THE SECOND TIME AROUND: RE-SAMPLING PREVIOUSLY GRID-SAMPLED FIELDS [1/]

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Grid soil sampling gained popularity in the mid-1990's as a practice designed to identify the variability of soil test levels within fields. The use of differentially corrected GPS allows users to navigate to, and log known soil sampling positions with a repeatable accuracy of 3-10 ft. Most would use a grid-point sampling technique which involves taking six to eight cores from an area having a ten ft. radius on a sampling density typically ranging between one (~200 ft.) and 2.5 acres (~300 ft.). Variable-rate fertilization maps can then created by interpolation methods from the known soil test values at the individual sample point. Grid-point sampling is a relatively expensive practice compared to conventional sampling for single-rate application because of the time required to take the samples, the additional cost of analysis, and the expense associated with the necessary specialized equipment (laptop computer, DGPS, software, etc.). However, grid-point sampling will provide a detailed layer of information on soil test variability which some growers used to improve their management of P and K fertilizer, lime, and other nutrients.

Grid soil sampling reveals considerable information concerning the soil fertility needs of fields. Many have been shown to have non-limiting soil test levels which reduce the need for additional fertilization. Other show large variability which was likely linked to previous nutrient application patterns from manure. This knowledge could be exploited to improve both the economic and environmental management of plant nutrients. Many producers had fields grid sampled but did not choose to make variable-rate applications, while others religiously made the prescribed variable-rate treatments.

It is now time to re-sample many of the grid sampled fields. Is there a need to re-sample every point if it is known what was applied (in fertilizers) and what was removed (in harvested crops), or is it possible to re-sample a few points to readjust variable-rate treatments? This paper will present a brief evaluation of a re-sampling exercise performed in several southern Wisconsin fields in 1999.

Procedure

Several production fields were selected in cooperation with Madison area fertilizer dealerships. They provided the original sampling maps, soil test data, and helped obtain grower permission to access the fields and use the data. Sample points were relocated with the original sampling map and were re-sampled in the spring of 1999 using the grid-point sampling technique described above. Some of the fields had been sampled on a one acre grid, however most had been sampled on a 2.5 acre grid. Fields evaluated were originally sampled in either 1995 or 1996.

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Many of the fields had been fall chisel plowed which experienced soil samplers would recognize is an impediment to sampling because of difficulty in obtaining samples of a uniform depth and the strains exerted on man and machine. This slowed the sampling process considerably. Regardless every effort was made to collect uniform, representative samples.

Samples were analyzed by the UW Soil and Plant Analysis Laboratory for pH, P, K, and organic matter according to their routine procedures. Descriptive statistics (mean, standard deviation, and range) were obtained for both the original soil test and 1999 data sets. Data from selected fields were plotted using MS-Excel and were interpolated to create "before and after" maps using ARCVIEW.

Results and Discussion

One observation that became apparent in the re-sampling of many of the fields was that management practices within a field are subject to change according to the will and needs of the grower. Sampling maps created in 1995 or 1996 showed fields, presumably of uniform management, within a defined field boundary. When re-sampled in 1999 a number of factors were encountered that made it apparent that a consistent fertilization plan, including variable-rate application, would not have occurred in a significant number of fields. A list of these are given an Table 1 demonstrating many of the challenges associated with site-specific management in Wisconsin.

Table 1. Listing of factors encountered in 1999 that could affect soil test variability in selected southern Wisconsin fields that had been grid soil sampled in 1995 and 1996.

- Multiple crops grown within original field.
- Corn harvested for silage or stalks collected on a portion of the field.
- Manure or other nutrient rich materials applied to areas of the field.
- Tillage differences (often related to previous crops within the field).
- House built within field with driveway bisecting field.
- Variable-rate management not consistently practiced each year.
- Producer changed suppliers (and recommendations) of fertilizer materials.

These factors, unless they are specifically known in rate and location, may render the comparison of soil test levels between sampling moot. There are obviously going to be differences between what a soil test recommends for a field, or portions of afield, and what the grower elects to apply and what is actually applied. This is a reality of nutrient management given the constraints of weather, time, and the human will.

Table 2 presents the descriptive statistics for eight fields that were sampled in either 1995 or 1996 and re-sampled at the same location in 1999. Six of the eight fields were sampled on a 2.5 acre grid and the remaining two fields were sampled on a one acre grid. All of the fields have silt loam surface textures and are either classified as subsoil group A or B.

Table 2. Descriptive statistics for selected southern Wisconsin fields comparing sampling in 1995 or 1996 and re-sampling in 1999.

Field ID	Sam. Year	No.	Mean pH	Mean P	Mean K	Range pH	Range P	Range K	Std. Dev. pH	Std. Dev. P	Std. Dev. K
				--- ppm ---			---- ppm --------			--- ppm ---	
F 20-1	1996	18	6.2	61	159	5.8-6.8	28-85	37-420	0.3	15	82
	1999	18	5.7	62	162	5.0-6.5	20-93	70-220	0.4	19	44
F20-2	1996	26	6.0	57	136	5.5-6.7	28-90	89-300	0.3	20	45
	1999	26	5.4	61	156	4.8-6.4	32-110	115-375	0.4	22	51
R1531	1995	30	5.3	89	194	4.8-6.1	36-190	111-288	0.3	40	41
	1999	30	5.6	64	167	5.1-6.3	16-200	95-310	0.4	38	41
K6801-1A	1995	24	6.0	36	204	5.0-6.8	20-60	136-358	0.5	12	56
	1999	24	6.4	35	199	5.7-6.9	14-65	135-310	0.7	14	46
K1171-1B	1995	38	6.5	52	156	5.9-7.0	5-170	107-368	0.2	43	60
	1999	38	6.2	57	229	5.6-7.1	10-200	135-510	0.6	48	87

G4	1996	54	6.6	36	112	5.4-7.9	6-101	64-201	0.6	26	33
	1999	54	6.5	51	114	5.8-7.6	19-110	85-175	0.5	22	24

Fields G2 and G4 sampled on a one-acre grid. All other fields sampled on a 2.5 acre grid.

Fertilizer applications are not given in this paper for several reasons. First, the only record that one dealership could make available was a copy of the invoice that only stated the total pounds of material applied to the field, even if a variable-rate application was made. Second, several of the cooperating producers used different suppliers and therefore records are incomplete. Finally, even where a variable-rate application map was available there was a concern that the “as-applied” condition would be different because of unintentional overlap or gaps as the spreader navigated the field.

Table 2 shows that soil test levels did not change dramatically in the eight fields following the three to four cropping seasons between samplings. Several fields do show a decrease in average soil pH to a point below that recommended for a corn/soybean rotation. Although this effect may be an artifact of sampling technique it is apparent that increased attention should be made toward liming. While all of the fields average high or excessively high in soil test P, six of the eight fields still have low or optimum soil test P levels. This could represent an important consideration for P index measurements.

Only fields G2 and G4 were known to consistently receive P and K fertilizer and lime by variable-rate application. One effect of variable-rate application would be the gradual “smoothing out” of soil test levels. In fact, some people originally thought that variable-rate application would in itself result in the demise of the practice because field variability would be minimized. The data for the G fields show a decrease in the standard deviation for all soil test measurements (Table 2). The ranges, however, have not changed substantially showing that one cycle of variable-rate management have not resolved variability.

Another way to evaluate the response to variable-rate management would be to simply plot soil test levels at each point for the various soil test parameter. These are shown for the G2 and G4 fields in Figures 1 and 2 respectively. Ideally, variable-rate management would increase the low testing areas (valleys) and decrease the high testing areas (peaks). Peak points would not be expected change as quickly as fertilized valley points because any decrease would be the result of crop removal and would be buffered by the soil. These figures show that there is reasonable repeatability in soil test measurements at the peaks where no material was applied. Simple correlations between 1996 and 1999 measurements are significant (data not shown) indicating that re-sampling at known points can give an accurate reassessment of soil fertility management. Further examination of Figures 1 and 2 show that in fact where materials were applied to the lower testing areas of the field soil test levels were increased.

The data for these fields was interpolated and mapped to show the effect of variable-rate treatment on the spatial distribution of soil pH and P and K. Maps are shown in Figures 3 and 4. The same soil test categories were used for each map and approximate the P and K interpretive ranges for corn grown on a subsoil group A soil. These maps clearly show a decrease in soil test variability because the 1999 maps have fewer categories and appear less complicated than those developed for 1996.

Summary and Recommendations

Grid soil sampling arguably provides the best approach to identifying responsive and non-responsive soil test areas within a field. An understanding of soil test variability may help explain crop yield difference and provide opportunities to reduce environmental risks from over-fertilization. The degree to which this information is used to manage fertilizer inputs understandably varies between growers. The fact that a field was once grid sampled does not guarantee that variable-rate applications were made or that the entire field received a uniform application of fertilizer.

Considerations for re-sampling previously grid sampled fields should be based on the expected soil test levels in the field and whether or not variable-rate applications are planned. Once a field is grid sampled it would appear to be reasonable to continue point sampling rather than revert to cell sampling. Speaking practically that is unlikely that fields that will receive single-rate fertilizer or lime treatment will continue to be grid sampled. These should be sampled on a five acre cell basis, with recommendations that accounts high testing P and K anomalies within the field.

While it is always better to re-sample the entire field, some savings in sampling cost could be realized in specific situations. The following logic is suggested to guide growers and consultants when making decisions on re-sampling previously grid sampled fields where it is likely that treatments will be made with state-of-the-art variable-rate applicators. At a minimum completely re-sample all variably managed fields every other sampling rotation. This recommendation applies to fields on medium- and fine-textured soils only. Organic and sandy soils that are grid sampled should be completely re-sampled at each sampling interval because of the faster change in soil test due to low buffering capacity on those soils.

<u>Situation 1.</u> Initial grid sampling showed <25 % of soil test P and K are “High” or less, or pH at or below rec. level.

- ❖ Re-sample equal number of low and high testing points to approximate 10 acres/sample. It is questionable whether variable-rate application is cost effective in this situation. Consider a modest rate of row-placed fertilizer over the entire field.

<u>Situation 2.</u> Initial grid sampling showed 25-75 % of soil test P or K are “High” or less, or pH at or below rec. level.

- ❖ Re-sample all points that are “high” or less for P and K, or are less than the recommended soil pH for the most sensitive crop in the rotation. Create management maps based upon the new soil test values. Use the existing “Excessively High” values in the interpolation to create management maps.

<u>Situation 3.</u> Initial grid sampling showed >75 % of soil test P or K are “High” or less, pH at or below recommended level.

- Completely re-sample field.