The Role of Perennial Biomass crops on Soil Health

Sowthini Vijayakumar, Sara Hasenack, Holly Ivany, Marc Szatkowski, Amir Bazrgar, Mahendra Thimmanagari, Bill Deen, Paul Voroney and Naresh Thevathasan

ses
school of environmental sciences

Ontario
Ministry of Agriculture, Food and Rural Affairs

ONTARIO BIOMASS PRODUCERS CO-OP

UNIVERSITY of GUELPH

OUTLINE

1. SOIL ORGANIC CARBON SEQUESTRATION AS INFLUENCED BY LAND-USE SYSTEMS AND BIOMASS CROPS
2. THE INFLUENCE OF BIO-FERTILIZERS ON SOIL NUTRIENTS, BIOMASS YIELDS AND SOIL HEALTH
3. THE COST ASSOCIATED WITH BIO-FERTILIZERS AND RECOMMENDATIONS
4. CONCLUSIONS

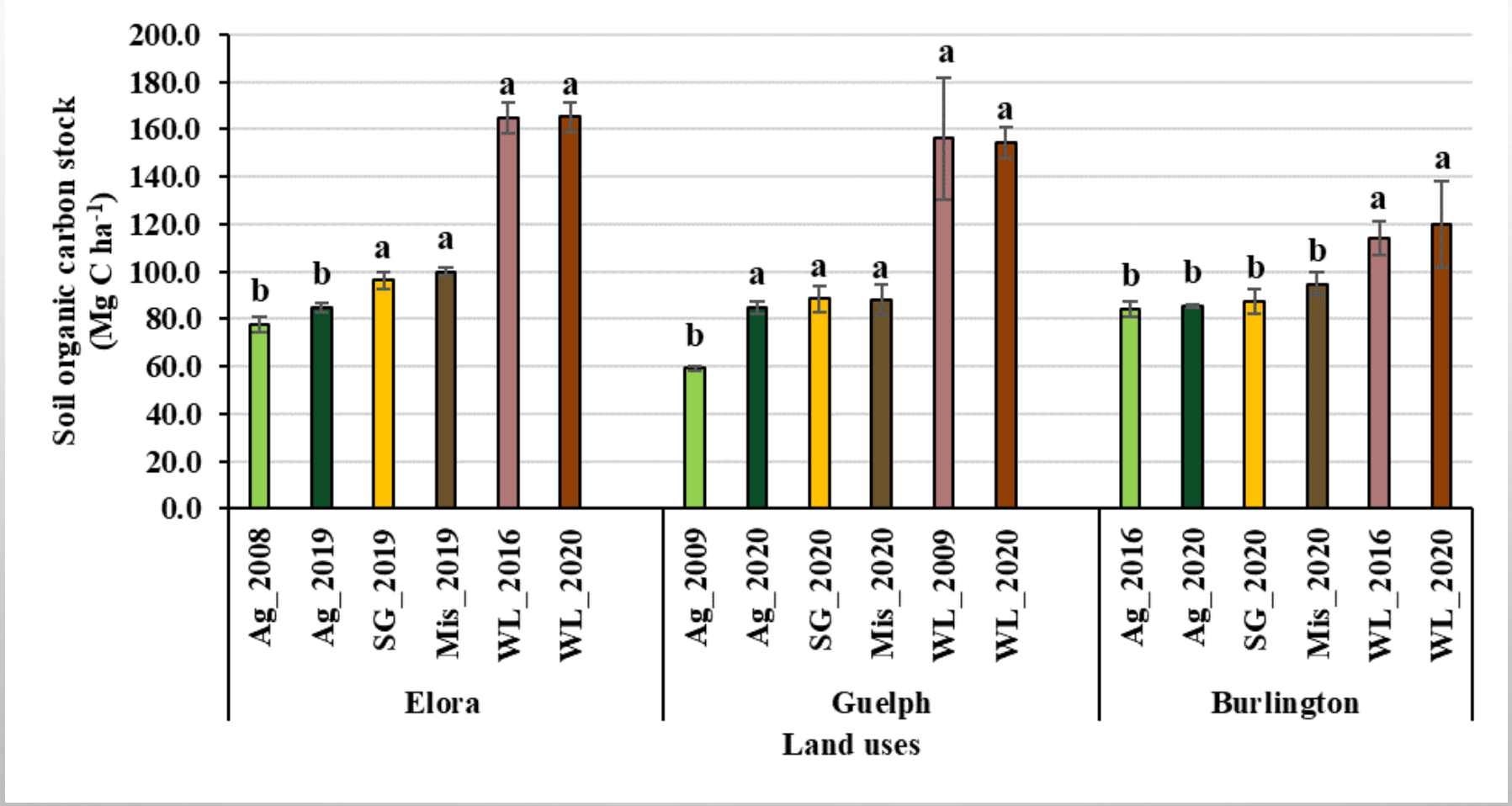
EXPERIMENTAL SITES – AERIAL VIEW SHOWING CLOSE PROXIMITY OF PBC, AG FIELD AND WOODLOTS

Elora (UG)

Guelph (UG)

Burlington (Norm's Farm)

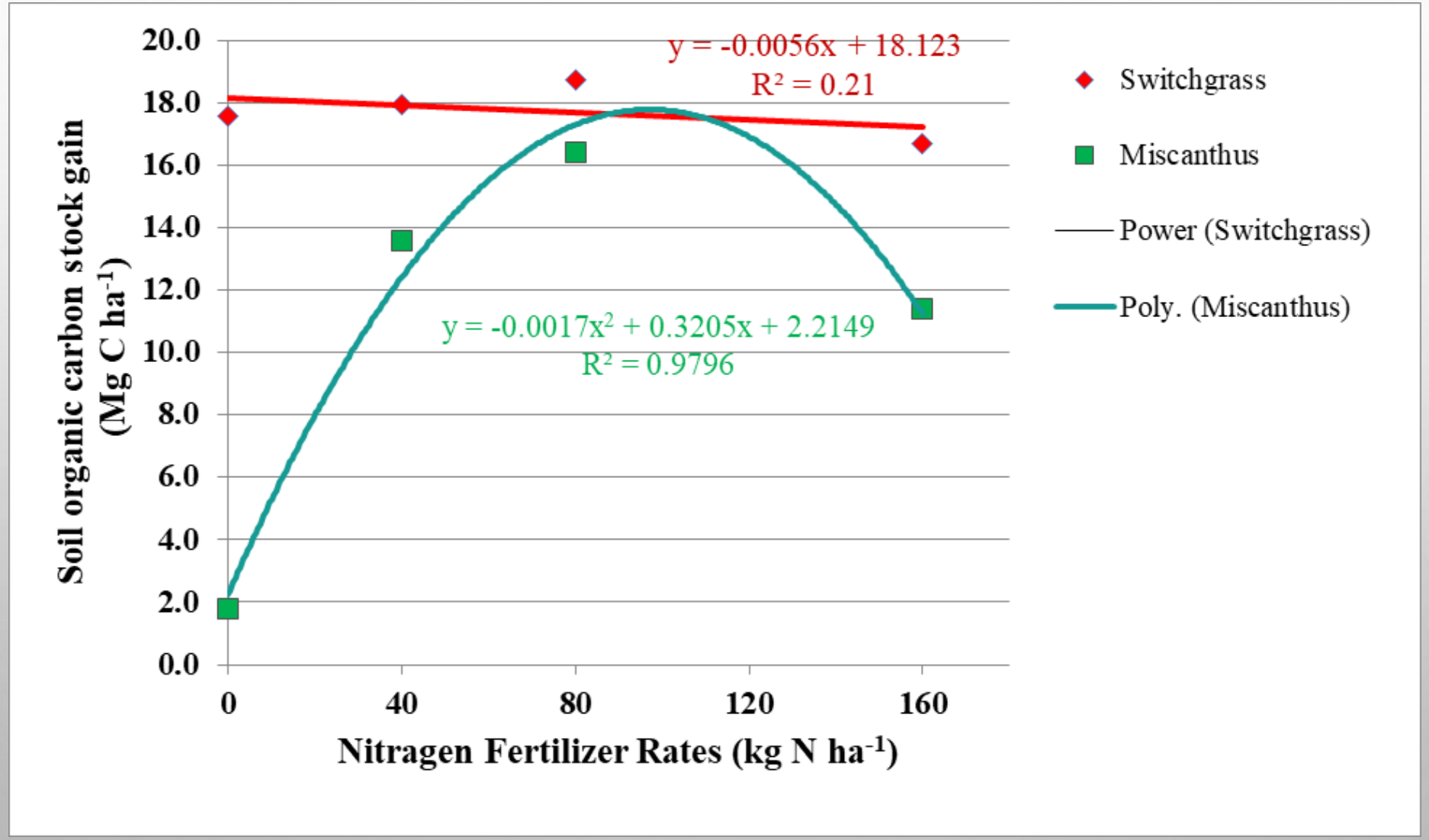
SOC STOCK CHANGE OVER 4 AND 11 YEARS



SOC STOCK GAIN, MEAN ANNUAL SOC SEQUESTRATION RATE, POTENTIAL FUTURE SOC GAIN, MOBILIZED CO2 EQUIVALENT (DURING THE STUDY PERIOD) AND POTENTIAL FUTURE EQUIVALENT OF CO2 MOBILIZATION BY BIOMASS CROPS AND AGRICULTURE CROPS INTO THE SOIL IN ELORA, GUELPH AND BURLINGTON, ONTARIO, CANADAA

Locations	SOC Stock Gain (Mg C ha^{-1})			Years of Crop Cultivation (y)	Mean Annual SOC Sequestration Rate (Mg C ha^{-1} y^{-1})			Mobilized CO_2 Equivalent (Mg CO_2 ha^{-1})			Potential Future SOC Stock Gain (Mg C ha^{-1})			Potential Future CO_2 Mobilization (Mg CO_2 ha^{-1})		
	Ag	SG	Mis	Ag/SG/Mis	Ag	SG	Mis	Ag	SG	Mis	Ag	SG	Mis	Ag	SG	Mis
Elora	7.4	18.7	22.4	11	0.67	1.70	2.04	27.6	68.6	82.2	80.3	69.0	65.3	294.7	253.2	239.7
Guelph	25.5	29.2	28.6	11	2.32	2.65	2.6	93.6	107.2	105.0	69.5	65.9	66.5	255.1	241.9	244.1
Burlington	1.7	3.4	10.6	4	0.46	0.85	2.65	6.2	12.5	39.0	34.0	32.3	25.1	124.8	118.5	92.1

SOC STOCK GAIN (MG C HA^{-1}) WITH FOUR DIFFERENT RATES OF NITROGEN FERTILIZER APPLICATION IN SWITCHGRASS (SG) AND MISCANTHUS (MIS) FIELDS IN ELORA, SOUTHERN ONTARIO CANADA (2008-2019).

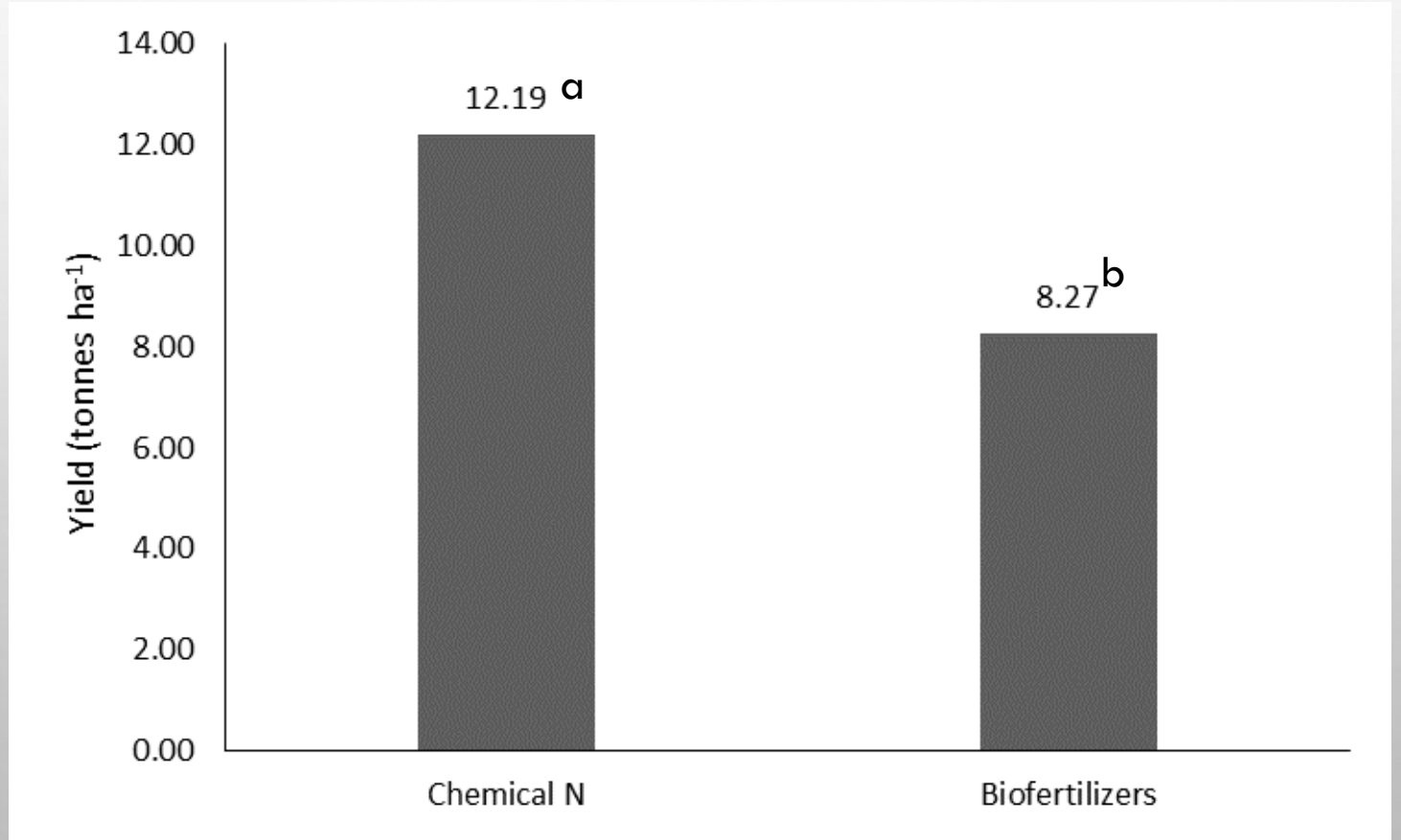


BIO-FERTILIZERS AND THEIR INFLUENCE ON PBC AND SOIL

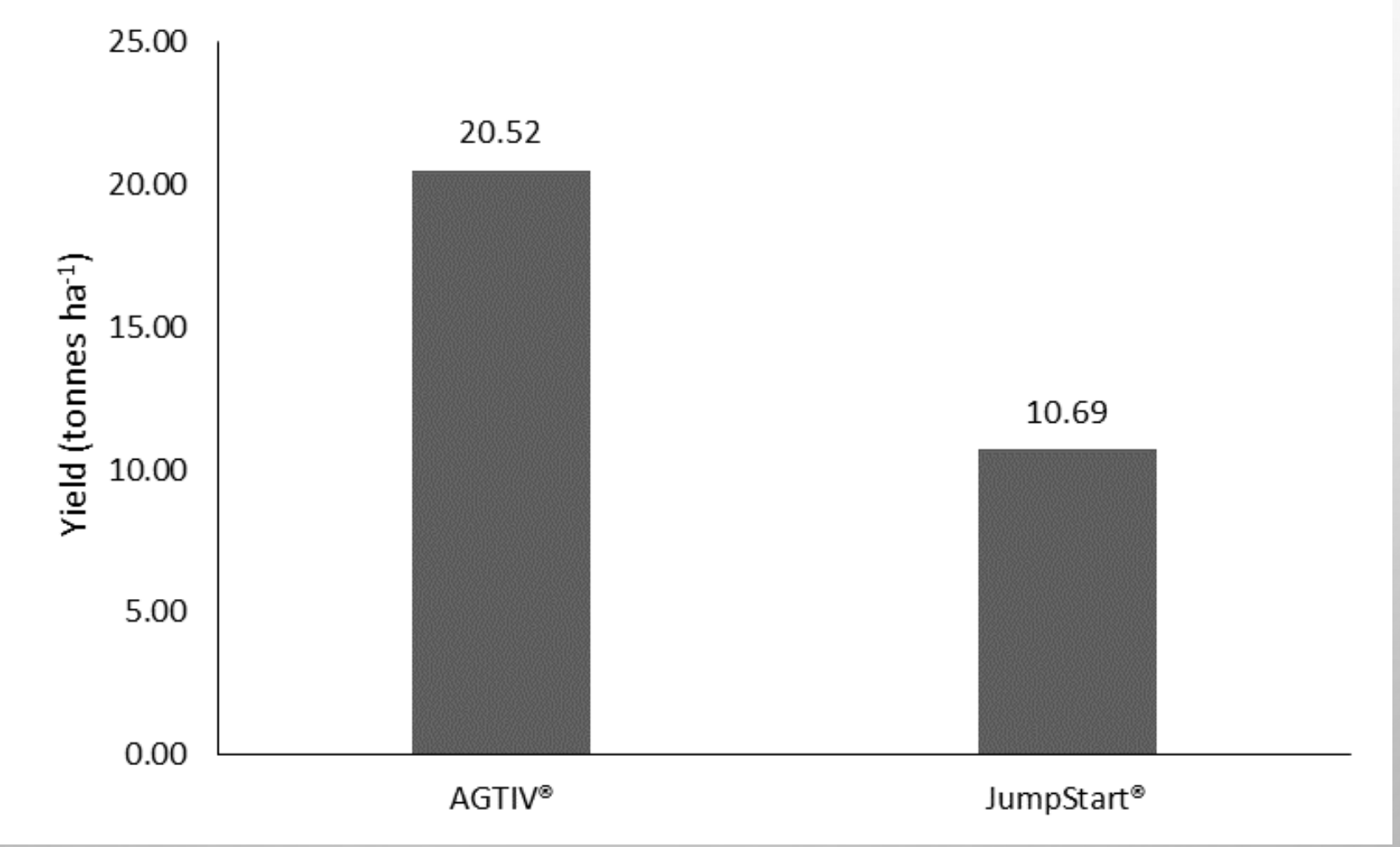
Treatment	*Description*
Control	No inputs of any kind.
Synthetic N	Food-grade urea applied at 60 kg N ha^{-1} (switchgrass) and 55 kg N ha^{-1} (miscanthus) according to OBPC recommended rates (Samson et al., 2018; Withers et al., 2016).
JumpStart®	Dissolved in water to a concentration of 2.05×10^5 cfu *Penicillium bilaiae* L^{-1} (based on manufacturer recommendations for wheat seed treatment; Novozymes BioAg, 2019) and applied at 1 L m^{-2} and food-grade urea applied at 30 kg N ha^{-1}. 2020: triple 2019 application rate (6.15×10^5 cfu *P. bilaiae* L^{-1}); no urea
MYKE® Pro / AGTIV	Surface-applied at a rate of 3.00×10^3 *Glomus intraradices* spores m^{-2} according to manufacturer recommendations (Premier Tech, 2020; Premier Tech 2021) and food-grade urea at 30 kg N ha^{-1}. 2020: no urea
LysteGro (2019 only)	Surface-applied at a rate of 60 kg N ha^{-1} corrected for a 50% N volatilization rate according to manufacturer recommendations (Lystek, 2019; M. Dougherty, personal communication, July 8, 2019).
Optimyc + MooR (2020 only)	Optimyc applied at 750 g ha^{-1} in combination with MooR applied at 25 L ha^{-1} according to manufacturer recommendations (M. Boersma, personal communication, May 13, 2020) by mixing both products in water to a concentration of 0.15 g Optimyc L^{-1} and 5 mL MooR L^{-1}. Final solution was applied at 0.5 L m^{-2}.

EXPERIMENT CONDUCTED IN 3 FARMS GUELPH (UG), JAMES FISHER'S FARM AND NORM RICHARDSON'S FARM

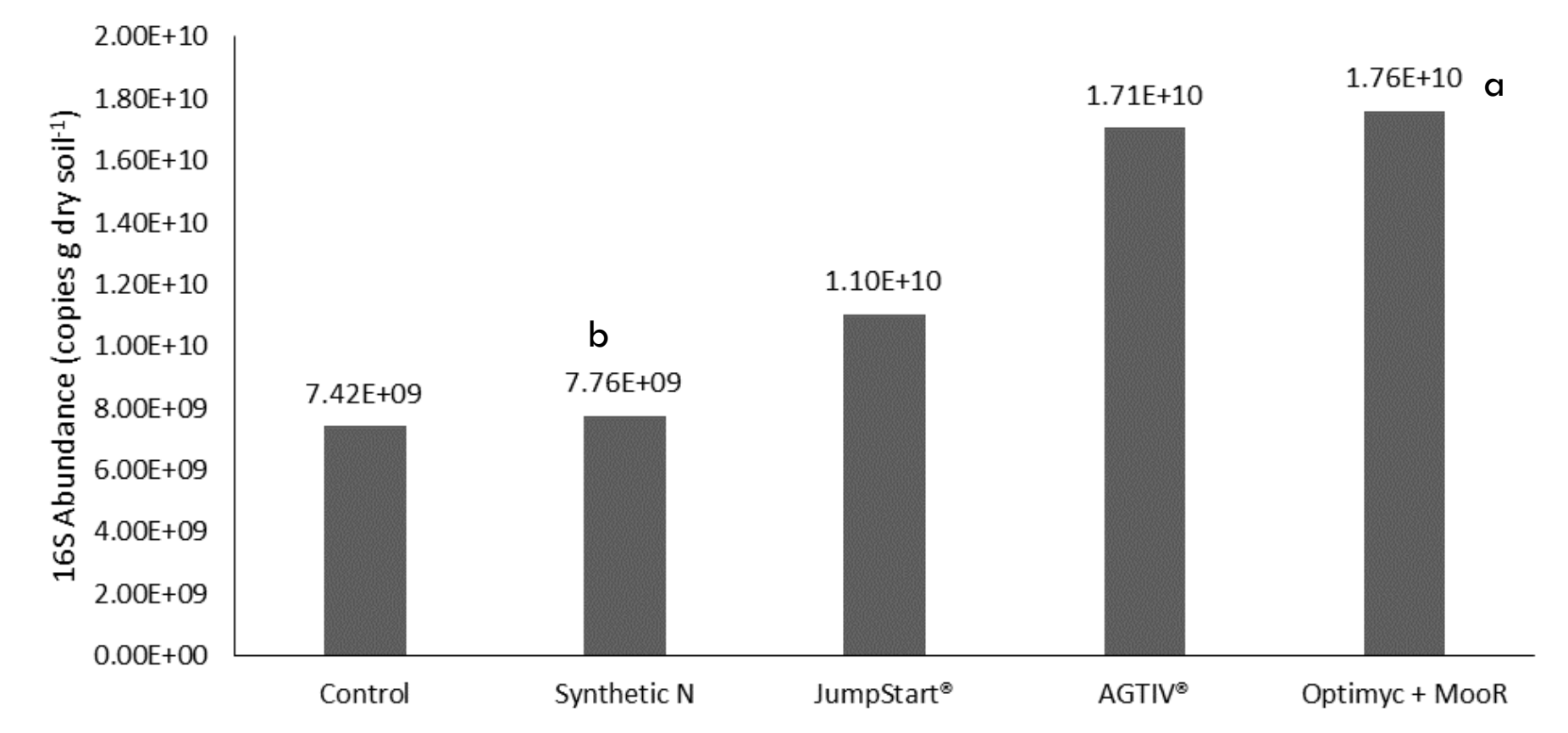
INFLUENCE OF SYNTHETIC NITROGEN (N) FERTILIZER VERSUS THE COMBINED AVERAGE OF THREE BIOFERTILIZERS (JUMPSTART®, AGTIV®, OPTIMYC + MOOR) ON SWITCHGRASS BIOMASS YIELD (TONNES HA^{-1}) AT THE GUELPH SWITCHGRASS SITE IN 2020. DIFFERENT LETTERS INDICATE SIGNIFICANTLY DIFFERENT MEANS ACCORDING TO ORTHOGONAL CONTRAST ($P \leq 0.05$).



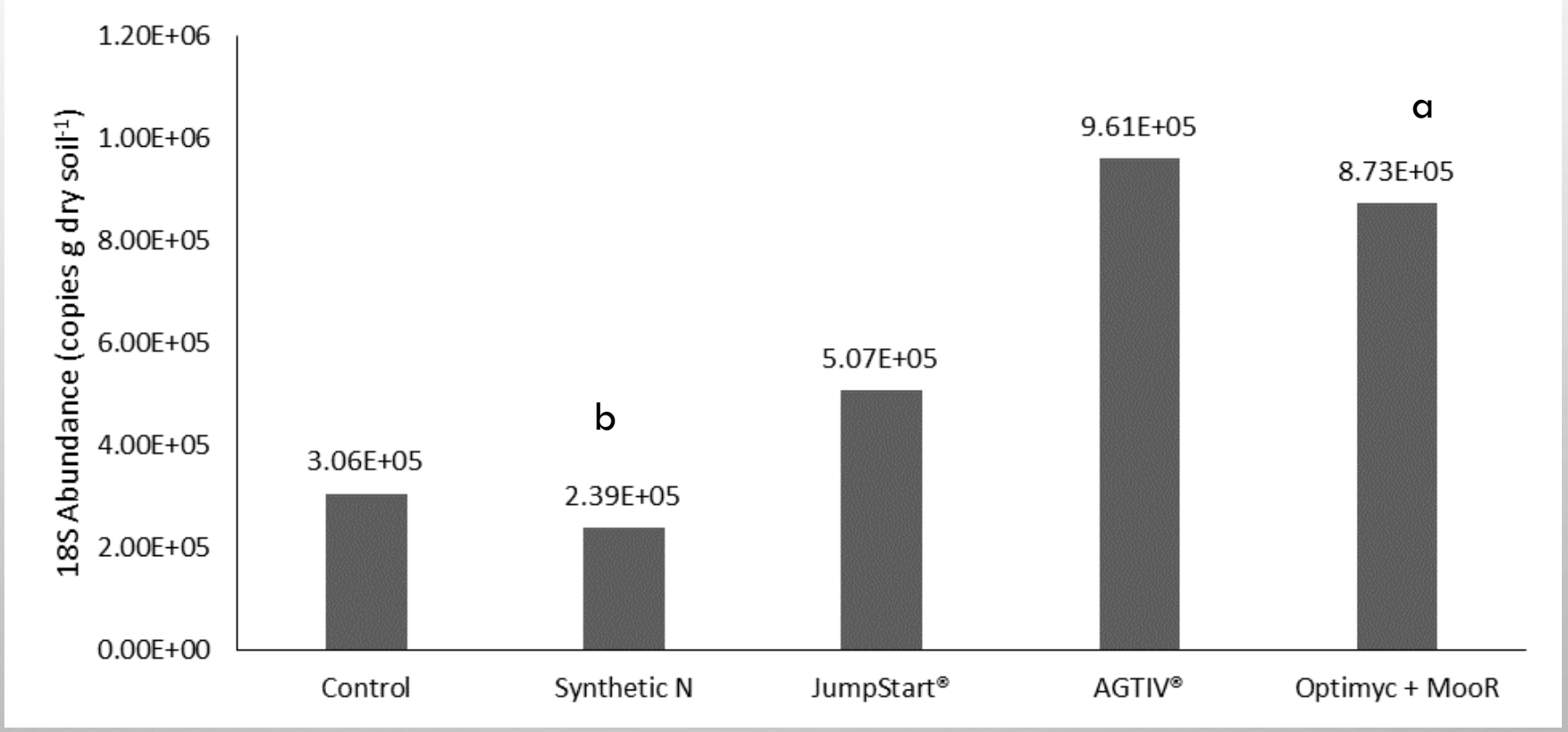
BIOMASS YIELD (TONNES HA^{-1}) FOR MISCANTHUS AS INFLUENCED BY AGTIV® VERSUS JUMPSTART® AT THE BURLINGTON MISCANTHUS SITE IN 2020. DIFFERENT LETTERS INDICATE SIGNIFICANTLY DIFFERENT MEANS ACCORDING TO ORTHOGONAL ANALYSIS ($P \leq 0.05$).



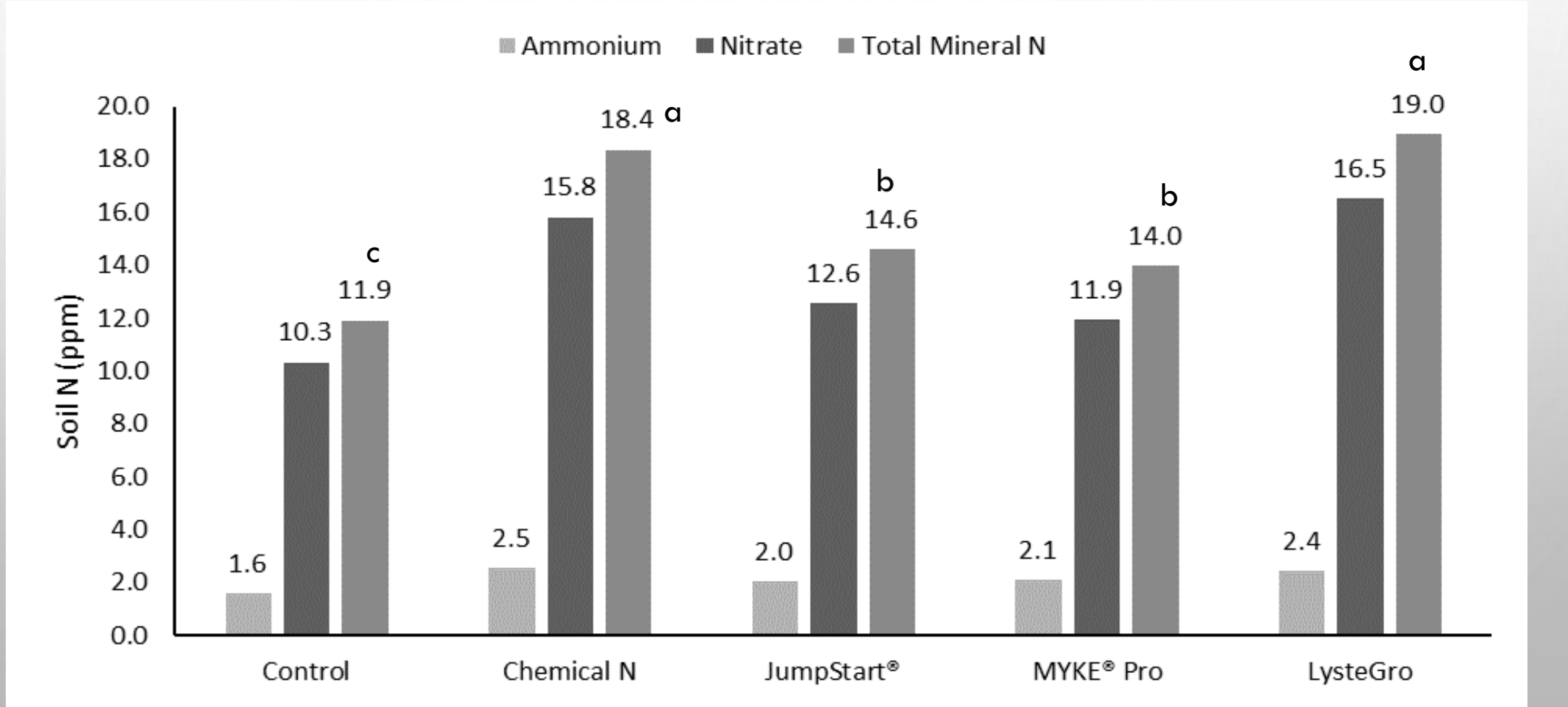
PEAK SEASON 16S BACTERIAL GENE ABUNDANCE (COPIES G DRY SOIL^{-1}) IN THE TOP 10 CM OF SOIL AS INFLUENCED BY FERTILIZER TREATMENT AT THE GUELPH SWITCHGRASS SITE IN 2020. DIFFERENT LETTERS INDICATE SIGNIFICANTLY DIFFERENT MEANS ACCORDING TO LEAST-SQUARE MEANS COMPARISON ADJUSTED PER THE TUKEY TEST ($P \leq 0.05$).



PEAK 18S FUNGAL GENE ABUNDANCE (COPIES G DRY SOIL^{-1}) IN THE TOP 10 CM OF SOIL AS INFLUENCED BY FERTILIZER TREATMENT AT THE GUELPH SWITCHGRASS SITE IN 2020. DIFFERENT LETTERS INDICATE SIGNIFICANTLY DIFFERENT MEANS ACCORDING TO LEAST-SQUARE MEANS COMPARISON ADJUSTED PER THE TUKEY TEST ($P \leq 0.05$).



AVERAGE AVAILABILITY OF NH4+, NO3-, AND TOTAL MINERAL N IN THE SOIL OVER A SEVEN-WEEK INCUBATION PERIOD AS AFFECTED BY FERTILIZER TREATMENT. DIFFERENT LETTERS INDICATE SIGNIFICANTLY DIFFERENT MEANS ACCORDING TO LEAST-SQUARE MEANS COMPARISON ADJUSTED ACCORDING TO THE TUKEY TEST ($P \leq 0.05$).



PRODUCT PRICING ($ CAD) AND BIOMASS YIELD (TONNES HA^{-1}) FOR FERTILIZER TREATMENTS OPTIONS APPLIED TO MATURE SWITCHGRASS AT THE GUELPH SWITCHGRASS SITE AND MATURE MISCANTHUS AT THE BURLINGTON MISCANTHUS SITE.

		Yield (tonnes ha^{-1}) [1]	
Treatment	*Price ($ ha^{-1} year^{-1})*	Switchgrass (GS)	Miscanthus (BM)
Synthetic N (60 kg N ha^{-1})	28.97	11.33	13.05
JumpStart®	88.65 - 100.79[2]	8.70	12.09
MYKE® Pro (2019) / AGTIV® (2020)	34.45-35.70[3]	8.61	16.22
Optimyc + MooR (2020 only)	98.84[4]	8.56	N/A
LysteGro (2019 only)	100.58	10.66	11.68

[1] Averaged over all available years of study.

[2] Price changes depending on the amount purchased and is based on the application rate used in 2020, which was triple the rate applied in 2019.

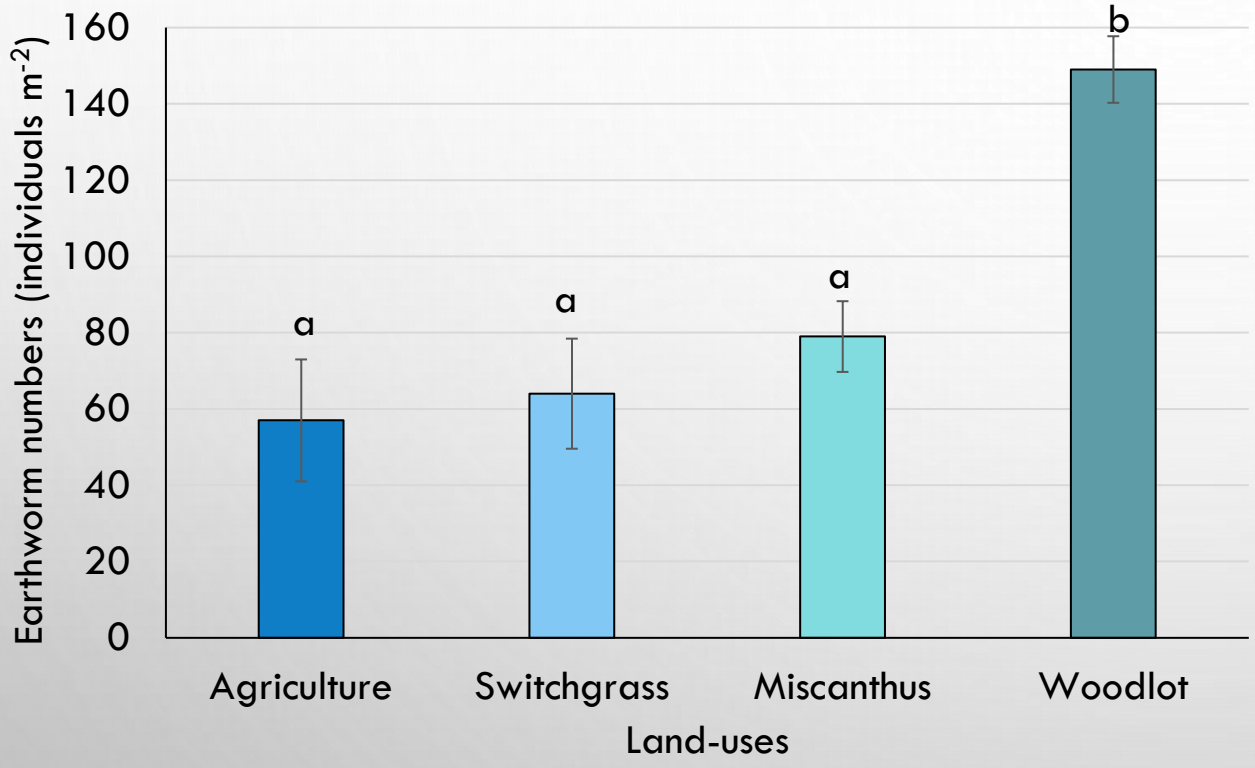
[3] Price changes depending on the amount purchased and is based on cost of AGTIV® (agricultural-grade version of the product), not MYKE® Pro (retail-grade version of the product).

[4] Average annual cost, based on the following 7-year cycle: Optimyc and MooR both applied in year 1, just

Soil health: Earthworm population

- assessing earthworm population by using the diluted formaldehyde solution.

Results



Earthworm populations (individuals m^{-2}) in different land-use systems.

- earthworm population :
  woodlot > biomass crops > agriculture
- SOC :
  woodlot > biomass crops > agriculture
- no record for earthworm population before converting to biomass crops

Summary

- Integrating PBCs (miscanthus or switchgrass) can increase the SOC and could significantly capture atmospheric CO_2 and store it in the soil as SOC.
- For PBC landowners C credit schemes should be developed to create additional revenue.
- Biofertilizers can positively influence biomass yield and soil microbial communities.
- Subsidies are needed for landowners to capture the additional cost.
- N fertilizer application may not enhance SOC sequestration in switchgrass but may enhance SOC sequestration in miscanthus.
- More details given in the factsheet.

Acknowledgements

ONTARIO BIOMASS PRODUCERS CO-OPERATIVE INC.

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Thank you!

For Further Information, please contact:

Dr. Naresh Thevathasan
Email: nthevath@uoguelph.ca