Biochar & Carbon Accounting

Lori Lilly

Executive Director, Howard EcoWorks

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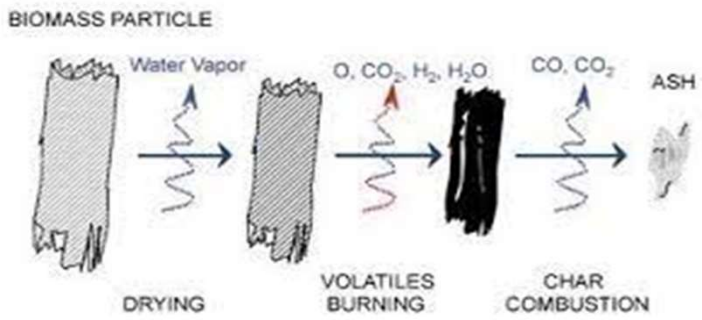
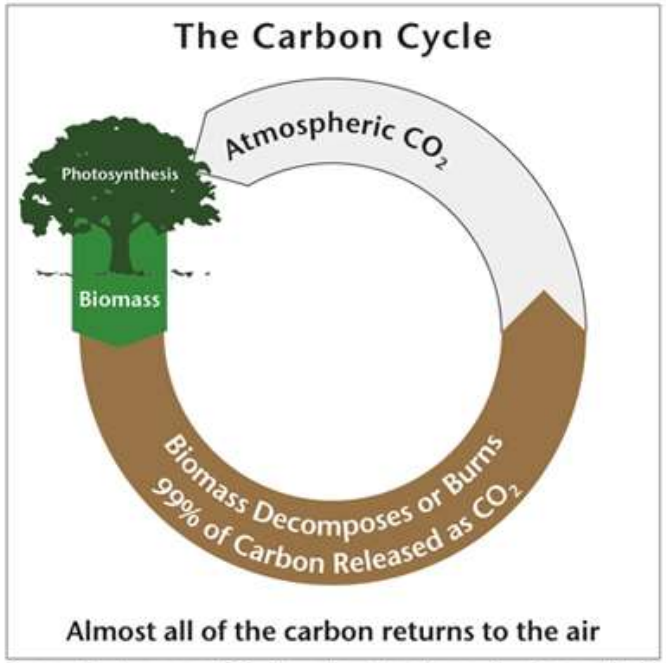
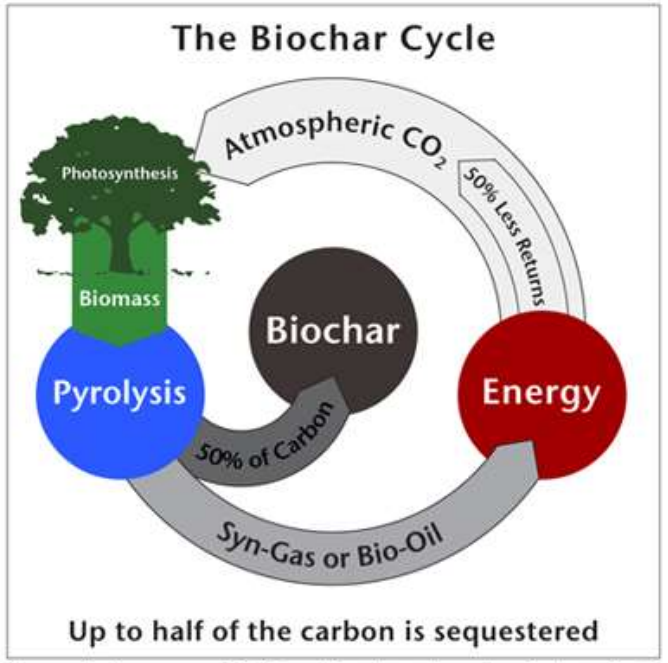


What is Biochar?

- **A Zero-Waste Solution** – Biochar is fine-grained charcoal made by pyrolysis, the process of heating biomass (wood, manure, crop residues, solid waste, etc.) with limited to no oxygen in a specially designed furnace capturing all emissions, gases, and oils for reuse as energy.
- **An Ancient Soil Conditioner** – Biochar has been used in agriculture for more than 2,500 years and is becoming increasingly popular in modern agriculture and horticulture as a safe, sustainable soil amendment.



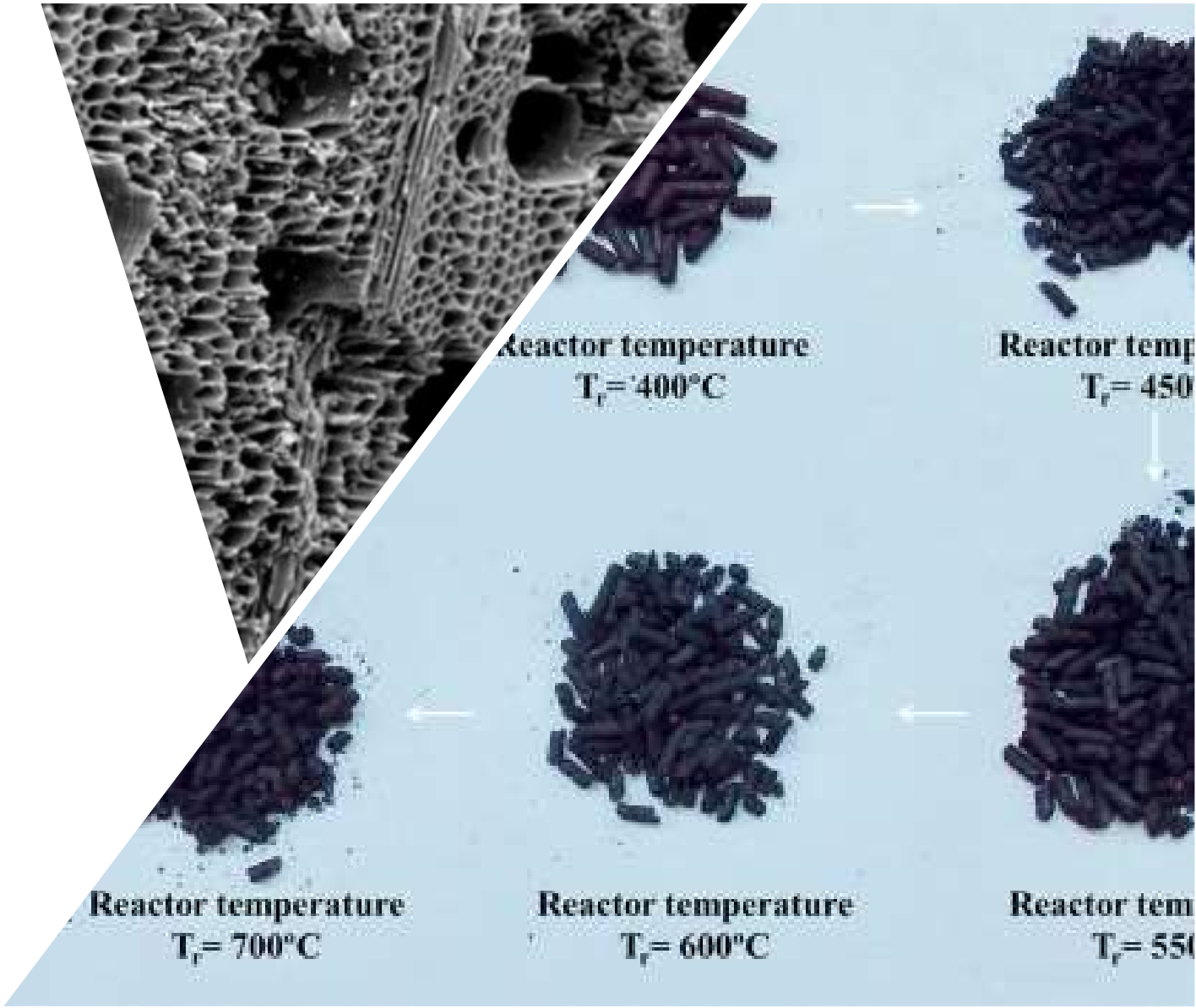
Green plants remove CO_2 from the atmophere via photosynthesis and convert it into biomass. Virtually all of that carbon is returned to the atmosphere when plants die and decay, or immediately if the biomass is burned as a renewable substitute for fossil fuels.



Green plants remove CO_2 from the atmophere via photosynthesis and convert it into biomass. Up to half of that carbon is removed and sequestered as biochar, while the other half is converted to renewable energy co-products before being returned to the atmosphere.

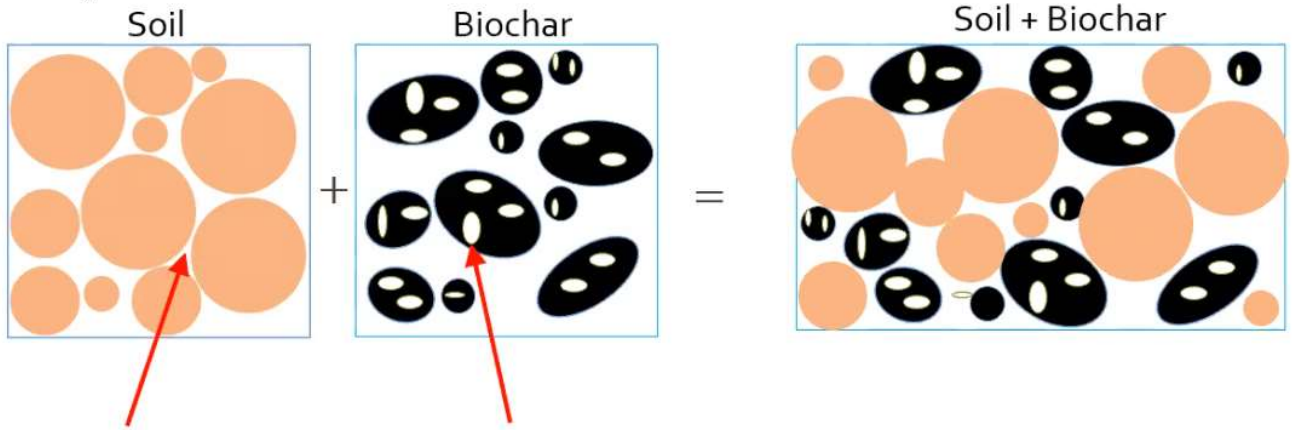
Biochar Benefits

- Soil amendment
- Increase organic matter
- Waste to resource
- Runoff reduction
- Pollutant removal
- Carbon sequestration
- Cost effectiveness



Biochar Impact on Soil Pore Structure

- Porosity



Interpores = pores between particles

Intrapores = pores inside particles

More intrapores than soil; soil **interpores altered**

Soak It Up - focus on the Tiber Hudson watershed draining to old Ellicott city

- A community engagement campaign to encourage individual action to help reduce stormwater runoff on private property
- Goal was to convert turf grass to native landscapes that infiltrate stormwater
- Included a biochar research component with University of Delaware

Removal of Topsoil

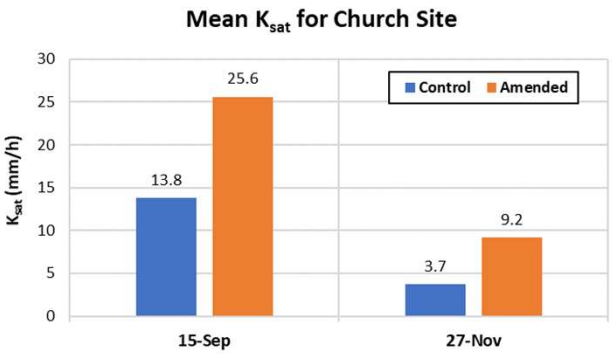
Tilling and Mixing of Soil

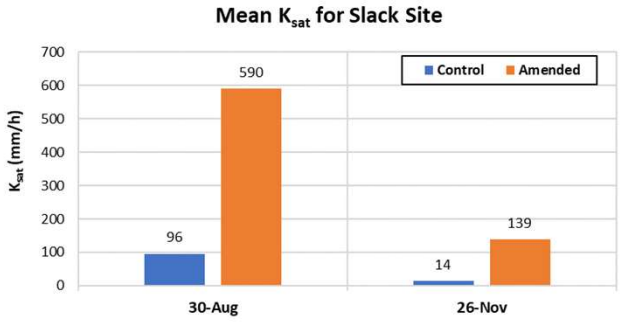
BIOCHAR INSTALLATION CHURCH SITE (MARCH 26-27, 2019)

Adding and Mixing 4% by Mass Biochar

Control and Amended Sections Church site

BIOCHAR INSTALLATION CHURCH SITE (MARCH 26-27, 2019)





Measured Mean Saturated Hydraulic Conductivity

Saturated hydraulic conductivity is the ease with which pores of a saturated soil transmit water.

Biochar amendment increased K_{sat} by factor 2 to 10

Infiltration calculator – used to determine: (1) the total percentage of annual volume infiltrated and (2) the percentage of events entirely captured by a roadside swale in a year

Treatment	Stormwater Infiltrated Church Site	Stormwater Infiltrated Slack Site
Control (no biochar)	20%	40%
Biochar	34%	>95%

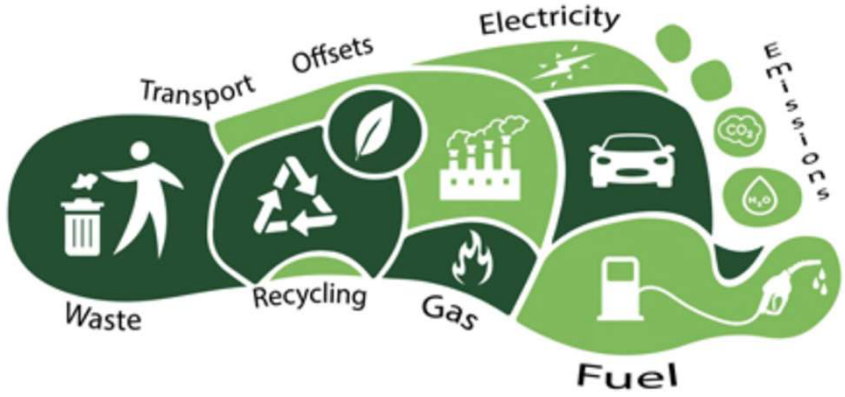
2022-2023 Transform Howard Biochar Project

- Carbon accounting of Howard EcoWorks operations
- Carbon offsets of BMPs (tree planting, rain gardens, conservation landscapes, woodland management)
- Biochar properties of kiln-produced biochars of 3 invasive and one native species
- Field trials to look at runoff reduction difference of kiln biochars v commercial biochars – installed next to pathway at HCC

Carbon Accounting

Howard EcoWorks generates roughly **54.5 tons** of carbon dioxide emissions annually

- Employee commutes accounted for 38.5 tons of CO2 emitted / year
- Office space accounted for 8 tons of CO2 emitted / year
- Company-owned vehicles accounted for 8 tons of CO2 emitted / year



For comparison – the avg carbon footprint for a person in the US is 16 tons

Carbon offsets of our projects and impact on the company footprint

Type	Yearly	30 - Year
Rain Garden	- 0.9484 tons	- 28.4520 tons
Conservation Landscape	- 0.9176 tons	- 14.4345 tons
Tree Planting	- 17.214 tons	- 516.428 tons
Bioretention	+ 0.2939 tons	+ 8.8173 tons
BMP - Total Sequestration	- 18.7861 tons	- 550.4972
EcoWorks without Offsets	+ 54.50 tons	+ 1,635.00 tons
EcoWorks with Offsets	+ **35.71 tons**	+ **1,084.50 tons**

34% reduction

Woodland Management + carbon accounting

What is this?

- Invasive species removal
- Tree and shrub plantings

Why has it been difficult to measure?

- Lack of studies addressing invasives' effect on C storage
- Difficult to quantify invasive coverage
- Potential for invasives to simply replace existing vegetation

Theoretical Compost and Biochar (50/50) Application – Additional Carbon Sequestration

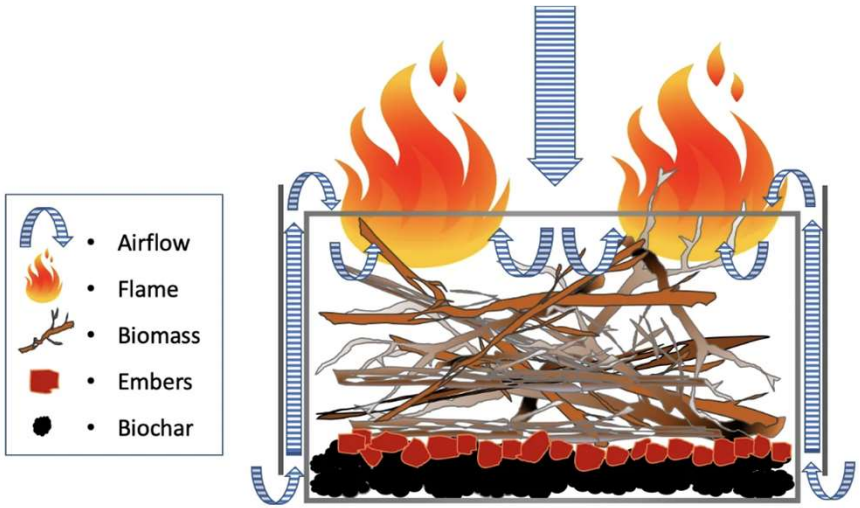
Type of BMP	Amended Area of BMPs	Cumulative Amended Area of BMPs	CO_2eq. Sequestered by Biochar/Charcoal
Rain Garden	166 sq. ft.	20,948 sq. ft.	10.2 tons
Conservation Landscape	293 sq. ft.	10,559 sq. ft.	5.2 tons
Tree Planting	2.4 sq. ft. for 1 tree	771 sq. ft. for 320.48 trees	0.38 tons
Bioretention	950 sq. ft.	2,850 sq. ft.	1.4 tons
BMP - Total Sequestration	N/A	35,127 sq. ft. (0.806 acres)	**17.2 tons**

EcoWorks without Offsets	+ 54.50 tons
EcoWorks with Offsets	+ 35.71 tons
EcoWorks with Offsets and Amendments	+ **18.5 tons**

66% reduction

Kiln-produced biochars

- Advantage of being able to be made locally, with local feedstocks – keeps the carbon cycle limited
- Couple with woodland management and invasive species control for additional benefits
- Q - How effective are these chars compared to commercial chars? How do they compare for sequestering carbon? For treating stormwater runoff? Example measures: carbon content, surface area, particle size distribution, internal porosity



Feedstocks


Ash

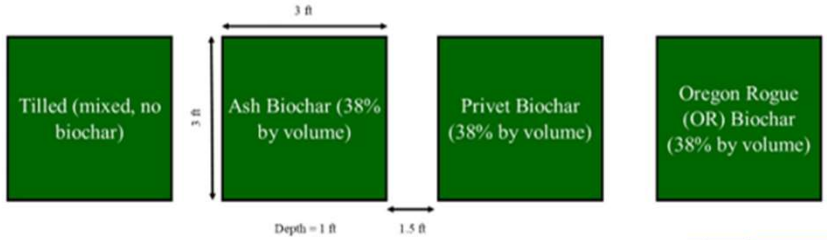

Paulownia


Chinese Privet


Autumn Olive

Field trials at Howard Community College

Figure 1: Site Location



- Crushed char added to 3x3x1'plots
- Installed in late July, 2022
- Seeded with standard grass seed mix of perennial rye and Kentucky bluegrass
- Two monitoring events by University of DE graduate students
- Weekly soil moisture monitoring by HCC students

Bulk density

- Bulk density = dry weight of soil divided by volume
- High bulk density indicates low soil porosity and compacted soils
- Compaction results in shallow plant root growth and poor movement of air and water through soil >> increased runoff and erosion or waterlogged soils
- Commercial char amendment had lower bulk densities than kiln chars but all were optimal for root growth
- Commercial char also had higher surface areas, which allows for more microbial activity and improved soil structure

Reference: Ideal bulk densities depend on soil type but generally <100 lb/ft^3

Table 1: Dry Bulk Density

Dry Bulk Density (lb/ft^3)	
Ash	14.5
Privet	17.1
Oregon Rogue	4.9

Table 2: Surface Area

Surface Area (m^2/g dry)	
Ash	295
Privet	259
Oregon Rogue	456

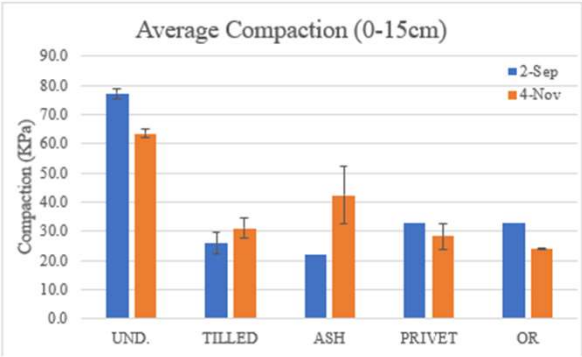


Figure 3: Average Compaction (0-15cm) Over Time

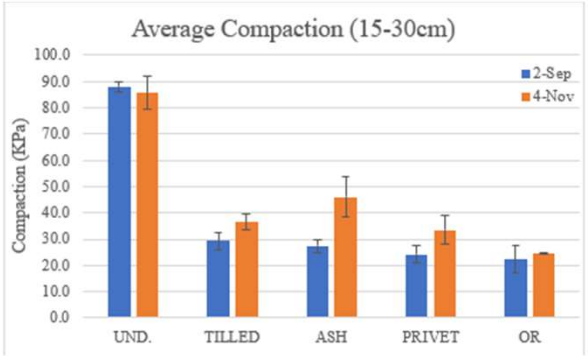


Figure 4: Average Compaction (15-30cm) Over Time

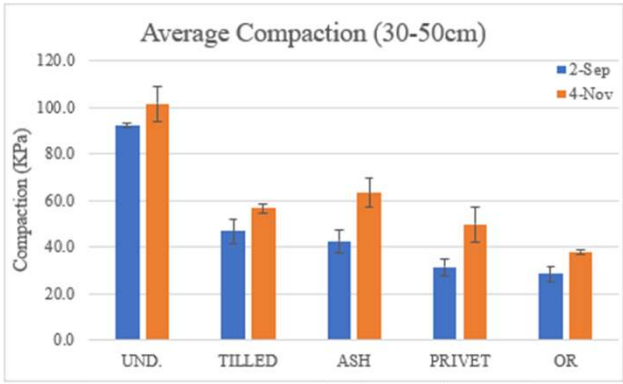


Figure 5: Average Compaction (30-50cm) Over Time

Compaction

- Compaction decreases and then increases over time
- Ash comparable to Tilled at depth, privet slightly better at depth and commercial char the best

Volumetric water content

- All chars increased water retention significantly
- Most significant effect observed was with privet char

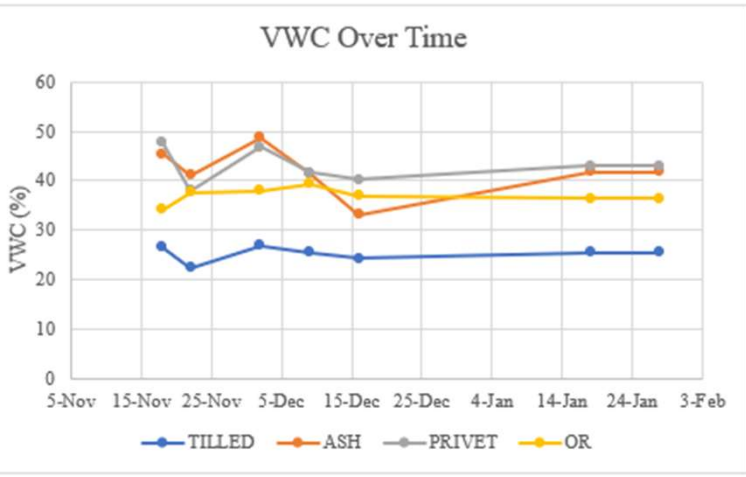


Figure 7: Volumetric Water Content (VWC) Over Time

Thank you!