Wisconsin

Grid Soil Sampling

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Site-specific nutrient management depends on a sound inventory of soil nutrient availability. Some suggestions are presented for a workable grid soil sampling procedure to support more precise nutrient management.

SITE-SPECIFIC nutrient management for crop production begins with an inventory of soil test nutrient levels in a field. Fertilizer recommendations are based on expected response to fertilizer application as a function of soil test levels. Therefore, site-specific fertilizer applications can be no better than the accuracy of the soil test map from which the fertilizer recommendations are based. Precision usually increases as fields are divided and sampled as smaller areas.

The common approach to achieve systematic soil sampling is to overlay a square or rectangular grid on a map or photograph of the field, identify and drive to the middle of each grid cell, and collect a soil sample at that point (**Figure 1**). The soil sample consists of several soil cores collected within a small radius of the cell center. The soil cores are composited and bagged as one soil sample for analysis at a soil testing laboratory. The purpose of compositing several cores is to average or "bulk" out variability in soil test properties that occurs over small distances.

Grid cell sampling can be efficiently conducted by counting crop rows and using distance measuring devices to locate sampling points. While easy to implement in the field, this practice can lead to bias. Tillage, fertilizer application,

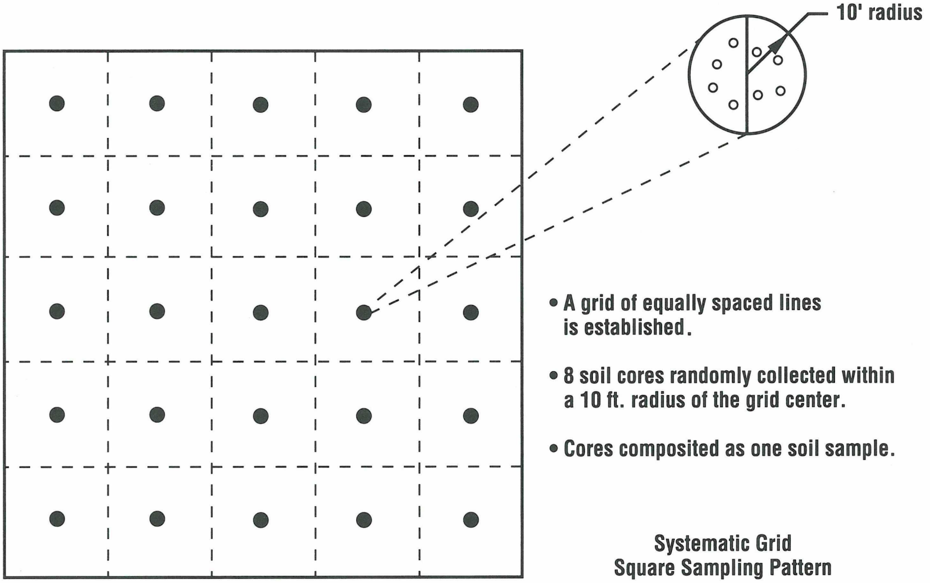

Figure 1. Schematic showing the layout of a square grid and locations where soil cores would be collected.

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Systematic Grid - Diamond Sampling Pattern

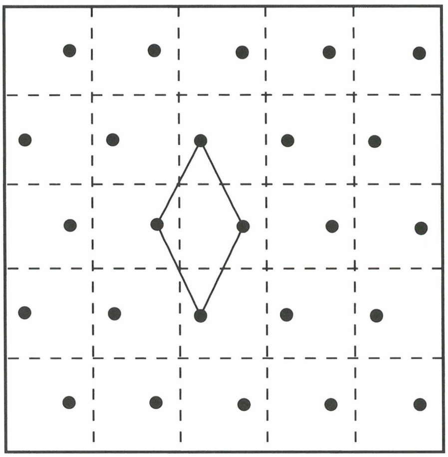

Figure 2. Modification of a square grid where alternating rows of sample points are shifted one half the distance from the cell center and edge.

Systematic Unaligned Grid

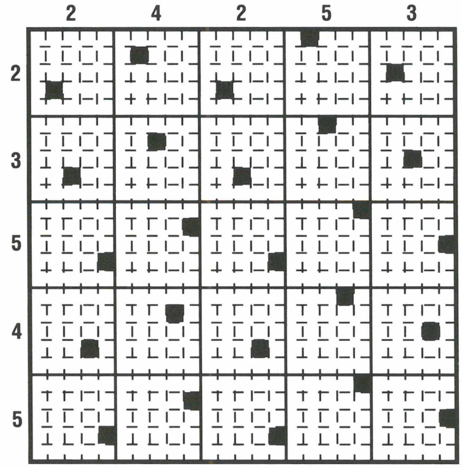

Figure 3. Schematic showing the layout of a systematic unaligned grid. The x,y coordinates were determined from a random number table.

drainage, old field boundaries and cropping patterns tend to occur in regular patterns across fields. If the grid sampling pattern is a multiple or fraction of other patterns, the soil samples may not correctly represent the soil test variability within the field.

The potential for bias can be minimized by shifting the sampling locations to the right or left of the cell center in alternating rows perpendicular to the management pattern (e.g. row direction). The resulting sampling grid takes on the appearance of a diamond pattern (**Figure 2**). This sampling pattern can also be implemented by counting rows and measuring distances.

With the development of the Global Positioning System (GPS), we can now navigate to locations in a field without counting rows or physically measuring distance. As farm level GPS hardware and software become available, we recommend adopting a **systematic unaligned** sampling protocol. This method combines the best of systematic sampling and random sampling.

Systematic unaligned sampling locations as illustrated in **Figure 3** can be determined for a field by the following procedure (adapted from R. Webster and M. A. Oliver, "Statistical Methods in Soil and Land Resource Survey, Oxford University Press", 1990, pp 46-47).

- Divide the field into cells by means of a coarse grid. Square cells are the norm but not mandatory.
- Superimpose a finer grid (reference grid) in each coarse cell. For example, if there are 5 rows and 5 columns in the coarse grid, you might choose to divide each coarse cell into 25 smaller cells.
- Choose a corner of the coarse grid, say top left, and randomly select a reference cell–in this example, one of the 25 reference cells.
- Move horizontally to the next coarse cell in the top row and keep the X coordinate the same but randomly select a new Y coordinate.
- Repeat the process for all the coarse cells in the top row.
- Return to the upper left corner and repeat the process down the first column

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tant, and soil testing laboratory. Note the fertilizer application charge is annual and represents the additional charge for variable rate application versus use of a single rate applicator.

Costs associated with variable rate P and K applications increase rapidly at grid spacings smaller than 200 feet **(Figure 1)**. The costs are easier to accept if they are amortized over a period of four years or longer. We speculate that intense (expensive) grid sampling is required only once if soil test information, fertilizer applications, and crop removals (yield) are georeferenced so that a nutrient balance budget can be maintained. Additional soil sampling at a later date may be needed in fields with contrasting soil types (textures) where the general fertilizer response function may not apply equally well to all soil types or to spot check for changes in soil test levels.

One cost not shown is mis-application of fertilizer based on random soil sampling which can lead to an incorrect map of soil test variability. We have observed yield and income losses when soils were classified as not needing additional fertilizer when in fact they were nutrient deficient. Any assessment of the profitability of variable rate fertilizer application must also include an evaluation of the effects of soil test map accuracy. ■

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of cells, this time keeping the Y coordinate the same, but changing the X coordinate in each successively lower coarse cell.

- The remaining positions are determined by the X coordinate of the point in the left-hand square of its row and the Y coordinate of the point in the uppermost square of its column.

With this procedure a constant interval both along the rows and down the columns is maintained without alignment. A more complete discussion on sampling and estimation can be found in the reference by R. Webster and M. A. Oliver cited on page 7. ■

Note: Soil sampling for variable rate application is different from soil sampling to determine the field average for a single rate application. Many Extension soil sampling guidelines for field-average recommendations call for dividing fields into smaller areas (five acres according to UW recommendations), but it is recommended that the soil cores within small areas be collected while walking a zigzag pattern across each area. The intent is to obtain a representative soil sample which averages out soil test variability within each small field area. An average or median value is calculated from the multiple soil test results to arrive at a single rate fertilizer application for the field.