

## T1.7 PASTURE SAMPLING TECHNIQUES

### Types of pasture sampling techniques

The main pasture sampling techniques can be summarised as follows

a) *Transect "X"* – these are samplings in the field, where you proceed along line segments guided by a surface, shapes (squares, circles, generally "quadrats") are created according to the line segments. Transects are used in areas where there are rapid and significant changes in vegetation, most often as a result of a change in some environmental factor (e.g. grazing of vegetation by cattle on pastures). Most transects have a disadvantageous position in terms of randomness of location, although it is possible to place the beginning and end of the transect randomly and only then record the data on the plots. The main purpose is to use transects in situations where vegetation changes are determinable and we examine these changes over short distances. Another good example of a so-called short transect is the study of the influence of recreation and trampling on vegetation change.

b) *"Lazy sampling (transect) W"* – simple random selection – not every unit from the studied set has a non-zero probability (chance) of getting into the sample set.

c) *Simple random selection* – each unit from the studied set has a non-zero probability (chance) of getting into the sample set. In random, the units (variables) have a similar distribution as in the whole population. The advantage of random sampling is that we are able to make an estimate from a randomly selected sample of how much the sample differs from the population from which it was selected. We distinguish between "simple random selection" (we assign a number to each unit, then randomly draw the required number of respondents from them) and "systematic random selection" (we include every n-th unit from the list in the sample).

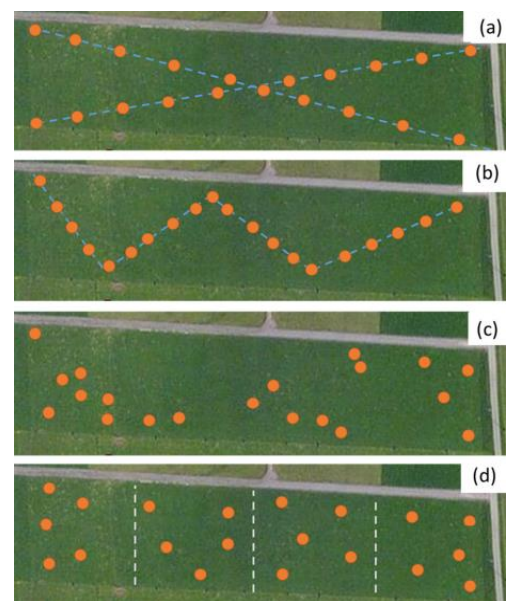
d) *Sampling with random stratified sampling* (Figure 1). We use this if the population from which we are sampling is quite heterogeneous, and we are planning a relatively small sample. In practice, we can for example imagine this by selecting random units from each individual survey area.

### How are pasture sampling techniques applied?

To account for pasture heterogeneity multiple samples or measurements may need to be taken at locations distributed throughout a paddock following a predetermined protocol.

The effectiveness of a sampling protocol can be defined by its accuracy, precision, and level of potential bias. To determine an absolute mean parameter value for a pasture, the entirety of the herbage within that pasture would need to be harvested and analyzed.

This may be possible on small, controlled trial plots used in research but is not practical on grazed paddocks. Therefore, the best possible representation of the absolute mean must be determined, henceforth referred to as the 'true' mean. Accurately estimating the 'true' mean of any herbage parameter can be difficult owing to the heterogeneous nature of grazed swards.



A significant source of measurement error is inconsistent operator use, which is defined in terms of reproducibility or operator bias. Bias error can be minimized by adhering to a robustly designed sampling protocol. Once a pasture measurement tool is used in accordance with manufacturer guidelines, bias in terms of sample area selection remains the greatest source of unknown bias.

For example, when measuring a pasture area, an operator may select the shortest path between the pasture entry and exit points and take all of their samples along this path, as this is the most convenient. This path may not give an accurate representation of the variation of herbage within the pasture and is therefore biased by the operator's desire for convenience.

Likewise, the operator may consciously or subconsciously select sample locations with either consistently high or low proportions of herbage. Similarly, an operator might choose to sample a paddock along transect lines in an attempt to distribute samples more evenly (Figure 1a).

This method is also biased by the operators' preference with regard to the positioning of each transect line. With regard to the RPM (revolution per minute), measurements are typically carried out 25–50 times in transects or in a 'W' pattern (Figure 1b) throughout a paddock. To avoid operator bias and maximize measurement precision, sample locations should be randomly selected and spatially balanced throughout a pasture, although this can be difficult to implement in practice.

If sample location selections are totally random, the entire area within a paddock has an equal probability of selection. Measurement parameter values can be treated as random variables and statistical analysis can be employed to determine parameter mean and estimation error without bias.

Increasing sampling area and resolution may increase measurement precision, however, these further increases sampling time and cost. There is a trade-off between the benefit of increasing accuracy versus time and cost. Reducing measurement time and effort is vital, not only in saving labor costs for farmers but also to encourage more farmers to measure grass on a regular basis. The time and cost requirements of regular and accurate grass measurement are significant barriers to promoting grass measurement on farms.

The requirement for the development of a universal pasture sampling methodology to reduce operator bias, give more precise representations of spatial variation, and minimize measurement labor has long been acknowledged.

The RSS method involves dividing the target measurement domain into several equally sized strata and then assigning an equal number of samples randomly within each stratum, as seen in Figure 1d. This allows for a more efficient distribution of samples within the domain in comparison with simple random sampling (Figure 1c) and average spatial variation within and across strata can be estimated without bias.

The implementation of robust sampling protocols in conjunction with GPS technology enables the use of geo-statistical procedures such as Kriging interpolation, which can be used to develop parameter heat maps of a pasture for spatial analysis and PA applications. Accurate geo-referenced measurement information of sward quantity and quality would enable the use of variable rate fertilization systems to reduce cost, GHG emissions, and nutrient leaching to waterways.

Moreover, such data could lead to more precise spatial analysis of sward characteristics and ultimately lead to increases in pasture utilization.

## Benefits

According to Murphy et al. (2021), increasing grass utilization has major financial benefits, as fresh grass is the cheapest feed source on Irish ruminant livestock farms. It is mentioned that in 2021 the average Irish dairy farmer is utilizing approximately 7–8 t DM ha<sup>-1</sup> of grass per annum, but has the potential to utilize 12–16 t DM ha<sup>-1</sup>. The value of increasing grass utilization has been estimated to be up to €173 tonne<sup>-1</sup> ha<sup>-1</sup> year<sup>-1</sup>. Frequent and accurate measurement of grass quantity and quality is one of the main methods of maximizing grass utilization and production on pasture-based farms. Optimal grassland management is highly dependent on the accuracy of the information on pasture quantity and quality that is available to the farmer.

## List of relevant sources

Murphy, D.J., Murphy, M.D., O'Brien, B., O'Donovan, M., (2021). A review of precision technologies for optimising pasture measurement on Irish grassland. *Agriculture* 2021, 11, 600. <https://doi.org/10.3390/agriculture11070600>

## Key words

*transect "X"*

*lazy sampling*

*simple random selection*

*sampling protocol*

*systematic random selection*

*random stratified sampling*

*measurement error*

*bias error*