Appendix 6

Optimum Shelter Belts

How to Guide

Monitoring the impacts of Optimum Shelter Belts on farmed animals

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Introduction

The behaviour of domestic animals can be broadly placed into six categories, namely locomotion, maternal, nutritional, reproductive, resting and social behaviour (Phillips, 1993). Access to trees and shrubs can offer benefits to all behaviour categories either directly (e.g., nutritional) or indirectly (e.g., improved ground conditions on locomotory behaviour). The presence of trees also play an important role in the maintenance of homoeostasis since thermal comfort is a key element of this and the subsequent utilisation of energy resources (e.g., Fisher, 2007). Greory (1997) states that '*providing shelter is a moral responsibility*' and whilst shelter is important for animals of all ages, the impacts of inadequate or no shelter are clearest at the start of life.

Lambs born outdoors can lose as much as 10 ^{o}C of body heat in the first thirty minutes of life with lamb losses to exposure and starvation combined recorded between 30 to 60 percent, and higher, depending on continent, farm management and seasonal weather conditions (McCutcheon et al., 1981; Kerslake et al., 2005). The presence of good shelter from a well-designed shelterbelt (Fig. 1) can further promote survival to weaning since shelter encourages the ewe to remain at the birth site for longer and the ewe-lamb bond is strengthened resulting in a higher level of care, alongside ongoing temperate conditions for the growing offspring (Alexander et al., 1984).

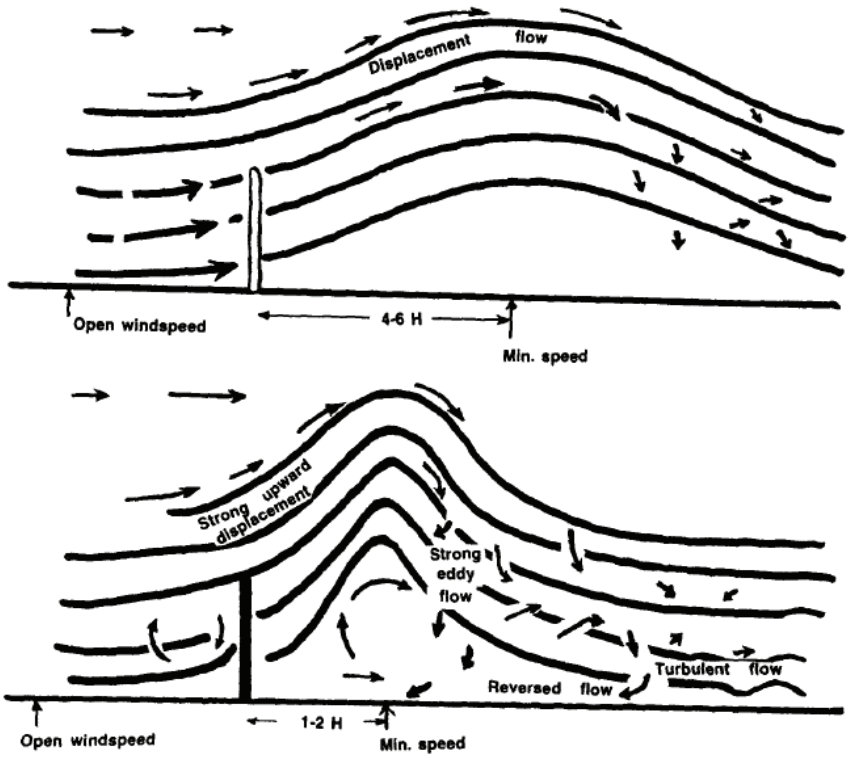

Figure 1: Windflow profiles through a permeable and dense barrier (Gregory, 1995, after Sturrock, 1969).

At a global level, the single most important role that trees play in livestock welfare is the provision of shade. Cooling can take place from reduced solar radiation and from leaf moisture evaporation (Shasua-Bar et al., 2009). When animals are heat stressed, they slow down or stop eating to limit the production of metabolic heat adding to their stress. Non-essential systems (digestion and reproduction) begin closing down, compromising animal and foetus health, alongside productivity e.g., growth rates and milk quality and yield (Fischer et al., 2008; Mitlohner et al., 2001). Digestive issues (a leaky gut from redirecting blood to cooling systems) results in an inflammation cascade and higher levels of mastitis and lameness in dairy cows (Bertocchi et al., 2014).

Although classed as preferential grazers, all livestock species will browse when there is access to trees and shrubs. At the annual level, the average intake of browse for cattle, sheep and goats is 12 percent, 20 percent and 60 percent respectively (Woodland Grazing Toolbox). As Pulido-Santacruz and Renfiro (2011) state, 'living fences' offer good browsing opportunities as well as providing habitat for native flora and fauna. At times, for example, in hot and dry seasons such as UK experienced in the summer of 2018, intake of browse can increase substantially to become the dominant component of the diet at 55 percent for cattle, 76 percent for sheep and 93 percent for goats (Dicko and Sickena, 1992).

In general, browse is a good source of nutrition for farm animals with energy and protein levels in several species comparing well with conventional feeds such as lucerne and ryegrass (e.g., Emile et al., 2016) and offers further benefits including pain relief and parasite control from the presence of plant secondary metabolites. Condensed Tannins (CTs) have a direct anthelminthic effect on gastro-intestinal parasites by limiting the number of larvae maturing to adults, the size of maturing adults and thus the number of eggs produced (e.g., Williams et al., 2014). Studies on sheep and goats show that feeding on tannin-rich browse can reduce faecal egg counts (indicating worm burden) by 50 percent (Min and Hart, 2003). There is increasing evidence of of farm animals being capable of making associations between food containing medication and the treatment of disease (Villalba and Provenza, 2007). The plant secondary metabolite, salicin, is a recognised pain suppressant that humans recognise as aspirin. Salicin has further medicinal properties including anti-inflammatory, antibiotic and antifungal and although it is present across the plant kingdom, it is abundant in some plants including willow and poplar trees.

The shelterbelt is composed of four rows of trees with a total of eighteen different species. A primary objective of the shelterbelt is to offer shelter to crops and livestock and to achieve this, the shelterbelt is composed of 18 species of trees of different heights. There are six trees each of tall, medium and shrub heights which, when planted in rows of increasing height on the side facing the predominant wind, create a sloping profile which minimises turbulence by lifting the wind smoothly up and over the shelterbelt. The six tall trees also offer extended shelter across the landscape (Fig. 1) before the airflow through the shelterbelt and the elevated air re-join and continue at the speed of unimpeded wind. Together with sheltering properties, the eighteen species are also intended to offer browse opportunities to livestock. For livestock, the eighteen species include browsable species such as field maple, hawthorn and hazel alongside goat willow which also offers an established source of the PSMs salicin and condensed tannins.

Focus animals

The dominant species of farm animals present on the OSB project farms are beef cattle and sheep. Therefore, the target animals are these two species considering both adults and youngstock, where present and where possible.

Rationale

The mixed farming systems in the project, with a predominance of arable agriculture, presents challenges for meaningful data collection for the animal focussed data collection since, unlike plant crops, the animals will not always be grazed in the presence of the OSB making it difficult to attribute any longer term outcomes to the presence of the shelterbelt. Nevertheless shorter term impacts can be monitored with protocols developed and adapted to on-farm conditions. Several standard, on-farm management practices involve data collection that is relevant to the trial and this will be utilised/adapted where possible.

It will be important to recognise the level of 'choice' animals face, particularly for the behaviour elements of the protocol, and if there are possible conflicts causing trade-offs between resources. Here, for example, the use of shade/shelter may be compromised by distance to water/feed or the presence of biting flies. Therefore, a clear description of management, available resources and distances between them will be highly relevant to the correct interpretation of results.

The animal protocols will be focussed on evidence of OSB influence on welfare and productivity. Here, productivity is measured as an 'outcome' of welfare status since animals living in low-stress conditions will reduce the 'wasting' of energy on coping mechanisms and thus can better achieve their genetic potential. Evidence of OSB influence will include measuring health status, recording daily activity patterns and social behaviours.

Mortality

Hypothermia (and starvation combined), is one of the biggest causes of lamb mortality and access to shelter for ewes at lambing time can significantly improve survival rates of their lambs at birth. With continued access to shelter it can also improve survival rates to weaning.

Where relevant and possible, the same data will be collected for cattle though block calving and year-round calving will need to be distinguished form each other. In both species, adult mortality rates and causes will also be recorded.

Equipment: Data sheets. On-farm records typically include both new-born and weaned survival figures and, if not already, cause of death will be included.

Morbidity

An increasingly large body of research on dairy cattle illustrate the strong link between compromised thermal comfort and a range of diseases. Furthermore, grazed animals are at risk of gastro-intestinal parasite burdens. Tier 1 will utilise on-farm health records and management including treatments, faecal egg counts and production records for measures strongly linked to diseases (e.g., heat stress and fertility). Alongside health records, on-farm feed input and liveweight/growth rate records will support data on animal health status.

Equipment: On-farm records (paper or app-based) modified to include required data:

Health records (illness and treatment);

Fertility records (number of attempts/length of time and number of barren animals);

Anthelminthic treatments FEC records;

Liveweight/growth rate records

Feed records

Animal use of resources

High welfare animal systems include offering animals an enriched environment where they can find what they need when they need it. As Sommerville and Jones (2013) stated, '*achieving a high quality of life for farm animals requires provision rather than deprivation*'. Animal observations and use of resources would indicate whether the presence of shade and shelter supports the animals to behave normally (e.g., thermal stress compromises normal, daily patterns of activity and feed intake) thus indicating low stress conditions.

Tier 1/2 data collection relies upon the presence of a person recording animal activity for a set period of time using a prepared ethogram (repertoire of appropriate behaviours for species and age groups being observed) and a check sheet for data recording. This level is recorded as both Tiers 1 and 2 since, whilst it is not overly difficult to measure behaviours, (particularly with a detailed ethogram as guidance and a well-designed check sheet), it can be time consuming and requires long bouts of directed focus regardless of weather conditions. It also requires some knowledge of the animal being observed to maintain the safety of both animals and humans. Tier 2 includes use of activity and location data loggers such as Nofence collars (Fig. 2), which, with virtual fence programming disabled, would provide reliable, 24-hour data for field and resource use. Alongside GPS tracking data, temperatures in specific locations could be measured either with the use of anemometers (where available) or with thermometers designed for use with livestock and wildlife which are more robust and can be left in situ reducing human presence and influence on the animals (Fig. 3). Tier 2 could also include the use of the woodland herbivore assessment, alongside its use in the biodiversity protocol for assessing and measuring deer-OSB interactions.

Figure 2: Nofence collars and app, a (virtual fence) GPS tracking system for livestock

An advantage of using technology is the absence of humans, whose presence may influence how animals use the landscape. A drawback can be the loss of environmental data which may explain animal movements (e.g., aversive stimuli such as loud noises or the presence of a predator) though these are typically exceptional events. An additional measure for Tier 2 is the use of technology to measure skin temperatures. Standard thermal stress thresholds are largely assumed for all livestock species being based on losses in productivity rather than actual animal measures. Understanding when animals are choosing to seek shade and shelter would be a major step forward in our understanding of thermal comfort at the animal level.

Figure 3: examples of existing animal temperature data loggers. The Kestrel data logger is focussed on heat stress where the Tinytag measures a range of -40 to +85 ^{o}C allowing for cold stress to be measured.

The gathering of behavioural data will indicate location, time spent in location and the activity in each location including behaviours such as resting, grazing, and social behaviour. These data will indicate overall use of space and available resources. This may provide information at two levels, depending on length of time spent in fields adjacent to the shelterbelt. The first level is 'whole picture' information showing daily and seasonal changes in behaviour and patterns of use. The second level is 'key episodes' which may be of animal-based or weather related and of shorter duration compared to the whole picture data. These key episodes include lambing or calving periods and, for example, a heatwave.

Since the presence of trees is considered to have a positive and calming influence on animal groups, the data collected will also include social behaviour, both positive and negative, such as grooming and head-butting respectively. A repertoire of expected social behaviours will be developed in an ethogram and recorded as counts data.

Equipment: ethogram of different behaviour patterns including daily activity and social interactions alongwith maternal/juvenile behaviour, check sheets for recording behaviour in person, animal mounted data loggers with associated apps, environment mounted temperature data loggers.

Direct access to the OSB

Where animals are allowed direct access to trees in the shelterbelt, evidence of browsing will be recorded alongside body rubbing on branches as evidence of individual body care.

Browsing behaviour can be measured by direct observations or by independent inspection of the OSB for browse damage. Here tree and shrub species should be recorded and an assessment of the percentage of available stems browsed. The diameter of browsed stems can also be recorded to indicate changes in browsing behaviour over time. The number/frequency of observations will be determined by season, how often and how long the animals have access to the trees. Recording of

browse behaviour may be supplemented with nutritional analysis of browsed species alongside grazed fodder analysis.

Body rubbing reduces an animal's heart rate thus contributing to a low-stress state. The physical act of rubbing reduces dead hair and skin (helping with thermoregulation) and removes external parasites and seeds which can penetrate the skin (contributing to overall health). When they have access to rubbing posts, animals spend time every day on body maintenance. In the absence of rubbing posts, anecdotal evidence shows that sheep are more likely to use the ground for rubbing increasing the risk of getting cast and being attacked/blinded by corvids. As part of the daily repertoire of behaviours, body maintenance behaviours will be recorded along with the object being rubbed on. An independent record of rubbing spots can also be taken, noting evidence of dusty, hairy branches and loss of grass where the animals are standing to rub.

Equipment: Ethograms of specific behaviours, check sheets for data entry.

As an additional illustration of animal interactions, for each category, photographs will be taken where possible.

Equipment: camera or camera app on smart phone.