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Merging Small Scattered Pastures into Large Pasture-Forest Mosaics Can Improve Profitability in Swedish Suckler-Based Beef Production

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Abstract: A scattered structure of small pastures has negative effects on profitability in beef enterprises because small enclosures result in high labor costs per livestock unit. Moreover, larger enterprises distribute the costs across more livestock units and hence achieve lower operating costs. Creating larger coherent pastures makes it easier to increase herd size and yields positive effects due to economies of scale. This study on five Swedish organic cow-calf enterprises examined how profitability is affected by creating larger pastures from small scattered pastures and adjacent forest land. Additional income, additional costs, reduced income and reduced costs were taken into account using a partial budgeting technique. A change to larger coherent pastures was found to be profitable for all enterprises examined. Agri-environmental payments and supports were the most important benefit from creating larger pastures, followed by income increases and cost reductions resulting from economies of scale and improved consolidation. Income reductions due to premature final felling (clearcutting of forest land) and the opportunity cost of forest land did not have a major influence. To conclude, creating large coherent pasture-forest mosaics by merging small scattered enclosures is profitable for Swedish organic cow-calf enterprises.

Keywords: pasture; semi-natural grassland; pasture-forest mosaic; cow-calf; beef; cattle; cow; economic; profitability; consolidation

1. Introduction

North European pasture is frequently scattered in structure, with small separate pasture areas [1,2], as is the case in Sweden [3]. Small scattered areas for pasture and forage harvesting can be expected to have negative effects on the profitability of farm enterprises, as managing these scattered plots separately results in expensive grazing with high fencing and labor costs, especially if the pastures are located far from the main farmyard. Fragmentation increases travel time between plots and results in higher cost for transport, animal supervision and water supply. Swedish animal welfare regulations state that all livestock must be checked daily [4], which results in high costs especially if pastures are small and scattered. Fencing in forest-dominated districts is assessed to be particularly expensive, due to smaller pasture areas and more irregularly shaped pasture compared to areas on open plains. There may also be an increase in the cost of fencing if many electric power units have to be used [5]. An additional effect of small pastures is the difficulty in expanding enterprise size, which impairs the competitiveness of Swedish beef enterprises compared with in other countries [6,7].

In North European beef production, small cow-calf enterprises are over-represented, with the majority of enterprises having less than 30 suckler cows [8,9]. When cow-calf enterprises are expanding, it is common practice to rent a number of small scattered pasture areas far from the farm itself, which increases the costs of transport, animal supervision and fencing. Achieving profitability in such small herds requires use of existing resources with low or no opportunity costs. Existing buildings, fences and machinery capital will ultimately reach the end of their economic lifespan and, moreover, small herds are often owned by old farmers. Hence, re-investment and full coverage of labor costs in small suckler beef enterprises are difficult to achieve [7,10–12].

Economies of scale by distributing the costs across more livestock units have been reported in cow-calf enterprises in the northern hemisphere, e.g., in the United States [13–15] and Sweden [16]. Creating larger coherent pastures facilitates an expansion of the herd size and provides an accompanying positive effect due to economies of scale in feeding, buildings and labor [16]. When herd size increases, the costs of breeding [14,15] and labor per livestock unit also decrease [16]. Hence, the larger farm, the higher the net income per animal [14–16].

Low profitability in suckler-based beef production, caused e.g., by small herd size, is a threat not only to farming but also to the social values of semi-natural pastures. Semi-natural pastures are a feed resource, but they also preserve biodiversity and represent a cultural heritage with substantial and amenity values [17–19]. Suckler cows and other grazing livestock provide an important function in preserving these values, as grazing management is a prerequisite for the values to prevail. The decreasing number of grazing livestock in Sweden over the past century and subsequent abandonment and fragmentation of grasslands have resulted in a trend towards disappearance of threatened plant and animal species [20,21]. To promote preservation of semi-natural pastures, the government provides agri-environmental payments for regular grazing of these areas and also for individual measures, such as restoration of overgrown or afforested former pasture land. These payments are important for achieving profitability in Swedish beef production [16,22,23]. Another factor important for profitability is organic farming, as it results in higher product prices and is also eligible for agri-environmental payments, both in Sweden [24,25] and in the rest of Europe [24,26–29].

Due to natural circumstances, most Swedish semi-natural pastures are small and scattered, especially in forest districts [3]. One way to increase profitability could therefore be to create large pasture-forest mosaics that combine small scattered semi-natural pastures and adjacent marginal arable and forest land [30]. However, when forest is included in pasture areas grazing livestock may damage trees, affecting future income from the forest [31–33]. Therefore, it is vital to consider the economics of beef production and the economics of forest production in the same analysis.

Knowledge of production costs and efforts to minimize these are also important, irrespective of herd size. Under Swedish conditions, it might be preferable not to replant forest after a regular clearcutting, but instead transform the forest land into pasture. At normal interest rates used in Swedish agriculture (3–4%) [34], replanting after final clearcutting gives a negative or poor return to land at timber production below eight cubic meter over bark per hectare (ha) and year [35]. Timber production capacity is below that threshold for nearly 60% of the forest land in southern and central Sweden and for all forest land in northern Sweden [35,36]. Given higher requirements on return to assets from forest production, a more profitable option may be to transform forest into pasture [10]. If forest land were not replanted after final harvesting, it would be possible to develop larger coherent pasture-forest mosaics that decrease the cost of fencing and labor compared with small scattered pastures. It is not well documented in the literature whether the resulting loss of forest income is compensated for by the benefits of more rational pasture size.

The aim of this study was, therefore, to compare profitability on a number of Swedish farms before and after changing from small to large pastures by merging small scattered enclosures of semi-natural pastures with adjacent, marginal arable land and forest into large coherent enclosures.

2. Material and Methods

Farmers with cow-calf enterprises who had recently created large coherent pastures from small, scattered pastures, and adjacent forest and/or transformed forest to pasture, were recruited for the study through advertisements in two national farming journals in Sweden, *Nötkött* (*Beef*) and *Ekologiskt Lantbruk* (*Organic Agriculture*). Twenty enterprises responded and were visited.

Out of the 20 farms, those who had suckler-based organic beef production with more than 20 cows, experience of major changes in pasture management and able to provide substantiated data were selected for the study. This resulted in a sample of five farms with varying herd size from different geographical locations across Sweden. This method is similar to the approach taken by Frankwick and co-workers [37] in their study of strategic decision making in high technology firms. The enterprises selected had 30–280 suckler cows and most kept their calves until slaughter. After the initial interview, the five farms were visited once more for a complementary interview regarding changes in their pasture management (Table 1), and the consequences of the changes (Table 2), based on the farmers' estimates and accounting records.

Table 1. Conditions before and after merging small scattered pastures into large coherent pasture-forest mosaics in five Swedish cow-calf enterprises.

Farm No., Geographical Location	Herd Size (No. of Cows) and Area of Arable and Pasture Land (Hectare, ha) before/after Change	Before Change: Small and Scattered Pastures	After Change: Large Coherent Pasture
Farm 1, forest district in Götaland	160 cows/160 cows; 221 ha/245 ha	Several rented small pastures far away.	Converted 24 ha of wind thrown forest causing premature final felling near the barn to pasture, replacing rented pastures far away.
Farm 2, plain districts in Götaland	30 cows/30 cows; 46 ha/63 ha	Own farmland divided into many small paddocks by internal fences. Cows kept in a labor-intensive stanchion barn in winter.	Created a large coherent pasture by merging semi-natural pasture, arable land and some forest through removing internal fences. Keeps the cows outside on pasture all year round, using forest as a form of weather protection.
Farm 3, plain districts of Svealand	280 cows/280 cows; 540 ha/545 ha	Several rented relatively small pasture areas far away. Own poorly consolidated arable land rented to other farmer.	Converted own arable land, including scattered semi-natural pastures, groves and 5 ha forest to large coherent pasture and stopped renting small, scattered pastures far away.
Farm 4, plain districts in Svealand	270 cows/295 cows; 800 ha/840 ha	Wetland pasture where cattle had to be removed during rainy periods, which required labor and fields for grazing and as a reserve.	Created a large coherent pasture from the wetland. Forest land was converted, so the livestock can graze during wet and dry periods. The change released land for growing forage and made it possible to increase the herd by 25 cows.
Farm 5, upper parts of Norrland	50 cows/50 cows; 80 ha/80 ha	Several rented small pasture areas far away.	Stopped renting some pastures far away and rented 16 ha pasture closer to the farm. Arable land in this area of Sweden has no or low opportunity costs and therefore no positive rent exists.

Table 2. Descriptions and calculations of items when creating large coherent pasturelands from small scattered pastures in five Swedish cow-calf enterprises.

Item	Description
Additional income	
Agri-environmental payments and supports	Agri-environmental payment per hectare (ha) [38] * no. of ha on farm
Higher survival of calves	Price for weaned calf at 300 kg [39] * percentage increase in calf survival on farm
Slaughter income	Price for carcass per kg [39] * carcass weight (kg) according to farmer's statement
Stumpage value of final felling	Stumpage value per ha [40,41] * annualized at 30 years and 4% interest rate
Reduced income	
Cost of premature final felling	Cost of premature final felling per ha [42,43] * annualized at 30 years and 4% interest rate
Opportunity cost of forestry land	Opportunity cost for forestry land [40,41] * interest rate
Loss of rent for agricultural land	Rent cost on arable land in the area per ha [38] * no. of ha on farm
Loss of value of manure	Net value of manure after cost for spreading + soil compaction [44]
Additional costs	
Restoration and fencing costs [a]	Restoration (wages per h and tractor cost per h) [11] * farmer's time estimate * (annualized at 30 years and 4% interest rate). Fences (wages per h [11] * farmer's time estimate) + cost for materials 2016, tax depreciation five years
Animal transports and supervision [a]	(Wages per h and tractor cost per h) [11] * farmer's time estimate (h).
Feeding cost at pasture [a]	(Wages per h and tractor cost per h) [11] * farmer's time estimate (h)
Outdoor housing	Outdoor housing systems for cattle [45]
Building cost of barn	(Material costs + wages per h) [11] * farmer's time estimate (h). Tax depreciation 20 years for the building structure and five years for the building equipment
Feed for more animals [a]	Feed quantity (kg dry matter) [11] * price per kg dry matter [11]
Labor for more animals	Wages per h [11] * farmer's time estimate (h)
Interest rate, animal and working capital	4% interest rate at increased animal capital and increased working capital
Reduced costs	
Animal transports, supervision and feed [a]	(Wages per h and tractor cost per h) [11] * farmer's time estimate (h)
Costs of pasturing [a]	(Wages per h and tractor cost per h) [11] * farmer's time estimate (h) in maintenance, land clearing and removal of deciduous trees from mixed stands
Costs of sires	Feed cost per sire [11] + (purchase price for sire - slaughter income per kg carcass weights) [39]
Rent of agricultural land	Rent cost on arable land in the area per ha [38] * no. of ha on farm
Indoor housing cost	Farmer statement and Agriwise [11]
Indoor feeding cost [a]	(Wages per h and tractor cost per h) [11] * farmer's estimate

[a] The cost of tractor and machinery in the table includes only fuel and maintenance and not capital costs, since the examined conversions studied on the farms did not change the need for new machinery investments.

The profitability of changing from small to large pastures by converting intermediate marginal arable land and forest land was calculated using partial budgeting techniques [46]. The change in profitability was calculated as:

(Additional income + Reduced costs) − (Additional costs + Reduced income).

The partial budgeting technique took into account the revenues and cost items that changed as a result of increasing pasture size by including intermediate, marginal arable and forest land. As a result, only the effects of the changes were examined, not the financial results for the whole farm.

The model included reduced income attributable to premature harvesting of forest land due to conversion of forest land into pasture. Reduced income also included the opportunity cost of forest land, given that the original value of land remains constant although the standing volume has been harvested. The annual reduced income was calculated as the annuity of the discounted value of future revenues from forest land in the event that premature harvesting is not enacted. The discounted present value (PV) of future net benefits originating from planned forestry activities in the event that the forest land is not transferred into pasture at time t, here denoted H_t, is given by the equation:

$$PV = \sum_{t=1}^{T} H_t(1+r)^{-t}$$

The equation was calculated for each of the five farms using Plan33 [40]. In accordance with theoretical developments reported by Lagerkvist and Andersson [47], r is an after-tax interest rate calculated at 4% in the basic calculation. It is important to note that all calculations were conducted "after tax", which means that applicable tax provisions were used both the investment in beef production and in forestry. All results are presented as Euros (€) per year.

In a second step, sensitivity analysis was enacted for a situation without agri-environmental payments and supports. Sensitivity analysis was also undertaken for changes in beef prices and price payed for weaned calf by decreasing the price with €0.5 per kg, for a decrease in the interest rate in forestry from 4% to 2%, and for a decrease in the market price of timber.

Finally, the factors affecting the farms were grouped into five categories defined by the impact on profitability:

(1) Agri-environmental payments (agri-environmental payments for grazing of semi-natural pasture, restoration of semi-natural pasture, and organic production) and supports (single farm payment, enterprise support, support for less favoured areas, and animal premium).
(2) Economies of scale (additional slaughter income with increasing number of animals minus additional costs for feed, building, labour, and interest).
(3) Improved consolidation (reduced costs of animal transport, supervision, feeding, pasturing, and sire due to the fact that small pastures far away from the farm centre were replaced by new pastures and removal of old internal fences).
(4) Net rent (reduced rent costs for former rented pastures far from the farm minus loss of income from high agri-environmental payments on these pastures and loss of rent for land previously rented out but now transferred to pasture).
(5) Forestry (additional income from final felling and loss of future forestry production).

3. Results

Arrangements designed to create larger coherent pasture areas contributed towards improved profitability on all farms studied (Table 3). The increase in profitability, expressed per farm and per ha, is highest for Farm 4, due to improved consolidation in combination with enlarging herd size.

On Farms 1 and 3, agri-environmental payments and supports are the primary source of increased profitability. On Farm 3, rent is a negative item due to the loss of income from previously rented-out arable land that is now converted into pasture. Farm 3 also loses some income from high agri-environmental payments associated with the smaller areas of rented pastures far away. Due to larger coherent pastures, and hence more cows in each enclosure, Farm 3 requires fewer sires which reduces costs.

Table 3. Change in profitability, Euro (€) per farm and year, according to the partial budgeting model, summing up additional income, reduced income, additional costs and reduced costs, attributable to the creation of larger coherent pasturelands from small scattered pastures in five Swedish cow-calf enterprises (1–5).

Farm	1	2	3	4	5
Additional income					
Agri-environmental payments and supports	7526		16,464	18,945	
Higher survival of calves		1045			
Slaughter income				18,804	
Stumpage value of final felling				7662	
Sum	**7526**	**1045**	**16,464**	**45,411**	**0**
Reduced income					
Cost of premature final felling	148			1887	
Opportunity cost of forestry land	8		−50	−277	
Loss of rent for agricultural land			26,233		
Loss of value of manure		1028			
Sum	**157**	**1028**	**26,183**	**1610**	**0**
Additional costs					
Restoration and fencing costs	12	721	280	190	145
Animal transport and supervision			2132		
Feeding cost at pasture		4400			
Outdoor housing		681			
Building cost of barn				2646	
Feed for more animals				7673	
Labor for more animals				289	
Interest rate, animal and working capital				1158	
Sum	**12**	**5802**	**2411**	**11,956**	**145**
Reduced costs					
Animal transports, supervision and feed	744	84	4315	777	2336
Costs of pasturing		882		544	
Costs of sires			1155		
Rent of agricultural land			14,380		
Indoor housing cost		4465			
Indoor feeding cost		1 366			
Sum	**744**	**6796**	**19,849**	**1321**	**2336**
Total sum per farm	**8102**	**1011**	**7719**	**33,166**	**2191**
Total sum per ha	**33**	**16**	**28**	**39**	**27**

Creating a larger enclosure including some forest on Farm 2 enables keeping cows outdoor all year round. Compared with using the former stanchion barn in winter, Farm 2 thus has reduced labor costs as a result of the change due to abandoning the indoor housing during winter. Furthermore, the survival rate of calves increased on changing housing system, providing additional income. However, when wintering the suckler cows outdoors Farm 2 had problem to handle all the manure, which causes a reduced income in its organic crop cultivation. On the other hand, after the change to an enclosure including forest, the suckler cows forage a lot of verges and also some brushwood, which reduced costs for land clearing that previously required farmer's labor.

Due to the increase in herd size, Farm 4 receives additional income not only from agri-environmental payments and supports, but also from slaughter livestock. Additional income from the animals exceeded the additional costs for feed, building, labor and interest, resulting in economies of scale. The final felling of the forest converted to pasture at Farm 4 provided a high stumpage value, due to the fact that the forest was cut at a period of high timber prices. The actual stumpage value was higher than the reduced income due to premature clearcutting and loss of future forest production. Consequently, conversion of forest land gives a net benefit.

The improved profitability on Farm 5 is entirely due to the replacement of rented pastures far away with 16 ha of pasture close to the farm, resulting in lower costs for animal transport and supervision.

The sensitivity analysis (Table 4) reveals that when agri-environmental payments and supports are excluded, the increase in profitability is, compared with baseline, halved for Farm 4 and drastically reduced for Farm 1. Moreover, without agri-environmental payments and supports the result is actually negative for Farm 3, due to loss of rent for arable land converted to pasture and loss of income from high agri-environmental payments on formerly rented pasture. On Farms 2 and 5, the creation of large pasture enclosures is profitable irrespective of payments and supports. Reducing the price paid for weaned calves and carcasses by €0.5 per kg respectively does not have any major effect on profitability on Farms 2 and 4. Halving the interest rate in forestry from 4% to 2% decreases profitability marginally on Farms 1, 3 and 4 on converting forest to pasture.

Table 4. Sensitivity analysis for profitability, € after tax per farm and year, when changing five variables relevant in creation of large coherent pastures from small scattered pastures in five Swedish cow-calf enterprises (Farms 1–4, Farm 5 not affected).

Farm	1	2	3	4
Total sum per farm, basic calculation	8102	1 011	7719	33,166
Excluding agri-environmental payments and supports	576		−8745	14,221
Reduced price paid for weaned calves, by €−0.5 per kg		825		
Reduced price paid for carcasses, by €−0.5 per kg				31,169
Interest rate in forestry, 2% instead of 4%	7393		7543	31,867
Missing the highest peak of timber price				29,986

If Farm 4 would have missed the highest peak of timber prices when the forest was harvested, the profitability increase is reduced only marginally. Thus, even when changing the variables in the sensitivity analysis, the measures undertaken are still profitable for all four farms except when taking agri-environmental payments and supports away from Farm 3.

It is apparent, as can be noted when five stated causes are allocated (Figure 1), that consolidation contributes to improved profitability on all five farms. Consolidation is the sole cause of increased profitability on Farms 2 and 5, due to large coherent pastures close to the farm enabling more rational housing and pasture management, respectively. Agri-environmental payments and supports is the major reason for the positive results of the changes on Farms 1, 3 and 4. As seen for Farm 4, forestry and economies of scale gave similar additional income. On Farm 3, the increase in agri-environmental payments and improved consolidation exceeded the loss of net rent (left-hand bar in Figure 1) due to the missed income from formerly out-rented arable land converted to pasture. In addition, Farm 1 displays an inconsiderable negative bar caused by reduced income in forestry.

4. Discussion

In this study of the effects of creating larger, coherent pastures, all organic cow-calf enterprises studied profited from the change, as additional income and reduced costs exceeded reduced income and additional costs. The increase in profitability is mainly due to higher agri-environmental payments and supports when forest land (Farms 1, 3 and 4) and arable land (Farm 3) is transformed into pasture eligible for agri-environmental payments and supports. Available statistics [38] shows that the agri-environmental payments and supports generally appears to have promoted an increase in beef herd size and conversion of arable land and abandoned farmland into pasture at national level in Sweden. Agri-environmental payments and supports are major factors affecting the profitability in cow-calf production. An important contribution on transforming forest land back to pasture being the payment for pasture restoration.

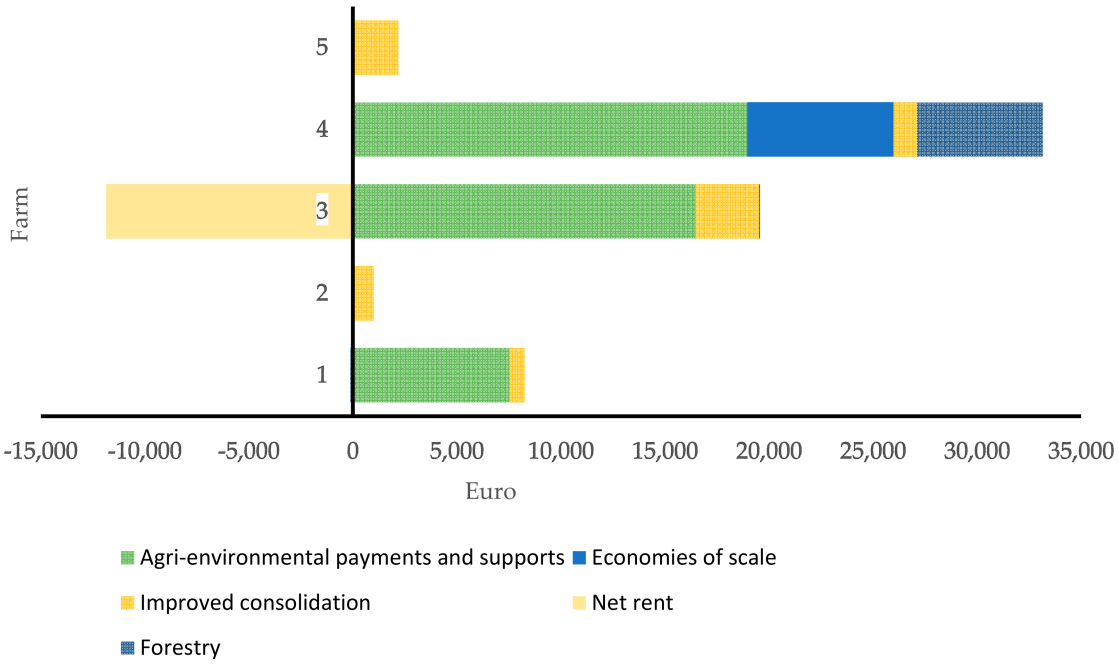

Figure 1. Magnitude, € after tax per farm and year, and reasons for profitability increases due to creation of large coherent pastures on five Swedish cow-calf enterprises.

In general, half the income in Swedish cow-calf enterprises derives from the agri-environmental payments for semi-natural pastures and organic farming and a variety of supports [11,38]. The sensitivity analysis in this study reveals that agri-environmental payments and supports are of crucial importance for the profitability of three of the farms studied. Depending on the enterprises situation, the agri-environmental payments and supports are more or less critical for the profitability.

Farm 4, which could increase its herd size when transforming forest to pasture, showed the highest profitability increase without agri-environmental payments and supports of all farms studied, due to economies of scale. Since the year 2000, average herd size in Swedish cow-calf production has increased by 60% [41]. Nevertheless, the average size remains at only 19 suckler cows per farm [38] and 78% of the farms have 1–25 suckler cows [48]. Thus, most Swedish cow-calf enterprises are smaller than those examined in this study (30–280 cows). It is well known, that distributing costs across more cattle reduces the costs per animal unit [13–16]. With larger herds, Short [14] found that the operating costs per animal in cow-calf production for feed, veterinary services, bedding and also some custom operations such as fuel and electricity declined with enterprise size. There was also a positive effect on capital costs for tractors, equipment and insurance. In contrast, Langemeier and co-workers [15] concluded that production costs are not always affected by the size of the enterprise and that the variation between farms is substantial. Similar findings are made in the present study, e.g., there is a substantial variation in costs between farms depending not only on herd size but also farm layout, rented pastures, transports etc. The results from this study show that there is potential on both small and large cow-calf enterprises, irrespective of location in Sweden, to achieve improved profitability by creating larger coherent pastures.

The results in this study are due to several factors. Time required for transport and supervision constitutes a major part of the reduced costs. Better consolidation has also been reported to increase profitability in other countries. For example, on dairy farms in Spain, profitability increased when the farm was less fragmented [49], while in Finland land consolidation decreased enterprise costs [50]. However, most Swedish pastures are small, especially in forest districts where there is much abandoned and marginal arable land with low or no opportunity cost, but which would be appropriate for beef production if better consolidated. In typical Swedish forest districts, where less than 10% of the area

consists of farmland and the average farm only has 30 ha arable land and pasture, the average size of pasture enclosures is only two ha [3]. Even if increasing the size of these pasture units would be profitable, it is not always possible due to different land owners and thus difficulty in acquiring enough land, intersecting roads and scattered habitations [30].

Cattle kept outdoors all year round may be healthier than cattle reared indoor [51]. It is known that a good air supply promotes calf health, with less respiratory diseases [52]. Hence, there exists a risk of increased infection pressure from crowding cattle indoors. It has also been found that the formation of cow-calf bond can be disturbed when calving occurs in groups, especially in crowded situations [53]. Creating a large pasture with forest to protect the animals from the weather on Farm 2 meant that calving occurs on pasture instead of indoors, resulting in higher survival rate of calves. A higher proportion of weaned calves implies more additional income due to the change. The price paid for weaned calves is positively correlated with the price paid for beef carcasses. In recent years, the price paid for beef carcasses at Swedish abattoirs has been high [38], Hence, the price of weaned calves has also increased [39]. A few years ago, the additional income from weaned calves on Farm 2 was not as high as at present.

A vital issue for Farm 3 was the termination of rented pastures far away from the farm, which required a lot of labor and fencing. When a larger pasture was developed on the farm's own land, the enterprise stopped renting distant pastures. Even though the farm's own pasture was of lower biological and cultural heritage value, resulting in a lower agri-environmental payment, creating a more coherent pasture enclosure by including marginal arable land produced more forage than the former rented land, so the change was profitable. Large pasture enclosures require shorter fence lengths per ha pasture. Furthermore, larger but fewer enclosures implies that fewer watering facilities are needed, less transports of cattle between enclosures and fewer stops on the daily cattle inspection tour.

Farm 5 faced problems with land tenure that made it difficult to merge pastures closer to the farm. The farm is situated along a river, with a multitude of owners with small land properties. Despite previous repeated attempts by the farmer, some of the landowners would not allow any cattle on their land. When Farm 5 was given the opportunity to rent a larger coherent pasture closer to the farm, it achieved a positive consolidation effect due to less transports.

Sweden consists of three million ha of farmland, 23 million ha forest, 13 million ha of mountains, and one million ha of built-up areas and related land. The southern and central parts of Sweden up to the southern border of the mountain area are dominated by coniferous and deciduous forest in which there is scattered farmland [54]. A few defined plain districts with economically sustainable crop production are located in southern and central parts. Large area of farmland in the forest districts has been abandoned during the past century, while the remaining arable land is becoming even more concentrated to the plains, where larger enterprises are possible. Less productive, often smaller, patches of arable land are abandoned and overgrown, or actively transformed to forest by planting.

In large parts of Sweden, farm enterprises often have both production of beef and forest [3,54]. Creating large coherent pasturelands, embracing both pastures and forests, is thereby possible on such mixed enterprises. With return requirements normally facing the agriculture and forestry sector (4% real interest rate in the present study), replanting after final felling has low profitability on much of Swedish forest land [35]. On Farms 1, 3 and 4, it proved profitable not to replant and instead transform the forest land to pasture after final felling, in order to improve the consolidation and/or get pasture for a larger herd. On Farm 4, even premature felling motivated by quickly obtaining access to more consolidated pasture was profitable. However, felling on this farm to transform forest to pasture was undertaken in 2010 when the prices of forest products were very high [43]. Furthermore, the logging was large-scale (40 ha) which might have had a positive effect when the farmer was bargaining on price, and there are good roads nearby for transport of the timber. Taken together, the stumpage value of final felling in this study might be higher than in an ordinary year and another situation. However, the sensitivity analysis reveals only marginal effects on profitability of decreasing the stumpage value to a more normal price.

There are a number of governmental environmental quality objectives in Sweden. Two of these, "a varied agricultural landscape" and "a rich diversity of plant and animal life", are dependent on continuously managed semi-natural pastures [55]. Grazing livestock serve an important function in the preservation of semi-natural pastures. Abandonment and fragmentation are the major threats to biodiversity, where short-lived plants can easily disappear if grazing management ceases and fragmentation and increasing distance between small scattered species-rich pastures obstruct seed dissemination to other grasslands [56]. Opening up fences around separate semi-natural pastures to create large coherent pastures embracing adjacent forest and ex-arable land increases connectivity between species-rich plots and thereby promotes the preservation of vulnerable grassland species. After restoration of abandoned grassland, the number and frequency of species increase with time, but the final outcome is dependent on presence of species in the neighborhood [56]. Re-colonization of biodiversity was not investigated in the present short-term study. However, systematic inventories of vascular plants were undertaken on Farm 3 before and after creation of large coherent pastures from a mosaic of managed and previously abandoned semi-natural pastures, arable land and forests. This revealed that some vascular plants have spread greatly from the managed semi-natural pastures to the other land [57]. Varying grazing system alter the composition and structure of pasture vegetation where species sensitive to continuous grazing are more frequent in rotationally grazed paddocks whereas less competitive species tend to increase in continuous grazing systems [58]. As a large part of the Swedish semi-natural pastures are less than 2 ha [3] they are too small to be part of a rational rotational grazing management. Rotational grazing among some large connected pastures, which are created from small scattered pastures, could therefore enable rational rotational grazing systems. Various rotational grazing systems is provided at Farm 1, 3 and 4 to promote biodiversity. Farm 2 and 5 do not have areas with high biodiversity values as continuous grazing is satisfying.

Farms 2 and 3 have both expanded pastures that include forest. Experience from the early 1900s, when forest grazing was common in Sweden, shows that excessive forest grazing can cause major damage to trees [32]. However, careful forest grazing at appropriate times and stocking rates causes insignificant forest damage [59,60], especially if the livestock also have access to lush open pasture [61]. Livestock grazing in coniferous replanting may even provide silvicultural benefits by removing deciduous vegetation [62], which competes with the young trees for nutrients, water and light [63]. Such positive effects have been noted on Farm 2. Grazing and trampling livestock may also be associated with decreased soil water storage and increased runoff. The effects of grazing on forest vary with rainfall, slope, soil stability and vegetation type, and also with animal density and stocking rate, as well as season and duration of use [62]. Forest damage due to grazing animals may not become apparent for decades and therefore it was not possible to assess this problem in the present study.

5. Conclusions

A scattered structure of small pastures has negative effects on profitability in cow-calf enterprises since small enclosures result in high labor costs per livestock unit. Creation of larger coherent pastures facilitates an increase of herd size, which yields positive effects due to economics of scale. This study examined how additional income, additional costs, reduced income and reduced costs affects the profitability, by using a partial budgeting technique, when creating larger coherent pastures from small, scattered pastures and adjacent forest land on five Swedish cow-calf enterprises. Decreased labor costs for animal transports and supervision as well as other cost reductions due to improved consolidation contributes to improved profitability on all five cow-calf enterprises examined. Consolidation is the sole cause of increased profitability for two of the farms, due to larger coherent pastures close to the farm, which enables more rational housing and pasture management, respectively. Agri-environmental payments and supports is the major reason for increased profitability on the other three farms. When agri-environmental payments and supports are excluded, two out of the three farms still display positive results, due to consolidation effects on one farm and economies of scale, forestry and consolidation on the other. For the latter farm expanding enterprise, economies of scale and

forestry gave similar additional income. A reduction of price paid for weaned calves or reduced price paid for carcasses did not have any major effect on profitability. Costs for premature final felling and opportunity costs for forestry land were of quite minor importance.

Improving the profitability, and thereby promoting the economic sustainability of beef production by creating large coherent pasture including e.g., semi-natural pasture, marginal arable land and former forest land, is of interest not only for the involved farmers. It is also socio-economically important because it improves the international competitiveness of Swedish beef production, creates employment opportunities in rural areas and enables the conservation of semi-natural pastures with high amenity and biodiversity values.

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