SOIL SAMPLING, TESTING AND TEST INTERPRETATION for Fertilizer Recommendations

HIGHLIGHTS

1 Test the soil from each field regularly for every complete crop rotation or every two to three years before making any fertilization decisions.

2 Collect soil samples from 0 to 6 inches in depth and choose a lab that uses Mehlich-3 extractant.

3 Obtain fertilizer recommendations based on the soil test for specific crops from the respective state soil testing lab, as these recommendations vary by crop and state.

4 Soil test nutrient concentration is reliable only for recommendations on phosphorus (P), potassium (K), sulfur (S) and zinc (Zn). Micronutrient recommendations mostly depend on soil pH and type of crop.

5 Soil test recommendations in Louisiana follow the sufficiency philosophy, which means fertilizing the crop for one year based on its immediate nutrient needs.

IMPORTANCE OF SOIL SAMPLING AND TESTING

1. **Accurate nutrient management:** Soil sampling and testing provides precise information about the nutrient status of the soil, enabling tailored fertilization that meets crop needs without over- or underapplication.

2. **Cost efficiency:** By determining the exact nutrient requirements, farmers can avoid unnecessary fertilizer expenses, optimizing input costs and maximizing returns on investment.

3. **Environmental protection:** Proper soil sampling helps prevent overfertilization, which can lead to nutrient runoff and environmental pollution. This ensures sustainable farming practices and protects water quality.

4. **Improved crop yields:** Knowing the specific nutrient deficiencies and soil pH allows for precise amendments, promoting healthier plants and higher yields.

5. **Soil health monitoring:** Regular soil sampling tracks changes in soil health over time, helping to maintain soil fertility and structure. This ensures long-term productivity and resilience against pests and diseases.

6. **Informed decision-making:** Detailed soil analysis provides data-driven insights, allowing producers to make informed decisions about crop rotation, fertilization schedules and soil management practices.

7. **Customized fertilizer recommendations:** Soil tests can provide recommendations tailored to specific crops and local conditions, enhancing the effectiveness of fertilization programs.

8. **Compliance with regulations:** In some regions, soil sampling and nutrient management plans are required by agricultural regulations to reduce environmental impact and promote sustainable practices.

9. **Optimization of lime application:** Soil sampling determines soil pH and lime requirements, ensuring the correct amount of lime is applied to adjust pH levels. This is crucial for nutrient availability and overall soil health.

10. **Enhanced soil structure and function:** Regular monitoring and appropriate amendments based on soil tests can improve soil structure, water retention and microbial activity, contributing to better crop growth conditions.

SOIL SAMPLING PROCEDURE

Figure 1. Soil sampling probe (AMS probe), position (on the top of the bed but 4 to 6 inches apart from the crop row), and depth (0 to 6 inches). Photo by Iftekhar Alam

1. **Frequency of testing:** Test soil at least once every two to three years or once per complete crop rotation.

2. **Timing and depth:** Take soil samples at the same time each year, maintaining a consistent depth of 0 to 6 inches using a soil probe or auger (see Figure 1).

3. **Sampling density**
   - **Zone sampling:** Take one composite sample for every 10 acres.
   - **Grid sampling**: Take one composite sample for every 2.5 acres. A smaller grid is better than a large grid. For new fields without prior soil testing information, it is advisable to start with a smaller grid (1 acre). If soil test results show minimal variation over a few years, you can gradually transition to a larger grid or zone sampling approach.
   - The number of samples should reflect the field's spatial variability. More samples are needed for fields with high variability. Consider soil type and color, topography, past management and yield maps when determining zone and grid sizes.

4. **Subsample collection**
   - Each composite sample should include 12 to 15 subsamples (one to two per acre for zone sampling and five to six per acre for grid sampling).
   - More subsamples are required for fields with past fertilizer banding or manure spreading.
   - Collect subsamples in a zigzag pattern within each zone or grid.

5. **Preparation for sampling:**
   - Remove vegetation from the soil surface before inserting the soil probe or auger.
   - In furrow irrigation systems, sample from the top of the bed, 4 to 6 inches away from the crop row.
   - Avoid sampling from fertilizer bands, manure or lime stockpiles, wet spots, fence rows and areas too small to manage separately.
   - Thoroughly mix all subsamples in a clean plastic bucket, removing stones, roots, stems, trash and other debris.

6. **Sample handling**
   - Place each composite sample in a clean plastic or paper bag.
   - Clearly label the bag with the farm name and location, sampling date and depth, previous crop and the expected crop to be grown.
   - Send the samples immediately to a soil testing lab for routine analysis.

SOIL TESTING

1. **Certified lab testing:** Test soil samples in a certified soil lab, such as the LSU AgCenter Soil Testing and Plant Analysis Lab in Baton Rouge. Ensure the lab uses the same soil extraction methods that were used to develop fertilizer recommendations for that state. In Louisiana, fertilizer recommendations are based on the Mehlich-3 soil extraction method for samples collected from a 0- to 6-inch depth.

2. **Consistency in analysis:** Analyze soil samples in the same lab each year to maintain a consistent historic record.

INTERPRETATION OF SOIL TEST RESULTS AND FERTILIZER RECOMMENDATIONS

Upon receiving the soil test report, the first aspect to check is the soil pH. Soil pH is a crucial component of soil quality as it significantly affects nutrient availability. Most nutrients are highly available at a soil pH of 6.5 (see Figure 2). Therefore, soil pH should be adjusted to the target level: apply lime for soils with low pH (less than 6.0) or elemental sulfur for soils with high pH (more than 7.5). Increasing soil pH through liming is more common than decreasing it with elemental sulfur. Before deciding on fertilizer rates, consider the following points.

1. **Understand the soil test results:** Soil test results should be interpreted based on recommendations derived from correlation and calibration research conducted across multiple site years. As soil-test-based fertilizer recommendations vary by crop and state, results for a specific crop in a particular state should be analyzed with crop-specific recommendations developed by that state (see Figure 3). Typically, soil scientists from each land-grant university develop their own recommendations for each crop. Hence, it is advisable to analyze soil samples at the state soil testing lab and obtain fertilizer recommendations from there. Note that recommendations from labs in different states (public or private) may not be accurate and could often suggest higher fertilizer application rates than necessary.

2. **Reliability of soil testing:** Soil testing is primarily reliable for phosphorus, potassium, sulfur and zinc. Recommendations for other nutrients from any soil testing labs may not be accurate. Fertilizer recommendations for most micronutrients (boron, iron, manganese and molybdenum) mainly depend on soil pH and type of crop grown. Generally, micronutrients, except molybdenum, are recommended for fields with pH higher than 7.0 to 7.5, while molybdenum is specifically recommended for soybean production in fields with pH lower than 6.0 and no lime applied in the previous fall.

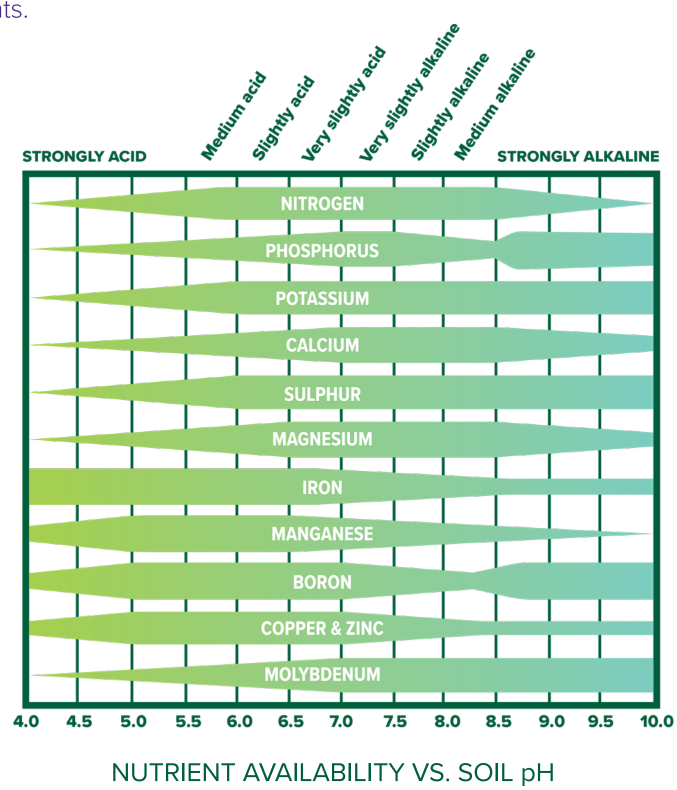

Figure 2. Soil pH and nutrient availability. Source: Reitsma et al. (2011). Chapter 2: Soil fertility. In: Alternative practices for agronomic nutrient and pest management in South Dakota. Edition: I. South Dakota State University, College of Agriculture and Biological Sciences

3. **Assess nutrient levels relative to crop needs:** Compare the nutrient levels indicated in the soil test report to the recommended optimal ranges (critical concentration is defined as the soil test nutrient concentration below which crop response to added fertilizer is expected and above which is unlikely) for the specific crops you plan to grow. Determine whether any nutrients are deficient, sufficient or in excess based on critical concentrations. For example, the critical nutrient concentrations for corn, soybean, cotton and grain sorghum in Louisiana usually range from 25 to 35 ppm (50 to 75 pounds/acre) for P, 100 to 130 ppm (200 to 260 pounds/acre) for K, 10 to 15 ppm (20 to 30 pounds/acre)

for S, and 1.5 to 2.5 ppm (3 to 5 pounds/acre) for Zn. Although the micronutrients such as boron (B), manganese (Mn), copper (Cu) and iron (Fe) recommendations depend on soil pH, the critical concentrations for these nutrients are 0.5 ppm (1 pound/acre) for B and Cu, 25 (50 pounds/acre) ppm for Mn, and 50 ppm (100 pounds/acre) for Fe.

4. **Prioritize nutrient needs:** Identify which nutrients are most critical for your crops based on their growth stage and specific requirements. For example, P is essential for early root development, while K is crucial for overall plant health and stress tolerance. Additionally, corn, soybean, cotton and grain sorghum are somewhat more responsive to K than P.

5. **Fertilizer response probability:** This refers to the likelihood that applying fertilizer will result in a measurable and beneficial increase in crop yield or quality. This concept helps producers and agronomists decide whether the cost and effort of applying fertilizer will be justified by the resulting improvement in crop performance. Generally, crop response to fertilization varies based on soil nutrient levels:

   a. **Very low P or K testing soils:** almost certain response (~100%)

   b. **Low testing soils:** highly likely response (~80%)

   c. **Medium (optimum or within critical concentration range) testing soils:** less likely response (10-50%)

   d. **High (above optimum) testing soils:** highly unlikely response (~0%)

   e. **Very high testing soils:** sometimes negative, especially under drought conditions.

   Several factors can impact fertilizer response probability, including the history of fertilizer application, crop rotation, fertilizer incorporation, irrigation, rainfall, favorable growing temperatures, soil pH, soil texture and organic matter content, fertilizer application timing and method, and crop type. Fields that have been well-managed and have adequate nutrient levels might show a lower response probability.

6. **Fertilization philosophy:** There are three main fertilization philosophies — sufficiency, buildup and maintenance, and cation saturation ratio.

   a. **Sufficiency approach:**

      - **Principle:** Fertilization is recommended only if the soil test nutrient level is at or below the critical level, with the fertilizer rate determined based on the expected crop yield increase.

      - **Usage:** This approach, commonly referred to as "fertilize the crop," is the most widely used philosophy in the United States and is endorsed by most land-grant universities, including LSU AgCenter.

   b. **Buildup and maintenance approach:**

      - **Principle:** Fertilization is almost always recommended unless the soil test level is very high. This philosophy involves two parts:

        - **Buildup:** For soils with nutrient concentrations below the critical level, the fertilizer rate is determined based on the sufficiency rate plus an additional amount to raise the soil test nutrient concentration above the critical level.

        - **Maintenance:** For soils with nutrient concentrations above the critical level, the fertilizer rate is determined based on the expected nutrient removal rate by the crop to maintain the soil test nutrient concentration at the same level.

      - **Usage:** Known as "fertilize the soil," care must be taken when applying this approach for potassium fertilization in coarse-textured soils with low cation exchange capacity (CEC less than 10), such as loamy sand to silt loam soils. Potassium is highly prone to leaching in these soils with excessive rainfall, making it potentially infeasible and uneconomical to build up soil test K levels in such conditions.

   c. **Cation saturation ratio:**

      - **Principle:** Fertilizer recommendations are based on maintaining specific ratios of cations, mainly calcium (Ca), magnesium (Mg) and potassium, on the cation exchange sites.

      - **Usage:** This approach is considered less accurate and economical compared to the other philosophies. Fertilizers are almost always recommended to meet certain nutrient ratios even though soil test values for those nutrients are very high.

Each philosophy has its own merits and limitations, and the choice of approach can depend on specific soil conditions, crop requirements and economic considerations. However, given the rising cost of fertilizers and the high demand for crop yields, it is generally recommended to adopt a sufficiency philosophy for most soils.

7. **Monitor and adjust over time:** Soil fertility is dynamic and can change over time. Monitor soil nutrient levels regularly through periodic soil testing and adjust fertilizer applications accordingly to maintain optimal soil fertility and crop productivity. Note that soil testing is the best method of determining actual fertilizer need except nitrogen (N) and the fertilizer recommendations that are provided by state lab is only for the current year/crop.

In summary, soil sampling and testing are essential tools in agronomic crop production, supporting efficient nutrient management, cost savings, environmental sustainability and improved crop performance. By following the outlined steps, producers can effectively interpret a soil test report and make informed decisions regarding fertilizer recommendations to optimize crop yields and promote sustainable agricultural practices. For detailed soil-test-based fertilizer recommendations for each crop, please visit the LSU AgCenter website.

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Soil Testing and Plant Analysis Laboratory
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Website: www.lsuagcenter.com/stpal

Date Received: 07/27/2021
Lab Number: 11211116014
Sample ID: DL SB3 Soy NXS
Soild Texture: silty clay
Area: Upland
Irrigated: No

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Soil Test Results

Element (Mehlich3)	Value	Soybeans
pH (1:1 Water)	7.88	High
Phosphorus, ppm	30.15	Medium
Potassium, ppm	224.40	Very High
Calcium, ppm	4,118.18	Very High
Magnesium, ppm	458.81	Very High
Sodium, ppm	25.75	Optimun
Sulfur, ppm	11.23	Low
Copper, ppm	3.75	High
Zinc, ppm	2.62	High

RECOMMENDATIONS

Crops	Form	*Units*: lb/Acre	Nitrogen	Phosphate	Potash
soybeans			0	30	0

For fertilizer timing and methods of application please see: (http://www.stpal.lsu.edu/recsheets/C-170.rtf)

If there are any questions about this report, please contact your local extension service office at (Telephone 318/435-7551)
The extension office also receive a copy of this report.

Figure 3. Soil test report developed by Soil Testing and Plant Analysis Laboratory, Louisiana State University AgCenter. Photo by Md. Rasel Parvej

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