Learning Series:
Navigating Drought

Speaker: Scott Gillespie

Understanding Water Movement in Soil

Soil water is influenced by various forces, including gravity, soil texture, organic matter, plant roots, and evaporation. Saturation occurs when all soil pores are filled with water, typically after heavy rainfall or irrigation. Field capacity is reached when water stops draining due to gravity and becomes available to plants. The permanent wilting point is the minimum amount of water in the soil that plants require to prevent wilting. When soil water drops below this level, the plant can no longer extract moisture from the soil, which leads to wilting and an inability to recover even with the addition of water to the soil.

Different soil textures have varying abilities to retain and release water to plants. Clay soils hold more water but release it more slowly, whereas sandy soils drain quickly and struggle to retain moisture. The interaction between organic matter and soil particles enhances water-holding capacity by creating more surface area for water to cling to. Soils with higher organic matter content hold more water.

Soil Texture and Water Holding Capacity (Southern AB Soils)

Sandy loam soils drain quickly and hold less water (~1.7 inches of available water per foot of soil depth). Loam soils provide a balanced water-holding capacity (~2.2 inches of water per foot of soil depth). Clay loam soils retain the most moisture (~2.4 inches of water per foot of soil depth), but a significant portion of it is unavailable to plants due to tight soil structure. Organic matter increases water retention and buffering capacity but takes years to build up significantly.

The bulk density of soils impacts water infiltration; looser soils (low bulk density) allow water to penetrate more effectively (there are more pore spaces in soils that have lower bulk density because they are less compacted). High-clay soils may experience crusting issues, reducing infiltration and leading to runoff rather than water absorption.

Rooting Depth and Water Uptake

Plants extract water at different soil depths based on their root system.

- Shallow-rooted crops (0-1 ft): Wheat, barley.
- Medium-rooted crops (1-3 ft): Corn, sunflowers.
- Deep-rooted crops (3+ ft): Alfalfa, trees.

Encouraging deeper root systems improves drought resilience. Irrigation practices should prioritize deeper watering to prevent shallow root dependency. This is especially important when plants are young.

Organic Matter and Soil Water Retention

Clay soils, due to their particle size (lots of small particles with large surface areas) have many areas for water to hold on to. This also allows them to hold on to more carbon/organic matter. Organic matter holds even more water, making clay soils better at retaining moisture. Particulate organic matter is made up of bits that are still recognizable (e.g., piece of leaf). This form of soil carbon is cycled between microbes, plants and the atmosphere. Mineral-associated organic matter has particles that are no longer recognizable and binds to soil particles. This is the most stable form of soil carbon.

Every 1% increase in organic matter can hold up to 25,000 gallons of water per acre, making it a key factor in drought resilience and soil health. Increasing organic matter is a long-term process, not an overnight fix.

Irrigation and Drought Mitigation Strategies

Deep watering early in the season encourages deeper root growth and greater resilience to dry conditions. Avoid shallow, frequent watering, which promotes shallow root systems that are vulnerable to drought stress.

A Dutch Auger is a recommended tool for assessing soil moisture at different depths. Plants uptake water at varying depths depending on their growth stage and root penetration ability. On average, 40% of water is absorbed from the top 25 cm (1 foot), with another 30% from deeper layers if roots can reach them. Under irrigation, maintaining soil moisture at 85% of field capacity ensures plants can access water efficiently.

Irrigated crops need strategic timing: holding off on irrigation at the right moments can encourage roots to extend deeper, making crops more drought-resistant.

Cover Cropping and Roller Crimping

Cover crops can improve soil health and protect against erosion, but they can also compete for water, making them risky in dryland systems. Winter-killed cover crops may lead to nutrient runoff if the soil cannot absorb melting snow efficiently. Roller crimping is effective for weed suppression and moisture retention but requires precise timing. In regions with limited rainfall, cover cropping should be approached carefully—water conservation may be more beneficial than biomass production. However, if no other cover is available, cover crops can protect soil from erosion and environmental elements.

Tillage vs. No-Till: Weighing the Tradeoffs

Tillage speeds up moisture loss but may be necessary for certain cropping systems. In dryland farming, maintaining soil cover is more critical than complete no-till strategies. Stripper headers can help soil retain moisture by leaving tall stubble, which reduces evaporation and traps snow. Managing tillage practices requires conscious decision-making, as tillage increases water loss and breaks up soil structure. Studies show that while no-till helps retain surface moisture, it may not significantly improve deep moisture retention in all soil types.