Chemical characterization of Biochars using parameters that are relevant to its use as a component of a peat based growing media

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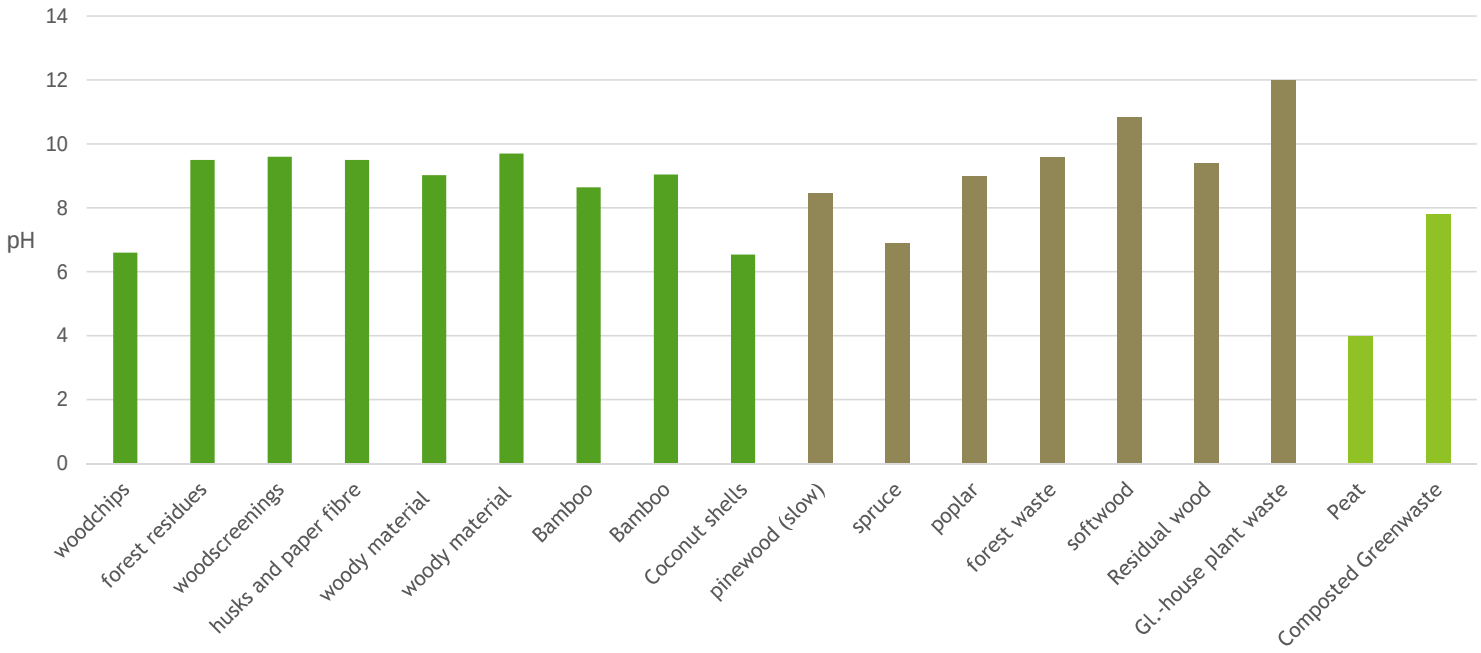
INTRODUCTION

- There is considerable interest in biochar a by product of pyrolysis process. Pyrolysis is used for syngas and Bio-Oil production
- Biochar has the ability to remove carbon from the atmosphere and sequester carbon for hundreds and thousands of year.
- Much work has been done on biochar as a soil amendment
- However much less work has been done for it's for use as a component of a growing media (peat replacement).
- Peat is the standard by which growing media is judged but peat harvesting releases large amount of GHG
- Despite the fact that the number of growing trials have been done on the use of biochar as a growing media component, the lack of proper characterization by methods relevant for growing media is lacking so the results cannot be compared adequately and the findings cannot be transferred in a meaningful way to new trials

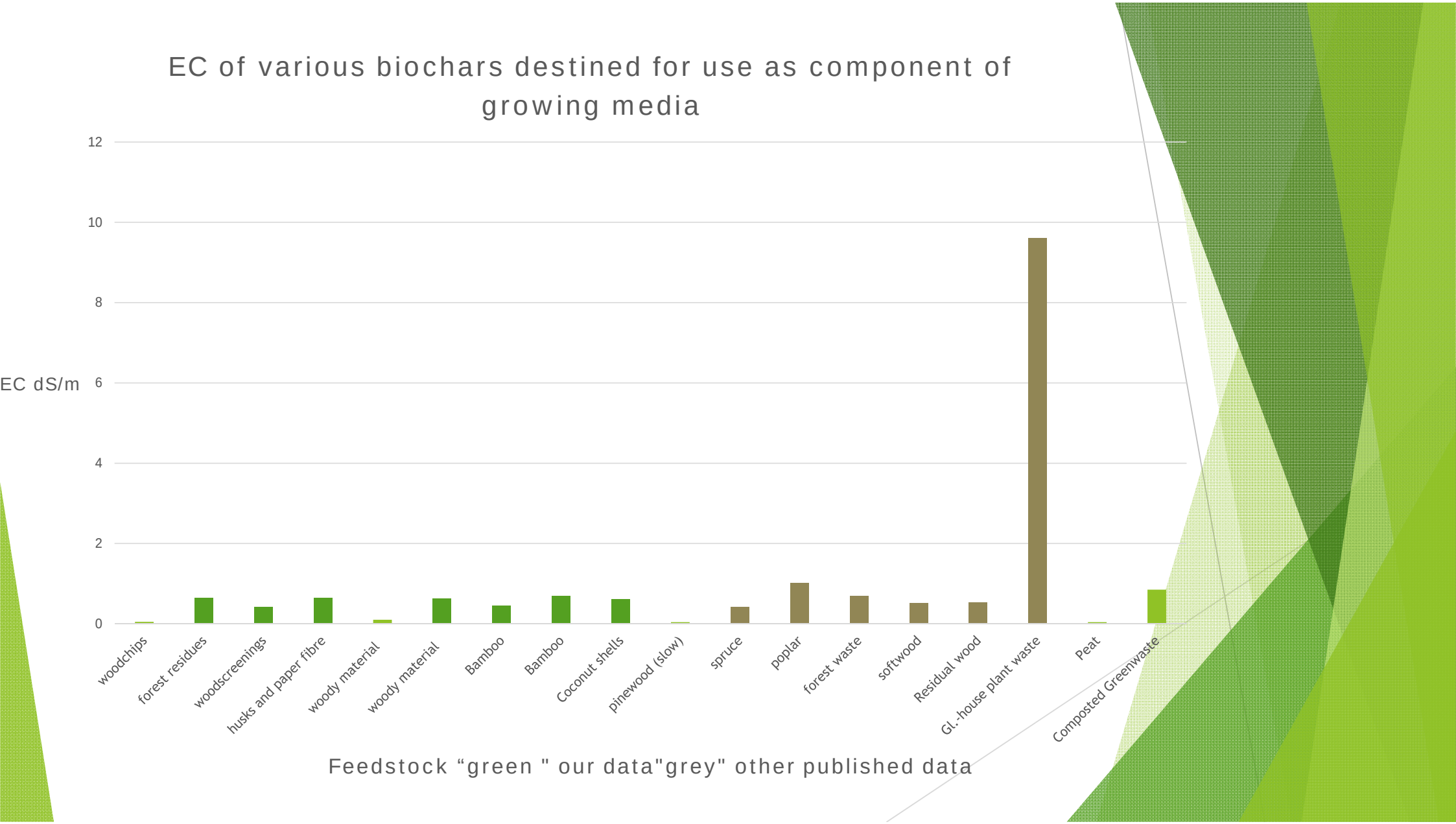
Objective

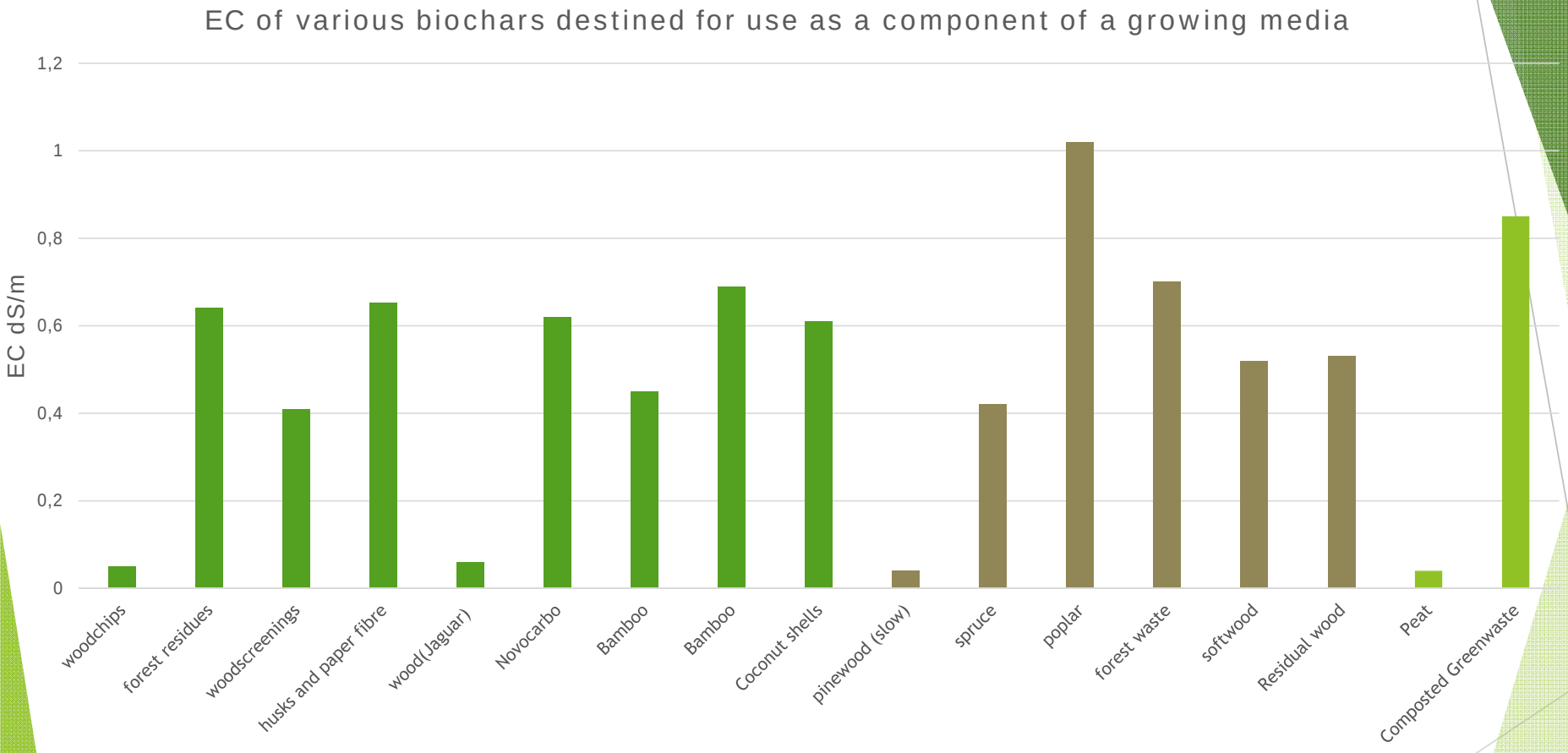
- To chemically characterize a range of commercially or near commercially available biochars from a range of feedstocks which we consider has a potential for use in Growing Media component (peat replacement)
- To compare our data which is relevant for testing of Growing Media to those obtained using similar test methods from other workers for the use as a component of growing Media(peat replacement)
- To critically appraise the findings from our tests and other similar tests, including shortcomings and it's implications for future work
- To assess N,P and K dynamics when biochars are added to fertilized peat over a long incubation period > 2 years

pH of various biochars destined for use as a component of growing media

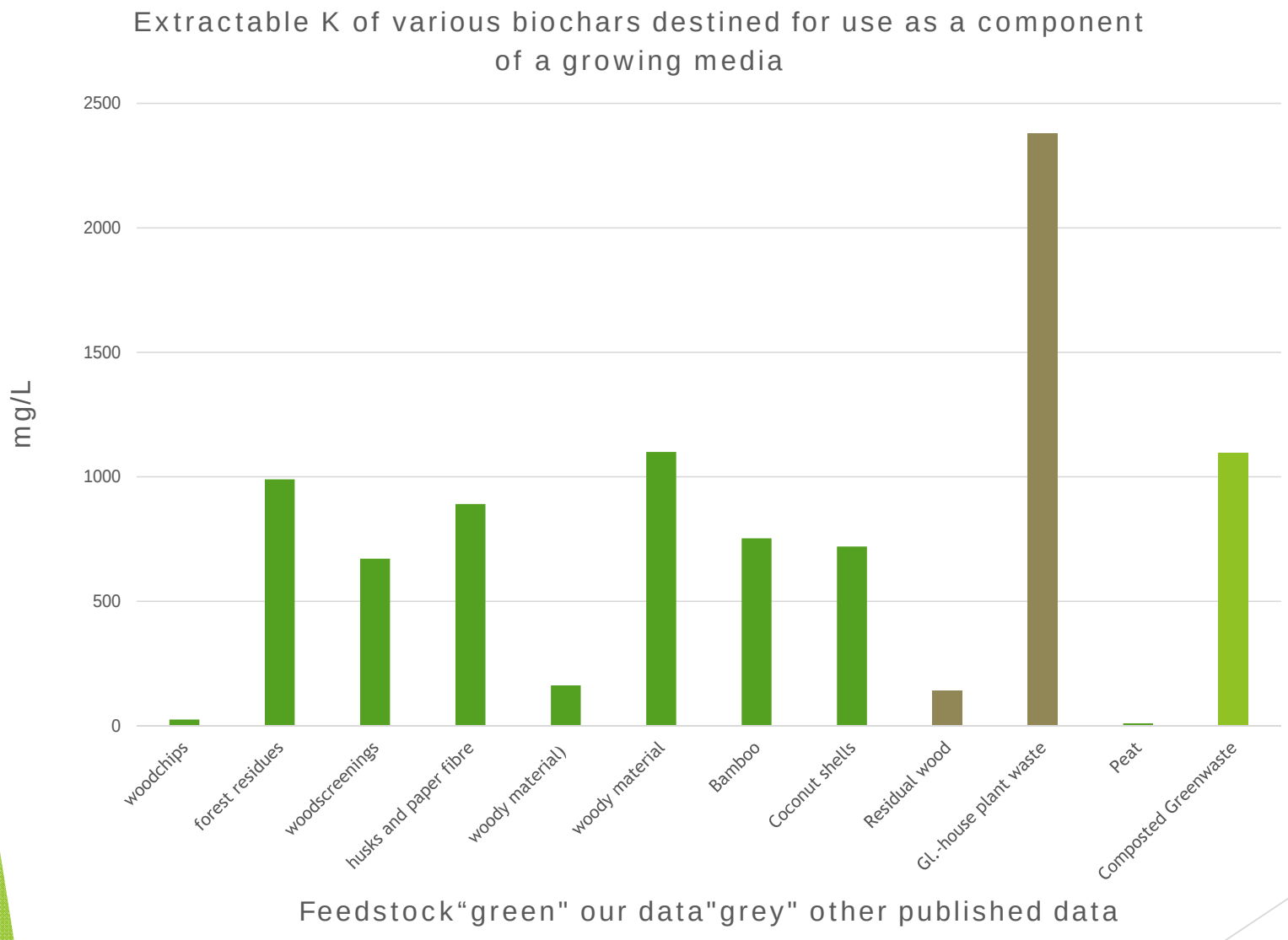


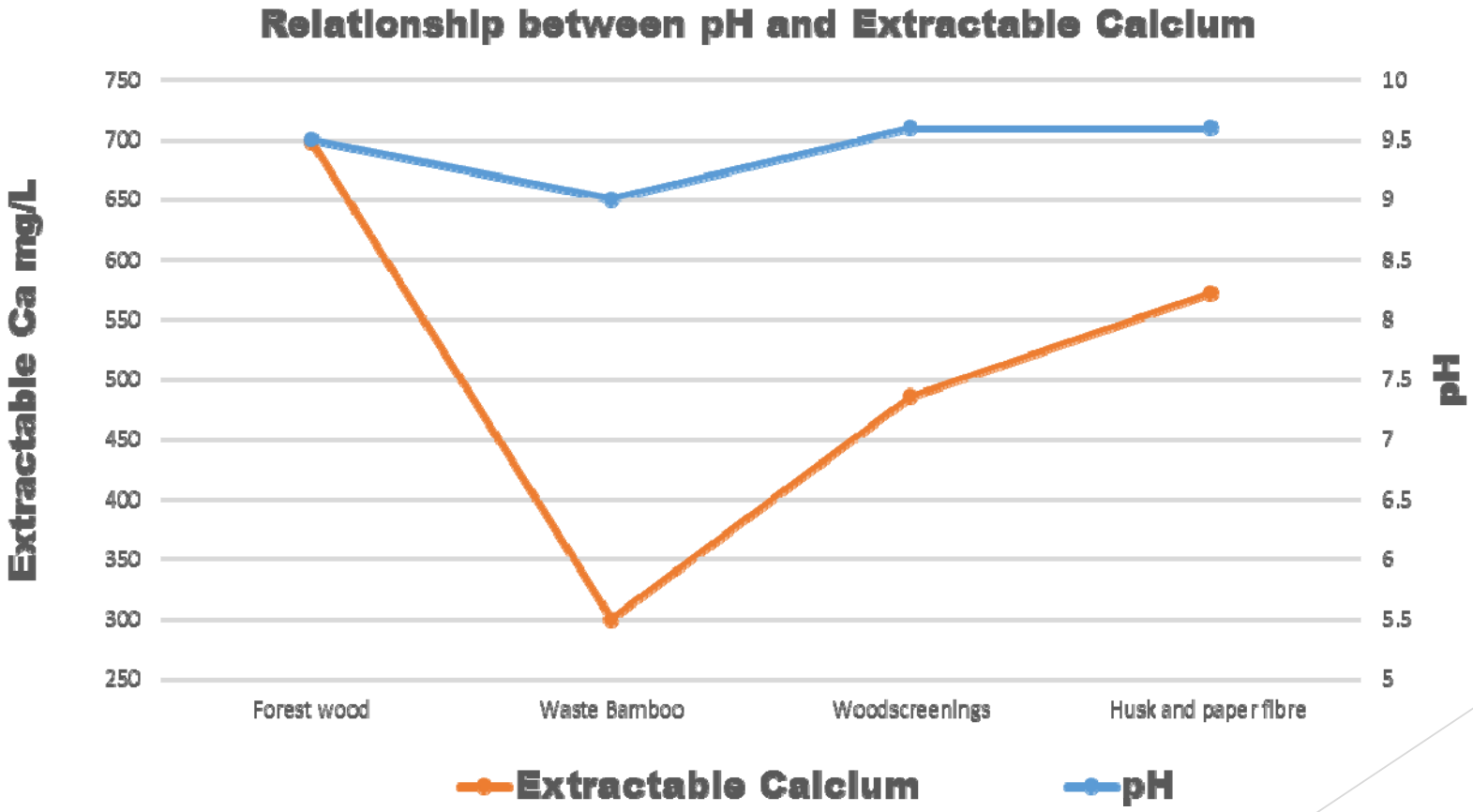
Feedstock, “green" our data,"grey" other published data

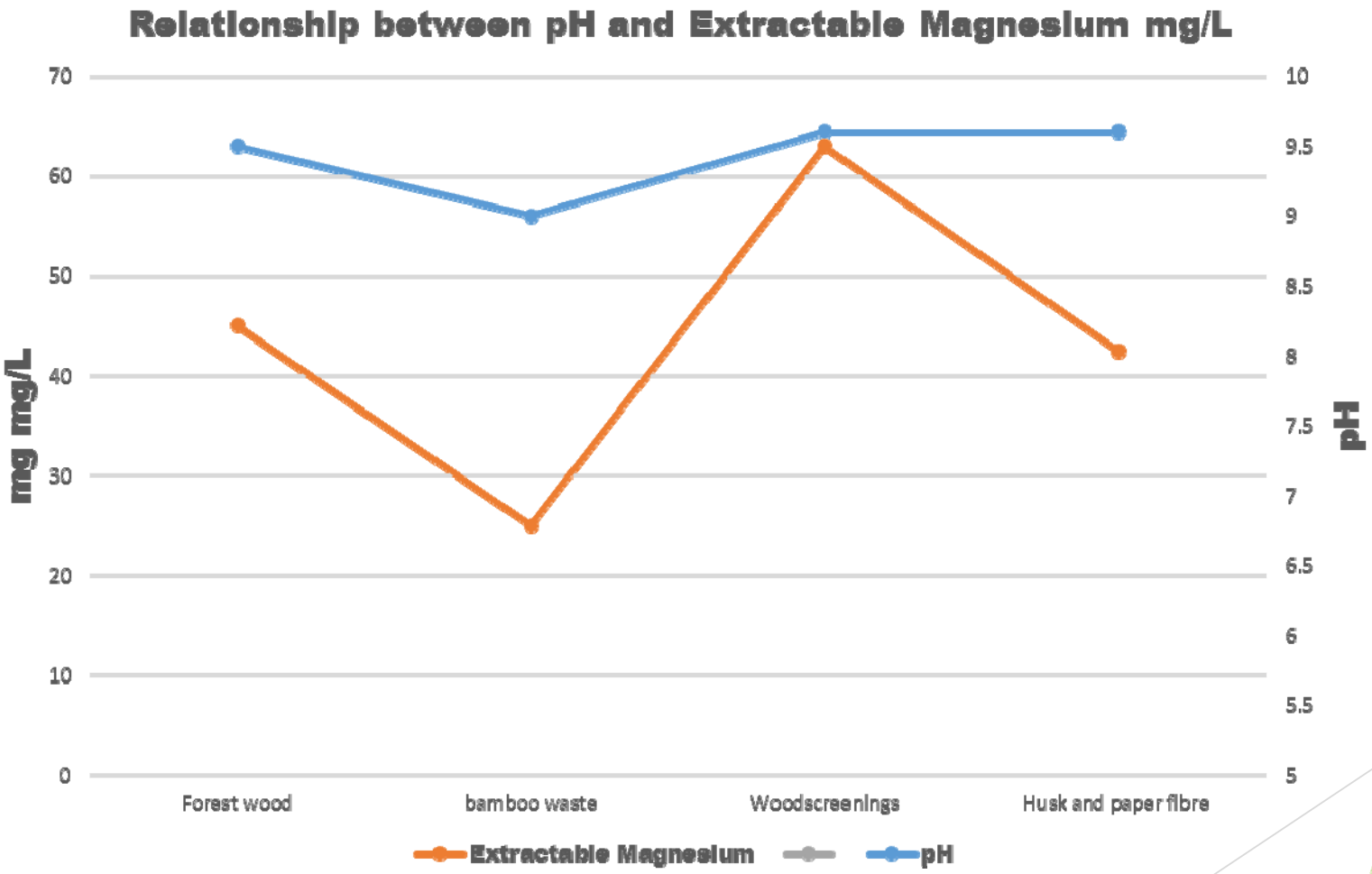

EC of various biochars destined for use as component of growing media
EC dS/m
12
10
8
6
4
2
0
woodchips
forest residues
woodscreenings
husks and paper fibre
woody material
woody material
Bamboo
Bamboo
Coconut shells
pinewood (slow)
spruce
poplar
forest waste
softwood
Residual wood
GL.-house plant waste
Peat
Composted Greenwaste
Feedstock “green " our data"grey" other published data

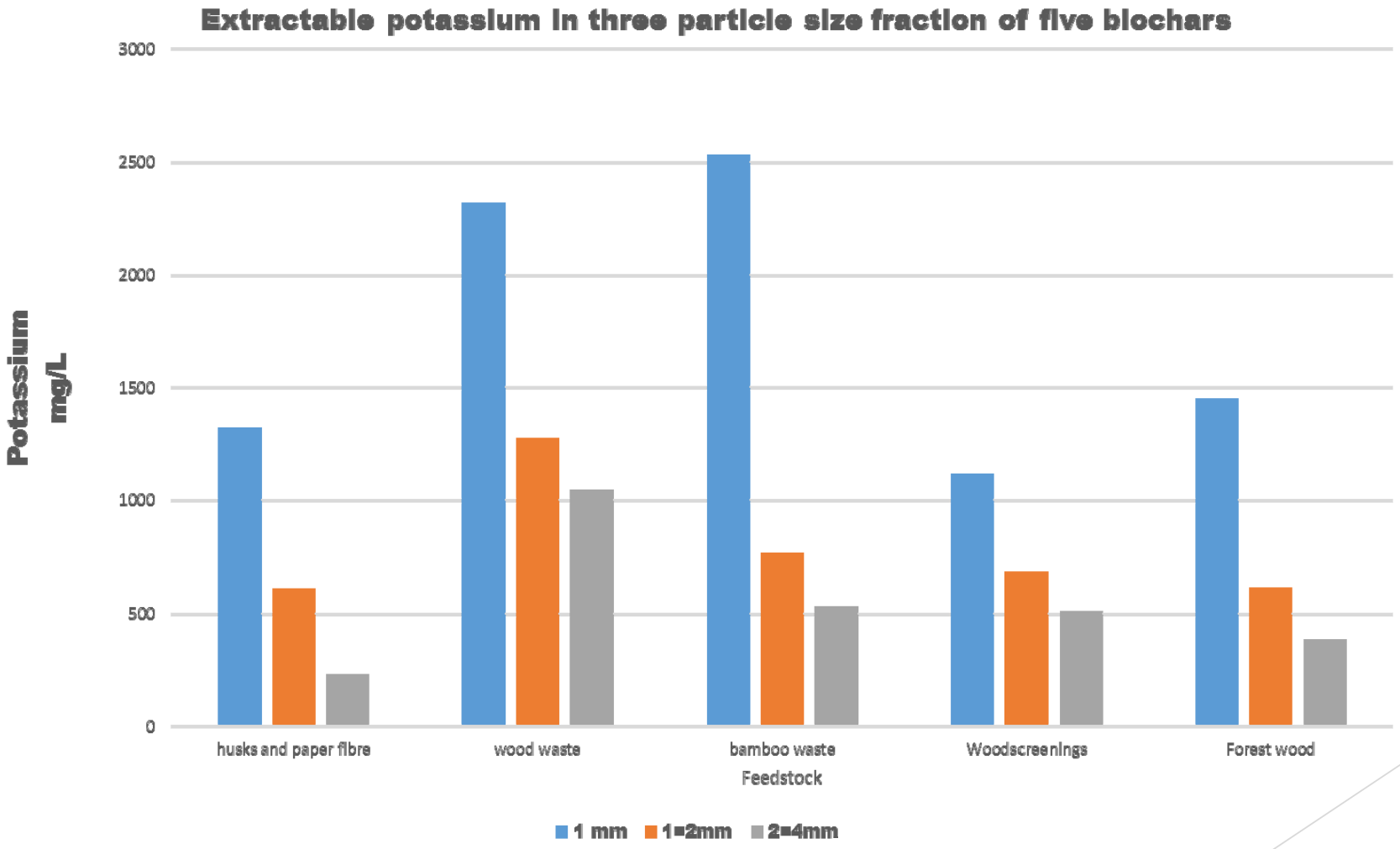


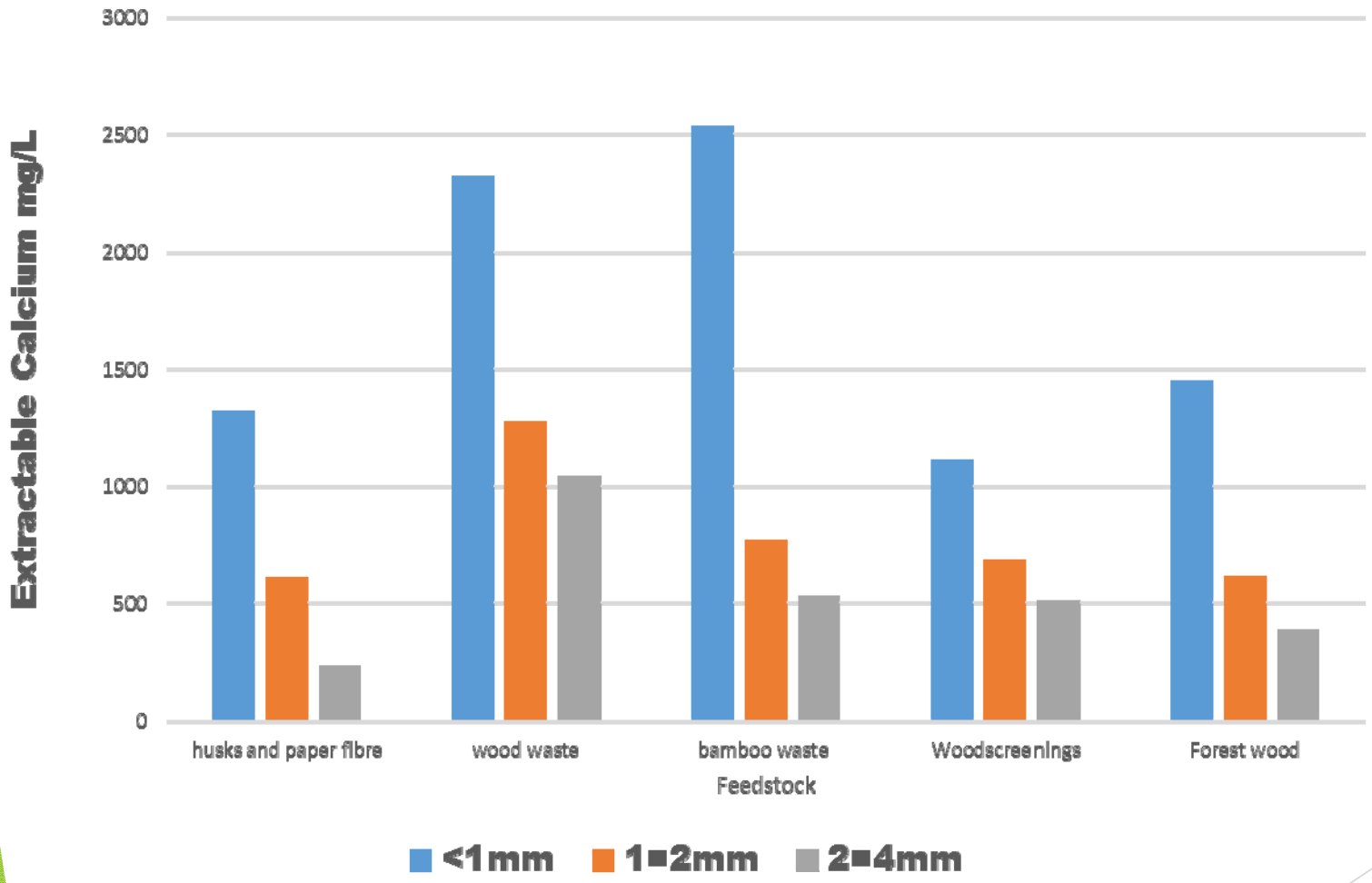
Feedstock“green" our data"grey"other publishrd data.
Note one very high figure omitted

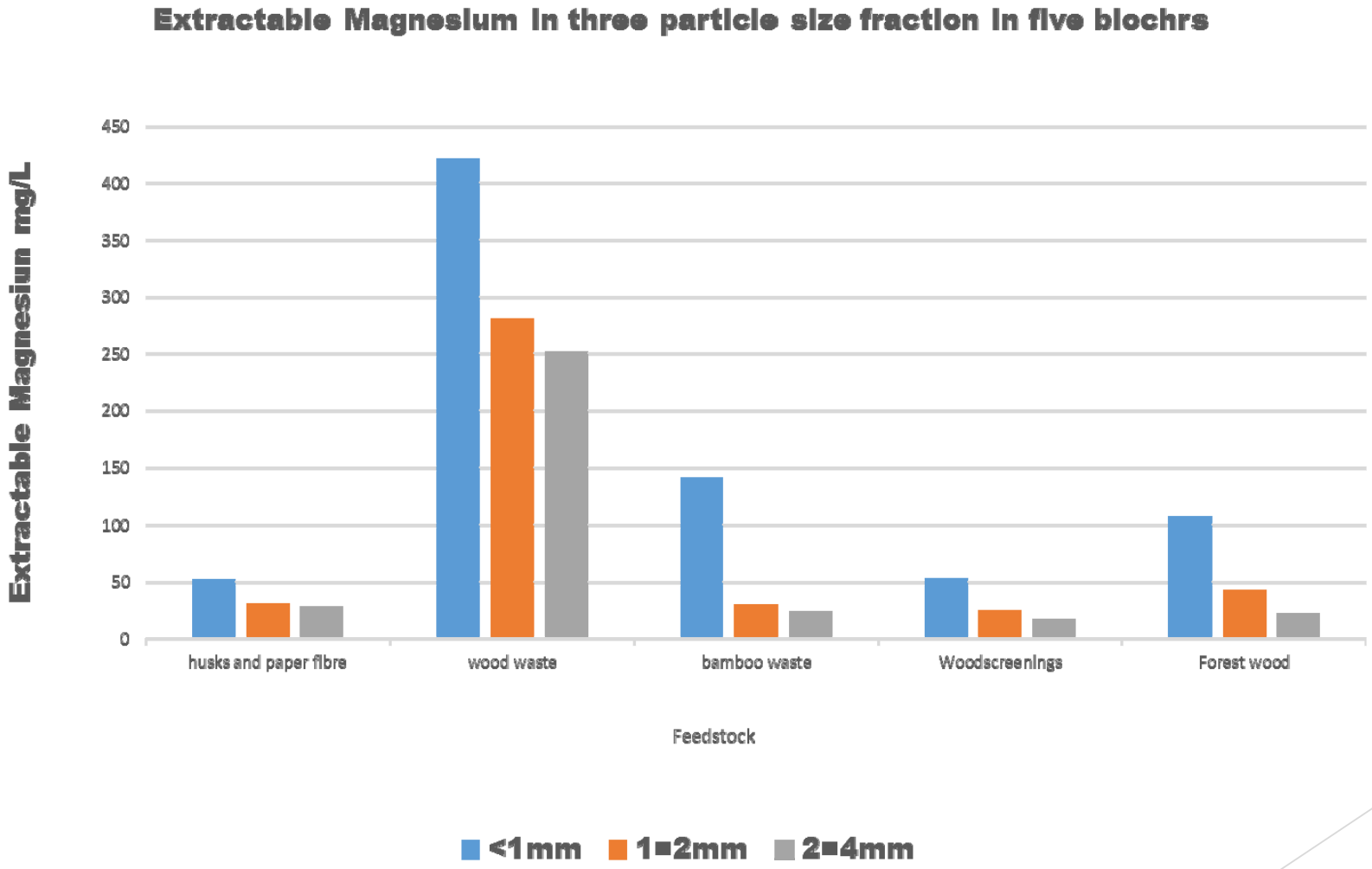

Extractable K of various biochars destined for use as a component of a growing media
mg/L
2500
2000
1500
1000
500
0
woodchips
forest residues
woodscreenings
husks and paper fibre
woody material)
woody material
Bamboo
Coconut shells
Residual wood
Gl.-house plant waste
Peat
Composted Greenwaste
Feedstock“green" our data"grey" other published data

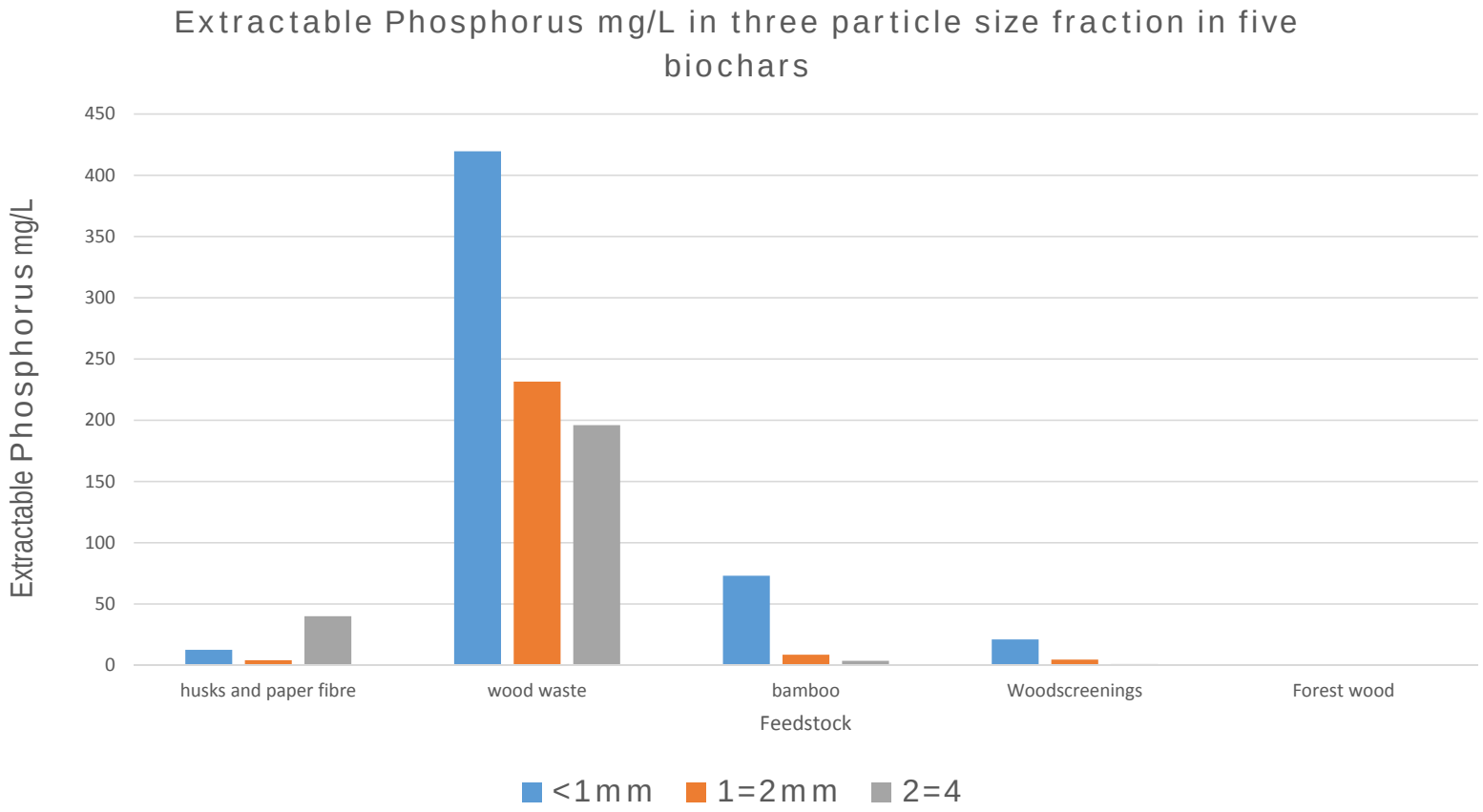

Relationship between pH and Extractable Calcium
Extractable Ca mg/L
750
700
650
600
550
500
450
400
350
300
250
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
pH
Forest wood
Waste Bamboo
Woodscreenings
Husk and paper fibre
Extractable Calcium
pH

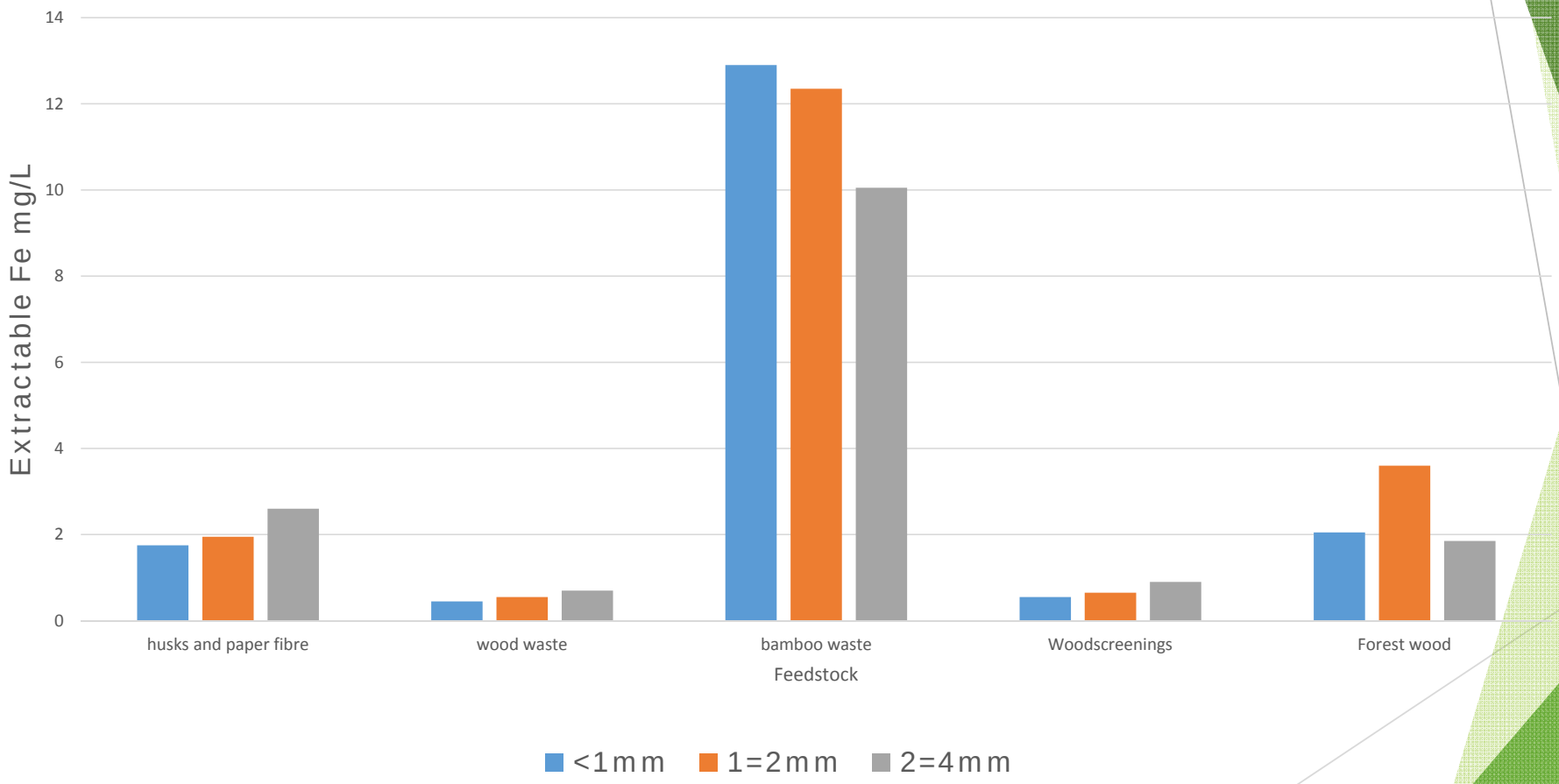

Relationship between pH and Extractable Magnesium mg/L
70
60
50
40
30
20
10
0
mg mg/L
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
pH
Forest wood
bamboo waste
Woodscreenings
Husk and paper fibre
Extractable Magnesium
pH

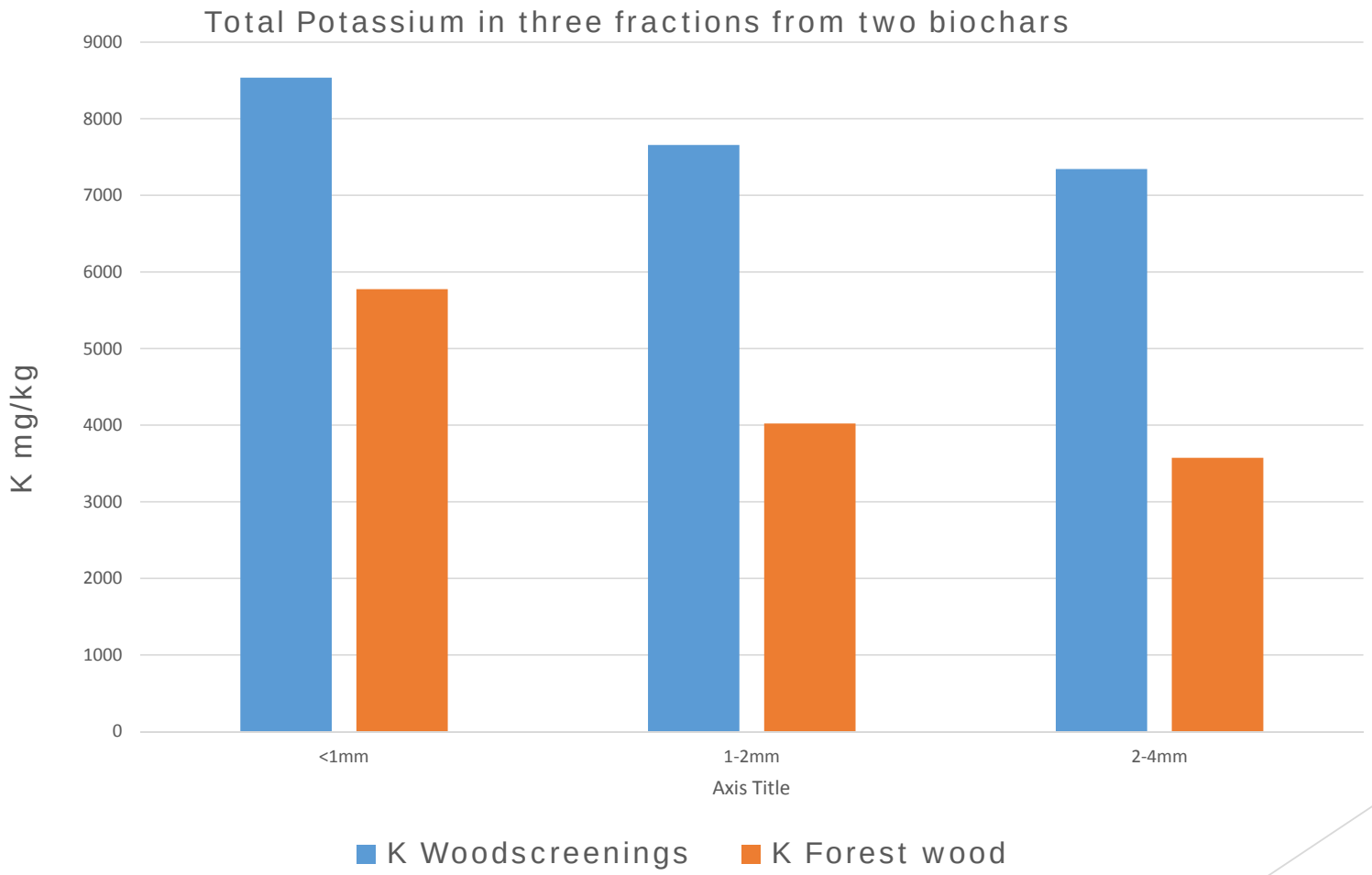

Extractable potassium in three particle size fraction of five biochars
Potassium mg/L
3000
2500
2000
1500
1000
500
0
husks and paper fibre
wood waste
bamboo waste
Woodscreenings
Forest wood
Feedstock
1 mm
1-2mm
2-4mm

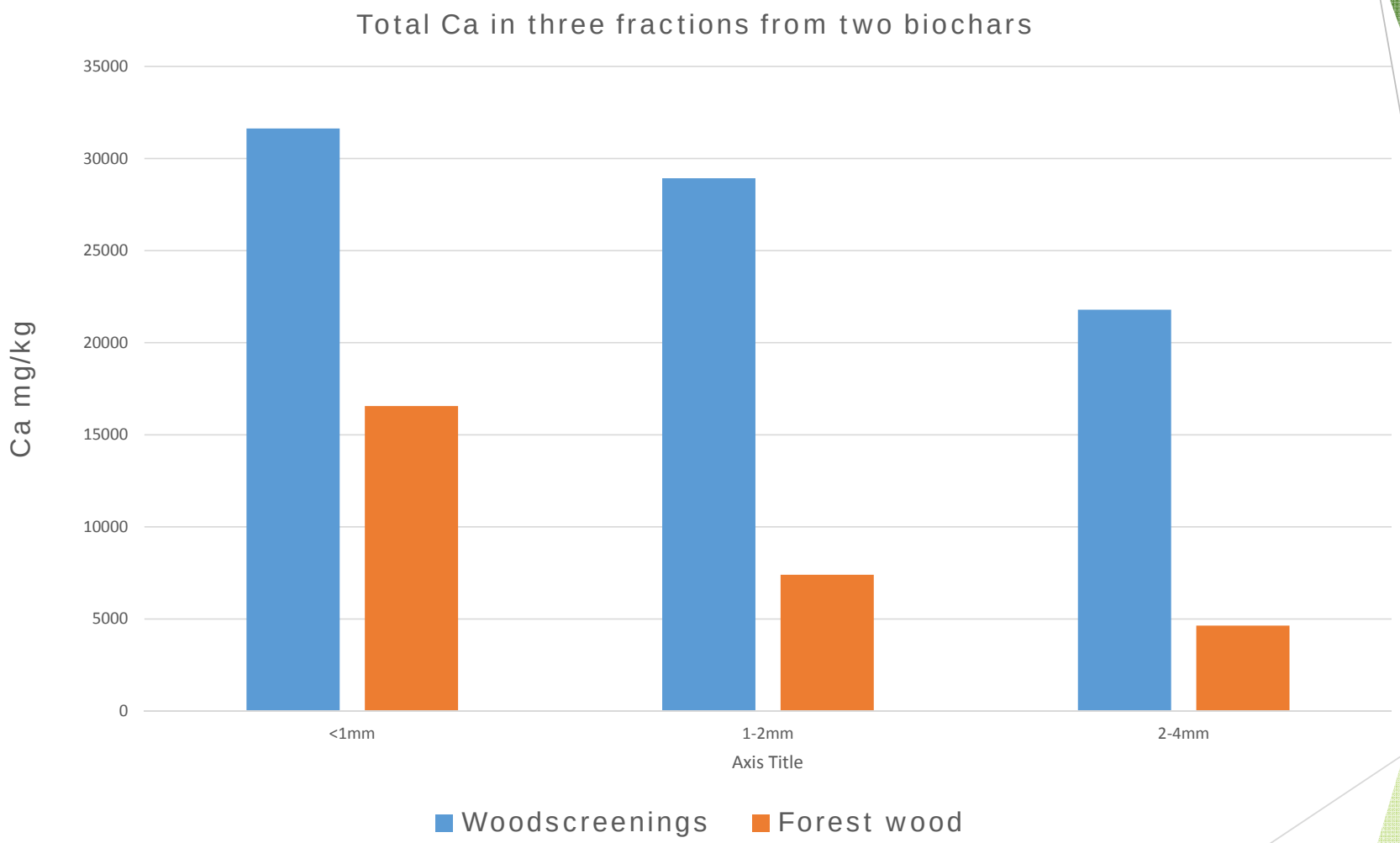

Extractable Calcium in three particle size fraction from five biochars
Extractable Calcium mg/L
3000
2500
2000
1500
1000
500
0
husks and paper fibre
wood waste
bamboo waste
Woodscreenings
Forest wood
Feedstock
<1mm
1-2mm
2-4mm

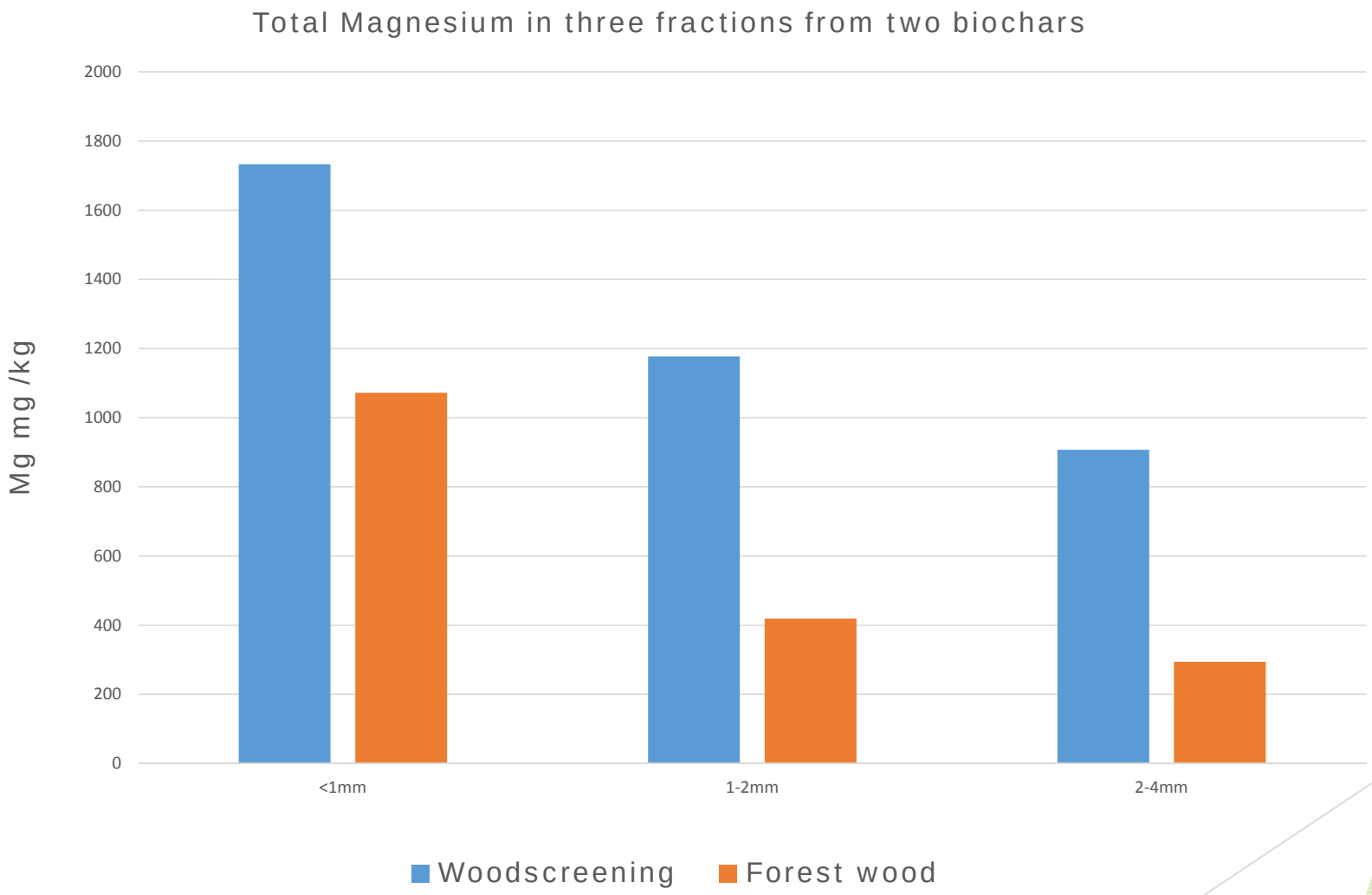

Extractable Magnesium in three particle size fraction in five biochrs
Extractable Magnesium mg/L
450
400
350
300
250
200
150
100
50
0
husks and paper fibre
wood waste
bamboo waste
Woodscreenings
Forest wood
Feedstock
<1mm
1-2mm
2-4mm

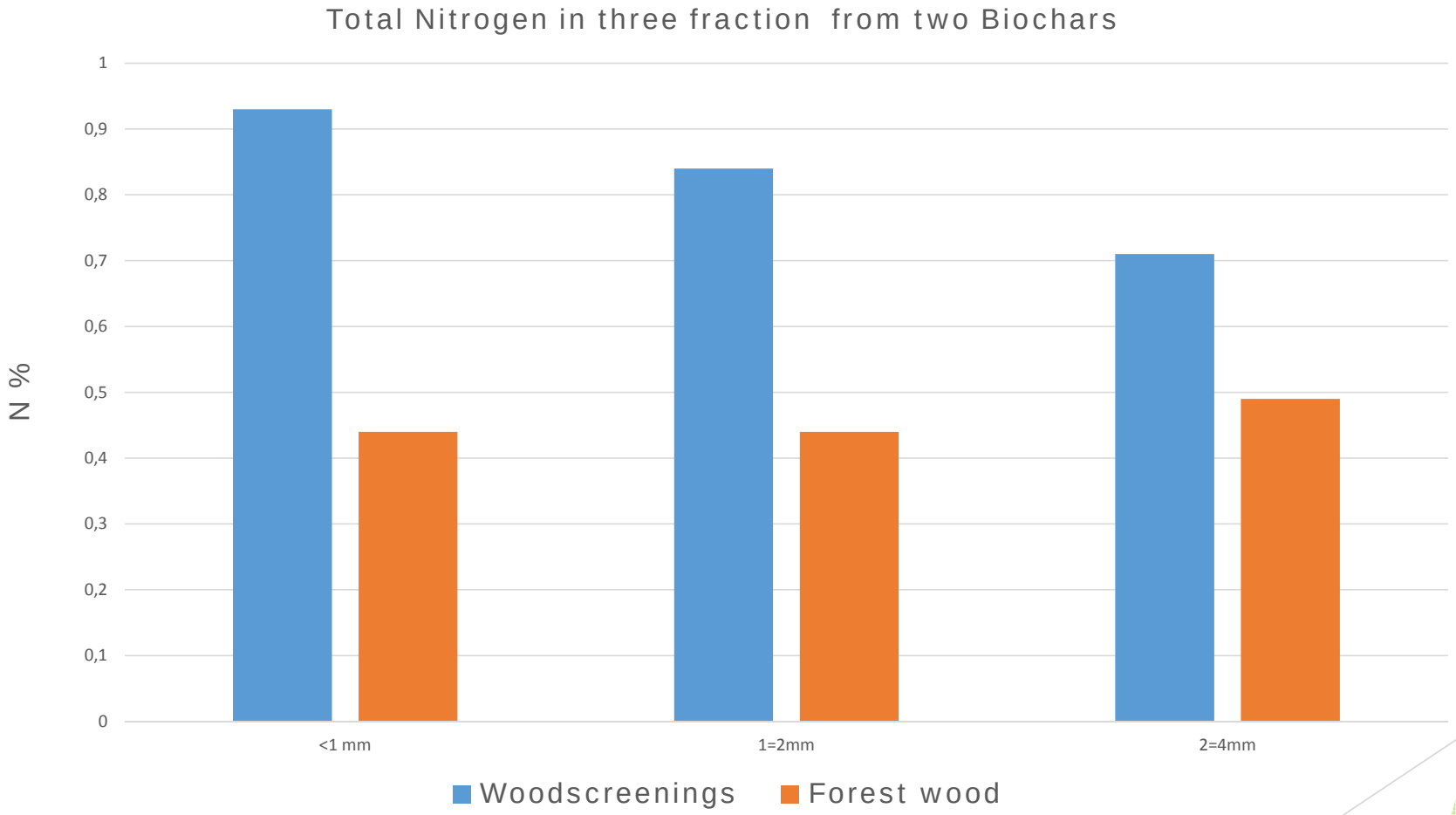

Extractable Phosphorus mg/L in three particle size fraction in five biochars
Extractable Phosphorus mg/L
450
400
350
300
250
200
150
100
50
0
husks and paper fibre
wood waste
bamboo
Woodscreenings
Forest wood
Feedstock
<1mm
1=2mm
2=4

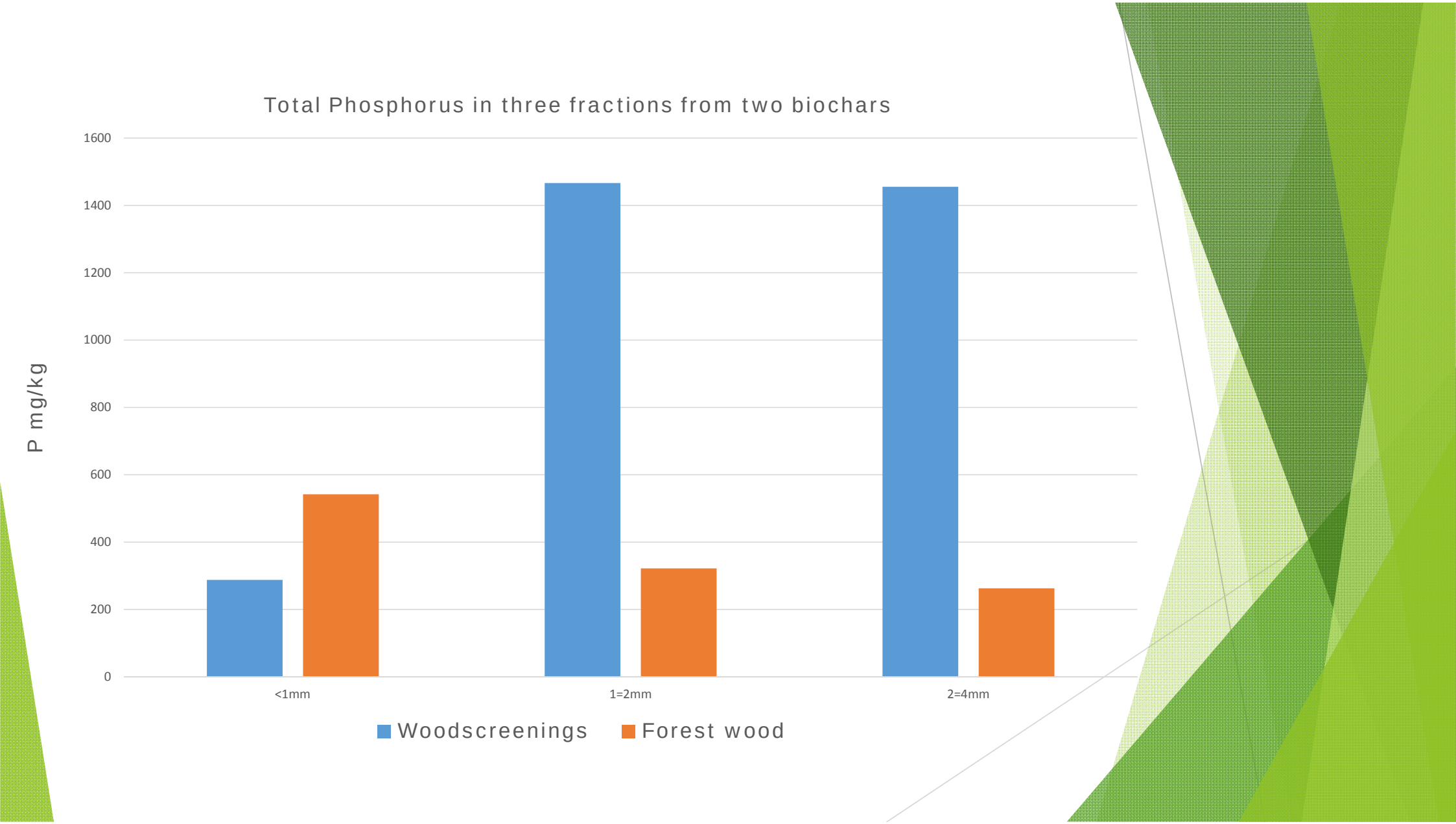

Extractable Iron mg/L in three particle size fraction in five biochars
Extractable Fe mg/L
14
12
10
8
6
4
2
0
husks and paper fibre
wood waste
bamboo waste
Woodscreenings
Forest wood
Feedstock
<1mm
1=2mm
2=4mm

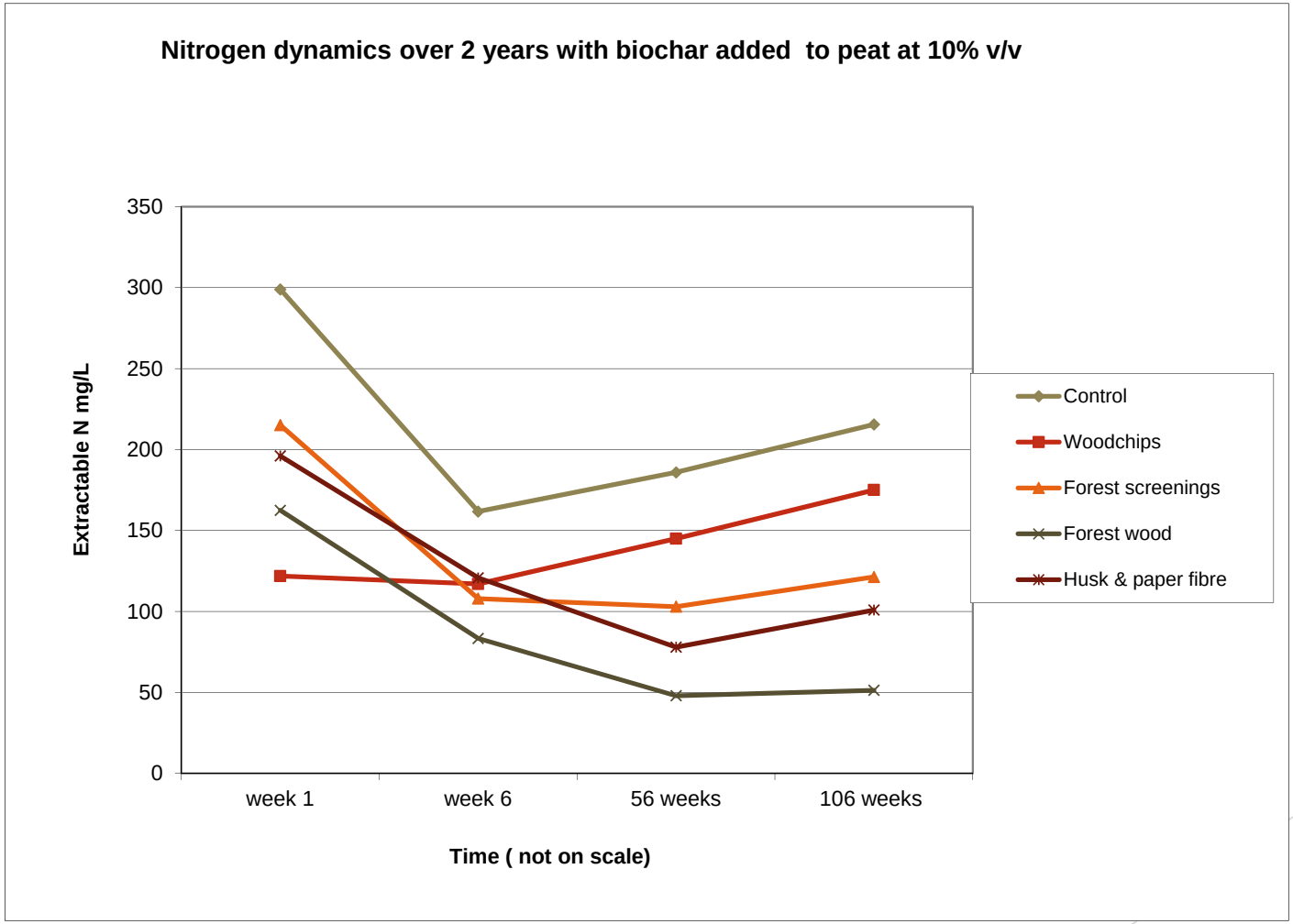

Total Potassium in three fractions from two biochars
K mg/kg
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
<1mm
1-2mm
2-4mm
Axis Title
K Woodscreenings
K Forest wood

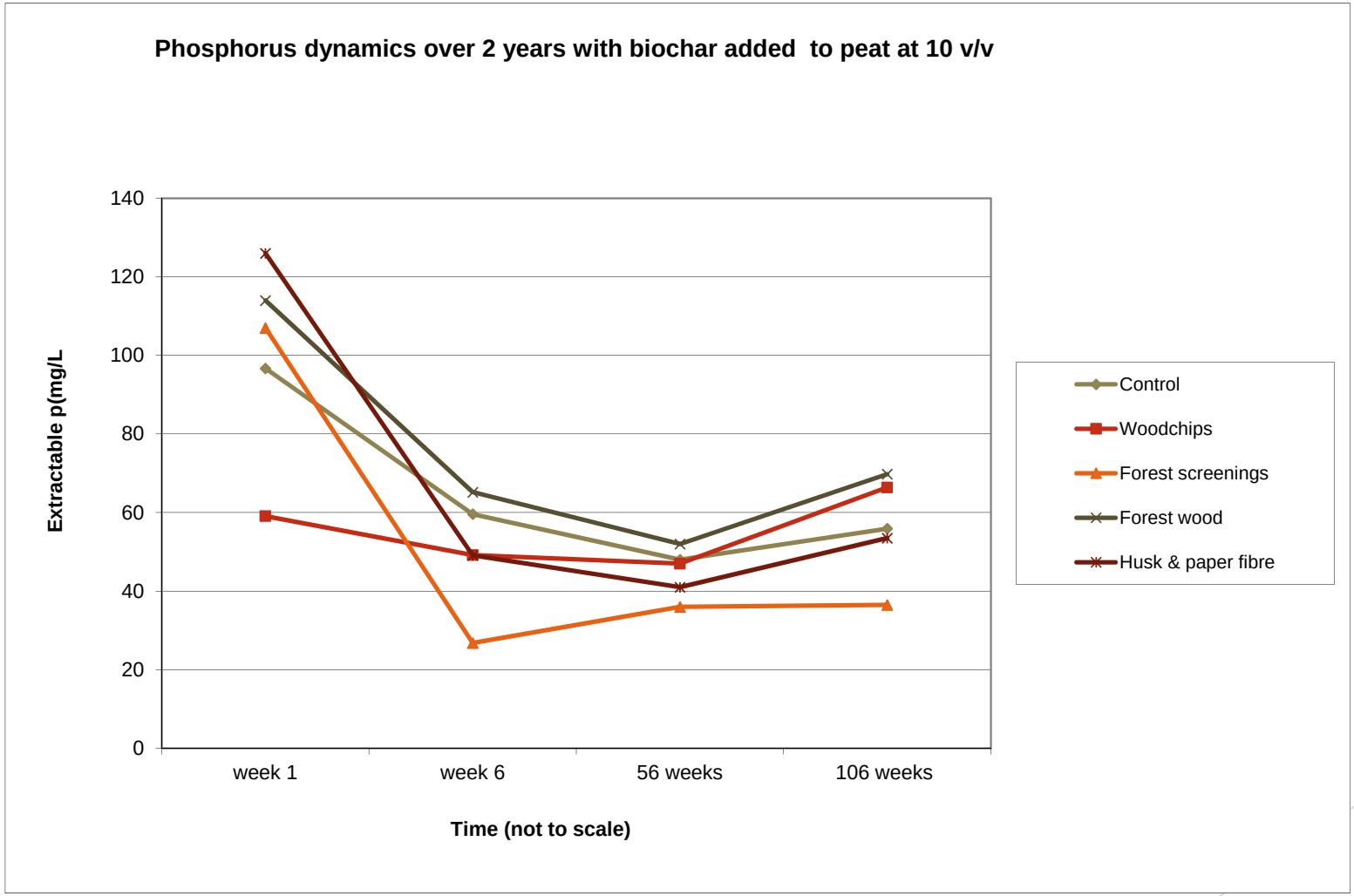

Total Ca in three fractions from two biochars
Ca mg/kg
35000
30000
25000
20000
15000
10000
5000
0
<1mm
1-2mm
2-4mm
Axis Title
Woodscreenings
Forest wood

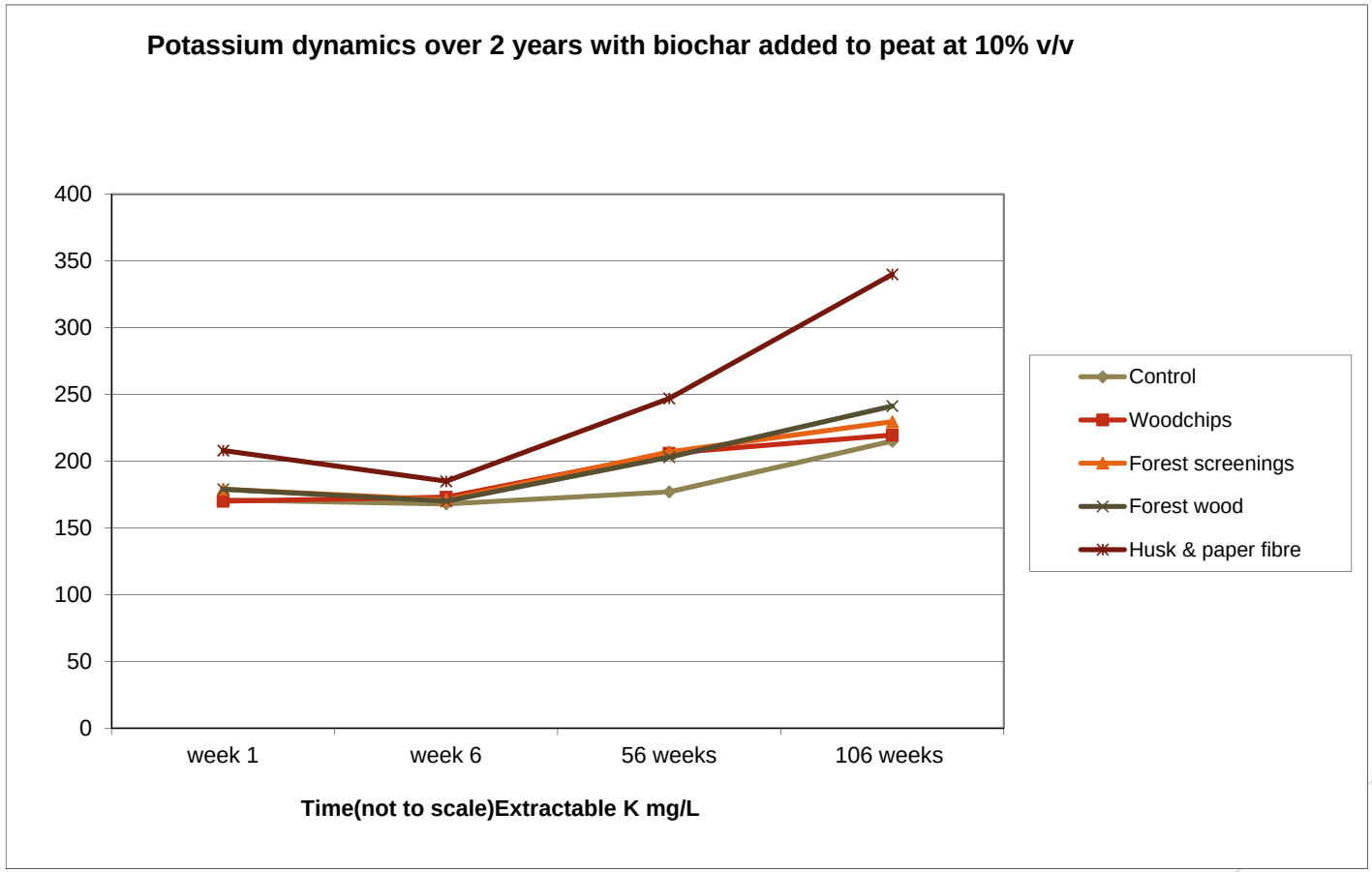

Total Magnesium in three fractions from two biochars
Mg mg /kg
2000
1800
1600
1400
1200
1000
800
600
400
200
0
<1mm
1-2mm
2-4mm
Woodscreening
Forest wood


Total Nitrogen in three fraction from two Biochars
N %
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
<1 mm
1=2mm
2=4mm
Woodscreenings
Forest wood


Total Phosphorus in three fractions from two biochars
P mg/kg
1600
1400
1200
1000
800
600
400
200
0
<1mm
1=2mm
2=4mm
Woodscreenings
Forest wood


Nitrogen dynamics over 2 years with biochar added to peat at 10% v/v
Extractable N mg/L
350
300
250
200
150
100
50
0
week 1
week 6
56 weeks
106 weeks
Time (not on scale)
Control
Woodchips
Forest screenings
Forest wood
Husk & paper fibre


Phosphorus dynamics over 2 years with biochar added to peat at 10 v/v
Extractable p(mg/L
140
120
100
80
60
40
20
0
week 1
week 6
56 weeks
106 weeks
Time (not to scale)
Control
Woodchips
Forest screenings
Forest wood
Husk & paper fibre


Potassium dynamics over 2 years with biochar added to peat at 10% v/v
400
350
300
250
200
150
100
50
0
week 1
week 6
56 weeks
106 weeks
Time(not to scale)Extractable K mg/L
Control
Woodchips
Forest screenings
Forest wood
Husk & paper fibre

CONCLUSION

- From this and oher results one can conclude that biochar made from woody material (biomass from forestry, municipal waste etc.) would be suitable for use as a component of a growing media.

- Published work by other workers on the use of biochar as a component of growing media have concluded that the high pH of biochar can be used to substitute dolomitic limestone ($CaMg(CO_3)_2$ to raise the pH of peats
  However our results show that this premise is not totally correct as we have shown that biochar with similar pH have different levels of extractable calcium and magnesium.
  It is also a moot point whether application of biochar at rates recommended would supply adequate calcium and magnesium that one gets when one applies dolomitic limestone at rates of 4kg/m3.
  It is therefore important to also measure extractable and total Ca and Mg in biochar before deciding the rate of lime or omitting it from peat based growing media

CONCLUSION(contd)

- We have shown particle size has a major effect on all macro nutrient availability as measured by extractable nutrients, with the fine fraction <1mm having much higher nutrient availability in all the 5 biochars studied.
  We have not been able to find any published work on this in context of growing Media.
  This is an important factor that should be considered when formulating peat-biochar based growing media In addition to feedstock and pyrolysis temperature which are well known to effect the quantity and availability of nutrients, particle size should be taken into account.
  Hardly any papers on Biochar as a component of peat based growing media have given details on particle size of biochar used.

- We are not able to conclude on basis of this work what effect particle size has on total nutrients as we got variable results.

- In our earlier published work we were able to show that biochar mixes with fertilised peat have a tendency to capture nitrate and phosphate over the short term.
  Our present result which is over a long period (2 years) shows little or no release of nitrogen and phosphorus that was captured by biochar
- We did find however there was a release of potassium.

Thank You !

Any Questions?