Appendix 3

Optimum Shelter Belts

How to Guide

Monitoring the microclimate changes from the presence of an Optimum Shelter Belt

Lindsay Whistance, Senior Livestock Researcher

Introduction

A key intention for planting a shelterbelt on farmed land is to improve the shelter available for both animals and crops. The presence of shelter can influence microclimate conditions including wind, temperature and moisture levels across a field tempering conditions for both crops and animals (e.g., Cleugh, 1998). Shelterbelt establishment and growth and the accompanying changes in height, profile and density (and thus porosity) will influence microclimate changes overtime, alongside the seasonal variation, with changing leaf cover, and associated seasonal changes in weather patterns. The outcomes of these changes will be measured using the microclimate protocol whilst the shelterbelt properties (height, profile and porosity) will be covered in the Shelterbelt Characteristics protocol.

Protocol

Measuring microclimate using in-field weather stations

Rationale

The data collected here plays a central role in the research on OSBs not only adding to our understanding of how the presence of the shelterbelt changes the local climate but also to help interpret the findings from data collected following the crop, animal and biodiversity protocols. It is important to measure weather and microclimate differences at each data collection point simultaneously across the trial field to ensure that any differences measured can be attributed to the shelterbelt. Additionally, these data will also inform OSB management practices and used to test the value of 's' as a simplified in-field measure of shelter. In order to standardise the data from all OSBs, to ensure accuracy and reliability of data, and to optimise the use of available equipment across sites, it is recommended that this protocol be researcher led. This is also the preferred approach for data transfer and collection purposes, managing the one dongle linked to the equipment.

Following the 'T' design of data collection points (Fig. 1) developed for all appropriate OSB measures including the biomass Carbon and soil Carbon samples, the weather stations will be set up to record microclimate measures across the trial field. The bar of the 'T' represents several points close to and parallel with the shelterbelt and the 'leg' of the T includes several sampling points perpendicular to the shelterbelt and across the trial field. Alongside the sample data points, there will also be a control data point included.

The position of the control weather station may change from trial field to trial field depending on access/ownership of both sides of the OSB and the crops grown on each side. Where the windward side of the OSB is not an appropriate control position, due to e.g., ownership/ topography/

infrastructure/ crop differences compared to the leeward side, a distant point in the trial field (along the same line of the perpendicular T measures) will be selected where the shelterbelt has no impact on the local microclimate. If placed on the windward side, the position of the control weather station will be sufficiently distant from the shelterbelt to avoid any changes in wind patterns related to the presence of the shelterbelt.

Figure 1: Position of sampling points developed for the Carbon above- and below ground data collection. The same positions will be used to collect microclimate data with three additional positions in the same 'T' shape. (Image: FWAG-SW)

The microclimate data gathered will develop a picture of how conditions change across the trial field in the moment as well as over seasons and time, and the protocol will be appropriate for data collection at different stages of OSB presence in the field, namely, 1) establishment, 2) established, 3) mature and 4) impacts of maintenance practice.

Climate measures

In all, ten measures of weather contributing to microclimate are included in the data collection investigating elements of wind (speed and direction), ambient temperature and effective temperature (wind chill and relative humidity) and moisture content (humidity, dew point and wet bulb). These climate measures will be supported with soil temperature measures which indicate the impact of weather on soil conditions relevant to crop establishment and early growth, animal resting comfort and soil biodiversity.

Recording time, frequency and duration.

For this protocol, there are some challenges to optimal data collection which include sharing equipment between 22 OSB sites thus limiting the amount of data that can be gathered at each site. A further challenge is the proximity of some OSBs to public access areas where vandalism has already been experienced and where equipment is at risk of theft or vandalism if left unguarded. A third challenge may be the presence of livestock and potential damage/loss of data from unwanted interactions with equipment.

Option 1:

Following the T design, for data collection, microclimate measures are recorded each month (12 datasets) with hourly intervals (24 data points) to measure annual and daily patterns of microclimate changes. Hourly data capture can be programmed to record a single moment in time or a set length of time (e.g., 15 secs.) where the mean is recorded. The latter option may be useful in very changeable, blustery weather.

Option 1 would provide important knowledge on seasonal and daily changes in microclimate conditions but is a high risk option for equipment safety. Furthermore, with 22 OSBs in total, and therefore, 22 days of data recording each month, and the necessary time lag from travelling between sites and setting up equipment, this option will likely not be possible across all sites but may be carried out on a selected subset of sites and in combination with Option 2 and Option 3.

Option 2:

Following the T design, for data collection, microclimate measures are recorded each quarter (4 datasets) with hourly intervals (24 data points) to measure seasonal and daily patterns of microclimate changes.

Option 2 is a simpler, less sensitive set of data, compared to Option 1, but will deliver basic knowledge of shelterbelt influence on microclimate overtime. Nevertheless, the risk of theft or vandalism would still be present at some OSB sites.

Variations of Options 1 and 2 in terms of time of year (monthly or seasonal) but with a reduced number of data points collected (e.g., daytime only) is also possible but important knowledge of circadian rhythms in weather and microclimate will be limited or lost.

Option 3:

A further option for data collection is to focus on the seasonally important times identified in other protocols. These might include crop germination and establishment times, lambing time or outwintering conditions, alongside key times for biodiversity surveys.

Options 1 or 2 and 3 are not mutually exclusive and the basic protocol will need to be tailored to suit different crops or animal system on each of the farms once use of field and crop selection is determined for that year.

Option 4:

A fourth option for microclimate data collection is related to flash weather events such as storms and heavy rain. Though important for assessing the impact of OSB presence in more severe conditions, they will be challenging to measure since they would require activity with minimal notice and may put people at risk when setting up equipment in field. They may also occur when the equipment is being used to collect data elsewhere and are therefore unavailable. The next phase of project activity, i.e., trialling protocols in the field, will determine whether this focus area can reasonably be addressed and at what level within the OSB project.

Soil temperatures

Soil temperature measures are included here since this strongly influenced by the microclimate and is a key measure for some aspects of crop germination and growth as well as animal thermal comfort and soil biodiversity. The soil temperature of the top 5 cm of soil will be measured at the same time as the microclimate data collection and following the 'T' design.

Tatter flags

Alongside the more technological equipment, Tatter Flags, a traditional visual method of assessing wind damage, may be used (see Fig. 3 below). These flags may be permanently erected at each point on the T design and periodically assessed for damage and wear.

Table 1: climate measures recorded by the Kestrel 5200 Professional Environmental Meter

Direction	Compass heading in true or magnetic North.
Wind speed	Wind Speed is the measurement of the wind passing through the impeller. For greatest accuracy, point the back of the Kestrel directly into the wind.
Crosswind	Crosswind uses the internal compass and a user selected heading to calculate the crosswind component of the full wind.
Headwind	Headwind uses the internal compass and a user selected heading or target direction to calculate the headwind component of the full wind.
Temperature	Ambient Temperature is the temperature measured at the thermistor. For best results, ensure the thermistor is not exposed to direct sunlight and is exposed to good airflow.
Wind chill	Wind Chill is a calculated value of the perceived temperature based on temperature and wind speed.
Humidity	Relative Humidity is the amount of moisture currently held by the air as a percentage of the total possible moisture that the air could hold.
Heat index (THI)	Heat Index is a calculated value of the perceived temperature based on temperature and relative humidity
Dew point	Dew Point is the temperature at which water vapour will begin to condense out of the air.
Wet bulb	Wet Bulb is the lowest temperature that can be reached in the existing environment by cooling through evaporation. Wet Bulb is always equal to or lower than ambient temperature.
Moisture/ humidity ratio	Moisture Content or Humidity Ratio is the ratio between the mass of water vapour measured in the air to the mass of dry air with no water vapour.

Equipment

The microclimate data will be collected using the nine, purchased Kestrel 5200 Professional Environmental Meter weather stations (Fig. 2) which include an anemometer with adjustable tripod and weather vane. These anemometers have data storing options and are Bluetooth enabled so data can be downloaded for analysis, thus extending data collection capabilities as well as minimising human errors in data transfer. These anemometers also support the use of rechargeable batteries. Six of the nine available weather stations will be used for microclimate data and the remaining three will be used to test ‘s’

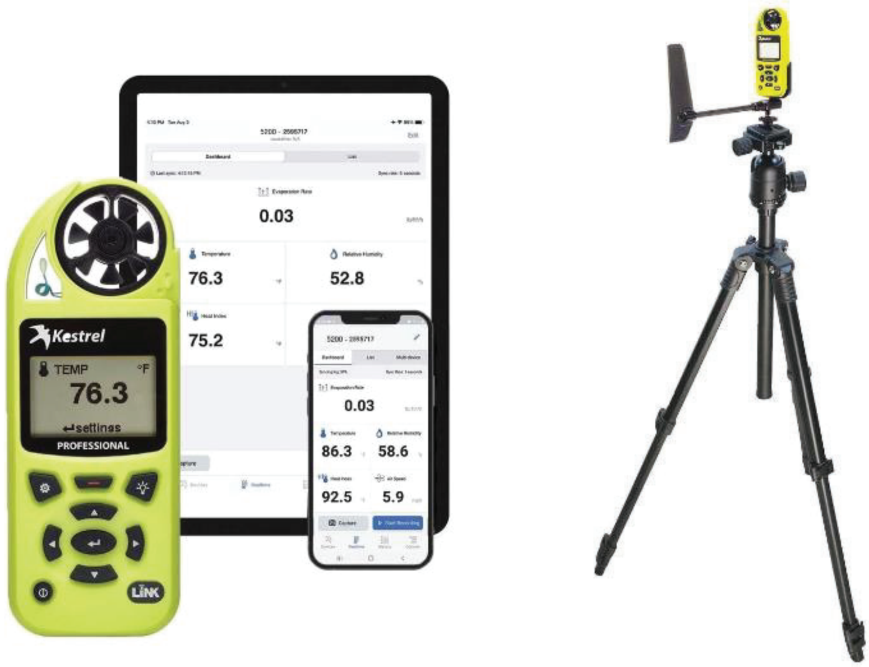

Figure 2: Kestrel 5200 Professional Environmental Meter

Soil thermometer

A digital soil thermometer (Fig. 3) will record the temperature of the top soil. The trial will require a robust thermometer to cope with the rigours of the soil types in the trial which includes Cotswold brash.

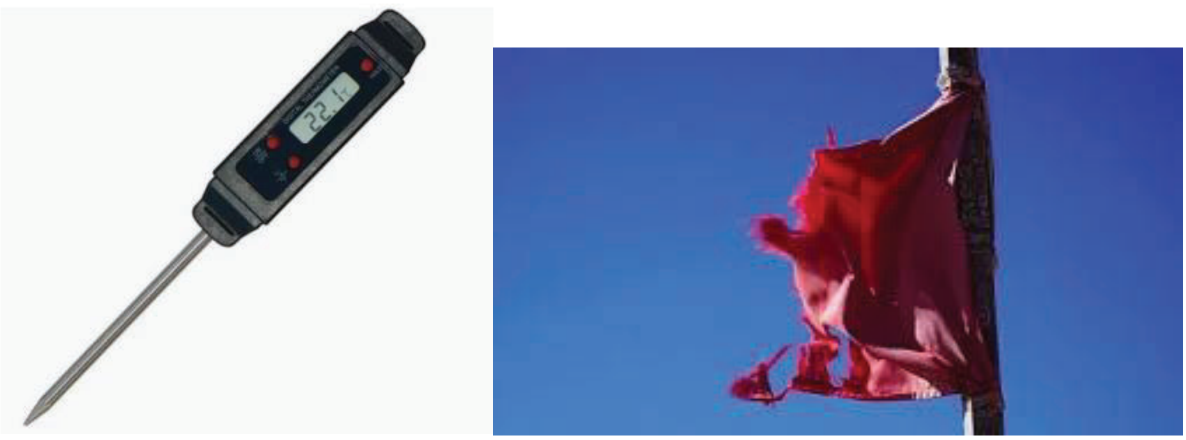

Figure 3: a soil thermometer for measuring the temperature of topsoil and a weather worn Tatter Flag.