Searching for economically sustainable Swedish suckle cow based beef production systems after decoupling of EU-income support

Pernilla Salevid

Licentiate Thesis

Sveriges Lantbruksuniversitet
Institutionen för husdjurens miljö och hälsa
Avdelningen för produktionssystem

Avhandling 6

Swedish University of Agricultural Sciences
Department of Animal Environment and Health
Section of Production Systems

Thesis 6

ISSN 1652-750X
ISBN 978-91-576-9135-4

Searching for economically sustainable Swedish suckle cow based beef production systems after decoupling of EU-income support

Abstract

After decoupling of European Union income support, the current Swedish systems for suckle cow-based beef production will be unable to pay the costs of new investments and the market wage for labour. In a Delphi study, production systems able to achieve full cost coverage were identified as being "Organic with high environmental grants and a premium price for beef" and "Conventional with outdoor wintering of cows". Both systems require large areas of semi-natural pasture per cow and larger herds than currently common in Sweden.

To test the results from the Delphi study, different models of suckle beef production were calculated for different regions of Sweden. The ambition was to identify production models with sufficient profitability to pay at least stipulated farm workers wage and a return on investment of 5% under Swedish conditions. In the calculations, the income from weaned calves, culled cows and European Union support was reduced by operating costs excluding labour. The result was divided by hours spent on labour requirement for animal husbandry and pasture management, which resulted in a return to labour per hour. Calculations for varying future scenarios with a changing Common Agricultural Policy showed that organic production models generated a higher return to labour than conventional production models. The main reason for this was the environmental areal payment for organic farming in combination with the higher acreage requirements in organic production. This resulting in higher environmental payments and other European Union supports per suckle cow. The most profitable production models were spring calving, heavy beef cow breeds and winter feed based on grass-clover silage. Some organic production models gave a return to labour above stipulated farm workers wage. However, if the Single Farm Payment scheme is phased out and not replaced by increased environmental payments, the return to labour will be at best half the stipulated farm workers wage.

A complementary telephone survey of 20 farmers with above-average herd size showed that the theoretical calculated profitability did not accurately reflect some of the real costs. One example was the opportunity cost of land, which was more expensive than calculated, because the areal payments are slowly moving from animal farmers towards passive retired farmers and landowners. The interviews indicated that the results of the Delphi study and profitability calculations are reliable and valid for cost-efficient future suckle beef operations, but overestimate the average profitability of current Swedish suckle herds.

Keywords: Suckle cow production, semi-natural pasture, profitability, future scenarios, grazing, forest-dominated regions

Author's address: Pernilla Salevid, SLU, Department of Animal Environment and Health,
P.O. Box 234, SE-532 23 Skara, Sweden
E-mail: Pernilla.Salevid@slu.se

Dedication

To all cows helping us maintaining our ”Emil i Lönneberga” landscape.

Use the history to produce for the future.
Mentioned at Berte Qvarn, Halland 2012

Contents

Searching for economically sustainable Swedish suckle cow based beef production systems after decoupling of EU-income support **1**

List of Publications **6**

Abbreviations **7**

1 Introduction **9**
1.1 Cow-calf production in Sweden 9
1.2 Weaned calves transferred to beef 10
1.3 Semi-natural pastures and maintaining the landscape in forest-dominated regions of Sweden 11

2 Aims of the thesis **12**

3 Materials and methods **13**
3.1 Paper I 13
3.1.1 Identification of satisfactory production models 13
3.1.2 The Delphi method 14
3.2 Paper II 15
3.2.1 Calculation methods 15
3.2.2 Production models 16
3.2.3 Basic calculations 16
3.2.4 Future scenarios and sensitivity analyses 16
3.3 Interviews 17

4 Results **18**
4.1 Paper I 18
4.1.1 Calf production 18
4.1.2 Finishing of bull calves 19
4.2 Paper II 20
4.2.1 Profitability in 2009 20
4.2.2 Future scenarios 21
4.3 Interviews 21

5 General discussion **23**
5.1 Cow-calf production and semi-natural pastures in Sweden today 23
5.2 Effect of payment model on cow-calf farming 24

5.3 Future scenarios for cow-calf production 25
5.4 Future need for farmland 26
5.5 Factors in the surrounding world 28
5.6 Reflection and ideas for further studies 28

6 Conclusions 29

7 Svensk sammanfattning 30

8 References 33

9 Acknowledgements 37

List of Publications

This thesis is based on the work contained in the following papers, which are referred to in the text by their Roman numerals:

I Salevid, P. & Kumm, K-I. (2011). Searching for economically sustainable Swedish beef production systems based on suckler cows after decoupling EU income support. *Outlook on Agriculture* Vol. 40, No 2 doi:105367/oa.2011.0037.

II Salevid, P. & Kumm, K-I. (2012). Profitability of organic and conventional cow-calf operations under Swedish conditions. *Organic Agriculture, Springer,* Dec 2012 doi: 10.1007/s13165-012-0035-6.

Abbreviations

2009	Basic calculation with which future scenarios are compared
4-CL	Production model in with calving in April (4), conventional production (C), light breed type (L)
Baseline	Budgets made for normal Swedish suckle cows and Swedish finishing models for beef bulls, steers and heifers in Paper I.
CAP	Common Agricultural Policy
Gsk	Forest districts in Götaland
Gsk-4CLW	Production model in Gsk region with calving in April (4), conventional production (C), light (British) breed type (L), outdoor wintered (W)
Gsk-4OH	Production model in Gsk region with calving in April (4), organic production (O), heavy breed type (H)
Gsk-4OLW	Production model in Gsk region with calving in April (4), organic production (O), light (British) breed type (L), outdoor wintered (W)
LFA	Less Favoured Areas
Nn	Lower Parts of Norrland
Nn-4OH	Production model in Nn region with calving in April (4), organic production (O), heavy breed type (H)
Nn-4OL	Production model in Nn region with calving in April (4), organic production (O), light (British) breed type (L)
Scenario A1	Situation in 2009 but without the Single Farm Payment
Scenario A2	Scenario A1 but with environmental payments increased by 50%
Scenario A3	Situation in 2009 without the Single Farm Payment on arable land but still on semi-natural pasture

Scenario B	Decreased prices for weaned calves as a result of decoupled male premium
Scenario C	Combination of scenarios A1 and B
Scenario D	Combination of scenario A2 and 25% reduction in building costs
SEK	Swedish crowns
Ss	Plain districts in Svealand
Ss-4OH	Production model in Ss region with calving in April (4), organic production (O), heavy (Continental) breed type (H)
Ss-4OLW	Production model in Ss region with calving in April (4), organic production (O), light (British) breed type (L), outdoor wintered (W)

Introduction

1.1 Cow-calf production in Sweden

Profitable suckle cow-based beef production with existing normal Swedish production systems and herd size requires the use of existing resources such as buildings, fences, machinery and labour with low or no opportunity costs (Kumm, 2006). However, such cheap existing resources become worn out and disappear sooner or later and the existing systems for suckle cows will be unable to pay the interest and depreciation costs for new investments and farm labour wages for labour inputs in feed production and animal management (Agriwise, 2011; Deblitz, 2011). Therefore it is important to find economically sustainable systems if farmers are to consider undertaking cow-calf production in future.

Between 2000 and 2010, the number of dairy cows in Sweden decreased by 80 000, while the number of suckle cows increased by 30 000 (Swedish Board of Agriculture, 2013). Therefore, the total number of cows, and hence calves available for meat production, showed a net decrease of 50 000 head, or 8%. Since 2010 the number of suckle cows has also begun to decrease, from 197 000 in 2010 to 193 000 in 2012 (Swedish Board of Agriculture, 2013). Consumption of beef in Sweden increased in the same period and therefore the degree of self-sufficiency has decreased from 85% to 56% since Sweden became a member of the European Union (EU) in 1995 (Swedish Board of Agriculture, 2011b).

A study of profitability among 13 specialist Swedish cow-calf operations found that total revenue consisted on average of 49% sales of calves and culled cows, 26% support for less favoured areas (LFA) and environmental payments, and 25% revenue from the Single Farm Payment scheme (Agribeef, 2011). Grants constitute a high proportion of income for farmers in the rest of European Union too, making up 15-60% of the total revenue in suckle beef operations in countries such as Austria, Germany, France, Spain, the United Kingdom and the Czech Republic (Deblitz, 2011).

As Sweden is part of the EU, decisions made there have a great influence on farming. The EU aims to maintain high-quality food production in combination with ensuring survival of the countryside as a place to live, work and visit. This includes maintaining farmland, the landscape and biodiversity (europa.eu, 2012).

During the past 10 years, herd/flock size in Swedish pig, milk and poultry production has increased by almost 100%. A similar change has not been seen in cow-calf and lamb production, where the increase in herd size has been only 30-40%. The average size of the Swedish suckler herd was 16 cows in 2010, although the number of herds with 25-99 cows is increasing relatively rapidly, while herds with less than 25 cows are decreasing. However, in 2011 only 1% of Swedish suckler cow herds had 100 or more cows (Swedish Board of Agriculture, 2012c).

1.2 Weaned calves transferred to beef

Animals originating from cow-calf enterprises represent about one-third of the total beef meat slaughtered in Sweden, including cows, with the remaining two-thirds originating from dairy cows and their offspring (Swedish Board of Agriculture, 2012a).

Beef finishing enterprises in Sweden fatten cattle of both dairy and beef breeds and the majority of finishing bulls and steers are kept in enterprises with 200 to 499 animals. How cattle are moved from dairy and beef herds is not fully mapped, but trade in cattle between holdings follows a pattern whereby males are sold to holdings that specialise in finishing (Swedish Board of Agriculture, 2012b). The scaling-up gives these finishing units advantages in terms of large volumes of homogeneous animals and a year-round production, which results in better prices, lower feeding costs and lower than average building costs and working hours per animal. Thus the units have similar advantages to international feedlot systems (Deblitz, 2012), but on a much smaller scale. The finishing units are located close to where grain and other feedstuffs are produced and not in forest-dominated regions of Sweden where the majority of the suckle herds are found.

In 2012, the male premium at slaughter of bulls and steers was decoupled from the production of beef and from now on will be paid as an extended Single Farm Payment. The effects of this shift are yet to be seen, since changes to the total Common Agricultural Payment (CAP) are underway at the moment.

1.3 Semi-natural pastures and maintaining the landscape in forest-dominated regions of Sweden

The Swedish agricultural acreage is only 8% of the total land mass. Land suitability for farming varies greatly throughout the country. In areas favourable for the production of crops such as grains and vegetables, the proportion of agricultural land is 25% (Ministry of Agriculture, 2010). In other parts of the country with less favourable conditions, specifically the forested districts, there is continuous abandonment of both semi-natural pastures and arable land. In these areas the landscape is characterised by relatively small fields and pastures interspersed with lakes and forest. In forest districts in Götaland (Gsk) and lower parts of Norrland (Nn), the agricultural acreage has decreased by 30% since World War II and the remaining farming operations comprise more or less 100% grazing and forage-based animal production (Swedish National Atlas, 2011), with low profitability (Agriwise, 2011). Continuation of farming operations in these regions is important in order to achieve the Swedish Environmental Objectives 'A varied agriculture landscape' and 'A high plant and animal biodiversity' (Swedish Environmental Objectives, 2011). For this to occur, suckle cow operations are central, especially for the specific objective stating that 450 000 hectares (ha) of semi-natural pasture are to be kept open by grazing.

After a long period of decreasing semi-natural pasture area, grazing acreage began to increase in 1995, when today's environmental payments were introduced, and this increase continued until 2005 when it began to decrease again, despite the continued payments. This was most likely due to lack of grazing animals. In 2010, the semi-natural pasture acreage was 420 000 ha (Swedish Board of Agriculture, 2011a), of which 160 000 ha were grazed by suckle cows and heifers (SCB, 2010).

2 Aims of the thesis

The overall aim of this thesis was to examine whether it is possible to have economically sustainable suckle cow-based beef production systems in forest-dominated regions of Sweden in the future, after decoupling of EU income support. These regions have weak conditions for profitable agriculture and, as a result, declining farm activity.

Specific objectives were to determine:

- What people working in the industry as researchers, farm advisers and farmers believe that the future will hold for cow-calf production.

- Which choices made by the farmer have the largest impact on profitability on farm level.

- Which choices made by decision makers have the largest impact on cow-calf production to fulfil the Swedish Environmental Objective of keeping open 450 000 hectares of semi-natural pasture through grazing.

3 Materials and methods

3.1 Paper I

3.1.1 Identification of satisfactory production models

The microeconomic theory of the firm presumes that the manager knows all feasible production alternatives and has all available information on their consequences and can combine this with knowledge of future prices of inputs and outputs to identify the profit-maximising option (Heady, 1952; Gravelle & Rees, 1992). However Simon (1997), questions this "the economic man" assumption and instead proposes "the administrative man", who is aware of only some of all possible production alternatives and chooses a satisfactory option from among these. This approach may be the most realistic for beef production, because there are no research results or empirical knowledge covering all the mathematical input-output, input-input and output-output functions needed for optimisation. This is especially the case in the new economic environment, in which the former economically optimal solutions, around which most experience and research have been concentrated, may be far from optimal.

Following the concept proposed by Simon (1997), in this thesis economically sustainable beef production is defined as being able to pay at least farm worker wage, including benefits and employer contributions, for labour inputs, at least the bank rate of interest on investments, and at least the opportunity cost to land used for producing pasture and other roughage for beef cattle.

In order to identify beef production systems satisfying these goals in a new economic situation, including decoupling of the male animal premium and changes in area-based income support, the whole production chain, including feed production, feeding, breeding, buildings and management, has to be considered. Each of these systems consists of several subsystems. For example, the winter feed production system includes soil management, choice of forage species and varieties for reseeding, fertilisation, and time and machinery for forage harvesting. By interviewing people in the industry, including researchers with detailed knowledge of different subsystems, innovative beef producers and experienced advisory workers, this thesis sought to summarise the entire production system.

3.1.2 The Delphi method

The Delphi method (Rowe et al., 1999; Rowe, 2007) was used to predict and develop future possibilities for Swedish beef production. The method is based on questionnaires presented to a panel of anonymous experts in two or more rounds. Each expert gives an answer and the reasons behind it. After each round, the answers are summarised by a coordinator. The summaries are then distributed to the panel members, who have the opportunity to revise their earlier answers on the basis of the feedback provided. This iteration continues with new rounds until stability in the responses is achieved. Traditionally, the Delphi method has been used for estimating numerical data (mean values, medians etc.). The new policy Delphi method seeks to place relevant options on the table (Rikkonen *et al*., 2006). The application in Paper I linked up with both these applications. It identified production models able to satisfy at least the profitability goal and resulted in median and range values of predicted profitability.

The Delphi panel used in the study were 12 anonymous Swedish experts in the beef research and industry, including four researchers, four beef producers and four extension workers. The experts were located in different parts of Sweden. The baseline for the study was budgets for normal Swedish suckle cows and Swedish finishing models for beef bulls, steers and heifers. The budgets were based on data from the Swedish University of Agricultural Sciences (Agriwise, 2009). They show negative economic results (income < costs) of SEK -6 600 per cow, SEK -2 900 per finished bull, SEK -5 300 per finished slaughter heifer and SEK -6 200 per finished steer. The task of the experts was to find adjustments to the production models that would allow the goal of at least market farm labour wage, bank rate of interest and opportunity costs of land to be achieved. The first round of questions was initiated by face-to-face meetings with the coordinator and each of the experts, during which the task was explained. The rest of the work was based on telephone calls and e-mails.

3.2 Paper II

3.2.1 Calculation methods

The results from the Delphi study formed the basis for further analyses of different production models for suckle cows in different regions of Sweden in 2009. In order to do this for 2009 and in future scenarios, a large amount of data had to be used as input.

The data used on calf output cow^{-1} were average survey values for breeding herds (Swedish Dairy Association, 2011). Labour demand cow^{-1} year^{-1} was based on survey data from large herds (Nelson, 2002). Costs of feed production (Kumm, 2009) and buildings (Häggström et al., 2005) were based on engineering data. The estimated feed demand (Clason, 2009) was based on theoretical nutritional needs. Taking all this into account gave better production results than the average for existing smaller cow-calf herds, while also allowing future possibilities for economically sustainable models to be calculated.

Other data such as prices, support payments and various enterprise costs were typical farm data from 2009, collected by the Swedish Board of Agriculture and the Swedish University of Agricultural Sciences (Agriwise), in 2010, including the stipulated wage of 180 SEK hour^{-1} including employer contributions. The opportunity cost for land was taken as the tenancy fee in the basic calculations (Swedish Board of Agriculture,). Details of data collection are given in the footnotes to Table 4 in Paper II.

Enterprise budgets were created for three different regions: Gsk (forest districts in Götaland), Ss (plain districts in Svealand) and Nn (lower parts of Norrland).

Total enterprise-specific income cow^{-1} year^{-1} minus the sum of the long-term operating costs (excluding the cost of labour) was calculated in a number of different production models keeping 100 suckle cows in varying future scenarios. The result was divided by the labour requirement for animal husbandry and pasture management, giving a return to labour in SEK hour^{-1} for these tasks. This value was compared with the stipulated farm labour wage in 2009.

Total enterprise-specific income included the sales revenue for weaned calves (bull calves plus heifer calves not used for replacement), a proportion of the culled cows and environmental grants for semi-natural pastures and leys, support for LFA and in some of the cases the Single Farm Payment. Long-term operating costs included feed, fencing, bedding, breeding bull, contractor, insurance, depreciation and maintenance of buildings, opportunity cost for land and interest on animal, building and working capital.

The three Swedish regions for which the calculations were carried out have varying natural opportunities, but all have fairly weak conditions for profitable agriculture, with a greater risk of closure of enterprises and the consequent loss of nature and landscape values. The Gsk, Ss and Nn regions contain 60% of the suckle cows and 57% of the semi-natural pastures in Sweden (Swedish Board of Agriculture, 2011a).

3.2.2 Production models

The production models studied in Paper II differed in sense of direction, organic (O) or conventional (C), winter housing of the animals (housed or outdoor wintered (W)), calving time (January (1), April (4) or June (6)) and breed type (light British (L)) or heavy Continental (H)). The feed rations were formulated for each separate production model and comprised a combination of grass-clover silage and late harvested grass silage. In regions with good availability of cheap straw, some models had straw replacing part of the grass silage. For production models in which feed rations included high levels of grass-clover silage or straw, the need for land decreased, but the areal payments decreased simultaneously. For an overview of the production models, see Paper II and Table 1.

3.2.3 Basic calculations

The basic calculations referred to the year 2009 with current Single Farm Payments, compensation grants, environmental payments, enterprise-specific incomes from weaned calves and culled cows and all operating costs. In Table 3 in Paper II, this is described as Scenario 2009 and the table shows values for payments, prices for weaned calves and opportunity costs for land for the Gsk region.

3.2.4 Future scenarios and sensitivity analyses

The value of payments, price of weaned calves and opportunity costs for land for the Gsk region in different future scenarios are also shown in Table 3 in Paper II. In the A-scenarios, the Single Farm Payment was phased out. In scenario A1, this was not compensated for, but the cost of land decreased when the market price was no longer influenced by the Single Farm Payments.

Without the Single Farm Payments, the opportunity cost for agricultural land would be zero in the regions studied (Agriwise, 2011). In Scenario A2, the phased out Single Farm Payment was compensated for by a 50% increase in the environmental payments. In Table 4 in Paper II, the method of calculation is described for the Gsk-4OH model with Scenario A2.

In Scenario A3, the Single Farm Payment stayed in place but was perceived by farmers of arable land as common income, meaning revenue that was independent of the cow-calf operation. Grazing, on the other hand, was needed to receive the Single Farm Payment on semi-natural pastures and was therefore seen as an enterprise-specific income in A3.

Scenario B included a decrease in the price of weaned calves as a result of the decoupled male premium. By combining A1 (the phased out Single Farm Payment not being compensated for, but lower cost of land) with scenario B, scenario C was created. By combining A2 (the phased out Single Farm Payment and 50% increase in environmental payments) with reduced building costs, scenario D was created. The same scenarios were studied for Ss and Nn, but payments and opportunity costs for land were adjusted accordingly.

Sensitivity analyses were made to show the effects of scaling up (200 cows), added organic product value (3 SEK per kg slaughter weight assumed to result in 10% increased calf price) and a 25% decrease in investment costs for buildings.

3.3 Interviews

In a complementary study, telephone interviews were conducted with 20 farmers with above-average suckle herd sizes in May 2012, in order to investigate the difficulties associated with increasing herd size. Producers with 50 to 250 suckle cows (median 120 cows) were asked how their production had changed during the past 10 years and the type of problems that had occurred during that period.

Specific questions included:

- What determining factors made you develop your operation to the size of today?
- What unexpected problems arose during expansion?
- How were these problems solved?

Answers from the interviews were grouped and analysed by regions and question.

4 Results

4.1 Paper I

High stability in the answers from the individual experts was achieved already in round 2, after which the process was concluded. However, there was still large variation between the answers of the different experts. The median, highest and lowest results reported by the panel for profitability in round 1 and 2 are shown in Figure 1 (calf production) and Figure 2 (finishing of bull calves) in Paper I.

4.1.1 Calf production

Income from calves could be higher than in the baseline according to most answers (Figure 1a in Paper I). Higher prices due to an impending shortage of calves were the main reason for assuming higher income from weaned calves. Heavier calves, due to crossing the cows with heavy breed bulls, were another reason.

Most panellists were of the opinion that 100% semi-natural pasture, preferably with high natural values and with high environmental payments, was an essential requirement for profitable cow-calf operations. Everybody also included the Single Farm Payment on pasture in the income, because grazing by cattle or other livestock is a prerequisite for this payment on pastures. This resulted in a median answer that was a surprising SEK 3 000 cow^{-1} higher than the baseline value for payments minus costs on pasture (Figure 1b in Paper I).

Concerning the question of cost of winter feed, there were large differences in the answers. The low cost estimates were characterised by use of by-products such as straw and distiller waste, or grass-clover silage produced without fertilisers on long-lying leys harvested only once per year. The high cost answers were characterised by small-scale production in northern Sweden with a long winter feeding period, and/or unnecessary high consumption of expensive silage (Figure 1c in Paper I).

Costs for housing and bedding showed a large range of variation (Figure 1d in Paper I). Low cost systems were outdoor wintering or rebuilding of existing buildings without opportunity cost. The high cost answers assumed new conventional buildings, e.g. a cubicle barn or a deep straw bedding barn. The latter is cheaper to build than a cubicle barn, but has high running costs for bedding, at least in forest-dominated regions without local straw production. Some of the respondents used a short depreciation time for buildings due to the political risk of further deterioration in economic conditions for cow-calf production.

Most of the experts consulted assumed large herds, which reduced the labour demand per cow compared with the baseline, especially if the indoor period was shorter. The lowest labour demand (6 h cow^{-1} $year^{-1}$) was suggested for a herd of more than 200 cows with outdoor wintering and a herd with 100 cows in a new deep straw bedding barn (Figure 1e in Paper I). Larger herds resulted in a lower cost of labour than in the baseline.

Figure 1f in Paper I shows the profit per cow and year (income minus costs). The median profitability in the answers was about SEK +1 800 cow^{-1} and in the best case SEK +3 300 cow^{-1}, which was SEK 8 400-9 900 cow^{-1} better than the baseline. The main reasons for the generally better profitability in the panellists' suggestions were a high level of environmental aid and a Single Farm Payment for semi-natural pastures. Another reason was lower cost of buildings and labour due to larger herds and/or outdoor wintering. Low cost of winter feed also contributed considerably to high profitability. The two most profitable suggestions were characterised as 'Organic with high environmental grants and a premium price for beef' and 'Conventional with outdoor wintering of cows'.

4.1.2 Finishing of bull calves

The profit (income minus costs) per finished bull calf is shown in Figure 2f in Paper I. In contrast to cow-calf production, the range of predicted profitability was relatively small and in fact the profitability in the median finishing production was negative. This indicates that the panel's opinion was that the price of beef must increase if costs are to be fully covered in beef production.

To improve the profitability in finishing beef bull calves, the experts suggested larger herds with lower costs of labour and buildings per head. Most of them also suggested conventional finishing of calves born in organic herds for two reasons: the risk of a lower growth rate in organic finishing and the fact that the organic scheme does not allow indoor finishing during the grazing season. However, the highest price expectations were based on experiences with finishing beef bulls in an organic scheme.

The number of answers from the experts on how to improve profitability in beef heifer and steer production was small and did not allow any conclusions to be drawn.

4.2 Paper II

In Paper II, the profitability of the different production models was calculated as return to labour in the situation of 2009 compared with the stipulated farm worker wage in 2009, which was SEK 180 $hour^{-1}$. The profitability goal was that the return should reach or exceed this wage level. The results are shown as grey bars in Figures 1 and 3 in Paper II for different models. The stipulated farm worker wage in 2009 is marked as a solid line.

4.2.1 Profitability in 2009

The results showed that when all payments for environmental services, LFA and the Single Farm Payment were included, a return to labour exceeding the stipulated farm workers wage was possible in Gsk and Nn with organic production and with cows of a Continental beef breed in an April calving system (Gsk-4OH and Nn-4OH). Cows of a British beef breed also achieved approximately this level of profitability in outdoor wintering systems in Gsk (with all grazing on semi-natural pasture, Gsk-4OLW) and in Nn (Nn-4OL). The best conventional model, a British beef breed in outdoor wintering systems in Gsk (with all grazing on semi-natural pasture, Gsk-4CLW) only achieved 60% of the stipulated farm workers wage. The conventional alternatives generally resulted in a considerably lower return to labour than the organic alternatives. The worst losses were found in production models with conventional production and with cows housed during winter, especially for the British beef breed.

The generally more favourable growing conditions in the Ss region were not strong enough to compensate for the lower grants and this led to lower profitability in Ss compared with the other two regions. The grants to leys in Ss were lower than in Gsk and much lower than in Nn, and only 20% of the grazing was assumed to be on semi-natural pasture in Ss, compared with 100% in Gsk. The best profitability in Ss was found in alternatives Ss-4OH and Ss-4OLW, i.e. with April calving and organic production. These alternatives achieved about 50% of the stipulated farm worker wage.

4.2.2 Future scenarios

Different simulations from the basic 2009 model were compared with the stipulated farm workers wage. Phasing out the Single Farm Payment (Scenario A1) resulted in zero opportunity cost of land, since the driving force for tenancy fees in the regions today is the Single Farm Payment. Such a scenario would reduce the return to labour to less than 50% of the stipulated farm workers wage. A model with a British beef breed in an outdoor wintering system and organic production in Gsk (with all grazing on semi natural-pasture, Gsk-4OLW) would have the least poor profitability in this scenario.

In Scenario A2, without the Single Farm Payment but with a 50% increase in environment payments for semi-natural pasture, leys and organic production, several organic models were profitable in Gsk and in Nn and one model was nearly profitable in Ss. No conventional model was profitable in this scenario.

In the sensitivity analyses, the return to labour was influenced not only by grants for different services and general production conditions, but also by choices made by the farmer. This is illustrated in Figure 2 in Paper II, where the effect of various single changes to the initial 2009 calculation was calculated for region Ss. Doubling the herd size to 200 cows would increase the return to labour from SEK 80 to120 hour^{-1} in the most profitable alternative (4OH). The extra price for producing organic calves and slaughter cows and reducing the investment costs for building would increase the return to labour even more, provided this did not increase the labour requirement.

In a 'worst case' scenario (Scenario C, Figure 3 in Paper II), with decreased calf prices following the decoupling of the male premium and the phased out Single Farm Payment without compensation, the return to labour was less than 30% of the stipulated farm workers wage for the models with the least poor profitability. In a 'best case' scenario (a combination of phased out Single Farm Payment compensated for by increased environmental payments and 25% lower building costs, Scenario D), almost all organic models were profitable but no conventional model (Figure 3 in Paper II).

4.3 Interviews

Farmers with enterprises in LFA (13 of 20 interviewees) were more satisfied and optimistic about future production than those outside. Eleven of the 20 farmers interviewed reported that herd expansion had led to more efficient production and a shorter working time per animal.

In response to the question 'What determining factors made you develop your operations to the size they are today?', the most common answers were (number of answers in brackets):

- We wanted to increase profitability (10).
- Our local production of branded meat needed more animals (3).
- We bought more land, so there was acreage for more cattle (2).
- For our organic production the slurry from more cattle was essential (2).

In response to the question 'What unexpected problems arose during expansion?', the most common answers were:

- Farm land for expansion was not on the market, passive landowners and old farmers keep the land themselves to get the subsidies (9).
- The different decisions by the 'authorities' as regards the requirements on semi-natural pastures have created problems and uncertainty (6).
- It took more time than we planned to get full production in the scaled-up enterprise (4).

In response to the question 'How were these problems solved?', the most common answers were:

- We have had to accept higher tenancy fees or graze other farmers' land for free (7).
- We got opportunities to buy more land (7).
- Buying good cows, increasing with our own heifers would take much more time (6).

5 General discussion

5.1 Cow-calf production and semi-natural pastures in Sweden today

Since Sweden became a member of EU in 1995, the total number of cattle in Sweden has decreased from 1.8 to 1.5 million head. For a time, the decreasing number of cattle of dairy breed was partly compensated for by an increasing number of suckle animals, but the number of suckle cows is now decreasing too. For example, between 2010 and 2012 there was a net decrease of 6 000 head (Swedish Board of Agriculture, 2013).

As Papers I and II show, there is no long-term sustainable profitability for cow-calf operations in Sweden today, except for organic producers in LFA areas with a high proportion of semi-natural pasture or high environmental grants for leys.

Herd size is stagnant or only growing slowly in cow-calf production in Sweden (Swedish Board of Agriculture, 2012c). However, investment in new houses for suckle cows is on a lower level than for dairy cows (Swedish Board of Agriculture, 2012d).

The acreage of managed semi-natural pastures in Sweden is decreasing (Swedish Board of Agriculture, 2012e). This might lead to problems meeting the Swedish Environmental Objective stating that 450 000 hectares of semi-natural pasture should be kept open by grazing (Swedish Environmental Objectives, 2011) and also to fulfil the EU's ambition to maintain farmland, landscape and biodiversity in the countryside (europa.eu, 2012). It will become difficult to fulfil these goals if the profitability in cow-calf production does not improve. The beef market and the payment model for environmental services must give clear signals of improved profitability if the number of suckle cows is to increase again.

5.2 Effect of payment model on cow-calf farming

Payments for environmental services, LFA and Single Farm Payments comprise about 50% of turnover in Swedish cow-calf production according to Agribeef (2011). The same is true in other countries in the EU (Deblitz, 2012). For the models with the best profitability in Paper II (Nn-4OH and Gsk-4OH, both organic models), the payments represented about 60% of turnover and for the best conventional model (Gsk-4CLW) about 55%.

With such a high proportion of income not connected to beef production, it is obvious that producers will adapt their production to this situation. This has also happened, for example producers increased the acreage of organic farmland from 203 000 to 480 000 ha between 2005 and 2011 (Swedish Board of Agriculture, 2012f). In cattle enterprises, 19% of the animals were organic in 2011, and suckle cows were the most common organic animal (Swedish Board of Agriculture, 2012b). Since there is a greater need for land in organic farming, the level of environmental payments for leys, support for LFA and Single Farm Payments increased accordingly on a per cow basis in organic production compared with conventional production.

The best conventional model (Gsk-4CLW) also used more land per cow than other conventional models, since the cows were assumed to be outdoors during wintertime. Models with a very low demand for land (e.g. 4CL) had low or negative profitability.

Models involving grazing only on semi-natural pastures and not on arable land had the same effect, as they used more land per cow compared with grazing on arable land. Area based payment models encourage extensification, in contrast to payments that are based on a per animal model.

Landowners have adapted to this new situation of area based support. Tenancy fees have increased by 72% since Sweden joined the EU (Swedish Board of Agriculture, 2010). Paper II discusses whether the support system could lead to passive landowners demanding a higher tenancy fee, which could make it harder to develop efficient cow-calf operations for the future. This was confirmed in our telephone survey, where 9 out of 20 farmers interviewed reported that their expansion had faced problems with leasing land.

The results described above can be seen as an effect of the ambition to maintain farmland, landscape and biodiversity in LFA (europa.eu, 2012). Outside these areas, the possibilities for profitable cow-calf enterprises are different (Agriwise, 2011; Agribeef, 2011), but that issue was not investigated in this thesis.

5.3 Future scenarios for cow-calf production

The Delphi study in Paper I illustrated a huge range in profitability in different predicted systems for cow calf production in Sweden. The panel clearly believed that profitable cow calf operations in the future must be placed where regional support and payments for semi-natural pastures are possible. Specialist cow-calf herds will therefore develop in the LFA and finishing units will be placed where conditions are more favourable for feed grain production.

Paper II revealed that the cow calf production in the future might have to adapt to a lower real price level for meat and calves (OECD-FAO (2011) and to changes in payments (new rules post CAP 2013).

In the case of uncompensated phased out Single Farm Payments, no production model reached a return to labour that covered the stipulated farm workers wage. When the phasing out was compensated for by a 50% increase in environmental payments, several organic production models were profitable in Gsk (where all grazing was assumed to be on semi-natural pasture) and in Nn (which had high environmental payments for ley and high support for LFA) but not in Ss (which had low grants and where most grazing was assumed to be on arable land with a relatively high opportunity cost of land). Overall, these results suggest that cow-calf operations have the most promising future possibilities on farms with much semi-natural pasture and in forest regions with high grants and low opportunity cost of land.

Farm level decisions, such as lower investments cost in buildings, higher calf and beef prices due to organic production or local labelling and increased herd size can improve the return to labour. Production models with calving in January would result in low profitability because of the extra feed costs for early calving, but also because payments are less since this model uses less pasture. June calving would affect calf production by resulting in lighter weaned calves and thus a lower price. April calving seemed to have the best profitability in most circumstances. By combining grass-clover silage with late harvested grass silage, feed rations can be adapted to early or late calving and lactation (Paper II).

This thesis shows that the possibility to maintain economically viable Swedish cow-calf production and fulfil the Swedish Environmental Objectives on grazing semi-natural pastures and organic production is dependent on the future configuration of agricultural support systems and environmental payments in the EU. The CAP post 2013 will have a great impact on how cow-calf enterprises develop.

The thesis also shows that this type of food production, i.e. which also improves the environment, is a step towards extensive sustainable biological farming that is the opposite to much farming in Europe today (Buck, 2001).

Other scientists see this type of beef production based on grazing and forage production on arable land in forest-dominated regions as a way of changing inedible grass into edible human food (Wilkinson, 2011). Further viewpoints could be that the Swedish people are willing to pay for keeping agricultural landscape open, according to Drake (1999). Such a payment model would have similarities to the current payments and support within the EU.

5.4 Future need for farmland

The production models discussed above might in the long run move the focus from traditional production questions and result in Swedish cow-calf producers being less efficient than farmers who receive no payment for environmental services. For example, profitable Irish cow-calf production is focusing on high-yielding grassland, with the ambition of increasing stocking rate per hectare by 30% in the immediate future (Murray, 2009).

The extensive use of land also makes it possible for old retired farmers and other landowners to meet the requirements for payments not connected with keeping animals, with very little effort. This makes it difficult for young farmers to get started in cow-calf production, since there is a scarcity of land on the market, according to the interviewees in this thesis.

In consideration of future needs of land for food and bioenergy production in Sweden, it could be an advantage if the present support system keeps the land in agricultural order so that it can be easily transferred into high-yielding food or energy crops. Such a viewpoint is rare in Sweden and the discussion more often concerns avoiding building cities on good farming land (Larsson, 2012). In Germany this question is dealt with in an eco-account, a way to compensate for the impacts of urban expansion by extending the acreage of environmentally friendly areas such as low-input managed grasslands (Kuepfer, 2008).

Beef production based on grazing and forage production on arable land in forest-dominated regions does not generally compete with any other food production system at present. In these areas the landscape is characterised by relatively small fields and grazing interspersed with lakes and forest. In the regions investigated in this study, the agricultural acreage has decreased by 30% since World War II and the remaining farms in Gsk and Nn are more or less 100% grazing and forage-based animal production (Swedish National Atlas, 2011).

However, if there is a shortage of land for the global food supply chain and/or for growing energy crops including trees to replace fossil fuels in the future, the proposed advantage of using large areas of land per cow could become a disadvantage. The efficiency of livestock production will need to be improved in order to ensure that it can meet the growing global demand for food (McAllister et al., 2011).

In that case, the acreage needed per cow in Swedish production can be lessened by, amongst other things, changing extensive grass leys into grass-clover leys, which in organic production systems yield twice the amount per hectare. Intensively fertilised conventional leys can produce even more (Kumm, 2009). By replacing grass silage with grass-clover silage and purchased straw, the acreage needed per cow would decrease further. The need for arable land for winter feed production can also be decreased by delaying the calving time to June, using a lighter breed of cow and replacing some of the silage in the feed ration with grain. Grazing arable leys rather than semi-natural pastures would also decrease the total acreage needed. On the other hand, arable land has a higher opportunity cost in the event of land scarcity for food production.

These acreage saving measures were not profitable in the scenarios studied in Paper II. However, with sufficiently high opportunity costs for arable land, in combination with decreased direct payments per hectare, the competitiveness of production models requiring less acreage improved. In order for cow-calf production to be profitable when there is a high opportunity cost for land and decreased areal payments that are not compensated for by payments per cow, a considerably higher price level for weaned calves is needed.

5.5 Factors in the surrounding world

There is a threat of young farmers striving to maximise their return to labour and reaching the conclusion that off-farm employment would pay a substantially higher wage than the stipulated farm workers wage, which was the target in Paper II. For example, construction workers receive 25% more than the stipulated farm workers wage in Sweden (Lönestatistik, 2011). In the past 10 years, the nominal price for weaned calves has increased by only 20% while the stipulated farm workers wage has increased by 40% (Agriwise, 2011).

Liberalisation of world trade might also reduce the future price of beef by allowing increased competition from e.g. South America, where the cost of production is substantially lower than in the EU (Deblitz, 2011)

5.6 Reflection and ideas for further studies

The willingness-to-pay study carried out by Drake (1999) for Sweden needs to be updated with today's interest in different types of agricultural landscape and different regions of the country. In areas where landscape has a high value for society, cow-calf production is a modern and reliable method for sustaining old Swedish semi-natural pastures for coming generations.

Combining trees and pasture also has a historical tradition in Sweden. New knowledge in light of greenhouse gas emissions and food and energy production indicates that grazing on semi-natural pastures that include growing trees can result in a very low climate impact from beef production. This type of production has similarities with agroforestry systems, which are predicted to have great potential for carbon sequestration (Monagnini, 2004). This might lead to new tasks for the cow-calf producers to solve.

6 Conclusions

In areas of Sweden with high regional and environmental payments, it is possible to run profitable cow-calf production at present. This will continue to be the case in the future if the Common Agricultural Policy post 2013 compensates for a reduced Single Farm Payment by increasing environmental payments, as in scenario A2 and D in Paper II.

Profitable enterprises can lead to sustainable Swedish beef production and fulfil the national objectives on grazing semi-natural pastures and on organic production.

The huge range of variation in profitability between different future production models of cow-calf production in Sweden identified in the Delphi study (Paper I) was confirmed by model calculations (Paper II). This suggests that it is important to choose the right production model. Papers I and II and a telephone survey of cow-calf farmers also showed that environmental payments, support for Less Favoured Areas and the Single Farm Payment are determining factors for profitability on enterprise level in today's cow-calf production.

Increasing herd size, higher prices for organic calves and slaughter cows and reducing the investment costs for building would all contribute to increased profitability at farm level, provided that this does not increase the labour requirement. Tenancy fees that exceed the payments will decrease profitability.

Payments per hectare encourage extensification, in contrast to payments per animal. However, payments per animal must be connected to semi-natural pasture if nature management is to be promoted. Area based payments with no connection to animals create higher tenancy fees and make it difficult for young or expanding farmers to develop their cow-calf production.

7 Svensk sammanfattning

I detta arbete beräknas lönsamheten i dagens dikalvsproduktion efter frikopplingen av djurbidragen och hur denna kan komma att ändras om gårdsstöden avvecklas eller andra förändringar på intäkter och kostnader sker. Beräkningarna fokuserar på förhållandena i Götalands skogsbygder (Gsk), Svealands slättbygder (Ss) och Nedre Norrlands skogs- och mellanbygd. I dessa områden finns cirka 60 % av både dikorna och naturbetesmarkerna.

Det finns ett samband mellan antalet dikor i Sverige och möjligheterna att uppnå målen för ett rikt odlingslandskap och biologisk mångfald. Målsättningen är att bevara 450 000 ha naturbetesmark. Med svag lönsamhet i dikalvsproduktionen, som förvärras om stöden minskar, är risken stor att betesmålet inte uppnås. Eftersom både antalet dikor och antalet hektar betesmark nu sjunker i Sverige, är det viktigt att beslut om framtida ersättningar möjliggör nyinvesteringar och expansion i dikalvsproduktion.

Artikel I redogör för en Delfiundersökning som gjordes med hjälp av 12 experter i branschen; fyra forskare, fyra rådgivare och fyra lantbrukare. Experternas uppgift var att beskriva vilka produktionsmodeller som har förutsättningar att bli lönsamma i framtiden. Resultatet blev två modeller för dikalvsproduktion: ”Ekologisk produktion kombinerad med höga miljöersättningar och merbetalning för köttet ” och ”Konventionell produktion med dikor som övervintrar utomhus, men med tillgång till ligghall”. Båda modellerna förutsätter att allt bete sker på marker som ger miljöersättning och bibehållet gårdsstöd för naturbetesmarker. Experternas förslag inkluderade också besättningar som är väsentligt större än dagens normala svenska dikobesättningar, för att på detta sätt få lägre kostnader för byggnader och arbete per ko.

I artikel II beräknas lönsamheten för dessa och andra produktionsmodeller, dels med dagens miljöersättningar, gårdsstöd och kompensationsbidrag, och dels med slopade gårdsstöd. Genom att ändra ersättningar, intäkter för kalvar och kött och särkostnader görs skisser på olika framtidsscenarier. Genom att minska alla intäkter med alla kostnader, utom arbetskostnaden, och dela med arbetstiden, har arbetsersättningen per timme och ko för olika produktionsmodeller beräknats. Denna jämförs sedan med aktuell lantarbetarlön. Produktionsmodellerna antogs ha 100 dikor och finnas i Gsk, Ss eller Nn. Kalvningsperiod var januari, april eller juni och korna var antingen av tung eller lätt ras och hade vinterstall antingen i liggbås eller ute med tillgång till ligghall.

Dagens ersättningssystem gör den ekologiska produktionsmodellen mest lönsam, eftersom den får ekologiska stöd och dessutom använder mer mark per diko vilket ger högre kompensationsbidrag, vallstöd och gårdsstöd. De bästa ekologiska modellerna gav något högre arbetsersättning än lantarbetarlönen, medan den mest lönsamma konventionella produktionsmodellen endast nådde 60 % av lantarbetarlönen. Om gårdsstödet försvinner och inte kompenseras med ökade miljöersättningar minskar arbetsersättningen för de bästa ekologiska modellerna till mindre än 50 % av lantarbetarlönen.

För att komplettera beräkningarna gjordes telefonintervjuer med 20 större dikalvsproducenter (median 120 dikor). Det vanligaste problemet vid expansion av dikalvsföretaget var enligt de intervjuade, att få tag på tillräckligt markunderlag. Ibland vill markägarna själva ha stöden och djurhållaren får beta ”gratis”. Detta leder till sämre lönsamhet än enligt modellberäkningarna där alla stöd ingick i intäkterna.

Expertpanelen i artikel I tydliggjorde att nyetableringar endast kommer att ske i områden där det finns möjligheter för höga regionala stöd och miljöersättningar. Arbetet i artikel II visar också att produktionsmodeller, i LFA områden, som använder stora arealer per diko har den bästa lönsamheten. Ekologisk produktion kombinerad med att allt bete sker på naturbetesmark bidrar till stor areal per ko. En tung diko som förbrukar mera foder än en lätt ko, samt kalvning i juni i stället för i januari har samma effekt. Ersättningsregler som baseras på areal leder till denna ”extensifieringseffekt”, som är ett resultat av EUs politik att stödja områden med svaga förutsättningar för jordbruk för att på så sätt bevara jordbruksmark, landskap och biodiversitet. Om ersättningarna hade varit djurkopplade hade detta i stället stimulerat till ökad produktion per hektar.

Ersättningsnivåerna, som många gånger är mer än 50 % av omsättningen i svenska och europeiska dikoföretag med liknande förutsättningar, leder till annorlunda utveckling jämfört med annan jordbruksproduktion. Telefonintervjun visade att mark som lämpar sig för dikalvsproduktion successivt har blivit dyrare på grund av att markägare och passiva lantbrukare vill ha allt mer av stöden som ersättning för att upplåta marken för bete och vallskörd. Ett resultat av detta är att storleksrationaliseringen av dikalvsföretag går mycket långsamt och att medelantalet dikor per besättning år 2010 endast var 16. Endast 1 % av företagen har mer än 100 dikor.

Uppdelning i extensiv och intensiv dikalvsproduktion finns också i andra länder. Dikornas förmåga att producera mat till människor på marginella marker ses i många länder som en tillgång, men om marken blir dyr kommer den att användas till andra ändamål, exempelvis energiproduktion eller skog. I länder med mycket intensiv betesvallsproduktion, exempelvis Irland, kan dikalvsproduktionen drivas intensivt, med många dikor per hektar.

Arbetet visar att det finns lösningar för att skapa en långsiktigt hållbar dikalvsproduktion i Sverige. Detta under förutsättning att prisnivån på kalvar och kött, samt ersättningar för miljöinsatser, hamnar på rätt nivå och utformas på rätt sätt. Effekterna av dagens ersättningssystem har minskat när stöden delvis hamnat hos markägare i stället för hos djurhållare. Det behövs klara signaler från marknad och myndigheter för att långsiktiga investeringar för framtida betesdjur ska göras.

8 References

Agribeef (2009, 2010, 2011). *Nötköttsproduktionens lönsamhet.* http://www.agribeef.se [2009, 2010,2011]

Agriwise (2009, 2010, 2011). *Verktyg för ekonomisk planering och analys.* http://www.agriwise.org [2009, 2010, 2011]

Buck (2001). *The role of production risks in the conversion to more sustainable arable farming.* Wageningen: Grafisch Bedrijf Ponsen en Looijen B.V.

Clason, C. (2009). *Beräkningar av total foderåtgång per diko*. Unpublished manuscript. Växa.

Deblitz, C. (2011). *Beef Report 2011.* Braunschwieg, Germany: Agri benchmark, Johann Heinrich von Thünen-Institut.

Deblitz, C (2012). *Feedlots; A new tendency in global feed production?* Braunschwieg, Germany: Agri benchmark, Johann Heinrich von Thünen-Institut. (Agri benchmark Beef and Sheep network: working paper 2).

Drake, L (1999). The Swedish agriculture landscape - economic characteristics, valuations and policy options. *International Journal of Social Economics.* vol. 26, pp.1042-1060.

Europa.eu (2012). *Agriculture and rural development.* http://ec.europa.eu/agriculture/capexplained/index_en.htm [2012-07-15]

Gravelle, H. & Rees, R. (1992). *Microeconomics*. 2 ed. London: Longman

Heady, E. O. (1952). *Economics of agricultural production and resource use.* New York: Prentice-Hall.

Häggström, A., Olsson-Hägg, H. & Wijkander, P. (2005). *Vinterhållning av nötkreatur för betesdrift.* LRF.

Kuepfer (2008). The eco-account: a reasonable and functional means to compensate ecological impacts in Germany. Nürtingen, Germany: University of Applied Sciences, Umvelt-unt Stadtplanung.

Kumm, K-I. (2006). *Vägar till lönsam nöt- och lammköttsproduktion*. Skara: Department of Animal Environment and Health, Swedish University of Agricultural Sciences (Report 11)

Kumm, K-I. (2009). *Produktionskostnad för grovfoder till köttdjur.* Skara: Department of Animal Environment and Health, Swedish University of Agricultural Sciences (Report 23)

Larsson, A (2012). Mål och metoder för hushållning med god jordbruksmark inom kommunal planering. *LTJ fakultetens faktablad*. Swedish University of Agricultural Sciences, Alnarp, faktablad 2012:8.

Lönestatistik (2011). *Lönestatistik för olika yrken och län.* http://www.lonestatistik.se [2012-06-30]

McAllister, T.A., Beauchemin, K.A., McGinn, S.M., Hao, X. & Robinson, P.H. (2011). Greenhouse gases in animal agriculture-Finding a balance between food production and emissions*, Animal Feed Science and Technology*, vol. (2011) 166-167, pp. 1-6.

Ministry of Agriculture (2010). *Landsbygdprogram för Sverige 2007-2013.* Stockholm: Jordbruksdepartementet (Version March 2010, pp 9, pp 66,67).

Montagnini.F. & Nair, P.K.R (2004). Carbon sequestration: An under exploited environmental benefit of agroforestry systems, *Agroforestry Systems.*vol.61,pp 281-295.

Murray A (2009). Potential for Increased Profitability on Irish Cattle Farms. *Farmers Journal Better Farm Programme*. pp. 1-10, Teagasc Grange.

Nelson, B-O. (2002). *Lönsamhet i olika besättningsstorlekar i olika produktionsmodeller.* Unpublished manuscript. SLA Analysgrupp.

OECD-FAO (2011). *Agricultural Outlook 2011-2020.* Paris: OECD Publishing

Rikkonen, P., Kavio-oja, J. & Aakkula, J. (2006). Delphi expert panels in the scenario-based strategic planning of agriculture, Foresight. *The journal of future studies, strategic thinking and policy.* vol. 8, No 1, pp. 66-81.

Rowe, G. (2007). A guide to Delphi. *The International Journal of Applied Forecasting*, vol. 8, pp. 11-16.

Rowe, G. & Wright, G. (1999). The Delphi technique as a forecasting tool: issues and analysis. *International Journal of Forecasting*, vol. 15, pp. 353-375.

SCB (2010). *Undersökning av företag med dikor/amkor.* Avdelningen för regioner och miljö, SCB (Teknisk rapport 2010-05-21).

Simon, H. A. (1997). *Administrative behaviour*. 4 ed. New York: The Free Press, pp 368.

Swedish Board of Agriculture (2010). *Agricultural rents 2010.* Sveriges officiella statistik: (JO39SM1101).

Swedish Board of Agriculture (2011a). *Yearbook of Agricultural Statistics 2011*. Sveriges officiella statistik: (Chapter 3 Utilization of arable land, Table 3.1, Chapter 6 livestock, Table 6.1, Chapter 11 Organic farming, Chapter 15 Manufacturing, Table 15.1)

Swedish Board of Agriculture (2011b). *Jordbruksverkets statistikdatabas*. http://statistik.sjv.se/Database/Jordbruksverket/databasetree.asp flap: Konsumtion av livsmedel. [2011-06-15]

Swedish Board of Agriculture (2012a). *Jordbruksverkets statistikdatabas*. http://statistik.sjv.se/Database/Jordbruksverket/databasetree.asp flap: husdjur [2012-06-15]

Swedish Board of Agriculture (2012b). *An analysis of the Swedish cattle industry*. Jönköping: Swedish Board of Agriculture (Statistikrapport 2012:03, pp.9, diagram 1.4, pp.13 diagram 2.2)

Swedish Board of Agriculture (2012c). *Antal företag med dikor respektive handjur.* Unpublished manuscript. Swedish Board of Agriculture, Statistikenheten. A.Grönvall (2012)

Swedish Board of Agriculture (2012d). *Statistik över förprövningar.* http://www.jordbruksverket.se/download/18.5ce6c400139a12671c880001593/F%C3%B6rpr%C3%B6vningsstatistik+2011.pdf [2012-05-16]

Swedish Board of Agriculture (2012e). *Jordbruksverkets statistikdatabas*. http://statistik.sjv.se/Database/Jordbruksverket/databasetree.asp flap: jordbruksmarkens användning [2012-07-08]

Swedish Board of Agriculture (2012f). *Organic farming 2011, converted areas and areas under conversion.* Sveriges officiella statistik: (JO10SM1203)

Swedish Board of Agriculture (2013). *Husdjur i juni 2012.* Sveriges officiella statistik: (JO20SM1201)

Swedish Dairy Association (2011). *Medelvärden av korrigerade 200-dagars vikter.* http://www.taurus.mu/aciro/bilddb/objektvisa.asp [2011-01-15]

Swedish Environmental Objectives (2011). *Environmental Objectives.* http://www.miljomal.nu/Environmental-Objectives-Portal [2011-06-17].

Swedish National Atlas (2011). *Agriculture and Forestry in Sweden since 1900.* Stockholm: Kungl. Skogs- och Lantbruksakademien.

Wilkinson (2011). Re-defining efficiency by feed used by livestock. *Animal*. Animal 5:7, pp.1014-1022.

9 Acknowledgements

Thanks to everybody working at Department of Animal Environment and Health, Section of Production Systems in Skara, for taking different parts in this long lasting project. Nobody mentioned, but nobody forgotten. Some taking me for a nice lunch and others discussing values and figures in this very important subject, profitability in production of Swedish beef calves!!

Searching for economically sustainable Swedish beef production systems based on suckler cows after decoupling EU income support

Pernilla Salevid and Karl-Ivar Kumm

Abstract: *After decoupling EU income support, normal Swedish systems for suckler cow-based beef production are unable to pay the costs of new investments and market wages for labour. New production systems, able to achieve full cost coverage, were identified by an expert panel. The two most profitable suggestions can be characterized as 'organic with high environmental grants and premium price for beef' and 'conventional with outdoor wintering of cows'. Both systems presuppose the availability of large areas of semi-natural pasture per cow and larger herd sizes than are now common in Sweden. Breeding progress and other biological improvements could only marginally improve the profitability.*

Keywords: *beef production; grazing; production systems; forest-dominated regions; profitability*

Pernilla Salevid (corresponding author) and Karl-Ivar Kumm are with the Department of Animal Environment and Health, Swedish University of Agricultural Sciences, PO Box 234, SE-532 23 Skara, Sweden. E-mail: pernilla.salevid@hmh.slu.se; karl-ivar.kumm@hmh.slu.se.

Profitable suckler cow-based beef production in the present Swedish systems is reliant on existing resources such as buildings, fences, machinery and labour with low or no opportunity costs (Kumm, 2006). However, such cheap existing resources become worn out and disappear sooner or later. The present systems for suckler cows and finishing of their calves are unable to pay both interest and the cost of depreciation for new investments or market farm labour wages (Agriwise, 2009; Agri Benchmark, 2009). Thus, finding new and economically sustainable systems is important for farmers who are considering investments and a future in beef production.

The importance of finding more cost-efficient beef production systems has increased since decoupling EU income support to agriculture. In 2004, one year before decoupling began, the premiums for suckler cows, male animals and slaughter premiums plus extensification grants came to SEK2,700 per suckler cow and SEK2,900 per finished bull (SEK1 = Euro0.10, September 2009). All these premiums and grants (except parts of the male animal premium) are now decoupled. As a result, the margins for paying for labour and investments have decreased drastically, according to both theoretical calculations (Agriwise, 2009) and accounting results from beef-producing farms (LRF Konsult, 2008).

After decoupling, beef production is forecast to decrease more in Sweden than in most other EU countries. According to a government report, this is due to the short grazing season, high demands on and hence cost for buildings, the small scale of production, scattered pastures in many locations and relatively high wage levels for farm workers (Jordbruksdepartementet, 2004). According to the Swedish Board of Agriculture (Jordbruksverket, 2007), there is a great risk that the number of suckler cows will decrease considerably up to the year 2020, especially in scenarios with deregulated global markets for agricultural products and increasing competition for land from bioenergy crops.

Finding economically sustainable beef production systems is important not only for existing and prospective beef producers, but it is also a necessity in order to fulfil the national environmental goal of grazing semi-natural pastures and of preserving a varied agricultural landscape in otherwise forest-dominated regions (Naturvårdsverket, 1997; Centrum för biologisk mångfald, 2008). However, the area of grazed semi-natural pastures in Sweden decreased by 11% between 2005 and 2008 (Jordbruksverket and SCB, 2009), despite the goal of grazing all existing semi-natural pastures (Environment Objectives Portal, 2009). The area of cropland in the forest-dominated regions has decreased by 8% since 1995 (Jordbruksverket and SCB, 2006, 2009), despite support to less favoured areas and environmental grants for keeping the landscape open. Apart from the mountains in the north and some flatland districts in the southern and central parts of the country, Sweden is dominated by forest. In seven provinces covering 70% of Sweden's land area, there are 15 million ha of forestland, but only 0.6 million ha of arable land and semi-natural pasture (SCB, 2009). Historical evidence suggests that abandoned agricultural land will become forest sooner or later.

The Swedish people's willingness to pay for keeping the agricultural landscape open was estimated in 1986 by contingent valuation surveys and shown to be SEK3,100 $ha^{-1}yr^{-1}$ by grazing arable land and SEK3,900 $ha^{-1}yr^{-1}$ by grazing semi-natural pastures, at 2009 money values (Drake, 1999). Such opinions have resulted in environmental grants for grazed semi-natural pastures (SEK1,100–2,500 ha^{-1}, depending on nature value) and grants for mown or grazed grass on arable land (SEK300 ha^{-1} in flatlands and SEK550–2,100 ha^{-1} in forest-dominated regions, depending on location in the country). In forest-dominated regions, there is also economic support for less favoured areas.

Suckler cows and their calves are becoming increasingly important for landscape management because the number of dairy cows, and thus dairy breed calves, is decreasing. From 1990 to 2008, the number of dairy cows in Sweden decreased from 576,000 to 357,000, whereas the number of suckler cows increased from 75,000 to 196,000 (Jordbruksverket and SCB, 2009 and others).

The aim of the paper is to identify future systems for suckler cow-based beef production that can be economically sustainable in an economic environment with fully decoupled EU income support, but with continued environmental grants and support to less favoured areas.

Methods

The micro-economic theory of a company presumes that the manager knows all feasible production alternatives and has all available information as to their consequences, and in the light of this, as well as knowledge of future prices of inputs and outputs, can identify the right alternative to maximize profit (Heady, 1952; Gravelle and Rees, 1992). However, Simon (1997) questions this 'economic man' assumption. He proposes that 'the administrative man', who is aware of only some of all the possible production alternatives, can choose a satisfying one. We find Simon's point of view most realistic for beef production because there are no research results, or empirical knowledge, covering all the mathematical input–output, input–input and output–output functions needed for optimization. This is especially true in the new economic environment in which the economically optimal solutions might be far from what used to be optimal and around which most experience and research have been concentrated.

To procure all the information needed for optimization in the new economic environment would be very expensive and take too long if the aim was to save the larger part of beef production and the grazing-dependent nature values. Therefore, following Simon's concept, we define economically sustainable beef production as a system that is able to pay at least a farm worker's wage, including benefits and payroll taxes for the labour input, at least the bank rate of interest for investments, and at least the opportunity cost on land used for producing pasture and other roughage for the cattle.

To find beef production systems satisfying these goals in the new economic environment, it is necessary to scrutinize the whole production chain including feed production, feeding, breeding, buildings and management. Each of these systems consists of several subsystems. For example, the winter-feed production system includes soil management, choice of forage species and varieties for reseeding, fertilization and time and machinery used for silage or haymaking. No single person has this broad knowledge, so it is necessary to collect knowledge from several sources, including researchers with detailed knowledge of different subsystems, innovative beef producers and experienced extension workers able to make a creative synthesis for the whole production system.

Delphi method

The Delphi method is used here to predict and explore the future possibilities for Swedish beef production. The method allows collection of knowledge and opinions from a large number of individuals in cases where model-based statistical and analytical methods are not available because of the lack of appropriate technical and economic data. The method is based on questionnaires presented to a panel of anonymous experts in two or more rounds. Each expert gives an answer and the reason behind it. After each of the rounds, the answers are summarized by the coordinator of the study. The summaries are distributed to the panel members, who are then given the opportunity to revise their earlier answer on the basis of the feedback provided. This iteration continues with new rounds until some stability in responses is achieved and there is little evidence of panellists changing their minds much further (Rowe and Wright, 1999; Rowe, 2007).

The traditional Delphi method seeks consensus in the forecast, and numerical data (mean value, median, quartile values, etc) provide the basis for the conclusions. New policy Delphi seeks to place all relevant opinions and options on the table for consideration and to examine the acceptability of any particular option (Rikkonen *et al*, 2006).

The opportunity to provide reasons for opinions allows Delphi participants to introduce new ideas into the discussion, and the transparent exchange of knowledge allows the experts to learn while participating in the process. Compared with traditional group meetings, Delphi improves the chances of obtaining unbiased estimates and forecasts that take full account of the knowledge and judgments of experts (Green *et al*, 2007). All involved in Delphi have an equal opportunity to contribute and be influential – and not just those with the loudest voices (Rowe, 2007). According to Armstrong (2006), the advantages of Delphi compared with group meetings are, for example, (1) people in groups are poor at generating creative approaches, (2) many people have difficulty performing complex analyses in the presence of others, and (3) groups are not always tolerant of creative solutions. People in groups have a tendency to discuss shared information rather than uniquely held information (Rowe, 2007), which is a severe limitation when seeking economically sustainable solutions in a new economic environment.

Application of the Delphi method

The Delphi panel used in the study consisted of 12 anonymous Swedish experts, including four researchers, four beef producers and four extension workers. The choice was based on our knowledge of these people from their many years in research and extension service within the beef sector. The researchers represented the fields of feed production, feeding and breeding. The beef producers represented both cow-calf production and finishing of calves. The producers, as well as the extension workers, were from different parts of Sweden. All the initially chosen experts took part in the study.

The questions to the panellists were based on a baseline budget compiled from budgets for presently common Swedish suckler cow-based beef production systems – including forage production – from the Swedish University of Agricultural Sciences (Agriwise, 2009). In order to explain all the details in the budgeting, the first round of questions was initiated with face-to-face meetings with the coordinator and each of the experts. The panellists were then asked to suggest visionary but realistic ways to improve profitability by altering input–output coefficients and prices in order to increase incomes and/or reduce costs. The aim was, if possible, to find adjustments so that the production reached the goal of at least covering farm worker wages, bank rates of interest and the opportunity cost of the land. The summary of the first-round answers, as well as the answers in the second round, was distributed by mail. When a panellist considered himself or herself not to have expertise about a certain budget item, the baseline amount was used for this item.

Results

The baseline

The baseline budgets for normal Swedish suckler cow-based beef production, on which the questions were based, are shown in Tables 1 and 2. They show negative economic results (incomes < costs) of –SEK6,600 per cow and –SEK2,900 per finished bull.

The baseline profitability as well as the panel's median, highest and lowest results in rounds 1 and 2 are shown in Figure 1a–f for suckler cows and Figure 2a–f for finishing bulls. High stability in the answers was achieved by round 2, after which the inquiry was finished.

Suckler cows

The income from the calf is higher, according to the answers, than suggested by the baseline (Figure 1a). Higher prices due to an approaching shortage of calves were the main reason for justifying higher prices for weaned calves. Heavier calves, thanks to crossing the cows with heavy breed bulls, were another reason.

In the baseline, about 50% of the grazing is intensively managed pasture on arable land with an SEK550 ha^{-1} environmental grant, and the other 50% of the grazing is on semi-natural pasture with an SEK1,100 ha^{-1} grant. There is no single farm payment. This results in higher costs than the environmental grant can cover and, consequently, delivers a net cost of pasture of –SEK900 cow^{-1} in the budget. Most panellists were of the opinion that 100% semi-natural pasture, preferably with high natural values (SEK2,500 ha^{-1} grant), was a necessary requirement for profitable cow-calf operations. All panellists also added the part of the single farm payment that requires grazing, since grazing is not possible without cattle. This then results in a net income of SEK2,400 cow^{-1} from pasture for the median panellist (Figure 1b). This is the question that demonstrates the biggest economic difference between the best and the least profitable answer, SEK4,100 cow^{-1} (Table 1).

In many cases, there are only marginal differences between conventional and organic cow-calf operations. The main difference is that the use of yield-increasing commercial fertilizers is forbidden in organic production. This is not an economic disadvantage if the operation has enough land with no opportunity cost, which is what most of the respondents supposed. Most of the respondents consequently supposed that organic production would result in an extra payment of SEK1,600 cow^{-1}.

The baseline cost of winter feed was SEK2,300 cow^{-1} and the median answer value was SEK2,000 cow^{-1}. However, there is a large difference between the highest and lowest cost (Figure 1c). The low-cost estimates are characterized by the use of by-products such as straw and distiller's waste, or silage produced without fertilizers on long-term leys harvested only once a year. The high-cost answers are typical of small-scale production in northern Sweden, with a long winter-feeding period and/or an unnecessarily high consumption of expensive silage.

Costs of building and bedding show a large variation (Figure 1d). Low-cost systems include outdoor wintering or rebuilding of existing buildings without opportunity cost. The high-cost answers suppose new conventional buildings: for example, a cubicle barn or a deep straw pack barn. The latter is cheaper to build than a cubicle barn, but carries a high cost for bedding, at least in forest-dominated regions without local straw production. Some of the respondents used a short depreciation time for

Table 1. Suckler cow: baseline budget, the two most profitable systems suggested by the panel, and the difference between best and worst answers (SEK yr^{-1}).

	Baseline budget (SEK)	Organic with high environmental aid, 100 cows (SEK)	Conventional with outdoor wintering cows, 200 cows (SEK)	Difference between best and worst answers in panel (SEK)
Income from weaned calves	3,900	4,500	5,000	1,800
Aid for organic production	0	1,600	0	1,600
Pasture, payments minus costs	–900	3,500	2,700	4,100
Cost of winter feed	–2,300	–1,400	–1,000	2,300
Costs of building and bedding	–2,600	–1,900	–600	3,100
Labour cost (SEK188 $hour^{-1}$)	–2,800	–1,700	–1,100	1,700
Other costs	–1,900	–1,300	–2,400	1,300
Profit (income minus costs)	–6,600	3,300	2,600	–

Table 2. Finishing slaughter bull from suckler cow: baseline budget, the two most profitable systems suggested by the panel, and the difference between best and worst answers (SEK $bull^{-1}$).

	Baseline budget (SEK	Organic with premium price of beef, more than 100 head (SEK)	Conventional, more than 100 head (SEK)	Difference between best and worst answers in panel (SEK)
Income from slaughter bull	10,100	12,600	11,700	2,500
Aid for organic production	0	500	0	500
Cost of weaned bull calf	–4,600	–5,400	–5,600	2,000
Cost of feed (roughage, grain, concentrate and minerals)	–4,000	–3,500	–3,100	800
Costs of building and bedding	–2,200	–2,100	–1,700	400
Labour cost (SEK188 $hour^{-1}$)	–1,500	–1,100	–1,300	400
Other costs	–700	–500	–700	200
Profit (income minus costs)	–2,900	500	–700	–

buildings due to the surmised political risk of further deterioration of the economic conditions for beef production.

In the baseline, the herd size is 38 cows and the indoor feeding period is six months. This results in a labour cost of 15 h cow^{-1}* SEK188 h^{-1} = SEK2,800 cow^{-1} (Figure 1e). Most of the experts consulted proposed the use of larger herds, which reduce the labour demand per cow, especially if the indoor period is also shorter. The lowest labour demand (6 h per cow) was suggested for a herd of more than 200 cows, with outdoor wintering and a herd with 100 cows in a new deep straw pack barn.

Among other costs, the interest on animal and circulating capital is the largest. Replacement costs can also be high if the cost of replacement heifers is considerably higher than the income from selling culled cows.

Figure 1f shows the profit (income minus costs) cow^{-1} $year^{-1}$. It is –SEK6,600 in the baseline (Table 1) and still more negative in the least profitable suggested system. However, the median reply predicted about +SEK1,800 and the best case +SEK3,300 per cow. The main reasons for the generally better profitability in the panellists' suggestions were the high environmental grants and single farm payment for semi-natural pastures. Another reason was the lower costs of buildings and labour enjoyed by larger herds. The costs of buildings and bedding were lowest in production models with outdoor wintering. Low cost of winter feed also contributes considerably to good profitability.

Slaughter bulls

The finishing section is limited to bulls. Most beef breed bull calves are finished as intact bulls in Sweden. Steers are not common (Taurus, 2009).

Finishing of the suckler cow's bull calves includes the period from about seven months of age to slaughter. All respondents but one – who proposed organic production – suggested feeding regimes with high-quality silage and grain, plus a protein concentrate, and slaughter at about 14 months. In the organic alternative the silage percentage was higher. The variation in economic terms was small

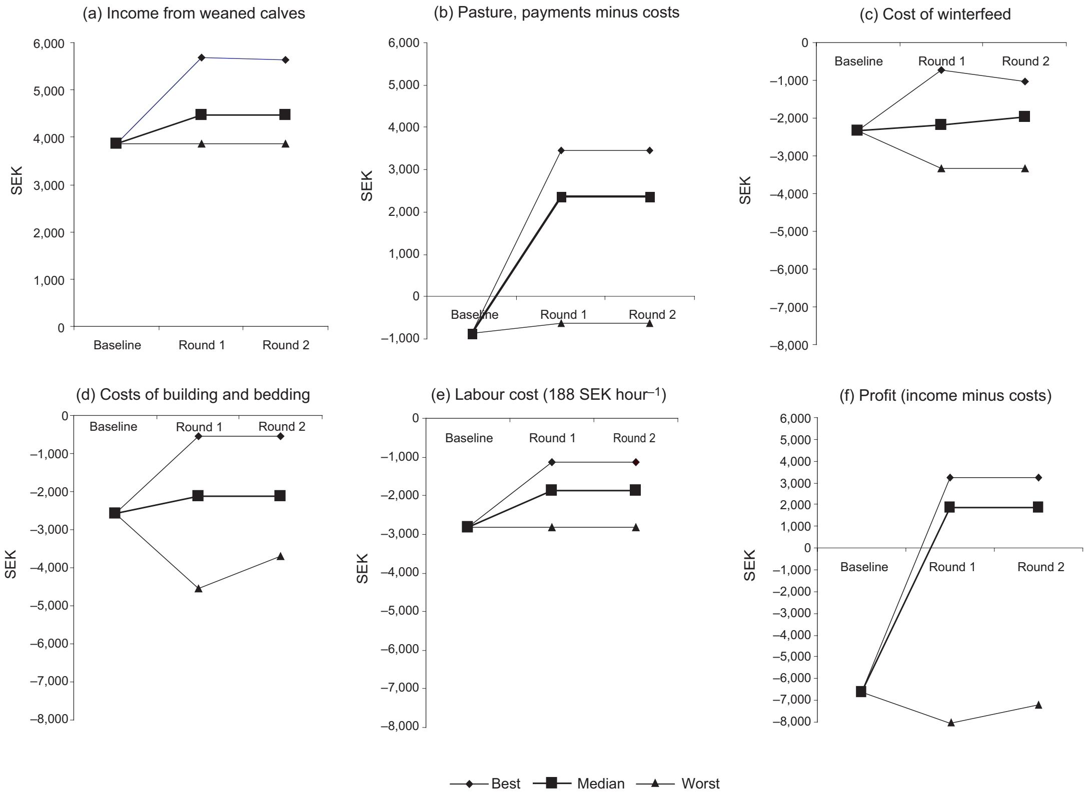

Figure 1. Income, costs and profit per cow per year in the baseline budget and according to the panel in rounds 1 and 2.

compared with the corresponding differences in cow-calf production.

The factor that influenced the anticipated profitability most was the assumed income from the slaughtered bull, in reality the future price of beef. The price in the baseline was SEK29 kg^{-1}. The median forecast was SEK30 and the highest SEK36. Higher carcass weight can, in the long run, influence the income from the slaughtered bull, but not to such a large extent as the beef price does. The high price expectations were based on a belief in a future plateauing of the price of beef in Europe. Sweden now has one of the lowest beef prices in the EU (SCB, 2009).

Most panellists proposed a higher cost of weaned bull calves than was stated in the baseline, which corresponds to their level of income from calf sales in the suckler cow budget (Figure 1a, 2b).

Cost of feed (roughage, grain, concentrate and minerals) differed by only SEK800 between the highest and the lowest answer (Figure 2c). Some respondents suggested that the use of cheap by-products from the food or grain-ethanol industry might be used to reduce the cost of feed.

Compared with the baseline, the median forecasts were somewhat lower for the costs of building and bedding and the cost of labour, thanks to larger operations (50 finished heads per year in the baseline) and more than 100 head in most forecasts (Figure 2d, 2e).

Most panellists were doubtful about finishing beef breed bulls in the organic scheme, for two reasons: the risk of a lowered growth rate and because the organic scheme does not allow indoor finishing during the grazing season. However, the highest price expectations were based on experiences with finishing beef bulls in an organic scheme.

Figure 2f shows the calculated profitability of bull finishing. The median profitability was –SEK1,400 and the variation SEK500 to –2,700. Even the least profitable prediction was better than the baseline (–SEK2,900). The main reasons for the predicted higher profitability were the higher price of beef and the lower costs of buildings and labour for larger herds.

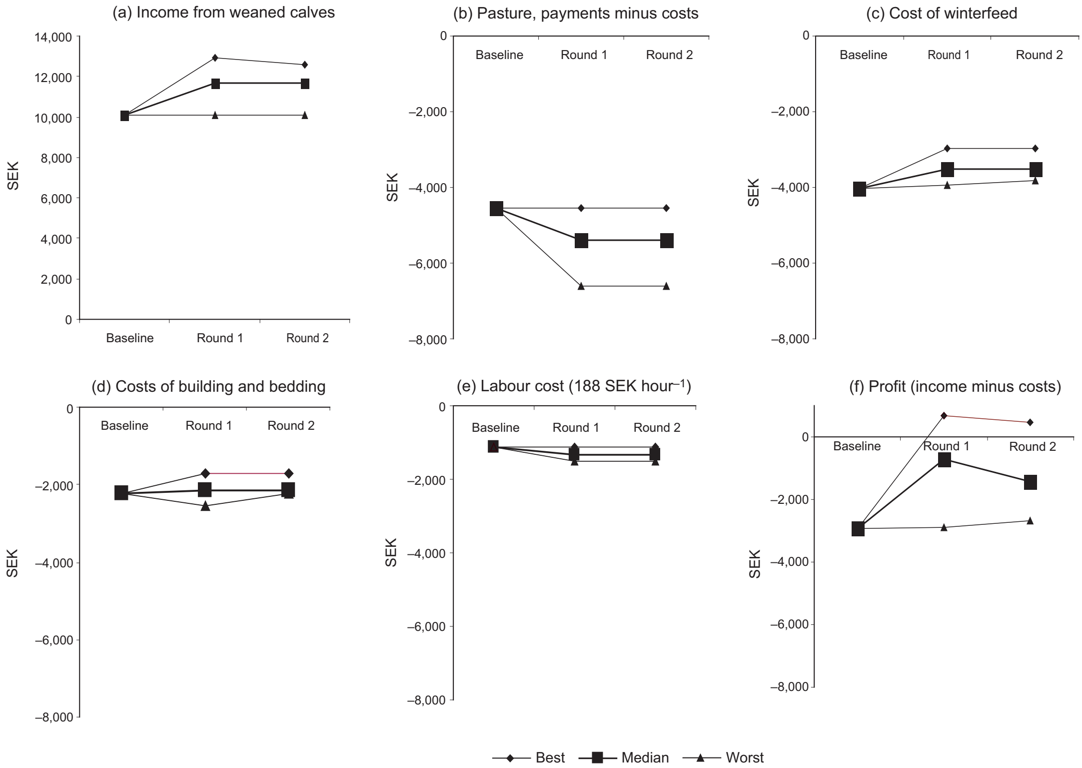

Figure 2. Income, costs and profit per finished bull per year in the baseline budget and according to the panel in rounds 1 and 2.

Most profitable systems

Incomes and costs for the two most profitable interview answers are illustrated in Tables 1 and 2. They can be described for the suckler cow as 'Organic with high environmental grants' (size 100 head) and 'Conventional with outdoor wintering' (size 200 head). For finishing cattle, they are described as 'Organic with premium price of beef' and 'Conventional'. Both finishing systems have more than 100 head.

The suckler cows are profitable in both systems because of, for example, the grant for organic production in the first case and the low cost for outdoor wintering in the second. Both qualify for high environmental grants, resulting in pasture becoming a net income instead of a net cost. The bull in the organic scheme is profitable mainly because of a high premium price on the beef, whereas the conventionally reared bull shows a negative return.

Discussion

After decoupling EU income support, normal Swedish systems for suckler cow-based beef production were unable to pay the capital costs for new buildings, fences and machinery and market wages for labour input. Thus, it is not economically sustainable. The Delphi panel suggested several production systems that could be economically sustainable, implying that the income from beef and environmental services were at least as high as the total cost of production, including cash expenses and full coverage of capital and labour costs.

The two most profitable suggested systems for cow-calf operations can be characterized as 'Organic with high environmental grants' and 'Conventional with outdoor wintering'. They achieved full cost coverage, plus profits of SEK3,300 and 2,600 cow^{-1} respectively (Table 1).

The main reasons for the good profitability of the suggested best systems are the large area of semi-natural pasture per cow needed and a relatively high environmental grant per hectare, thanks to the high environmental values of the grazing. The panellists also considered that the single farm payment for semi-natural pasture should be included in the variable incomes, since grazing is needed to qualify for the payment. All this together results in the pasture being a net income in the cow budgets of SEK2,700–3,500 cow^{-1}. In the 'Organic with high environmental grants' alternative, the payment of SEK1,600 cow^{-1} for organic production contributes considerably to the profitability (Table 1).

The second most important reason for a higher profitability compared with the baseline is the lower costs of buildings and bedding. The two most profitable suggestions use either a deep straw pack barn (SEK1,900 cow^{-1}) or outdoor wintering (SEK600 cow^{-1}). Larger herds than in the baseline also contribute to lower costs for buildings per animal, but above all to the decreased cost of labour per cow (Table 1).

In the most profitable suggested systems, the cost of winter feed is lower than in the baseline. This is because of the extensive silage production on land with no opportunity cost, environmental payments for preserving a varied agricultural landscape in the case of 'Organic with high environmental grants', and straw feeding combined with distiller's waste in 'Conventional with outdoor wintering'. One conclusion is that the cost of winter feeding can be reduced by using inexpensive crops or other cheap by-products with appropriate feed values for the animals used in these systems.

It is not just the two most promising suggested systems for suckler cows that are profitable. The median suggestion is also profitable (Figure 1f). All profitable suggestions are, compared with the baseline, characterized by large herds, large areas of semi-natural pasture per cow, relatively high environmental grants and the presence of the single farm payment to semi-natural pasture as a variable income.

The relatively high grants for grazing semi-natural pastures and preserving a varied agricultural landscape in otherwise forest-dominated regions seem to be firmly established in the minds of the Swedish people (Drake, 1999) and in the national official policy (Environmental Objectives Portal, 2009).

Creating large herds with a large area of semi-natural pasture per cow is difficult in most parts of Sweden. Having 100–200 cows (Table 1) combined with the assumed large pasture area (median 1.4 ha per cow) presupposes 140–280 ha of pasture per cow-calf operation, besides arable land for winter feed production. In typical forest districts in southern Sweden, the average agricultural land area on the farms is only 8 ha of semi-natural pasture and 22 ha of arable land. In northern Sweden, the average area of semi-natural pasture is even smaller. The pasture areas are also normally scattered in several small patches on each farm (Jordbruksverket, 2007). On the plains, the area per farm is larger and the field layouts better, but in these areas the opportunity cost of land is normally too high for profitable pasture-based beef production (Kumm, 2006). However, large connected pastures can, in some cases, be created in forest districts by enlarging the presently small scattered pastures with adjacent overgrown pastures, marginal arable land and final cut forestland. Creating large pastures and herds also requires cooperation between cattle farms and nearby farms without cattle (Kumm *et al*, 2007).

The possibilities for improving the profitability by implementing cheap outdoor wintering systems for suckler cows are limited by strict Swedish animal welfare legislation. However, experience from a cow-calf operation upon which the system suggestion 'Conventional with outdoor wintering' is based shows that outdoor wintering can work well for the animals in cases with suitable ground conditions and good management. The system 'Conventional with outdoor wintering' with considerably larger herds than are common in Sweden is applied in parts of Canada with similar natural conditions to large parts of Sweden. In the Canadian regions, pasture and hayfields, some of which are used for wintering the cattle, occupy more than half the area on farms, whereas forest or grain dominates on most Swedish farms (small-scale farming *versus* ranching). The number of suckler cows has increased in the Canadian region in recent decades, despite there being no government payments (Kumm, 2005).

The two most profitable systems for finishing bull calves suggested by the Delphi panel can be characterized as 'Organic with premium price of beef' and 'Conventional'. The first is calculated to give a profit of SEK500 $bull^{-1}$. The second will not attain full cost coverage, but results in much lower losses than the baseline. Larger herds with lower costs of labour and buildings per head, as well as a lower cost of feed, gave a better economic result. However, the main reason for the better profitability is the supposed higher price of beef (Table 2). In 'Organic with premium price of beef', SEK36 kg^{-1} is supposed, which is 25% higher than the baseline. In 'Conventional', SEK33.5 kg^{-1} is supposed. The high price expectations were based on a belief in the levelling out of the price of beef in Europe, since Sweden now has one of the lowest beef prices in the EU (SCB, 2009). In the organic alternative, premium payments for organic and local production increased the price expectations still more.

Acknowledgments

The study was financed by the Swedish Farmers' Foundation for Agricultural Research.

References

Agri Benchmark (2009), 'Beef report', website: www.agribenchmark.org (accessed January 2009).
Agriwise (2009), 'Områdeskalkyler', Swedish University of Agricultural Sciences, website: www.agriwise.org (accessed February 2009).
Armstrong, J. S. (2006), 'How to make better forecasts and decisions: avoid face-to-face meetings', *Foresight, The International Journal of Applied Forecasting*, Vol 5, pp 3–8.
Centrum för biologisk mångfald (2008), *Mångfaldsmarker*, AlfaPrint, Solna.
Drake, L. (1999), 'The Swedish agricultural landscape – economic characteristics, valuations and policy options', *International Journal of Social Economics*, Vol 26, pp 1042–1060.
Environment Objectives Portal (2009), 'A varied agricultural landscape', website: http://www.miljomal.nu/english/obj13.php# (accessed 20 March 2009).
Gravelle, H., and Rees, R. (1992), *Microeconomics*, 2 ed, Longman, London.
Green, K., Armstrong, J. S., and Graefe, A. (2007), 'Methods to elicit forecasts from groups: Delphi and prediction markets compared', *Foresight, The International Journal of Applied Forecasting*, Vol 8, pp 17–20.
Heady, E. O. (1952), *Economics of Agricultural Production and Resource Use*, Prentice-Hall, New York.
Jordbruksdepartementet (2004), *Genomförandet av EU:s jordbruksreform i Sverige*, Vol 2004, No 9, Jordbruksdepartementet, Stockholm.

Jordbruksverket (2007), 'Jordbrukets miljöeffekter 2020 – en framtidsstudie', Rapport 2007, Vol 7, Jordbruksverket, Stockholm.
Jordbruksverket and SCB (annual), *Jordbruksstatistisk årsbok*, Jordbruksverket and SCB, Stockholm.
Kumm, K.-I. (2005), 'Economically sustainable preservation of grazing-dependent biodiversity in Sweden with Canadian ranching systems', *Outlook on Agriculture*, Vol 34, No 4, pp 255–260.
Kumm , K.-I. (2006), 'Vägar till lönsam nöt- och lammköttsproduktion', Rapport 11, Institutionen för husdjurens miljö och hälsa, SLU, Skara.
Kumm, K.-I. (2008), 'Lönsam betesdrift genom stora sammanhängande betesmarker', Rapport 16, Institutionen för husdjurens miljö och hälsa, SLU, Skara.
Kumm, K.-I., Klasson, J., and Rustas, B.-O. (2007), 'Utedrift med köttdjur – effekter på mark, skog och djurmiljö', Vol 14, Institutionen för husdjurens miljö och hälsa, SLU, Skara.
LRF Konsult (2008), *Lantbrukets lönsamhet 2008*, LRF Konsult, Stockholm, pp 34–38.
Naturvårdsverket (1997), 'Det framtida jordbruket', Rapport 4755, Naturvårdsverket, Stockholm.
Rikkonen, P., Kavio-oja, J., and Aakkula, J. (2006), 'Delphi expert panels in the scenario-based strategic planning of agriculture', *Foresight, The Journal of Future Studies, Strategic Thinking and Policy*, Vol 8, No 1, pp 66–81.
Rowe , G. (2007), 'A guide to Delphi', *The International Journal of Applied Forecasting*, Vol 8, pp 11–16.
Rowe, G., and Wright, G. (1999), 'The Delphi technique as a forecasting tool: issues and analysis', *International Journal of Forecasting*, Vol 15, pp 353–375.
SCB (2009), 'Lantbruksenheten', Statistics Sweden, Stockholm.
SCB (annual), *Statistisk årsbok*, SCB, Stockholm.
Simon, H. A. (1997), *Administrative Behaviour*, 4 ed, The Free Press, New York.
Taurus (2009), 'Statistik, Slaktstatistik', website: www.taurus.mu (accessed 20 September 2009).

II

Org. Agr.
DOI 10.1007/s13165-012-0035-6

Profitability of organic and conventional cow-calf operations under Swedish conditions

Pernilla Salevid · Karl-Ivar Kumm

Received: 5 April 2012 / Accepted: 12 November 2012

Abstract In order to maintain the high natural values of Swedish semi-natural pasture, suckler cow numbers must increase, but numbers are more likely to decrease due to low profitability, changes to the EU support system and increasing wage levels. This study sought to identify production models for cow-calf operations with sufficient profitability to pay at least stipulated farm workers wage. In the calculations, the income from weaned calves and EU support was reduced by operating costs, excluding labour. The surplus was divided by hours spent on labour, resulting in a return to labour per hour. The calculations were carried out in varying future scenarios where the Common Agricultural Policy is changing. The results showed that organic production models created a higher return to labour than conventional production models. One reason for this is the environmental payment for organic farming. Another reason is that organic production maintains more acreage, equalling higher environmental payments and other EU support per suckler cow. Other more profitable production models included spring calving, heavy cows and winter feed based on silage. Some organic production models gave a return to labour above the stipulated farm workers wage. However, if the single farm payment scheme is phased out and not replaced by an increase in environmental payments, the return to labour will be at best half the stipulated farm workers wage.

Keywords Semi-natural pasture · Cow-calf · Organic · Profitability · Future scenarios

Introduction

Since 1995, when Sweden joined the EU, the number of dairy cows has decreased by 134,000, while the number of suckler cows has increased by 40,000 (Swedish Board of Agriculture 2011a). Therefore, the total number of cows, and hence calves available for meat production, has decreased. Total Swedish beef production decreased from 140,000 t in 1995 to 131,000 t in 2010 (Swedish Board of Agriculture 2011a). Consumption of beef in Sweden increased during the same period from 163,000 to 239,000 t (Swedish Board of Agriculture 2011b). As a result, the degree of self-sufficiency in beef has decreased from 85 to 56 % since Sweden became a member of the EU.

The Swedish Environmental Objectives require national biodiversity to be maintained at the current level and used in a sustainable way. In order to do so, an existing agricultural sector with grazing animals is needed (Ministry of Agriculture 2010). Suckler cows are therefore very important for reaching the Swedish Environmental Objectives, especially the objective

P. Salevid (✉) · K.-I. Kumm
Department of Animal Environment and Health,
Swedish University of Agricultural Sciences,
Skara, Sweden
e-mail: pernilla.salevid@slu.se

Published online: 09 December 2012

stating that 450,000 ha of semi-natural pasture be kept open for grazing (Swedish Environmental Objectives 2011). After a long period of decreasing semi-natural pasture area, the grazing acreage began to increase in 1995, when the current environmental payment system was introduced, until 2005, when the acreage started to decrease again, most likely due to a lack of grazing animals. In 2010, the semi-natural pasture acreage was 420,000 ha (Swedish Board of Agriculture 2011a), of which 160,000 ha are grazed by suckler cows and heifers (SCB 2010).

One goal for the Swedish Rural Development Programme is to have 20 % of agricultural land in quality-assured organic production by 2013 (Swedish Board of Agriculture 2010a). In 2010, the proportion of certified agricultural land was 14 % (Swedish Board of Agriculture 2011c). A large proportion of Swedish suckler cow production is organic. According to one survey, 37 % of the nation's suckler cow operations receive environmental support for organic farming. Of the suckler cow operations with more than 100 cows, 70 % are organic (SCB 2010). The differences between organic and conventional cow-calf operations include a ban on pesticides and commercial mineral fertilisers and restricted use of veterinary medicines and concentrate feeds, which may result in lower yields, a need for lower stocking rates per hectare and longer grazing periods (KRAV 2012).

The Swedish agricultural acreage is only 8 % of the total land mass. The suitability for farming varies greatly throughout the country. In areas favourable for arable farming, the proportion of agricultural land is 25 % (Ministry of Agriculture 2010). In other parts of the country with less favourable conditions, specifically the forested districts, there is continuous abandonment of both semi-natural pasture and arable land. In these areas, the landscape is characterised by relatively small fields and grazing, interspersed with lakes and forest. In the forest districts in Götaland (Gsk) and lower parts of Norrland (Nn), the agricultural acreage has decreased by 30 % since the Second World War and the remaining farming operations are more or less 100 % grazing and forage-based animal production (Swedish National Atlas 2011) with low profitability (Agriwise 2011). Continuing farming operations in these regions are important in reaching the Swedish Environmental Objective of ‘A varied agriculture landscape’ (Swedish Environmental Objectives 2011). For this to occur, suckler cow operations are essential.

From the viewpoint of the Swedish Environmental Objectives, organic farming practices have several advantages compared with conventional farming. The ban on the use of pesticides and rapidly soluble mineral fertilisers and the requirement for a larger proportion of leys in the crop rotation are some of these advantages. Farming without mineral fertilisers decreases emissions of climate gases and eutrophying effluents. Crop rotations with leys increase the biological diversity in the landscape (Nilsson 2007). These advantages have resulted in an organic grant of 1,800 SEK suckler cow^{-1} year^{-1} (including replacement heifer), according to the Rural Development Programme in Sweden for 2007–2013 (Swedish Board of Agriculture 2011c). Cow-calf operations (both conventional and organic) deliver on these objectives and can assure long-term sustainable use of agricultural land as semi-natural pasture and arable land in forest-dominated regions are part of the ecosystem.

Swedish organic cow-calf operations are held in high esteem by consumers because the criteria on animal welfare in the organic regulations are more in line with natural cattle behaviour and because suckler cows with calves graze large areas of semi-natural pasture. In 2008, Swedish consumers were willing to pay 4.50 SEK kg^{-1}, or 18 % above the ordinary price of prime beef, for this service (Swedish Board of Agriculture 2010a). In spite of this, many organically raised suckler calves are sold to conventional fattening operations without any added value for the organic status. Of Swedish cattle stocks, 8 % are quality-assured organic (Ekoweb 2012) in accordance with the KRAV certification programme for organic production (KRAV 2012). Only 4 % of the prime beef slaughtered in 2006 was KRAV-assured (Swedish Board of Agriculture 2008). The sale of any type of organic meat is below 2 % of total meat consumption. However, the sale of branded meat, often locally branded, has increased from 9 to 19 % during the same period (SCB 2011).

According to Agribeef (2011), there are profitable cow-calf operations in regions with high levels of environmental payments and other EU support, combined with favourable biological production conditions. Farm businesses with low levels of support and/or low biological production have very poor profitability. The fact that many of these farmers still carry on with their operations suggests that they treat the decoupled single farm payments as an enterprise-specific income from beef, despite the fact that they would receive the payment for arable land regardless of whether they have cows or any other form of production. The payment should therefore be seen as a common income. According to regional calculations preformed by the Swedish University of Agricultural Sciences based on feasible achievements under efficient Swedish conditions, the revenue from grazing-based beef production can cover short-term operating costs but not stipulated farm workers wage, investments in buildings or capital needs (Agriwise 2011). The Ministry of Agriculture (2004) concluded that there was a greater risk of decreased beef production in Sweden compared with other EU countries due to the shorter vegetation period, higher official specifications on farm buildings, the small-scale structure of most Swedish beef production, a lack of large interconnected grazing areas and a high level of labour cost per hour.

The future for cow-calf operations in Sweden is uncertain. In 2012, the male premium of around 1,300 SEK bull^{-1} and 1,900 SEK steer^{-1} was abolished. If this is not compensated for, by a higher price at slaughter, the price for calves sold from cow-calf operations will most probably decline. OECD-FAO (2011) has projected a price level decline for beef in the years leading up to 2020, which would decrease revenue even more. A possible decrease in the single farm payment would also negatively affect cow-calf operations, since these systems utilise large areas of land. In a future study by the Swedish Board of Agriculture (2007), a decrease in Swedish beef production and grazing acreage was predicted. This could have a variety of causes, including a decrease in EU support, deregulation of world trade in agricultural products and competition for agricultural land from the bio-energy market.

In order to ensure that there is a new generation of farmers willing to continue with beef production and to invest in new buildings when old buildings are run down, a return to labour comparable to the stipulated farm workers wage and a market level return on invested capital are likely prerequisites. An expert panel consisting of beef producers, farm advisors and researchers in genetics and nutrition interviewed in a Delphi study implied that in order to achieve such profitability in suckler cow beef production, organic production with environmental support and a higher price on beef is needed. Alternatively, a large-scale conventional production system for overwintering cows outdoors could achieve the cost differential needed. Both systems require access to large areas of interconnected semi-natural pasture for grazing. Above average fertility rates, growth rates and feed conversion rates are in themselves insufficient to reach the profitability goals, according to the expert panel (Salevid 2011). The purpose of the present study was to examine whether future organic and conventional cow-calf operations can achieve a stipulated farm workers wage and a return on investment of 5 % under Swedish conditions.

Method and premises for calculations

Method of calculation

The sum of enterprise-specific income minus the sum of long-term operating costs, excluding the cost of labour, was calculated per cow and year for a number of different production models comprising 100 suckler cows in varying future scenarios. The result was divided by the labour requirement for animal husbandry and management of the grazing land, to give a return to labour per hour for these tasks. The sum of enterprise-specific income included the sales revenue for weaned calves (bull calves and heifer calves not used for replacement), a proportion of the cull cows, environmental grants for semi-natural pasture and leys, support for less favoured areas and, in some cases, the single farm payment. In other words, this is the income that will appear when starting up a cow-calf operation and that will disappear if it ceases. Long-term operating costs included feed, fencing, bedding, breeding bull, contractor, insurance, depreciation and maintenance of buildings, opportunity costs for land and interest on animal, building and working capital. Again, these were the costs that would be incurred when starting up a cow-calf operation and that would disappear when it ceases. It was assumed that all labour used in growing and harvesting the winter feed was supplied by a contractor paid the full market price.

The data used on calf output per cow are average survey data for breeding herds (Swedish Dairy

Association 2011). Labour demand per cow per year was based on survey data from large herds (Nelson 2002). Feed demand (Clason 2009) and cost of feed production (Kumm 2009) and buildings (Häggström et al. 2005) were based on engineering data. The feed demand was based on theoretical nutritional needs. Taking all this into account gave better production results than the average for existing smaller cow-calf herds and also allowed future possibilities for economically sustainable models to be calculated.

Other data such as prices, support payments and other costs are typical farm data from 2009, collected from the Swedish Board of Agriculture and the Swedish University of Agricultural Sciences (Agriwise), including the stipulated wage of 180 SEK h^{-1} plus employer contributions. Details of the data collection are given in the footnotes of Table 4.

Calculations were made for: (1) various production areas with different natural conditions and (2) various possible future scenarios. The scenarios were chosen based on the fact that prices and politics will change during the depreciation period, averaging 15 years, for farm buildings and their inventory. The scenarios included abolition of the single farm payments scheme, changes in the environmental payments and a decrease in the market value of weaned calves as a result of the abolition of the male premium. The calculations were based on the fact that the single farm payments on arable land can be perceived by the farmer as a common income independent of production or an enterprise-specific income for suckler cows. In the sensitivity analyses, returns to labour were calculated for changes in building costs, rationalisation by scaling up and a price premium for organic beef, resulting in an increase in calf prices. The calculations were carried out for three regions with various natural opportunities, but in all cases with fairly weak conditions for profitable agriculture and hence a greater risk of farm closure and associated loss of nature and landscape values. These regions were forest districts in Gsk, plain districts in Svealand (Ss) and the lower parts of Nn. Together, these regions contain 60 % of the suckler cows and 57 % of the semi-natural pasture in Sweden (Swedish Board of Agriculture 2011a).

Production models

The production models studied differed in orientation (organic or conventional), winter housing of the animals (housed or outdoors), calving time (January, April or June) and breed type (light or heavy cows). The feed rations were customised for each separate production model. By combining clover-grass silage with late harvested grass silage, the feed rations were adapted to early or late pregnancy and lactation. This resulted in a clover-grass silage share of 100 % when calving in January, 50 % when calving in April and 25 % when calving in June. In regions with good access to cheap straw (cereal-dominated areas in Gsk and Ss), some models involved straw replacing grass silage. Feed rations with high levels of clover-grass silage or straw decrease the acreage needed, but simultaneously decrease the acreage-based payments. No calculations were made using grain in the feed rations of the suckler cows. The various production models in each area are described in Table 1.

Outdoor wintering of suckler cows has its limitations due to ground and climate conditions in Sweden. Wet and unfrozen ground will be damaged by trampling, especially if the cow breed type is heavy. For this reason, heavy cows were not used in the outdoor wintering calculation models. In Nn, outdoor wintering was also excluded due to uncertainties about how snow depth and predators would influence the production results. The size of each operation was taken as 100 suckler cows including replacement heifers, plus grazing and arable land sufficient for feeding these cows and replacement heifers. The farms were assumed to have no other business than the cow-calf operation, which thus had to bear all the costs of the farm business, including administration. All calves were assumed to be sold at weaning except replacement heifers.

Organic feed production differs from conventional by not using pesticides or commercial mineral fertilisers, which results in lower yields. For grass-clover leys, the difference is relatively small, while it is large for grass leys which are more dependent on the nitrogen in mineral fertilisers. The yield levels used in the calculations are presented in Table 2. Grassland yields are low in Sweden compared with many other countries in Europe (Smit 2008) due to the Nordic climate and the fact that the environmental payment system does not allow semi-natural pasture to be fertilised with natural or commercial fertilisers.

Table 1 Different production models calculated for the regions Gsk (forest districts in Götaland), Ss (plain districts in Svealand) and Nn (lower parts of Norrland)

Production model	Organic, O					Conventional, C				
Winter housing	Housed			Out wintering, W		Housed			Out wintering, W	
Calving month	1	4	6	4	6	1	4	6	4	6
Light breed type, L, 550 kg	1OL	4OL	6OL	4OLW	6OLW	1CL	4CL	6CL	4CLW	6CLW
Heavy breed type, H, 700 kg	1OH	4OH	6OH			1CH	4CH	6CH		

In each region, the calculations were made with or without access to straw. The numbers 1, 4 and 6 refer to the calving month (January, April and June, respectively)

O organic production, *C* conventional production, *L* light cow breed (550 kg), *H* heavy cow breed (700 kg), *W* outdoor wintering

Basic calculation, future scenarios and sensitivity analyses

The basic calculation used 2009 data on current single farm payments, compensation grants, environmental payments and prices for weaned calves. In the future calculations, the return to labour was calculated for varying scenarios that differed regarding current agricultural politics and therefore payments, calf prices and land costs. In the scenario A, the single farm payment was assumed to be phased out. In scenario A1, this was not compensated for, but the cost of land decreased when the market price of land was no longer influenced by the single farm payments. Without single farm payments, the opportunity cost for agricultural land is zero in the studied regions (Agriwise 2011). In scenario A2, the phased out single farm payment was compensated for by a 50 % increase in the environmental payments. In scenario A3, the single farm payment stayed in place, but was perceived by the farmer as a common income for arable land, i.e. a revenue that was independent of the cow-calf operation. Grazing, on the other hand, is needed to receive the single farm payment on semi-natural pasture and was therefore seen as an enterprise-specific income in scenario A3.

Scenario B describes decreased prices on weaned calves as a result of the abolition of the male premium. By combining A1 (phased out single farm payment, not being compensated but lower cost of land) with scenario B, scenario C was created. By combining A2 (phased out single farm payment plus 50 % increase in environmental payments) with reduced building costs (see below), scenario D was created. The various future scenarios and their designations are described in Table 3 for the Gsk region. The same scenarios were formulated for Ss and Nn, but payments and land costs were adjusted accordingly. Analyses were carried out to examine the effects of scaling up (200 cows), a price premium for organic beef (3 SEK kg^{-1} slaughtered weight, assumed to result in a 10 % increase in calf price) and a 25 % decrease in investment cost in buildings.

Sample calculation with data

The method of calculation for the production model 4OH, with 100 suckler cows in the Gsk area for scenario A2, is described in Table 4. The methods used for obtaining the biological, technical and economic data used in the calculation are described in footnotes to that table.

Table 2 Net forage and grazing yields (kilogram dry matter per hectare per year) for organic and conventional production in regions Gsk, Ss and Nn, according to Kumm (2009)

	2 Gsk and Ss organic	Conventional	Nn organic	Conventional
Forage, 2 cuts per year, clover-grass ley	6,480	7,290	5,200	5,820
Forage, 1 cut per year, grass ley	3,200	6,210	2,560	4,970
Cultivated grazing	1,950	3,340	1,200	2,050
Grazing on semi-natural pastures	1,600	1,600	n.a.	n.a.

Table 3 Single farm payment, support for less favoured areas, environmental payments, calf prices and land costs in the basic calculation (2009) and in the various scenarios in the Gsk region (1 SEK≈0.10 €, 2009)

Scenario	Single farm payment SEK ha^{-1}	Support for less favoured area SEK ha^{-1}	Environmental payments			Calf prices		Land cost
			Grass ley, SEK ha^{-1}	Semi-natural pasture, SEK ha^{-1}	Organic production, SEK cow^{-1}	Bulls, SEK head^{-1}, light–heavy breed	Heifers, SEK head^{-1}, light–heavy breed	Arable land/ grazing land, SEK ha^{-1}
2009	1,194	515	550	1,100	1,800	5,100–5,700	3,400–3,900	850/425
A1	0	515	550	1,100	1,800	5,100–5,700	3,400–3,900	0
A2	0	515	825	1,650	2,700	5,100–5,700	3,400–3,900	0
A3	0 arable, 1,194	515	550	1,100	1,800	5,100–5,700	3,400–3,900	0/425
B	1,194	515	550	1,100	1,800	3,800–4,400	3,400–3,900	850/425
C	0	515	550	1,100	1,800	3,800–4,400	3,400–3,900	0
D	0	515	825	1,650	2,700	5,100–5,700	3,400–3,900	0

Results

As noted in the ‘Production models’ section, a large number of production models were examined. To simplify the description of the results, only the models achieving the highest return to labour in each category, organic and conventional, are included (Table 5).

In Fig. 1, the return to labour in the base year 2009 is compared with scenario A1 (decoupled single farm payments), scenario A2 (decoupled single farm payments compensated for by 50 % increase in environmental payments for leys, semi-natural pasture and organic production) and scenario A3 (single farm payment on arable land seen as common income by the farmer). The stipulated farm workers wage is marked as a solid horizontal line. As can be seen in the diagram, the best alternatives in 2009 achieve a return to labour level with the stipulated farm workers wage in Gsk and Nn, but not in Ss. The conventional alternatives result in a considerably lower return to labour than the organic alternatives. In Ss, no conventional alternative can pay for any labour according to Fig. 1. The best profitability is found in alternatives 4OH and 4OLW, alternatives with spring calving and organic production. In the event of decoupled single farm payments (A1), the best alternatives decrease to half the stipulated farm workers wage in Gsk and Nn and decrease even further in Ss. If the phased out single farm payment is compensated for by 50 % increased environmental payments (A2), the best alternatives in Gsk and Nn reach a higher return to labour than the stipulated farm workers wage and the best models in Ss nearly reach this level. Scenario A3 (single farm payment in place but considered common income for arable land) has approximately the same result as the base calculation year 2009 in Gsk due to the small arable acreage in this region, where all grazing takes place on semi-natural pasture. In Ss and Nn, where the majority of the acreage is arable land, the effect of A3 is practically the same as in A1 (decoupled single farm payment) (Fig. 1).

The generally more favourable growing conditions in Ss are not strong enough to compensate for the lower grants and this leads to lower profitability in the region compared with the other two regions. The sensitivity analyses for different models in Ss revealed that the return to labour is influenced not only by grants for different services and general growing conditions, but also by choices made by the farmer. This is illustrated in Fig. 2, where the effects of various single changes to the initial 2009 calculation are shown for region Ss. By reducing the investment costs for buildings by 25 %, the return to labour increases by nearly 60 SEK h^{-1} compared with model 4OH. If an organically produced weaned calf gets a price premium of 1.50 SEK kg^{-1} live weight (equal to 3 SEK kg^{-1} carcass weight), the return to labour increases by 45 SEK h^{-1} compared with model 4OH. Doubling the herd size in an organic production system increases the return to labour by approximately 35 SEK h^{-1} (Fig. 2).

Table 4 Method of calculating enterprise-specific income less operating costs excluding labour (SEK per cow per year) and return to labour (SEK per hour)

Enterprise-specific income		
Calves	3,700[a]	
Slaughter revenue	1,633[b]	
Support for less favoured areas	1,215[c]	
Environmental payment semi-natural pasture	3,089[d]	
Environmental payment leys	406[e]	
Environmental payment organic production	2,687[f]	
Total enterprise-specific income		12,730
Operating costs		
Feed	3,953[g]	
Other costs	2,316[h]	
Building (depreciation and upkeep)	2,152[i]	
Opportunity cost of land	0[j]	
Interest	1,222[k]	
Total operating costs, excluding labour		9,643
Enterprise-specific income minus operating costs excluding labour		3,087
Labour, hours	13.2[l]	
Enterprise-specific income minus operating costs per h^{-1}	3,087/13.2	234

Example scenario A2 (phased out single farm payment compensated for by increased environmental payments), production model 4OH (April calving, organic production and heavy breed suckler cow housed in a cubicle system)

[a] Income from 0.28 heifer calves (275 kg at 14 SEK kg^{-1}) and 0.46 bull calves (300 kg at 19 SEK kg^{-1}) cow^{-1}. A light cow weans a lighter calf (245 kg heifers, 270 kg bulls). June calving means earlier weaning and therefore selling a 15 % lighter calf compared with January or April calving (Swedish Dairy Association 2011); 0.20 heifer calves are used as replacements

[b] 0.19 cow slaughtered and 0.01 cadavers (20 % replacement), 0.01 breeding bull is slaughtered per year (in total five breeding bulls on 100 cows, with one being replaced each year). A cow or a breeding bull from a heavy breed kills out at 350 and 450 kg, respectively. The slaughter weights for a light breed are 275 and 400 kg, respectively (Taurus 2011). The price level is 23 SEK kg^{-1} carcass weight (Agriwise 2011)

[c] The size of the support for less favoured areas is coupled to the number of animals and the acreage of leys and semi-natural pasture. The basic level in this region is 1,350 SEK ha^{-1} for acreages between 0 and 90 ha, on condition that there is at least 1.3 animal units (a.u.) ha^{-1}. In Ss, the minimum level is 1.1 and in Nn 1.0 a.u. ha^{-1} (Swedish Board of Agriculture 2011c). In the future scenarios, the support for less favoured areas is on the same level as in 2009

[d] 1.87 ha semi-natural pasture cow^{-1} (Clason 2009) is used (in total 187 ha) at the payment of 1,650 SEK ha^{-1} (+50 % compared with the starting point in 2009). January calving decreases the need for semi-natural pasture by 25 %, while June calving increases it by 10 %. A light breed cow lowers the grazing need by 20 %. In Gsk, 100 % of the grazing is semi-natural pasture. In Ss, 20 % of the grazing is semi-natural pasture and 80 % is leys on arable land. In Nn, all grazing is leys on arable land

[e] The environmental payment for leys is 300 SEK ha^{-1} base level and 250/700/1,800 SEK ha^{-1} for additional levels presupposing a stocking level of 1.3/1.1/1.0 a.u.ha^{-1} in Gsk/Ss/Nn (Swedish Board of Agriculture 2011c). In scenario A2, the grass leys support is increased by 50 %

[f] The environmental payment for organic production is 1,600 SEK a.u.$^{-1}$ providing that there is 1 ha organic arable land or 2 ha semi-natural pasture a.u.$^{-1}$ (Swedish Board of Agriculture 2011c). One cow is 1 a.u. and a heifer is 0.6 a.u. In scenario A2, the organic production payments are increased by 50 %

[g] The feed costs are calculated based on input costs to produce own feed (seed, contractor) in different models with feed rations calculated by Clason (2009) and the net forage harvest in the different regions (Kumm 2009). The production costs for forage and grazing plus that bought as feedstuff (minerals, calf feed) create feed costs per cow. Of the models studied, Ss-6CLW has the lowest feed costs. In the model reported above (Gsk-4OH), 20 ha arable land are used for 100 cows to harvest good quality silage for cows and replacement heifers. For harvesting low quality silage, 29 ha of arable land are used. In the case of January calving, 15 % less arable land is used and in the case of June calving 10 % more. A light breed cow uses 15 % less arable land than a heavy breed cow. Conventional production uses 30 % less arable land due to larger harvests

[h] Other costs include fencing, electricity, administration, breeding bull, bedding, insurance and various costs for foot trimming, cadaver removal, ear tags and quality assurance schemes (Hushållningssällskapet 2006; Agribeef 2011)

[i] The investment costs are 36,000 SEK cow^{-1} (cubicle stable) (Häggström et al. 2005; index adjusted to the 2009 price level) and the investment support is 6,000 SEK cow^{-1}. The average depreciation period is 15 years and the cost of upkeep is 0.5 %, resulting in an annual depreciation and upkeep cost of 2,152 SEK. With June calving, the cost is 20 % lower. In deep litter housing systems, the building costs are 300 SEK less, but bedding costs are 900 SEK cow^{-1} $year^{-1}$. Housing costs for organic and conventional production are the same. Construction costs for the outdoor wintering of cows (frost-free water supplies, sick boxes, handling facilities and fencing for the winter paddock) amount to 4,500 SEK cow^{-1}, which is depreciated over 10 years (personal estimates based on experience from Swedish ranching operations)

[j] The opportunity costs for arable land and semi-natural pasture are 0 SEK in all three regions if the single farm payment is decoupled (Agriwise 2011). In the base level calculation for 2009, the land costs equal the tenancy fees for the region reported by the Swedish Board of Agriculture (2010b)

[k] The interest is set at 5 % for the average capital needed for buildings and 6 % for animal and working capital

[l] The working hours stated refer to animal husbandry including pasture management. The time spent working with the animals was estimated using a calculation model (Nelson 2002) based on collected data from cow-calf operations. The working time spent managing pasture was calculated using a template created for this purpose by Hushållningssällskapet (2006). The working time in outdoor wintering systems is 17.5 h cow^{-1} $year^{-1}$ based on data from interviews with farmers using this type of production model

Figure 3 shows the return to labour per hour in scenario C, a combination of lower calf prices following the abolition of the male premium and the phased out single farm payment without compensation. This can be seen as a 'worst case' scenario. Scenario D is also included in Fig. 3 as a combination of phased out single farm payment compensated for by increased environmental payments and 25 % lower building costs. This can be seen as a 'best case' scenario. In the worst case scenario, the return to labour is 50 SEK h^{-1} or less. In the best case scenario, the most profitable production model is much higher than the stipulated farm workers wage. As Fig. 3 also shows, the Ss region has lower profitability in scenario 2009 and scenario D compared with regions Gsk and Nn.

Discussion

The aim was to calculate possible future economically sustainable production systems. For this reason, average production data for current, generally small, and in many cases, economically unsustainable herds were not included. Therefore, the calculations were based on data from cow-calf operations with better than average production. This includes breeding herds with high calf output (Swedish Dairy Association 2011) and large, well-managed herds with low labour demand per cow (Nelson 2002). The feed demand was theoretically calculated (Clason 2009) and optimal feed production technology was assumed (Kumm 2009). The feed consumption is higher in many cow-calf operations today due to spillage and over-consumption (Arnesson 2011). The cost of feed production is often higher than necessary due to use of sub-optimal techniques. This suggests that the results presented here are reliable and valid for cost-efficient future cow-calf operations, but overestimate the profitable average Swedish cow-calf herds at present.

The revenues from a specialist cow-calf operation consist of the sales of weaned calves and culled cows, the payments for environmental services and support for less favoured areas and the single farm payment. The revenue from the calves is dependent on the weaning weight and the price per kilogram obtained. The price in turn is dependent on the profitability of fattening to slaughter operations. The support for less favoured areas presupposes that the farm is situated in a supported region. The environmental payment is coupled to the classification of the grazing land; whether the farm is organic or not; and the acreage available for grazing and leys. The single payment scheme depends on where in Sweden the farm is situated and the acreage of the farm. The results of this study and those of a Delphi study based on an expert panel (Salevid 2011) suggest that payment for environmental services, support for less favoured areas and the single farm payment are determining factors for profitability. Despite only small differences in the costs of production and revenues from calves and cull cows, there are gross variations in the return to labour between the alternatives due to the differences in various EU support payments.

In a previous study of profitability among 13 specialist Swedish cow-calf operations, the total revenues consisted of 49 % sales of calves and cull cows, 26 % support for less favoured areas and environmental payments and 25 % revenue from single farm payment schemes (Agribeef 2011). Similarly, in other European countries such as Austria, Germany, France, Spain, the UK and the Czech Republic, various grants make up

Table 5 Description of the calculated production models showing the highest return to labour within each respective category, organic and conventional production

Production model	Organic, O		Conventional, C	
Winter housing	Housed	Out wintering, W	Housed	Out wintering
Calving month	4	4	4	4
Light breed type, L, 550 kg	4OL	4OLW	4CL	4CLW
Heavy breed type, H, 700 kg	4OH		4CH	

Number 4 indicates calving in April

O organic production, *C* conventional production, *L* light breed cows (550 kg), *H* heavy breed cows (700 kg), *W* outdoor wintering

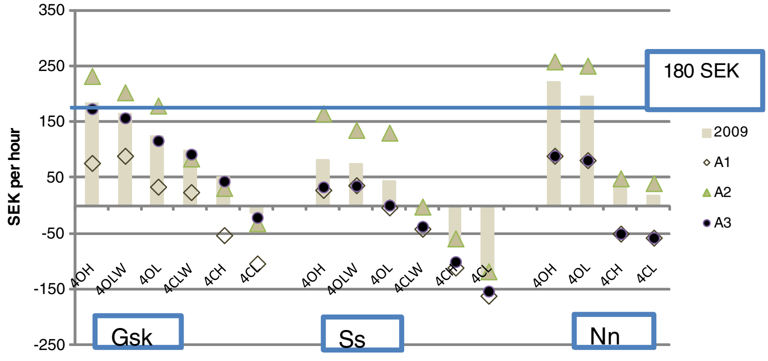

Fig. 1 Return to labour (SEK per hour) for various production models at base line year 2009 and scenarios A1, A2 and A3. The stipulated farm workers wage, 180 SEK h^{-1}, is shown as a *solid horizontal line*

15–60 % of the total revenue in cow-calf operations. On the other hand, in countries such as Canada, the USA, Argentina and Brazil, sales of calves and cull cows make up 100 % of the revenue in cow-calf operations (Agribenchmark 2011).

One threat, not only to beef production, but also to grazing management as an environmental service, is that farmers largely view the single farm payment on arable land as something they receive without having to use the land for production, such as roughage for suckler cows (scenario A3 in Fig. 1). Such a viewpoint could lead to currently active farmers phasing out their production. It could also lead to passive landowners demanding a higher tenancy fee, which could make it harder to build efficient cow-calf operations in the future. Another threat is that farmers will strive for maximised return to labour and reach the conclusion that employment outside the farm pays a substantially higher wage than the stipulated farm workers wage, which was the target in the present study. Building workers have a 25 % higher salary than farm workers in Sweden (Lönestatistik 2011). Only organic production in scenarios with 50 % higher environmental payments (A2 and D) can come anywhere near the building worker's wage level, according to Figs. 1 and 3. A third threat is relative price development over time. In the past 10 years, the nominal price for weaned calves has increased by only 20 %, while the stipulated farm workers wage has increased by 40 % (Agriwise 2011). This issue of wages increasing at a faster rate than beef prices is likely to be a continuing trend over the next 10 years (OECD-FAO 2011).

There was a large variation in profitability expressed as return to labour per hour between the different production models, regions and future scenarios studied here (Figs. 1 and 3). The organic

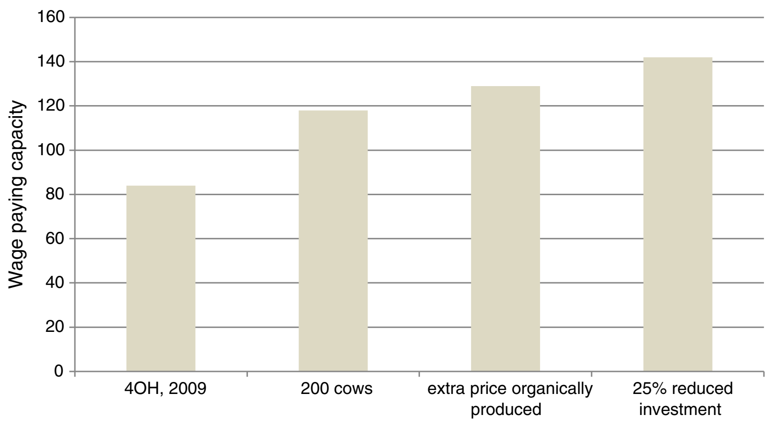

Fig. 2 Return to labour (SEK per hour) in sensitivity analyses for 4OH in Ss when increasing the herd size, adding an organic price premium and reducing the investment cost of buildings

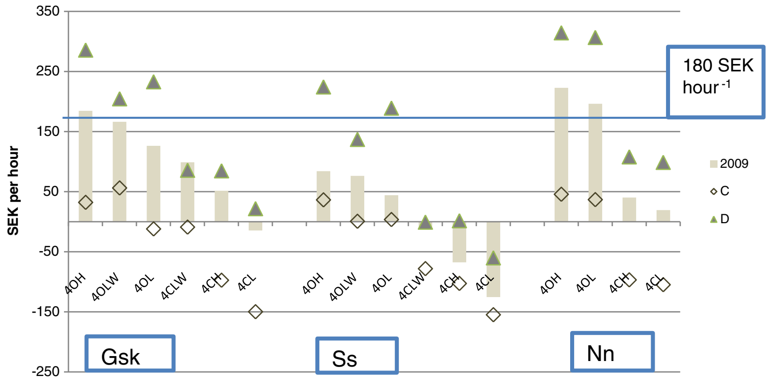

Fig. 3 Return to labour (SEK per hour) for various production models at base line year 2009 for scenarios C and D. The stipulated farm workers wage, 180 SEK h^{-1}, is shown as a *solid horizontal line*

production model had consistently higher profitability than the conventional model due to the organic environmental payments and the larger acreage needed per cow because of lower feed yields. The organic environmental payment was 1,800 SEK cow^{-1} including replacements in most scenarios, which corresponds to approximately 60 SEK h^{-1} for labour if 13 h is spent working (Table 4, footnote l). The greater need for land in the organic alternatives also makes the level of environmental payments for leys, support for less favoured areas and single farm payments higher on a per cow basis in organic production than in conventional production. This same reason makes heavier breed cows more profitable than light breed cows, since the former need more land for feed and grazing. The most land-demanding conventional alternative, 4CLW, had the best return to labour in the conventional group.

The forest-dominated regions of Gsk and Nn showed better profitability than the plains-dominated region Ss in spite of the natural growing conditions such as higher yield per hectare and the favourable farm layout in the latter region (Figs. 1 and 3). One reason for the higher profitability was the higher level of environmental payments for the semi-natural pasture in Gsk, where the whole grazing acreage was assumed to be on semi-natural pasture. In Nn, the support for less favoured areas and the environmental payments for leys were higher per hectare than in Gsk and Ss (Table 4, footnote d). In this way, the subsidy system enhances the variation in profitability and both enables and disables production in different regions. In the long run, this creates a steering mechanism with animal production in regions where the subsidy systems can ensure profitability. Future investments and generation/ownership shifts will occur where this is economically viable. The variation in profitability between different regions will accelerate specialisation towards calf production in certain regions.

In the case of the uncompensated phased out single farm payment (A1), no production model reached a return to labour wage in the level of the stipulated farm workers wage. When the phasing out was assumed to be compensated for by a 50 % increase in environmental payments (A2), a few of the organic production models in Gsk and Nn reached the stipulated farm workers wage. When the single farm payment was assumed to remain, but to be perceived as a common income for arable land and not a part of the suckler cow revenue (A3), only one production model, 4OH in Gsk, reached the stipulated farm workers wage (Fig. 1).

The sensitivity analyses in Fig. 2 showed some strategic choices that could at least partly compensate for decreases in subsidies and in the market price for calves. For example, a 25 % reduced investment cost in buildings increased the return to labour by 140−80 =60 SEK cow^{-1}, provided that cheaper buildings do not increase the labour requirement. The strong effect of decreased building costs indicates that investment subsidies and changes in regulations allowing for simpler building solutions are important in this context. However, as Figs. 1 and 3 show, 60 SEK h^{-1} is not enough to reach a return to labour in line with the stipulated farm workers wage in many of the production models and future scenarios. By marketing organic beef at a premium (1.50 SEK kg^{-1} live weight or 3 SEK kg^{-1} carcass weight) and hence creating an extra price for organic weaned calves and cull cows, the return to labour can be increased by approximately 45 SEK h^{-1}.

Doubling the herd size to 200 cows increased the return to labour in Ss by 35 SEK h^{-1} and in Gsk by 60 SEK h^{-1}. This is due to lower investment costs and labour requirements per cow when the herd increases. In spite of this, the majority of current Swedish cow-calf operations are with small herds in old buildings. At present, less than 2 % of Swedish suckler cows are in herds of 100 cows or more (SCB 2010) and the average herd size is 16 suckler cows (Swedish Board of Agriculture 2011a). The biggest barrier to size rationalisation is the question of access to land. Even though there are unused areas of physically available semi-natural pasture and arable land that could be made into effective units for larger cow-calf operations, there are many factors limiting such development. Traditions, ownership structures of the land and the present subsidy system are some such factors.

A combination of decreased calf prices following the abolition of the male premium and a phased out single farm payment not being compensated for (scenario C in Fig. 3) would lead to very low or even negative levels of return to labour. On the other hand, a combination of phased out single farm payment compensated for by increased environmental payments and 25 % lower building investments would result in a return to labour that equals or even exceeds the stipulated farm workers wage (scenario D Fig. 3). This is true even for region Ss, where in many other cases the profitability is very low. The results indicate that the possibility to maintain sustainable Swedish beef production and to fulfil the Swedish Environmental Objectives on grazing semi-natural pasture and organic production is dependent on the future configuration of the agricultural support systems and the increasing environmental payments.

Beef production based on grazing and feed production on arable land in forest-dominated regions does not compete with any other food production system at present and in fact could be described as changing inedible plant material into edible human food (Wilkinson 2011). Today, this kind of land is considered non-profitable for grain production and lacks an alternative value as agricultural land (Agriwise 2011). The area of agricultural land in forest regions is also decreasing (Swedish Board of Agriculture 2011a) and if the single farm payment should cease, large areas of such land will be turned into forest (Swedish Board of Agriculture 2007). In the Gsk region, where all grazing is on semi-natural pasture, the need for arable land for the most profitable alternatives 4CLW and 4OH was 0.4 to 0.5 ha cow^{-1}, respectively. The need for semi-natural pasture varied between 1.7 and 1.9 ha cow^{-1}, respectively, for the same alternatives. The need for arable land in the Nn region (where both grazing and forage production are performed on arable land) is 1.4 and 2.2 ha cow^{-1} for 4CH and 4OH, respectively. However, if there is a future shortage of land for the global food supply chain and/or for growing energy crops including trees to replace fossil fuels, the proposed advantage of using large areas of land per cow could change into a disadvantage. In the case of future competition for land for food production, it is preferable if the present support system keeps the land within agriculture so that it can be easily transferred into highly productive food crops.

In the case of land scarcity, the need for acreage per cow can be lessened by, amongst other things, changing grass leys to clover-grass leys, which in the organic production systems yielded twice the amount per hectare (Table 2). The winter feed in the most profitable of the production scenarios investigated (4OH) consisted of 60 % grass silage and 40 % grass-clover silage. By replacing the grass silage with clover-grass silage and purchased straw, the acreage required per cow would decrease from 0.49 to 0.24 ha in this organic production model. In the corresponding conventional production scenario using only clover-grass silage and straw (4CH), the need for arable land would decrease to 0.22 ha cow^{-1}. The need for arable land for winter feed production could be decreased even further by delaying the calving time to June, using lighter breed cows and replacing some of the silage with grain in the feed rations. By grazing on arable leys rather than semi-natural pasture, the total acreage needed would also be lessened. On the other hand, arable land has a higher opportunity cost in the case of scarcity of land for food production.

These acreage-saving measures were not profitable in the scenarios studied here. However, with a sufficiently high opportunity cost for arable land, in combination with decreased payments per hectare, the lower acreage production models would result in higher profitability. In order for higher acreage, suckler cow-based beef production to be profitable in these conditions, a considerably higher price level for beef would be needed. According to a future study by the Swedish Board of Agriculture (2007), there will be a large transfer of grazing and arable land to forest in already forest-dominated regions if the acreage-based support system is abolished. The Swedish peoples' willingness to pay for keeping agricultural landscape open by cereal production, grazing arable land and grazing semi-natural pasture, instead of being afforested, is estimated to be 1,600, 3,100 and 3,900 SEK ha^{-1} $year^{-1}$, respectively, based on a contingent valuation survey by Drake (1999) recalculated for the 2009 value of the SEK. This is comparable to the combined acreage-based support payments for organic production for the majority of the scenarios studied here (Table 3). A future research task is to calculate the society-based profitability of various organic and conventional production models for suckler cow-based beef production in the event of land scarcity and environmental payments based on willingness to pay studies.

Conclusions

Given the current environmental support for organic production, it is possible to achieve a return to labour equal to the Swedish stipulated farm wage with an organic cow-calf operation of 100 suckler cows if this is situated in a region where most of the required grazing can be done on semi-natural pasture with environmental support. This profitability also requires continuation of the single farm payment system or increased support for environmental services if the single farm payment is phased out. A further prerequisite is unchanged support for less favoured areas. Profitability equal to the stipulated farm wage is also possible in regions with insufficient semi-natural pasture granted extra support for leys and less favoured areas. Conventional cow-calf operations that receive lower environmental support per hectare and use less land per cow have a considerably lower return to labour than organic operations under the present support systems. The means to support organic production are justified by the non-use of pesticides and fertilisers and the larger proportion of leys in the crop rotations as examples. The existing support model makes the differences between the regions greater than they should be without the support. There are risks that the area-based support system could cause landowners to demand higher tenancy fees, which would reduce the profitability of active farmers dependent on rented land. If scarcity of land for food and energy production should arise in the future, the cow-calf production models must change to more land-efficient models. This could be achieved by replacing grass silage with clover-grass silage and purchased straw, delaying the calving time to June, using lighter breed cows or replacing some of the silage with grain. Conventional production might also be competitive in such a scenario, despite the energy demand for fertiliser production.

Acknowledgments This study was funded by the Swedish Farmers' Foundation for Agricultural Research.

References

Agribeef (2011) Profitability in beef production. http://www.agribeef.se. Accessed 15 Feb 2011

Agribenchmark (2011) Beef and Sheep Report, http://www.agribenchmark.org. Accessed 15 Feb 2011

Agriwise (2011) http://www.agriwise.org/. Accessed 15 Nov 2011

Arnesson S (2011) Cow-calf production on two farms in western Sweden, Report 30, Swedish University of Agricultural Sciences, pp 13–15

Clason (2009) Consulting firm Växa Sverige, personal communication

Drake (1999) The Swedish agriculture landscape—economic characteristics, valuations and policy options. Int J Soc Econ 26:1042–1060

Ekoweb.nu (2012) Ekologisk livsmedelmarknad, Rapport om den ekologiska branchen sammanställd av ekoweb.nu 26 januari 2012, pp 19

Hushållningssällskapet (2006) Betesmarken 1.1

Häggström A. et al. (2005) LRF, Swedish Meats, LRF Konsult, WWF, Hagmarks Mistra, Taurus Vinterhållning av nötkreatur för betesdrift, Affärsmöjligheter –ekonomi och samarbete, Liggbåsstall för 100 dikor, p 5, Liggbåsstall för 200 dikor, p 6

KRAV (2012) http://www.krav.se/System/Spraklankar/In-English/KRAV-/. Accessed 15 Jan 2012

Kumm (2009) Cost of roughage production to beef cattle, Swedish University of Agricultural Sciences, Department of Animal Environment and Health, Section of production systems, Report 23, pp 10–20

Lönestatistik (2011) http://www.lonestatistik.se/. Accessed 15 Sept 2011

Ministry of Agriculture (2004) Genomförande av EU:s jordbrukspolitik. Departementsserien Ds 2004:9

Ministry of Agriculture (2010) The rural development program for Sweden 2007–2013, version mars 2010, pp 66–67, pp 9

Nelson (2002) Lönsamhet i olika besättningsstorlekar i olika produktionsmodeller, Skogs- och Lantarbetsgivareförbundet, SLA Analysgrupp

Nilsson (2007) Ekologisk produktion och miljökvalitétsmålen—en litteraturgenomgång. CUL, Swedish University of Agricultural Sciences, pp 1–2

OECD-FAO (2011) Agricultural outlook 2011–2020. http://www.fenalce.org/archivos/agricoutlook2020.pdf. Accessed 15 Sept 2011

Salevid (2011) Searching for economically sustainable Swedish beef production systems based on suckler cows after decoupling EU income support. Outlook Agric 40:131–138

SCB (2011) Sveriges officiella statistik, Statistiska meddelanden, Food sales 2010, Livsmedelsförsäljning inom detaljhandeln, HA 24 SM 1101, pp 12–14

SCB (2010) teknisk rapport 2010-05-21, Selander, Brundell, Avdelningen för regioner och miljö, Processavdelningen, Undersökning av företag med dikor/amkor, pp 835

Smit (2008) Spatial distribution of grassland productivity and land use in Europe. Agric Syst 98(2008):208–219

Swedish Board of Agriculture (2007) Jordbrukets miljöeffekter 2020—en framtidsstudie, 2007:7

Swedish Board of Agriculture (2008) Prisutveckling och lönsamhet inom ekologisk produktion. Rapport 10:27

Swedish Board of Agriculture (2010a), Hur styr miljöersättningarna för ekologisk produktion?—effekter på marknad och miljö, Rapport 2010:1, pp 5, pp 51: Table 12

Swedish Board of Agriculture (2010b) Agicultural Rents 2010, JO39SM1101, Table 2

Swedish Board of Agriculture (2011a) Yearbook of Agricultural Statistics 2011, Chapter 3 Utilization of arable land, Table 3.1, Chapter 6 livestock, Table 6.1, Chapter 11 Organic farming, Chapter 15 Manufacturing, Table 15.1

Swedish Board of Agriculture (2011b) Jordbruksverkets statistikdatabas http://statistik.sjv.se/Database/Jordbruksverket/databasetree.asp. Konsumtion av livsmedel. Accessed Dec 2011

Swedish Board of Agriculture (2011c) http://www.sjv.se/amnesomraden/stod. Accessed Feb 2011

Swedish Dairy Association (2011) Medelvärden av korrigerade 200-dagars vikter. http://www.taurus.mu/aciro/bilddb/objektvisa.asp. Accessed 15 Jan 2011

Swedish National Atlas (2011) The Royal Swedish Academy of Agriculture and Forestry, Agriculture and Forestry in Sweden since 1900, pp 62, 78, 88–89

Taurus (2011) http://www.taurus.mu/aciro/bilddb/objektvisa.asp. Accessed 15 Feb 2011

Wilkinson (2011) Re-defining efficiency by feed used by livestock. Animal 5(7):1014–1022

Vid **Institutionen för husdjurens miljö och hälsa** finns tre publikationsserier:

* **Avhandlingar:** Här publiceras masters- och licentiatavhandlingar

* **Rapporter:** Här publiceras olika typer av vetenskapliga rapporter från institutionen.

* **Studentarbeten:** Här publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

Vill du veta mer om institutionens publikationer kan du hitta det här:
www.slu.se/husdjurmiljohalsa

DISTRIBUTION:

Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och Husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Box 234
532 23 Skara
Tel 0511–67000
E-post: hmh@slu.se
Hemsida: www.slu.se/husdjurmiljohalsa

Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Environment and Health
P.O.B. 234
SE-532 23 Skara, Sweden
Phone: +46 (0)511 67000
E-mail: hmh@slu.se
Homepage: www.slu.se/animalenvironmenthealth