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Evaluation of the long-term effects of pre-conditioned biochar on soil organic carbon in temperate soils using the Century Soil Organic Matter model

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INTRODUCTION

- Conventional agriculture = loss of SOC
- Biochar addition to soil
 - Increase soil C sequestration & stabilization
 - Contains limited available nutrients for crop productivity
 - Requires high rates (10 t/ha) of biochar addition plus fertilizer and/or manure
- Pre-conditioned biochar
 - Soaking biochar in urea ammonium nitrate (UAN-enriched biochar)
 - Decreases biochar application (1 - 2 t/ha)
- How does pre-conditioned biochar influence soil C sequestration over the long-term?

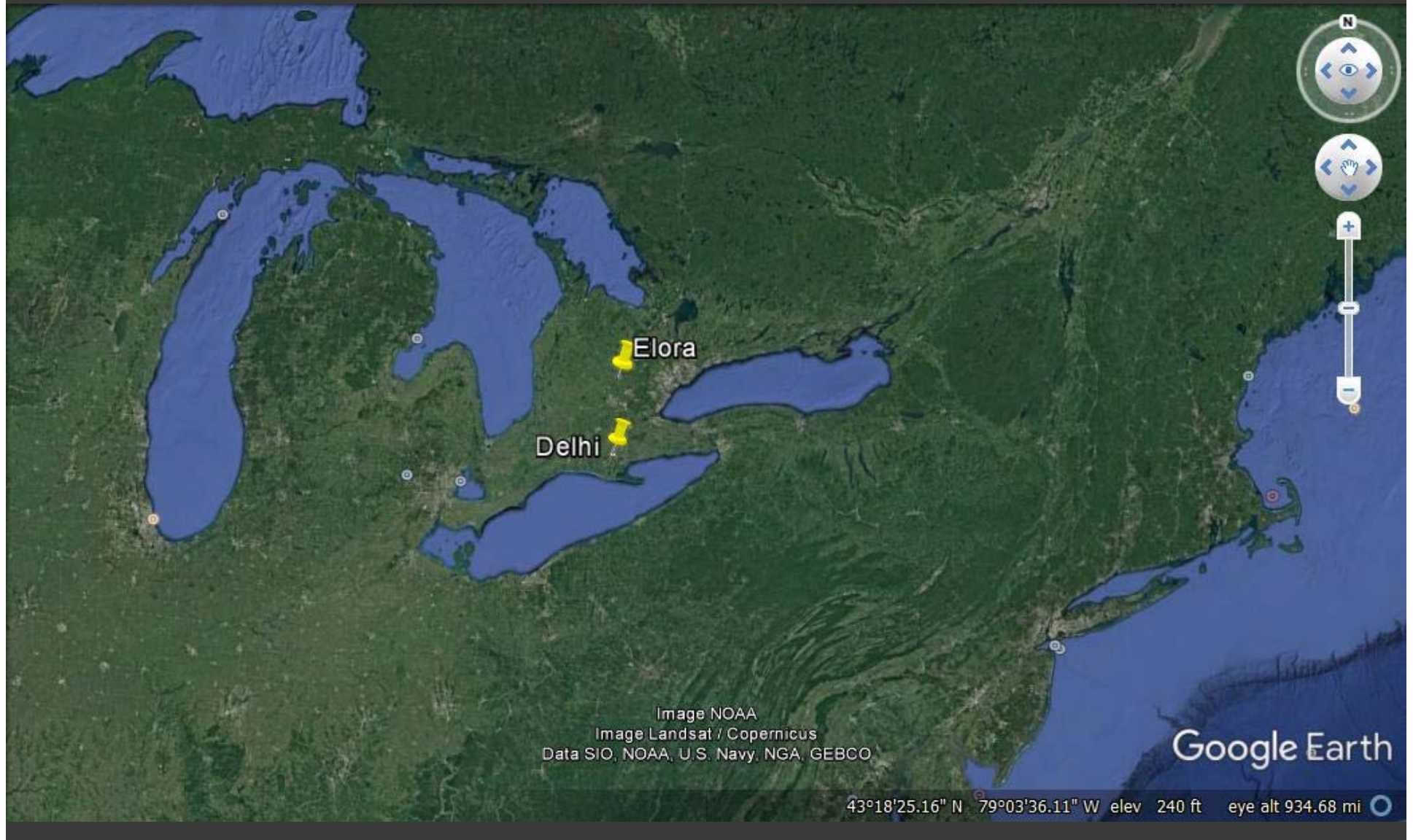
OBJECTIVE

To evaluate the long-term (150 years) impact of adding UAN-enriched biochar on SOC and SOC fractions compared to other commonly used agroecosystem management practices in coarse and medium-textured soil using the Century soil organic matter model

MATERIALS & METHODS: SITES

	Coarse textured soil	Medium textured soil
Location	Delhi, Ontario	Elora, Ontario
Latitude/longitude	42°51'N/80°29'W	43°52'N/80°21'W
Altitude (m.a.s.l.)	240	376
Mean precipitation (mm/y)	697	778
Mean temperature (°C)	7.8	6.0
Soil classification (FAO)	Luvisol	Cambisol
Sand (%)	85	21
Silt (%)	11	55
Clay (%)	4	24
Bulk density (g/cm ³)	1.4	1.3
pH	6.9	7.1
SOC (%)	0.7	2.2
Total N (%)	0.06	0.19

LOCATION OF DELHI & ELORA



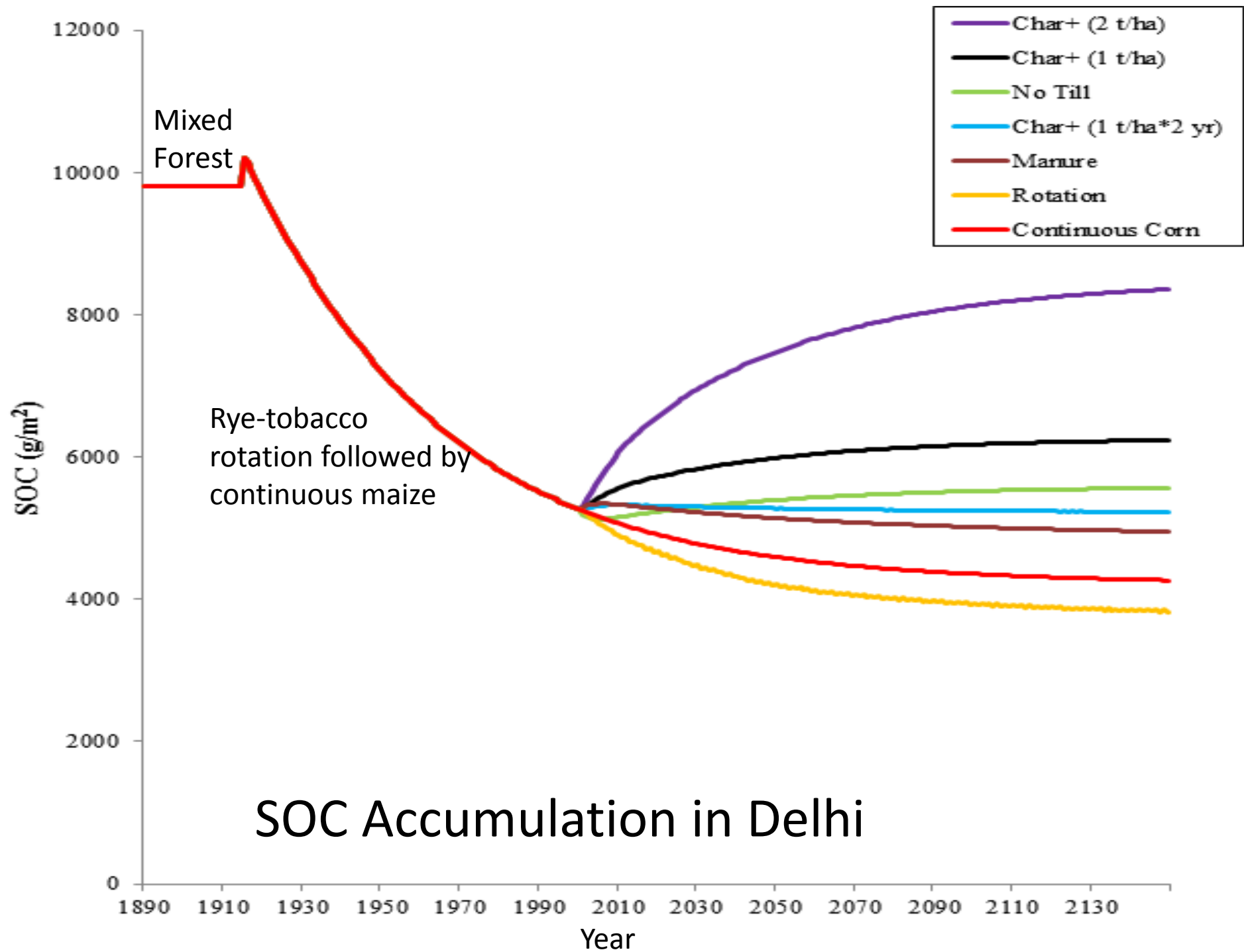
CENTURY MODEL

- CENTURY
 - Site-specific model
 - Simulates soil-plant-climate interactions
 - Evaluates agroecosystem management practices
 - Crop types, crop rotation, tillage types, amendment addition etc.
- Our Simulation
 - CENTURY Version 4.0
 - Calibration with input of site specific data
 - Climate & soil

Management Practices Used:

- Continuous maize, plough
- 200 g/m²UAN-biochar (Char⁺200g/m²), plough
- 100 g/m²UAN-biochar (Char⁺100g/m²), plough
- 2x100 g/m²UAN-biochar (Char⁺100g/m² x 2yrs), plough
- Manure (cow), plough
- No till, maize continuous
- Maize-soybean rotation, plough

Downloadable version of Century at <https://www.nrel.colostate.edu/projects/century/>

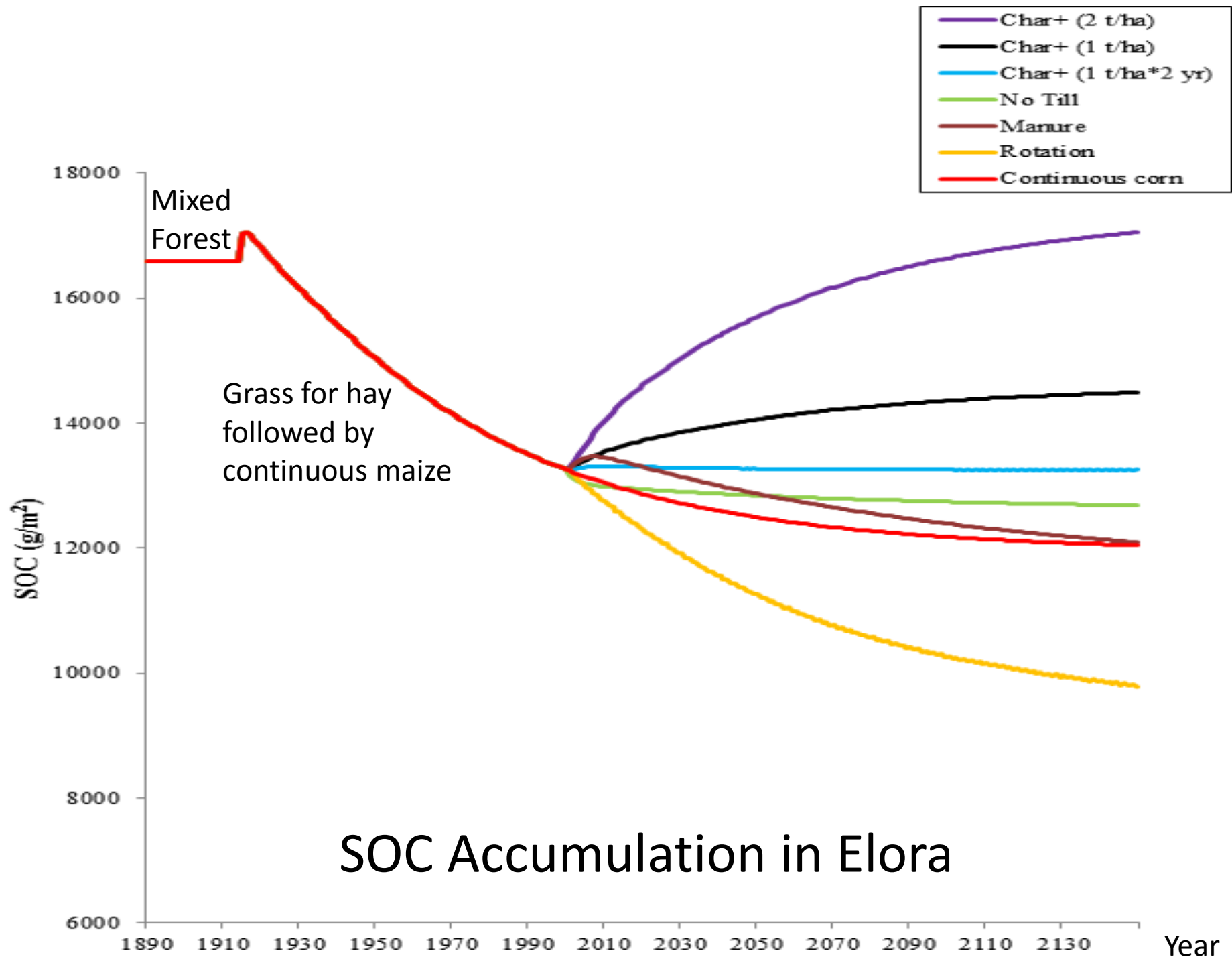


Changes in SOC stocks in Delhi

Management Practice	SOC in year 2150 (g/m ²)	SOC change from year 2001 (g/m ²)	Change from continuous maize (g/m ²)
Continuous maize	6,344	-456	--
Char ⁺ 200g/m ²	10,522	3,715	4,178
Char ⁺ 100g/m ²	8,319	1,515	1,975
Char ⁺ 100g/m ² x 2yrs	7,208	404	864
Manure	6,986	180	642
No till	5,725	-1,077	-619
Maize-soybean rotation	4,975	-1,825	-1,369

Changes in SOC fractions in Delhi

Management Practice	Active SOC fraction (g/m ²)	Slow SOC fraction (g/m ²)	Passive SOC fraction (g/m ²)
Continuous maize	-7	-686	37
Char+200g/m ²	37	2,591	97
Char+100g/m ²	15	973	68
Char+100g/m ² x 2yrs	3	154	53
Manure	-5	17	47
No till	-101	-708	-47
Maize-soybean rotation	-72	-1,647	-21



Changes in SOC stocks in Elora

Management Practice	SOC in year 2150 (g/m ²)	SOC change from year 2001 (g/m ²)	Change from continuous maize (g/m ²)
Continuous maize	12,042	-1,183	--
Char ⁺ 200g/m ²	17,048	3,658	5,006
Char ⁺ 100g/m ²	14,484	1,226	2,442
Char ⁺ 100g/m ² x 2yrs	13,246	-12	1,204
Manure	121,088	-1,194	46
No till	12,680	-478	638
Maize-soybean rotation	9,783	-3,442	-2,259

Changes in SOC fractions in Elora

Management Practice	Active SOC fraction (g/m ²)	Slow SOC fraction (g/m ²)	Passive SOC fraction (g/m ²)
Continuous maize	-26	-1,156	-1
Char+200g/m ²	80	118	3,561
Char+100g/m ²	27	817	59
Char+100g/m ² x 2yrs	1	-174	29
Manure	-245	3791	174
No till	-71	-302	-44
Maize-soybean rotation	-159	-3,099	-126

Conclusions

- Addition of biochar leads to an increase in SOC and its long-term stabilization
- Adding biochar more than one year
 - Does not always increase SOC
 - Can decrease C accumulation in some of the SOC fractions
 - Dependent on soil texture
- Biochar can be added at a much lower rate if pre-conditioned with N (eg. UAN)
- Soil texture influenced which SOC fraction had the greatest influence on SOC accumulation and stabilization

Acknowledgements

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