# Measuring and Managing Variability in Potassium Fertility for Hill Country Pastures

By R. Tillman and S. Officer

**The complex suite of factors controlling potassium (K) fertility of New Zealand hill country pastures results in a large variation in soil K content across both large- and small-scale topography. At the same time, the deposition of high K urine and dung patches by grazing animals increases the range in soil K levels likely to be detected and can have a large influence on the measured K content of bulked samples from multiple sampling sites. The potential exists to underestimate the K status of hill country paddocks using conventional sampling techniques. A survey undertaken on North Island hill country pastures identified typical distributions of soil K measurements and suggested more appropriate sampling strategies.**

Approximately 40 percent of New Zealand's land surface is characterized by the steep, non-arable hills below 1,000 m altitude, popularly called hill country. As reported in the related article preceeding, several factors interact in a complex way to produce a wide variation in K fertility across the landscape, resulting in a mosaic of high K fertility and potentially K responsive areas. Under these conditions, the ability of current soil sampling procedures to identify developing K deficiencies is questionable, and alternative methods of measuring the K fertility status of hill country pastures are needed.

A survey was undertaken on a 10 ha hill country site in the North Island to determine the variability in soil K status with distance and the frequency distribution of soil K measurements from individual sampling sites.

Characterizing the spatial distribution of a variable involves taking many measurements at known distances apart and constructing a picture of the rates of change in the variable with distance. This survey was based on an approximate 50 m grid with each square sampled using a 25 m long sampling string anchored on one end to the center of the square. Six samples were taken along the string placed in a random direction, so that the distances between points were equal to 0.25 m, 1.0 m, 2.5 m, 10 m, and 25 m. At each sampling point, note was made of several descriptive landscape categories: the predominant pasture species, aspect, medium scale, and small-scale topography. Soil

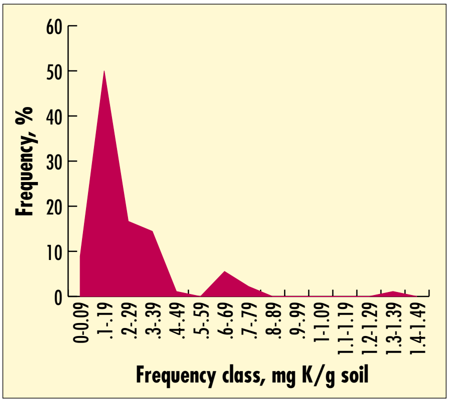


**Figure 1.** Distribution of soil test K measured from a hill country site is heavily skewed. The arithmetic mean (which would be approximated by bulking the samples) is much higher that the median value, giving a false indication of the K status of the site.

samples were taken from each point and analyzed for exchangeable K (Quick Test K - two minute ammonium extraction).

## Distribution

A wide range in soil exchangeable K content (from 0.07 to 1.34 mg K/g) was found in the 90 samples taken from the site. The frequency distribution of soil K measurements was skewed (assymetrical), with the bulk of samples lower than the arithmetic mean and a long tail of much higher values (**Figure 1**). This is compared with the median value, which more closely represented the bulk of the samples.

The distribution of exchangeable K values in this survey was similar to two further surveys conducted 18 months later on this pasture and another hill country site. This suggested that the distribution of exchangeable K was not affected by seasonal changes and is probably representative of the variability found in many hill country pastures.

## Distance Dependent Variability

At the smallest sampling distance of 0.25 m, no changes occurred in any of the descriptive landscape categories (**Figure 2**). At distances of 1.0 m, only the small-scale topography changed, with about half of the sampling sites now positioned on a different small-scale topographical formation. Comparing points 2.5 m apart showed that by now pasture species were also changing with distances, and by 10 m distance, all the descriptive categories had at least some degree of change.

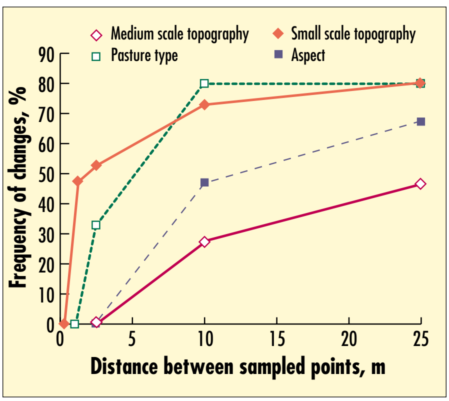


**Figure 2.** At the smallest sampling distance of 0.25 m, no changes occurred in any of the descriptive landscape categories.

The amount of variation in exchangeable K was so great that no significant relationship between distance and frequency of change could be identified. Even at the smallest sampling distance of 0.25 m, the variability of soil K tests was considerable. It seemed that soil K variability was not primarily influenced by any one of the landscape characteristics described and that all of the variability in soil K may already have been present at 0.25 m. This is a very small scale, but corresponds with the approximate size of a urine patch.

## Discussion

Current sampling procedures rely on the assumption that the distribution of soil K status across a paddock is approximately normal (i.e., the mean = median) and that a sufficient number of samples will result in a representative sample and soil test result. However, bulking samples from soils with such wide-ranging and skewed distributions of

K content may introduce significant sampling errors.

There are several reasons for the inappropriateness of bulked samples in hill country. Even if a bulked sampling test result does happen to accurately reflect the arithmetic mean of the soil population, the relevance of a single number as an adequate representation of such a wide-ranging population remains highly debatable. Collecting individual samples and analyzing them separately to find a median and range may be a more appropriate way of describing these distributions.

It is also noteworthy that if the main effect of grazing is an increasing incidence of very high K sites, then the average values of bulked samples will be disproportionately increased. This could create the incorrect impression of increased K fertility under grazed pasture, when in fact the bulk of the soil area is being depleted of K.

The high degree of variability within very small distances also sheds doubt over the effectiveness of avoiding known affected areas such as camp sites where animals rest, and bulking samples from smaller, apparently even areas. In addition, it poses problems for the conduct of small-plot field trials, with it being almost impossible to delineate plots with a low degree of variability. This may suggest that a change to large scale, landscape area experimental approaches would not suffer the penalty of increased within-plot variation, an advantage if a move to precision aerial application techniques in experimentation is likely. **BCI**

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## Factors Controlling Potassium... *(continued from page 28)*

Soil testing and trials to assess likely plant growth responses clearly have to be conducted at a scale that makes best use of the opportunities afforded by the spreading technologies. In the future, use of global positioning system (GPS) technology in planes is likely to improve markedly the precision of spreading, and this will place additional demands on soil testing and fertilizer recommendation schemes. **BCI**

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