The Agriculture Program
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Management Zone Soil Sampling on the Texas High Plains

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Summary

Soil sampling strategy is an important management tool that has economic and environmental consequences. Sound soil sampling practices help assure realistic and economically profitable fertilizer applications.

Excessive fertilization is unprofitable. It can reduce crop yields, and can lead to contamination of ground- and surface waters.

Our research has shown that soil sampling for nitrate-nitrogen by zones (defined by topography or soil type) to a depth of 24 inches is superior to the typical method of sampling zero to six inches deep at random across a field. Zone sampling can help producers reduce fertilizer costs while maintaining yield potential. Zone sampling also protects ground- and surface water quality by minimizing topsoil phosphorus buildup, and by minimizing subsoil nitrate buildup and leaching.

Details

Some producers often neglect soil sampling, and scientists have not re-evaluated traditional sampling strategies for many years. Improper sampling can result in incorrect fertilizer applications, loss of production/profits, and nitrate contamination of groundwater.

Applying animal waste to croplands is another important nutrient issue. Excessive manuring without proper soil sampling can result in nitrogen and phosphorus imbalances and contamination of surface waters. Nutrient contamination of ground- and surface waters is a pressing environmental concern.

Finally, variable-rate fertilizer equipment guided by global positioning systems (GPS) is readily available, but there is a need for economical soil sampling procedures to implement this technology. Researchers typically collect soil samples using a half-acre to 2.5-acre grid, while commercial fertilizer applicators commonly rely on the 2.5-acre grid to produce soil test maps for specific nutrients.

Some commercial applicators on the Texas High Plains are now using variable-rate fertilizer application technology. However, grid soil sampling using half-acre to 2.5-acre grids typically is not practical or profitable for producers. Pulling soil samples from larger "management zones," a common practice in this country and overseas, may be more feasible for producers.

Our approach in the soil fertility group at the Texas Agricultural Experiment Station at Lubbock, Texas, is to take half-acre grid soil samples for research purposes during the first several years of our precision agriculture pro

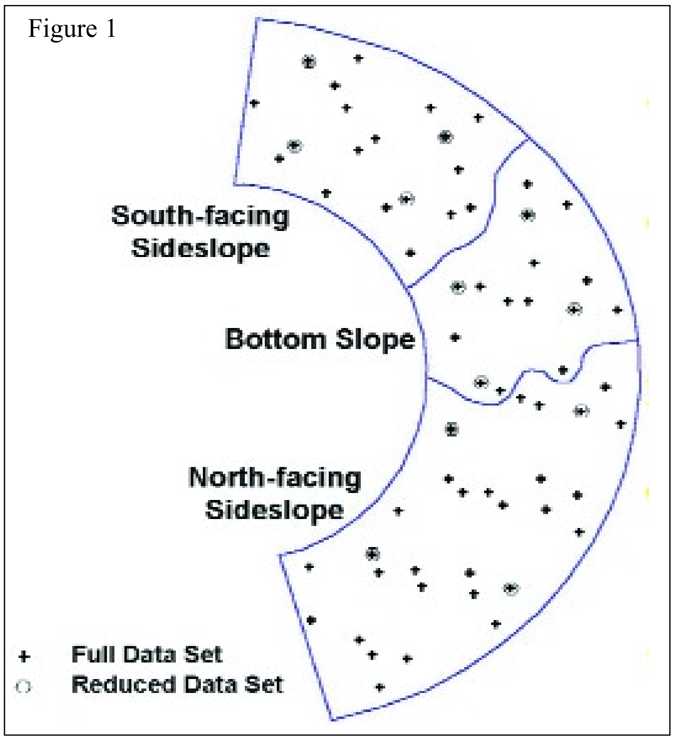
J.D. Booker pulls soil samples in a cotton field.

gram. We hypothesize that smaller-grid intensive sampling will serve as a basis for management zone sampling.

Figures 1 and 2 show two 27-acre fields where we conducted our precision agriculture research. The approximately 60 points marked **Full Data Set** represent half-acre grid points where we took soil samples (two cores per point) at depths of zero to six inches, six to 12 inches, and 12 to 24 inches. Soils were analyzed for routine nutrients such as nitrate, phosphorus, potassium, calcium and pH.

Management zones are delineated by blue lines at each site. Three landscape positions outline management zones at Lamesa (Figure 1), while two soil types outline management zones at Ropesville (Figure 2). These management zones are based on historical yield trends.

Figure 1



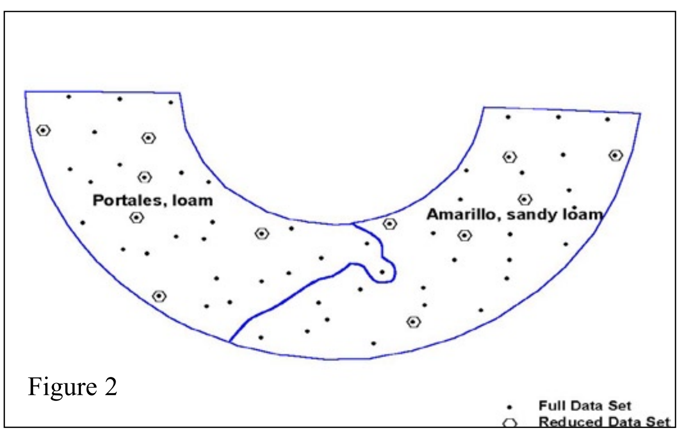


Figure 2

At Lamesa, for example, the greatest yields in most years generally occur in the bottomslope, and the lowest yields generally occur in the south-facing sideslope. Redistribution of water is the main reason for higher yields in the bottomslope. At Ropesville, historically lower yields occur in the Portales soil, compared to the Amarillo soil.

To see if a modest number of soil samples taken from each management zone would adequately represent the zone, we chose four original points from the full data setfrom each zone at Lamesa, and six points per zone from the full data set at Ropesville. Tables 1 and 2 indicate the averages of the soil properties for each zone are similar with either sampling method.

In terms of 2000 yield data, differences between zones at Lamesa were consistent with historical trends (Table 1). On the other hand, Ropesville yields were similar between the two zones/soil types (Table 2). However, we observed a phosphorus fertilizer response in the Amarillo soil at Ropesville, but not in the Portales soil.

Our data consistently showed low nitrate in spring in the top six inches of soil. This is due to plant uptake during the previous growing season, and off-season precipitation leaching nitrate out of the surface layer first.

Table 1. Selected soil properties for "management zones" at 27-acre site in Lamesa, TX

	North-facing sideslope		Bottomslope		South-facing sideslope	
	Full sampling	Reduced sampling	Full sampling	Reduced sampling	Full sam-	Reduced sampling
Calcium[1]	758	715	708	697	755	783
	16.7	13.0	16.2	20.0	18.0	17.7
Nitrate-N[2]	16.9	17.5	15.8	13.8	8.6	7.4
EC[3]	22.0	--	20.6	--	26.3	--
Lint yield[4]	636		699		552	

[1]ppm, 0- 6 in. sample
[2] lb/acre, 0-24 in. sample
[3]mS/m, 0-3 ft.
[4]lb/ac, 0.002 ac hand-pulled samples on 0.5-ac grid

Table 2. Selected soil properties for "management zones" at 27-acre site in Ropesville, TX

	Portales loam		Amarillo sandy loam	
	Full sampling	Reduced sampling	Full sampling	Reduced sampling
Calcium[1]	4531	4586	1823	1752
Phosphorus[1]	20.0	20.2	17.0	19.0
Nitrate-N[2]	14.2	14.8	13.0	13.2
EC[3]	21.0	--	27.1	--
Lint yield[4]	611		613	

[1]ppm, 0- 6 in. sample
[2] lb/acre, 0-24 in. sample
[3]mS/m, 0-3 ft.
[4]lb/ac, 0.002 ac hand-pulled samples on 0.5-ac grid
Fig. 3. Electrical conductivity in 0-3 foot soil at Lamesa, TX

In the spring of every site-year we sampled, nitrate was greatest in the 12- to 24-inch soil layer. This subsoil layer in the Texas High Plains is usually sandy clay loam, clay loam or clay. The clay layer restricts water and nitrate leaching below 24 inches, and the exhange capacity of the clay holds the nitrate ion.

Basing nitrogen fertilization on a nitrate soil test from the top six inches of soil will usually result in over-fertilization, because subsoil nitrate is essentially ignored. For a two-bale cotton yield goal, we recommend subtracting subsoil nitrate-nitrogen readings (pounds per acre) from 120 pounds of N per acre if we are to achieve an accurate nitrogen fertilizer recommendation. One drawback of deep soil sampling is producers may not have the soil augers required to reach subsoils.

Another technology becoming more available in Texas is soil electrical conductivity, or EC. Veris Technologies (Salina, Kansas) produces lightweight carts pulled by a pickup or all terrain vehicle. The carts take real-time EC measurements at GPS-referenced points.

Soil EC values for our study sites are shown in Figures 3 and 4. At Lamesa, the lower-yielding, south-facing sideslope is delineated by lower EC readings (Figure 3 and Table 1). At the Ropesville site, the two soil types are clearly delineated by low and high EC readings (Figure 4 and Table 2).

Soil EC technology is relatively inexpensive and rapidly generates data that need be acquired only once.

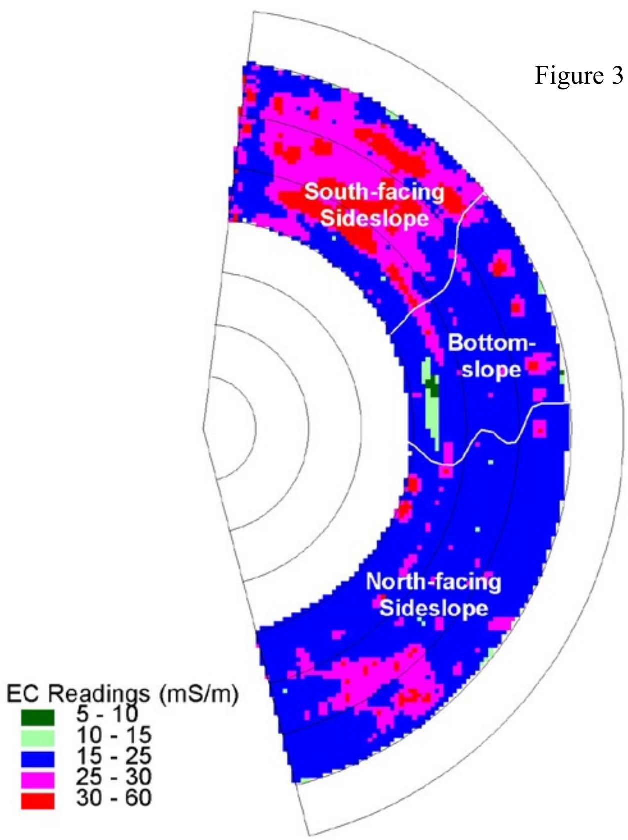


Figure 3

Soil moisture levels and sampling dates affect the overall EC readings, but not the spatial patterns within the field. These spatial patterns are related to bulk density, clay content, and depth to root-restricting layers.

Soil EC technology provides another valuable layer of dense, GPS-referenced data that can assist growers in identifying meaningful management zones in their fields.

In summary, prior knowledge of soil types and landscape positions (topography) can help a producer define management zones in a field or fields. Yields may not differ between zones every year, but this does not lessen the advantages of managing by zone.

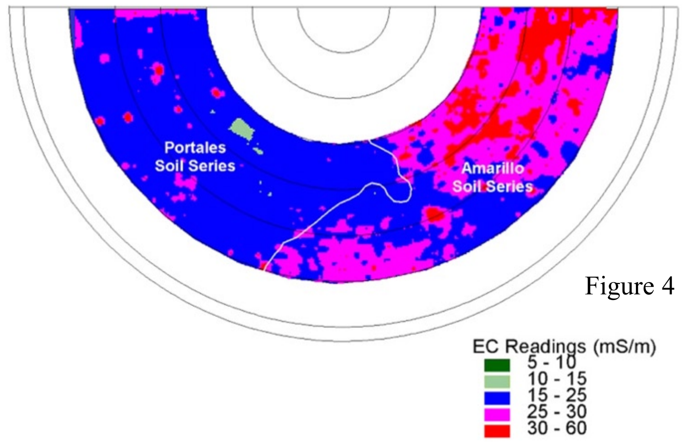


Figure 4

A farmer utilizing zone management could pull and composite four to six soil samples from each management zone, and send a soil sample from each zone to a state or private soil testing laboratory for analysis. If this grower was farming our research sites, he/she could pull and submit three composite samples from Lamesa and two from Ropesville, compared to ten samples from each of these 27-acre sites if he used a 2.5-acre grid for soil sampling.

Besides providing a simpler means of targeted soil sampling, the management zone strategy allows producers to apply different rates of fertilizer to a small number of zones. Adjusting fertilizer application rates to match zone soil test recommendations could help producers reduce overall fertilizer costs without affecting yield potential.

Management zone and deep soil sampling are easy to understand and implement. Site-specific management is especially beneficial in identifying nutrient hot spots (e.g. areas where animal wastes were applied).

These strategies will also help mitigate excessive nitrate buildup in the subsoils of the Texas High Plains, and minimize leaching to groundwater. Site-specific soil sampling and fertilization can also help producers avoid excessive phosphorus applcations, and minimize movement of phosphorus in runoff to surface waters.

An Amarillo soil series, such as the one seen above at our Ropesville research site, is quite common on the Texas High Plains. Note the distinct color of this soil.

A Portales soil series, such as the one shown at left at our Ropesville site, also has a distinct color. Calcium carbonate nodules (caliche) are visible throughout this soil. This soil type contributed to depressed growth of cotton plants in our study. About 15 percent of all soils on the Texas High Plains are calcareous.

Notes:**

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