Effects of heifers and sheep grazing on herbage production on a previously abandoned grassland

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Abstract

Large areas of cultivated grassland are annually abandoned and no longer used for production in Norway. Such areas will over time be encroached by shrubs and trees, which is regarded as undesirable. We assessed plant community development, pasture production, herbage quality and pasture utilization by sheep and heifers of a grassland that has been unmanaged for 12 years. The experiment was run for two consecutive years. Sheep grazed the whole area for one month in spring and autumn. During the summer, the area was assigned to three replicated treatments: (1) control with no management; (2) grazing heifers; and (3) grazing sheep with offspring. The stocking rate was 1.8 LU ha^{-1}, in both b and c, for a duration of one month. The area was left resting for a month after treatment and before autumn sheep grazing. Pasture production and herbage intake was estimated using grazing exclosure cages. Herbage consumed during summer period was on average 211 g DM m^{-2} and the pasture utilization was 55%. The annual consumption and utilization was 336 g DM m^{-2} and 62% in the grazed treatments and 28 g DM m^{-2} and 15% in the control, respectively. Total annual pasture production was on average 72% higher in the grazed treatments compared to the control. There was no difference between the grazed treatments on annual production, herbage intake or pasture utilization. Grazing stimulated herbage production, and such abandoned grasslands are valuable forage resources.

Keywords: grassland, productivity, utilization, botanical composition

Introduction

In Central Norway, the total farmland area was reduced by 4.9% (11 100 ha) between 2002 and 2012, of which grassland accounted for 80% of the decrease (SSB 2016). The reasons for abandoning farmland varies. Some land is lost to roads and urbanization. High quality land is commonly preferred at the expense of more marginal, remote and less suitable areas for intensive farming. Societal reasons, such as land ownership, does also influence land use. The abandoned areas will over time be encroached by shrubs and trees. This is regarded as undesirable because grasslands are important cultural landscape elements and agricultural land is scarce. Access to grassland is a limiting factor in sheep production. The use of grazing areas in spring and autumn are common but at the expense of yield of winter feed. Further, a general change from small to larger sheep flocks implies that there is a need for access to land for those that invest in future sheep farming. We elaborated the grass and animal production potential of abandoned grassland and the societal constraints that obstruct sheep farmers from using or getting access to such areas. The objective of the work presented here was to test the effect of sheep and heifer grazing on herbage yield and utilization of previously abandoned grassland.

Materials and methods

A 15.3 ha grassland area that had been unmanaged for 12 years was selected for the study. Before abandonment, the area was used as pasture for dairy cows. The prevailing plant species prior to onset of the experiment, assessed autumn 2013, included species that most likely were cultivated previously, such as common bent (*Agrostis capillaris* L., 37% of dry matter (DM) yield), smooth meadow-grass (*Poa pratensis* L., 12%), and naturally occurring species such as tufted hair-grass (*Deschampsia cespitosa* (L.) P. Beauv., 18%) and meadow buttercup (*Ranunculus acris* L., 7%). Reed canary-grass (*Phalaris*

arundinacea L.) constituted dense stands in small patches. The experiment was run for two consecutive years. The area was not fertilized, and the soil is of morainic origin with high content of organic matter (ignition loss 12.1%), with moderate pH (5.4) and P (P-AL=7.8 mg 100 g^{-1}) and K (K-AL=5.8 mg 100 g^{-1}) contents. Sheep grazed the whole area for approximately one month in spring (Period 1: from May 23/20 to June 20/19 in 2014/2015) and autumn (Period 4: from September 17/14 to October 21/14 in 2014/2015). During the summer (Period 2), the area was assigned to three treatments: (1) control with no management; (2) grazing heifers; and (3) grazing sheep with offspring. The fields were on average 1.7 ha, and each treatment had three replicates. The stocking rate was 1.8 LU ha^{-1}, in both b and c, for a duration of approximately one month (from June 20/19 to August 12/3 in 2014/2015). The area was left resting for about a month after treatment and before autumn sheep grazing (Period 3: from August 12/3 to September 17/14 in 2014/2015).

Pasture production and herbage intake were estimated using grazing exclosure cages. Five cages, size 2 m^2, were placed at random in each of the nine paddocks. The cages were moved after each period. Herbage was cut at ground level inside and outside the cages (0.25 m^2) at 4 occasions when spring grazing finished, after summer grazing, end resting period, and after the end grazing in October. The samples were sorted into edible species and non-edible species (meadow buttercup, marsh thistle (*Cirsium palustre* L.), and dead material), forced dried at 60 °C for 48 hours and weighed. Herbage consumed was calculated by subtracting the yield outside from the yield inside the cages, and herbage utilization was calculated as herbage consumed divided by yield inside the cages. Annual herbage production was calculated by adding the herbage production in each period. The herbage production in each period was calculated by subtracting the yield estimates outside the exclosure cages at the start of each period from the yield in the exclosure cages at end of each period. Herbage botanical composition was estimated by using the dry-weight-rank method (Jones and Hargreaves, 1963) and by estimating plant ground cover for individual species in four permanent plots of 1 m^2 in each field in autumn (2013, 2014, and 2015) and spring (2014, 2015). Total DM yield and pasture utilization were analysed by using the mixed procedure in SAS (SAS 2011) to discern significant effects of treatment. There were no significant effects of year or year by treatment interaction and these effects were therefore omitted as fixed effects from the analysis.

Results and discussion

During the spring period (period 1) the accumulated total and edible DM yields were on average 196 (SEM 25.6) and 136 (SEM 18.8) g m^{-2}, and the sheep consumed on average 47 (SEM 12.7) g m^{-2}. In the summer (period 2) when the area was subjected to the different grazing treatments, the sheep and heifers consumed on average 211 g DM m^{-2} and utilized about 55% of the total biomass (Table 1). There were no significant effects of animal species on herbage production, consumption and utilization. The additional grazing with heifers and sheep during summer (period 2), resulted in 72% more total biomass production (526 vs 306 g DM m^{-2}), 159% more biomass production of edible plants (323 vs 125 g m^{-2}), 12 times more biomass consumed (336 vs 28 g m^{-2}) and 4.2 times higher utilization of the total biomass produced (0.63 vs 0.15) on an annual basis than in the control plots (Table 1).

No effects of grazing system on plant community were observed during the experimental years. In October, common bent was the prevailing species in all paddocks (on average 50% of DM yield, SD=10.3), whereas in May meadow buttercup dominated (32, SD=6.8%). Meadow buttercup was more widespread than creeping buttercup (*Ranunculus repens* L., average 2, SD=1.8% in October). Proportions of tufted hair-grass varied greatly between fields, but the species was evenly distributed between the treatments and accounted for 17 (SD=6.6) and 18 (SD=9.5) % of DM in yield in spring and autumn, respectively. The proportion of smooth meadow-grass was higher in October (11, SD=7.8%) than in May (1.5, SD=1.69%). In October 2015 (57%), the ground cover of dead material was higher than in October 2014 (31%). In total more than 60 plant species were registered. Most likely, the short duration of the

Table 1. Herbage consumed and pasture utilization by sheep and heifers during the summer period (period 2) and annually of two consecutive seasons of a previously abandoned grassland (n=6).

	Treatment			SEM	*P*-value
	Control[1]	Heifers	Sheep		
Period 2					
Consumed, g m^{-2}	5	215	208	33.4	0.018
Utilization, proportion consumed of total	0.06	0.57	0.52	0.102	0.035
Annual, period 1 to 4					
Total yield, g m^{-2}	306	526	527	47.0	0.040
Edible yield, g m^{-2}	125	320	327	42.4	0.042
Edible, proportion of total	0.41	0.59	0.61	0.112	0.106
Consumed, g m^{-2}	28	348	323	46.4	0.012
Utilization, proportion consumed of total	0.15	0.64	0.61	0.094	0.009

[1] Control is plots without grazing during the summer period, period 2.

experiment explains why no effects of grazing treatments on botanical composition could be observed. The plant species present at the onset of the experiment were species that are adapted to grazing. Grazing of the entire area with sheep in spring and autumn, short grazing period during summer and variation of plant communities between fields contributed to veil potential differences between treatments. The interaction of grazing livestock and plants is well known (McNaughton, 1979; Matches, 1992), but these interactions are often complex and plant community succession may occur slowly. In addition to grazing, mechanical cutting, draining, fertilisation, liming and reseeding with pasture seed mixtures may help to improve yields and feed value of herbage from abandoned grasslands. In the studied grassland, focus should be on liming and removing dead stems and leaves of tufted hair-grass, marsh thistle and reed canary grass.

Conclusions

Grazing during summertime stimulated herbage productivity up to 1.7 times that on ungrazed control plots, but two years of grazing had no significant effect on plant community composition.

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