Agenda

10:00-10:30: Introductions
10:30-10:45: Introduction to biochar
10:45-11:15: Starting the fire, outline of biochar production physics
11:15-12:00: Biochar Benefits
12:00-12:30: Lunch
12:30-1:00: Middle of fire process, hand processing and machine loading
1:00-2:00: Forestry 101
2:00-2:30: Summary of local research
2:30-3:00: Market potential, Marketing
3:00-3:45: Extinguishing the fire and Post Processing
3:45-4:00: Questions and conclusion

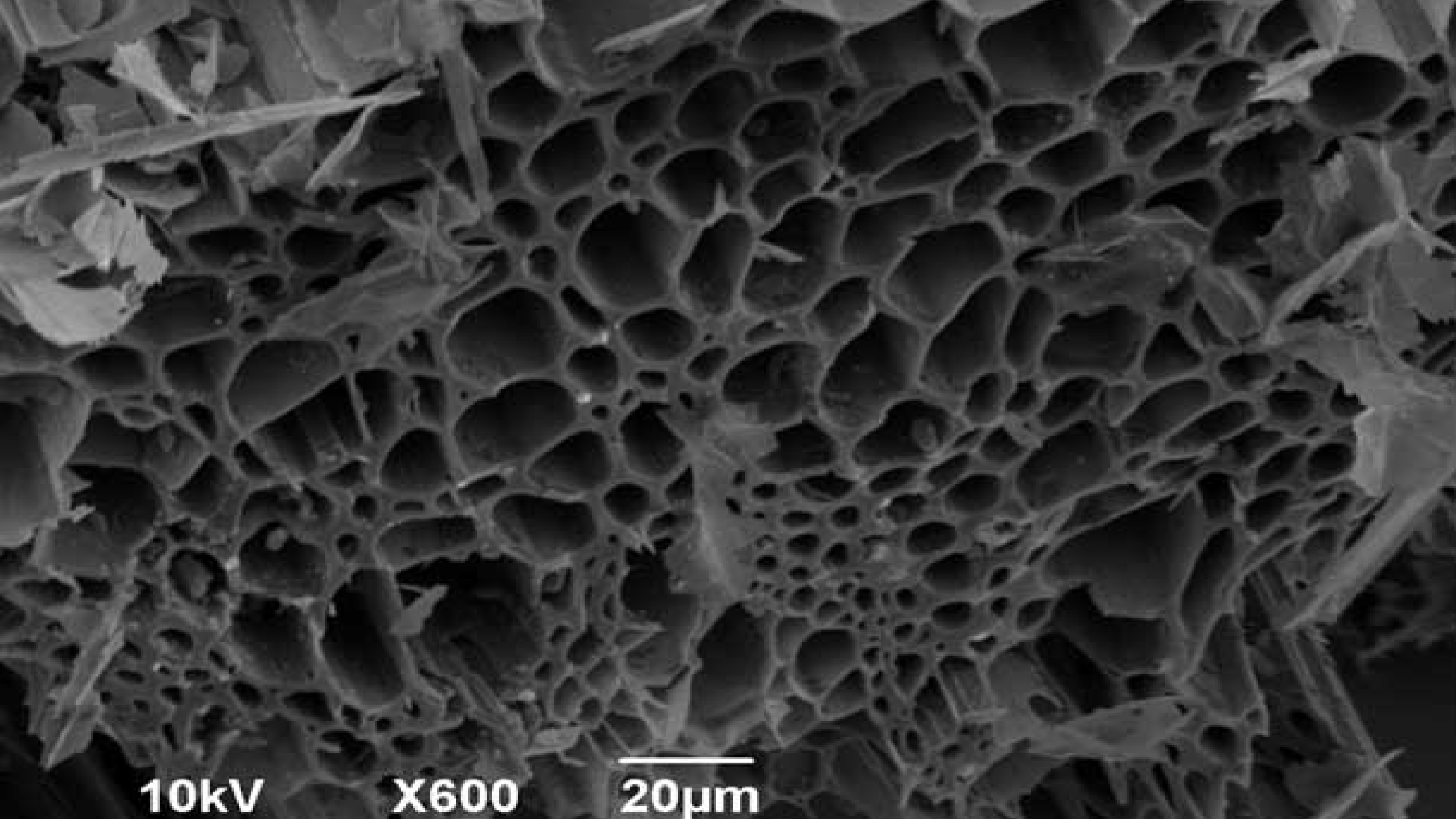
Global off-gassing of 50-70% of our total agricultural carbon

By the year 1980 a third of the carbon humanity had already added to the atmosphere since the Industrial Revolution came from plowing the world's soils.

Without carbon we require more inputs and produce less resilient crops in a changing climate.

The global population is estimated to be 11 billion people in 2100.


Art


10kV
X600
20μm

Terra Preta de Indigo


LONDON

Black carbon and soil properties at historical charcoal production sites in Germany, Borchard, N. et al 2014.

Results

- The results showed that historical charcoal production sites were enriched with Biochar and also exhibited increased stocks of natural SOC and total N possibly due to enhanced stabilization of natural SOC by the charcoal.

Biochar stability in soil: meta-analysis of decomposition and priming effects JinYang Wang et al, 2016.

Results

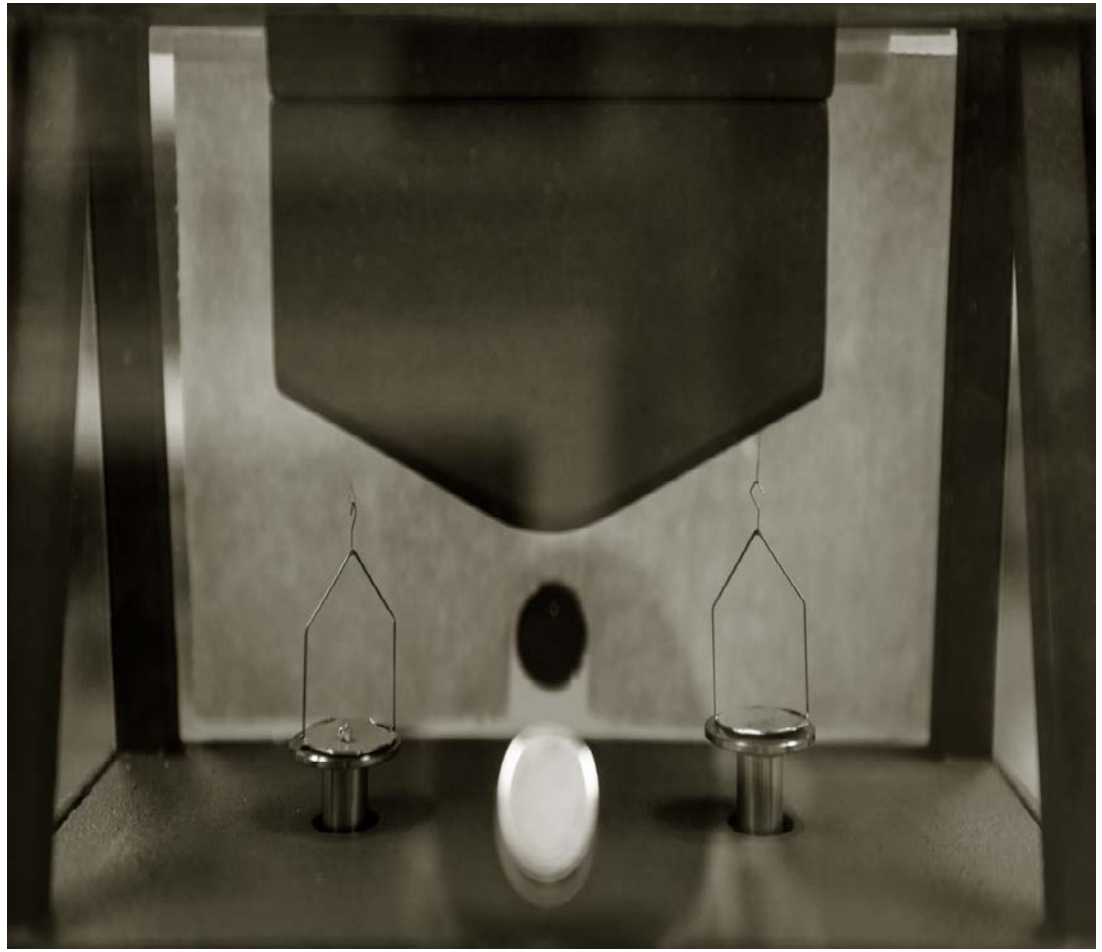
- The biochar decomposition rate varied significantly with experimental duration, feedstock, pyrolysis temperature, and soil clay content. The MRTs of labile and recalcitrant biochar C pools were estimated to be about 108 days and 556 years with pool sizes of 3% and 97%, respectively.

Biochar suppressed the decomposition of organic carbon in a cultivated sandy loam soil: A negative priming effect, Weiwei Lu et al 2014

Results

- Biochar, even when combined with N amendment, significantly ($P < 0.05$) reduced CO_2emission from native SOC by 64.9–68.8%, indicating that biochar inhibited the decomposition of native SOC and the stimulation effect of inorganic N on native SOC degradation, a negative priming effect.
- Significantly ($P < 0.05$) lowered dissolved organic C (DOC) content in soil, primarily due to sorption of DOC/rhizodeposits by the biochar.
- Our study suggested that biochar application could effectively reduce the decomposition of native organic C and a potential effective measure for C sequestration.

Response of soil carbon dioxide fluxes, soil organic carbon and microbial biomass carbon to biochar amendment: a meta-analysis Shuwei Liu et al, 2016



Results

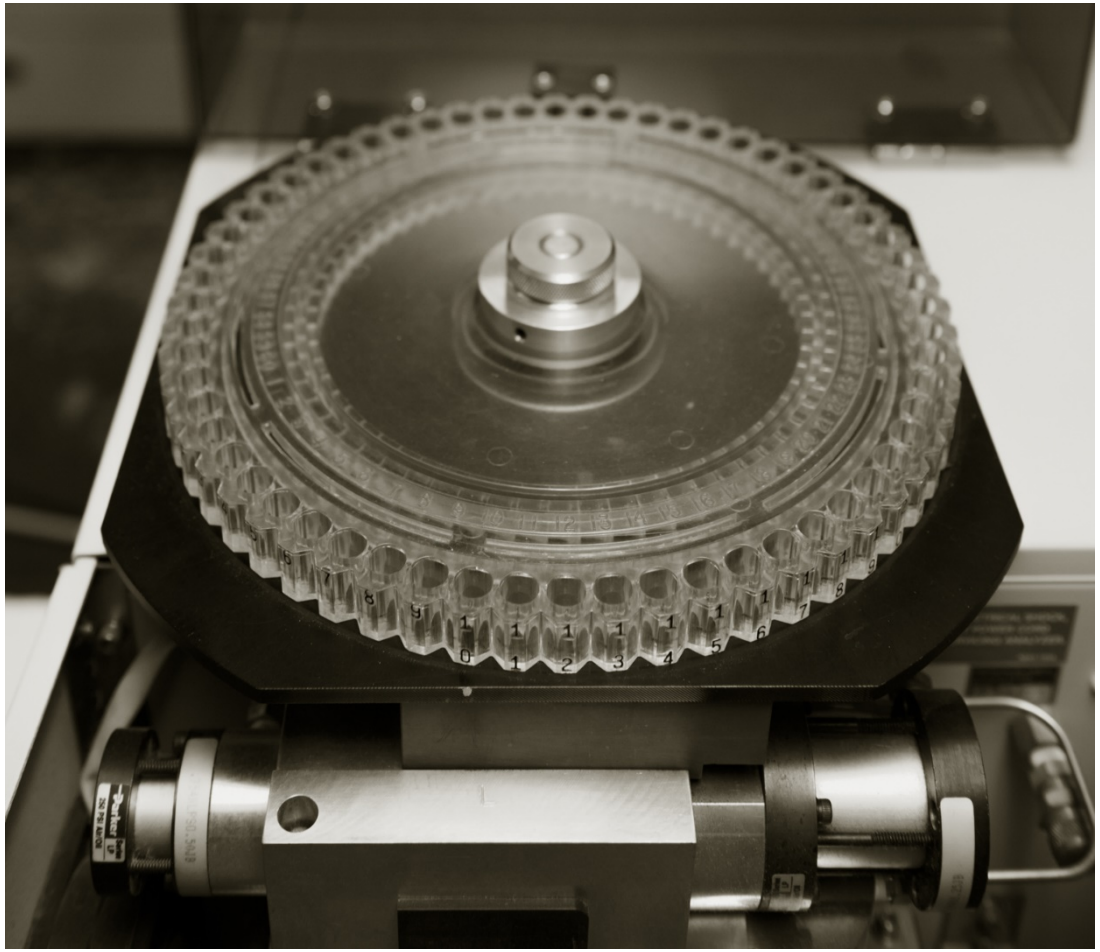
- Updated data derived from 50 papers with 395 paired observations were reviewed using meta-analysis procedures to examine responses of soil carbon dioxide (CO2) fluxes, soil organic C (SOC), and soil microbial biomass C (MBC) contents to biochar amendment. When averaged across all studies, biochar amendment had no significant effect on soil CO2 fluxes, but it significantly enhanced SOC content by 40% and MBC content by 18%.

Response of soil carbon dioxide fluxes, soil organic carbon and microbial biomass carbon to biochar amendment: a meta-analysis Shuwei Liu et al, 2016 continued

Results

- A positive response of soil CO2 fluxes to biochar amendment was found in rice paddies, laboratory incubation studies, soils without vegetation, and unfertilized soils. Biochar amendment significantly increased soil MBC content in field studies, N-fertilized soils, and soils with vegetation.

Response of soil carbon dioxide fluxes, soil organic carbon and microbial biomass carbon to biochar amendment: a meta-analysis Shuwei Liu et al, 2016 continued



Results

- Biochar-induced changes in SOC content were significantly and positively correlated with those in MBC content across all observations (Fig. 2a).
- Biochar amendment significantly increased MBC content in soils with coarse texture, while biochar effects on MBC were not significant in soils with medium and fine textures.
- While biochars with pH of 8.1–9.0 had the greatest enhancement of SOC and MBC contents.

Changes in microbial biomass and the metabolic quotient with biochar addition to agricultural soils: A Meta-analysis. Huimin Zhou, 2017.

Results

- There was an overall increase by 25% in soil microbial biomass carbon (SMBC) and nitrogen (SMBN) but a decrease by 13% in qCO2, under biochar compared to the control.
- Whereas, the reduction was great (by over 30%) both in clay soils and in neutral soils but moderate (by 15%) in soil organic carbon (SOC) depleted soils, respectively in terms of soil texture, reaction and SOC level.

Biochar stimulates the decomposition of simple organic matter and suppresses the decomposition of complex organic matter in a sandy loam soil, Hongguang Cheng, 2017.

Results

- Although biochar application initially stimulated native SOM turnover, in the longer term, it significantly reduced SOM and plant residue turnover, consistent with the findings of previous studies in the same soil (Jones *et al*., **2012**) and in the meta-analyses undertaken by Maestrini *et al*. (**2015**) and Wang *et al*. (**2016**). Lu *et al*. (**2014**) also observed that biochar application suppressed SOC decomposition.

Influence of biochar produced from different pyrolysis temperature on nutrient retention and leaching, Hongguang Cheng et al, 2017.

Results

- Consistent with previous studies, our results showed that higher pyrolytic temperatures led to increases in specific surface area and moisture retention while decreasing CEC and DOC content (Mukherjee *et al*., **2011**; Wang *et al*., **2013**). The characteristics of these high temperature biochars promoted greater negative priming of SOM in our study, and they have recently been advocated as the best type of char for maximizing soil C storage (Yuan *et al*., **2014**).

Influence of biochar produced from different pyrolysis temperature on nutrient retention and leaching, Hongguang Cheng et al, 2017 continued.

Results

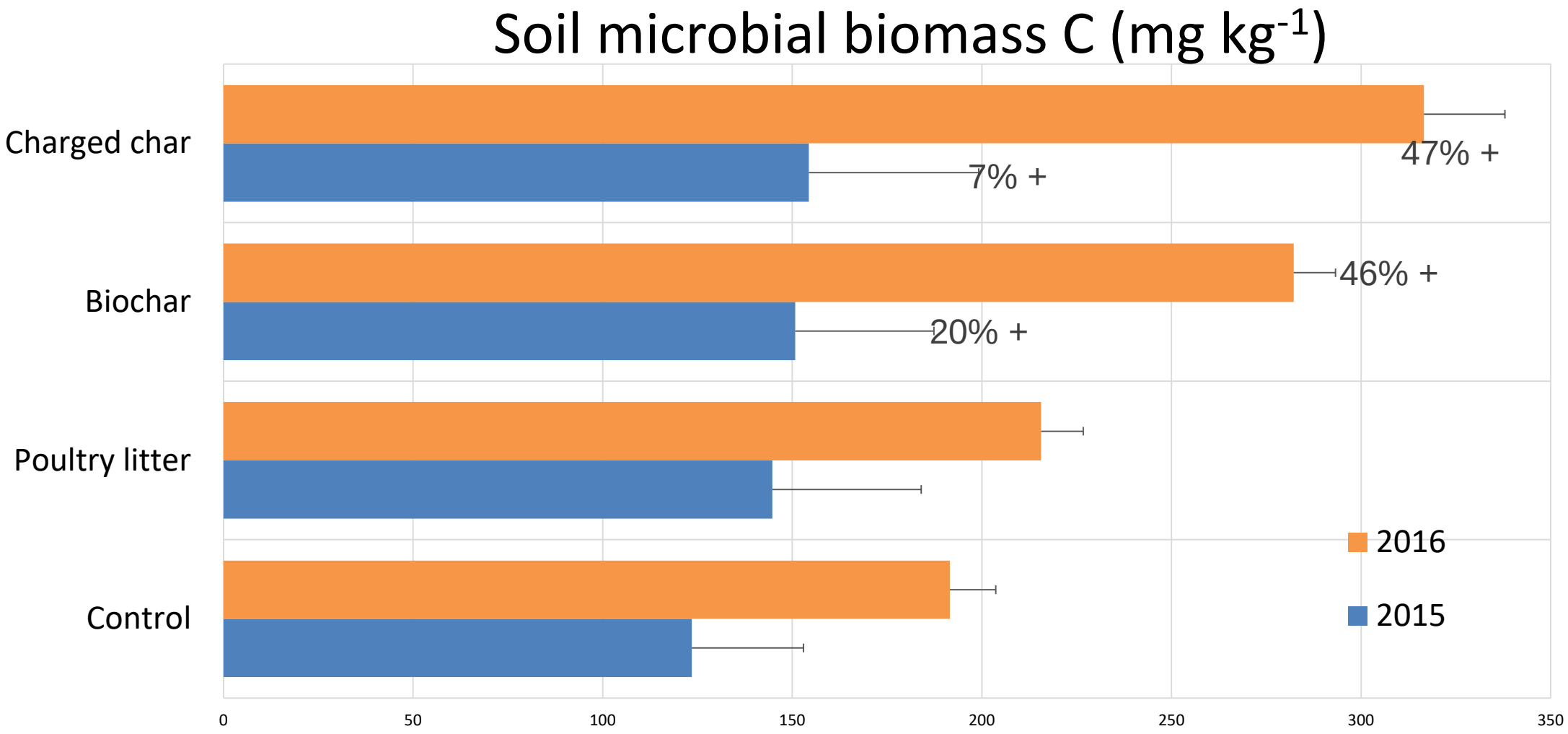
- However, increasing amounts of C are also volatilized during the production of biochar at higher pyrolysis temperatures (Lehmann *et al*., 2006), so ultimately less C per unit mass of feedstock is available for soil incorporation. In addition, some of the beneficial properties of the biochar may be lost (i.e., its ability to retain nutrients and moisture). Therefore, even though low temperature chars and torrefied biomass do not provide the optimal conditions for SOM stabilization, the greater volume of C available to add to the soil may offset this.

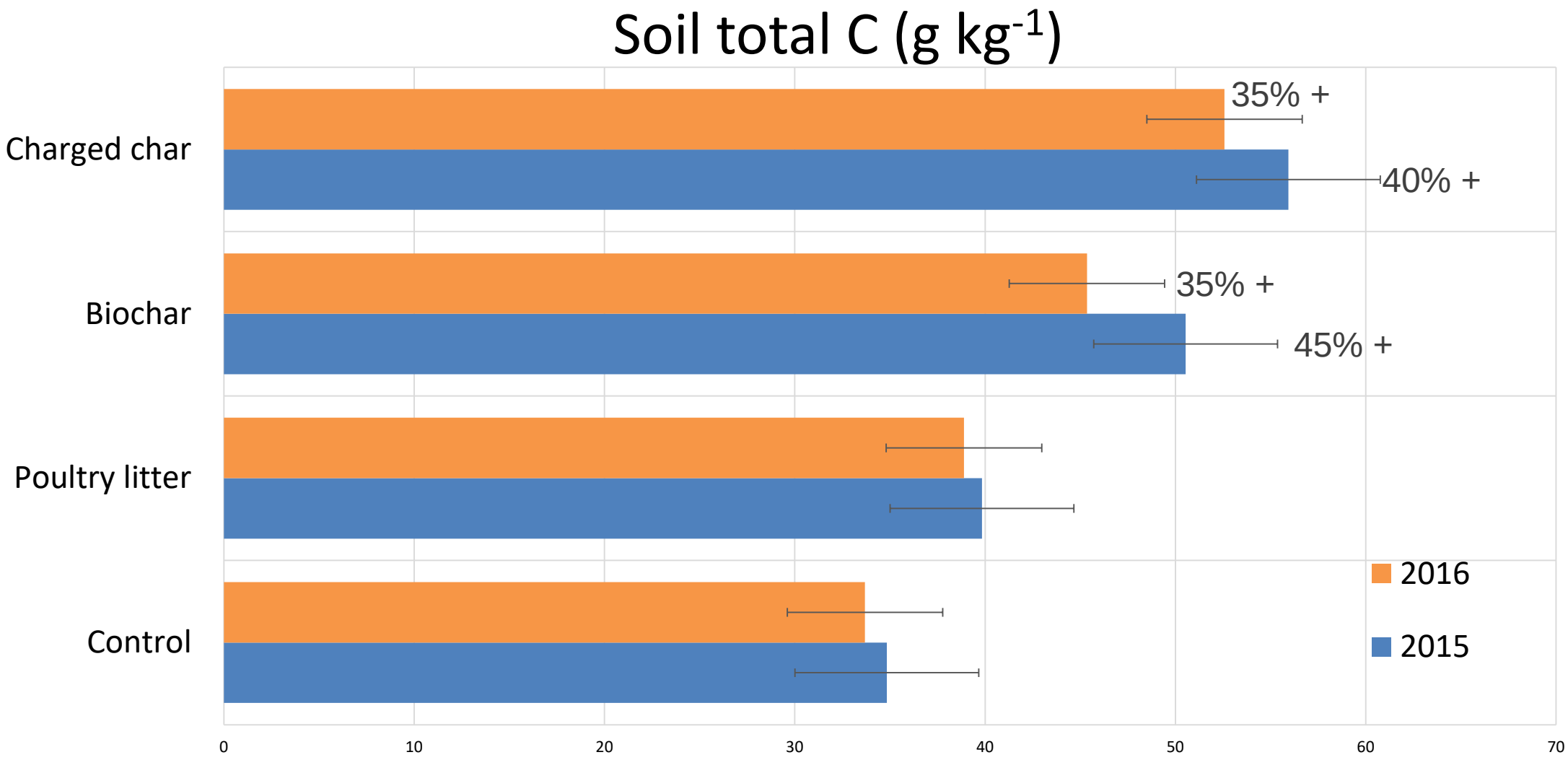
Positive and negative carbon mineralization priming effects among a variety of biochar-amended soils Andrew R. Zimmerman a,*, Bin Gao b , Mi-Youn Ahn, 2011.

Results

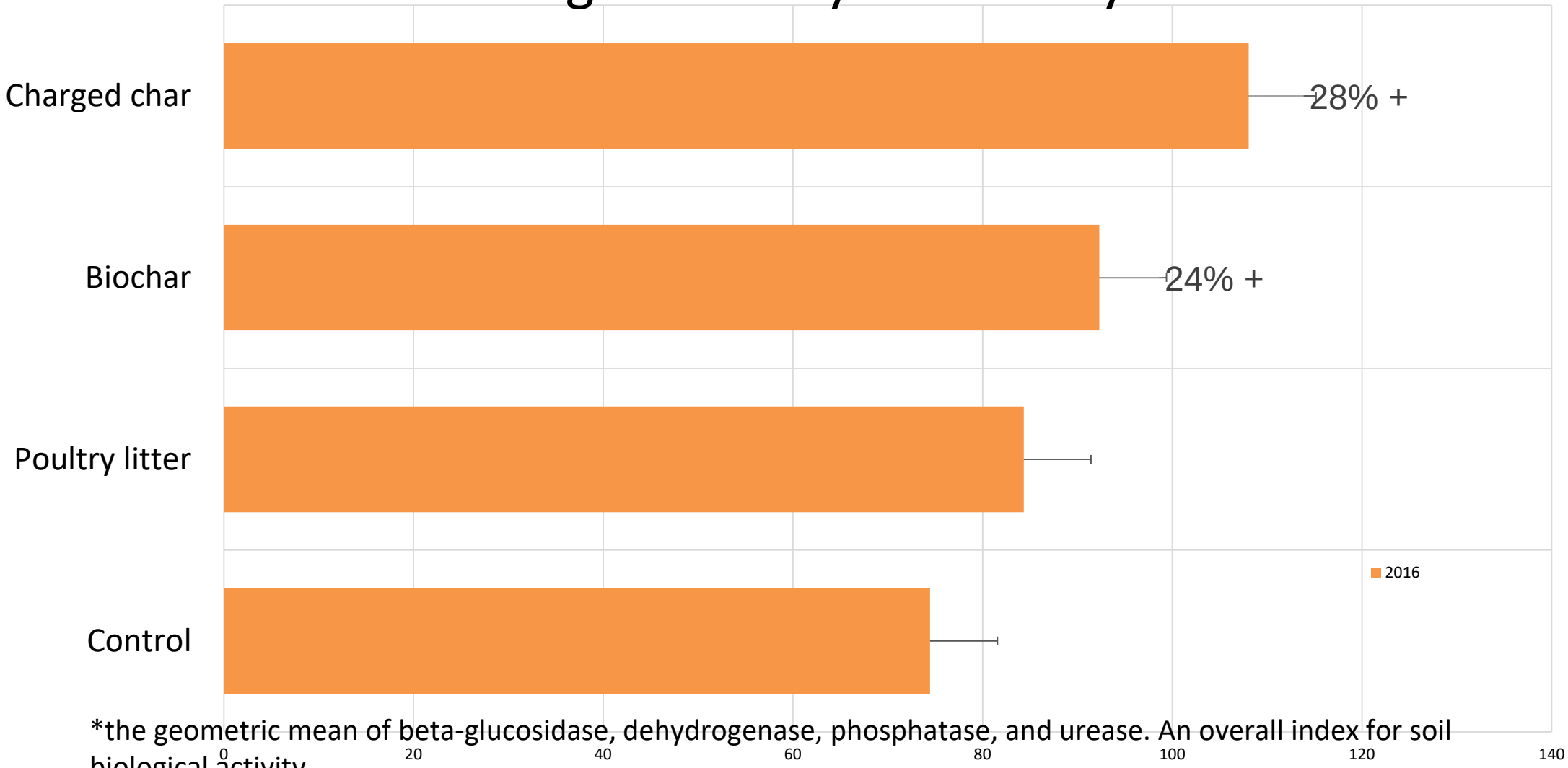
- C mineralization was generally less than expected (negative priming) for soils combined with biochars produced at high temperatures (525 and 650 C) and from hard woods, particularly during the later incubation stage (250 to 500 days).


Photo: Si Gao

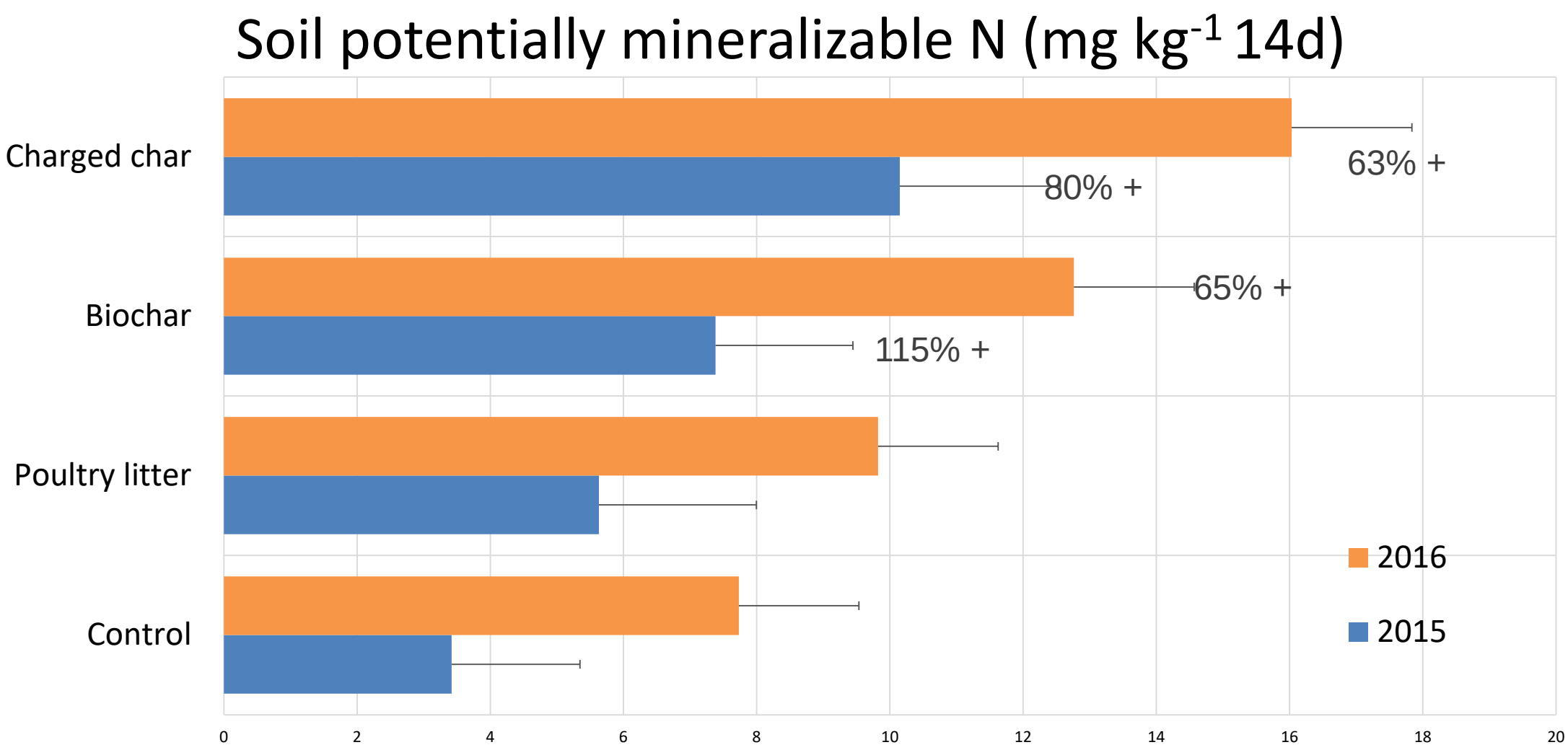

Soil microbial biomass C (mg kg-1)
Charged char
Biochar
Poultry litter
Control
47% +
7% +
46% +
20% +
2016
2015
0
50
100
150
200
250
300
350


Soil total C (g kg-1)
Charged char
Biochar
Poultry litter
Control
35% +
40% +
35% +
45% +
2016
2015
0
10
20
30
40
50
60
70

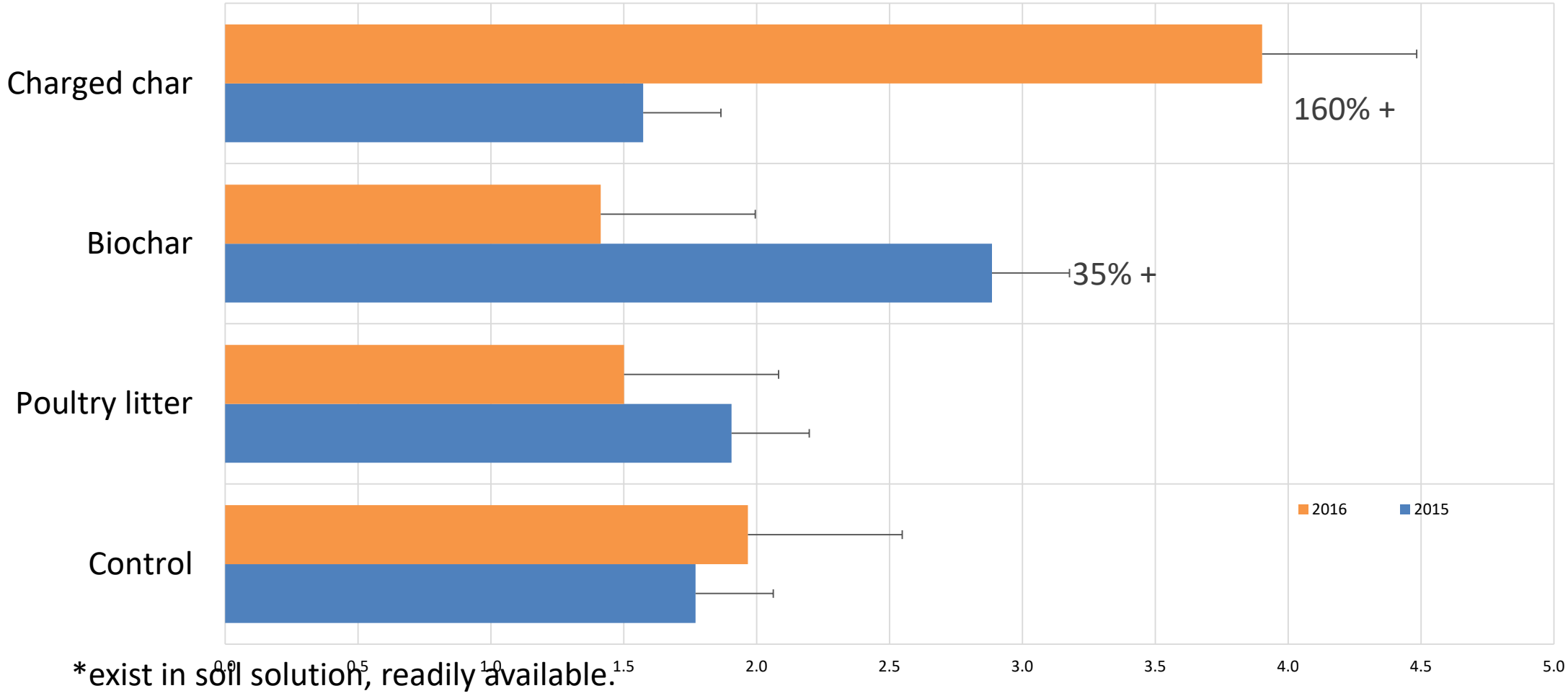
Average soil enzyme activity*



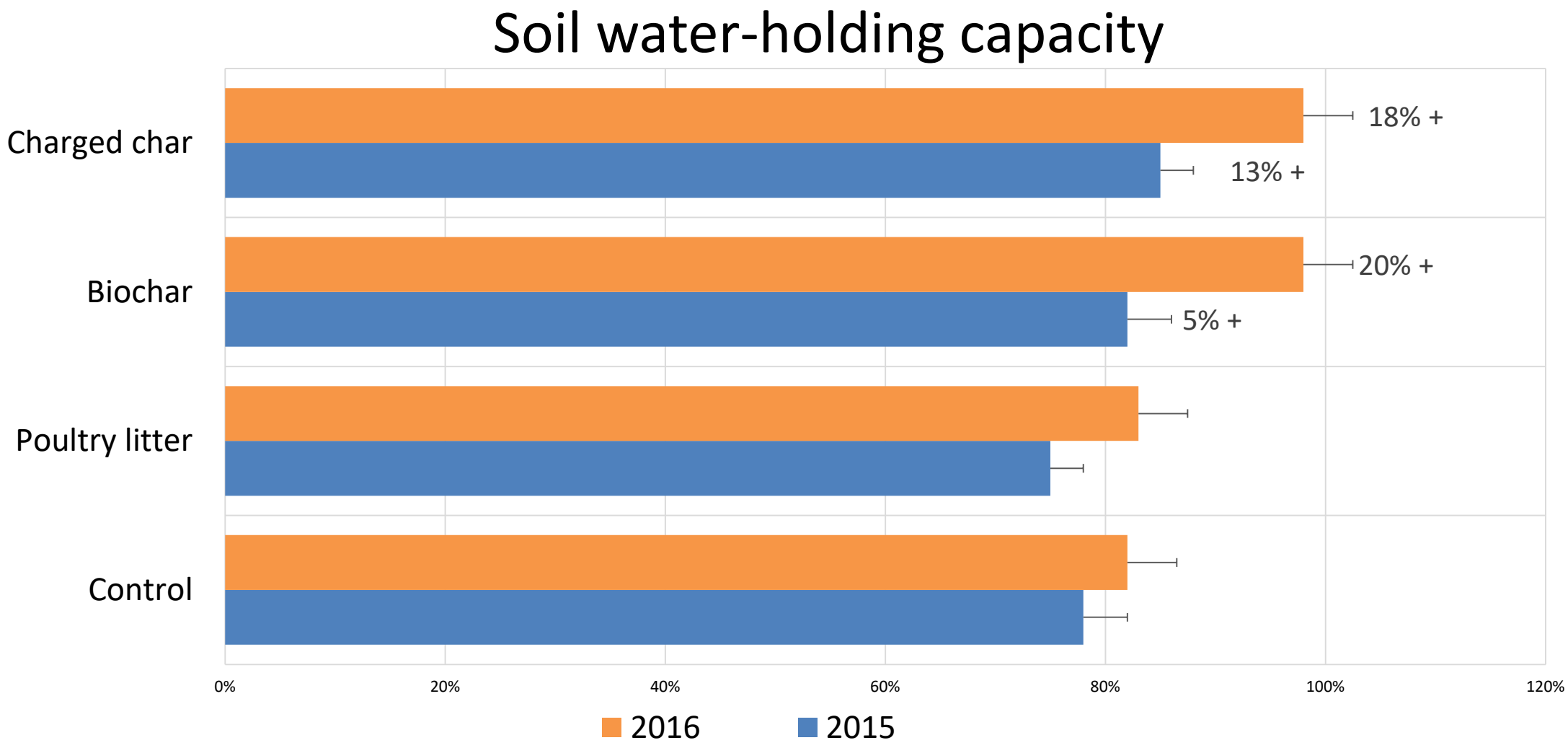
*the geometric mean of beta-glucosidase, dehydrogenase, phosphatase, and urease. An overall index for soil biological activity.


Soil potentially mineralizable N (mg kg-1 14d)
Charged char
Biochar
Poultry litter
Control
63% +
80% +
65% +
115% +
2016
2015
0
2
4
6
8
10
12
14
16
18
20

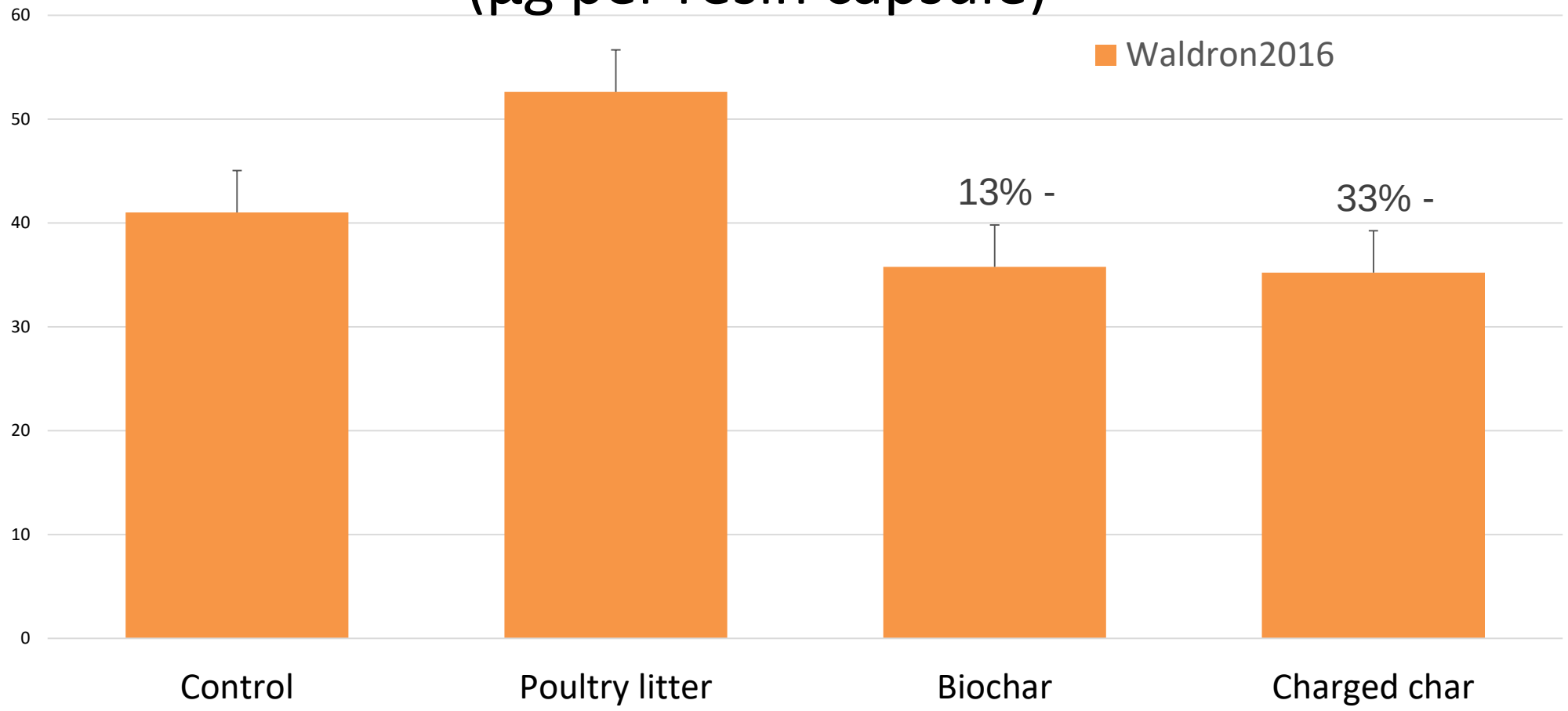
Soil soluble inorganic P* (mg kg^{-1})



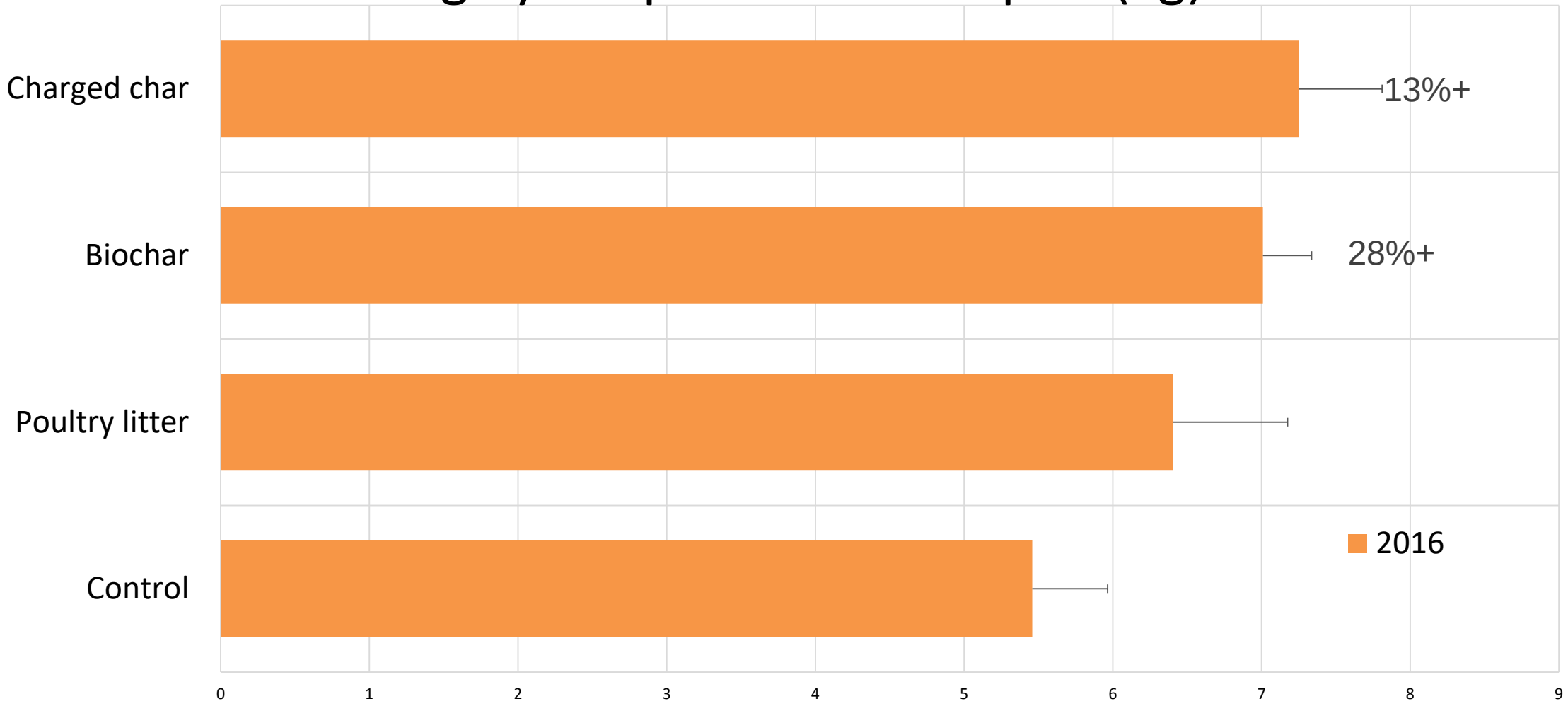
*exist in soil solution, readily available.


Soil water-holding capacity
Charged char
Biochar
Poultry litter
Control
18% +
13% +
20% +
5% +
0%
20%
40%
60%
80%
100%
120%
2016
2015

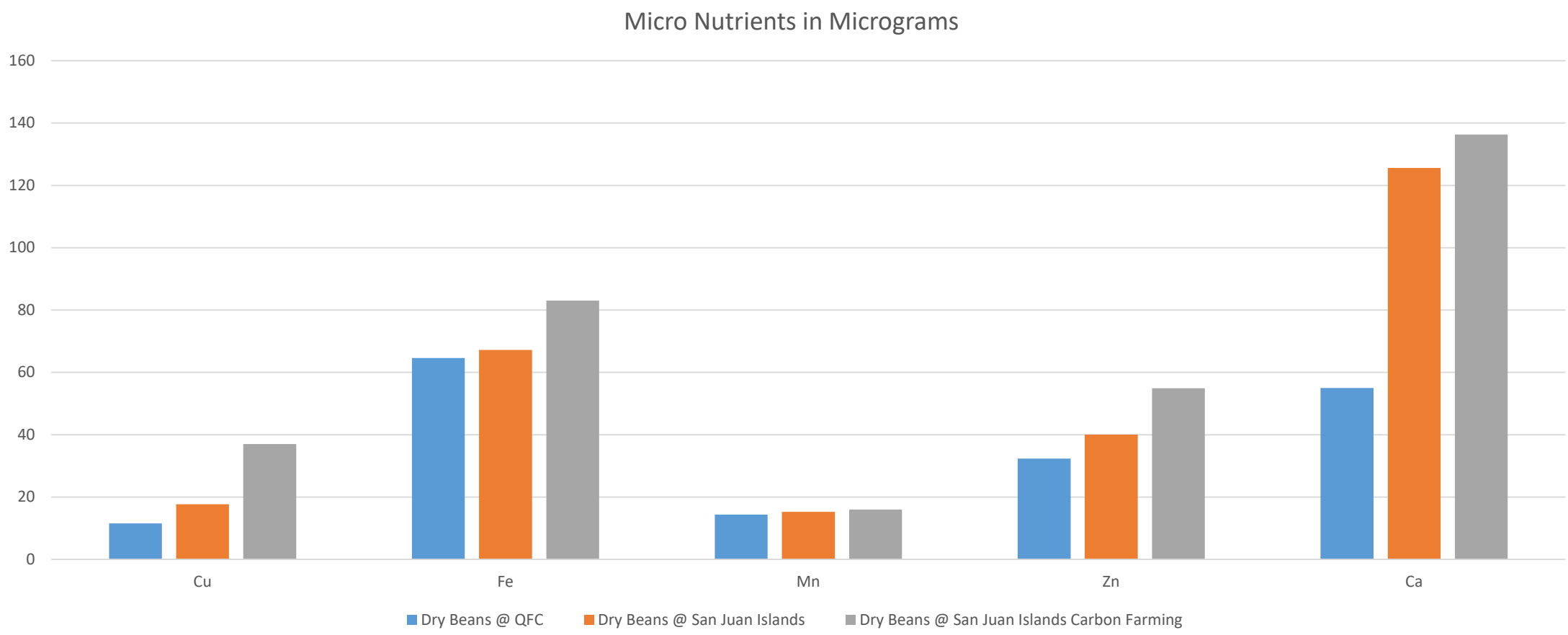
Accumulated NH_4^+ -N below rooting zone (µg per resin capsule)



Average yield per treatment plot (kg)



Nutrient Density in Dry Beans 2015



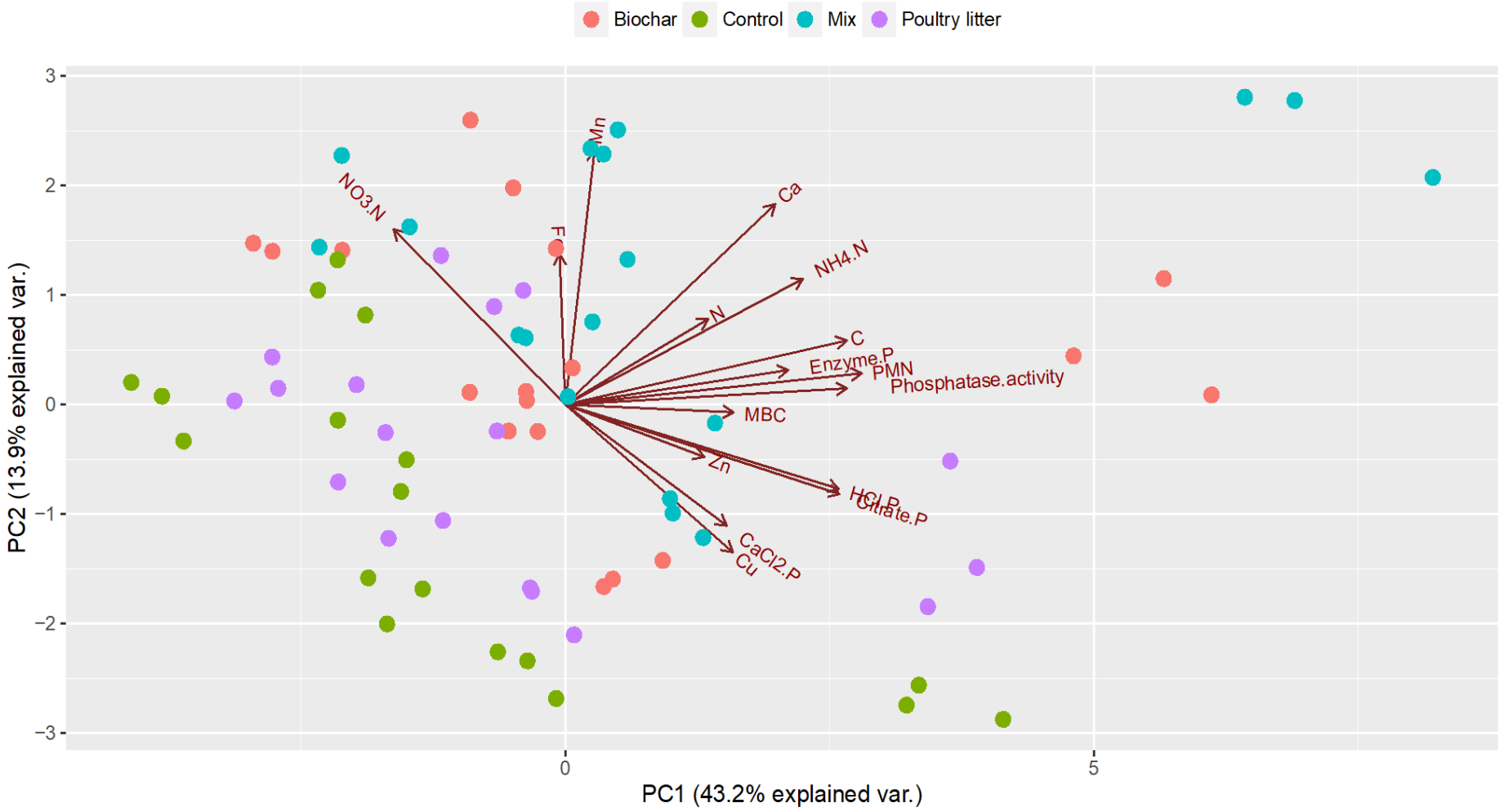
Compare soil biochemical parameters all together……

Analysis was based on 72 plots × 16 soil biochemical parameters;

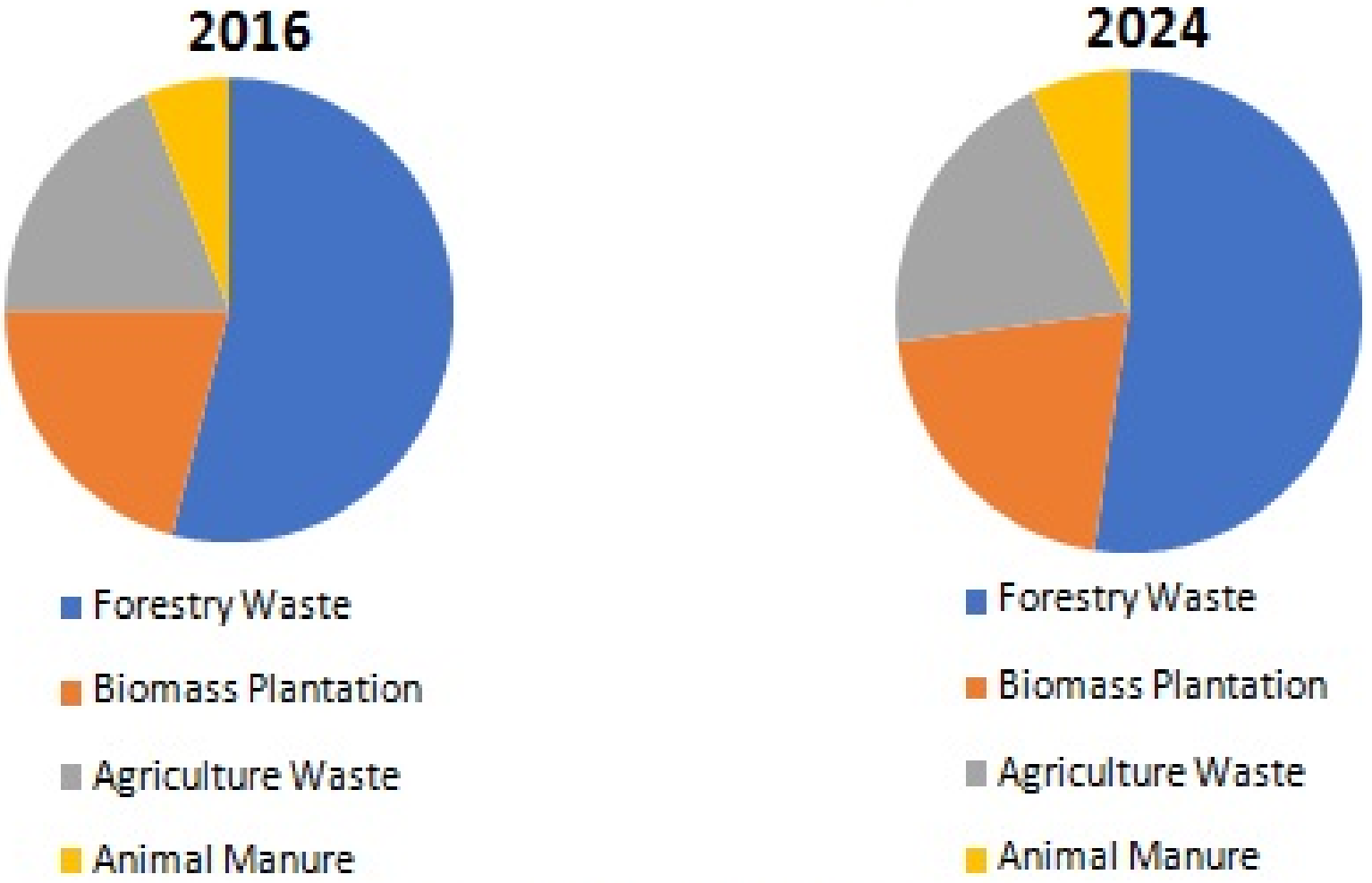
Graph interpretation:

1. Biochar incorporation has changed the whole soil biochemical properties throughout the growing season -
   - Evidence: Each point indicates a plot. Most controls (green dots) are at the 3rd quarter corner → followed by poultry litter (purple dots) → most biochar and charged biochar (red and blue dots) are at the 1st quarter corner;
2. Multiple soil biochemical parameter are responsible for this overall change -
   - Principle components that are responsible for the overall change in soil biochemical properties are:
     1) Potentially mineralizable Nitrogen
     2) Phosphatase activity
     3) Total C
     4) Citrate extractable P
     5) NH_4^+-N concentration
     6) Enzyme extractable P
     7) Ca concentration
   - These variables together explained 43.2% of the total variance (relatively high)

Principle component analysis of soil biochemical parameters following biochar incorporation

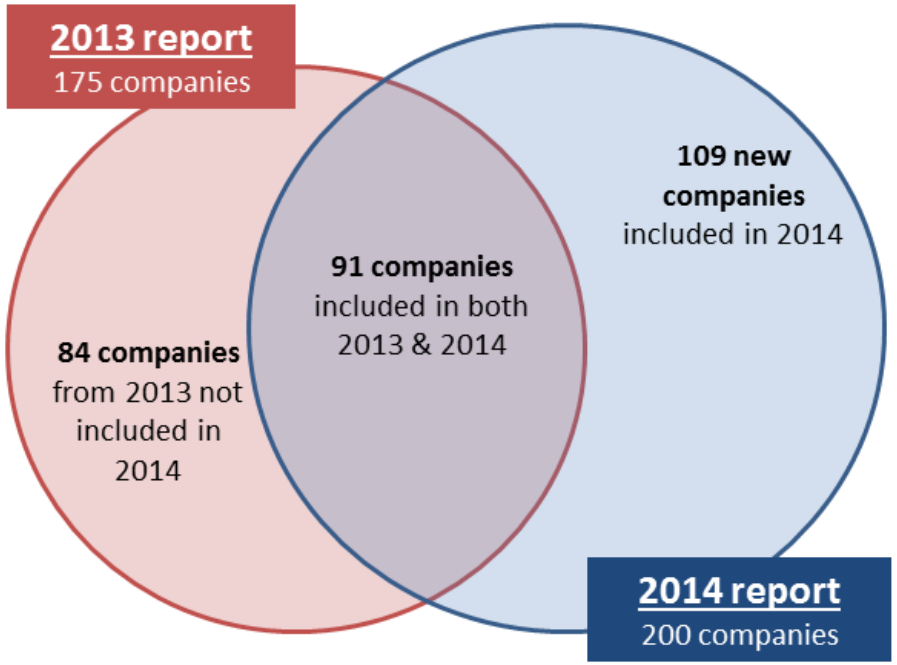


Global Biochar Market, by Feedstock



Source-Variant Market Research

UBI Market Analysis



- In 2014, similar to 2013, the biochar industry has yet to make a substantial entry into large-scale agricultural operations.
- The **number of companies included in this report rose from 175 in 2013 to 200 in 2014**. Although a large number of companies left the biochar field, new biochar companies are coming online; many with a focus on multiple value streams from biochar.
- **Companies reported volumes of biochar sales totaling 7,457 metric tons**. A significant majority of those transactions were made by a small number of businesses in Asia.
- **17.4 million in 2014 for global sales**
- **Woody biomass continues to be the largest source of feedstock for the biochar industry**, with 87% of respondents using woody biomass as a biochar feedstock.

Projections

- The global biochar market is expected to reach USD 3.14 billion by 2025, according to a new report by Grand View Research, Inc. Globally increasing consumption of organic food has been a major factor driving market growth. In addition, growing awareness regarding the advantages of biochar as soil amendment is further supplementing demand for the global market.
- Biochar is an emerging industry and the product is at its nascent stage.


FRONTIER
SIDE
UP

Marketplace

Local Sales

- Orcas Coop: 6 cft, 1 6cft
- San Juan Coop: 2 cft
- Browns Lumber: “A few thousand”
- Briarwood Farm: