Can Swedish beef production become profitable by learning from Canadian beef production?

Kan svensk köttproduktion få bättre lönsamhet genom att lära av kanadensisk köttproduktion?

Sofia Nyman

Master in Animal Science

Sveriges lantbruksuniversitet **Skara 2009** **Studentarbete 290**
Institutionen för husdjurens miljö och hälsa
Avdelningen för produktionssystem

Swedish University of Agricultural Sciences ***Student report 290***
Department of Animal Environment and Health
Section of Production Systems

ISSN 1652-280X

Can Swedish beef production become profitable by learning from Canadian beef production?

Kan svensk köttproduktion få bättre lönsamhet genom att lära av kanadensisk köttproduktion?

Sofia Nyman

Studentarbete 290, Skara 2009

Avancerad E, 30hp, Självständigt arbete husdjursvetenskap, kurskod: EX0517

Handledare: Karl-Ivar Kumm, Box 234, Gråbrödragatan 19, 532 23 Skara
Examinator: Birgitta Johansson, Box 234, Gråbrödragatan 19, 532 23 Skara

Nyckelord: cow-calf operation, feedlot, Canada, outdoor wintering

Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Avdelningen för produktionssystem
Box 234, 532 23 SKARA
E-post: hmh@slu.se, **Hemsida:** www.hmh.slu.se

Index

Abstract

To make Swedish beef production more profitable and sustainable, even without subsidies, there is a need to find alternative production systems to reduce the cost of production. One way to find cheaper solutions for Swedish beef production is to learn from beef producers in other countries and regions with similar natural conditions as Sweden. Western Canada has a good and large scale cow-calf production and finishing of calves, and Peace River Region (PRR) in British Columbia (BC) has similar natural conditions as Central Swedish Flatlands (CSF). Alberta, where most calves from PRR are finished, and PRR are used as study regions for finding cheaper beef production systems than present in Sweden. How to reduce Swedish costs are investigated by comparing PRR and CSF budgets for cow-calf operations as well as Albertan and CSF budgets for finishing beef cattle. For CSF, budgets from the Swedish University of Agricultural Science are used. One important reason for the low costs of beef production in western Canada is outdoor wintering of the cows and finishing of young cattle in open feedlots. In order to more closely study the possibilities of introducing Canadian production systems in Sweden; natural conditions, history and especially present production systems in western Canada, cow-calf operations in PRR, feedlots in Alberta and a museum were visited.

Swedish beef production is characterized by high costs of production caused by small herd sizes, relatively high labour costs, high demands on buildings, short vegetation period and lack of large and connected pastures. Western Canadian beef production is much younger than Swedish beef production and is more characterized by outdoor wintering, large scale production, ranching culture and low building costs. Cow-calf operations are the start of most beef production in western Canada and these are mostly situated in areas where there are poorer conditions for grain production. Beef cows are kept outdoor year around and outdoor wintering reduce the costs of buildings and labour since the cattle are grazing for a longer period. Feedlots are located in regions where the grain production is high and most feedlots in Canada are located in southern Alberta.

Most expenses in cow-calf operations are considerably higher in CSF than in PRR and the biggest differences are building and labour costs. Since the wages per hour for a farm worker in PRR and in CSF are almost the same, one reason why labour costs are lower in PRR is the fewer working hours that are needed per cow, which depends on bigger herd sizes in PRR. A reason why building costs are lower in PRR than in CSF is that beef cows are wintered outdoors with a minimum of constructed shelter in PRR while in CSF the cows are wintered indoors in expensive buildings. Rational outdoor wintering can also be a reason for lower labour costs because outdoor wintering is more cost effective. If cow-calf production in Sweden would follow the production model in Canada, with 200 beef cows and outdoor wintering, the expenses could be fully covered, whereas the present Swedish cow-calf production is unable to cover its costs including e.g. feed, buildings and labour. If the governmental payment will be abolished, even though the PRR cow-calf system is used the result will be negative, but not as negative as with present Swedish cow-calf production.

In finishing operations the costs of building, labour and feed are higher in CSF than in PRR. To reduce these costs in Sweden there is a need for bigger herds and less demand on the buildings. In Alberta it is enough with windbreakers but in present Swedish production system the animals are housed indoors in expensive buildings. If the finishing operation in Sweden, with male animal premium, could follow Albertan feedlot model the operations could be profitable. If the male animal premium would be abolished, even though the

Albertan production system will be used, the result will still be negative, but not as negative as with present Swedish finishing system.

To have cattle wintered outdoors in Sweden, with a minimum of constructed shelter, there is a need to find suitable areas. Such areas can be where the climate is suitable i.e. not too much precipitation and solid frost in the ground during winter time. The land should have low opportunity cost and the soil should be a dry sandy moraine soil with good infiltration capacity.

Sammanfattning

För att få en mer lönsam och uthållig köttproduktion i Sverige, även utan bidrag, finns det behov av att finna alternativa produktionssystem för att få lägre produktionskostnader. Ett sätt att hitta billigare lösningar är att ta del av andra länders och regioners, med liknande naturliga förutsättningar som Sverige, köttproduktion. Västra Kanada har både en bra och storskalig dikoproduktion och slutuppfödning av kalvar, och Peace River Region (PRR) i British Columbia (BC) har liknade naturliga förutsättningar som Svealands Slättbygder (CSF). Alberta, där de flesta kalvar från PRR slutgöds, och PRR är regioner som valts att studeras för att hitta billigare produktionssystem än de nuvarande som finns i Sverige. Hur kostnader skall kunna reduceras i Sverige undersöks genom att jämföra dikokalkyler för PRR och Sveriges Lantbruksuniversitets (SLU:s) områdeskalkyler för CSF. Detsamma gäller för slutuppfödningen av kalvar där kalkyler för Alberta och CSF jämförs. En viktig orsak till Kanadas låga produktionskostnader i köttproduktionen är att dikorna övervintras och utfodras utomhus och slutuppfödningen av kalvar sker i öppna så kallade feedlots. För att noggrannare studera de naturliga förutsättningarna, historia och speciellt nuvarande produktionssystem i västra Kanada besöktes dikoproducenter i PRR och feedlots i Alberta, samt ett museum.

Svensk köttproduktion karaktäriseras av höga produktionskostnader vilket kan bero på småskalighet, relativt höga arbetskostnader, höga krav på byggnader, kortare vegetationsperiod och brist på större och sammanhängande betesmarker. Västra Kanadas köttproduktion är betydligt yngre än Sveriges och karaktäriseras av övervintring utomhus, storskalighet, ranchkultur och låga byggnadskostnader. Dikoproduktionen är starten på västra Kanadas köttproduktion och dikoproducenterna befinner sig oftast i områden som har sämre förutsättningar för spannmålsproduktion. Dikorna är utomhus året runt vilket minskar kostnader för både byggnader och arbete då korna betar under en längre period. Feedlots är oftast lokaliserade i regioner där spannmålsproduktionen är hög och de flesta feedlots i Kanada är lokaliserade i södra Alberta.

De flesta kostnaderna i dikoproduktionen är högre i CSF än i PRR och de största skillnaderna är byggnadskostnader och arbetskostnader. Då lönerna per timme i princip är lika höga i både PRR och CSF kan en orsak till de lägre arbetskostnaderna i PRR vara färre arbetstimmar per ko, vilket är ett resultat av större besättningar i PRR. En förklaring till att byggnadskostnaderna är lägre i PRR än i CSF kan vara att korna i PRR övervintras utomhus med minimala väderskydd, medan i CSF övervintras de i dyra byggnader. Rationell övervintring utomhus kan också vara en anledning till att arbetskostnaderna i PRR är lägre, då övervintring utomhus är mer kostnadseffektiv. Om Sveriges dikoproduktion skulle ta efter produktionssystemet i PRR, med 200 dikor och övervintring utomhus, och med nuvarande miljöersättningar och betesbaserade gårdsstöd skulle produktionskostnaderna kunna täckas fullt ut medan nuvarande produktionssystem i Sverige inte kan täcka kostnaderna som inkluderar t.ex. foder, byggnader och arbete. Däremot skulle dikoproduktionen inte vara lönsam utan miljöersättningar, trots att produktionssystemet från PRR skulle användas, men resultatet kommer inte att bli lika negativt som med nuvarande svenska produktionssystem.

I slutuppfödningen är det främst kostnader för byggnader, arbete och foder som skiljer mellan PRR och CSF. För att minska kostnaderna i Sverige behövs även här större besättningar och mindre krav på dyra byggnader. I Alberta räcker det med vindskydd som väderskydd medan nuvarande svenska produktionssystem för slutuppfödning innebär att djuren hålls inomhus i dyra byggnader. Om slutuppfödningen i Sverige, med nuvarande handjursbidrag, kunde ske som i feedlots i Alberta skulle produktionen kunna bli lönsam. Utan handjursbidrag kommer

inte slutuppfödningen i Sverige att vara lönsam trots att slutuppfödningsmodellen i Alberta används, men resultatet är mindre negativt än med nuvarande slutuppfödningsmodell som används i Sverige.

För att ha köttdjur utomhus under vintern finns det behov av att finna lämpliga områden för detta. Sådana områden kan vara där klimatet är lämpligt, d.v.s. inte alltför mycket nederbörd samt kallare vintrar som ger en frusen och fast mark. Området skall ha låg alternativkostnad på mark och jorden skall vara av torr sandig morän jordar med god filtreringsförmåga.

Aim

The aim of this thesis is to find beef production systems that can make Swedish cow-calf production and finishing of cattle economically profitable and sustainable without subsidies. If the Swedish beef production will have a chance to attain full cost coverage in the long run, costs of new buildings and labour input per cattle must be reduced.. One way to find cheaper solutions for Swedish beef production is to learn from beef producers in other countries and regions with similar natural conditions as in Sweden.

Method

One way to find cheaper solutions for beef production in Sweden is to compare it with other countries or regions with large beef production, despite low subsidies and high wages. There must also be similar natural conditions as in Sweden, and Canada is probably the most suitable country for a comparison. Canada is, as Sweden, situated far north and has a rich market economy with high wages.

Peace River Region (PRR) in British Columbia (BC) could probably be a suitable region in Canada to scrutinize and is the most northern region in North America with a considerable agricultural production (Bonnier Lexikon, 1999). In figure 1, a map over BC is shown and the darker region is the British Columbian part of PRR. This region is situated at the same latitude as Skåne (55-56°N) but has less fertile soil than Skåne due to e.g. high elevation (600-700m). PRR is a region that is located in both Alberta and BC. PRR in BC is not as dry and windy as the prairies in Alberta, not as hilly as the Rocky Mountain-area and not as fertile as parts of eastern Canada (Environment Canada, 2008). With regard to this, PRR in BC is more like Sweden than other important beef producing regions of Canada. According to Kumm (2005) PRR has relatively similar natural conditions for beef production as Central Swedish Flatlands (CSF).

Figure 1. Map of British Columbia and the British Columbian part of Peace River Region (dark) (Source: Wikipedia, 2008).

PRR and Alberta, where most calves from PRR are finished, are used as study regions for finding cheaper beef production systems than present Swedish systems. Ways to reduce the Swedish costs are investigated by comparing PRR and CSF budgets for cow-calf operations as well as Albertan and CSF budgets for finishing beef cattle. There might be obstacles for introducing Canadian beef production systems in Sweden and because of that, the hypothesis that PRR and CSF have similar natural conditions for beef production is tested by literature studies. The history of western Canada, especially PRR, will be compared with relevant parts of the Swedish agricultural history, this to scrutinize if historical differences might make it difficult to introduce Canadian beef production systems in Sweden. Beef production systems in western Canada with cow-calf operations and feedlots for finishing are also described as a background for the analysis of what might be learnt from Canada. One important reason for the low costs of beef production in western Canada is outdoor wintering of the cows and finishing of young cattle in open feedlots. The risk of cold stress and increased feed requirements in those systems will also be analysed in this project. The literature studies are mostly based on western Canadian sources, but also sources from other part of the world with similar conditions, principally western US, are used.

In order to more closely study the natural conditions, history and especially present production systems in western Canada; six cow-calf operations in PRR and two feedlots in

Alberta were visited. Alberta with its climate and natural resources are especially suitable for cattle finishing industry (Alberta beef Producers, 2008b). One of the feedlots that was visited has a capacity for 5000 heads of cattle and the other one has a capacity for 20 000 heads. The cow-calf operations in PRR have around 200-300 beef cows with calves that are sold to feedlots after weaning or as yearling. A museum was also visited to get more information about the agricultural history of PRR. The trip was done in October-November 2008 and questionnaires for cow-calf producers, feedlot managers and museum manager are shown in appendix 1, 2 and 3.

To reduce the cost of production in Swedish beef production and to find possibilities to introduce more cost efficient production systems in Sweden, it is important to look at factors that contribute to the present high costs, i.e. agricultural history and present beef production structure.

Swedish agricultural history and beef production

History of Swedish agriculture

Swedish agricultural and livestock history is several thousand of years old. During the nineteenth century the population increased rapidly on the countryside which resulted in small sections of land for each family to farm (Norrman, 1981). According to Swedish Board of Agriculture (2005) most of the farms were small and had only 2-20 hectares of land. From late nineteenth to early twentieth century the numbers of farms increased, but after that the numbers decreased. The smaller farms, 2-20 hectares, were shown to be the ones that had most drastic reductions, while larger farms, with more than 100 hectares of arable land, increased. In connection with decreasing numbers of farms, employment in agriculture decreased by 82% between 1951 and 2003 and most of the farmers were over 55 years of age in 2003 (Swedish Board of Agriculture, 2005)

During the nineteenth century there was a constant increase of cattle and there were about 75% more cattle in 1900 than in 1805. The increase continued during early twentieth century but after 1940 the number of cattle started to decrease. This was primarily a cause of the decreasing numbers of dairy cows. In the middle of twentieth century there was a large-scale rationalization in Swedish agriculture and the numbers of farms with cattle decreased by 93% between 1927 and 2004 (Swedish Board of Agriculture, 2005).

According to figure 2 the total number of dairy cows has, since 1980, decreased by 44%, which had an impact on the beef production with regard to the decreased number of calves from the dairy industry (Swedish Board of Agriculture, 2006). The figure also shows that the number of suckle cows in Sweden has increased, even if the total number of cattle has decreased. An increase in suckle cows, and thus calves from beef breeds, and higher slaughter weights, have only partly compensated for the decreased beef production of dairy origin (Kumm, 2006). This means that the number of suckle cows has to increase even more to maintain the total beef production.

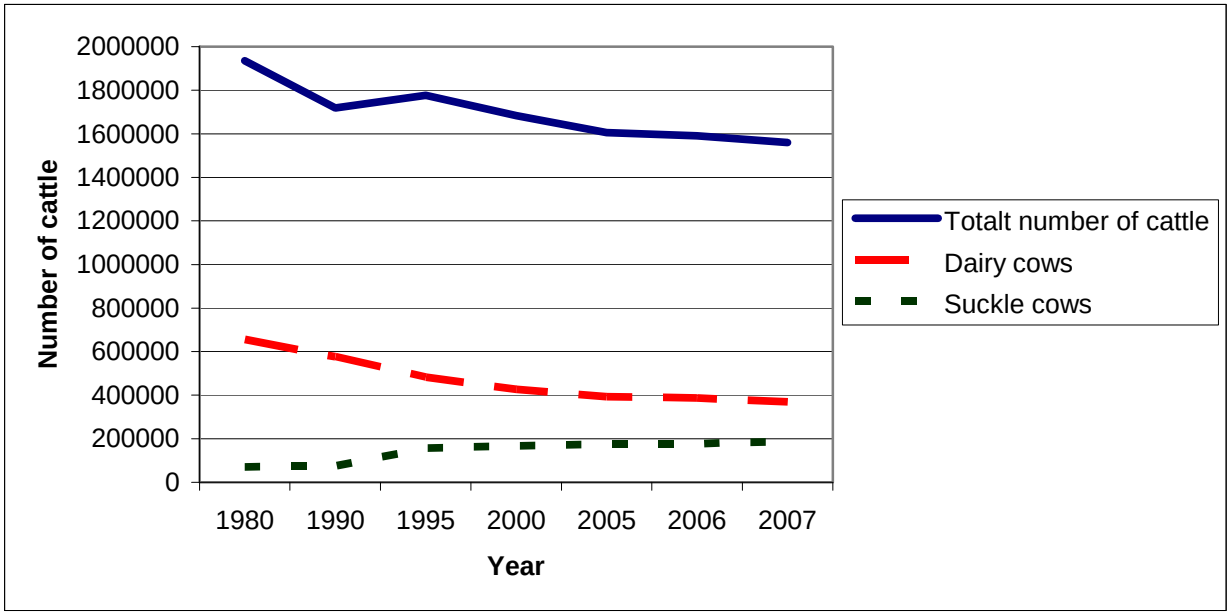

Figure 2. Total numbers of cattle, dairy cows and suckle cows in Sweden from 1980 -2007 (Swedish Board of Agriculture, 2008).

Present beef production

Present beef production in Sweden can be divided into two main systems. The first is beef from calves that originate from the dairy production, where the milk is the main product and the calves are a by-product. The other one is cow-calf production where the calves are the main product. In this production system the calves follows the cows until they are weaned at approximately six months of age. Only around 11% of the male calves are castrated and slaughtered as steers. Bull calves are usually intensively feed indoors until slaughter but steers are often grazing one summer after weaning. Around 40% of the heifer calves are used as replacement heifers in the cow-calf production and the rest of the heifer calves are finished and slaughtered (Hessle, 2007). Normal carcass weight for bulls is approximately 330kg (18 months of age), steers 300kg (25 months of age) and heifers 270kg (23 months of age) (Hessle, 2007; Swedish Meats, 2008). Today about two third of the beef produced are of dairy breed and one third of the beef originates from cow-calf production (Hessle, 2007).

Consumption and production of beef

In the early 1990s consumption and production of beef were at the same level and the self-sufficiency was 100%. Since 1990 Swedish beef consumption has increased by 36%, figure 3, whereas the beef production has been almost unchanged, and even decreased somewhat the last few years and in 2006 the self-sufficiency was only 59% (Swedish Ministry of Agriculture, 2004; Swedish Board of Agriculture, 2006). The increased consumption has been covered by import and according to the Swedish Board of Agriculture (2006) the import of beef has tripled between 1997 and 2006. The beef production is supposed to continue decreasing even if there is a high biological productivity today. The biological productivity will probably not be enough to cope with the increased competition on the international market or competition of land if bio-energy production becomes profitable (Swedish Board of Agriculture, 2007).

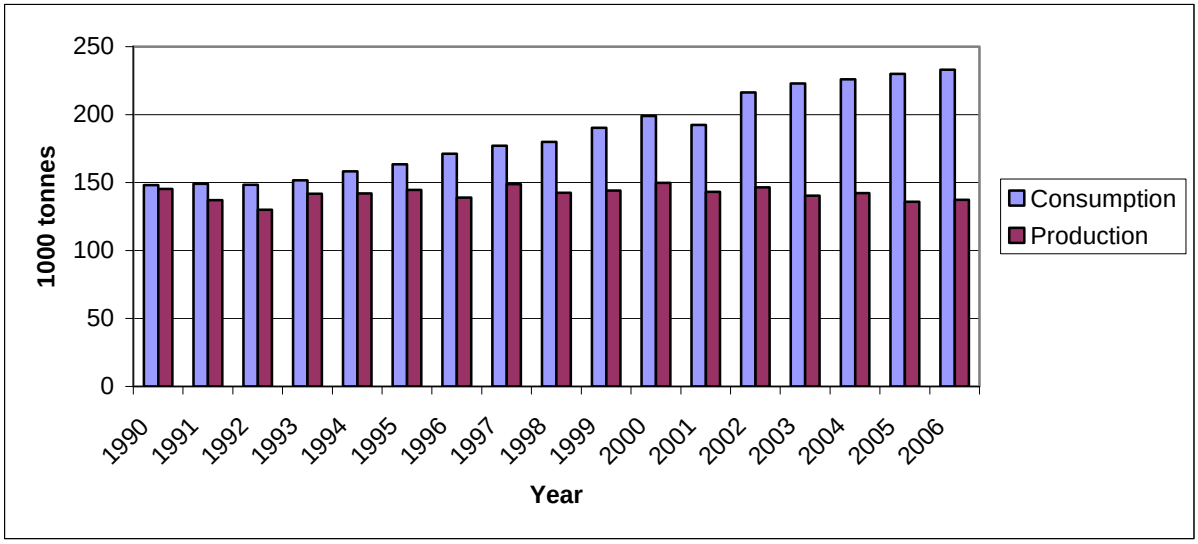

Figure 3. Consumption and production of beef and veal in Sweden 1990-2006 (Swedish Board of Agriculture, 2000; Swedish Board of Agriculture, 2006).

Consumers in Sweden have high preferences for Swedish beef (Min mat, 2005) and grazing cattle are needed to keep the landscape open and to reach the national environmental goals; to preserve meadows and pastures and a rich diversity of plant and animal life (Environmental Objectives Portal, 2007).

High costs of Swedish beef production

Since 1995 Swedish agriculture has been supported by governmental payments. These payments are supported by European Union (EU) and are a big part of the revenue, around 50%, for Swedish beef producers. In 2005 the agricultural payment became decoupled from the production and instead it became linked to environment, food safety, animal and plant health and animal welfare standards. There are also requirements to keep all farmland in good agricultural and environmental condition (European Commission, Agricultural and Rural Development, 2008). The decoupling of the former European animal subsidies will decrease the variable revenue for the farmers. This will make it more important to reduce the costs of e.g. buildings to make the beef production and grazing-based management more sustainable (Kumm *et al.*, 2007). Year 2005 suckle cow subsidy, slaughter subsidy and the aid for extensification were decoupled and the male animal premium was reduced to 75% compared to earlier (Swedish Board of Agriculture, 2004; Johnsson *et al.* 2004).

According to Swedish Ministry of Agriculture (2004) beef production will decrease even more in Sweden than in other countries when decoupling of EU payment is fulfilled. This could be due to the high cost of production caused by small herd sizes, relatively high labour costs, high demands on buildings, shorter vegetation periods and lack of larger and more connected pastures (Swedish Ministry of Agriculture, 2004). A maximized decoupling of the male animal premium might decrease the Swedish beef production by 16% (Jensen and Frandsen, 2003).

Small herd sizes and relatively high labour costs

Swedish beef production is mostly characterized as small-scale production and practised as a part time company or as a complement to other production branches in a bigger company

(Swedish Ministry of Agriculture, 2004). The average herd size of suckle cows has, during the last years, increased somewhat and is today about 15 suckle cows (Swedish Board of Agriculture, 2008).

According to Johnsson *et al.* (2004) and Kumm (2006) there is a variation in amount of work per animal between different herd sizes and labour cost will decrease with increasing numbers of animals in the herd. If the herd size is about 100 suckle cows the amount of work per cow would be half compared to a herd size at approximately 25 suckle cows (Johnsson *et al.,* 2004; Kumm, 2006). Low labour input cost per cow is especially important if the wage level is relatively high as in Sweden (Kumm, 2006).

Wages for farm workers are low compared to other occupational groups in Sweden but higher than farm worker wages in many other beef producing countries (Swedish Ministry of Agriculture, 2004). According to Swedish University of Agricultural Science (2008a) the wage for a Swedish farm worker is about 181SEK per hour.

High demand on buildings

In Sweden, as in the rest of Scandinavia, the traditional housing system for dairy cows and beef cattle has been insulated or uninsulated buildings. According to Manninen (2007) it is mainly due to small herd sizes, tradition of keeping cattle indoors during winter, convenience and lack of enough winter pastures. The investment costs for new traditional buildings range between 15 000-50 000SEK per cow, depending on what type of building that is used. The more advanced buildings the more expensive it will be. The annual cost for new buildings, i.e. depreciation, interest and maintenance is about 1500-5000SEK per cow and year (Johnsson *et al.*, 2004).

Since winter housing costs have a large inpact on the economics it is important to find ways to reduce these costs. Since suckle cows have lower demands for winter housing facilities than dairy cows and growing cattle, one way to decrease building costs is to keep suckle cows outdoors during the winter (Manninen, 2007) or at least reduce the indoor feeding days. Beef cattle are in Sweden generally housed for about 185 days per year (Johnsson *et al.*, 2004) and according to von Wachenfeldt (2005) around 15-20% of all suckle cows are wintered outdoors.

In Sweden there are regulations about outdoor wintering of cattle and according to Swedish Animal Protection Agency (2007) only animals that are suited to be outdoors during the cold season, can be kept outdoors during the winter. These animals must have, during the part of the year when there is no vegetation, a shelter for wind and weather protection. The shelter is recommended to have three walls and a roof. Outdoor cattle also need to have a dry and clean space where they can rest (Swedish Animal Protection Agency, 2007).

Lack of larger and more connected pastures

During 1800 century there were about 2 millions hectares of semi-natural grasslands plus large areas of forest grazing in Sweden. Today there are less than 490 000 hectares of, mostly small and unconnected semi-natural pastures, left and forest grazing has practically disappeared (Swedish Board of Agriculture, 1994; Swedish Board of Agriculture, 2008). Most of the old semi-natural grassland and grazed forest are today spruce-dominated forest (Mattson, 1985).

Most farms in Sweden do not have enough semi-natural pastures for being the only grazing source. A common way for most farmers is to have a mixture of both semi-natural pastures and pastures on arable land (Kumm, 2006).

Beef production in Sweden is mostly concentrated to those areas where grain production is not profitable (Swedish Ministry of Agriculture, 2004). In other areas where the arable land can be used for profitable grain or timber production the opportunity cost of especially fertile land will be high. Swedish agriculture has been supported with area-based income subsidy for crop production which increases the opportunity cost for the land even more. Without the income subsidy the opportunity cost will be zero on less fertile land, which means that the area could be suitable for beef production. With the governmental payment today the production costs of pasture are less for semi-natural pastures than of pastures on arable land (Kumm, 2005; Kumm, 2006).

Feeding suckle cows harvested feed during the indoor period will be more expensive than to have them grazing outdoors on pastures. This means that another way to decrease the cost of production is to make feeding costs cheaper by e.g. having suckle cows grazing and fed outdoors during a longer period (Keady, 2005). This increases the need for larger and more connected pastures. If larger and more connected semi-natural pastures in forest dominated regions could be re-created by connecting present and overgrown pastures and with adjacent forest and arable land without opportunity cost, the cost of grazing could decrease. It could also make it possible to increase the herd size. Including forest into the pastures could also provide natural weather protection for the cattle which could result in an extended grazing period (Kumm, 2004).

Western Canadian agricultural history and beef production

Agriculture in Canada is young compared to Sweden and western Canadian agricultural history only range 200 years back. In PRR the agriculture is even younger and the farming settlement started in the beginning of the twentieth century. Before agriculture began there were buffaloes grazing on the big ranges (South Peace Historical Society, 2008).

Western Canadian history

During nineteenth century buffaloes ranged from Peace River country of Alberta to northern Mexico. The total number of buffaloes, at its peak, was about 60 millions and from 1840 the number of buffaloes started to decline. Within only three quarters of a century they declined to around 600. The greatest impact of the decrease did the hide industry have, but the railway construction crew and European pleasure hunters did also have a great impact. Millions of buffalo hides went into the belt-and-pullery-powertrain industry, which was demanded for the industrial boom after the end of the American Civil War, 1865. In 1990 the number of buffaloes had once again increased and was believed to be around 100 000, but now mostly in private farms and at ranches (Ewing, 1990).

The Canadian ranching industry did not start until after the American Civil War. At this time many of the aboriginal people starved and to help them meet the demand for meat, United States contracted cattle producers to bring large herds of Texas Longhorn cattle up to western Canada. In Canada there were wide areas for grazing but the land got stocked quiet fast (Canadian Cattlemen's Association, 2008).

The first Hereford and Black Angus cattle came to western Canada in 1868 and in early 1900s there was a heavy infusion of British genes into the cattle (Ewing, 1995). Cattle were grazing on open ranges, which mean unfenced grazing areas and outdoor wintering. The land was neither owned nor leased; the livestock was just turned out there. This was until the homesteaders came and settled down around 1910 (Ewing, 1990).

The winter 1906-1907 was the worst ever, more than 60 degrees below zero, and many ranchers lost most of their cattle. This made the land open for homesteading and the money were put on crops instead of beef (Canadian Cattlemen's Association, 2008). To keep livestock out from other homesteaders' crops and for not mixing cattle with other beef owners', people started to lease fenced grazing areas. This was also for keeping cattle in for winterfeeding and keep range cattle out from hay stacks (Ewing, 1990).

During 1930s the draught-horses got replaced by tractor power which resulted in increased production of grain, particularly barley. The available feed grain gave an important increase of beef cattle on mixed grain farms. This resulted in an increase by 6 millions of cattle in western Canada between 1940 and 1975 (Canadian Cattlemen's Association, 2008).

During 1950s finishing of calves in feedlots became much more interesting and also more economic in eastern Canada. This was due to the increased corn silage production. In western Canada calves were still finished out on the range and finishing feedlots did not get more prominent until early 1970s when the great surplus of cheap grain, and improved marketing and transportation made finishing economically interesting on the prairies (Jacobs, 1993; Canadian Cattlemen's Association, 2008).

Peace River Region History

During nineteenth century European-Canadian explorers penetrated PRR by canoeing on the Peace River and established trading posts at Fort St John and Hudson's Hope. The first grown barley are said to be produced during 1809 and could be the start of agricultural industry in PRR, but the larger agricultural era did not start until 100 years later (South Peace Historical Society, 2008).

Around 1910 the first 4 hectares of land was officially cultivated and before that, there was only forest everywhere, mostly spruces and pines. Application for one quarter of land, 73 hectares, at a cost of 65SEK when around 1.4 million hectares were available meant that around 21 500 people over 16 years old could apply for one quarter each (Clare, 2008; South Peace Historical Society, 2008). Many of the early farms were established through pre-emption or a homestead program, where up to one quarter of land was deeded. This was offered to homesteaders that lived on the land for at least three years and spent approximately 41SEK per hectare for improvement. After three years the homesteader was required to pay local taxes for the land. Land could also be purchased from the Crown (British Columbia Ministry of Agriculture, Food and Fisheries, 2000).

In the beginning of 1910s it was difficult to get land to farm elsewhere in North America and a lot of people moved around and looked for somewhere to settle down. In spring 1911 a lot of settlers moved in to PRR and at this time there were about six townships surveyed. During the next years, 1912-1913, a railway from Edmonton, Alberta, to Athabasca, BC, was built which opened up PRR for settlement and this became the time when most people settled down in PRR. Each settler secured large areas on mainly forest-covered land for a very low price. Clearing the land from bushes and bringing it into cultivation was labour-intensive and labour was short in supply, especially in the early days of settlement. Despite shortage of labour and financial capital, PRR soon became an important agricultural area producing large quantities of grain and livestock for shipment to markets outside the region. Beef production has always been the more important part of the livestock sector, whereas dairy industry has been of minor importance (South Peace Historical Society, 2008).

The first cattle came into BC around 1846 but not until 1918 the first larger number of cattle came to PRR and this was the time when the first ranch with horses and cattle was started (British Columbia Cattlemen's Association, 2008; South Peace Historical Society, 2008).

During 1920-1930s the railroad was build all the way to PRR which made it easier for transportation and marketing. This opened up the export, especially for the surplus of barley, to other regions (South Peace Historical Society, 2008).

The communities in PRR grew rapidly during the Second World War when United State Army built Alaska Highway to Alaska and the population in Dawson Creek increased from 600 people in 1940 to 6000 in 1942. After Alaska Highway was built the beef industry was increasing and it became a better market for cattle (Clare, 2008).

In figure 4, a historical view over land use in PRR is shown. There is more total farm area today than it was in 1990 and also more semi-natural pastures, seeded pastures and hay/silage. Annual crops and fallow has decreased and also the amount of forest and other land.

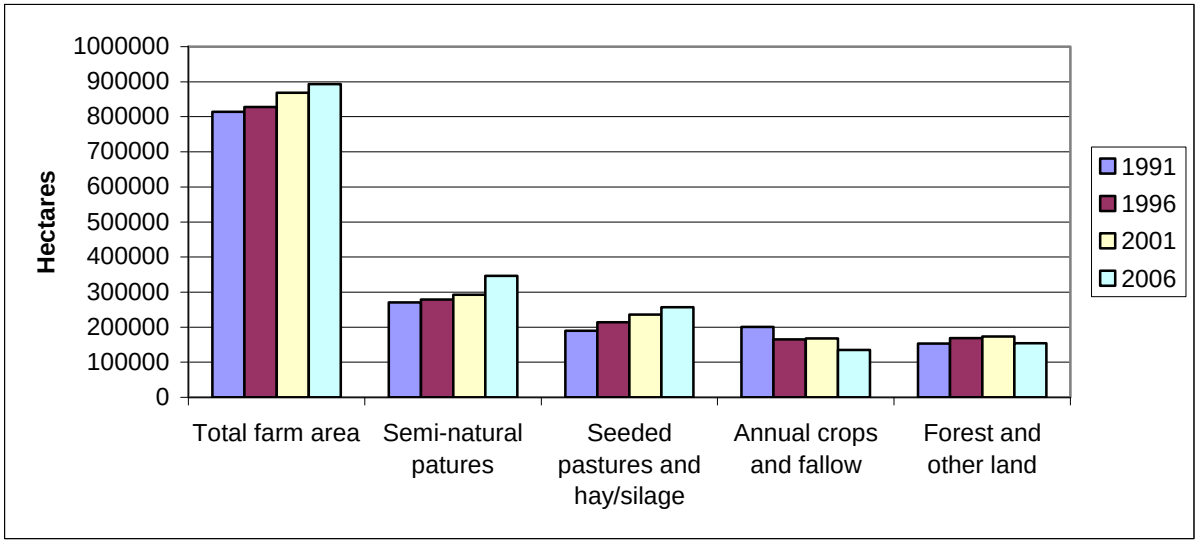

Figure 4. Historical view over land use on farms in PRR 1991 to 2006 (British Columbia Ministry of Agriculture, Fisheries and Food, 1997; Statistics Canada, 2001; Statistics Canada, 2006).

There is still a lot of land that are not used in PRR and pastures could be provided by development of areas that are not fully arable. Clearance of forestland for increasing beef production and making it more cost-efficient still continues in PRR (South Peace Historical Society, 2008).

The number of beef cows in PRR increased with approximately 30%, from 1991 to 2006 (Figure 5). Most cows in PRR are beef cows and in 2006 there were only 380 dairy cows.

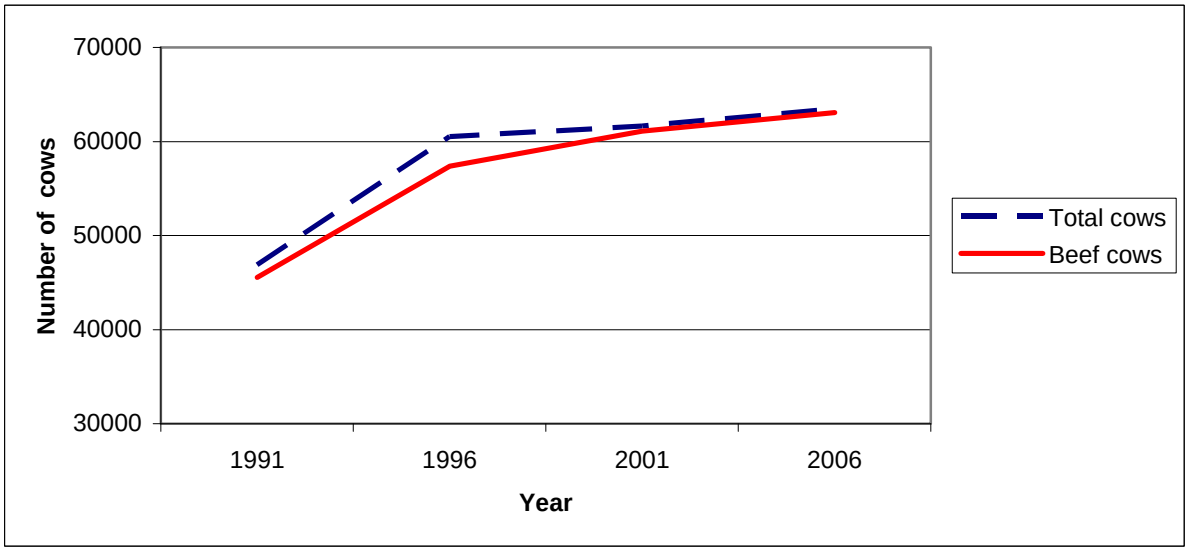

Figure 5. Number of cows during 1991-2006 in PRR (British Columbia Ministry of Agriculture, Fisheries and Foods, 1997; Statistics Canada, 2001; Statistics Canada 2006).

Industry in PRR today is mostly companies composed for the oil and gas extraction (Wikipedia, 2008). The first drilling was done in early 1920s and became, at that time, the third largest gas well in North America. Oil and gas industry grew and during 1957 there were about 25 different oil companies in Dawson Creek and Fort St John. Even if oil and natural

gas was discovered early, it was not an important economic resource until many years later. This industry gave a few people a lot of money but also gave farmers some income when companies used their land. It also gave employment opportunities (South Peace Historical Society, 2008). In the oil and gas industry today the employees are very well paid which leads to high opportunity cost of labour and results in labour shortage on the farms. This can also lead to difficulties when the farms shall be transferred to younger generations (Clare, 2008).

Market prices of beef in Canada

In figure 6 historical prices for culled cows and slaughter steers in Canada are shown. The price for heifers follows the same pattern but steers and culled cows were chosen to be shown in the figure because they were the ones that were mostly affected by the Bovine Spongiform Encephalopathy (BSE) crisis. The prices peaked during 2001 but after that it started to decreased. During 2004 the prices reached its bottom and after that year the prices turned and increased again, but not as high as during the peak.

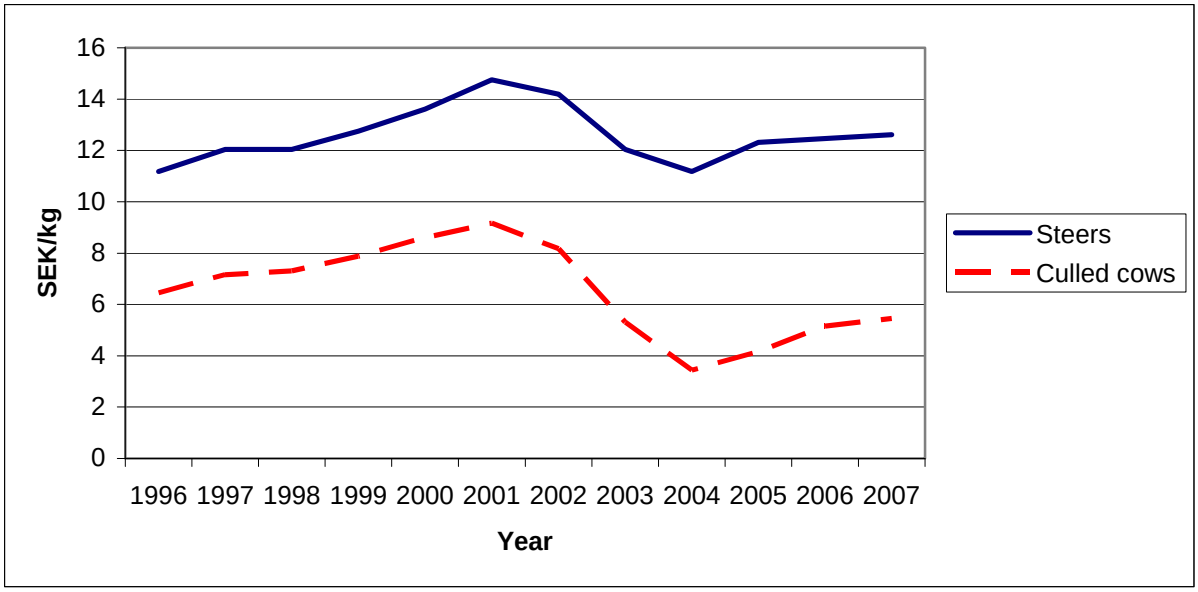

Figure 6. Historical prices for culled cows and slaughter steers, [SEK per kg live weight; 1CAD= 6.5SEK] (Own calculations based on Agri Benchmark, 2008).

One cause of the decrease in prices during 2003 was the BSE crisis. Because of this the Canadian border closed for export of beef cattle, and over one night the Canadian beef production lost up to 60% of its market (Canadian Cattlemen's Association, 2008). Canadian beef production is extremely export dependent and the export sank from 9% of the world market export 2002 to only 3% year 2003 (FAOSTAT, 2008). Before BSE cattle raised in Canada, was slaughtered in processing plants both in USA and Canada. After the crisis the Canadian government stopped all shipments to USA which affected Canada by decreased market prices for cattle (Weerahewa *et al.*, 2007). Culled cows were most affected with a 32% decline in the market price and slaughter steers were also greatly affected with a 21% decline (Schmitz *et al.*, 2003). In 2007 Canada had about 11% of the world beef cattle export market (Canfax, 2008)

Some comparisons between PRR and Swedish agricultural history

When agriculture in PRR started in the 1910s and the homesteaders had approximately 73 hectares, only 10% of the Swedish farms had more than 20 hectares of arable land. In PRR, agriculture expanded rapidly after 1930 which was around the time the area of agricultural land and number of cattle started to decrease in Sweden (Swedish Board of Agriculture, 2005). Table 1 shows a comparison of land use between CSF and PRR. There are more annual crops and forest in CSF and in PRR there are higher amount of semi-natural pastures, seeded pastures and hay/silage, as well as more beef cows. According to Kumm (2005) the larger semi-natural pastures for grazing and smaller area for annual crops and forest in PRR has similarities to historical patterns of Swedish land use.

Table 1. Land use (hectares) and number of beef cows per 100 hectares of land on farms in Central Swedish Flatlands (CSF) and Peace River Region (PRR) year 2006 (Statistics Canada, 2006; Swedish Board of Agriculture, 2007; Swedish Board of Agriculture, 2008)

	PRR	CSF
Semi-natural pastures	39	5
Seeded pastures and hay/silage	29	13
Annual crops and fallow	15	32
Forest and other land	17	50[1]
Beef cows	9[2]	2

[1] Hectares of forest in CSF is from 2007.
[2] Included one adult bison per 100ha

Around 97% of the cows in PRR were beef cows in 1991 and nearly 90% of the cows in Sweden were dairy cows (British Columbia Ministry of Agriculture, Fisheries and Food, 1997; Swedish Board of Agriculture, 2005). Swedish agricultural history is to a large extent characterized by small scale and dairy production and still most of the beef that is produced in Sweden is from the dairy industry and only one third is from cow-calf operations (Hessle, 2007). Western Canadian and PRR agricultural history is characterized by large scale agriculture, beef production and ranching culture and in PRR almost all the beef originates from cow-calf operations and barely nothing from the 380 dairy cows.

In Sweden import of beef is important because of the low self-sufficiency of beef and veal. In Canada it is more important with export of beef and veal and about 11% of the world market beef cattle are from Canada. Even though Canada is self-sufficient their import of beef cattle was, during 2007, about 3% of the world market. EU 25 had during the same time around 2% of the world markets beef export and 9% of the beef import (Canfax, 2008).

For a long time it has been easy to get an off-farm job in Sweden while in PRR it has been difficult until the oil and gas business had its boom. In PRR the jobs were at family farms, to support the family, but after the oil and gas boom agriculture in PRR got problems (Clare, 2008; South Peace Historical Society, 2008). Since the average age of farmers in both CSF and PRR are high, there might be problems with the high opportunity cost of labour when the farm shall be transferred to next generation.

In Canada the returns on farms mainly rely on the market prices while the farms in EU all have a mix of market returns and government payments (Agri Benchmark, 2007). The Producer Support Estimate (PSE)[1] to beef and veal production in Canada was less than 10% for 14 years out of 18 between 1986 and 2003, whereas it was more than 50% for 14 years out of 18 in the EU during the same period (OECD, 2004).

[1] PSE is an indicator of the annual monetary value of gross transfers from consumers and taxpayers to support agricultural producers, measured at farm gate level, arising from policy measures, regardless of their nature, objectives or impacts on farm production or income. The percentage PSE is the ratio of the PSE to the value of total gross farm receipts, measured by the value of total farm production (at farm gate prices), plus budgetary support (OECD, 2003).

Natural conditions in PRR and CSF

PRR in BC is 55-56° north in north-eastern part of BC with an elevation on 600-700m (Figure 1; Environment Canada, 2008). The climate in PRR is more severe than in CSF where the latitude is 59-60° north and the elevation 0-100m (SMHI, 2008).

Climate

The monthly average temperatures for Fort St John in PRR and Uppsala in CSF are shown in figure 7. The annually mean temperature in Uppsala is 7.2°C and Fort St John 2.6°C (Environment Canada, 2008; SMHI, 2008). The winters are colder in PRR which results in frosted ground during the whole winter. During spring and fall the temperature rises and falls much faster in PRR than in CSF. This means that in the fall the ground becomes frosted much faster and in spring the breaking up of the frost in the ground will be faster (Kumm, 2005).

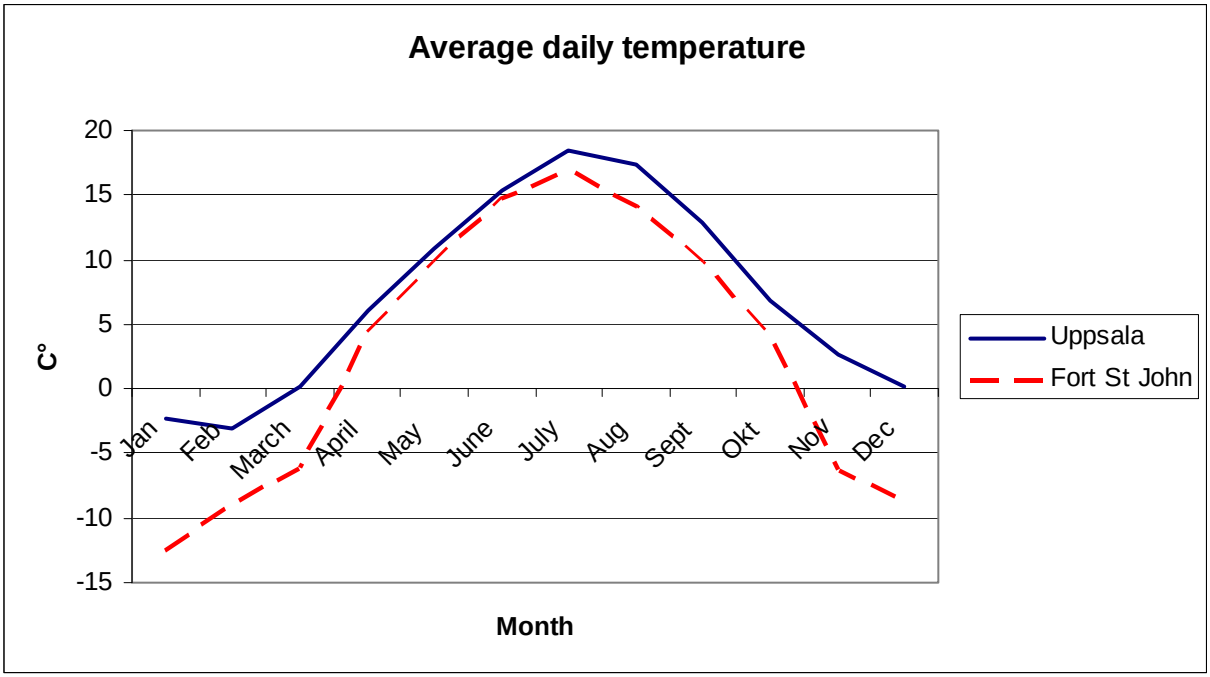

Figure 7. Average daily temperatures from 2003-2007 in CSF (Uppsala) and PRR (Fort St John) (Environment Canada, 2008; SMHI, 2008).

Other circumstances that can lead to muddy conditions in CSF are the rainy falls and springs together with mild temperatures, as well as the thawing periods in wintertime. This can be considered to make it more difficult when wintering beef cattle outdoor without buildings. According to Lindgren and Lindahl (2007) muddy conditions gives damaged ground, dirty cattle, and a risk of decreased animal welfare.

In figure 8 the average monthly precipitation is shown for both Fort St John in PRR and Uppsala in CSF. The precipitation in Sweden, 2003-2007, did not give accurate results compared to earlier studies (Ångström, 1958), which is why a longer period, 1901-1930, is included in the figure for Uppsala.

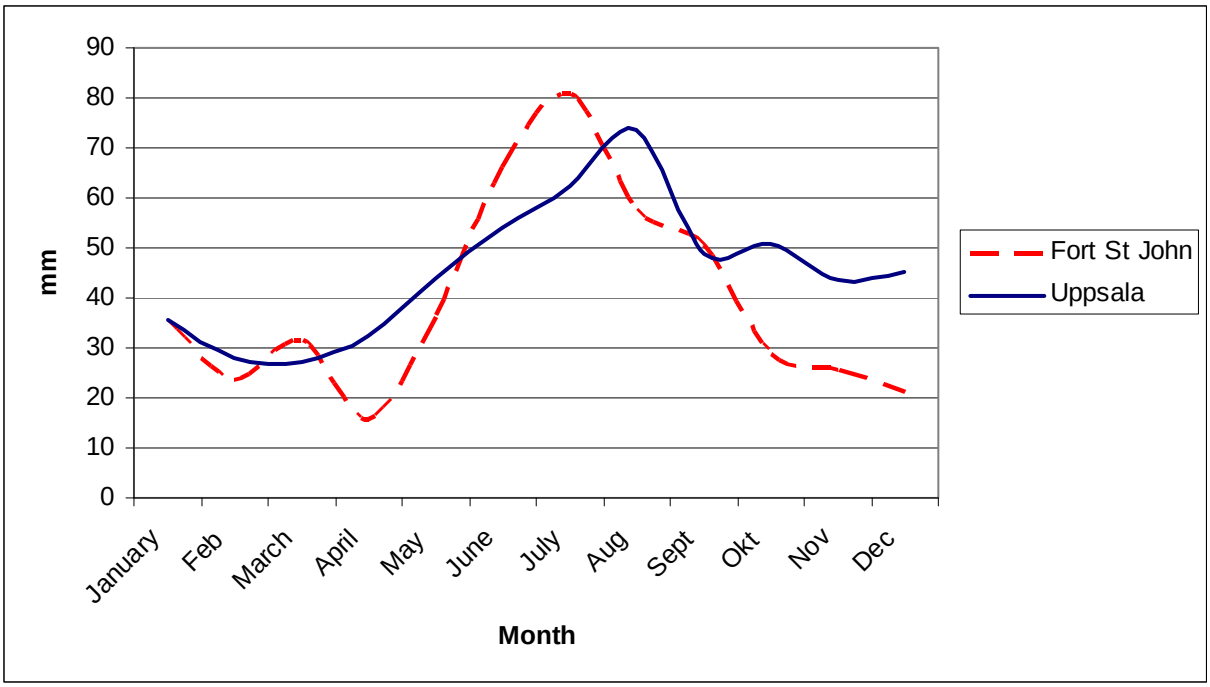

Figure 8. Average monthly precipitation 1901-1930 and 2003-2007 in CSF (Uppsala) and 2003-2007 in PRR (Fort St John) (Ångström, 1958; SMHI, 2008; Environment Canada, 2008).

The precipitation is higher in CSF in late summer, fall and during spring, but lower in the middle of the summer compared with Fort St. John. Average annual precipitation in Fort St John is 470mm and 550mm in Uppsala (Ångström, 1958; Environment Canada, 2008; SMHI, 2008). Most precipitation in PRR is during the summer, June to August. According to Alexandersson (2004) there is more precipitation now than a couple of decades ago in Sweden and a reason for that can be milder falls, winters and springs.

Wetter summers and falls in Sweden leads to expensive harvesting and storage methods of roughage, in the form of silage or barn-dried hay (Swedish Dairy Association, 1997). In PRR hay is usually dried and stored on the ground which makes the costs for storage much lower, but instead there can be more losses on the field. An example of how storage of hay and straw can be done in PRR is shown in picture 1.

Picture 1. Example of how hay bales are stored in PRR (Picture by Sofia Nyman, 2008).

Environment

PRR is characterized by rolling hills and the vegetation is dominated by the Boreal White and Black Spruce Zone and aspen parkland[2] (Wikipedia, 2008). Picture 2 shows a typical rolling landscape in PRR with spruces and deciduous forest partly transformed to pasture.

Picture 2. Landscape in Dawson Creek, PRR (Picture by Sofia Nyman, 2008).

[2] Aspen parkland where aspen poplars and spruces groves, interspersed with areas of prairie grasslands

Pastures used for outdoor wintering of suckle cows in PRR has generally recently been transformed from forest to pastures (Picture 2). The experience of interviewed farmers in PRR is that pastures newly transformed from forest are firmer and can stand the cattle trampling better during winter than pastures that have been cultivated for many years. The farmers also see wintering cattle with manure and feed-residues as a way of improving the humus and nutrient content which results in a better fertility of the former forest land. Swedish experiences suggests that former humus-poor sandy forest soil can be good for wintering cattle for some years but becomes muddier after a couple of years of cattle wintering (Kumm *et al*., 2007).

In Sweden pastures have normally been cultivated for centuries and have, thus, higher humus content and are less suitable for wintering cattle especially as the precipitation and temperature are higher during fall, winter and spring in most places in Sweden. In CSF much of the soil in agricultural land is clay with low infiltration capacity or silt with capillary rising which is less suitable for cattle wintering than sandy soils with greater infiltration capacity. Dry sandy forest hills are more suitable especially if they are situated more northerly where the fall, winter and spring are colder (Kumm *et al.*, 2007), as in PRR.

Beef production systems in western Canada

Beef cattle production in BC has become an important part of agriculture. The beef cow herd has grown by 30% from 1986 to 2003 and cattle are bred all over the province (Henry, 2003). Production practices vary throughout BC, depending on the weather and the local climate (British Columbia Ministry of Agriculture, Food and Fisheries, 2004). The Canadian cattle production cycle is shown in figure 9. There are four sides of the production; cow-calf operations, backgrounding feedlots (stocker operations), feedlots (finishing) and dairy operations. Outside the circle there are the export of live animals and slaughterhouses.

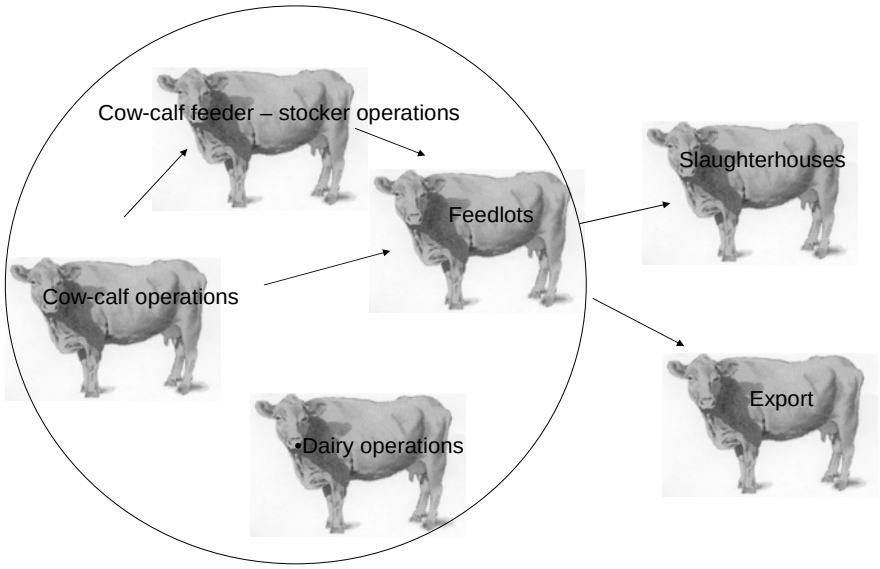

Figure 9. Cattle production cycle (Natural Resources Canada, 2008).

Cow-calf operations are the start of most beef production in western Canada and these are mostly in areas where there are poorer conditions for grain production (British Columbia Ministry of Agriculture, Food and Fisheries, 2004). BC has about 288 000 breeding cows and 43 500 breeding heifers (British Columbia, Ministry of Agriculture and Lands, 2007) and PRR has approximately 21% of all the herds in BC (Ramsey and Schmitz, 2002; Henry, 2003). BC has also a small feedlot sector to which some producers send their calves for finishing. The average feedlot in BC holds 400 heads of cattle but there are feedlots much larger holding up to 5000 animals (British Columbia, Ministry of Agriculture and Land, 2008). Most producers in BC, around 87%, send their calves to feedlots in Alberta where the feedlot sector is much bigger (Henry, 2003). Alberta's feedlots finish more than 65% of Canada's beef cattle (Ramsey and Schmitz, 2002) and have approximately 4000 feedlots which make this province the fifth biggest feedlot area in North America. These feedlots have capacities of a few hundred up to 40 000 heads of cattle. Most of these feedlots are located in the southern region of Alberta where land, water resources and climate are suitable for this kind of production (Alberta Beef Producers, 2008a).

Cow-calf operation

Cow-calf operations are based on an annual schedule with suckle cows producing one calf per year. Heifers usually produce their first calf at two years of age (Alberta Beef Producers, 2008a). A cow-calf producer breed calves for sale and traditionally 90-95% of the calves are

born in the spring. Most spring born calves are born in April, but calving season can start in late winter and continue throughout the spring. This varies between producers; some also prefer fall calving. Both cows and calves are turned out on pastures to graze in late spring, and the grazing continues until late fall. The bulls are generally turned out with the cows during spring and summer so they can breed the cows. Spring calving cows are generally wintered outdoor on winter pastures (British Columbia Ministry of Agriculture, Food and Fisheries, 2004).

Traditionally, weaning period is in the fall, depending on when the calving season is, when the calves are around six to eight months old (British Columbia Ministry of Agriculture, Food and Fisheries, 2004). The average weaning weight, for both steers and heifers, is around 250kg, but can range between 160 kg to 320 kg depending on breed, age, genetic background and conditions of the calf and pasture during the grazing season (Alberta Beef Producers, 2008a; Canada Beef, 2008). After weaning, calves can be wintered and backgrounded by the cow-calf producer on a forage-based diet and then sent to a finishing feedlot, or the calves can be sent to a backgrounding feedlot directly after weaning (Beef InfoNet, 2008).

Most beef cattle producers feed the cows outdoor where they consume forage by directly grazing on either rangeland or pastures. Rangelands are lands that have native vegetation which includes grasses, forbs and shrubs suitable for grazing. This land can either be owned by the Crown or be deeded and are commonly grazed from spring to fall with very limited winter use. Cattle densities on rangeland are very low because of the poor quality of the grass. Pastures are also normally grazed from spring to fall but also some winter grazing is possible. This kind of pasture has grass that includes both native and tame species and is often irrigated in dryer parts of western Canada, but not in PRR, to improve production. For rangelands and pastures, manure is directly spread by the animals and available as a crop fertilizer without any more fertilizing required. In these areas cattle often have access to natural water sources for drinking (British Columbia Ministry of Agriculture, Fisheries and Foods, 1992).

During the part of the year when the cows are not grazing, they have to be fed. Producers often feed their cows in open fields that produce forage crops during rest of the years. These wintering sites are called seasonal feeding areas. Since feed is brought to the special feeding area the cattle density can be high, and then also the manure amount which could be an environmental concern. In figure 10 an example of a seasonal feeding area is shown. The feeding area can be a hay field that has a gentle slope towards a creek. There can be trees as natural windbreaker, or constructed windbreakers can be placed in the fields (British Columbia Ministry of Agriculture, Fisheries and Foods, 1992). Bedding and feeding area should be constantly moved to distribute the manure over a larger area (Alberta Cattle Commission, 2008). A berm is built just beneath the slope to divert runoff water from a natural water source.

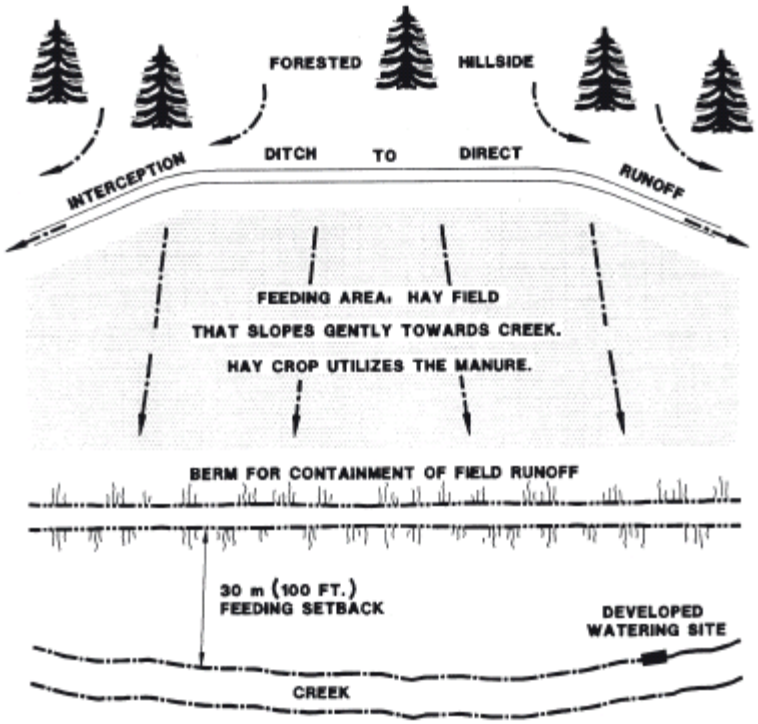

Figure 10. Example of a seasonal feeding area (British Columbia Ministry of Agriculture, Fisheries and Food, 1992).

Feedlots

Historically, beef cattle were born, fed and raised on the same farm but the trend has gone towards bigger herds and larger farms. Finishing of beef has become more specialized and now most weaned calves are backgrounded and finished in feedlots (Alberta Beef Producers, 2008a; Canada Beef, 2008). Beef production in Canada has become more efficient since the producers are more specialized to either type of production (Natural Resources Canada, 2008).

Backgrounding feedlot

After one summer on the field with the cows the calves are either moved directly to a backgrounding feedlot or retained by the owner who feed a backgrounding ration at the farm. Backgrounding is a multi-stage feeding system, where the steers and heifers are fed either in a confined livestock area or out on a smaller pasture. The calves starts on a high forage diet that is given for a couple of weeks and then the proportion of grain is increased until the ration is 85-90% grain and 10-15% forage in the end of the backgrounding period (House and Eng, 2003; Schmitz *et al.*, 2003; Alberta Beef Producers, 2008a; Canadian Beef, 2008). The goal is that the calves will gain approximately 1kg per day, until they reach a live target weight at around 340-360kg (McCartney *et al.*, 2007; British Columbia Ministry of Agriculture and Land, 2008; Natural Resources Canada, 2008).

Finishing feedlot

When the cattle reach a desired weight on backgrounding rations they will start on the finishing diet (Alberta Beef Producers, 2008a; Natural resources Canada, 2008). A feedlot owner either purchases calves from backgrounding feedlots or directly from a cow-calf operator. Another way is that the cattle are custom fed at the feedlot for a fee charge (Alberta Beef Producers, 2008a). Finishing is the process when cattle are fed high energy rations until they reach their slaughter weight (Natural Resources Canada, 2008). The average slaughter

weight is approximately 600kg for steers and 550kg for heifers (Canadian Beef, 2008). According to House and Eng (2003) this type of feedlot is used to control weight gain so the cattle gain enough muscles and bones before putting fat for covering and marbling (Alberta Beef Producers, 2008a).

Feedlot designs

When cattle are fed for growth and weight gain, it is more common that they are held in more confined areas instead of pastures or seasonal feeding areas. Confined areas are designed to get good animal performance from the feed that is provided. The animal density in confined areas can be high which will result in an excess of manure that has to be scraped of and spread on land used by crops (British Columbia ministry, Fisheries and Food, 1992).

In western Canada open feedlots without sheds are most common but confinement buildings are supposed to be necessary in regions where the annually precipitation is greater than 600mm, e.g. on the coast in BC. Cattle fed in these high precipitation regions are often in covered feeding barns. These are essentially totally roofed and can have a higher stocking density than dryland feedlots. However, most feedlots in Canada are located in regions, e.g. interior BC and in Alberta, were sheds are supposed to be unnecessary (British Columbia ministry, Fisheries and Food, 1992).

In interior of BC and in Alberta, beef cattle are fed in open and unpaved areas because of the low precipitation, less than 600mm per year. In figure 11 there is an example of a dryland confined livestock area with several options of feed sources. One is a hay shed that acts like hay storage and has also enough feed bunk space for self-feeding. There is also a fence-line feed bunk that is for limited feeding of e.g. grain and concentrate. In the middle of each lot there is an elevation that is called mound that can be bedded which give the cattle a dry place to stay and rest on. On two sides there are windbreakers with a 20% porous fencing. Porous windbreak fencing provides better shelter than solid fencing and a 20% porous windbreak can reduce the wind at distance of 20 times the height of the fence (British Columbia Ministry of Agriculture, Food and Fisheries, 2002a).

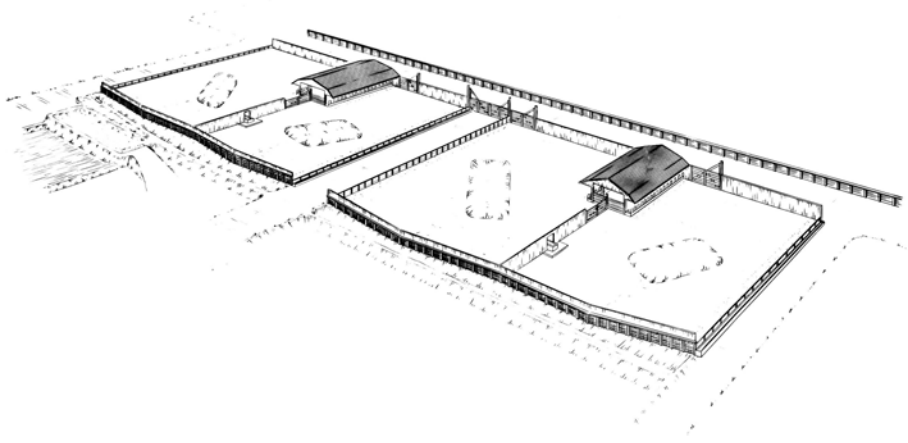

Figure 11. Dryland confined livestock area (feedlot). The buildings in the figure are not common in practice (British Columbia Ministry of Agriculture, Food and Fisheries, 2002a).

The costs in a feedlot are; yardage cost and cost of feed (McCartney *et al.*, 2007). Feedlot yardage cost is defined as the daily overhead costs associated with maintaining cattle in a feed yard. This cost includes capital cost of machinery, buildings and corrals, labour, fuel and miscellaneous and is approximately 2.60-2.90SEK per animal and day (1CAD=6.50SEK) (Western Beef Development Centre, 2003; Kaliel, 2004).

Feedlot environmental aspects

The beef cattle industry uses both land and water resources in a wide range of production systems, from land for grazing to feedlots. The industry uses a wide range of production systems and affects the environment in many aspects (British Columbia Ministry of Agriculture, Fisheries and Food, 1992).

Feedlots, but also cow-calf operations, can be established close to densely populated areas which make it important to protect humans from waste products. Animal wastes from feedlots are more dangerous than waste products from grazing animal because of naturally existing epizootics in confined feedlot facilities. Animal feedlots should be located in areas where surface run-off waters can be controlled and infiltration into the ground would not result in pollution of water (Wehrle, *et al.*, 1973; British Columbia Ministry of Agriculture, Fisheries and Food, 1992).

Runoff water is not allowed to enter natural water courses (British Columbia Ministry of Agriculture, Food and Fisheries, 2002b). All provinces have legislations regulating the discharge of runoff water to surface and groundwater. There has to be a shaped shallow ditch built to collect runoff water and to lead it into a holding system (British Columbia Ministry of Agriculture, Food and Fisheries, 2002a).

Beef cattle manure is a valuable by-product but there is a need for well planned manure handling and storage system. Manure is normally only collected and stored from cattle in confined livestock areas. The manure can be stored in a permanent facility that is located and operated to contain manure and runoff water. Manure can also be stored temporary on the field but only just before spreading on the field and is not a storage that is meant to replace permanent storage facilities (British Columbia Ministry of Agriculture, Fisheries and Food, 1992). According to British Columbia Ministry of Agriculture, Food and Fisheries (2002b) the most practical solution to dispose animal waste is to return the nutrients to the land.

Outdoor wintering

During winter time most beef cattle in Sweden are kept indoors while in western Canada beef cattle are kept outdoors year around. Outdoor wintering reduces the cost of buildings and labour and winter grazing can also reduce the cost of feed (Keren and Olson, 2006).

Animal environment

Different factors affect cattle that are kept outdoors all year around e.g. temperature, wind, radiation and humidity. During winter it is especially cold temperatures together with high winds that affect cattle out on pastures (Keren and Olson, 2006). According to Young (1981 and 1983) cattle that are heavily affected by these factors will e.g. consume more feed or reduce their production.

Heat balance

All mammals, including beef cattle, are warm-blooded and need to maintain a constant body temperature (Tarr, 2007). To maintain a constant body temperature, the animal has to establish heat balance, which is when the energy from the feed is at the same amount as the energy bounded to the animal product, e.g. meat, milk or foetus, and the energy that is lost by the animal in form of heat. Except for evaporation the animal can loose heat by radiation, convection and conduction. If the heat produced is not enough for maintaining heat balance there is a risk for fat reserve usage and/or there will be an increase in feed consumption to counteract cold stress (Sällvik, 2005). According to Boyles and McCutcheon (2008) the maintenance requirement of feed is the nutrients required for keeping an animal in a body balance where body reserves is neither gained nor lost.

Cattle respond differently on cold stress. Some visible sign of cold stress can be that the cattle are shaking and shivering (Sällvik, 2005). They conserve energy by lowering their metabolic rate or resting heat production, seeking shelter, altering activity patters and/or locating to sunny and windless areas. Solar radiation lowers the metabolic requirements (Keren and Olson, 2006).

Thermoneutral zone

The thermoneutral zone (TNZ) can be defined as a range in which both heat loss and feed energy intake are independent of the environmental temperature (Manninen, 2007). At the lower rage of TNZ the normal metabolic process supplies enough heat to maintain body temperature (Tarr, 2007). At the upper limit of the TNZ, heat produced in metabolism is dissipated principally by evaporation of water from the skin and from the mucous membranes of the upper respiratory tract (Manninen, 2007).

The temperature at the lower limit of TNZ is called lower critical temperature (LCT). Below this temperature the animal experience cold stress and has to increase its rate of heat production to maintain body temperature. This can be done by increase the energy intake. There is also a need to reduce heat losses by keeping the body surface temperature low with vasoconstriction (Manninen, 2007; Sällvik, 2005)

Newborn calves are at high risk to get cold stress during cold months (Table 2). This because of their high LCT limit which is 8°C. If the temperature will decrease to zero the energy requirement will increase by 25% for the calves. If the temperature will decrease even more, below freezing point, there will be a poorer uptake of important immunoglobulin in the

colostrums. This will increase the risk of infections for the calf (Manninen, 2007). The LCT limit for newborn calves can also be a reason for a later calving season which will lead to a decrease in death losses, diseases and input costs (Pruitt *et al.*, 2005). For lactating beef cows and feedlot steers the LCT limit is low, minus 47°C respectively 45°C. LCT is also relatively low for pregnant cows and growing calves.

Table 2. Lower critical temperatures (LCT) for beef cattle (Manninen, 2007)

Animal	Live weight, kg	LCT (°C)
Beef cow early pregnancy	500	-13
Beef cow late pregnancy	500	-26
Beef cow lactating	500	-47
Growing calves	200	-31
Feedlot steers	400	-45
Newborn calves	35	8
Month-old calf	50	-2

Cows, but especially heifers that are in poor body condition and are calving outdoor in winter and early spring, are at higher risk to get calving problems. The result could be weaker and lighter calves, death losses and calves more susceptible to diseases e.g. scour (Boyles and McCutcheon, 2008).

Animals that have a long and thick coat have a better capacity for heat insulation. The coat has to be clean and dry to have the best effect. Fat depot is a kind of thermo insulation in cattle and insulates the animal's core from the environment (Tarr, 2007).

Generally, LCT is lower and the thermal zones are wider for cattle and other larger mammals than for smaller and more cold-susceptible animals (Young *et al.,* 1989). There are also individual differences which are due to age, breed, nutrition, phase of production, physiological status, adaptation to cold and management. There are difficulties to decide the exact state of LCT, but it is a way to decide if the animals can manage the climate and also if there is a need for shelter or not (Manninen, 2007).

At the Upper Critical Temperature (UCT) the animal starts panting and sweating to get rid of heat excess. A combination of high air temperature and high humidity can affect animals with heat stress. This can lead to decreased feed intake and also decreased growth and production (Young, 1983). Economic losses during summer, that can be attributed to environment causes, can be equal or exceed those in winter, this because it is more common with deaths from heat stress than from cold stress (Mader *et al*. 1999).

Wind chill effect

Precipitation and wind can exacerbate the impact of thermal stress and contribute to heat loss from the body (DiCostanzo, 2007). Wind reduces the insulation of hair coat and increases the convective loss of body heat (Young *et al.*, 1989). An illustration of how temperature and wind together affect the thermal situation is shown in the wind chill chart in table 3.

Table 3. Wind Chill Effect for cattle at different combinations of wind and air temperature (Sällvik, 2005)

Wind (m/s)	Air Temperature (°C)						
	-1	-7	-12	-18	-23	-34	-40
0	-1	-7	-12	-18	-23	-34	-40
2	-3	-9	-15	-21	-26	-38	-44
9	-16	-23	-32	-40	-47	-63	-71
18	-21	-30	-38	-47	-58	-73	-82

Mud

Besides cold weather, mud can be a cause of reduced cattle performance. Cold mud has a greater effect on energy losses than a frozen ground and during the summer, mud can be a reservoir for disease causing organisms. Cold mud withdraws body heat and takes energy from cattle and may depress the feed intake by about 15-30% at any temperature (Neel, 2003; Hicks, 2007). According to Boyles and McCutcheon (2008) it is not clear how mud affects the energy requirement in beef cows, but it can increase the maintenance requirement by 7-30%. Mud can also have a big affect on calves e.g. following the cows takes a lot of energy and contact to the cold mud conducts a lot of energy from the calves' bodies (Neel, 2003).

Protection against cold weather, precipitation and wind

Cow-calf herds may graze on pastures or ranges without any protection during the summer, but during rest of the year they need some kind of protection. As mentioned before, cattle suffer more from precipitation, cold winter winds and mud than only from low temperatures alone (Neel, 2003). During winter months most cattle are fed in seasonal feeding areas which are areas that should include a feeding area, a sheltered area and a water source (Figure 10; Alberta Cattle Commission, 2008). It is important to have a good strategy for wind protection and bedding to help cattle cope with environmental changes and cold weather during the winter (Mader, 2003). Windbreakers play an important role in North American beef production without buildings, especially in production of young cattle and in areas with cold northerly winds during winter and early spring. Windbreakers reduces wind speed, lower animal stress, improve animal health and increases feeding efficiency (South Dakota Department of Agriculture, 2006; Quam *et al*, 2006). Where naturally sheltered areas are insufficient, constructed windbreakers can be used to provide protection (Alberta Cattle Commission, 2008).

Both natural and constructed windbreakers can be utilized in a number of ways to provide protection for livestock. They can act like windbreakers during both winters, as a protection from cold winds, and summers when they provide shade and protection from hot winds (Agriculture and Agri-Food Canada, 2008). Constructed windbreakers can either be permanent or portable. In picture 3 permanent windbreakers are shown.

Picture 3. Permanent windbreakers (Picture by Sofia Nyman, 2007).

According to Alberta Cattle Commission (2008) portable windbreakers are useful to encourage the cows to move around on the pasture. Changing bedding and feeding locations on a regular basis will result in easier and more evenly spreading of nutrients from manure and urine over a larger area, and trampled ground is avoided. This makes it less labour intensive because the fertilizer is already on the field (Alberta, Agriculture and Development, 2002). Another advantage is that portable windbreakers are easy to move with tractors (Interviews with farmers in PRR, 2008). A disadvantage can be that they are more expensive to build than permanent windbreakers (Alberta, Agriculture and Rural Development, 2002). In picture 4 portable windbreakers are shown.

Picture 4. Portable windbreakers (Government of Saskatchewan, 2008).

South Dakota Department of Agriculture (2006) has compared cattle in Montana with and without weather protection. The result was that cattle sheltered by windbreakers gained, during mild winters, on an average 15kg more than cattle in an open feedlot without any protection. During severe winters cattle in protected feedlots lost approximately 5kg less in weight than cattle in unprotected feedlots. According to Quam *et al.* (2006) cattle in an

unprotected winter range need about 50% more feed than cattle protected by windbreakers and cows in wind protected areas had a two percent better calving result than cows in unprotected areas.

Bedding in feedlots has been shown to have a positive economic benefit with an increase in average daily gain, even though it also gives higher labour costs (Manninen, 2007). If the bedding constitute a fibrous feed source it is possible that the cattle start consuming bedding. This could result in a decreased intake of their normal high-energy feed which will decrease energy intake and lower performance (Mader, 2003). An alternative is to use chopped wood as bedding since cattle likes it as bedding but do not eat it (Interview with feedlot manager in Alberta, 2008).

Protection against ground and environmental damages

To have cattle wintered outdoors can lead to high pressures on the ground with regard to excess of manure, trampling and mud. Most affected areas are where the animals spend most of their time e.g. around water, feeding areas, wind protection areas and transportation areas.

A vegetation cover on the seasonal feeding area will improve heavily affected areas that will be cleaner and dryer. A good cover will also have an impact on the following summer; with maintained feed production and nutrient uptake. If it is intact it will reduce the risk for water pollution by leaching, surface runoff and erosion (British Columbia Ministry of Agriculture, Fisheries and Food, 1992; Kumm *et al.*, 2007). Animal density on the pastures also affects the degree of affection on the ground (von Wachenfeldt, 2005). A higher animal density results in higher amount of manure contributed to the ground. It also causes a greater snow compaction which result in greater frost penetration, that may add to runoff risk (British Columbia Ministry of Agriculture, Fisheries and Food, 1992). According to Kumm *et al.* (2007) the trampling affect on the ground can be reduced by spreading the animals over a larger area, constantly moving of the feeding area and by yearly changing wintering pastures. Trampling affect on the ground can also be reduced if the ground has a slope and is leachy (Kumm *et al.*, 2007), but this can also result in a higher risk of water pollution. This is determined by the degree of slope, amount of precipitation and cattle density. A slope to the south is often selected for a wintering site to gain the exposure to the winter sun (Alberta Cattle Commission, 2008; British Columbia Ministry of Agriculture, Fisheries and Food, 1992).

According to British Columbia Ministry of Agriculture, Fisheries and Food (1992) forest cover has the least risk of runoff water and long crop stubble has the greatest resistance of runoff. The amount of precipitation has also a major affect on the risk of runoff and particularly the amount of rain during feeding period. Water cannot infiltrate a frozen ground which is why melted snow on frozen ground can be a high risk. Runoff water from the feeding area can be limited if there is a perimeter ditch or a berm, to divert any containments, just beneath the slope. This is shown in figure 10 where an example of a seasonal feeding area is shown. Many beef producers make a ditch as it often improves the feeding area by reducing mud problems (British Columbia Ministry of Agriculture, Fisheries and Food, 1992).

One important consideration is also to look at the water source for the animals, they need high quality water also during the winter. Contamination of the water, which is a health risk, could be less if the water source is at an acceptable distance from the feeding area (Alberta Cattle Commission, 2008). These distances have to be considered in relation to soil type. Infiltration risk to groundwater is greatest in sandy or gravelled soils and least infiltration risk does clay soils have (British Columbia Ministry of Agriculture, Fisheries and Food, 1992). As

mentioned before the most appropriate ground for outdoor wintering of cattle is a ground which has a sloped sandy moraine soil with high infiltration capacity and the least appropriate ground is a dense clay soil. A silt soil with high capillary transportation of water is impropriate (Kumm *et al.*, 2007).

To use natural windbreakers as forest seems good considered to animal welfare but can cause damages to the forest. According to Klasson (2007) most damages on the forest are connected with trees that are ring-barked, root trampling and compaction of the ground. Trees that seem to be most sensitive against bark and root damages are spruces and the least sensitive are pine and birch (Klasson, 2007).

Other factors that have to be taken into concern when talking about outdoor wintering of beef cattle and environmental health are e.g. denitrification and ammonia missions to the air (von Wachenfeldt, 2005).

Winter feeding in western Canada

During a great deal of nineteenth century animals grazed free on the ranges all year around and with no provision of winter feed. This resulted in big areas that became overgrazed and during the severe winter 1886-1887 there was probably not enough grass under the snow, which resulted in a lot of animals starving. After that winter, feeding with hay became more common (Ewing, 1990).

In western Canada the grazing period without supplementary food, is in some cases only between 150-200 days (British Columbia, Ministry of Agriculture and Food, 1998; McCartney *et al.*, 2008), and according to McCartney *et al.* (2008) winter feeding cost is the most expensive part in cow-calf operations. In confined livestock areas also bedding, manure handling and storage of winter feed have to be added to the feed production cost and this productions system also requires around 40% more labour than seasonal feeding areas (McCartney *et al.*, 2008). According to Jungnitsch (2008) and Kallenbach (2000) harvested hay can be more than double the cost of the same amount nutrients from pastures. Reasons why hay is more expensive are that hay production requires larger investments of equipments and is, as mentioned before, more labour intensive than pastures. Another issue is also that often more than 50% of the hay is wasted by poor storage and/or bad feeding methods (Kallenbach, 2000). In a study by Jungnitsch (2008) a big difference between seasonal feeding areas and confined livestock areas is the cost of machinery, which is more expensive in the confined livestock areas. Feeding and bedding costs are very similar in both systems (Jungnitsch, 2008), but according to McCartney *et al.* (2008) there will be less feed harvesting, storage and hauling and less manure handling costs when using seasonal feeding areas.

During winter it can also be problems with feed that freezes. Feeds that are suited for cold conditions are e.g. hay, straw and concentrate which could be due to the high dry matter content. Even silage with high dry matter content is suited for colder conditions (Manninen, 2007).

One way to feed on a seasonal feeding area is swath grazing (Picture 5) which is when whole-grain forage is swathed just before killing frost and the crop should have reached the soft to late dough stage. The swaths are left in the field for the cattle to graze during the winter and can be grazed in snow as deep as approximately 60cm (Alberta, Agriculture and Rural Development, 2004). Alberta, Agriculture and Rural Development (2004) states that swath

grazing can extend the grazing period which will result in reduced feed, labour and manure handling costs (Cuomo *et al.*, 1999; McCartney *et al.*, 2003).

Picture 5. Cows that are swath grazing (Source: Alberta, Agriculture and Rural Development, 2004).

Another way to feed on seasonal feeding areas is hauling large round bales out to the pasture, then grinding and spreading the hay with a hay processor or unrolling the bale with a bale unroller. A third way is to put bales out on the feeding area before feeding and then feed gradually by using portable electric fences that regulate the accessibility; this is called bale grazing (Kallenbach, 2002; Jungnitsch, 2008). In picture 6 there is an example of bales out on a winter pasture prepared for bale grazing.

Picture 6. Bales put out on a field prepared for winter and bale grazing (Picture by Sofia Nyman, 2008).

Feeding methods during the winter, including feed handling, labour and equipment, vary widely between farmers (McCartney *et al.*, 2008) and both swath grazing and bale grazing can reduce or even eliminate costs for corral cleaning, manure spreading and feed handling (Alberta, Agriculture and Rural Development, 2004; Manitoba Forage Council, 2008). According to Lardner (2006) there is not a big difference in feed wastage between the different feeding methods.

Wildlife can be a big problem when using swath and bale grazing. Deer, moose, elk, ducks and geese can defecate and trample in the swaths that are left for feeding the cattle. In areas where wildlife is of big concern, other feeding systems should be considered (Alberta, Agriculture and Rural Development, 2004).

Water is important for cattle because reduced water intake leads to reduced feed intake which can result in decreased weight gain. Water intake is about 25% less in the winter than in summer and according to Manninen (2007) water intake reduces by half as the air temperature decrease from 32°C to 4°C. Water can be supplied in different ways and one way is to have dugouts (Picture 7). The cattle can drink directly from dugouts or from water troughs. The water troughs are connected to pipelines that transport the water from a dugout to the water troughs in paddocks or at pastures (Farm Animal Council of Saskatchewan Inc., 2008). Heated cups with insulated pipes are a good investment in order to prevent winter freeze and it is important to check the water during cold periods (Manninen, 2007). Nose-pumps save water because the water is only coming on the demand of the animal (Farm Animal Council of Saskatchewan Inc., 2008). Snow can also be an adequate water source but can not be the only source if snow conditions or lack of snow becomes a problem (Alberta, Agriculture and Rural Development, 2004).

Picture 7. Dugout in PRR (Picture by Sofia Nyman, 2008)

Case studies: Farms in PRR and feedlots in Alberta

In October and November 2008 six farms with cow-calf production in PRR, BC, and two feedlots in Alberta were visited. The farms were located around Dawson Creek and Fort St John, which are the biggest cities in PRR. The two feedlots were both in south of Alberta, Calgary area. Feedlot operations are much bigger in Alberta than in BC and most farmers in BC send their calves for finishing in Alberta (Henry, 2003; Alberta Beef Producers, 2008).

During 2008 the weather was drier than normal in PRR which, according to Robinson (2008), resulted in high losses in grain and forage production, lower crop yields, less grazing days and pastures in poorer condition going into winter and lack of water available for livestock. Other concerns that became problems were wildlife, competition for private and Crown land (Peace River Forage Association of British Columbia, 2008). From January to September, 2008, the precipitation was more than 100mm less than average during the same time 2003-2007 (Environment Canada, 2008).

There are different ways of renting land in PRR which differs from Sweden, so first there will be a description of land rental in PRR and then a short description of the farms and feedlots.

Land use

There are three different ways to rent land in PRR; community pasture, grazing permit[3] and leased land. Community pasture is land owned by the Crown and many farmers can, at the same time, use the land to graze their cattle. One third of all the cattle around Dawson Creek are grazing on community pastures. The cost to use this land is around 39-65SEK per Animal Unit Month (AUM [4]). This price differs between pastures, depending on how much management of the cattle that is included in the price. The second one is grazing permit which is rented land with a 10 year contract. The price is around 40SEK per AUM. Leasing land is the third way to use land and is a 21 year leasing agreement. Earlier the Crown land was sold out to the homesteaders by quarters (73 hectares) and the agreement was that they could buy the land after 21 years, if 50% of the land was arable. To lease one quarter of land cost today 3250SEK per year, plus taxes, 1950SEK per year.

Observations on farms

Farm 1

This farm is located southwest of Dawson Creek and is a cow-calf operation with 200 cows of a cross between Gelbvieh[5] and Simmental or Charolais. The farm has 1220 hectares land and produce hay and green-feed on approximately 600 hectares. The rest of the land is divided into 20 pastures on where the cows are rotate grazing. The cows are winterfed for about 200 days on a seasonal feeding area that is used during the winter which is approximately 20 hectares. They are swath grazing during November to March but also fed with hay or silage bales as a complement. The feeding area is continually moved around depending on wind and manure build up. The pasture has a south slope to take advantage of the winter sun and the cows are fed round bales that are rolled down the hill. At the seasonal feeding area there are only natural windbreakers (forest edges) as weather protection.

[3] Grazing permit can also be called grazing license or range tenure

[4] One Animal Unit (AU) is a cow with her calf and one AUM is a cow with her calf during one month.

[5] Gelbvieh is a smaller breed that originates from Germany and have good mother traits, good fertility, but is not as good in conformation and meat quality. That is why it is crossed with Simmental or Charolais.

Calving starts in May and the calves are sold directly after weaning, but some bulls and heifers are kept as replacement animals. Calving area are close to home and also close to buildings where the animals can be handled if there are any problems with calving. This building also works as a treatment barn with stalling opportunities, corrals and a handling corral.

Farm 2

This farm is located east of Dawson Creek and is a combined cow-calf operation and backgrounding feedlot. In the cow-calf operation there are about 300 suckle cows of which 120 belongs to the farmer and the rest of the cows are custom fed. The feedlot is a part of True North Beef and backgrounds both heifers and steer from different producers. True North Beef is an organized feedlot cooperation to promote market for Peace Country Beef (True North Beef, 2008). This organisation includes three farmers that gather their own calves, and other producers calves, and background them before selling them to a finishing feedlot in Calgary.

The farmer produces barley silage on 240 hectares. During winter, from November to March, the cows are swath grazing and fed silage as a compliment. The seasonal feeding area that are used during the winter is 120 hectares and do not have any constructed windbreakers just natural ones. During calving season the cows are in smaller areas close to home. There are also buildings that could be used for cows with calving problems. The calves at the feedlot are in confined livestock areas.

Farm 3

This farm is located west of Dawson Creek and has 275 suckle cows crossed between Hereford and Angus. The farm use totally 2560 hectares of land and 1600 hectares of these are deeded land and the rest of it is owned together with neighbours. During the winter the cows are fed in a seasonal feeding area of 130 hectares. This pasture has only natural windbreakers and during seven months the cows are bale grazing hay.

Calving starts in March and the calves are weaned in November. Calving area is close to home and the cows are separated into one big corral, without a shed, and smaller corrals, confined livestock areas, that have sheds with roof. There is a machine hall next to the corrals where machines are kept during winter time. In this hall there are facilities to use if there are any problems with calving. The calves are fed one winter and then the steers are sold to a feedlot. The heifers are kept over the summer and sold the next spring since they have low weaning weights, approximately 181kg. A couple of bulls are kept to one and a half year of age and then sold as breeding bulls.

Farm 4

This farm, which was located between Dawson Creek and Fort St John, started in 1979. On the farm there was about 300-350 cows of Black Angus/Simmental crosses. There were totally 1500 hectares of land and around 280 hectares of this land was used for hay/silage production and approximately 1200 hectares for grazing. The grazing pastures were divided into 8 pastures were the cows were rotate grazing. During the winter, for 200 days, the cows were bale grazing and in the fall they were grazing the regrowth on the hay fields.

Farm 5

This farm is divided into two units and are both located north of Fort St John. At one unit there are 400 Black Angus/Hereford crosses and hay/silage production, and at the other unit there is grain production and a feedlot. On the feedlot calves are both backgrounded and finished. Backgrounding starts out on pastures where calves are grazing and fed some grain. Calves on finishing rations are in confined livestock areas with wind protection in form of sheds with roof. The finished calves are either sold to a slaughter house in Dawson Creek or to one in Calgary. In picture 8 the confined livestock area with the shed is shown.

Picture 8. Confined livestock area with roofed shed (Picture by Sofia Nyman, 2008).

There are about 3600 hectares of pastures at the farm and 200 hectares are for hay/silage production. Approximately 4000-5000ton barley silage is produced per year to cover both feed for the cows during winter and silage for feedlot calves. Around 1400 hectares is for grain production and about 80% of the grain is sold which is the biggest income for the farm.

Farm 6

The last farm that was visited is also located north of Fort St John and has 285 cows of a Black Angus/Limousine cross. Around 4700 hectares are used for pastures and approximately 320-360 hectares is used for grain and hay production. The cows are winterfed for 200 days, on both swaths and round bales. There are natural windbreakers in both the seasonal feeding area, which is used for the cows during the winter, and in the calving pastures. The topography in the pastures is beneficial with hills, which gives the cows dry areas for resting. The south sloped hills also give the cows some winter sun. Calving period starts in April on a big pasture closer to home. In picture 9 calving area is show with trees as windbreakers and a south sloped ground.

Picture 9. Calving area with natural windbreaker and a south slope (Picture by Sofia Nyman, 2008).

At home there are buildings that are used in care of any calving problems. During winter the breeding bulls are fed in big confined livestock areas at home. The steers are sold directly after weaning in the fall, while the heifers are kept to the spring and sold as yearlings.

Observations on feedlots

The two different feedlots have different locations and are of different sizes which can affect the yardage cost. For the smaller feedlot the yardage cost is low, 1.10SEK per head and day and for the bigger feedlot the yardage cost is 2.90SEK per head and day. Yardage cost is usually around 0.98-3.25SEK per head and day which can depend on size of feedlot and location. The smaller feedlot could not have a more expensive yardage cost because then it would be hard to get calves into the feedlot (Interviews with feedlot managers in Alberta, 2008).

It is common to market the feed up and in these cases both feedlots marked the feed up with approximately 15%. This is a way for the feedlot owner to get some money for their own wages (Interviews with feedlot managers in Alberta, 2008).

Feedlot 1

This backgrounding feedlot is located in Airdrie and is a smaller feedlot with a capacity of 5000 animals, but at the time for the visit there were only around 1300 animals at the feedlot. This feedlot manager has also a cow-calf operation with 400 cows beside the feedlot. The feedlot started in 1970 and used to be a custom fed feedlot with retained ownership but today the feedlot manager owns all the animals at the feedlot.

The calves are on feed for approximately 300 days per year and they are fed silage and barley. The silage is produced at the farm but barley and hay are bought. The farm has approximately 800 hectares of land that is equally divided between the feedlot, grain production, silage production and native grass for grazing.

Feedlot 2

The second feedlot is bigger and more like a more common Albertan finishing feedlot with a capacity for 20 000 animals. At the time for the visit there was about 16 500 cattle in the

feedlot but usually the feedlot gets filled during the spring. In picture 10 an overview over the feedlot is shown. This feedlot is a part of a bigger company owned by one family. The company also has a fertilizer operation, grain farm and machines for custom work.

Picture 10. An overview over feedlot number 2 (Picture by Pernilla Salevid, 2008).

Around 6000 hectares of land are connected to the feedlot operation, and this is used for feedlot area and for producing feed on the grain farm. The cattle stay at the feedlot for seven to eight months and leave when they are about one and a half to two years of age, depending on weight. Picture 11 shows calves in a confined livestock area.

Picture 11. A confined livestock area at feedlot number 2 (Picture by Sofia Nyman, 2008).

Market prices

According to British Columbia, Ministry of Agriculture and Food (2007) the sell price for heifers is traditionally 0.52-0.65SEK per kg lower than steers. As figure 12 shows the prices are lower for heifers but how much lower can vary during the year. From middle of March to Middle of May there were no sales, that is why there are no numbers in April. According to Canfax (2008) bred cows cost, during middle of October 2008, around 3250-6500SEK and cow-calf pair price was between 4875-5525SEK.

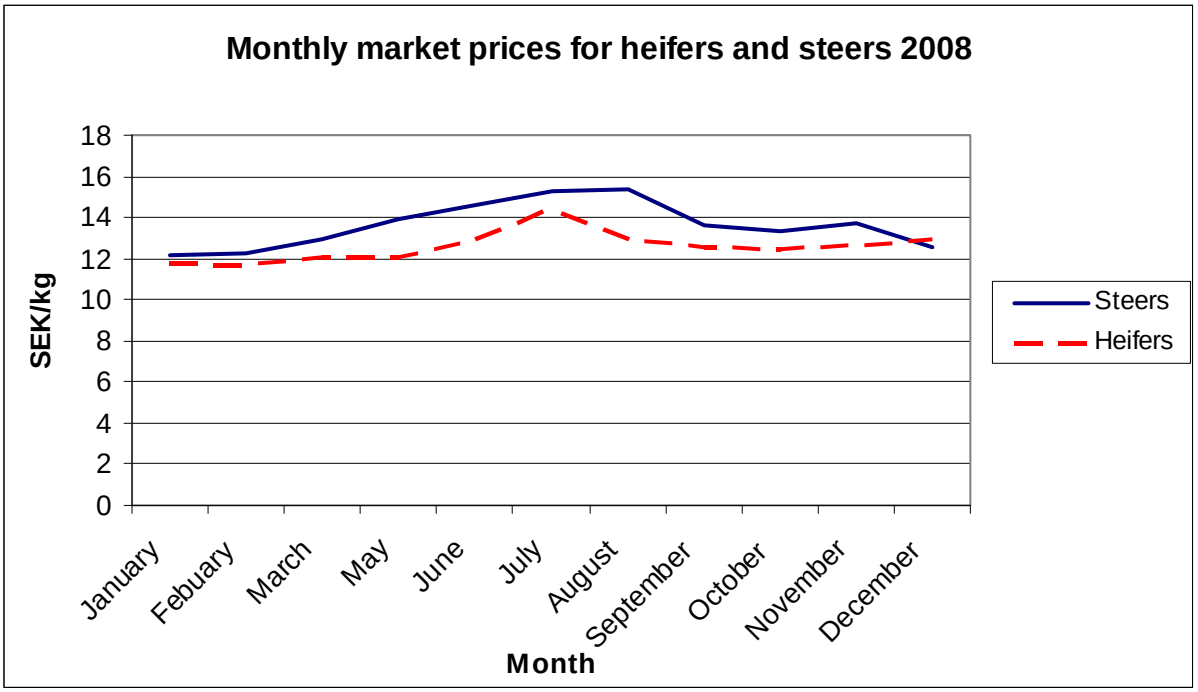

Figure 12. Monthly market prices during 2008 for heifers (227kg) and steers (272kg) (Source; Dawson Creek Auction ´Mile Zero City´ Homepage, 2008).

Another component that affects calf price is transportation costs. This means that location of farms and feedlots, the distance between the two operations, affects the price of the calf. Cow-calf producers in Dawson Creek that sell their calves to feedlots in Alberta have a higher transportation costs and get less net price for their calves than those producers that are located closer to a feedlot (Interviews with farmers in PRR, 2008).

Buildings and windbreakers

Since one of the most expensive items in Swedish beef production is buildings, one of the questions to the farmers was about the importance of buildings and if it is necessary with roof or sheds during winter. All the farmers thought that it was enough with natural windbreakers, like forest, or constructed windbreakers (Picture 3 and 4). In picture 12 a natural windbreaker from one of the farms is shown. The natural windbreaker is located on the top of a south slope. A south slope takes advantage of the sun and just in front of the trees the cows and calves are fed in feeding troughs (Interviews with farmers in PRR, 2008).

Picture 12. An example of natural windbreaker (Picture by Sofia Nyman, 2008).

In feedlots it is more important with windbreakers but still not necessary with roofed sheds. It is more important in the winter to prevent snowdrifts into the lots (Interviews with feedlot managers in Alberta, 2008). At farm number 5 there is a shed with roof in the confined livestock area (picture 8) but the animals seldom use it as protection (Interviews with farmers in PRR, 2008).

The most important building is considered to be a shop where the farmers can work during wintertime, when their least busy time is. In picture 13 a typical working shop is shown. This one is used for e.g. machine repair, storage of tools etc. It is heated so that the farmers can work there even during cold winter months (Interviews with farmers in PRR, 2008).

Picture 13. A working shop that is used during the whole year (picture by Pernilla Salevid, 2008).

It is also important to protect the machines from precipitation so a roof over the machinery during winter is important for most of the farmers. To use contractors for machine work is not very common in PRR because it is really expensive due to the long distance between farms (Interviews with farmers in PRR, 2008).

Another building that is important, according to the farmers, is a building that can be used during calving season. There are different building on different farms, it can be a barn, machine hall or just a shed with a roof and walls etc. In picture 14 a barn is shown. This barn was built during 1985 and is used for cows with calving difficulties and when treating sick animals (Interviews with farmers in PRR, 2008).

Picture 14. A barn that is used during calving season (Picture by Sofia Nyman, 2008).

In picture 15 a machine hall is shown. This machine hall is usually used for machines storage but since there are facilities e.g. water and portable fences installed, the hall can also be used for cows with calving problems during the calving season. The buildings are not insulated but have roofs and walls as protection against wind and precipitation (Interviews with farmers in PRR, 2008).

Picture 15. A machine hall that is used during calving season (Picture by Sofia Nyman, 2008).

Economic calculations; comparisons between CSF and PRR

When the EU-support will be fully decoupled, Swedish beef production will suffer and have lower profitability, which probably will result in a decreased production. In this part, budgets for cow-calf operations in PRR and CSF as well as finishing operation in CSF and Alberta, where PRR calves are finished, will be compared. The comparison can suggest ways to reduce cost of production in Sweden and, thus, improve the sustainability of Swedish beef production.

Cow-calf operation

In table 4, assumptions for cow-calf operations in PRR and CSF are shown. There is a big difference between cow herd size in PRR and CSF, 200 and 38 suckle cows respectively and also the size of land for pastures and forage production. Another big difference is the production cost for hay/silage. CSF has higher yields but at a higher production cost than PRR that has cheaper production costs but a higher feed requirement per cow and year. Lower yield in PRR can depend on e.g. a poorer soil and more extensive and low input production.

Table 4. Assumptions and production factors for a cow-calf operation in PRR and in CSF [1CAD = 6.5SEK]. 100% semi-natural pastures are assumed in Sweden. PRR numbers are based on information from farmers and own calculations based on Malmberg and Peterson (2006). CSF numbers are based on Swedish University of Agricultural Science (2008a) and Swedish University of Agricultural Science (2008b)

	PRR	CSF
Number of cows	200	38
Total forage (ha)	480[1]	70
Hay/Silage Yields (ton DM/ha)	4	5
Total Hay/Silage costs (SEK/ton DM)	336	1701
Weaning percentage (%)	95	94
Weaning weight (kg) :Steers/bulls	250	300
:Heifers	234	275
Sale price at weaning (SEK/kg) :Steers/bulls	17	16
:Heifers	14	11
Hay/Silage requirement (ton DM/cow & year)	4	1.3

1. Beside this area pasture is rented (cf. Grazing fees in table 5 and 6)

The forage that is produced in PRR, is of lower quality, i.e. nutrition value, than the forage in CSF. Forage with low nutrition value will results in an increased feed intake, this to meet the nutrition requirement. Another reason for higher forage requirement for beef cows in PRR can be the cold winters. The cows need more feed to keep their heat balance. In PRR there are also more losses of hay when e.g. storage and feeding on the fields, which will lead to a higher feed consumption in PRR compared to CSF.

The revenues and expenses per suckle cow are calculated and shown in table 5. The revenue for cow-calf is slightly higher in CSF than in PRR, 3191SEK and 2990SEK per cow and year respectively. The total revenue in PRR, 3276SEK per cow and calf, is just half the total revenue in CSF, 6460SEK per cow and year, which depends on the extra income from governmental payment for semi-natural pastures and seeded grasslands in CSF. These payments make up almost 50% of total revenue in cow-calf operations. In the governmental payment , beside environmental payments, also single farm payments to semi-natural pastures is included, because grazing is required for receiving the payment for semi-natural pastures. Without later governmental payments the total revenue minus total expenses would be decreased from minus 4334 to 7603SEK per cow and year, which is also shown in the same table.

Table 5. Revenue and expenses for cow-calf operation in PRR and CSF [SEK per cow and year; 1CAD = 6.50SEK] (Source: If nothing else is mentioned in the footnotes there are own calculations based on British Columbia Ministry of Agriculture and Food, 2007; Malmberg and Peterson, 2007; Swedish University of Agricultural Science, 2008a and Swedish University of Agricultural Science, 2008b)

Revenue	**PRR**	**CSF**
Cow-calf[1]	2990	3191
Crops	286	0
Environmental payment	0	3269[2]
Total Revenue	**3276**	**6460**
Expenses		
Feed Purchase	0	115
Seed, fertilizer, twine, silage additives	215	801
Grazing fees, land taxes	228[3]	0
Vet and medicine & minerals and salt	195	304
Machinery[4]	1895	1198
Buildings, fences and bedding[5]	352	3668
Labour	1818[6]	3515
Land cost[7]	0	304
Interest[8]	395	644
Other costs[9]	527	245
Total Expenses	**5625**	**10794**
Total Revenue less Total expenses	**-2349**	**-4334**
Total Revenue excl. environmental payment, less Total Expenses	**-2349**	**-7603**

1. Revenue for weaned calves and culled cows less bull and replacement expenses, less marketing and trucking. Replacement in CSF is 20% and in PRR 15%
2. EU-support: 1100SEK per ha is environmental payments to semi-natural pastures, 300SEK is environmental payments to ley and 1100SEK per ha is single-farm payment to semi-natural pastures
3. Community pasture; 39-65SEK per Animal Unit Month, Grazing permit; 40SEK per Animal Unit Month, 21 year lease (Interviews with farmers in PRR, 2008)
4. Ten percent depreciation on whole investment cost and six percent interest on half investment cost. Fuel, lube and repair are also included (Interviews with farmers in PRR, 2008; Maskinkalkylgruppen, 2008 for PPR, and Maskinkalkylgruppen, 2008 for CSF)
5. Ten percent depreciation on whole investment cost and six percent interest on half investment cost for buildings and fences
6. One fulltime working man per 200 cows. Wage including payroll taxes and benefits 175SEK per hour and approximately 2100 working hours in PRR (Interviews with farmers in PRR, 2008) and 181SEK per hour in CSF
7. Opportunity cost for land
8. Six percent interest on operating and animal capital
9. Other costs are crop insurance, custom work, death losses, taxes, lisc., leases and ins. and miscellaneous.

Most expenses are considerably higher in CSF than in PRR and the biggest differences are costs for labour and buildings. Labour costs are lower in PRR thanks to economies of scale in larger herds. The building cost is lower in PRR because the cows are wintered outdoors with a minimum of constructed shelter while wintered indoors in expensive buildings in CSF. Other costs that are higher in CSF are e.g. opportunity cost of land and seed, fertilizer etc in hay/silage production.

The wage for a farm worker in Sweden is 181SEK per hour. In western Canada wages for farm workers are between 98-163SEK per hour. At most of the farms that were visited, the wages for paid labour are 163SEK per hour and with payroll taxes and benefits the paid

labour cost became 175SEK per hour, which is the number that is used in PRR budget. One reason for the higher labour costs in CSF than in PRR is higher labour demand per cow in the small Swedish herds compared to the demand for labour in the bigger herds in PRR, that are also wintered outdoors. The working hours on an average farm in PRR is approximately 2100 hours per year and the busiest time is in the spring during calving season, another busy time is during harvest in the summer. In later fall it is time for weaning and than again a lot of time is spend on the cows. During winter most of the labour is for feeding the cows and calves and rest of the time is spent on e.g. repairing machineries. Working hours are almost equally shared between animal production and crop production (Interviews with farmers in PRR, 2008). Opportunity cost of labour has a big impact on farms in PRR even though they are not close to a bigger town. Most impact does the oil and gas businesses have. For both farmers and feedlot owners, oil and gas business causes big problems with opportunity cost of labour. Western Canada energy has a high demand for labour, construction and manufacturing sector too (Interviews with farmers in PRR, 2008).

Opportunity cost for land for producing silage to one cow in Sweden is 304SEK per cow and year which is mostly due to the profitable grain production. In PRR the opportunity cost is zero which probably is a cause of the poorer soil and more hilly and uneven terrain on the farms which is not suitable for grain production. Forest has low value in PRR due to long distances to wood industry which means that forest does not compete with beef production about the land in that specific area. The forest is just shuffled down and burnt to get more pastures and space for beef cattle. The farmers that were visited were only interested in having cow-calf operation and did not care about producing e.g. grain even though the grain prices were high at the moment. If cow-calf operations are located in areas where the land is more suitable for other operations, e.g. more grain, the opportunity cost will be higher. In PRR it is common to have the cows grazing on Crown land or to lease land for a fee and the grazing fee is 228SEK per cow and year, as shown in table 5.

The amount of machinery differs between different farms in PRR. Some farmers have more machinery than is needed for the specific operation, while others just have a couple of machines and borrows other machinery they need. It is common that farmers buy machineries that e.g. are jointly used, together with friends or neighbours. To use a contractor to do machinery work is not very common since the distance to and between farms makes it too expensive. In Sweden the amount of machinery also varies a lot between farmers and it is relatively common to hire contractors for custom work in Sweden.

In Sweden, beef production is generally a part-time job because it is not profitable enough to have beef production as the only income. PRR has almost the same situation and e.g. the oil and gas industry are, for many farmers, a big income. The farmers are paid to have oil and gas plants on their land and the farmers may also take care of some work for oil and gas companies. Without this extra income the beef production in PRR would also be unprofitable which is shown in table 5.

In table 6 the Swedish labour and building costs in a cow-calf operation are changed to Canadian numbers. The gross profit will then be 679SEK per cow and year instead of a negative number at minus 4334SEK per cow and year. This suggests that cow-calf production in Sweden would give full cost coverage in a 200 cow herd with outdoor wintering. If the opportunity cost of land in CSF was zero and the governmental payment retained, the production would be profitable.

Table 6. Sensitivity analysis for cow-calf production in CSF with present production model and PRR production model including 200 cows and outdoor wintering [SEK/cow and year] Own calculations and data based on table 5

Revenue	CSF (with present production model)	CSF (with PRR production model)
Cow-calf	3191	3191
Crops	0	0
Environmental payment	3269	3269
Total Revenues	**6460**	**6460**
Expenses		
Feed Purchase	115	115
Seed, fertilizer, twine, silage additives	801	801
Grazing fees and land taxes	0	0
Vet and medicine & minerals and salt	304	304
Equipment	1198	1198
Buildings, fences and bedding	3668	352[1]
Labour	3515	1818[2]
Land cost	304	304[3]
Interest	644	644
Other costs	245	245
Total Expenses	**10794**	**5781**
Total Revenues less Total Expenses	**-4334**	**679**
Total Revenue, excl. environmental payments, less Total Expenses	**-7603**	**-2590**

[1.] From Canadian cow-calf calculations
[2.] From Canadian cow-calf calculations
[3] x times larger area of arable land in PRR then with present CSF production model. Thus, 304*x SEK cost of land with present PRR production model in CSF.

If all the governmental payments expire there will still be a negative result in the calculation, minus 2590SEK per cow and year, even though lower building and labour costs. This result is still better than with governmental payments in present Swedish beef production, 7603SEK per cow and year.

Finishing operation

Most calves produced in PRR are sent to and finished in Alberta, which is why finishing operations in Alberta were chosen to study. The Canadian numbers are based on a feedlot operation in Alberta with 1000 heads of cattle but the calculations are also complimented with numbers from Highmoor (2005a and b) and Highmoor and Monchuck (2004) to cover all the facts that are needed. In table 7, calculations for finishing operations in Alberta and CSF are shown.

The revenues from sold cattle are higher in CSF compared to Alberta, 9993SEK and 7200SEK per head, respectively. The Swedish calculation is based on bull calves which are of a heavier beef breed while the Canadian calculation is based on steers and heifers which are of lighter beef breeds, e.g. Angus and Hereford. Live weight at slaughter are approximately 600kg, and the same for both bulls in CSF and steers in Alberta, even though there are different breeds, whereas the live weight for heifers in Alberta is 550kg. This can be a result of the implants that are used in Canada.
In this calculation weaning weight for a bull calf in CSF is 300kg and in PRR the weaning weight is 250kg for a steer and 226kg for a heifer which can be a reason for the lower calf expense in Alberta.

Table 7. Revenue and expenses in cattle finishing operation in CSF and PRR calves in Albertan feedlot [SEK per head; 1CAD= 6.5SEK]. : If nothing else is mentioned in the footnotes there are own calculations where CSF data are based on calculations from Swedish University of Agricultural Science, 2008a and Swedish University of Agricultural Science, 2008b. Alberta data are collected from own interviews with feedlot managers in Alberta, and Highmoor (2005b) and Highmoor and Monchouk (2004)

Revenue	**Feedlot in Alberta**	**CSF**
Fed Cattle Sold	7200[1]	9993
Male Animal Premium	0	1356
Total Revenue	**7200**	**11349**
Expenses		
Calf	3497[2]	4700
Feed	2224[3]	4010
Veterinary & medicine, minerals	195[4]	174
Buildings, corrals, machinery, fuel	410[5]	1986
Labour	364[6]	1539
Interest[7]	220	277
Other costs	383[8]	264
Total Expenses	**7293**	**12950**
Total Revenue less Total Expenses	**-93**	**-1601**
Total Revenue excl. male animal premium, less Total Expenses	**-93**	**-2957**

1. Approximately 600 kg live weight for finished cattle. The price for finished cattle is approximately 12SEK per kg (Interviews with feedlot managers in Alberta, 2008)
2. Calf sold from PRR; 3497SEK from cow-calf calculations, table 5
3. 300 feeding days (Interviews with feedlot managers in Alberta, 2008)
4. Mineral cost 0.59SEK per animal and day and veterinary cost is 0.07SEK per animal and day (Interviews with feedlot managers in Alberta, 2008)
5. Depriciation 0.61SEK per day, repairs 0.25SEK per day and fuel 0.20SEK per day (Highmoor and Monchuck, 2004)
6. 1000 heads per employee. Annual wage including payroll taxes and benefits 364 000SEK (Interviews with feedlot managers in Alberta, 2008)
7. Six percent interest on operating and animal capital
8. Other costs include death losses, bedding, custom work, taxes, lisc., leases and ins., utilities and miscellaneous.

Feed costs per head are higher in CSF compared with Alberta although the fact that the finishing period is longer, about 300 days, in Alberta than in CSF where the finishing period is about 210 days. One reason for lower feed costs in Alberta is lower costs per kg feed. Another reason is that hormone implants reduces the feed consumption per kg growth.

Minimized weather protection is a reason for lower building costs in Alberta. In CSF the bulls are fed intensively indoors which makes the impact of the weather less important but also gives a higher building cost with the high demand on the buildings. Another reason for low costs of buildings, corrals and machinery in Alberta is economies of scale in larger feedlots.

The wages per hour for a feedlot workers in Alberta are at the same level as for farm workers in PRR, between 98-163SEK per hour. Things that can decide the level of wages are where the feedlots are located and what the opportunity cost for labour is. The smaller feedlot that was visited is located closer to one of the biggest cities in Alberta, which results in a bigger competition for labour and increased demand for higher wages to get employees. At the smaller feedlot the cost of labour was 175SEK per hour including payroll taxes and benefits.

In the other feedlot, that was located further away from densely built-up areas, the wage was only 127SEK per hour (Interviews with feedlot managers in Alberta, 2008).

Even though the wages are at the same level as in Sweden, total labour cost is much higher in CSF. This depends on higher labour demand per head in the small Swedish indoor operation (50 heads) than in the larger Canadian feedlots with thousands of heads. According to feedlot managers in Alberta (2008), a rule of thumb is to have one man per 1000 cattle at a feedlot.

In Sweden beef cattle finishers get government payments in form of male animal premium. This is about 12% of the total revenue. If this premium will be totally decoupled, total revenues minus total expenses will be minus 2957SEK per head instead of minus 1601SEK per head. In Alberta the total revenue less total expenses is minus 93SEK per head.

Since the costs of labour and buildings are much cheaper in Alberta there can be ways to reduce these costs in Swedish beef finishing. In table 8 a sensitivity analysis is shown, where the present production model in CSF is compared with a calculation for CSF with Albertan feedlot production model. Costs for labour and buildings are changed to the Albertan numbers for the same items in this analysis.

Table 8. Sensitivity analysis for revenues and expenses in cattle finishing operation in CSF with present production model and Albertan feedlot production model [SEK per head]. Own calculations based on table 7

Revenue	**CSF (with present production model)**	**CSF (with Albertan feedlot production model)**
Fed Cattle Sold	9993	9993
Male Animal Premium	1356	1356
Total Revenue	**11349**	**11349**
Expenses		
Calf	4700	4700
Feed	4010	4010
Veterinary, medicine & minerals	174	174
Buildings, corrals, machinery & fuel	1986	410[1]
Labour	1539	364[2]
Interest	277	277
Other costs	264	264
Total Expenses	**12950**	**10199**
Total Revenue less Total Expenses	**-1601**	**1150**
Total Revenue excl. male animal premium, less Total Expenses	**-2957**	**-206**

[1.] From Canadian finishing feedlot calculations
[2.] From Canadian finishing feedlot calculations.

The results show that with male animal premium and with Albertan feedlot production model, beef production in Sweden can be profitable, 1150SEK per head. Without the premium there will still be a negative result, minus 206SEK per head. The result will however be less negative than with present Swedish costs for labour and buildings and with male animal premium, minus 1601SEK per head.

Discussion

Both cow-calf operations and finishing of beef cattle are today unprofitable in Sweden according to budgets from the Swedish University of Agricultural Science. They also have high expenses compared with western Canadian beef production. If the governmental payments will be abolished the result for the farmers in Sweden will be even more unprofitable than present. This means that there is a need to find ways to decrease the costs of beef production.

As shown in the economic calculations for cow-calf production the largest cost differences between CSF and PRR is labour and buildings. The same are for finishing of beef where labour and building costs are higher in Sweden. One way to reduce theses costs is to keep the cattle outdoors during the winter, as they do in PRR and Alberta. This has to happen without decreasing animal welfare. The animals need some kind of protection from cold winds, mud and precipitation to keep their health. Even though the absence of buildings in Canada the cows were in good shape and health and no one of the cows, calves or cattle were suffering from cold stress. A positive factor with outdoor wintering is that the animals can practice their natural behaviour all year around.

Outdoor wintering will reduce the cost for buildings since the buildings in PRR and Alberta are much simpler and cheaper. Animal protection rules in Sweden have high demands on buildings and how to keep the cattle when they are outdoor wintered, which can be an obstacle. According to farmers in PRR and feedlot managers in Alberta there is no need for roofed sheds on the winter pastures or at the feedlots. Because the most important thing is to protect the cattle from cold winds and windbreakers may be enough. The climate in PRR and Alberta is dryer than in Sweden. The temperature falls and rises more rapidly during fall and spring and it is also colder during the winter. This can be another reason why it is enough with windbreakers, either natural or constructed ones in PRR and Alberta but not in CSF where the rain, together with low temperatures, can be a big problem for the cattle. Another obstacle, with the combination of high precipitation and low temperature in CSF, is the mud. Muddy condition occurs mostly during spring and fall and when the snow is melting. This results in trampled and damaged ground and also dirty animals which will consequently affect both environmental aspects and animal welfare. These conditions can also occur when the animal density is too high on the pastures. To decrease muddy conditions around specific places, e.g. around feeding areas, resting areas and water supplies it is good to e.g. use more than one water supply and continually move the resting and feeding areas. This can be done by using e.g. portable feeding troughs, portable windbreakers and fencing which regulates the area on where the cows can move. Portable windbreakers are common in western Canada and can be moved when necessary. When moving these, feeding and bedding areas are also continually moved. Another way to decrease mud is to either increase the size of pasture or decrease the animal density.

An obstacle for introducing western Canadian beef production systems in Sweden, with outdoor wintering and larger herds, can be the Swedish agricultural history with small scale structure, expensive buildings, governmental payments and feeding the cattle indoors. For centuries cattle have been wintered indoor in Sweden while cattle in western Canada have been outdoor year around since the agriculture started. Traditions are often hard consolidated into people and it can be hard to change these. In PRR the pastures are more suitable for outdoor wintering because they are more connected and much larger than in Sweden, which they have been since the start. The pastures are also more focused around the farms which

make it cheaper and less labour intensive to transport animals and forage to and between pastures. Sweden has smaller scattered pastures that are located further away from each other and located at different distances from the farm. To increase the efficiency the pasture has to be larger and more connected and closer to the farm. Larger pastures also give the opportunity to have bigger herds which decrease the labour costs per animal as well as reduces the costs for fences per hectare.
PRR have larger areas with pastures and forage production than CSF. In Sweden it is often more profitable with grain and forest production which makes it harder to encourage the farmers to produce forage or use the land for grazing. However, the opportunity cost for land varies between different areas in Sweden. In areas with less arable land, e.g. north of Sweden, where the climate is a limit for good grain production or on dry sand with low producing pine forest, the opportunity cost of land is zero. Such forest land in the north is also suitable for wintering cattle due to small mud problems. In for example south of Sweden where the land is more arable the opportunity cost for land will be much higher since the grain and forest production is profitable.

Another aspect when looking at outdoor wintering is to find areas where this kind of housing system could work. One important thing is to look at the soil type and another thing is the climate. Some soil types are more suitable than others for outdoor wintering and dense clay soil is not to recommend while a sandy moraine soil with high infiltration capacity is good. Clay soil does not have the capacity to get rid of surface water which results in a muddier ground. In areas where the climate is more like PRR and the ground has the capacity to stand trampling, there are good opportunities to have cattle wintered outdoors also in Sweden. Examples of suitable areas can be where the climate is colder and where the precipitation is low. Colder winters are good because there will be solid frost in the ground for a longer period. Too cold weather will increase the feed requirement for the cattle, but this is not a big problem in Sweden. Instead, as written before, high precipitation together with lower temperatures can lead to problems in some parts of Sweden. This because it will affect the animals that are getting wet and cold, and the ground that will be muddy.

To finish cattle in feedlots in Sweden might work if they are small, compared to most of the western Canadian ones, because we do not have enough cattle for big scale finishing in Sweden. The feedlots have to be located in areas with high grain production. To build a smaller feedlot for backgrounding or finishing together with other producers, like True North Beef, could be an idea. They have their own cow-calf production and then together they background their calves before they are sold to a finishing feedlot. A higher and more specified knowledge can result in a more profitable production, which means that it might be better to specialize on either cow-calf or finishing production.

One limitation with having feedlots in Sweden could be that most farmers do not castrate their bulls and to put a lot of bulls together into small lots could cause problems. In Canada many producers use hormone implants in both steers and heifers which increase their weight gain without increased feed intake. It is also easier to put steers and heifers, from different origins, together compared to bulls. In Sweden we are not allowed to use implants which can be a problem when castrating the bulls and at the same time keep the present growth level.

A problem for farmers in both Sweden and PRR is the question about who shall take over the farm. This can be a cause of the opportunity cost for labour in both countries. In PRR e.g. the oil and gas industry has a big influence on labour cost and in Sweden farm workers have a lower wage than most other occupations. According to farmers in PRR (2008) people in PRR

today want to earn money and farm work is hard work with a small payoff which is why people chose to work outside the farms instead. This is why it could be difficult to get the children, and also paid labour, into farming.

Conclusions

With a cow-calf production system like the one in PRR, bigger herds and outdoor wintering, the cost of cow-calf production in Sweden could be fully covered. It could even be profitable if the opportunity cost of land would be zero.

With a finishing production system like the one in Alberta, bigger herds and lower building costs, and with present male animal premium, the cost of finishing operation in Sweden could be profitable. Without the premium it would still be a negative result, but not as much as with present finishing system.

In Sweden one of the most expensive costs in both cow-calf production and finishing of calves are buildings. To reduce theses cost we can

- have outdoor wintering
- decrease the demand of buildings
- have simpler and cheaper weather protection e.g. forest and portable windbreakers
- have larger and more connected pastures which decrease the cost for fences

The other cost that was much higher in both cow-calf production and finishing of calves in Sweden was labour cost which can be reduced by

- increase the herd size
- feed the cattle outdoor during the winter
- larger and more connected pastures

Having cattle wintered outdoor is not possible everywhere in Sweden because there are limitations with this kind of production system. One limit is the climate and environmental conditions in certain areas. The mild springs and falls, and also winters, in south and middle of Sweden and the high precipitation, in form of rain, makes it difficult with outdoor wintering. This because the affection on the environment and animal welfare. Another factor can be the ground that has to be suitable for outdoor wintering and the soil needs to be of a dryer material, e.g. sandy moraine soil with high infiltration capacity. To make outdoor wintering possible it is also important to find the driving forces behind the change in attitude.

More specialized production will give a more efficient beef production. In western Canada most producers are specialized in either cow-calf production or finishing of calves. In PRR most cow-calf operations are located in areas with low or no opportunity cost which for example give cheaper pastures. Finishing of beef are located in areas with higher grain production which will lower the feed price at the feedlots.

Acknowledgement

This is my master thesis performed at Department of Animal Environment and Health, Swedish University of Agriculture and Sciences, Skara. It has been really interesting and I have enjoyed writing this project.

I would like to thank everyone that have been supporting and believing in me, with special thanks to:

Karl-Ivar Kumm, *hmh, Skara* – my supervisor who has supported and helped me with his expertise during my writing.

Julie Robinson, *Peace River Forage Association, British Columbia* – that helped me organizing the visits at the farms in PRR. She has been really wonderful and made the trip interesting and worthwhile.

Pernilla Salevid, *hmh, Skara* – that travelled around Alberta and BC with me.

All **cow-calf producers, feedlot managers** and **Gerry Clare**, *Dawson Creek, Fort St John in BC, and Alberta* – they were so hospitable and helped us answer all our questions. They were also gentle and took their time to show us around their farms, feedlots and at the museum. Everything was very interesting.

I would also like to say thank you to my wonderful **family** that have been really supportive and have had really good patience with me. **Love you**!

Sofia Nyman

Kristinehamn, February 2009

References

Agri Benchmark. 2007. Beef Report 2007. Benchmarking Farming systems worldwide. The Agri Benchmark project, Federal Agricultural Research Centre (FAL). Braunschweig, Germany.

Agri Benchmark. 2008. Price Database of Beef & Cow-calf. [Online]. Available at http://www.agribenchmark.org/pricedb/index.php (accessed 16 December, 2008). Agri Benchmark. Institute of Farm Economics. Federal Agricultural Research Centre (FAL). Braunschweig, Germany.

Agriculture and Agri-Food Canada. 2008. Livestock benefits from shelterbelts. [Online]. Available at http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1192562636367&lang=e (accessed 15 August, 2008). Agriculture and Agri-Food Canada. Ottawa, ON.

Alberta, Agriculture and Rural Development. 2002. Portable Windbreak Fences. [Online]. Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex4516 (accessed 20 September, 2008). Agdex 711-1. Alberta, Agriculture and Rural Development. Edmonton, AB.

Alberta, Agriculture and Rural Development. 2004. Swath Grazing in Western Canada: an Introduction. [Online]. Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex9239/$file/420_56-2.pdf?OpenElement (accessed 5 December, 2008). Agri-Facts, Practical Information for Alberta's Agriculture Industry. Agdex 420/56-2. Alberta, Agriculture and Rural Development. Edmonton, AB.

Alberta Beef Producers. 2008a. Beef Production Chain. [Online]. Available at http://albertabeef.org/industry/beef-production-chain/ (accessed 25 July, 2008). Alberta Beef Producers. Calgary, AB.

Alberta Beef Producers. 2008b. Industry - Beef Production. [Online]. Available at www.albertabeef.org/industry/beef-production-chain/ (accessed 10 August, 2008). Alberta Beef Producers. Calgary, AB.

Alberta Cattle Commission. 2008. Cattle Wintering Sites. Managing for Good Stewardship. [Online]. Available at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex3517/$file/420_580-2.pdf?OpenElement (accessed 22 September 2008) Alberta Agriculture and Rural Development. Edmonton, AB.

Alexandersson, H. 2004. Variationer och trender i nederbörden (1860-2003). [Online]. Available at http://www.smhi.se/content/1/c6/02/23/82/attatchments/variationer_och_trender_nbd.pdf (accessed 15 January, 2009). SMHI. Faktablad, nr 22. Direct offset AB, Norrköping. Sweden.

Beef InfoNet. 2008. Canada's Beef Cattle Industry. [Online]. Available at http://www.vido.org/beefinfonet/economics/marketing.php?heading=menuEconomics#general (accessed 9 December, 2008). Canadian Beef Industry – General. Vaccine and Infectious Disease organization, University of Saskatchewan. Saskatoon, SK.

Bonnier Lexikon. 1999. Bonniers stora världsatlas. Prepress Ytterlids Infodesign AB. Bonnier Lexikon AB.

Boyles, S. and McCutcheon, J. 2008. Winter Cold Stress On Cattle. [Online]. Available at http://www.mtbeefnetwork.org/article/Prime%20Cuts/Prime%20Cuts%20January%202.pdf (accessed 20 September, 2008). Montana State University. Bozeman, MT.

British Columbia Cattlemen's Association. 2008. Beef Industry Statistics, History. [Online]. Available at http://www.cattlemen.bc.ca/statistics.htm#history (accessed 17 September, 2008). British Columbia Cattlemen's Association, Kamloops, BC.

British Columbia, Ministry of Agriculture and Food. 1998. Planning for Profit. [Online]. Available at http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/beef/peace98.pdf (accessed 20 April, 2008). Government of British Columbia, Ministry of Agriculture and Land. Vancouver, BC.

British Columbia, Ministry of Agriculture and Food. 2007. Planning for Profit. [Online]. Available at http://www.agf.gov.bc.ca/busmgmt/budgets/budget_pdf/beef/2007cow_dawsoncreek.pdf (accessed 9 June, 2008). Government of Bitish Clumbia, Ministry of Agriculture and Land. Vancouver, BC.

British Columbia, Ministry of Agriculture and Land. 2007. Fast Stats-Agriculture, Aquaculture and Food. Ministry of Agriculture and Land, Government of British Columbia. Vancouver, BC.

British Columbia, Ministry of Agriculture and Land. 2008. About the Agriculture Industry. [Online]. Available at http://www.agf.gov.bc.ca/aboutind/products/livestck/beef.htm (accessed 29 September, 2008). Ministry of Agriculture and Land, Government of British Columbia. Vancouver, BC.

British Columbia Ministry of Agriculture, Fisheries and Food. 1992. Environmental Guidelines for Beef Cattle Producers in British Columbia. Canadian Cataloguing in Publication Data. Abbotsford, B.C.

British Columbia Ministry of Agriculture, Fisheries and Food. 1997. Census of agriculture statistics Regional districts British Columbia 1991 & 1996. Statistical Service Unit. Policy and Legislation Services. Vancouver, BC.

British Columbia Ministry of Agriculture, Food and Fisheries. 2000. Small lot agricultural - The Role of Small Lot Agriculture in the South Coastal Region. [Online]. Available at http://www.al.gov.bc.ca/resmgmt/sf/Publications.htm#other (accessed 18 September 2008). British Columbia Ministry of Agriculture, Food and Fisheries, Government of British Columbia, Vancouver, BC.

British Columbia Ministry of Agriculture, Food and Fisheries. 2002a. Backgrounding Feedlot. [Online]. Available at http://www.agf.gov.bc.ca/resmgmt/publist/Leaflets/Beef/312-24.pdf (accessed 15 September, 2008) Agricultural Building System Handbook. Plan 312-24. B.C.

British Columbia Ministry of Agriculture, Food and Fisheries. 2002b. Beef Feeding Barn – Drive Through Feed Alley – 400 Head. Agricultural Building System Handbook. Plan 310-01.

British Columbia Ministry of Agriculture, Food and Fisheries, 2004. Strengthening Farming Right to Farm – Commodity. [Online]. Available at http://www.agf.gov.bc.ca/resmgmt/fppa/refguide/commodity/870218-5_Beef.pdf (accessed 17 September, 2008). British Columbia Info Basket, Ministry of Agriculture and Land, Government of British Columbia. Vancouver, BC.

Canada Beef. 2008. Our Industry. [Online]. Available at http://www.cbef.com/Industry.htm (accessed 19 September, 2008). Canada Beef Federation Offices, Calgary, AB.

Canadian Cattlemen's Association. 2008. History of the cattle industry. [Online]. Available at http://www.cattle.ca/about_cca/history.htm (accessed 16 September, 2008). Canadian Cattlemen's Association, Calgary, AB.

CanFax. 2008. Cattle Market Outlook and Analysis. Canfax West. Volume XXXVIII Issue 43. ISSN 1201-382X.Calgary, Alberta.

Cuomo, G., Johnsson, D. & Head, B. 1999. Beef Cattle Management Update. Stockpiled forage to extend the grazing season. Issue 46. *Department of Animal Science, University of Minnesota*. USA.

Dawson Creek Auction ´Mile Zero City´ Homepage. 2008. Market Reports. [Online]. Available at http://www.vjvauction.com/Web/VJVDawson/market_reports.html (accessed 27 November, 2008). Vold, Jones & Vold Auction Co. Ltd. Dawson Creek, BC.

DiCostanzo, A. 2007. Effects of cold climate on feedlot cattle. *University of Minnesota*. USA.

Environment Canada. 2008. National Climate Data and Information Archive. [Online]. Available at http://climate.weatheroffice.ec.gc.ca/index.html (accessed 9 September, 2008). Environment Canada. Fredericton, New Brunswick.

Environmental Objectives Portal. 2007. Environmental Objectives Portal. [Online]. Available at http://www.miljomal.nu/english/english.php (accessed 17 September, 2008). Swedish Environmental Protection Agency. Stockholm, Sweden.

European Commission, Agricultural and Rural Development. 2008. CAP-form a long-term perspective for sustainable agriculture. [Online]. Available at http://ec.europa.eu/agriculture/capreform/index_en.htm (accessed 11 December, 2008). European Commission, Agriculture and Rural Development. Brussels, Belgium.

Ewing, S. 1990. *The Range*. Mountain Press Publishing Company. Missoula, Montana, USA.

Ewing, S. 1995. *The Ranch*. Mountain Press Publishing Company. Missoula, Montana, USA.

FAOSTAT. 2008. Export Value. [Online]. Available at http://faostat.fao.org (accessed 12 February, 2008). Food and Agriculture Organization of the United Nations.

Farm Animal Council of Saskatchewan Inc. 2008. Managing Water Supplies in a Drought. [Online]. Available at http://www.facs.sk.ca/pdf/cattle_facs/managing_water_supplies.pdf (accessed 17 December, 2008). FACTS. Saskatoon, SK.

Government of Saskatchewan. 2008. Portable Windbreak Fences. [Online]. Available at http://www.agriculture.gov.sk.ca/Default.aspx?DN=adb8ecee-7d31-4f72-8d83-c71ac97baba4 (accessed 13 February, 2009). Regina. SK.

Hessle, A. 2007. Beef Cattle on Semi-Natural Grasslands – Production of Meat and Nature Conservation. Doctor Thesis. *Department of Animal Environment and Health. Swedish University of Agricultural Science,* Skara.

Henry, G. 2003. Beef Production- An economic profile. Economic Development Branch and BC Ministry of Sustainable Resource Management. BC.

Hicks, B. 2007. Environmental impact on cattle. Beef cattle research update. [Online]. Available at http://gpvec.unl.edu/mud/EnviroImpactOnCAttle-OSU%20BeefCattleResearchUpdate%20an2007.pdf (accessed 16 September, 2008). Oklahoma Panhandle Research & Extension Centre. Oklahoma State University, U.S.

Highmoor, T. & Monchuk, C. (2004) 2002 & 2003 Saskatchewan Feedlot Yardage Analysis: How do you compare? Western Beef Development Centre.

Highmoor, T. (2005a). 2003-04 Saskatchewan backgrounding economics. Western Beef Development Centre. Fact Sheet # 2005-05.

Highmoor, T. (2005b). 2003-04 Saskatchewan feedlot finishing economics. Western Beef Development Centre. Fact Sheet # 2005-09.

House, H. K. and Eng, P. 2003. Housing Requirements for Backgrounding Beef Cattle. Engineer, Beef and Dairy Structures and Equipment. Ontario Ministry of Agriculture, Food & Rural Affairs.

Jacobs, F. 1993. Cattle and us, frankly speaking. Detselig Enterprises Ltd. Calgary, Alberta, Canada.

Jensen, H. G. & Frandsen, S.E. 2003. Impacts of Eastern European accession and the 2003-reform of the CAP. Consequences for individual member countries. Working Papers, 11/03. Danish Research *Institute of Food Economics*. Copenhagen.

Johnsson, S., Kumm, K-I, Jeppson, K-H., Lidfors, L., Lindén, B., Pettersson, B., Ramvall, C-J., Schönbeck, P. & Törnquist, M. 2004. Production system for beef. Housing system, working environment, animal welfare, nutrient cycling, feeding, economy. Report 5. *Department of Animal Environment and Health, Swedish University of Agricultural Science*. Skara.

Jungnitsch, P. F. 2008. The effect of cattle wintering feeding systems on soil nutrients, forage growth, animal performance, and economics. Thesis. *University of Saskatchewan*, Saskatoon, Canada.

Kallenbach, R. 2000. Reducing losses when feeding hay to beef cattle. [Online]. Available at http://extension.missouri.edu/explorepdf/agguides/crops/g04570.pdf (accessed 23 November 2008). *University of Missouri-Columbia*, Columbia, MO.

Kaliel, D. A. 2004. Yardage – the Cost Beyond Feed. AgriProfit$, Technical Bulletin. Alberta Agriculture, Food and Rural Development. Edmonton, AB.

Keady, T.W.J. 2005. *Ensiled maize and whole crop wheat forages for beef and dairy cattle: effects on animal performance*. From book; Silage production and utilization. Edited by: Park R.S. and Stronge, M.D. pp 51-64.

Keren, E. N. and Olson, B. E. 2006. Thermal balance of cattle grazing winter range: Model application. *Journal of Animal Science.* 84:1238-1247.

Klasson, J. 2007. Experience of Outdoor wintering of beef cattle in Sweden and Canada. Student Report 126. *Department of Animal Environment and Health. Swedish University of Agricultural Science*, Skara.

Kumm, K-I. 2004. Does re-creation of extensive pasture- forest mosaics provide an economically sustainable way of nature conservation in Sweden's forest dominated regions? *Journal of Nature Conservation.* Nr. 12, pp. 213-218.

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. Scenarios for profitable beef and lamb production. Report 11. *Department of Animal Environment and Health, Swedish University of Agricultural Science.* Skara.

Kumm, K-I., Klasson, J. & Rustas, B-O. 2007. Out-door wintering of beef cattle-impact on land, forest and animal performance. Report 14. *Department of Animal Environment and Health. Swedish University of Agricultural Science*, Skara.

Lardner, B. 2006. Winter feeding beef cows – Feed waste & Feed site forage production. Western Beef Development Centre Fact Sheet. Pub. No. 2006-01. 4 pp.

Lindgren, K. & Lindahl, C. 2007. Stabilisering av mark för bättre djurvälfärd och miljö – kartläggning av gräsarmering. JTI report, Lantbruk och industri, no. 354.

Mader, T. L. 2003. Environmental stress in confined beef cattle. *J Anim Sci*. 81: E110-119

Mader, T. L., Dahlquist J. M., Hahn, G. L. & Gaughan, J. B. 1999. Shade and winter barrier effects on summertime feedlot cattle performance. *Journal Animal Science* 77: 2065- 2072.

Malmberg, M. & Peterson, T. 2006. Final Report: A Project to Develop Baseline Data on Typical Ranch in BC. Ministry of Agriculture and Land. Dawson Creek, BC.

Manitoba Forage Council. 2008. The Basics and Benefits of Bale Grazing. [Online]. Available at http://www.mbforagecouncil.mb.ca/CustomBlox/Files/Live/Blox/836/27-2008_The_Basics_and_Benefits_of_Bale_Grazing.pdf (accessed 20 January, 2009). Growing Opportunities Centre. Brandon, MB.

Manninen, M. 2007. Winter feeding strategies for suckle cows in cold climatic conditions. Academic dissertation, publication 91. *Department of Animal Science. University of Helsinki.* Helsinki.

Maskinkalkylgruppen. 2008. Maskinkostnader 2008. underlag och kalkylexempel på timkostnader för lantbruksmaskiner. Hushållningssällskapet, HIR Malmöhus. LRF Konsult, MaskinKonsulenterna.

Mattson, R. 1985. Jorbrukets utveckling I Sverige. Aktuellt från Lantbruksuniversitetet, nr. 344. Uppsala.

McCartney, D., Basarab, J. A., Okine, E. K., Baron, B. S. & Depalme, A. J. 2003. Alternative fall and winter feeding systems for spring calving beef cows. *Canaian Journal of Animal Science* 84; 511-522.

McCartney, D. H., Lardner, H. A. & Stevenson, F. C. 2007. Economics of backgrounding calves on Italian ryegrass (Lolium multiflorum) pastures in the Aspen Parkland. *Canaian Journal of Animal Science*. **88,** pp. 19-28.

McCartney, D. H., Baron, J. Basarab, J., Okine, E., Lastiwka, G., Depalme, A. & Young, D. 2008. Winter grazing and feeding systems in Western Canada. *Western Forage Group, Agriculture and Agri-Food Canada, Alberta Agriculture, Food and Rural Development.* Lacombe, AB. ID # 22-17.

Min mat. 2005. Åtta av tio vill ha svenskt nötkött. [Online]. Available at www.minmat.org (accessed 15 September, 2008).

Natural Resources Canada. 2008. The Atlas of Canada. [Online]. Available at http://atlas.nrcan.gc.ca/site/english/index.html (accessed 29 September, 2008). Natural Resources Canada, Ottawa, ON.

Neel, J. B. 2003. Poor nutrition, cold weather and rain contribute to calf losses. Info Series : AS-B-261. [Online]. Available at http://animalscience.ag.utk.edu/beef/pdf/PoorNutrition.261.pdf (accessed 20 September, 2008). *Department of Animal Science, University of Tennessee. Institute of Agriculture,* U.S.

Norrman, E. 1981. Svenskarna och deras husdjur. Resursanvändning från forntid till nutid. 1th edition. LT: s förlag. Stockholm.

OECD. 2003. Glossary of statistical terms. [Online]. Available at http://stats.oecd.org/glossary/detail.asp?ID=2150 (accessed 13 January, 2008). OECD. Paris, France.

OECD. 2004. Table III.3. OECD: Producer Support Estimated by country. Beef and Veal. [Online]. Available at http://www.oecd.org/dataoecd/33/14/32360823.xls (accessed 13 January, 2009).

OECD. Paris, France.

Peace River Forage Association of British Columbia. 2008. Drought Impact on Forage Producers. Dawson Creek, BC.

Pruitt, R. J., Johnson, B. J., Epperson, W. B. & Rops, B. D. 2005. Effect of Calving Time and Weaning Time on Feedlot Performance – A Preliminary Report. [Online]. Available at http://ars.sdstate.edu/beefext/beefreports/2000/effect_of_calving_time_and_weani1.htm (accessed 19 December, 2008). Technical Information for the Canadian Forage Beef Industry. Lacombe Research Centre, AB.

Quam, V., Johnson, L., Wight, B. & Brandle, J.R. 2006. Windbreakers for Livestock Operations. [Online]. Available at http://www.ianrpubs.unl.edu/epublic/live/ec1766/build/ec1766.pdf (accessed 8 August, 2008). Lincoln Extension EC 1766. Nebraska University. USA.

Ramsey, L. and Schmitz, A. 2002. A Profile of Alberta's Beef Industry: Lessons for Saskatchewan? Working Paper #6. Centre for Studies in Agriculture, Law and the Environment. Saskatoon, SK.

Schmitz, A., Ayers, M., Highmoor, T. & Perillat, B. 2003. An Assessment of Western Canadian Beef Development. Centre of Studies in Agriculture, Law and the Environment. Saskatoon, SK.

SMHI. 2008. Års- och månadsstatistik från Väder och Vatten. [Online]. Available at http://www.smhi.se/cmp/jsp/polopoly.jsp?d=10963&l=sv (accessed 16 December, 2008). SMHI. Norrköping, Sweden.

South Dakota Department of Agriculture. 2006. Benefits of Livestock Windbreakers. [Online]. Available at http://www.state.sd.us/doa/forestry/publications/Benefits-of-Livestock-Windbreakers.pdf (accessed 20 September, 2008). Divison or Resource Conservation and Forestry. Pierre, SD.

South Peace Historical Society. 2008. A History of the Peace. [Online]. Available at http://www.calverley.ca/table2004.html (accessed 16 September, 2008). South Peace Historical Society, Dawson Creek, BC.

Statistics Canada. 2001. 2001 Agriculture Community Profiles. [Online]. Available at http://www25.statcan.ca:8081/AgrProfile/showData.jsp?LocCode=039943 (accessed 15 December, 2008). Statistics Canada. Ottawa, ON.

Statistics Canada. 2006. 2006 Agriculture Community Profiles. [Online]. Available at http://www26.statcan.ca:8080/AgrProfiles/cp06/PlaceSearch.action;jsessionid=BD853231A0827358373D575E4A870F12 (accessed 8 August, 2008). Statistics Canada. Ottawa, ON.

Swedish Animal Protection Agency. 2007. Swedish regulations for animals. L100. DFS 2007:5. Skara.

Swedish Board of Agriculture. 1994. Naturbetesmarker. Biologisk mångfald och variation i odlingslandskapet. OVR3:5. Jönköping.

Swedish Board of Agriculture. 2000. Marknadsöversikt - animalier. Report 2000:23. Jönköping

Swedish Board of Agriculture. 2004. Handjursbidrag. JS21. Jönköping

Swedish Board of Agriculture. 2005. Swedish Agriculture in figures 1800- 2004. Statistic report 2005:6. Jönköping.

Swedish Board of Agriculture. 2006. Marknadsöversikt - animalier. Report 06:35. Jönköping.

Swedish Board of Agriculture. 2007.Jordbrukets miljöeffekter 2020 – en framtidsstudie. Report 2007:07. Jönköping.

Swedish Board of Agriculture. 2008. Yearbook of agricultural statistics 2008 including food statistics. *Official Statistics of Sweden*. Örebro.

Swedish Dairy Association. 1997. Höberedning. Kvalitetssäkrad mjölkproduktion. Totab AB, Eskilstuna, Sweden.

Swedish Ministry of Agriculture. 2004. Genomförandet av EU:s Jordbruksreform i Sverige. Ds 2004:9. Stockholm.

Swedish Meats. 2008. Uppfödningsmodeller nöt. [Online]. Available at http://www.swedishmeats.com/webit/websidor/visasida.asp?Idnr=06NAHCDnFf1KTXzBIB3LOIdgafKGMUpBZMEVbJRqYV6WKSfTJMjBhHgCSFDG (accessed at 18 November, 2008). Swedish Meats ekonomisk förening, Stockholm, Sweden.

Swedish University of Agricultural Science, 2008a. Databoken. [Online]. Available at www.agriwise.se (accessed 10 September, 2008). *Swedish University of Agricultural Science*. Sweden.

Swedish University of Agricultural Science, 2008b. Områdeskalkyler. [Online]. Available at www.agriwise.se (accessed 10 September, 2008). *Swedish University of Agricultural Science*. Sweden

Sällvik, K. 2005. Husdjurens Värmebalans och Termiska Närmiljö. Undervisningskompendium. *Department of Agricultural Biosystems and Technology. Swedish University of Agricultural Science.* Alnarp.

Tarr, B. 2007. Cold Stress In Cows. Fact Sheet Order No. 07-001. Ontario Ministry of Agriculture, Food and Rural Affairs.

True North Beef. 2008. True North Beef. [Online]. Available at http://truenorthbeef.com/ (accessed 10 November, 2008). Dawson Creek, BC.

von Wachenfeldt, H. 2005. Outdoor transport areas and yards for cattle, an approach for future technical design. Report 137. *Department of Agricultural Biosystems and Technology. Swedish University of Agricultural Science.* Alnarp.

Weerahewa, J., Meilke, K. D. & LeRoy, D. 2007. An Economic Assessment of the BSE Crisis in Canada: Impacts of Border Closure and BSE Recovery Programs. [Online]. Available at http://www.uoguelph.ca/~catprn/PDF/Working%20Paper%202007-1a.pdf (accessed 16 December, 2008) CATPRN Working Paper 2007-1. Canada.

Wehrle, P. F., Brendel, W., Brent, R. L., Chisom, J. J., Doyle, J. L., Fagan, E. L., Finberg, L., Miller, R. W., Nahmias, A. J., Thompson, G. D. C. & Horton, R. J. M. 1973. Animals Feedlot – A Policy Statement With Background. *Pediatrics*. 51: 582.

Western Beef Development Centre. 2003. What are the yardage costs associated with feeding cattle? [Online]. Available at http://www.wbdc.sk.ca/pdfs/fact_sheets/2003/what_are_the_yardage_costs_associated_with_feeding_cattle.pdf (accessed 19 September, 2008). Western Beef Development Centre. SK.

Wikipedia, 2008. Peace River Country. [Online]. Available at http://en.wikipedia.org/wiki/Peace_River_Country (accessed 12 December, 2008). Wikipedia the free encycklopedia. Wikimedia Foundation Inc.

Young, B. A. 1981. Cold Stress as it Affects Animal Production. *Journal of Animal Science* 52: 154-163.

Young, B. A. 1983. Ruminant Cold Stress: Effect on Production. *Journal of Animal Science* 57: 1601-1607.

Young, B. A., Walker, B., Dixon, A. E. & Walker, V. A. 1989. Physiological Adaptation to the Environment. *Journal of Animal Science* 67: 2426-2432.

Ångström, A. 1958. Sveriges klimat. 2nd edition. Generalstabens Litografiska Anstalts förlag. Stockholm.

Personal communication

Clare, Gerald. 2008-10-30. President, South Peace Historical Society. Dawson Creek, BC.

Robinson, Julie, 2008-10-30. Peace River Forage Association of British Columbia. Dawson Creek, BC.

Appendix 1

Questions for cow-calf producers

- How many beef cows do they have?
- What is the average weaning percentage?
- What is the average weaning weight?
- How many days do they winter feed the cows?
- What is the total acreage of the farm?
- How many acres are pastures?
- How many acres are hay/silage?
- What is the average hay/silage yield?
- What is the sale weight for weaned steer and heifer calves?
- What is the sale price for steer and heifer calves?
- What is the average hay/silage requirement per cow and year?
- What is the average wage for a farm worker?
- What are the labour costs including payroll taxes and benefits?
- How much labour is needed per animal and year?
- When is the busiest time of the year?
- What kind of machines do they have?
- How much is the replacement costs for the machines?
- What kind of buildings is needed?
- Are there any buildings for machine storage?
- Are there any buildings for feed storage?
- Is there a need for roofed sheds at the winter pastures?
- Which of the buildings is the most important one?

- How long fence line is needed around all the pastures (km)?
- What is the labour cost for fencing and fence repair?
- How do they deforest land for pastures?
- How much does deforesting cost?
- What is the leasing cost for land?
- How much does it cost to buy land?
- What is the opportunity cost on land?
- Has the increased grain price affected opportunity cost of land?
- Are there any governmental payments, if that is the case, how much?
- How much is feed costs?
- How do they winter the animals?
- Where are the cows during the winter?
- What do they feed the cows during wintertime?
- How do they feed?

Appendix 2

Questions for feedlot managers

- How many cattle are placed one feed?
- How many are the average days on feed?
- What is the average daily gain?
- How much is the yardage cost?
- How much are the feed costs?
- How many acreage are used for the feedlot?
- Are there any governmental payments?
- How much are veterinary and medicine costs?
- How much is the average wage for a feedlot worker?
- What is the labour cost (including payroll taxes and benefits)?
- How much labour is needed per animal and year?
- Where do they put most of their labour?
- Do the cattle need buildings with roof?
- How do they handle manure and how do they storage the manure?
- What is the price for different feedstuff?
- How much feed is given to the animals?
- Has the number of feedlots based on by-products from ethanol industry increased?

Appendix 3

Questions for museum manager

- When did PRR start with farming?
- How did the farming start?
- How did the geography look like before farming started?
- How much land did the homesteaders get or how much could they buy at the start?
- What was the most important crop when farming started and how has it changed during the years?
- Have there been any subsidies to farmers during the time?
- Has there been any other way to get money to support the family in PRR?
- Why have the numbers of beef cows increased or decreased during the last century?
- How has the climate and environment changed during time?
- How is deforestation done then and now? What are the costs?
- How common is it with semi-natural pastures?

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.hmh.slu.se

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.hmh.slu.se

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.hmh.slu.se