EXPLORING THE FUTUR OF LOWLAND PEAT

Lowland agricultural peat-perspective from Canada

1

Fenland Conference
Ely - 2023

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PRESENTATION PLAN

Peat and agricultural peat in Canada and Québec

A little bit of history…and socio-economic importance

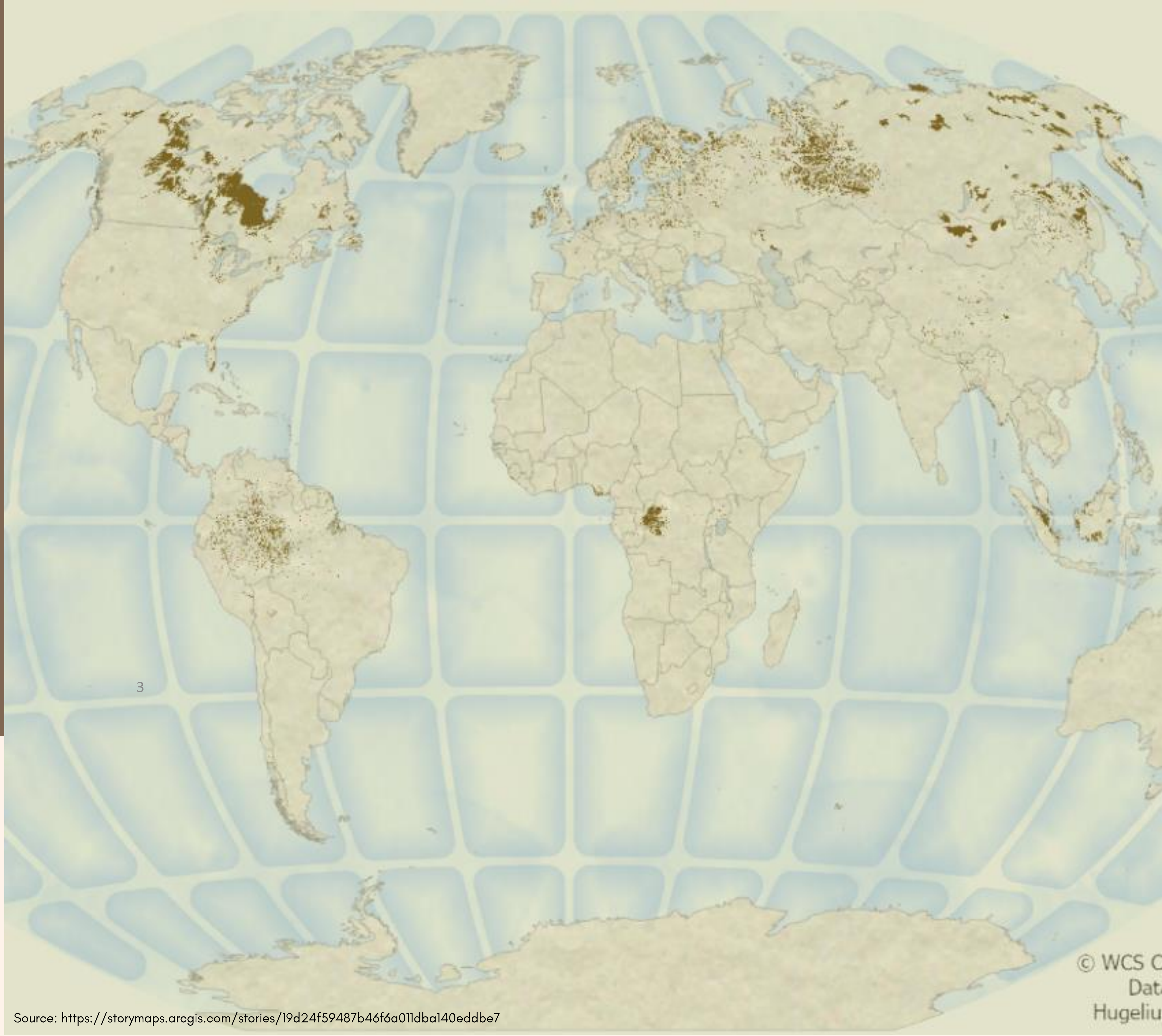
Degradation problem in our climatic conditions

Research and conservation strategies

PEATLANDS AROUND DE WORLD

3%

PEATLANDS COVER ONLY 3% OF THE EARTH'S LAND SURFACE



Source: https://storymaps.arcgis.com/stories/19d24f59487b46f6a011dba140eddbe7

PEATLANDS OF CANADA

25%

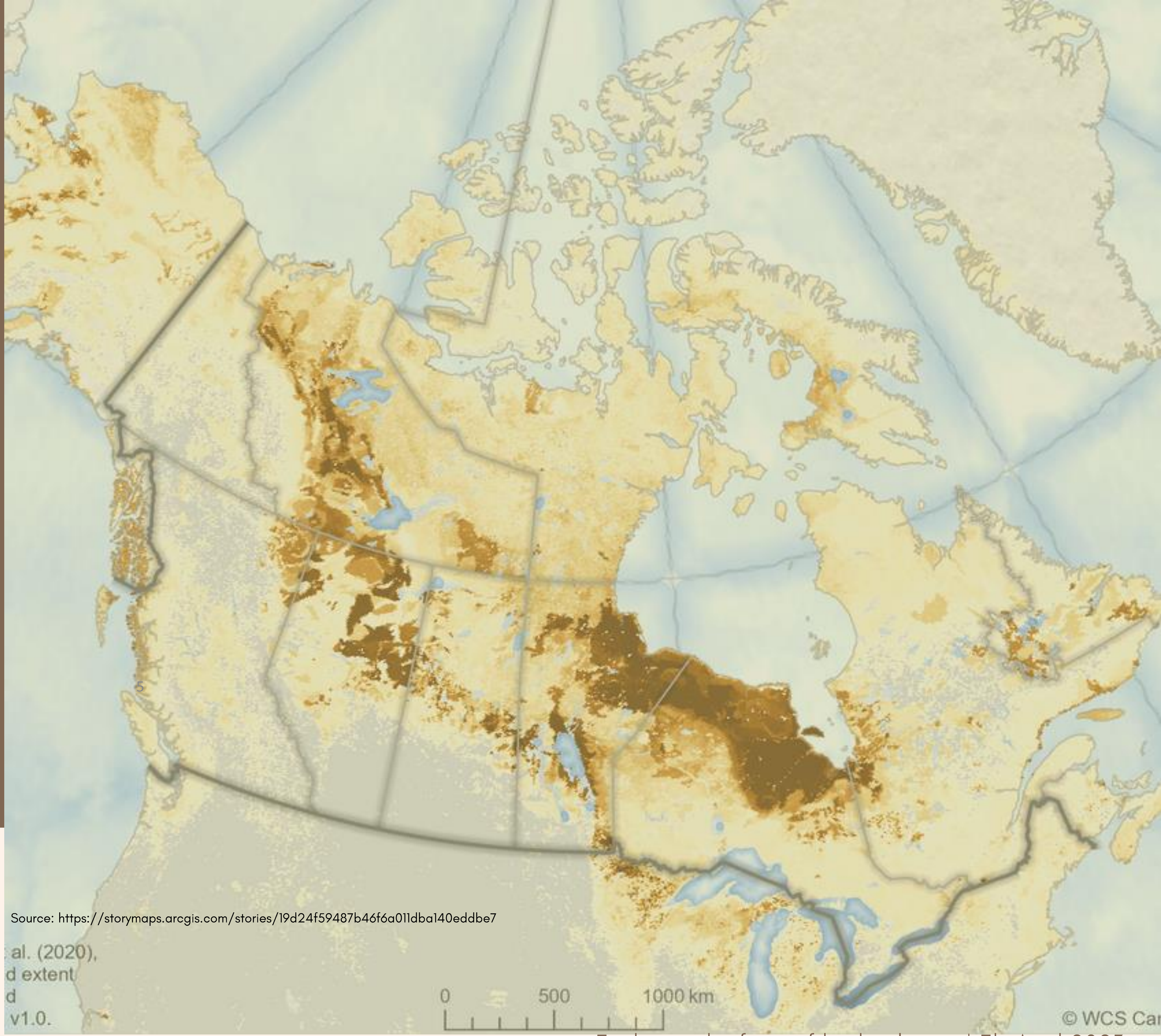
OF THE GLOBAL PEATLAND COVER

Source: https://storymaps.arcgis.com/stories/19d24f59487b46f6a011dba140eddbe7

PEATLANDS OF CANADA

12%

100 MILLIONS HECTARES (HA)
including 36 millions below the permafrost limit



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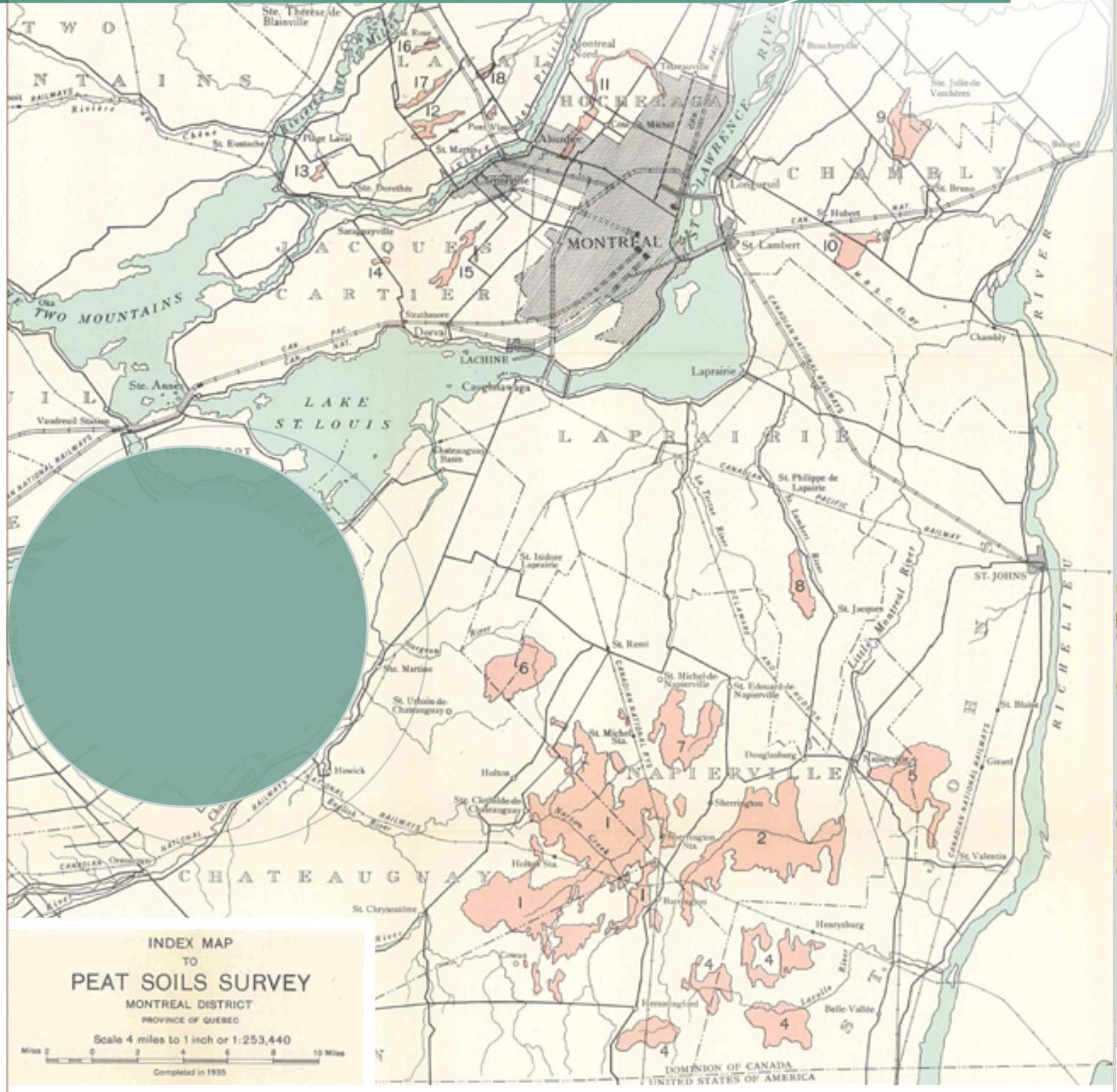
PEATLANDS IN QUEBEC PROVINCE

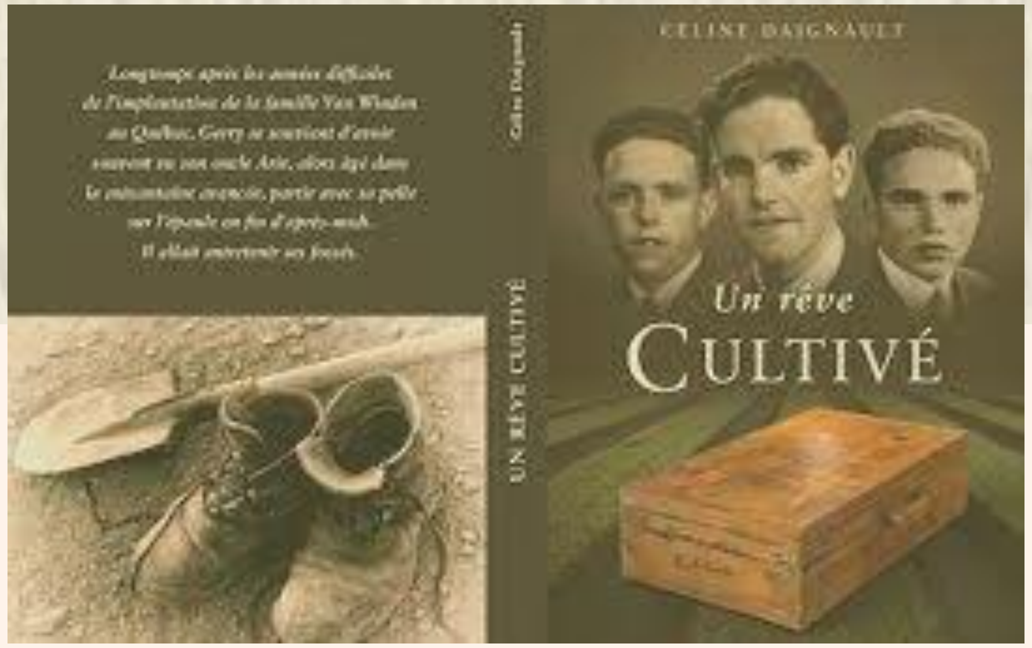
8%

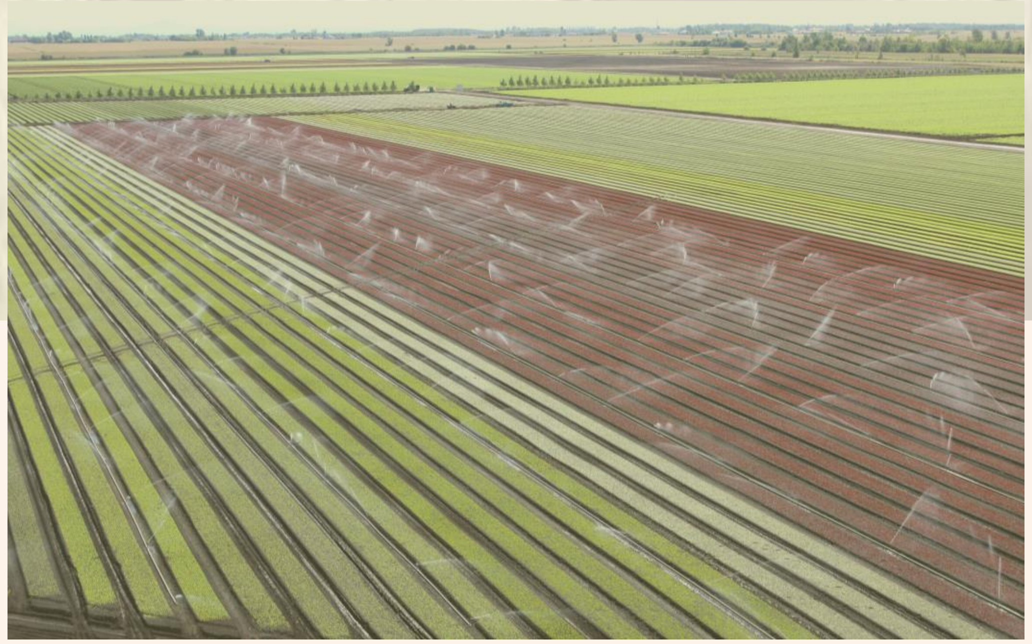
13 MILLIONS HECTARES

Québec: 10 000 HA OF DRAINED AGRICULTURAL PEATLANDS



A little bit of history…and socio-economic importance





1950-

Three brothers from Netherland…

1980-

Producers come together to form several cooperatives to pack, process and market vegetables

TODAY

35% of vegetables crop production is on drained agricultural peatland
50% of the market value
80% of canadian lettuce production

Degradation problem in our climatic conditions

WATER EROSION

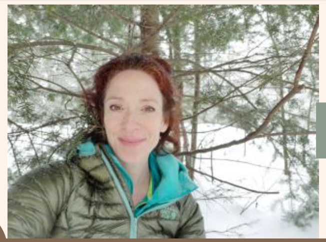
WIND EROSION

ORGANIC MATTER MINERALIZATION

- AVERAGE SOIL LOSS OF **2 CM PER YEAR**
- REDUCTION OF SOIL PHYSICAL QUALITY
- REDUCTION OF CROP PRODUCTIVITY
- QUESTIONNABLE SUSTAINABILITY

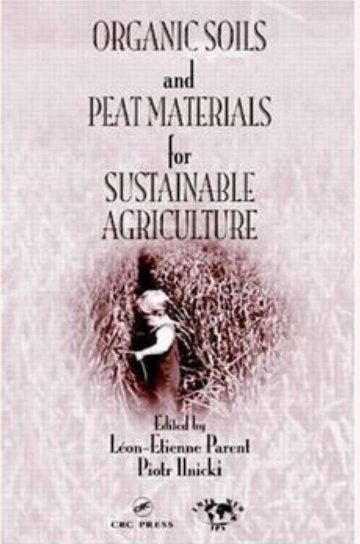
HISTORY OF RESEARCH





70S-90S: SUBSIDENCE AND COPPER ADDITION

Improving our understand on degradation mechanism
Use of copper to limit degradation rate



2007-2014: IRRIGATION

Improving irrigation technique for vegetable crops, mainly lettuce, using tensiometer

2014-2019: DRAINAGE

Strategies to improve drainage such as subsoilling, crop rotation with deep root species and and caracterisation of compact layer

2016-2023: CONSERVATION STRATEGIES **PHASE I**

Intensive caracterisation of degradation state
Soil erosion
Drainage with willow trenches
Soil amendment
Biomass production

2023-2028: CONSERVATION STRATEGIES **PHASE II**

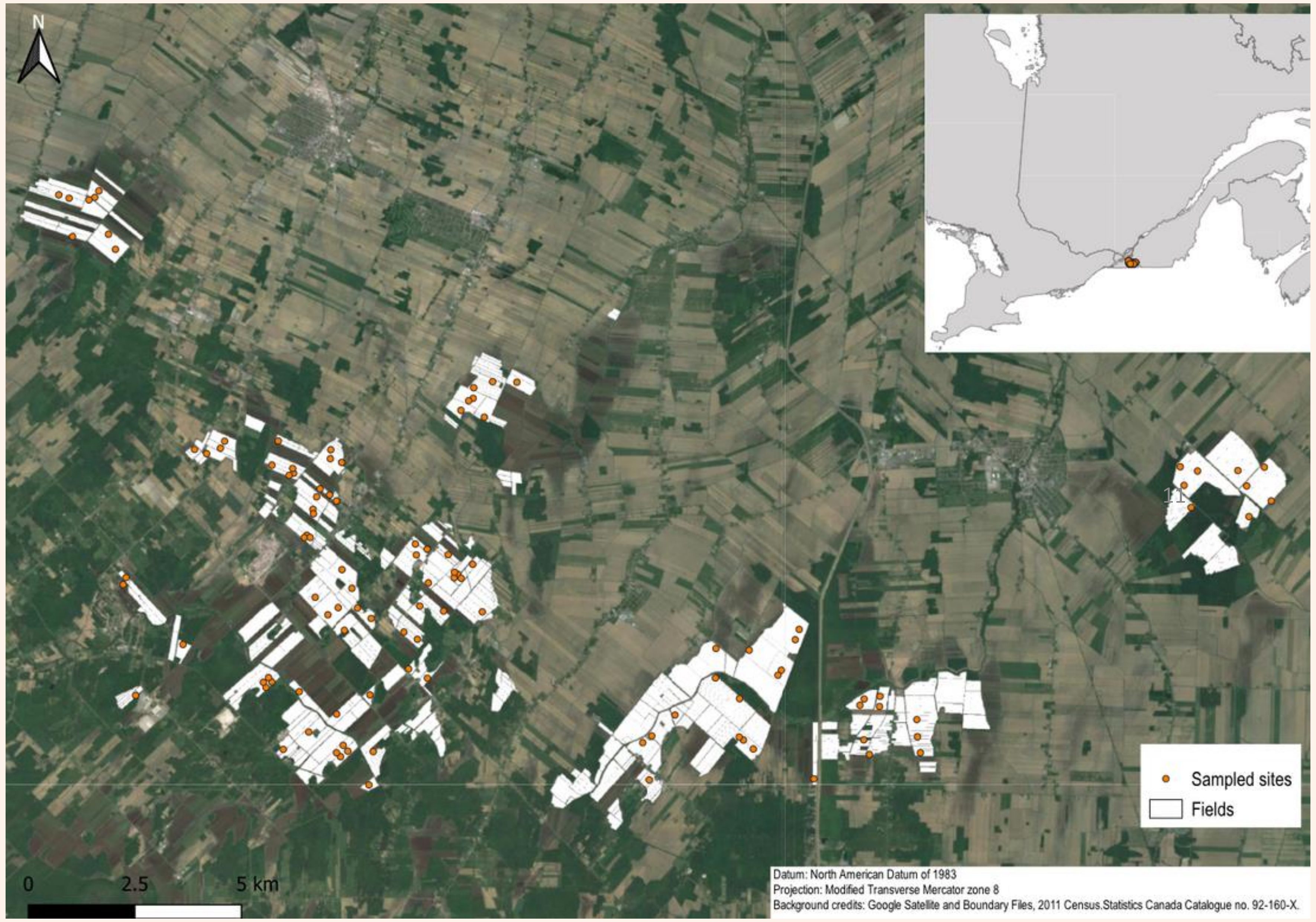
GHG emission
Carbon stock
Soil amendment + Biochar
Biomass production
Cover crop
Ecosystem services

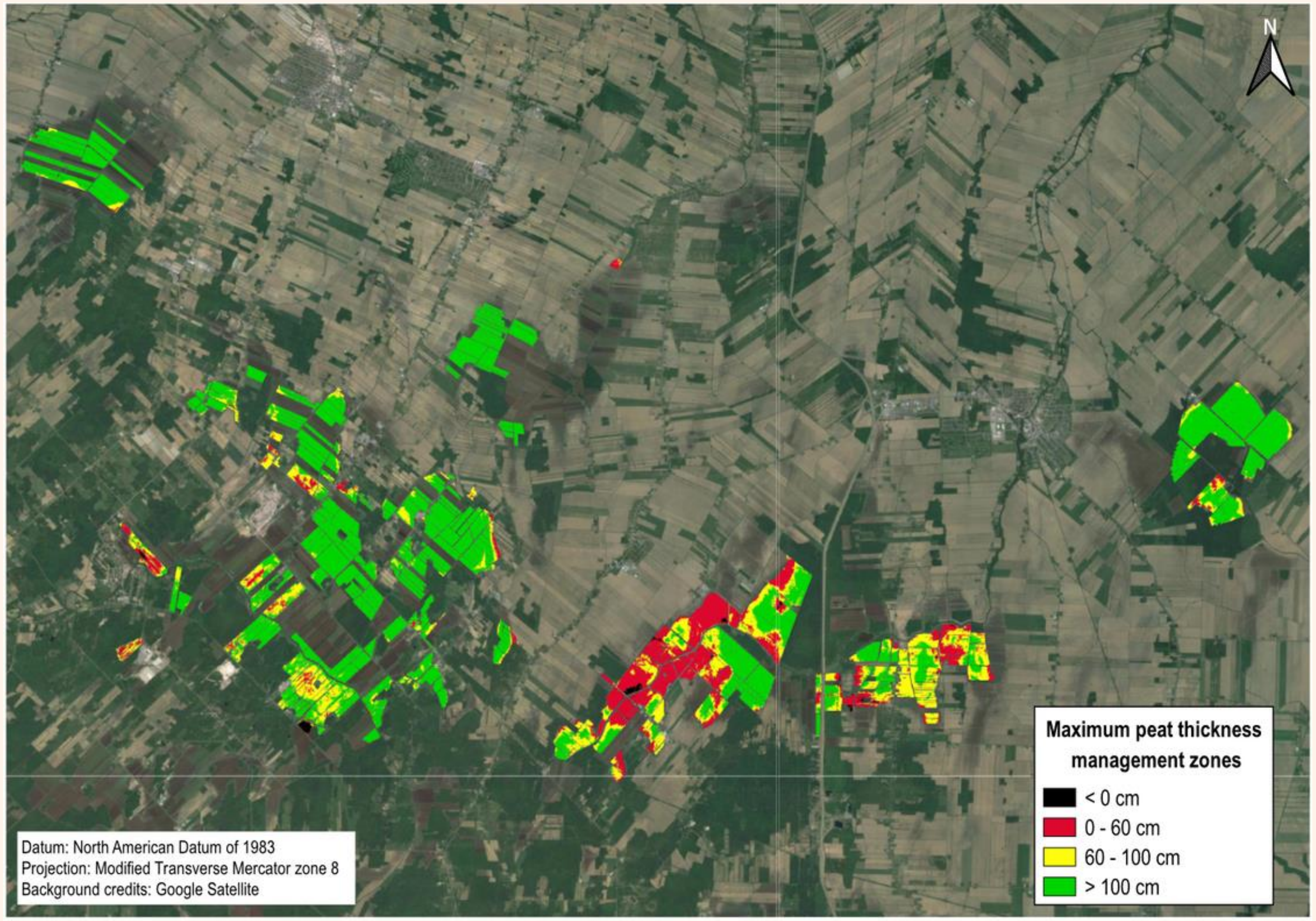
CONSERVATION STRATEGIES

OVERVIEW OF OUR RESEARCH SINCE 2016

DEGRADATION STATE

Raphael Deragon Master Thesis





14 farms and 114 manual soil profile descriptions.... Deragon et al., 2022

DEGRADATION STATE

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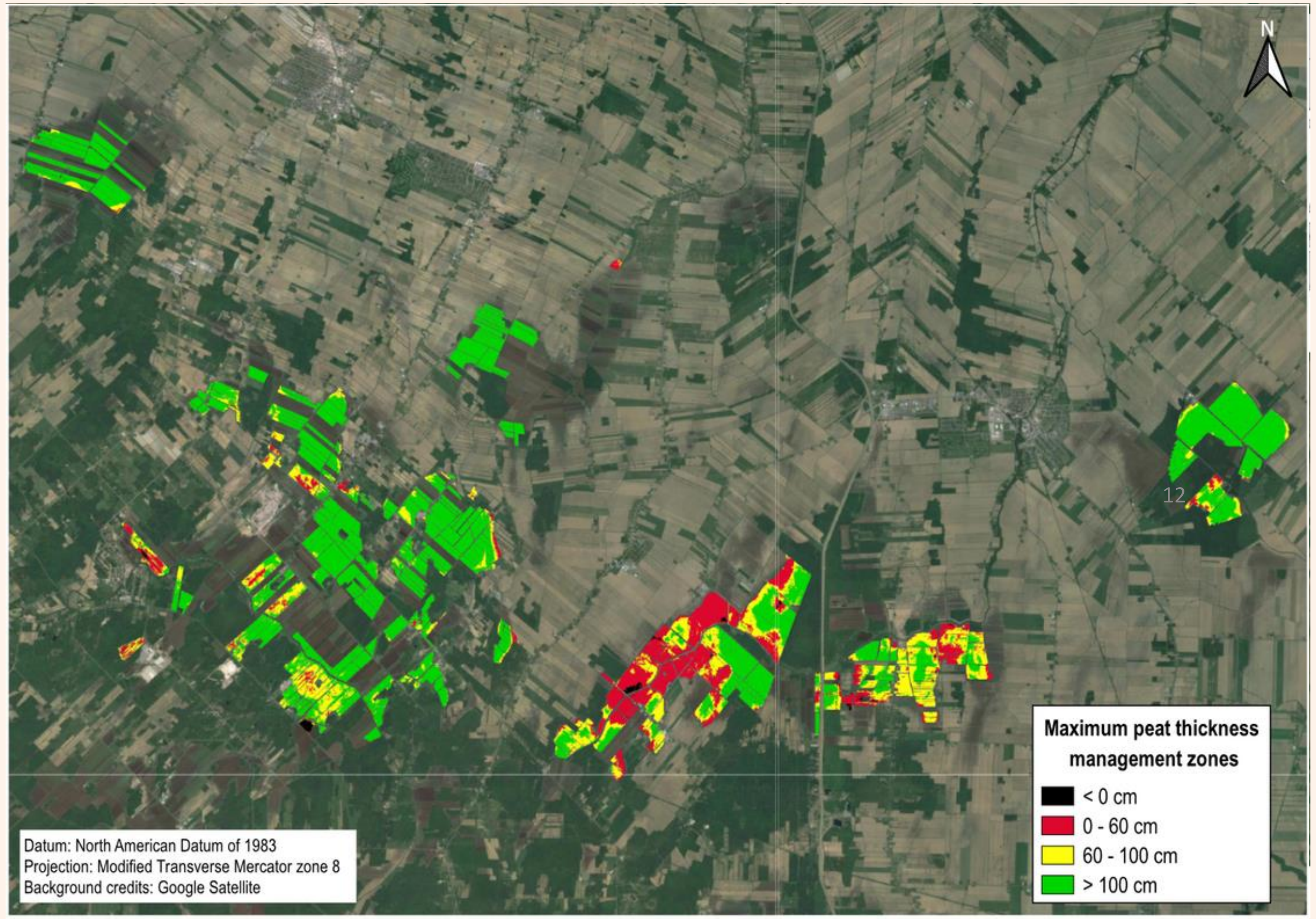
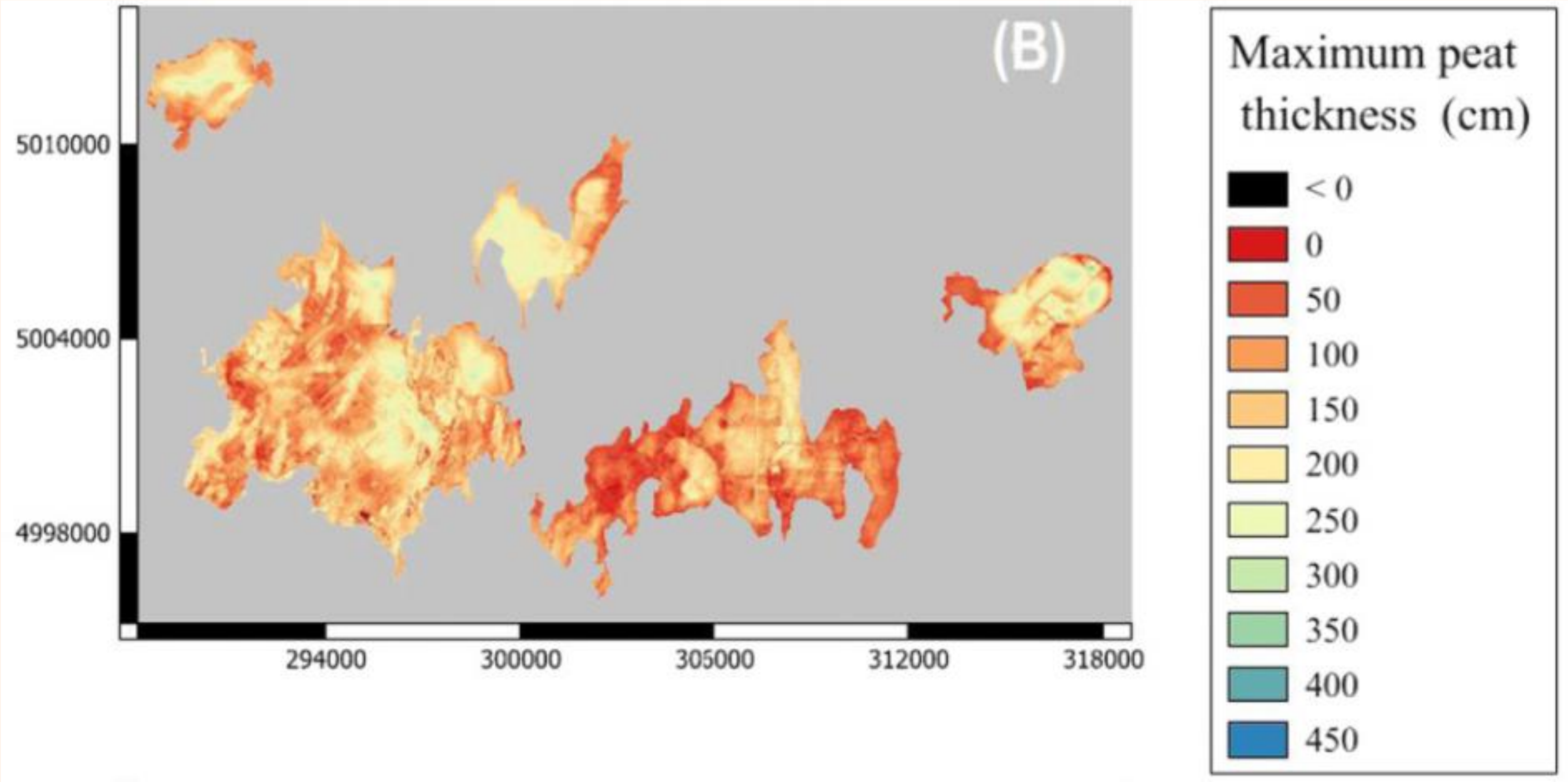




Mapping using different techniques.... Deragon et al., 2023

14 farms and 114 manual soil profiles description.... Deragon et al., 2022

BIOMASS PRODUCTION AND SOIL AMENDMENT

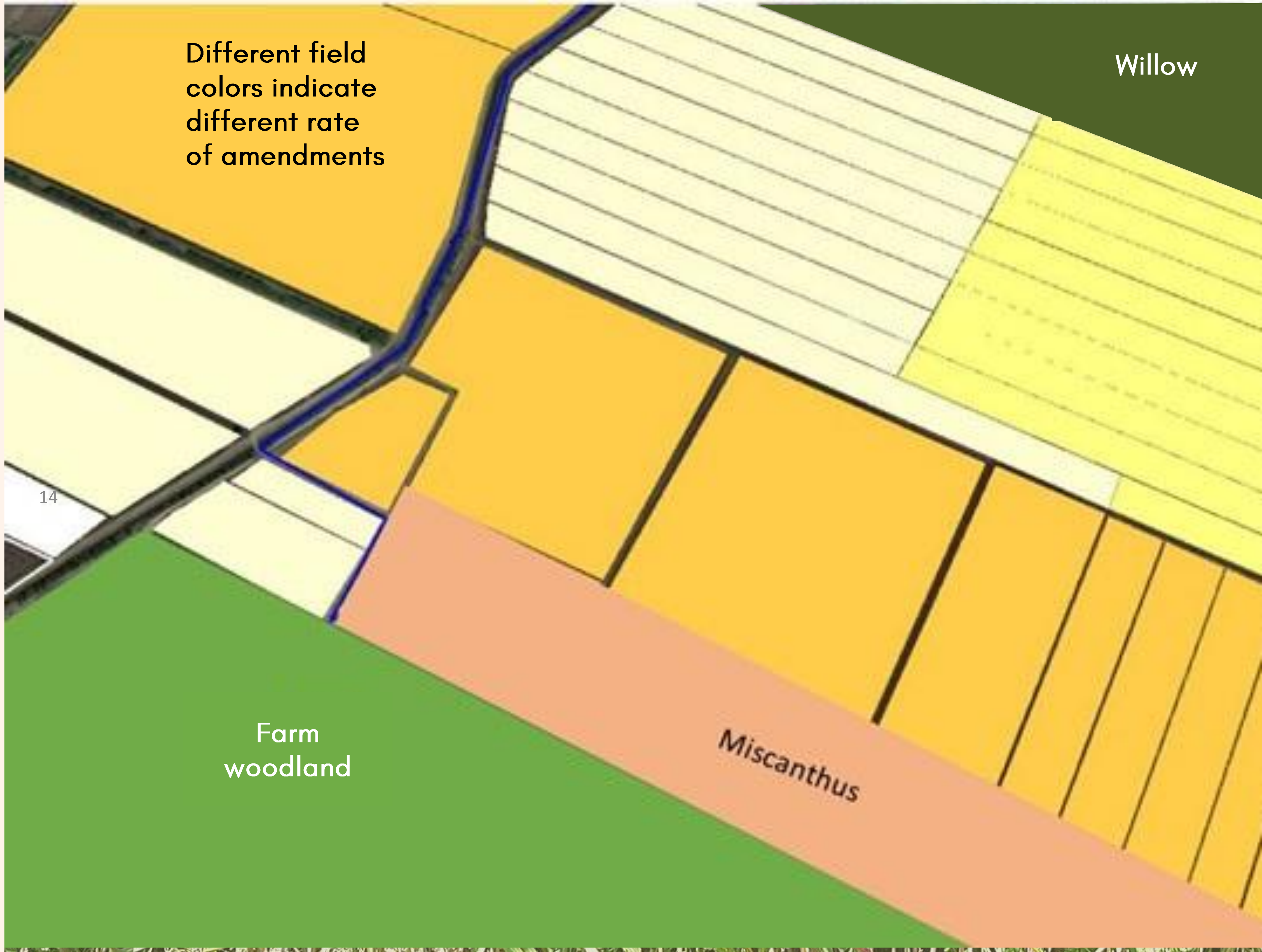
BIOMASS PRODUCTION AND SOIL AMENDMENT

GENERAL IDEA:

USE DEGRADED ZONE OF THE FARM TO GROW BIOMASS CROP TO:

1) RESTORE THE SOIL UNDERNEATH

2)PRODUCE ON FARM WOOD CHIP AND/OR STRAW FOR SOIL AMENDMENT

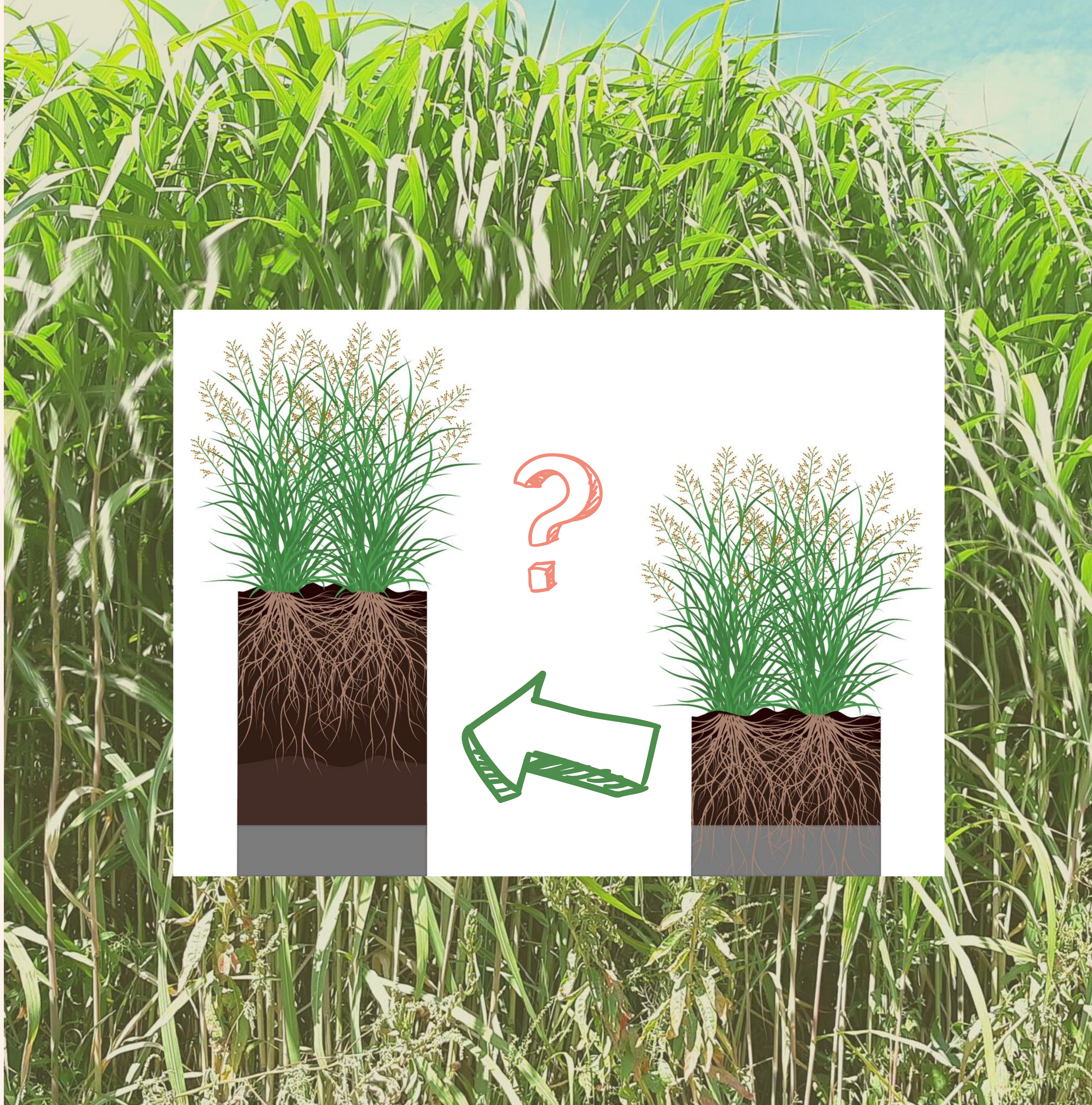


BIOMASS PRODUCTION AND SOIL AMENDMENT

CAN WE GROW HIGH YIELD BIOMASS CROP ON DEGRADED SOIL?

CAN WE PRODUCE ENOUGH MATERIAL FOR SOIL AMENDMENT?

CAN WE RESTORE DEGRADED SOIL?



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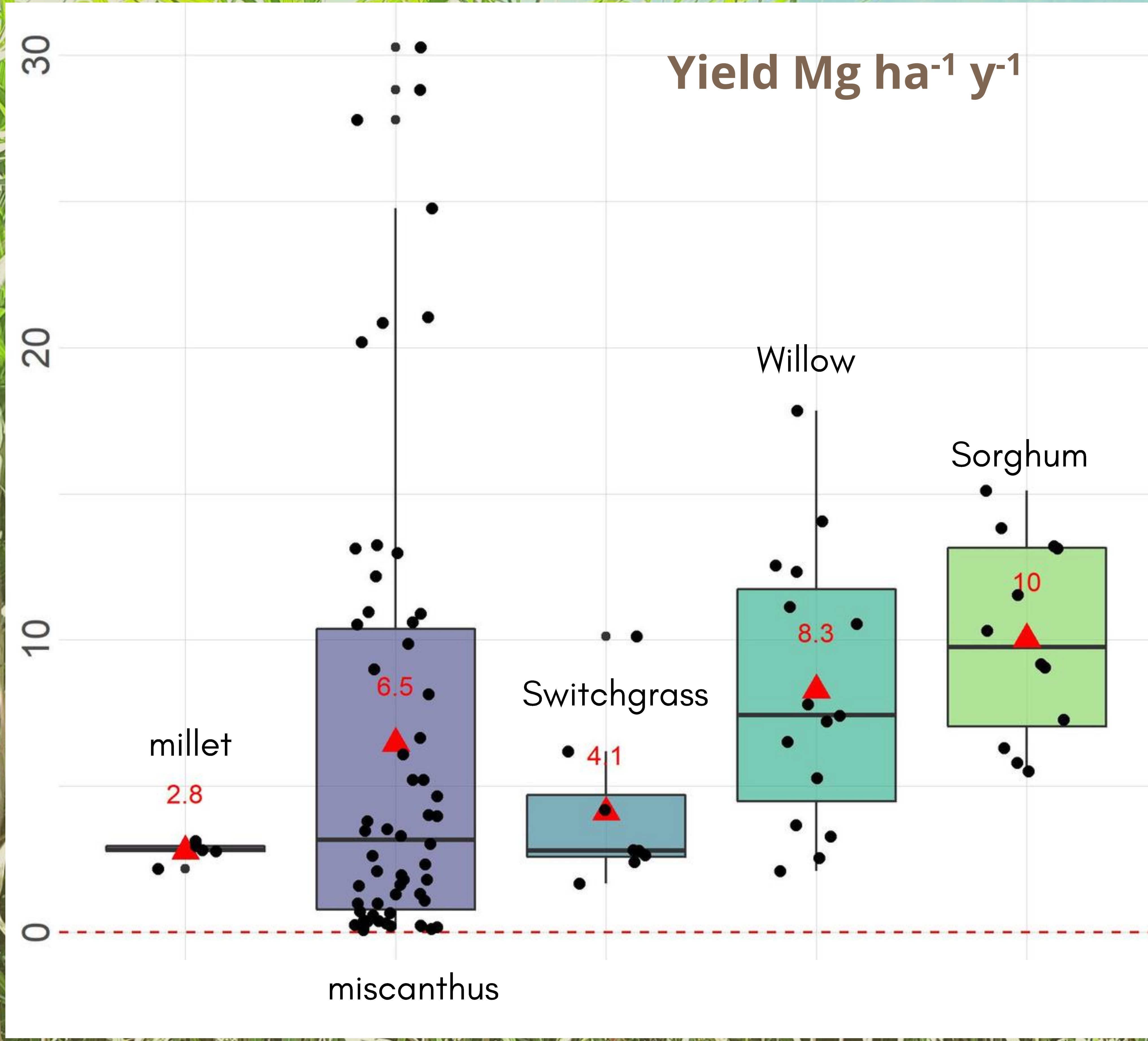

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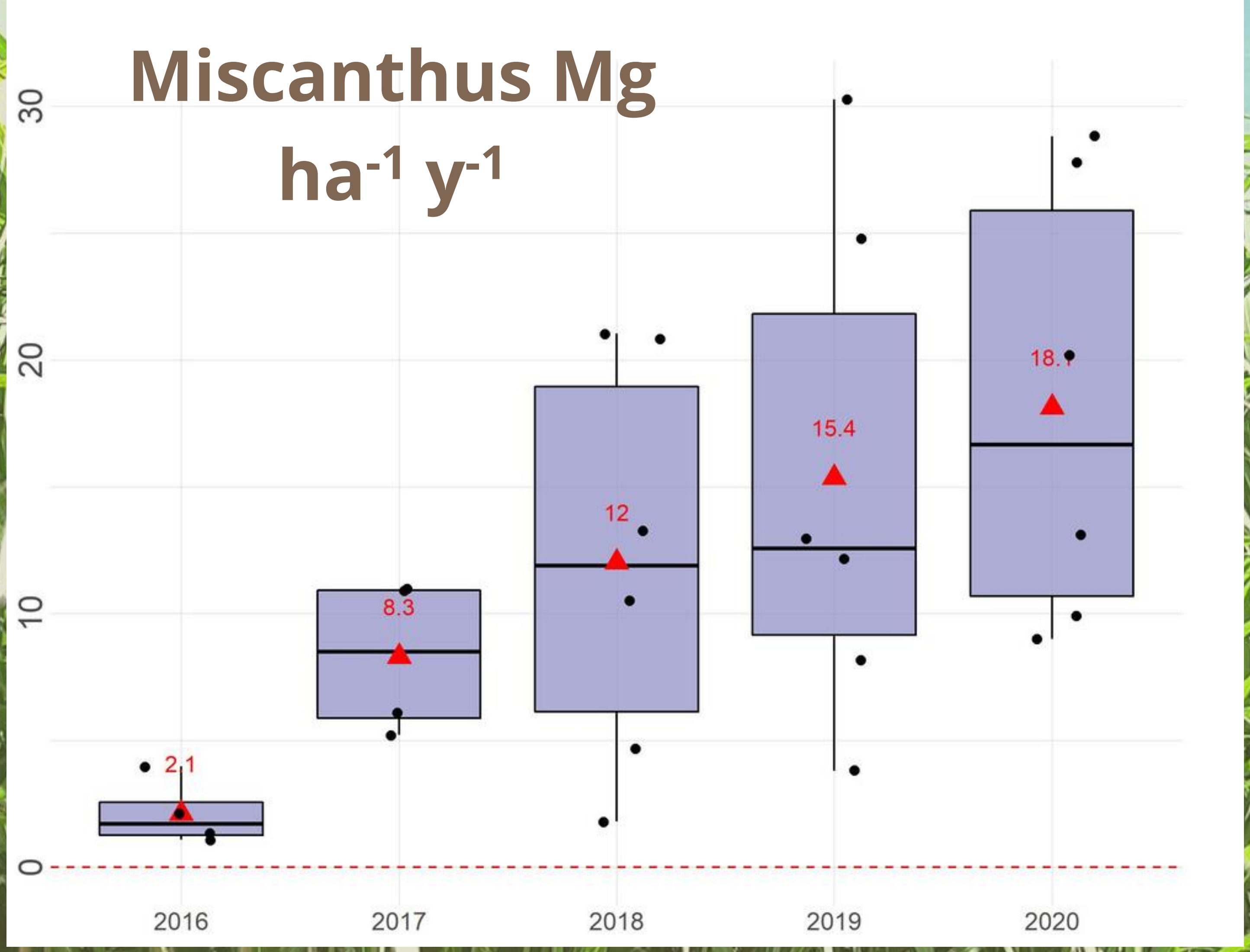
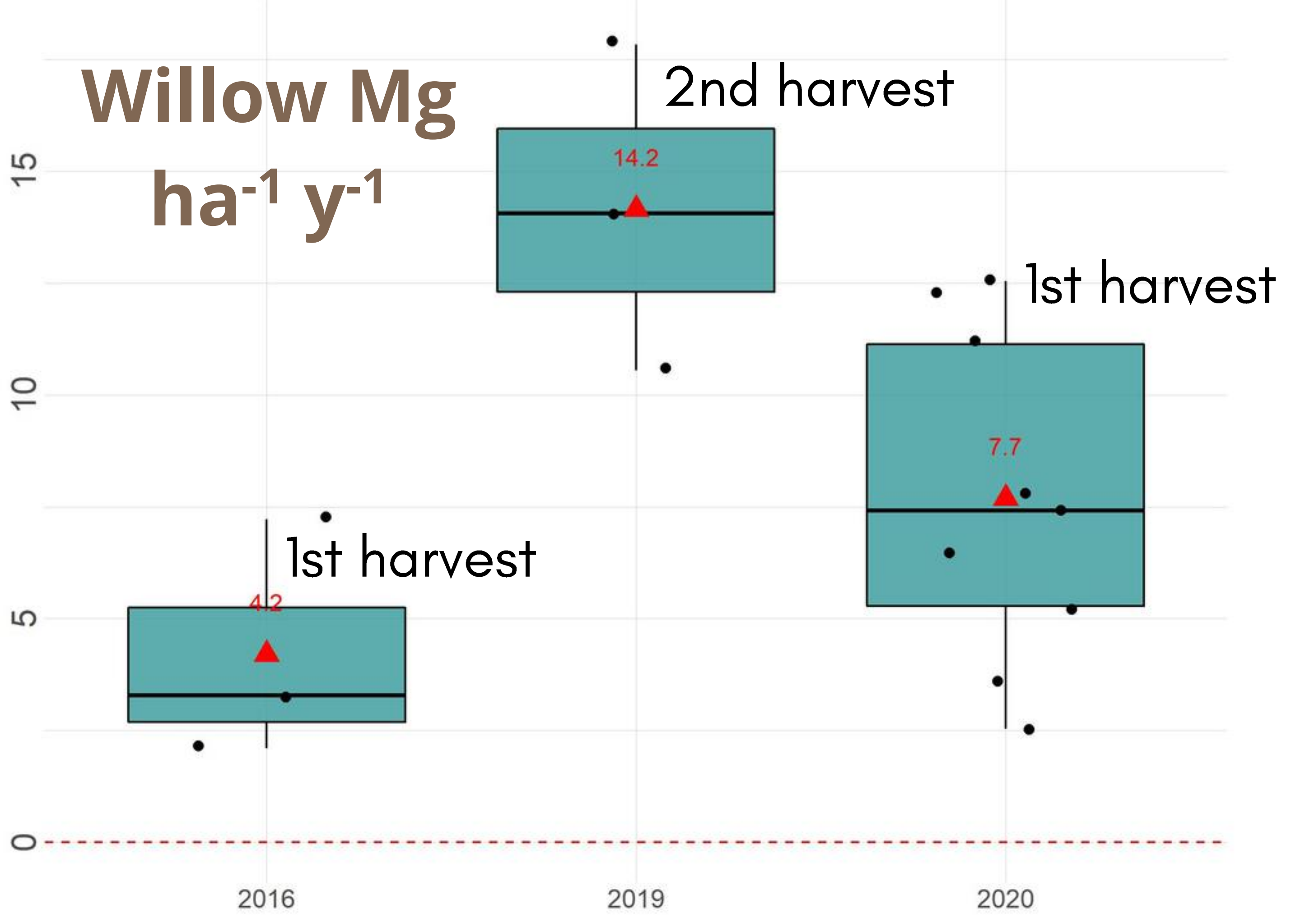
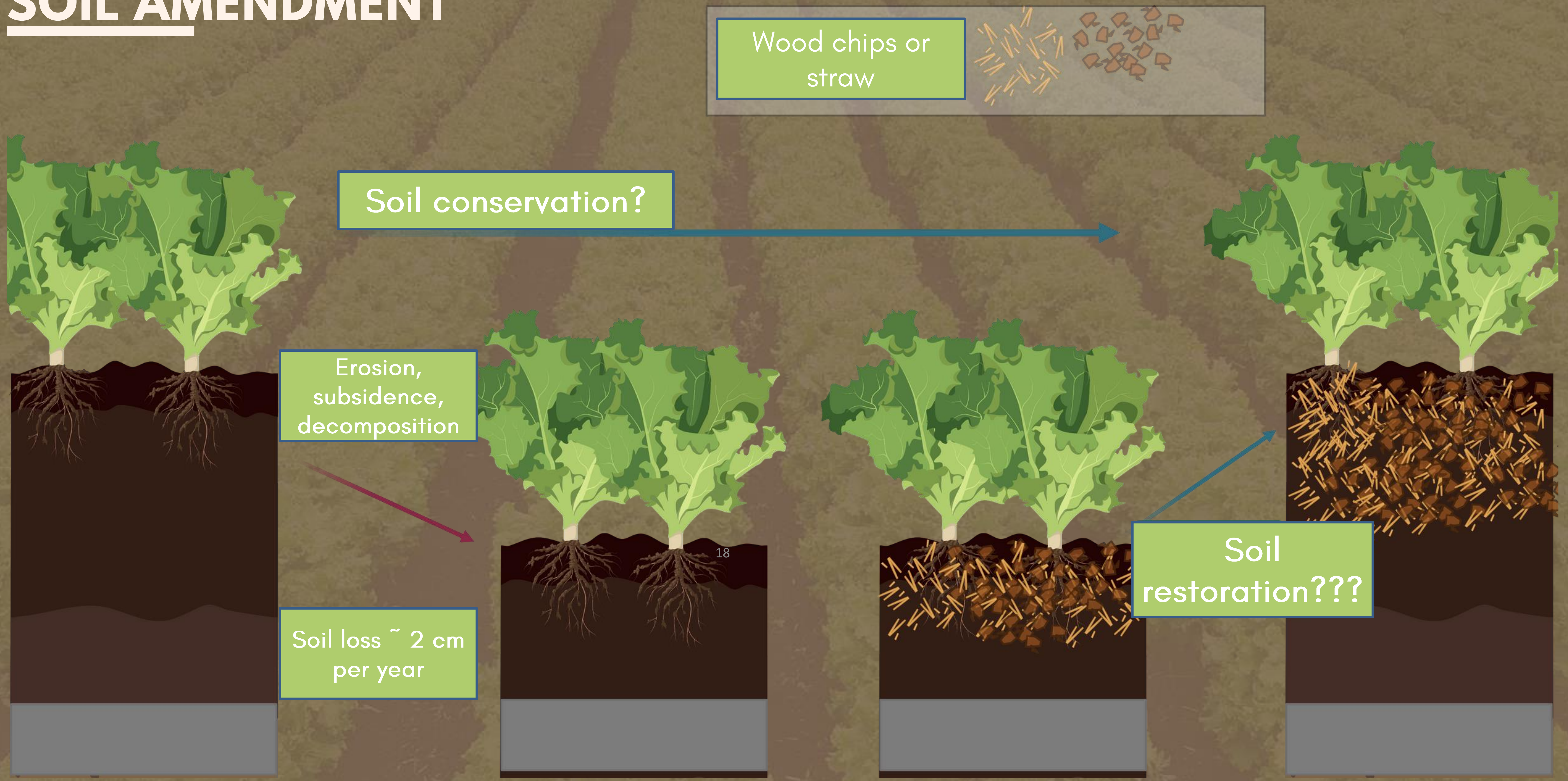




SOIL AMENDMENT



WHAT TYPE OF SOIL AMENDMENT ARE WE LOOKING FOR?

With the entry of air and the activation of aerobic microorganisms, the mineralization process is irreversible

Very few carbon protection mechanisms in drained peat soil:

- Little aggregation
- Few mineral surfaces
- Recalcitrance of the amendment

WE ARE LOOKING FOR RECALCITRANCE (RESISTANCE TO MICROBIAL AND ENZYMATIC DEGRADATION DUE TO THE CHEMICAL STRUCTURE)

WHAT TYPE OF SOIL AMENDMENT ARE WE LOOKING FOR?

With the entry of air and the activation of aerobic microorganisms, the mineralization process is almost irreversible

Very few carbon protection mechanisms in organic soil:

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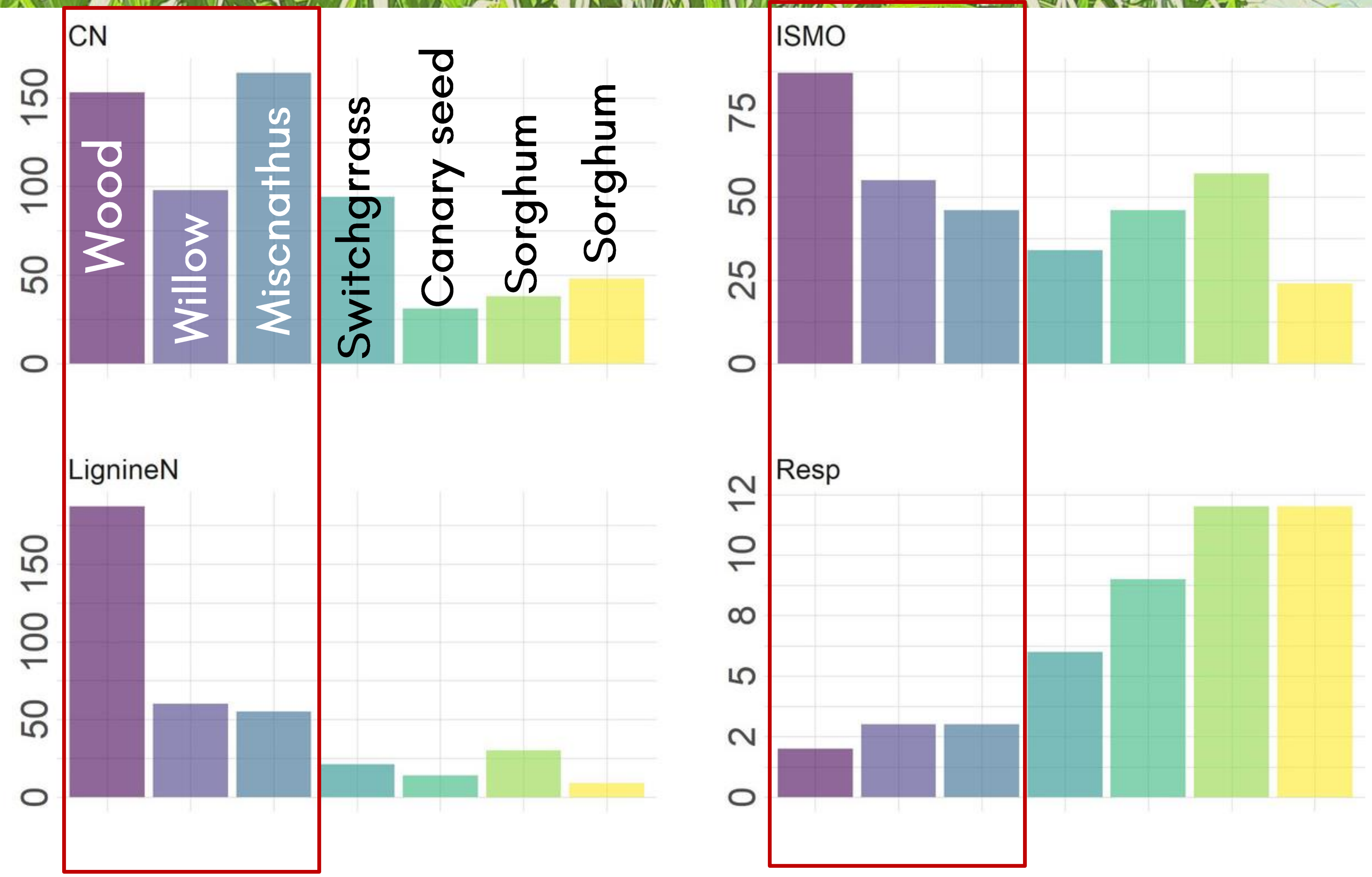

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Experiment in the greenhouse
2017-2021 = 10 growing seasons

Impact of amendment type and rate on **physical** properties of the soil

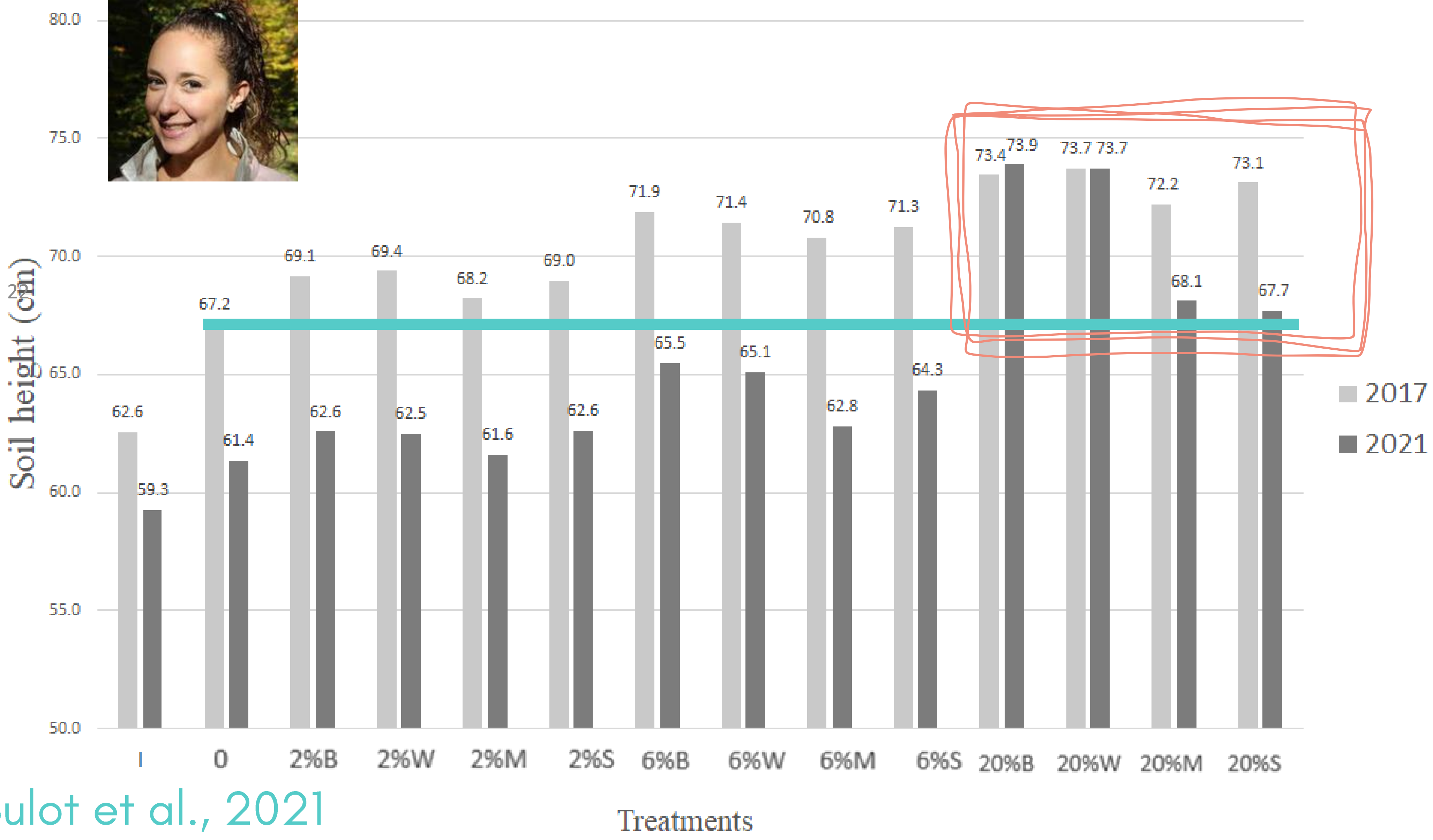
WHAT TYPE OF SOIL AMENDMENT ARE WE LOOKING FOR?

Experiment in the greenhouse
2017-2021 = 10 growing seasons

Amendment with different rate and different source

A rate of 12 Mg ha^{-1} y^{-1} maintains soil height

	Treatments	T/ha/1y
Wood chips	2% B or W	6
Straw	2% M or S	2,6
Wood chips	6% B or W	12,7
Straw	6% M or S	5,04
Wood chips	20% B or W	31,4
Straw	20% M or P	13,7



Bulot et al., 2021

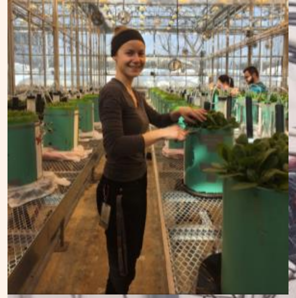
AMENDMENT AND CARBON STOCKS

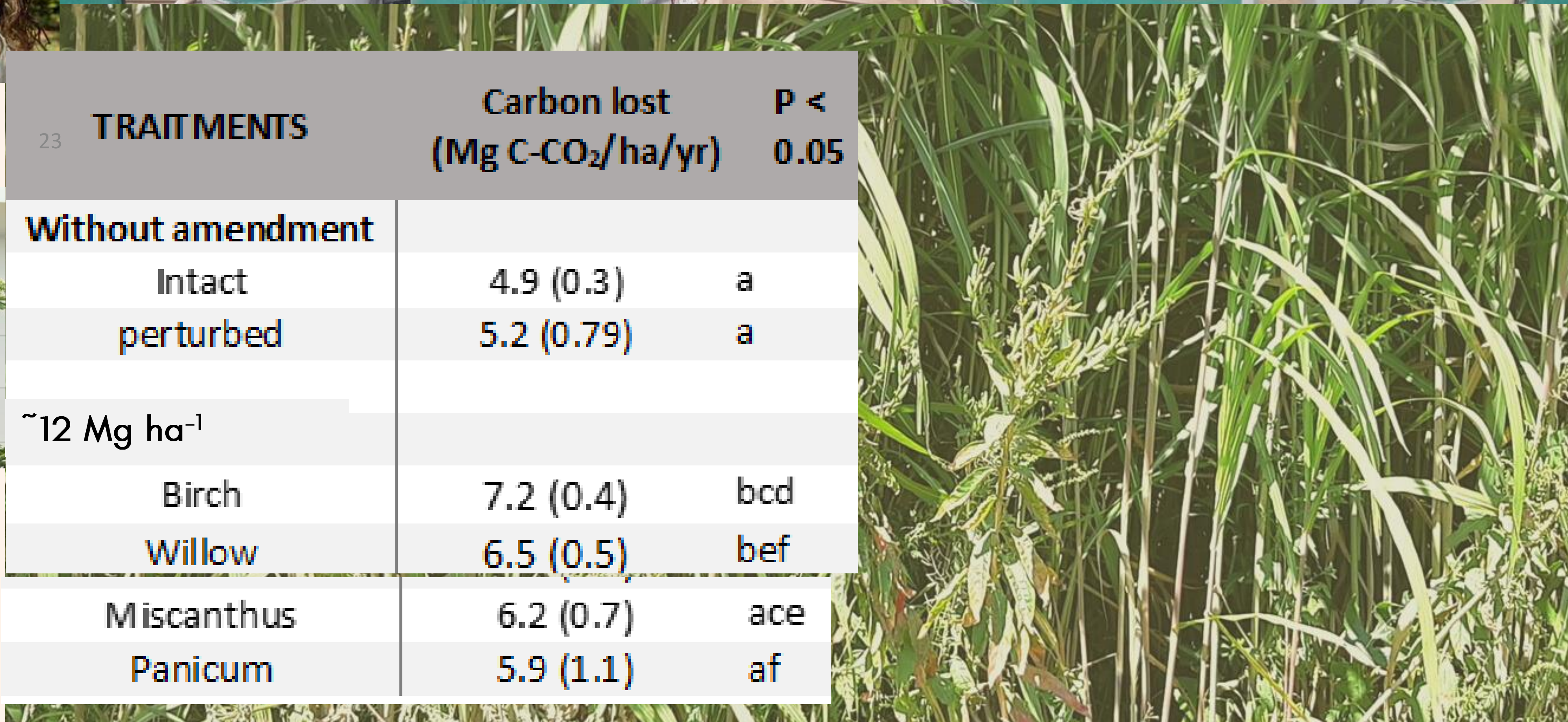
Experiment in the greenhouse
2017-2021 = 10 growing seasons

At the end of the experiment CO_2 loss was measured during 9 weeks

Few difference between amended and non-amended

Measurement over a short period, data to take with some caution





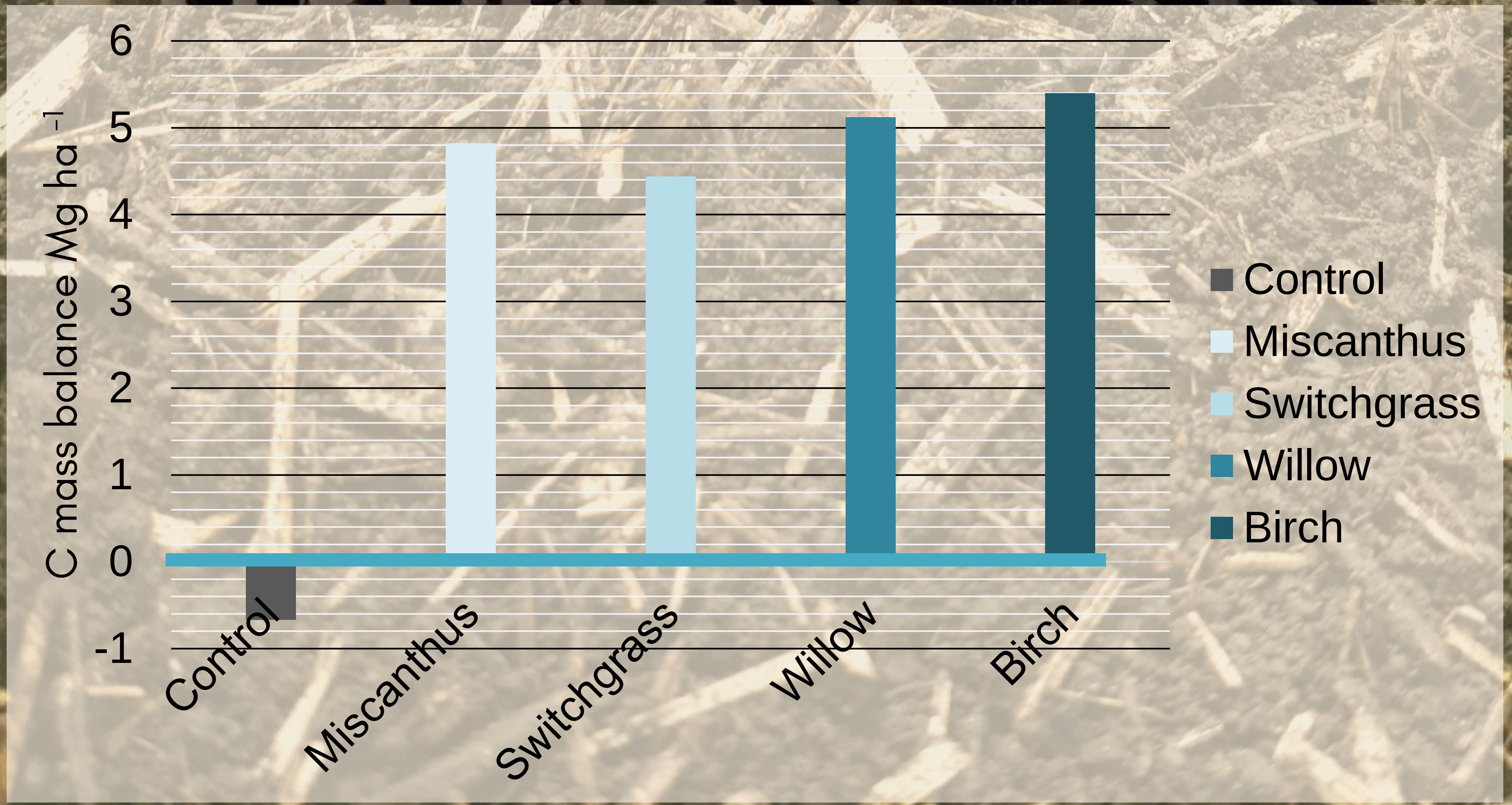
23 TRAITMENTS	Carbon lost (Mg C-CO_2/ha/yr)	P < 0.05
Without amendment		
Intact	4.9 (0.3)	a
perturbed	5.2 (0.79)	a
˜12 Mg ha^{-1}		
Birch	7.2 (0.4)	bcd
Willow	6.5 (0.5)	bef
Miscanthus	6.2 (0.7)	ace
Panicum	5.9 (1.1)	af

AMENDMENT AND CARBON STOCKS

Pot incubation experiment (145-365 days)

To reach Positive mass balance in Mg ha^{-1} (carbon input with the amendment – carbon loss via CO_2 emission)

<u>One to three inputs</u> at a rate of 15 Mg ha^{-1} of amendment (straw or chips) <u>depending on the degradation stage</u> of the peat soil



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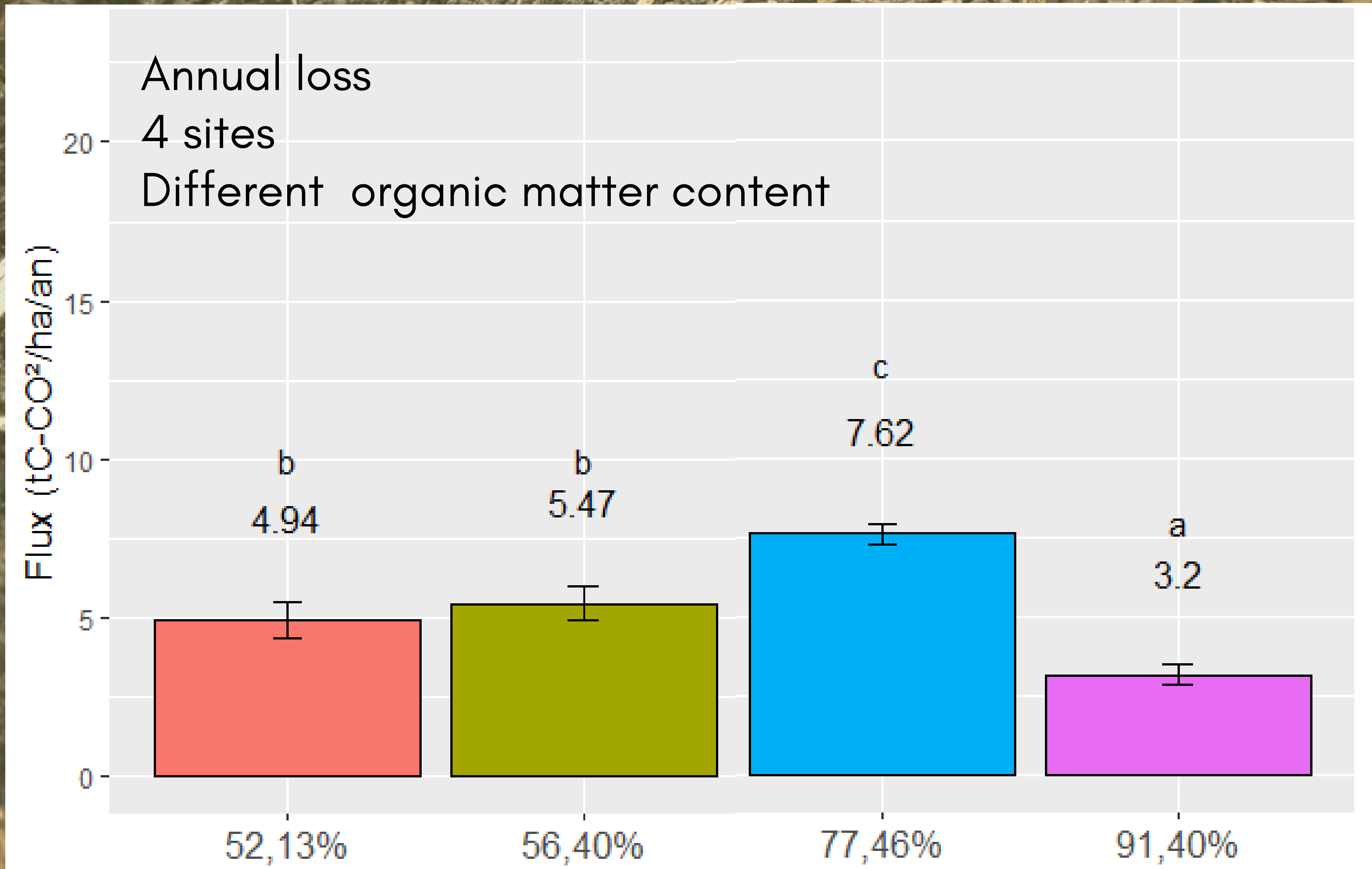
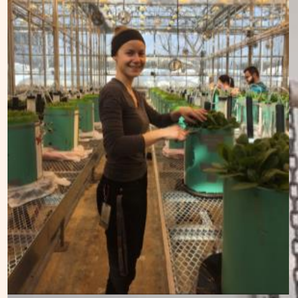
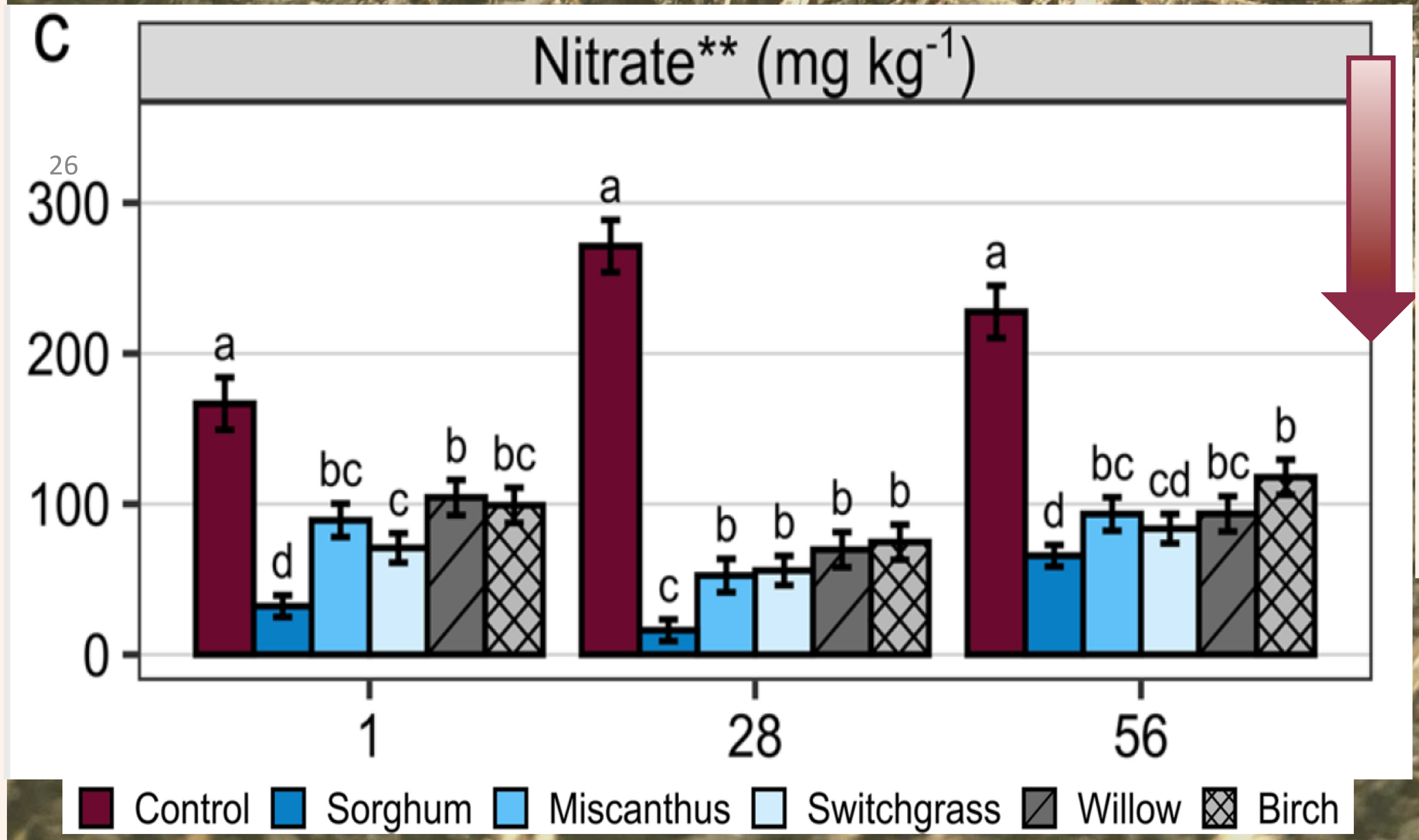


AMENDMENT AND FERTILITY

Experiment in the greenhouse, pots and in the field

Impact on fertility (pot and greenhouse) using a rate of 15 Mg ha^{-1})





Decrease in availabl
N:
Sorghum: 80%
Miscanthus: 51%
Switchgrass: 70%
Willow: 60%
Birch: 52%

AMENDMENT AND FERTILITY

Experiment in the greenhouse, pots and in the field

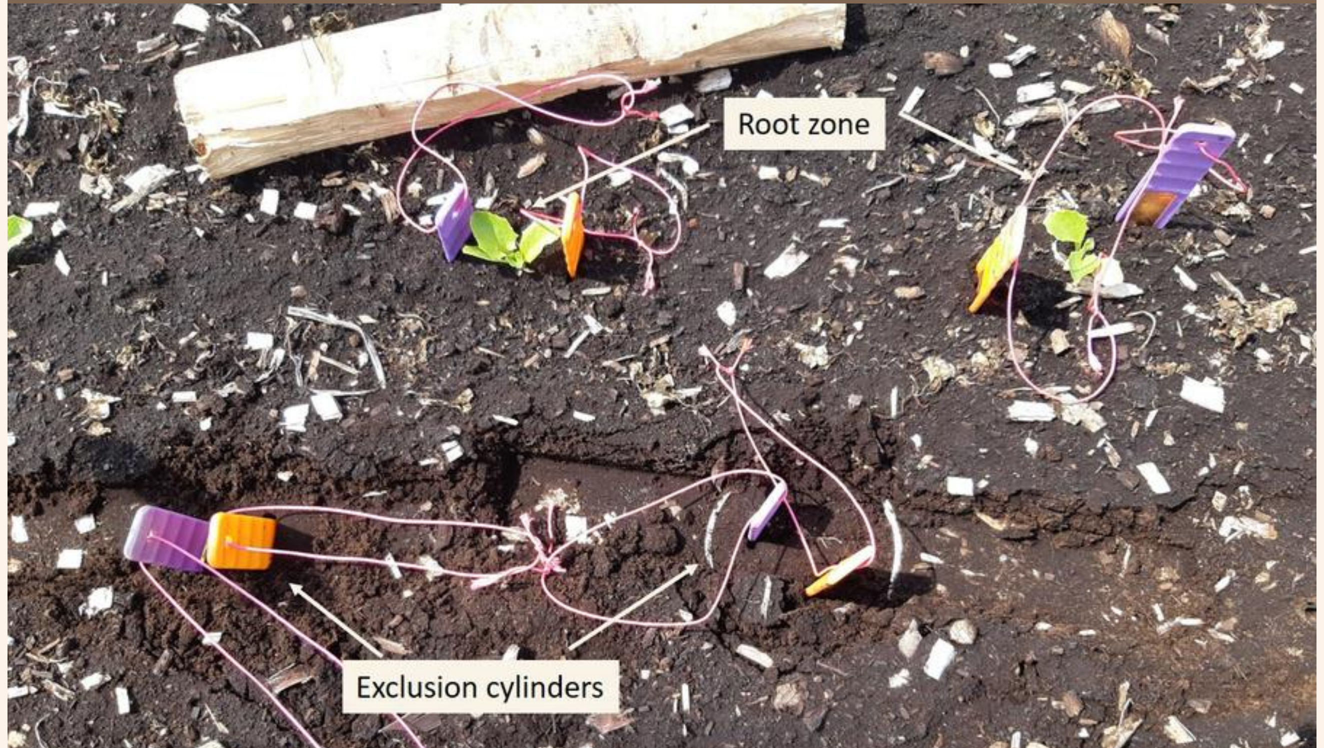
Impact on fertility (field)

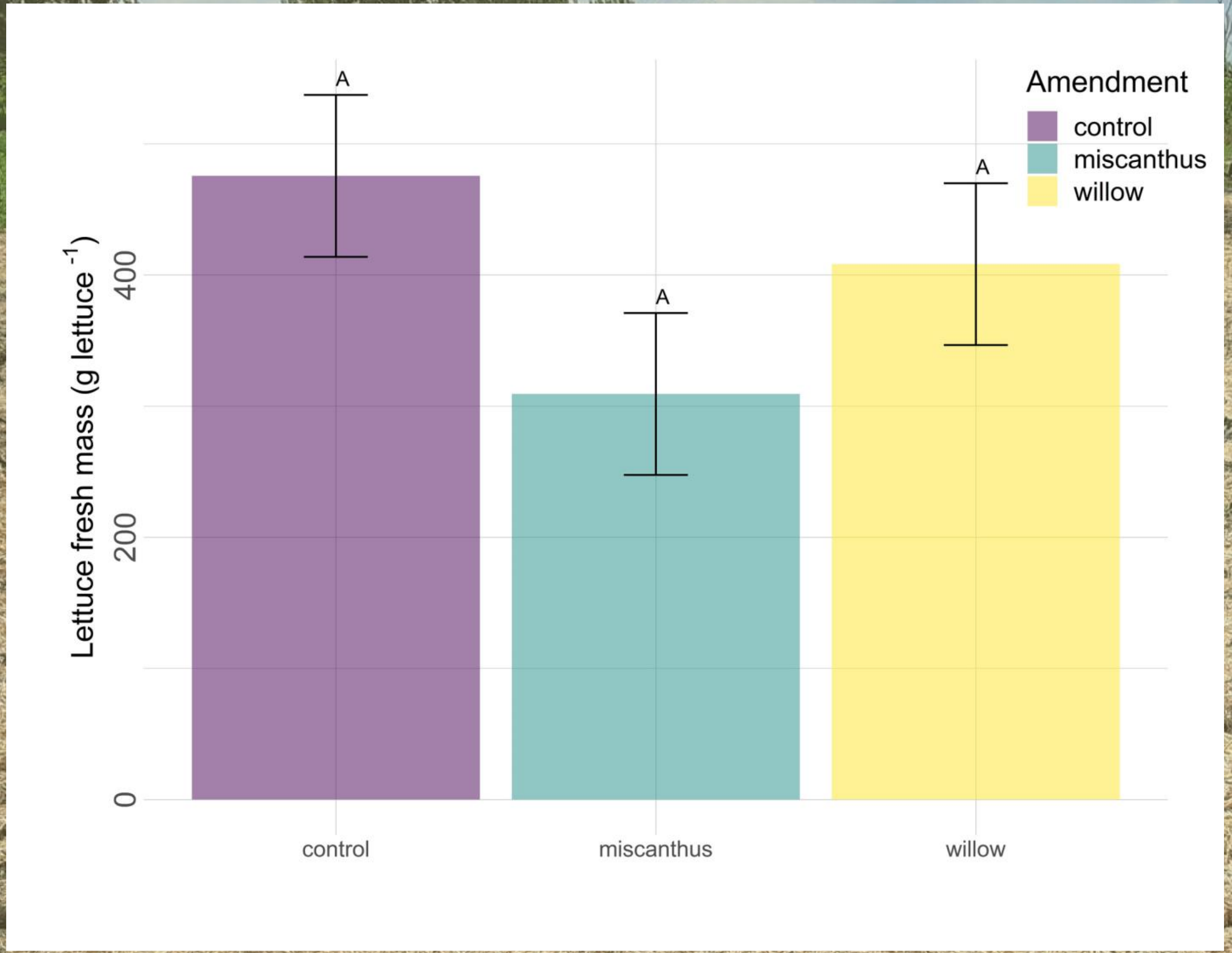
AMENDMENT AND FERTILITY

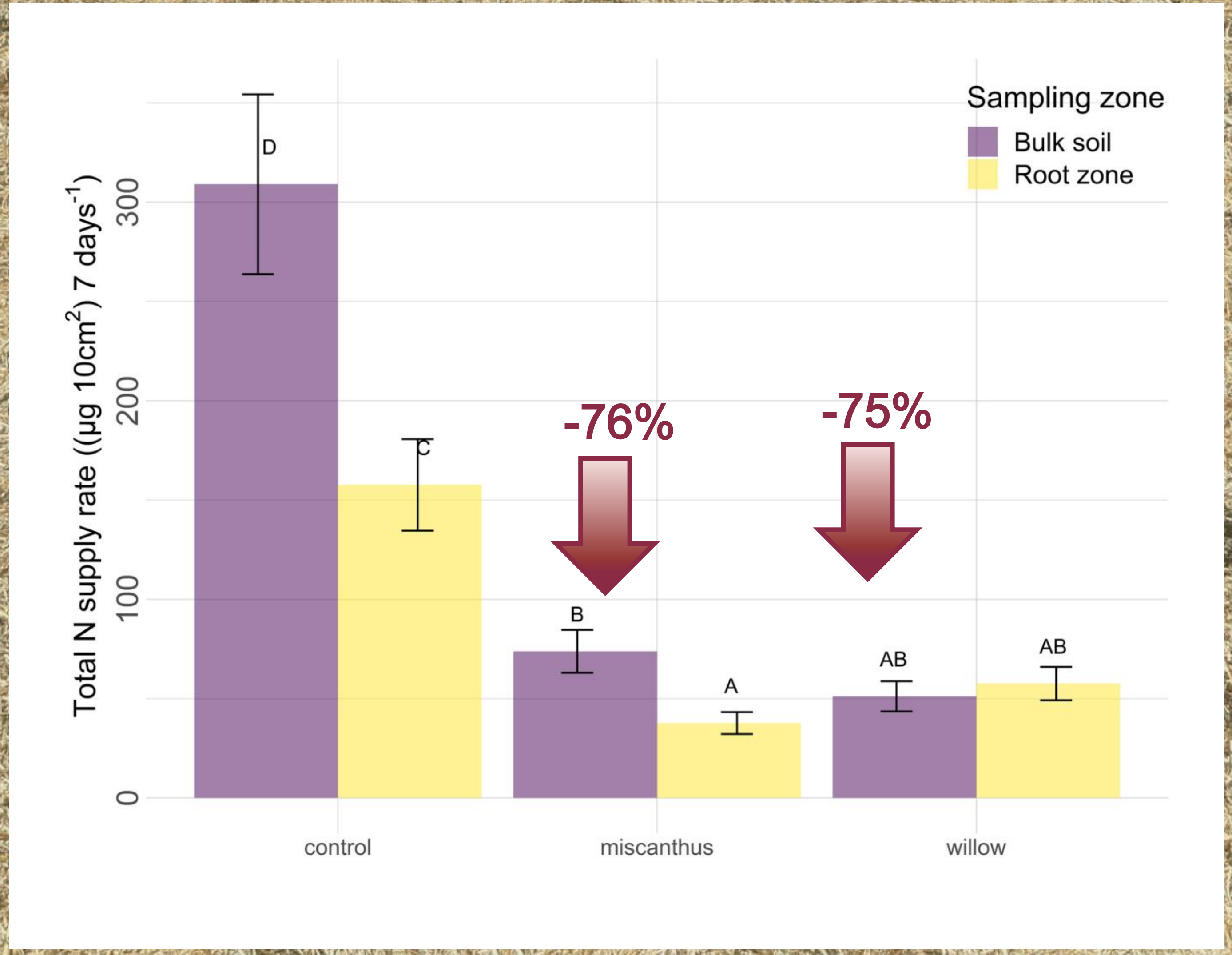
Experiment in the greenhouse, pots and in the field

Impact on fertility (field application at a rate of 15 Mg ha^{-1} in the spring)

Important reduction of available N







CANADIAN PERSPECTIVES

Given the great economic and societal value of these precious soils, it is worth studying the possibility of adapting them to sustainable agricultural production.

PERSPECTIVES

GHG EMISSIONS

CARBON STOCKS

SOIL AMENDMENTS + BIOCHAR

BIOMASS PRODUCTION COVER

CROPS ECOSYSTEM SERVICES

NEW PROJECT TO COME

Intergrated and sustainable management of agricultural peat under climate change