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# Plant traits relevant for multi-functionality of grassland swards for free-range chicken husbandry

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## Introduction

The sward of the outdoor run serves multiple important functions in free-range chicken husbandry systems. Vegetation ground cover is crucial for soil conservation. Moreover, by providing a foraging enrichment it is relevant for animal welfare (Shimmura *et al.* 2008). Scientific knowledge of the plant-animal interactions of swards in outdoor chicken runs is only just emerging. An understanding of these will help to improve swards both in view of the conservation of an intact vegetation cover, and for fostering animal welfare.

In the present field study, we investigated: (1) the growth of a number of grassland plant species under conditions of chicken stocking in order to identify species that provide a durable greening of run areas; and (2) the foraging behaviour of chickens on swards of different botanical composition and canopy cover. Based on these data, our aim was to determine properties of plants that are particularly suitable for greening outdoor chicken runs.

## Methods

A three-factorial field experiment was conducted with a split plot design and three replications in randomized blocks. The main factor was plant species ( $n=15$ : grasses: *Agrostis stolonifera*, *Deschampsia cespitosa*, *Elymus repens*, *Festuca arundinacea*, *F. rubra*, *F. trichophylla*, *Lolium perenne*, *Poa pratensis*, *P. supina*; forbs: *Achillea millefolium*, *Plantago major*, *Ranunculus repens*, *Taraxacum officinale*, *Trifolium repens*; one mixed sward comprising all 14 species). A subordinate factor was the duration of stocking with four laying hens per square metre (1-d, 2-d, 3d stocking; non-grazed control). Repeated measurements were made to analyse the third fixed effect, stocking cycle, which is the effect of consecutive stocking events. Data were sampled during two years, with grazing from late July to mid-September in 2009, and from late May to mid-September in 2010. A detailed description of the experimental design is given in Breitsameter *et al.* (in press).

Sampling of vegetation parameters: We assessed canopy

cover and herbage accumulation as indicators of resistance and resilience of the swards to stocking with chickens. Canopy cover was determined by colour analysis of digital photographs of the grazed swards immediately post-stocking and three weeks post-stocking during each stocking cycle. Herbage accumulation was calculated based on a quantification of standing biomass using a rising plate meter in regular intervals during each rest period.

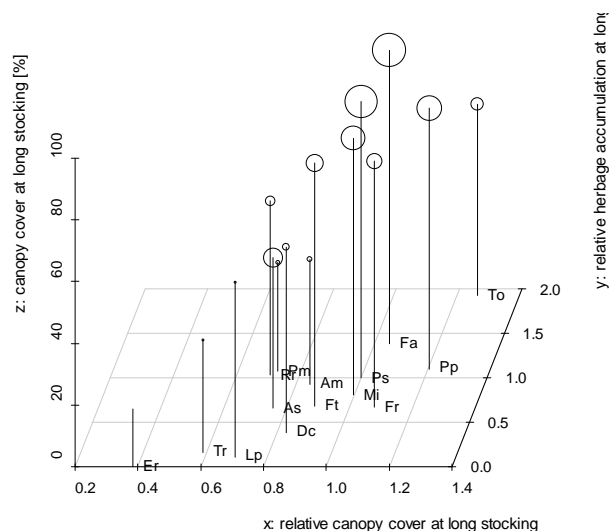
Behavioural data were recorded by point sampling from 0800 to 1030 h the last day of each period of grazing on a sub-plot. The frequency of the behavioural traits 'pecking plants' and 'ground pecking' was determined for each day of observation.

Three-factorial split-plot ANOVA was calculated to analyse the effects of plant species, stocking duration, and stocking cycle (repeated stocking) on the vegetation parameters. The effect of sward botanical composition and stocking duration on the frequency of behavioural traits was determined calculating generalised mixed effect models. The correlation of the frequency of the behavioural traits with sward canopy cover was analysed by linear regression. All statistical data analysis was performed using the software R version 2.14.2.

## Results

### Plant performance

The plants differed distinctly with regard to their response to stocking with chickens. Repeated and prolonged (factor stocking duration) stocking had a significant negative effect on both herbage accumulation and canopy cover in a number of the tested species (Fig. 1). The species *F. arundinacea* and *P. supina* showed constant and high biomass accumulation rates of  $>4.5$  g dry matter/day/m<sup>2</sup>, and a constant canopy cover of  $>80\%$  at repeated and prolonged stocking with chickens; *P. pratensis* and *T. officinale* also had a comparatively high resilience and resistance to chicken stocking, but their herbage accumulation or canopy cover was lower than those of the aforementioned species. In contrast, in *T. repens* and *E. repens*, repeated and prolonged stocking caused a distinct reduction of herbage accumulation and canopy cover.



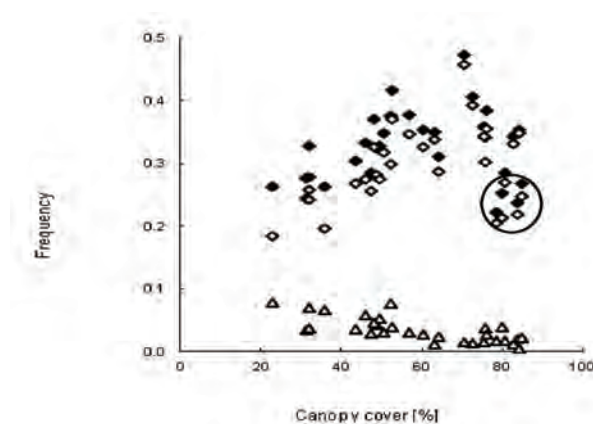
**Figure 1.** Resistance to repeated 3-d stocking with chickens as measured by relative canopy cover (x-axis; ratio of canopy cover at 3-d stocking to that at 1-d stocking) and resilience as measured by relative herbage accumulation (y-axis; ratio of herbage accumulation at 3-d stocking to that at 1-d stocking). Z-axis: canopy cover at repeated 3-d stocking [%]; size of circles: biomass allocation at repeated 3-d stocking. Abbreviations: Am – *Achillea millefolium*; As – *Agrostis stolonifera*; Dc – *Deschampsia cespitosa*; Er – *Elymus repens*; Fa – *Festuca arundinacea*; Fr – *F. rubra*; Ft – *F. trichophylla*; Lp – *Lolium perenne*; Mi – mixed sward; Pm – *Plantago major*; Pp – *Poa pratensis*; Ps – *P. supina*; Rr – *Ranunculus repens*; To – *Taraxacum officinale*; Tr – *Trifolium repens*.

### Behaviour

The botanical composition of the sward had a significant effect on the frequency of plant pecking; this behaviour was more frequent in *Poa* and forb swards than in *F. trichophylla* and *F. arundinacea* swards. The frequency of plant pecking decreased with increasing stocking duration, whereas the opposite was observed for ground pecking. There was a significant negative correlation between the frequency of ground pecking and sward canopy cover over the whole range of sward types (Fig. 2). The frequency of plant pecking and that of the total sward-directed pecking activity (ground and plant pecking together) was positively correlated with canopy cover for most sward types; however, pecking frequency was comparatively low in *Festuca* swards irrespective of high canopy cover (Fig. 2).

### Discussion

To provide a foraging enrichment, the stimulation of



**Figure 2.** Correlation of vegetation canopy cover [%] with the frequency (percentage of total behavioural data) of the behavioural traits ground pecking (triangles), pecking plants (open diamonds) and ground and plant pecking together (filled diamonds). Data of individual sward types, from 2009 and 2010. Circle: pecking behaviour on swards of the species *Festuca arundinacea* and *F. trichophylla*.

sward-directed pecking of the chickens is desirable. According to our data, this can be achieved by species that are highly palatable and maintain a full canopy cover and a high herbage accumulation under conditions of repeated and prolonged stocking. The latter aspects also provide benefits for soil conservation. Among the species tested within the present experiment, *Poa supina*, and to a lesser extent (with regard to herbage accumulation) *P. pratensis* fulfilled these criteria and therefore appear to be suitable for establishing multi-functional swards for outdoor chicken runs.

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