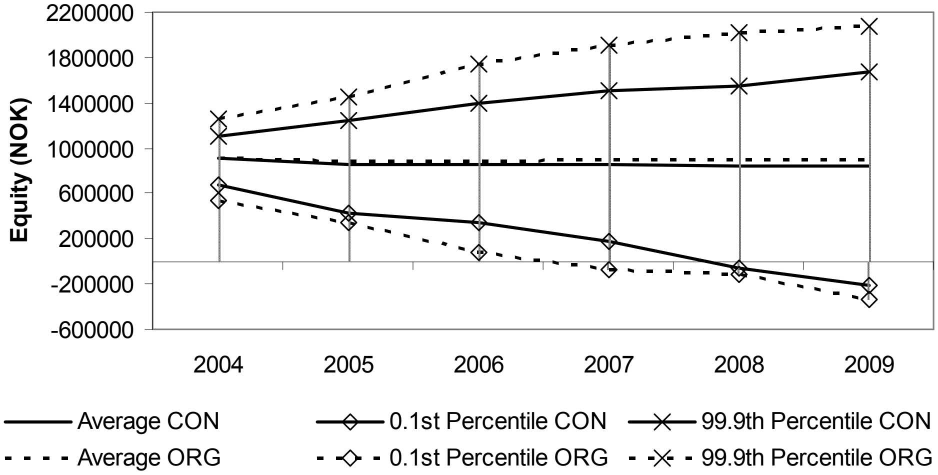

Figure 1 Simulated mean and range of equity in NOK for the six year planning period for conventional (CON) and organic (ORG) farming systems under scenario 1.

On average the ORG farming system, compared to CON, has somewhat higher equity during the planning period. However, the variability is also greater.

The cumulative distribution functions (CDFs) of terminal equity of the two systems are presented in the left part of Figure 2. Although the sustainability of the ORG systems appears to be somewhat less than for CON, for neither of the systems is economic sustainability seriously threatened (less than 0.02 probability for negative terminal equity for the ORG system). Which of the two farming systems a farmer would prefer may therefore depend on their relative overall risk efficiency, as discussed in the Introduction. The SERF analysis of the two farming systems is summarised in the right part of Figure 2.[6] The CON system will be more preferred than the ORG system for farmers with moderate or high degrees of risk aversion.

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[6] A negative exponential utility function was used (because a power function, which would have been preferable, does not work for negative values, as we have in this study), and the typical level of a farmer’s wealth was assumed to be NOK 1 000 000. A value of absolute risk aversion with respect to wealth $r_a(W)$ in the range 0 to 0.000004 corresponds to $r_r(W)$ in the range 0 to 4, which was used as the risk aversion bounds in the SERF analysis.

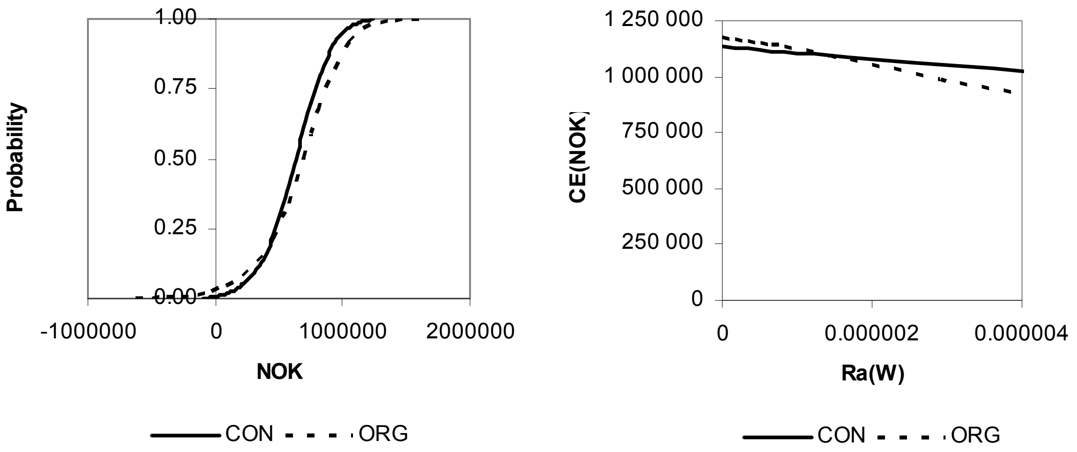

Figure 2 Simulated CDFs of terminal equity in NOK (to the left) and certainty equivalent (CE) curves of NPV in NOK (to the right) for conventional (CON) and organic (ORG) farming systems, scenario 1.

These results imply that the sustainability of the CON system is superior to that of the ORG, as judged for any cut-off value of terminal equity below about 500 000 NOK, yet only a rather to extremely risk averse decision maker (relative risk aversion above 1.5) would prefer CON to ORG based on the two distributions of NPV. Cacho and Simmons (1999) found a similar divergence between economic sustainability and risk efficiency using a different approach.

5.2 Scenario two: effects of gradually reduced organic price premiums

In this scenario 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. Figure 3 illustrates the relationship between time and economic sustainability of the two farming systems for this scenario. The probability of survival of the organic system begins to decline from 2007 reaching a level of 86.1 per cent by 2009. The corresponding probability of survival for the CON system by 2009 is estimated to be 99.8 per cent.

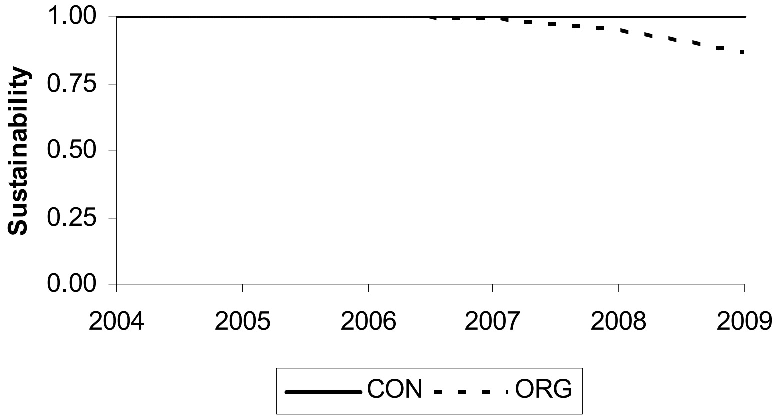

Figure 3 Relationship between time and economic sustainability of the CON and ORG farming systems with decreasing organic price premiums.

A closer investigation of which input variables affected the sustainability of the ORG farming system most under the assumption of declining price premiums is reported in Table 1. The product price and yield (yields and product prices have exactly equal effects) for potatoes affected the sustainability of the ORG farming system most, in that sustainability increased by 0.42 per cent for a 1 per cent increase in product price or yield. The second most sensitive exogenous variables were found to be the price and yield of barley and oats and the variable cost for wheat, the elasticity for each of which was plus or minus 0.28.

Table 1 Sensitivity elasticities of sustainability with respect to product price and yields, variable costs and area payments for the ORG farming systems with decreasing organic price premiums

Variable type	Production	Sensitivity elasticity
Yield and product price	Barley and oats	0.28
	Wheat	0.23
	Potatoes	0.42
	Clover grass	0.23
Variable cost	Barley and oats	-0.19
	Wheat	-0.14
	Potatoes	-0.28
	Clover grass	-0.14
Area payment	Barley and oats	0.14
	Wheat	0.14
	Potatoes	0.14
	Clover grass	0.14

If the organic price premiums should (partly) erode, could yield improvement over time compensate for the decreased prices? Organic farming may have a potential for increased yields due to rising soil fertility (Mäder *et al.* 2002) and to improved management. (Productivity could rise as farmers new to this form of production accumulate experience in how to do things better.) However, simulation results show that even an unrealistic annual 5 per cent increase in yields in organic farming would not be enough to outweigh the unfavourable impact of declining organic price premiums on sustainability.

As Figures 3 and 4 show, there is consistency between the farming system choice based on sustainability grounds and on risk efficiency. By both criteria the CON system is superior to ORG.

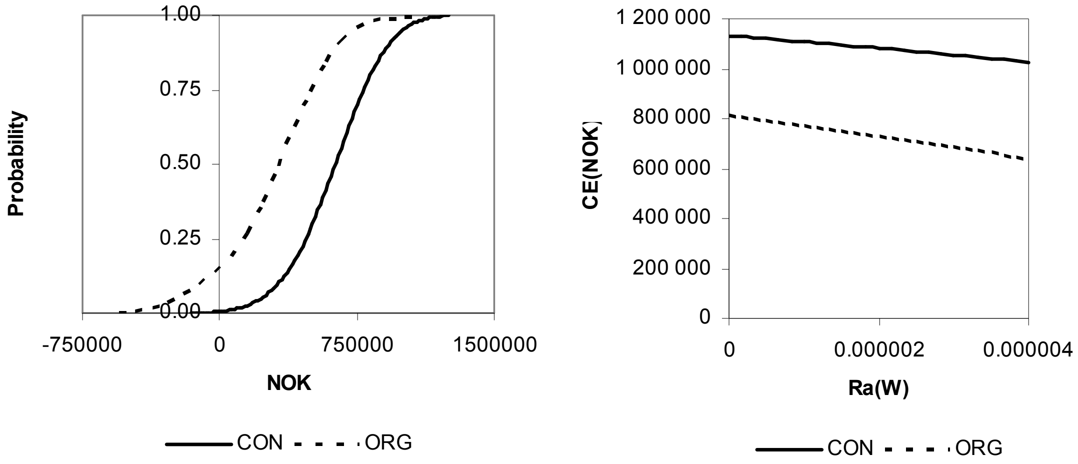

Figure 4 Simulated CDFs of terminal equity in NOK (to the left) and certainty equivalent (CE) curves of NPV in NOK (to the right) for conventional (CON) and organic (ORG) farming systems, under the assumption of declining organic price premiums.

5.3 Scenario three: capacities of the systems to respond to crop failures

In this scenario we artificially introduce crop failures in the third year of the six-year planning horizon. We assume that third year yield levels are so low that the crops are not worth harvesting (i.e. zero yields). As a consequence, we also reduced the variable costs for grain and clover grass production, for potato production to account for the estimated harvesting and post-harvesting costs saved. Figure 5 shows the sustainability graph.

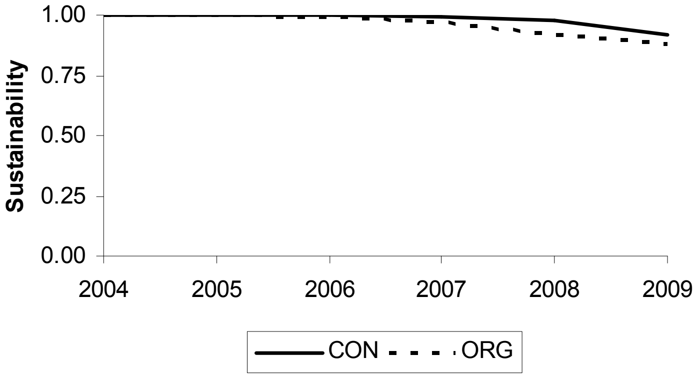

Figure 5 Relationship between time and the sustainability of CON and ORG farming systems in the event of crop failures in the third year.

As expected, the sustainability of both the CON and ORG system was negatively affected by the crop failures. By the final year, the probability of survival was found to be 88 per cent for the ORG system, compared with 92 per cent for the CON system. In Table 2 the variables that most influence the sustainability of the two systems are presented.

Table 2 Sensitivity elasticicities (SE) of sustainability with respect to product price and yields, variable costs and area payments for the CON and ORG farming systems in the event of crop failures in the third year

Variable type	Production	SE CON	SE ORG
Yield and product price	Barley and oats	0.35	0.32
	Wheat	0.35	0.32
	Potatoes	0.39	0.59
	Clover grass		0.36
Variable cost	Barley and oats	-0.52	-0.41
	Wheat	-0.26	-0.23
	Potatoes	-0.52	-0.45
	Clover grass		-0.18
Area payment	Barley and oats	0.26	0.23
	Wheat	0.17	0.18
	Potatoes	0.00	0.05
	Clover grass		0.05

The most sensitive exogenous variables for the CON system were found to be variable costs of barley and oats, and of potatoes. The product price and yield of potatoes affected the sustainability of the ORG farming system most, in that sustainability increased by 0.59 per cent for a 1 per cent increase in product price or yield.

Figure 6 shows the CDF graph of terminal equity (to the left) and the SERF graph of NPV (to the right).

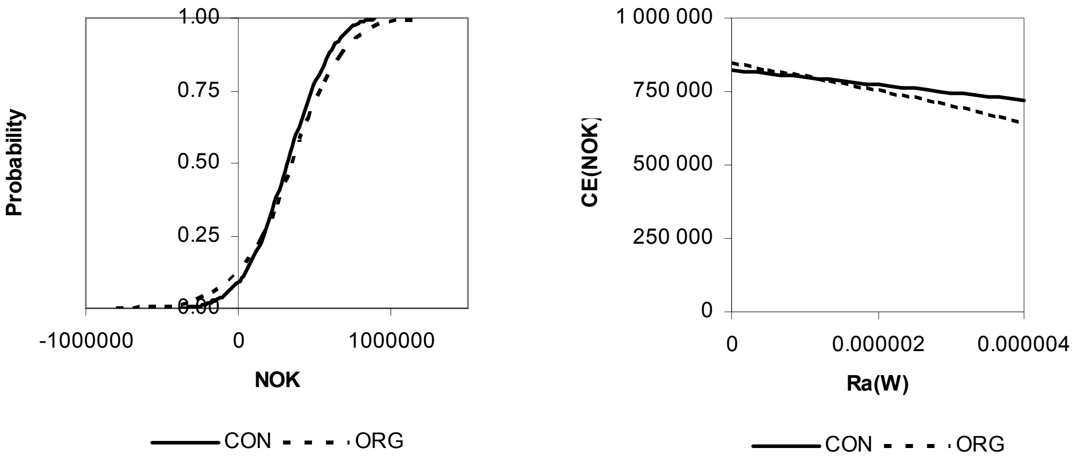

Figure 6 Simulated CDFs of terminal equity in NOK (to the left) and certainty equivalent (CE) curves of NPV in NOK (to the right) for conventional (CON) and organic (ORG) farm systems, under the assumption of crop failures in year 3.

The left part of the figure shows that the CON system is more sustainable than the ORG system for any setting of the criterion of financial failure below about NOK 250 000, and the right part of the figure shows that only a risk indifferent to moderately risk averse farmer would prefer ORG to CON.

6. Discussion and conclusion

On the basis of the above results, it seems that the ORG farming system is somewhat less sustainable than the CON system, under the cases examined with the organic area payment removed. This must be a qualified conclusion for various reasons. The first relates to the unavoidable omission of any long-term difference between the two systems. Critics of conventional high-input farming often argue that this form of production will have adverse long-run consequences. They take this position often in the face of positive historical trends in output and productivity. On the other hand, some studies, including some in Norway, have reported declining soil nutrient concentrations of nitrogen, phosphorus and/or potassium, under organic farming, calling into question the long-term sustainability of these crop farming practices (e.g., Eltun *et al.* 2002; Gosling and Shepherd 2005).

If it became widely accepted that real differences between the two systems in soil fertility were developing, favouring one or other system, a price gap would open up between land farmed in the two different ways. Any such a difference in value would need to be included in the calculation of the asset values under the two systems examined.

Second, this analysis has taken no account of differences in externalities of the two systems. It would be possible to extend the study by valuing and including any externalities. Unfortunately, measuring and valuing such externalities is likely to be difficult. As an alternative, it could be possible to account for the assessed risk that negative externalities such as ground or surface water pollution, might lead to legal liabilities, which themselves would threaten the continuation of the farming system.

Third, the present model is confined to two fixed farming systems, one for each form of production, as represented in the experimental data. However, in practice, farmers are likely to change cropping plans in the light of evolving expectations about yields and prices relevant to the different modes of production. It might be possible in future work to link the simulation model to a mathematical programming model to compute optimal annual farm plans accounting for a farmer's individual beliefs, preferences and circumstances.

With these reservations, we suggest that the model illustrated above could be useful for supporting decisions by farmers on whether or not to shift out of CON production and into ORG farming. In such applications it would be relatively easy to 'tune' the model to reflect an individual farm and farmer's circumstances and expectations.

Similarly, use of the above model could be helpful to policy makers. The Norwegian government is keen to encourage the expansion of organic farming. Results such as those presented above might be useful in deciding what policies would be effective to pursue that aim. For example, the results presented above suggest that the aim may be compromised if the market premiums for organic produce diminish. Seeking to push farmers too quickly into changing to organic farming could lead to an over-supply of organic produce and a fall in price premiums not dissimilar from that modelled, leading to unsustainability for some ORG producers.

An important point illustrated in the results presented is the difference between the particular measure of sustainability used and risk efficiency. While the prescriptions for choice are in the main similar between sustainability and risk efficiency criteria, there are differences. Logic suggests that no criterion of sustainability (whether based on a single or on multiple indicators) will yield identical prescriptions for choice to those indicated using economic efficiency criteria – even when the latter are extended to include changes in values of assets and externalities. Those making recommendations to farmers 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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