OKLAHOMA COOPERATIVE EXTENSION SERVICE

# Procedures Used by OSU Soil, Water, and Forage Analytical Laboratory

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The Soil, Water, and Forage Analytical Laboratory (SWFAL), located in the basement of Agriculture Hall at OSU, was established to meet the soil, plant, and water quality testing needs of farmers, ranchers, homeowners, and consultants throughout the state. The laboratory provides fast, accurate analyses and reliable service, so the data obtained from testing can be used as a guide to good soil and crop production management. The tests have been developed to assist producers in areas such as fertilizer requirements, forage quality, water quality, and soil salinity management.

All tests offered have a firm research basis. This research involves many disciplines within OSU, and it is conducted at OSU Agronomy Research Stations and private cooperators' fields throughout the state. These ongoing studies, under diverse management and cropping systems, enable accurate, long-term calibration of each test.

Accurate laboratory results are maintained through the use of laboratory standards, blank samples, internal and external check samples, and technical review of all results. All methods and procedures used in the lab are approved by either national or regional professional organizations. All instruments are calibrated daily and checked with high quality standards. Blank samples are routinely used to check each day's analyses. Internal check samples are used every 20 samples. Blind samples are run with fertility samples. The laboratory is involved in four national and international quality assurance programs. All results are double-checked for data entry accuracy and reviewed for any apparent problems.

SWFAL consists of three subdivisions: 1) soil fertility, 2) water and salinity, and 3) forage. These three subdivisions use shared facilities and instruments. In addition, personnel are cross-trained between divisions. However, sample handling is different for each subdivisions. Abbreviations used in this fact sheet can be found in Table 4.

## Soil Fertility Lab

The soil fertility subdivision analyzes about 25,000 soil samples per year. This testing can identify nutrient status and appropriate fertilizer application rates. Soil samples are received from county Extension offices or fertilizer dealers. The Extension offices also provide information on proper sampling procedures and soil bags for samples. They can also help interpret the results.

When the samples arrive at the laboratory, the information is logged into a computer system with a barcode reader, and the soils are dried at 100°C for 6 to 12 hours. The soils are then ground to pass through a 2mm screen and brought into the lab for chemical analysis. Table 1 shows the brief procedures for each analysis. Soil samples normally take three working days to complete with reports mailed to the sample senders.

## Water and Salinity Lab

The water and salinity subdivision analyzes about 4000 samples a year. The water test identifies the suitability of water for irrigation, livestock drinking water, or rural household use. (SWFAL does not analyze water for bacteria, pesticides, lead, or other heavy metals; therefore, drinking water should be analyzed by a state-certified laboratory that can test these constituents.) The salinity test identifies salt problems in the soil. Samples are usually submitted through the county Extension offices. These offices can supply soil bags for salinity samples and bottles for water samples. They can also provide information on good sampling procedures and help interpret the laboratory results.

When the samples arrive at the laboratory, the information is logged into the computer system. Water samples are taken into the lab, filtered through Fisher P-4 paper filters, and the filtrate is analyzed. Salinity management samples are dried at a 100°C over night and ground to pass through a 2mm screen. A 1:1 soil:water slurry is prepared and allowed to equilibrate for four hours, and the solution is filtered for analysis. The comprehensive salinity samples are not dried, but wetted to a saturated paste, and then filtered for analysis. Table 2 illustrates the procedures to analyze and calculate the parameters offered under water and salinity tests. Water and salinity samples normally take three to five working days to complete with a report mailed to the county Extension office or other sample sender.

**Table 1. Soil Fertility Procedures.**

***Routine Test***

| *Analysis* | *Soil Amount* | *Procedure* |
|---|---|---|
| pH | 15 g | Add 15 ml $H_2O$, Equilibrate 0.5 hour, read on pH meter. |
| BI | | If pH < 6.5, add 30 ml SMP buffer, shake one hour, read on pH meter again. |
| $NO_3$-N | 10 g | Add 25 ml calcium sulfate, shake 0.5 hour, filter, analyze on flow injection analyzer using cadmium reduction chemistry. |
| K | 2 g | Add 20 ml *Mehlich* 3, shake 5 minutes, filter, analyze on ICP. |
| P | 2 g | Use K extract, mix 1.5 ml sample with 26.5 ml ascorbic acid color complex, let stand 30 minutes, analyze on spectrophotometer at 880 nm. |

***Secondary Test***

| *Analysis* | *Soil Amount* | *Procedure* |
|---|---|---|
| Ca and Mg | 2 g | Use K extract and analyze on ICP. |
| $SO_4$-S | 10 g | Add 25 ml calcium mono-phosphate, shake 30 minutes, filter, analyze on ICP. |

***Micronutrient Test***

| *Analysis* | *Soil Amount* | *Procedure* |
|---|---|---|
| Fe and Zn | 10 g | Add 20 ml DTPA solution, shake 2 hours, filter, analyze on ICP. |

***Boron Test***

| *Analysis* | *Soil Amount* | *Procedure* |
|---|---|---|
| B | 15 g | Add 30 ml calcium chloride solution, boil 5 minutes, cool, filter, analyze on ICP. |

**Table 2. Water and Salinity Testing Procedures.**

| *Analysis* | *Offered by Tests** | *Procedure* |
|---|---|---|
| pH | 5,6 | Add 15 ml $H_2O$ to 15 g soil, equilibrate 0.5 hr., read on pH meter. |
| pH | 1, 2, 3 | Direct electrode reading of water samples. |
| $CO_3$ | 1, 6 | Titrate with 0.02 N $H_2SO_4$ to pH 8.3, $CO_3$ = ml titrant x 0.02 x 6000/ ml sample. |
| $HCO_3$ | 1, 6 | Titrate with 0.02 N $H_2SO_4$ from pH 8.3 to 4.5, $HCO_3$ = ml titrant x 0.02 x 12,200/ ml sample. |
| EC | 1, 2, 3, 5, 6 | Direct electrode reading. |
| Na, Ca, Mg, K | 1, 3, 5, 6 | Direct reading on ICP. |
| $SO_4$ | 1, 3, 6 | Direct reading on ICP. |
| B | 1, 5, 6 | Direct reading on ICP. |
| $NO_3$-N | 1, 2, 3, 6 | Automated cadmium reduction. |
| Cl | 1, 3, 6 | Automated ferricyanide. |
| TSS | 1, 2, 3, 5, 6 | Greater of $\Sigma$ (anions + cations) or EC x 0.66 |
| SAR | 1, 3, 5, 6 | $0.043498 \times Na / [(0.04990 \times Ca + .08229 \times Mg)/2]^{1/2}$ |
| PAR | 1, 3, 5, 6 | $0.025577 \times K / [(0.0499 \times Ca + 0.08229 \times Mg)/2]^{1/2}$ |
| EPP | 5, 6 | $(10.51 \times PAR + 3.60) / [1 + (0.1051 \times PAR + 0.036)]$ |
| ESP | 5, 6 | $(1.47 \times SAR - 1.26) / (0.01475 \times SAR + 0.99)$ |
| Na % | 1, 3 | $0.043498 \times Na / (0.043498 \times Na + 0.08229 \times Mg + 0.04990 \times Ca)$ |
| Residual $CO_3$ | 1 | $(0.033328 \times CO_3 + 0.016389 \times HCO3) - (0.08229 \times Mg + 0.04990 \times Ca)$ |
| Hardness | 1, 3 | $(0.04990 \times Ca + 0.08229 \times Mg) \times 50$ |

* Tests: 1 = Irrigation, 2 = Livestock, 3 = Household, 5 = Salinity Management, 6 = Comprehensive Salinity

## Forage Lab

The forage subdivision analyzes about 4,000 plant samples a year to determine forage quality and nitrate levels. Forage quality is determined by measuring protein, ADF, NDF, and moisture. The turn-around time varies with the tests desired. However, all work is normally completed in three to five working days with a report mailed to the county Extension office.

Nitrate testing in forage is important to avoid feeding poisonous forage to livestock. Since this information is vital, nitrate results are telephoned back to the county Extension office as soon as results are obtained from the laboratory. A report of the results is also mailed at a later time. Nitrates are normally analyzed in one to two working days.

After logging in the forage sample, it is prepared for analysis by weighing the sample, drying the sample at 60°C for about 12 hours (very wet samples may take longer), weighing the sample after drying for moisture calculation, grinding to pass through a 1.0mm screen, and taking the sample to the lab for analysis. Procedures and calculations are shown in Table 3.

**Table 3. Forage Testing Procedures.**

| *Analysis* | *Wt (g)* | *Procedure* |
|---|---|---|
| Moisture | 2-3 | Weigh, dry 2 hr. at 135°C, weigh after cooling. |
| Protein | .15-.2 | Dry combustion analysis using a LECO instrument. |
| ADF | .5 | Weigh, digest at 100°C in ADF solution for 55 minutes, rinse 5 times in water, soak 5 minutes in acetone, dry at 100°C for 12 hours, weigh. |
| NDF | .25 | Use NDF solution, then same as ADF. |
| TDN | | 88.9 - (0.779 x ADF). |
| Energy | | |
| Maintenance | | $-0.508 + (1.37 \times 0.01642 \times TDN) - [0.3042 \times (0.01642 \times TDN)^2] + [0.051 \times (0.01642 \times TDN)^3]$ |
| Lactation | | $(TDN \times 0.01114) - 0.054$ |
| Gain | | $-0.7484 + 1.42 \times 0.01642 \times TDN - 0.3836 \times (0.01642 \times TDN)^2 + 0.0593 (0.01642 \times TDN)^3$ |
| RFV | | [88.9 - (0.779 x ADF)] x (120/NDF) x 0.775 |

**Table 4. Common Abbreviations.**

| *Abbreviation* | *Definition* |
|---|---|
| BI | Buffer index |
| ICP | Inductively coupled plasma |
| EC | Electrical conductivity |
| TSS | Total soluble salts |
| SAR | Sodium absorption ratio |
| PAR | Potassium absorption ration |
| EPP | Exchangeable potassium percent |
| ESP | Exchangeable sodium percent |
| ADF | Acid detergent fiber |
| NDF | Neutral detergent fiber |
| TDN | Total digestible nutrients |
| RFV | Relative feed value |

# The Oklahoma Cooperative Extension Service
## *Bringing the University to You!*

The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
- Extension programs are nonpolitical, objective, and research-based information.
- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
- More than a million volunteers help multiply the impact of the Extension professional staff.
- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

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