

Beef Cattle on Semi-Natural Grasslands

- Production of Meat and Nature Conservation

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Abstract

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Beef production is performed in varying systems, with or without grazing, but the common goal is to obtain high-quality carcasses. Semi-natural grasslands are characterized by specific flora and fauna and they are dependent on grazing management to be maintained. The aim of this thesis was to evaluate factors influencing nature conservation, animal performance and meat quality in beef production using semi-natural grasslands in summer.

In a first study, effects of breed and season on foraging behaviour and diet composition were studied in heifers grazing semi-natural grasslands. In two further studies, effects of feed intensity and length of rearing period on feed intake, weight gain, feed conversion and carcass traits were investigated. One of these studies included finishing dairy steers, which had grazed semi-natural grasslands in previous summer, and the other study included beef heifers, which were reared from weaning until slaughter including a grazing period on semi-natural grasslands. For the heifers also meat quality, as affected by feed intensity, slaughter age and suspension method, was studied.

Foraging behaviour and diet composition were more influenced by season than by breed. Over the grazing period, the heifers decreased their levels of activity, but increased their time spent grazing. The grazing time composed of more eating jaw movements and fewer pauses as the grazing period progressed. Wet areas, dominated by *Deschampsia cespitosa* (tufted hairgrass), were consistently avoided for grazing, whereas browsing on *Alnus glutinosa* (alder) increased over the grazing period.

Increased indoor feed intensities were accompanied by increased weight gains and improved feed conversions. In the steers, an intermediate length of finishing resulted in the best feed conversion. Carcass traits were more affected by length of rearing period than by feed intensity. A prolonged rearing period resulted in heavier and fatter carcasses with increased dressing percentages and improved conformation. Meat from pelvic suspended sides was tenderer than meat from sides suspended by Achilles tendon after 14 days of ageing.

Production of quality-grade carcasses with tender meat can be combined with the management of semi-natural grasslands on the conditions of regular controls of animal weights, strategic grazing regimes and proper post-slaughter procedures.

Keywords: beef, cattle, finishing, suspension method, breed, season, grazing, foraging, semi-natural grassland, nature conservation

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Appendix

Paper I-V

The present thesis is based on the following papers, which will be referred to by their Roman numerals:

- I. Hessle, A., Rutter, M. & Wallin, K. Effects of breed, season and pasture moisture gradient on foraging behaviour in cattle on semi-natural grasslands. *Accepted with revisions.*
- II. Hessle, A., Jörgen Wissman, Jannicke Bertilsson & Erling Burstedt. Effects of breed and season on defoliation and faecal composition in cattle grazing semi-natural grasslands. *Submitted.*
- III. Hessle, A., Nadeau, E. & Johnsson, S. 2007. Finishing of dairy steers having grazed semi-natural grasslands. *Livestock Science 106*, 19-27.
- IV. Hessle, A., Nadeau, E. & Johnsson, S. 2007. Beef heifer production as affected by indoor feed intensity and slaughter age when grazing semi-natural grasslands in summer. *In press in Livestock Science.*
- V. Lundesjö Ahnström, M., Hessle, A., Johansson, L., Hunt, M. C. & Lundström, K. Influence of feeding regimen, animal age and carcass suspension on heifer meat quality. *Manuscript.*

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Introduction

Beef production in Sweden

Stock of animals

In Sweden, 26,000 beef-producing units annually deliver on average 16.5 cattle for slaughter, resulting in 130,000 ton of beef meat (Official Statistics of Sweden, 2006). Historically, Swedish beef production was composed of offspring and culled cows from dairy production. Dairy bulls are still the basis of Swedish beef production divided equally between Swedish Red and Swedish Holstein cattle (Swedish Dairy Association, 2005). In the 1970's, the number of suckler herds with specialised beef breeds started to increase in Sweden and today the proportion of beef originating from suckler herds represents a third of the beef produced (Fig. 1). The average suckler herd consists of 14 cows (Official Statistics of Sweden, 2006). The cattle in the suckler herds consist of Continental beef breeds, British beef breeds, dairy breeds and to a tiny extent (0.4%) of Swedish traditional breeds (Swedish Board of Agriculture, 2006). A majority (65%) of the cattle slaughtered from the suckler herds are cross-breds (Hanna Åström, pers. comm.).

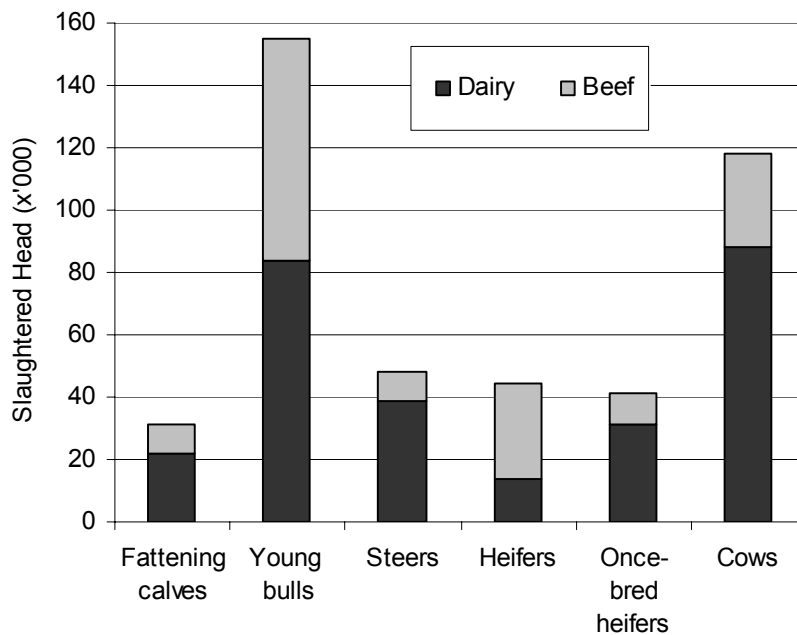


Fig. 1. Number of cattle of beef breeds (including cross-breds) and dairy breeds slaughtered in Sweden during 2005 (data from Hanna Åström, pers. comm.).

Rearing of cattle of dairy breeds

The dairy bulls reared in Sweden are offered feed rations varying in proportions of grass-clover silage and grain-based concentrate resulting in an average carcass weight of 309 kg at slaughter age of 19.8 months (Hanna Åström, pers. comm.). Traditionally, both Swedish dairy and beef bulls are reared and slaughtered as intact young bulls. However, during the last decade special premiums to steer production and environmental support for grazing semi-natural grasslands have increased the proportion of dairy bull calves that are castrated and raised as steers from 3% to 32% (Swedish Board of Agriculture, 2004; Official Statistics of Sweden, 2006; Hanna Åström, pers. comm.).

Rearing of cattle of beef breeds

As a result of the increased proportion of suckler herds in Swedish livestock, beef cattle breeds constitute an increasing proportion of slaughtered cattle. The calves usually are spring-born and reared on pasture together with their dams during summer. After weaning in autumn, the bull calves are usually intensively fed indoors until slaughter at an average age of 17.8 months with a carcass weight of 327 kg (Hanna Åström, pers. comm.). Only 11% of the male calves are raised as steers (Hanna Åström, pers. comm.). For the female suckler calves, the former practise was to slaughter them at weaning as fattening calves, but today many of them are raised for slaughter as finishing heifers at an average age of 23.0 months and 270 kg carcass weight (Hanna Åström, pers. comm.). Carcasses from once-bred heifers usually are not the result from a planned beef production but are comprised of culled primiparous cows from dairy and beef production.

Carcass and meat qualities

Steers and heifers are well suited for forage-based rearing systems as they have lower weight gain capacities than bulls and should be fed relatively extensively to avoid excessive fatness at low liveweights (McMillin *et al.*, 1990; Steen, 1995). An advantage with steer and heifer production is that beef meat from these genders is tenderer than beef from bulls (Jeremiah, Tong & Gibson, 1991; Purchas, Burnham & Morris, 2002). Tenderness, juiciness and taste are the most important meat characteristics for consumers (Grunert, 1997). Tenderness and juiciness are positively correlated to intramuscular fat content (Jeremiah *et al.*, 2003; Li *et al.*, 2006). Because consumers in general are hesitant to buy meat with visible fat (Grunert, 1997), selling a high-quality, tender retail cut of beef to household consumers can require ingenuity. However, there are other means than attaining high levels of intramuscular fat to obtain tender meat, such as prolonged ageing (Gruber *et al.*, 2006).

Economical aspects

Swedish beef consumption has increased by 36% during the last decade and is higher than ever, 25.5 kg per capita during 2005, but the increase in consumption has not been accompanied by an increase in native beef production (Federation of Swedish Farmers, 2006; Official Statistics of Sweden, 2006). Some farmers have ceased beef production because of an unsustainable social situation, for example a

deteriorating social infrastructure or constraints (Stenseke, 2004), but others because of insufficient profitability in comparison to other alternatives for land use and employment (Kumm, 2003, 2006). The soaring production costs are caused by the farm structure with small enterprises occupying small and scattered pastures, high expenditures for buildings and indoor feeds as well as for high national ambitions regarding environmental protection and animal welfare (Kumm, 2006; Taurus, 2006). On the other hand, even though prices for agricultural land in Sweden have doubled in the last decade, the land still is considerably cheaper than in many other European beef-producing countries resulting in favourable competitiveness (Official Statistics of Sweden, 2006; Taurus, 2006). Furthermore, the Swedish production units are more efficient, expressed as man-hours per suckler cow or per kg of beef produced, compared to production units in many other European countries (Taurus, 2006).

For consumers in general, price is not the sole trait taken into consideration when buying beef (Grunert, 1997). Many Swedish consumers are willing to pay for the more expensive domestic beef compared to the cheaper imported beef (Plateryd, 2004; <http://www.minmat.org>, 16-March-2007). Besides the intrinsic value of domestic origin, the added values are food safety, animal welfare, environmental protection and preservation of an open landscape and semi-natural grasslands (Plateryd, 2004; <http://www.minmat.org>, 16-March-2007). However, a fresh appearance, pleasant taste and perceived high quality are still key issues when buying meat (Plateryd, 2004; <http://www.minmat.org>, 16-March-2007).

Semi-natural grasslands

Acreage

Semi-natural grasslands represent land of diverse landscape types (Fig. 2), all of which have been used continuously for fodder production for centuries. Therefore, they are characterized by specific native flora and fauna, and dependent on human management to maintain (Jefferson & Robertson, 2000). Fodder production, and thereby survival of livestock and people, was historically the sole reason for managing these areas. Today, the main reasons for managing the grasslands are the ecological aspects, as they contain many endangered species and perform ecosystem services, as well as they are representing traces of cultural heritage values, recreation possibilities and amenity values in addition to fodder production (Ihse & Norderhaug, 1995; Luoto *et al.*, 2003).

Semi-natural grasslands comprise 1.5% of the Swedish land area and often are scattered within forests (Official Statistics of Sweden, 2006). The average size of grasslands assessed as valuable is 5.2 ha and half of the grassland area belongs to enterprises with less than 50 ha arable land (Persson, 2005a; Official Statistics of Sweden, 2006).

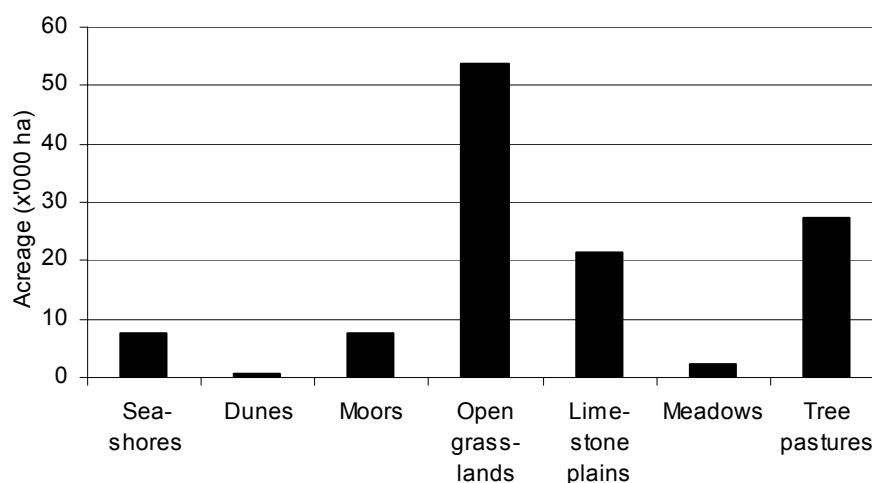


Fig. 2. Most frequent landscape types of Swedish semi-natural grasslands (Persson, 2005a).

Public opinion and agri-environmental measures

Society is willing to pay for the preservation of these areas, which has been concretized in political goals (Drake, 1992; Government Offices of Sweden, 1999; Commission of the European Communities, 2006). Nevertheless, the acreage of semi-natural grasslands in Sweden has decreased drastically, in some regions to one-tenth of the acreage 50 years ago (Mejersjö & Kronqvist, 2000). Currently, 510,000 ha of permanent grasslands remain in Sweden of which 270,000 ha are classified as valuable (Persson, 2005a; Official Statistics of Sweden, 2006). The biggest single threat to the grasslands is cessation of grazing and abandonment resulting in overgrowing and, finally, afforestation. Today, 13% of the valuable grasslands are threatened by reduced land management (Persson, 2005a). Despite increasing numbers of sheep and horses, cattle compose the vast majority of available grazers (Official Statistics of Sweden, 2006). A continuing decrease in the number of grazing livestock is forecasted because of the decrease of dairy cows and their offspring are not replaced by a corresponding increase in beef cattle (Kumm, 2003; Official Statistics of Sweden, 2006). Therefore, optimal use of the existing livestock to obtain desirable grazing effects is necessary.

To fulfil the political goals, support for management of semi-natural grasslands must be paid, as is the case today (Swedish Board of Agriculture, 2004). Society has great opportunities to influence landscape characteristics by directed agri-environmental measures and compensatory allowances. It appears that in the immediate future, Swedish opinion continues to be favourable to compensating farmers to manage semi-natural grasslands (Government Offices of Sweden, 2006). Therefore, many beef producers could find a path to success by combing high-quality carcass production together with management of valuable semi-natural grasslands.

Aims of the thesis

In previous studies of beef production, nature conservation aspects have usually not been considered. The main objective of this thesis was to evaluate factors affecting animal production *and* nature conservation in beef production on semi-natural grasslands. Three studies were undertaken in the thesis. A foraging study (Papers I & II) aimed to investigate foraging behaviour and nature conservation ability in cattle grazing semi-natural grasslands. A study of steers (Paper III) aimed to examine performance of finishing dairy steers having grazed semi-natural grasslands. A study of heifers (Papers IV & V) aimed to investigate performance and meat quality in beef heifers grazing semi-natural grasslands with maintained biodiversity in summers.

Materials and methods

Experimental design

The foraging study (Papers I & II)

The effects of breed and season on foraging behaviour, location, defoliation of competitive plant species and faecal plant fragment composition in cattle grazing semi-natural grasslands were investigated. Two contrasting breeds of cattle (Väneko vs. Charolais) were studied three times during a grazing period (spring, summer and autumn).

The steer study (Paper III)

The effects of initial weight, level of grain feeding and length of finishing period on feed intake, weight gain and carcass traits in dairy steers were investigated in an experiment with a $2 \times 2 \times 3$ factorial design. Two levels of initial weight (low vs. high), two levels of grain feeding during finishing (0.5 vs. 1.0% of liveweight), and three lengths of finishing period (3, 5 vs. 8 months) were used. Levels of initial weight and grain feeding were replicated over three years whereas levels of finishing periods were replicated over two years.

The heifer study (Papers IV & V)

The study included one trial with Charolais and one trial with Angus heifers. The effects of indoor feed intensity (low vs. high) and slaughter age (18 vs. 22 months) on feed intake, weight gain, carcass traits and meat quality in the heifers were investigated in an experiment with a 2×2 factorial design. The study included an initial indoor period followed by a grazing period on semi-natural grasslands for all animals. At housing from pasture, the 18-month heifers were slaughtered directly from pasture whereas the 22-month heifers were housed for a second indoor period. For meat quality parameters, the effects of carcass suspension method (by pelvic bone vs. Achilles tendon) were studied in addition to the effects of indoor feed intensity and slaughter age.

Animals and management

Study site

The experiments were conducted at The Götala Research Station, Skara, in south-western Sweden (long 13° 21'E, lat 58° 42'N; elevation 150 m) during the years 2000–2004. During the indoor periods, experimental cattle were kept in loose housing systems with seven (Papers I, II, IV & V) or four (Paper III) head per pen. During the grazing periods, the cattle were kept on mainly open semi-natural grasslands at the research station, consisting of 20% dry, 60% mesic and 20% wet areas. The grasslands were dominated by *Deschampsia cespitosa* (tufted hairgrass), especially the wet areas.

Animals

All animals were purchased from commercial farms and slaughtered at a commercial abattoir. In the foraging study (Papers I & II) and the heifer study (Papers IV & V), weaned suckler heifer calves were bought at eight months of age. There were 12 heifers each of the traditional Swedish breed Väneko and 12 of the commercial breed Charolais in the foraging study (Papers I & II). In the heifer study, 56 Charolais and 56 Angus heifers were raised, with 40 of each breed being used for meat quality studies (Papers IV & V). In the steer study (Paper III), 72 steers of the dairy breeds Swedish Red and Swedish Holstein were purchased at 18 to 21 months of age for three consecutive years. Before the experiment, the steers had grazed semi-natural grasslands without supplemental feeding for one or two grazing periods.

Indoor feeding

During the indoor periods, all experimental animals except Angus heifers at low feed intensity (Papers IV & V) were fed a grass-dominated, wilted grass-clover silage *ad libitum*, whereas concentrates were offered at restricted amounts. In the steer study (Paper III), daily amounts of grain fed corresponded to 0.5 and 1.0% of the animal liveweights for steers on low and high feed intensity, respectively. In the heifer study (Papers IV & V), Charolais heifers at low feed intensity were fed grass-clover silage *ad libitum* only, whereas heifers at high feed intensity were fed 2.0 kg of grain daily in addition to the silage. For Angus heifers, low feed intensity was grass-clover silage at 80% *ad libitum* and high feed intensity was silage *ad libitum*. To fulfil requirements for minerals and vitamins, a mineral supplement containing vitamins was fed at recommended levels to all animals.

Grazing systems

The grazing periods lasted from May to October. In the foraging study (Papers I & II), 18 ha of the grasslands was used. The animals were split into three paddocks per breed, which were grazed continuously during the grazing period. In the heifer study (Paper IV), the animals were rotated among five paddocks, in total composing 38 ha.

Collection of data

Feed sampling and analysis

Silage samples were collected daily and concentrate samples were collected weekly during the indoor periods. Pasture sward heights were recorded continuously every second week during the grazing periods. Pasture herbage samples were collected at three occasions (spring, summer and autumn) separately for dry, mesic and wet areas, respectively, in the foraging study (Papers I & II) and at every change of paddocks during the grazing period for the total grazing area in the heifer study (Paper IV).

Silage, concentrate and pasture herbage samples were analysed by conventional methods for organic matter digestibility and for contents of dry matter, ash, crude protein and neutral detergent fibre (NDF). In concentrates, also starch and crude fat contents were determined. Concentrations of metabolizable energy (ME) in the feeds were calculated.

Foraging behaviour and location

Grazing, ruminating and idling behaviour were recorded from individual heifers automatically by using IGER Behaviour Recorders and analysed by using the Graze software (Rutter, Champion & Penning, 1997; Rutter, 2000). Animal position fixes were recorded using collars equipped with GPS receivers (GPS Plus 2, Vectronic Aerospace GmbH, Berlin, Germany). The animal position fixes were merged with pasture area data using the GIS software ArcMap (ESRI, 2002) to determine if the animals were located in dry, mesic or wet areas and to calculate travelling distances. Heifer activity levels were recorded by accelerometer sensors on the collars. The behaviour recordings and location data were merged.

Defoliation and faecal plant fragments

Defoliation of the competitive grassland plant species *Filipendula ulmaria* (meadowsweet), *Juncus effusus* (soft-rush), *Alnus glutinosa* (alder) and *D. cespitosa* were recorded in 0.5 × 0.5 m plots on the pasture. The proportion visited plots as well as the length and proportion of defoliated shoots in the plots were determined. Faecal samples were collected from individual heifers at pasture for microhistological determination of plant fragments and prepared for analyses following the procedures of Garcia-Gonzalez (1984). A trained technician identified fragments from 30 plant species and plant groups.

Grazing management scoring

At the end of the grazing periods, the pasture was visually examined to assess if the heights were short enough to ensure that no litter had been accumulated onto the sward (Swedish Board of Agriculture, 2004). Inspections of the paddocks were conducted according to a national inspection protocol (Persson, 2005b). The judgements were performed as an average per paddock in the heifer study (Paper IV), whereas dry, mesic and wet areas in the paddocks were judged separately in the foraging study (Papers I & II).

Feed intake and weight gain

Animal feed intakes were determined weekly during the indoor periods whereas animal liveweights were recorded every second week throughout the experiments. The average daily feed intakes, weight gains and feed conversions of the animals were calculated.

Carcass traits

The cattle were slaughtered according to commercial procedures (Paper III-V). Conformation and fatness were graded according to the European classification schemes EUROP modified to the Swedish system (SJVFS, 1998; Commission of the European Communities, 2005). From each animal, weights of carcass, kidney knob and channel fat, and right hind quarter were recorded, as well as the weight of the seven most valuable retail cuts, trim fat and bones of the right hind quarter. Marbling, *i.e.* intramuscular fat content, in *M. longissimus dorsi* (strip loin) was visually determined in a cross-section of the muscle.

Meat quality

In Paper V, the left side of each carcass was suspended by the pelvic bone whereas the right side was suspended by the Achilles tendon. Samples of *M. longissimus dorsi* from both sides were vacuum packed and aged for 7 or 14 days. The pH values, intramuscular fat contents and instrumental tenderness (Warner-Bratzler shear force) of the samples were determined as well as freezing and cooking losses. A trained panel performed a descriptive sensory analysis.

Statistical methods

Statistical analysis was performed by using the procedure GLM for feed intake data in Papers II–IV; the procedure MIXED for behaviour data in Paper I, defoliation and plant fragment data in Paper II, weight gain data in Papers I–IV, and carcass and meat quality data in Papers III–V; the procedure t-test for foraging areas in Paper I and the procedure GENMOD for visited plots in Paper II (SAS, 2001). Repeated measurements were used when effects of season were investigated (Papers I & II). In Paper II, Bonferroni tests were used to correct for false significant effects.

Summary of results

Foraging and nature conservation traits

Foraging behaviour and location

In Paper I, the Väneko heifers had a higher overall activity than the Charolais heifers, but no effect of breed on location of grazing was found. The heifers spent more time grazing in the autumn (43% of the day) than earlier in the grazing period (39% of the day). The ruminating time increased over the grazing period, whereas the distances travelled and levels of activity decreased. The proportion of eating time during grazing time increased as the grazing period progressed, *i.e.* the heifers had fewer pauses between eating jaw movements in the autumn than earlier in the grazing period. On average over seasons, 28% of the herbage mass was found in the wet areas, but only 8% of the grazing occurred there. In the wet areas, the proportion of eating time during grazing time was lower than it was elsewhere.

Defoliation and faecal plant fragments

In Paper II, Väneko heifers foraged more *F. ulmaria* in spring than Charolais heifers, but no further breed effects on defoliation and faecal plant composition were found. Season influenced defoliation and faecal plant composition, where defoliation of *F. ulmaria* and *A. glutinosa* increased over the grazing period. The proportion of fragments of Cyperaceae (sedges and rushes) was higher in spring than later in the grazing period and the proportion of herbs was lowest in the autumn. The proportion of *Nardus stricta* (mat-grass) was highest in the summer, whereas the proportion of *Festuca rubra* (red fescue) was highest in the autumn.

Grazing management assessments

At the end of the grazing periods in the heifer study (Paper IV), grazing pressure from a nature conservation perspective was assessed as having been satisfactory to excellent in the rather dry year 2001, whereas it was assessed as having been satisfactory to moderate in 2002. After the rainy 2004 grazing period in the foraging study (Papers I & II), the grazing pressure was assessed as satisfactory in the dry and mesic areas, whereas it was weak in a majority of the wet areas.

Beef production

Feed intake and weight gain

An increased indoor feed intensity resulted in a higher feed intake and weight gain as well as an improved feed conversion in both Angus heifers (Paper IV) and dairy steers (Paper III). Cattle with a previous low weight gain gained more than cattle with a previous high weight gain when feed became abundant. This was true both for Angus heifers turned out to pasture (Paper IV) and for finishing dairy steers (Paper III), where the steers with low initial weights (*i.e.* with previously low weight gain) had a better feed conversion during finishing than steers with high initial weights. Furthermore, feed conversion was best in steers with an intermediate length of finishing (5 months).

Carcass traits

High feed intensity resulted in increased marbling in the Angus heifers (Paper IV). However, carcass traits were more affected by length of rearing period (defined as slaughter age for heifers in Paper IV and length of finishing for steers in Paper III) than by feed intensity. A prolonged rearing period for heifers and steers as well as higher initial weights for steers resulted in heavier and fatter carcasses with higher dressing percentages, better conformation and lower proportions of fat-trimmed valuable retail cuts and bones than for cattle slaughtered after a shorter rearing period or with low initial weights.

Meat quality

In Paper V, meat from the Charolais heifers at high feed intensity had improved tenderness and lower bite resistance than heifers at low feed intensity. High feed intensity also resulted in lower cooking losses after 7 days of ageing and lower pH values. For Angus heifers, a slaughter age of 22 months resulted in tenderer and more marbled meat with more intense fat taste than a slaughter age of 18 months. For both breeds, pelvic suspension increased tenderness and decreased bite resistance for both slaughter ages when aged for 7 days, but no differences in tenderness between the two suspension methods were found when aged for 14 days. When the heifers were slaughtered at 18 months of age, pelvic suspension also decreased visible marbling in the sensory test.

General discussion

Nature conservation

Effects of season

The heifers increased their grazing time over the grazing period, and they also were more effective grazers in the late grazing period, *i.e.* they had fewer pauses between single eating jaw movements (Paper I). The prolonged grazing time in autumn can be explained by the decreased nutrient concentrations in the herbage in the late grazing period, but do not explain the increased efficiency in grazing. Anti-predator theory predicts that large herbivores avoid foraging in darkness due to a perceived risk for predating (Rutter, 2006). Fewer daylight hours in the autumn may explain why the grazing was more effective in autumn than earlier in the grazing period, *i.e.* the extent of daylight hours limited the time available for grazing. The shorter distance travelled and the lower activity of the animals in the autumn also support the anti-predator theory (Rutter, 2006). A limited grazing time may have negative impact on liveweight gains of livestock on pasture.

Both the proportion of woody plant species in the faecal plant fragments and the defoliation of *A. glutinosa* were higher in autumn than earlier in the grazing period (Paper II). More woody plants in the diet in late season is supposed to be due to a lower nutrient quality in grasses and herbs during autumn than earlier, whereas nutrient concentrations in leaves are relatively constant over the grazing period

(Ciszuk & Murphy, 1982; Garmo, 1986; Ganskopp *et al.*, 1999). Consequently, grazing livestock are better at controlling pernicious brushwood in autumn than in spring. Nevertheless, in our study the proportions of woody plant fragments in the faeces were low, indicating manual clearance can be necessary, especially with low stocking rates (Tallowin, Rook & Rutter, 2005).

Effects of breed

Several comparisons were made between the two breeds, yet only a few differing traits were found. The Väneko heifers were more active than the Charolais heifers (Paper I) and they were more inclined to explore different plant species in spring, including less preferred and less nutritious ones found in wet areas, such as Cyperaceae and *F. ulmaria* (Paper II). Similar results have been shown in previous studies of ruminants foraging on semi-natural grasslands (Steinheim *et al.*, 2005; Sæther, Bøe & Vangen, 2006; Sæther *et al.*, 2006). The results agree with the theories of resource allocation and contrafreeloading which predict livestock of less specialized production breeds to be more explorative during foraging and more willing to forage less nutritional feed than livestock of production breeds (Schütz & Jensen, 2001; Väisänen, Lindqvist & Jensen, 2005). The lesser selectivity can be explained by the reduced metabolic rates and low maintenance requirements in these genotypes (Webster, 1985). However, in applied nature conservation work, breed probably is of less importance than many other management factors (Rook *et al.*, 2004; Rook *et al.*, 2006).

Avoided areas

Herbage in wet areas was dominated by *D. cespitosa* and Cyperaceae and had a lower ME concentration and a higher NDF concentration than herbage from herb-rich dry areas (Papers I & II). In early spring, nutrient concentrations of *D. cespitosa* are comparable with grasses from leys, but as soon as the plants start maturing, the digestibility decreases rapidly (Andersson, 1999; Lifvendahl, 2004). In addition, nutrient concentrations in Cyperaceae are low at late maturity stages (Garmo, 1986; Lifvendahl, 2004). Cattle foraging in heterogeneous semi-natural grasslands with abundant herbage actively forage for food which is followed by a nutritional benefit, whereas animals avoid herbage resulting in malaise or continued hunger (Launchbaugh & Howery, 2005). Consequently, the heifers in our study preferred to avoid grazing the wet areas (Paper I) resulting in an unsatisfactory defoliation of competitive plant species in these areas (Paper II). If livestock have the option to forage other areas, their avoidance of foraging in wet *D. cespitosa*- and Cyperaceae-dominated semi-natural grasslands may constitute a challenge when managing these areas (Krahulec *et al.*, 2001). Dividing heterogeneous grasslands with fences to direct robust animals to these areas in early spring, aiming to delay the maturation with accompanied decreased digestibility of these plants (Lifvendahl, 2004), may be necessary to obtain satisfactory management of these areas.

Experimental techniques

The automatic behaviour and location sampling enabled us to obtain 24 h recordings and exact time budgets for the animals without manual behaviour samplings (Paper I). Nevertheless, the sampling was labour intensive as the animals had to be brought indoors to attach and remove the equipment, especially as manufacturing failure of the behaviour recorders forced us to repeat many recordings. It might seem strange that breed differences were found in activity, measured by the accelerometer sensors, but not in travelling distances, measured from the GPS data. However, the two estimates of animal movements were measured in different scales, where the accelerometer sensors measured small-scale activity and the GPS coordinates estimated movements on a larger scale. Automatic recording seems to be a useful tool when sampling location and foraging in grazing livestock, especially when the animals are kept on extended semi-natural grasslands with poor visibility.

We used microhistological examination of faecal plant fragments as estimates of diet composition even though the method has been criticized for being biased towards the estimates of graminaceous species due to its digestion characteristics (Paper II; Holechek, Vavra & Pieper, 1982; McInnis, Vavra & Krueger, 1983). The bias can be overcome by using newer methods such as analysing alkanes in plant wax cuticle. However, the reliability of the alkane method is low when used for grazers on species-rich grasslands (Dove & Mayes, 1996). Furthermore, when using microhistology, several authors suggest that the effects of differential digestions are only minor (Dearden, Pegau & Hansen, 1975; Johnson & Pearson, 1981; Badsberg, Nielsen & Hansen, 2003).

Beef production

Weight gain on pasture

The proportion of liveweight gain from weaning to slaughter derived from pasture varied between 22 and 67% of total gain in the beef heifer production systems depending on indoor feed intensity and slaughter age (Paper IV). In general, varying gains on pasture are most likely affected by previous feed intensity as well as the quality and quantity of pasture herbage.

Cattle previously fed restricted rations have compensatory growth when feed becomes abundant (reviewed by Berge, 1991). The relatively low average daily weight gain for the Charolais heifers during the grazing period 2001 could be due to the high gains during the previous indoor period for animals at both feed intensities studied (Fig. 3; Paper IV). Conversely, the Angus heifers at low indoor feed intensity had compensatory growth with high weight gains during the subsequent grazing period 2002 and, in agreement with earlier studies, retained about half of their lost weight gain on pasture (Wright, Russel & Hunter, 1989).

Nutrient concentrations vary considerably among different types of vegetation in semi-natural grasslands (Andersson, 1999). The nutrient concentrations of herbage on our *D. cespitosa*-dominated semi-natural grasslands were low and may have

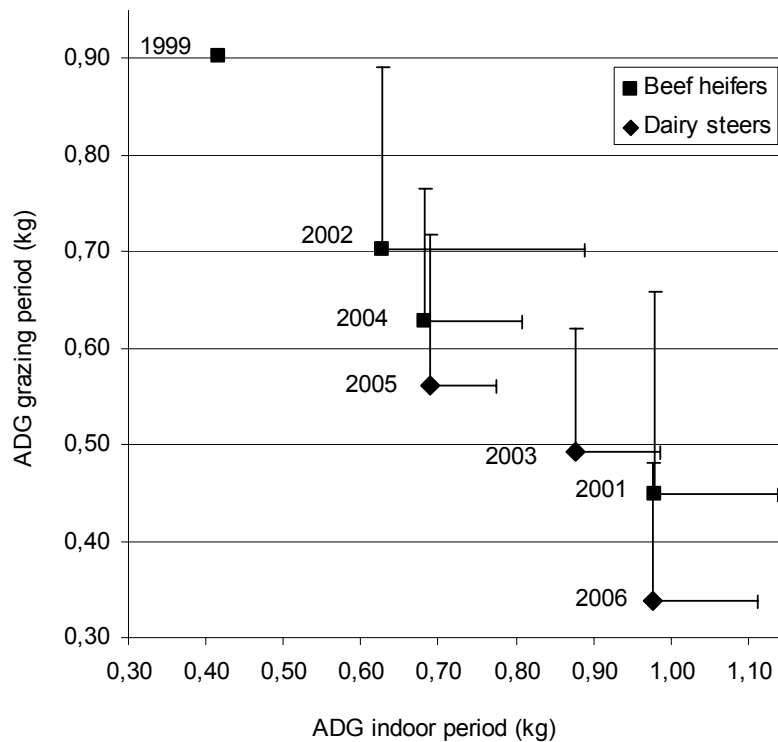


Fig. 3. Average daily liveweight gains (ADG) during grazing periods in relation to ADG during previous indoor periods in cattle kept on *Deschampsia cespitosa*-dominated semi-natural grasslands at The Götala Research Station during 1999 to 2006; error bars are standard deviations; data from 2001, 2002 and 2004 are described in Papers II & IV.

impacted on the weight gains during the grazing period. However, the low liveweight gains on pasture in the driest year studied, $0,45 \text{ kg day}^{-1}$ in 2001, were most probably restricted by the herbage mass rather than the nutrient concentrations. At the end of the grazing period, the average final sward height was low (2 cm) and the grazing pressure was assessed as having been higher than necessary to obtain the nature conservation goals (Paper IV). During the additional two years studied, 2002 and 2004, precipitation was heavier and grazing pressures were assessed as having been weaker (Papers I, II & IV). At the same time, the liveweight gains of the heifers were higher ($0,70$ and $0,57 \text{ kg day}^{-1}$ in 2002 and 2004, respectively). Hence, at approximately similar stocking rates ($1,4$ to $1,8 \text{ animal ha}^{-1}$), variations among years is of significance for the outcomes.

When Sweden joined the European Union and introduced the scheme for management of semi-natural grasslands, high grazing pressures were enjoined to obtain maximum maintenance of biodiversity (Swedish Board of Agriculture, 1995). This standpoint was criticized both from animal production and nature conservation perspectives (Götmark, Gunnarsson & Andrén, 1998; Spörndly, Olsson & Burstedt, 2000; Stenseke, 2004). Therefore, to receive environmental support for managing semi-natural grasslands today, a more moderate grazing

pressure is required (Swedish Board of Agriculture, 2004) and the contradictions between beef production and nature conservation goals seem to belong to the past.

If grazing is undertaken on semi-natural grasslands instead of leys, the costs for a possible lower animal liveweight gain on pasture, and thereby a longer finishing period, can be economically compensated by the environmental supports for managing the semi-natural grasslands. The following scenario is based on the assumption of the basic level of Swedish environmental supports (1,100 SEK ha⁻¹ for semi-natural grasslands and 300 SEK ha⁻¹ for leys) and stocking rates of one animal ha⁻¹ on semi-natural grasslands and four animals ha⁻¹ on leys. During an assumed subsequent indoor finishing period the animal cost (including labour, feeds and buildings) is 20 SEK day⁻¹ for cattle previously grazing leys, whereas cattle previously grazing semi-natural grasslands are assumed to have a 10% higher feed intake and 50% compensatory growth compared to cattle previously grazing leys. Under these circumstances and with an assumed pasture liveweight gain of cattle on leys of 1.0 kg day⁻¹, a decrease to 0.6 kg day⁻¹ for cattle grazing semi-natural grasslands results in similar total net income.

However, animal liveweight gains on pasture probably are more affected by grazing management than whether the animals are grazing semi-natural grasslands or leys. Independent of pasture type, animal weight gains are favoured by strategic utilization of grazers and grasslands available. In a recent study of replacement heifers in 122 Swedish dairy herds, the 80% central range for average liveweight gains in first season grazers ranged from 0.32 to 0.71 kg day⁻¹ (Hessle, Nadeau & Svensson, 2004). A majority of the herds (85%) used semi-natural grasslands, including herds with high animal weight gains. Herds using semi-natural grasslands only or using semi-natural grasslands in combination with leys obtained average weight gains on pasture up to 0.68 and 1.00 kg day⁻¹, respectively (unpubl. data).

Indoor weight gain and feed conversion

Length of rearing periods investigated in these studies, which implies initial weights and length of finishing periods for steers (Paper III) and slaughter ages for heifers (Paper IV), had greater effects on weight gain and feed conversion than feed intensity. The ability of compensatory growth can be used not only on pasture after restrictive winter feeding but also during indoor finishing after a grazing period with low weight gain. This was true for the dairy steers (Paper III) where carcass gains were higher and feed conversion was better in steers with low initial weights compared to steers with high initial weights, which is in agreement with earlier studies (reviewed by Berge, 1991).

For the Angus heifers (Paper IV), ME intakes for animals at the high feed intensity was 40% higher than for animals at low feed intensity, resulting in higher liveweight gains in the heifers at high feed intensity. For the Charolais heifers (Paper IV) and the steers (Paper III), the differences in ME intakes at the levels of feeding were smaller (14 and 8% for the heifers and steers, respectively) resulting in similar liveweight gains between feed intensities. Nevertheless, for the steers,

data on carcass gain was also obtained and steers at high feed intensity had higher daily gains and better feed conversion than steers at low feed intensity expressed in terms of carcass gains. In another study at The Götala Research Station, even higher feed intensities for finishing dairy steers were investigated (Karin Wallin, pers. comm.). A further increase of daily concentrate ration from 1.0 to 1.5% of animal liveweights resulted in a 14% increase of liveweight gain. In other studies, differences in weight gain have been found when the differences between feed intensities have been major, but not if they have been minor (Steen, 1995; Steinwider *et al.*, 1996; Steen & Kilpatrick, 1998; Keane & Allen, 2002).

In Paper III, steers finished for 5 months had the highest daily carcass gain and the best feed conversion. Steers slaughtered after 3 months of finishing probably did not have time to convert to the indoor feed rations and fully utilise their compensatory growth capability, whereas steers slaughtered after 8 months of finishing converted a major part of their ME intake to fat. Because heavier cattle use a higher proportion of the ME intake for fat deposition as kidney knob and channel fat, subcutaneous fat, and finally intramuscular fat than cattle with lower liveweights, weight gain decreased and feed conversion degraded with increasing carcass weights resulting from high initial weights or a prolonged finishing period. Hence, medium carcass weights (300 to 320 kg) resulted in the best feed conversion.

Carcass traits

More fat deposition in heavier carcasses is consistent with the findings in other experiments (Martinsson & Olsson, 1993; Steen & Kilpatrick, 2000; Keane & Allen, 2002). In this study, higher carcass weights not only resulted in fatter carcasses but also in higher dressing percentages (steers and Angus heifers) and conformation scores (steers and Charolais heifers; Papers III & IV). Along with an increasing proportion of trim fat, the proportions of bones and fat-trimmed valuable retail cuts in the hind quarters decreased, which agrees with results of others (Martinsson & Olsson, 1993; Steinwider *et al.*, 1996; Steen & Kilpatrick, 2000). However, the amounts of retail cuts were higher in the heavy carcasses indicating higher values from them.

Only 13% of the cattle slaughtered after having grazed semi-natural grasslands at the start of the steer study (Paper III), achieved a carcass quality resulting in full payment because of too small and lean carcasses. Likewise, in the heifer study (Paper IV) the carcass quality from heifers slaughtered at housing would have been improved by another indoor period. These results show that cattle at this age often need finishing to achieve desirable carcass weights and qualities as reported earlier (Therkildsen *et al.*, 1998; Vestergaard *et al.*, 2000). After a further indoor period, few of the Angus heifers (Paper IV) obtained carcass weights high enough to achieve full payment. Hence, a decreased minimum carcass weight or increased maximum fatness for full payment would favour beef heifer production. With the current criteria, female Angus cattle might, because of their low maintenance requirements, be more competitive as suckler cows than as terminal carcass producers.

Meat quality

For the sensory traits in meat from both the Charolais and Angus heifers, only few traits were improved after postponed slaughter until the age of 22 months (Paper V). However, Achilles suspended sides from the Angus heifers got increased tenderness and corresponding lower bite resistance after prolonged rearing. Pelvic suspension increased tenderness and reduced bite resistance, which is in agreement with previous findings (Bouton & Harris, 1972; Hostetler *et al.*, 1972). Pelvic suspension also resulted in the marbling to be less visible, probably due to fat cells being outstretched. This might be an advantage when selling retail cuts to household consumers, who want to buy tender meat, but with low content of visible fat (Grunert, 1997). Differences between suspension methods found in sensory tenderness and bite resistance were not always confirmed by the results from the shear force measurements, indicating the sensory panel in this study to have been more sensitive to differences in tenderness than the instrumental evaluation.

Meat quality means not only sensory and technological qualities, but also nutritional quality such as fatty acid composition. Polyunsaturated omega-3-fatty acids likely promote human health and prohibit diseases (Simopoulos, 2004a, b). The concentrations of these compounds in meat can be increased by changing animal feed rations towards higher proportions of forage (Wood *et al.*, 2004). The Charolais heifers in our foraging study (Papers I & II) were split into three treatments at housing, including slaughter either directly from pasture or after indoor finishing on a grain-based feed ration or on grass-clover silage only (Enfält *et al.*, 2006). Beef meat from heifers slaughtered from pasture or after finishing on grass-clover silage had higher concentrations of omega-3-fatty acids than beef from heifers finished on grain, which is in agreement with previous studies (Wood *et al.*, 2004). These findings suggest that value-added beef could be marketed to health-conscious consumers year round, either from grass or grass silage finishing.

Final remarks

Suckler cows may be the most proper cattle for grazing semi-natural grasslands because of high digestive capacities in combination with relatively low production levels. Nevertheless, growing cattle can also successfully be utilized to managing these areas. The two categories of growing cattle studied in this thesis, dairy steers and beef heifers, are both suitable for beef production systems including grazing on semi-natural grasslands. If the proportion of Swedish dairy bull calves that are castrated and raised as steers will continue to increase to, for example, half of calves born, these steers would need about 100,000 ha of semi-natural grassland. If no Swedish beef heifer born would be slaughtered as fattening calves but raised as finishing or replacement heifers with a grazing period on semi-natural grasslands as yearlings, they would be able to manage another 60,000 ha. All together, the area corresponds to 60% of Swedish valuable pasturelands (Persson, 2005a). Simultaneously, production systems for dairy steers and beef heifers on semi-natural grasslands in summer, including an indoor finishing period if necessary, enable production of fresh Swedish high-quality beef meat all year

round. There also are other beef production models suitable to be based on semi-natural grasslands, such as steers and once-bred heifers of beef breeds, which remain to be investigated.

The structure of Swedish beef cattle herds with many small production units might be valuable in preserving the dispersed semi-natural grasslands, but may have disadvantages for beef production profitable as the mosaic landscape may limit the herd size and thereby inhibit structural rationalization of the enterprises (Johnsson *et al.*, 2004; Kumm, 2004, 2006). Individual beef producers might be more proficient if they specialize in either cow/calf-production and grazing management or on indoor finishing. Results from the steer study (Paper III) indicate that infectious diseases such as pneumonia do not present any major problem when bringing together cattle with different immunological and infectious status. Therefore, assembling cattle from several farms' grazing areas for finishing in specialized herds could be a profitable solution for combining grazing on dispersed semi-natural grasslands with production of high-quality carcasses.

Society's willingness to pay for management of semi-natural grasslands has increased many beef producers' interest for such production systems (Stenseke, 2004). From not only the farmer's but also from society's perspective, combining nature conservation and animal production seems to be a cost-efficient strategy to promote preservation and management of semi-natural grasslands for the public goods on the one hand, and on the other hand, to produce beef meat to benefit private goods, instead of two unconnected approaches for the two objectives.

Conclusion

In this thesis, extent and location of foraging in cattle on semi-natural grasslands as well as their diet composition were more affected by season than by breed. The cattle browsed more leaves from pernicious wood such as *A. glutinosa* in autumn than earlier in the grazing period. Wet *D. cespitosa*-dominated areas were avoided for foraging throughout the grazing period, which may negatively affect the possibilities to preserve these areas. Strategic use of a limited number of grazers might be to direct them to *D. cespitosa*-dominated areas in spring, whereas control of brushwood can be postponed to autumn. Both dairy steers and beef heifers can be successfully used for beef production in systems where semi-natural grasslands are utilised in summers. In this thesis, length of rearing period, *i.e.* slaughter age for the heifers and initial weight and length of finishing period for the steers studied, affected carcass traits more than indoor feed intensity. However, differences in feed intensities were generally small. For the steers studied, a medium length of finishing period (5 months) with medium carcass weights (300 to 320 kg) resulted in the best feed conversion. Beef meat quality was more dependent on post-slaughter than pre-slaughter treatments for the heifers in this thesis. Meat quality was improved by pelvic suspension of the carcasses, mainly by increasing the tenderness of the meat, but also by decreasing the visibility of the marbling.

Svensk populärvetenskaplig sammanfattning

Nötköttsproduktion

Omfattning av svensk nötköttsproduktion

Den svenska nötköttsproduktionen har som bas 26 000 företag som i medeltal levererar 16,5 slaktnöt per år. Djuren är av såväl mjölkkras som kötträs och de föds upp på många olika sätt. Antalet nötkreatur i Sverige har minskat kontinuerligt de senaste decennierna. Den inhemska produktionen av nötkött är idag mindre än konsumtionen och 45% av det nötkött som säljs är importerat. Det finns dock en stark efterfrågan på svenskt kött, eftersom man anser att det är producerat på ett djur- och miljövänligt sätt och att livsmedelssäkerheten är hög. Det allra viktigaste för medelkonsumenten är emellertid att köttet är fräscht, mört och gott.

Slaktkroppskvalitet

Kvigor och stutar passar bra i betesbaserade uppfödningssystem, medan tjurar passar bättre i intensivare uppfödning på stall. Kroppar hos växande djur innehåller en ökande andel fett allt eftersom de närmar sig sin vuxenvikt. Om kvigor och stutar växer för fort riskerar man att de ansätter för mycket fett innan de har kommit upp i tillräckligt hög vikt. Detta gäller särskilt kvigor av lätt kötträs, det vill säga raserna hereford och angus. Vad som är lagom fettansättning och lagom vikt vid slakt varierar stort mellan olika kundsegment, mellan länder och över tiden, där svenska konsumenter vill ha något fetare slaktkroppar idag än för ett par decennier sedan. I Sverige idag ges vanligen högst betalning för slaktkroppar som innehåller 8–10% putsfett och finns i viktintervallet 275–400 kg. Muskelnas konformation, uttryckt som slaktkroppens formklass, är också viktig för prissättningen där en slaktkropp renderar högre pris ju högre formklass den har.

Ätkvalitet

Beträffande ätkvalitet är kött från kvigor och stutar i regel mörare än vad kött från tjurar är. Vidare är vanligen kött från yngre, och därmed intensivare uppfödda, djur mörare än kött från äldre djur vid samma vikt. Dock påverkas ätkvalitetsparametrar, såsom mörhet, inte bara av vad som händer före slakt utan också på behandlingen efter slakt. I vanliga fall hängs slaktkroppshalvorna upp i hälsenan efter slakt och hänger kvar så i lodrätt läge tills dödsstelheten har inträffat. Ett alternativ är att istället hänga slaktkroppshalvan i bäckenbenet. Då hänger bakbenet rakt ut från kroppen, vilket efterliknar den naturliga vinkeln för benet. Om slaktkroppen hänger så när dödsstelheten inträder behåller de värdefulla musklerna på bakparten sedan sitt utsträckta läge, vilket påverkar deras mörhet. Efter styckning sker mörning genom att musklerna, styckningsdetaljerna, lagras i vacuumförpackning.

Naturbetesmarker

Definition

Begreppet naturbetesmark används om marker där tamboskap har betat kontinuerligt under hundratals år utan att markerna har gödslats eller plöjts upp. På många av de marker som idag betraktas som naturbetesmarker slog man tidigare också hö. Betes- och slätterhävden har gett markerna speciella karaktärer, vilket har lett till att många idag både ovanliga och hotade växt- och djurarter trivs här. Naturbetesmarker tillhör de mest artrika marker vi har i landet och de utgör många olika naturtyper, till exempel öppna gräsmarker, skogsbeten och strandängar. Gemensamt för dessa marker är att de, förutom sina biologiska värden, också ofta har höga kultur- och skönhetsvärden.

Hävdbehov

På naturbetesmarker finns det ofta konkurrensstarka växter som gärna breder ut sig och tar överhanden om de ej hålls tillbaka av betesdjuren och/eller manuella insatser. För att naturbetesmarkernas värden ska bestå krävs därför en rätt anpassad betesdrift. Med det antal betesdjur som kan tänkas finnas i Sverige framöver är det viktigt att djuren används strategiskt. Eftersom allmänheten har nytta och glädje av naturbetesmarker får idag personer som åtar sig skötsel av sådana marker ekonomisk ersättning för detta från staten och EU.

Avhandlingens syfte

En nötköttsproducent med naturbetesmarker får intäkter dels för försäljning av slakt- och livdjur och dels från olika EU-ersättningar, där ersättning för hävden av betesmarkerna är mycket betydelsefulla för företagets lönsamhet. För bästa ekonomiska resultat är det därför viktigt att företaget både levererar slaktkroppar som är lagom stora, lagom feta och har tillräckligt hög formklass samtidigt som skötseln av betesmarkerna uppfyller ställda krav.

Syftet med den här avhandlingen var att undersöka hur man i betesbaserad nötköttsproduktion kan få fram bra slaktkroppar samtidigt som betesmarken blir hävdad på ett önskvärt sätt.

Genomförda försök och deras resultat

Betesbeteende och födoval på naturbetesmark (artikel I & II)

I ett av försöken som gjordes inom ramen för avhandlingen jämfördes var (artikel I) och vad (artikel II) kvigor av lantrasen väneko och köttrasen charolais betade när de hölls på heterogen naturbetesmark. Dessutom jämfördes betandet vid tre tidpunkter; vår, sommar och höst. Var kvigor betade registrerades med automatisk utrustning på djuren. Kvigorna hade på sig dels en grimma med en töjbar käkrem som registrerade tuggningar och dels ett halsband med en mottagare för satellitsignaler (Global Positioning System, GPS) som registrerade var de befann sig. För att veta vad kvigor ått, undersöktes växtrester i träcken från dem i mikroskåp. Vi registrerade även avbetning av ohävdsarterna älggräs, tuvtåtel,

veketåg och klibbal i fuktiga och blöta områden av betesmarken, vilka dominerades av tuvtåtel och halvgräs (starr och tåg).

I medeltal betade kvigorna 40% av dygnet. Fuktiga och blöta områden undveks för bete trots riklig betestillgång. Detta berodde troligen på att betesdjur vill ha näringsrikt foder och vegetationen i de fuktiga och blöta områdena hade lågt näringsinnehåll och troligen dålig smaklighet. Generellt var skillnaderna mellan raserna små, men vänekvigorna var mer aktiva och de betade mer älggräs på våren än vad charolaiskvigorna gjorde. På hösten var näringsinnehållet i betet lägre än tidigare under betesperioden, vilket kvigorna kompenserade med att beta en större del av dygnet. I allmänhet undviker betesdjur att beta under dygnets mörka timmar i rädsla för rovdjur. Våra kvigor betade med färre pauser under hösten än vad de gjorde under vår och sommar, vilket troligen berodde på detta.

Gräs och örter utgjorde 75% respektive 18% av dieten medan halvgräs, löv och mossa endast betades i liten utsträckning. Löv från till exempel klibbal äts mer ju längre fram på säsongen det gick, medan avbetningen av tuvtåtel och veketåg var svag hela betessäsongen. För att få bra beteskvalitet och avbetning med ett begränsat antal betesdjur bör djuren tidigt på betessäsongen styras till områden med tuvtåtel för att förhindra att den växer sig grov och osmaklig. Områden med alsly är det inte lika bråttom med utan de kan med fördel betas senare under säsongen.

Uppfödning av stutar och kvigor (artikel III & IV)

I de två andra försöken i avhandlingen studerade vi två olika djurmaterial där bete på naturbetesmark ingick i uppfödningen till slakt. I det ena fallet köptes ett och ett halvt år gamla mjölkrasstutar in för slutuppfödning efter att de hade betat naturbetesmarker (artikel III). I det andra fallet födde vi upp charolais- och anguskvigor från avvänjning till slakt, där kvigorna under sommartid betade naturbetesmark (artikel IV).

I båda försöken var djuren indelade i två olika utfodringsintensiteter på stall. Förutom fri tillgång på ett gräs/klöverensilage fick stutarna en daglig spannmåls-giva motsvarande 0,5 eller 1,0% av sin levandevikt och charolaiskvigorna fick antingen 0 eller 2,0 kg spannmål/djur och dag. Anguskvigorna fick ingen spannmål utan de utfodrades med antingen fri tillgång på ensilage eller 80% av fri tillgång. Stutarna var grupperade utifrån sin insättningsvikt (låg eller hög). Stutarna slutuppföddes i tre, fem eller åtta månader och kvigorna slaktades vid antingen 18 eller 22 månaders ålder. Kvigorna med 18 månaders slaktålder slaktades direkt efter betesperioden medan kvigorna med 22 månaders slaktålder efter betesperiodens slut fick ytterligare fyra månaders uppfödning på stall.

En högre utfodringsintensitet gav större foderkonsumtion för både stutar och kvigor. För stutarna och anguskvigorna var även levandeviktstillväxten högre och foderomvandlingsförmågan bättre. För stutarna var slaktkroppstillväxten högre vid låg jämfört med hög insättningsvikt liksom den var högre vid hög jämfört med låg

utfodringsintensitet. Den medellånga slutuppfödningstiden, fem månader, gav högst slaktkroppstillväxt (630 g/dag) och bäst foderomvandlingsförmåga, uttryckt som energiåtgång per kg slaktkroppstillväxt. Samtidigt var slaktkropparna från dessa stutar lagom stora för dagens marknad (300-320 kg). Anguskvigorna med låg utfodringsintensitet var snålt utfodrade på stall. När de kom ut på bete tog de, tack vare så kallad kompensatorisk tillväxt, igen hälften av den tillväxt de tappat under vintern gentemot sina gelikar med hög utfodringsintensitet. Från avvänjning till slakt växte anguskvigorna i medeltal 630 g/dag och charolaiskvigorna 750 g/dag uttryckt i levandeviktstillväxt. Kvigorna betade naturbetesmarkerna tillräckligt väl för att markerna skulle bibehålla sina naturvärden.

För både stutarna och kvigorna hade uppfödningstidens längd, och därmed deras vikter vid slakt, större betydelse för hur slaktkropparna såg ut än vad utfodringsintensiteten hade. Slaktkroppar från stutar med hög insättningsvikt och med längre slutuppfödningstid var, liksom kvigor slaktade vid 22 månaders ålder, tyngre, fetare och hade bättre formklass än initialt lättare och tidigare slaktade djur. Bakparterna på de tyngre djuren innehöll mer putsfett och mindre andelar värdefulla styckningsdetaljer och ben än vad bakparterna på de lättare djuren gjorde, även om den faktiska vikten på styckningsdetaljerna var högre. Försöken visar att det vid uppfödning av slaktnöt är viktigt att ha noggrann uppföljning av vikterna på djuren.

Ätkvalitet (artikel V)

Vi ville även se hur utfodringsintensitet, slaktålder och hängningsmetod påverkade köttets ätkvalitet, vilket undersöktes i ryggbiffar från kvigorna (artikel V). Uppfödningens formen hade i vår studie mindre betydelse för ätkvaliteten än vad behandlingen efter slakt hade. Kött från bäckenbenshängda slaktkroppshalvor var mörare än kött från slaktkroppshalvor som hängt i hälsenan. Efter två veckors mörning hade dock skillnaden i mörhet försvunnit. Bäckenbenshängning är således ett alternativ till förlängd mörningstid för att uppnå mörkt kött.

Slutsatser

Betesbeteende och födoval påverkas mer av årstid än av ras, där djuren till exempel äter mer löv på hösten än tidigare under betesperioden. Även om ökad utfodringsintensitet ger bättre tillväxt och foderomvandlingsförmåga påverkas slaktkroppsegenskaperna i regel mer av slaktvikten än av utfodringen. Köttets ätkvalitet påverkades i denna studie mer av faktorer efter slakt än av uppfödningen, där bäckenbenshängning gav ökad mörhet. Med regelbunden uppföljning av djurens vikt, strategisk betesdrift och lämplig mörning av köttet finns det goda förutsättningar för att producera bra nötslaktkroppar med hög ätkvalitet och samtidigt hävda naturbetesmarker.

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