



INNOVATION GRANT FINAL REPORT

PROJECT TITLE: Soil carbon loss from newly drained Red River Basin soils

REPORTING PERIOD: Final Report and Invoice due by Oct 29, 2021

FARMER INNOVATOR:

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1.) PROJECT ACTIVITIES COMPLETED DURING THE REPORTING PERIOD. *(Describe project progress specific to goals, objectives, and deliverables identified in your project proposal.)*

A final set of soil samples was taken in October of 2021 in the drained/undrained plots at the Northwest Research and Outreach Center. That completes two full seasons of thrice-yearly sampling during the growing season, and analysis of these samples for soil carbon will continue under AFREC-funded research.

Graduate students Kyle Sherbine and Aaron Frankl and undergraduate student Natalie Kern worked on analyzing potentially mineralizable C (PMC), water-extractable organic C (WEOC), and total C during this period.



2.) IDENTIFY ANY SIGNIFICANT FINDINGS AND RESULTS OF THE PROJECT. (*This could include photo documentation of the project at various stages if you haven't already provided these as well as final relevant images of the project at completion. Any data analysis (especially Level 3 Grants), graphics or record of observations throughout the growing season or during the field day event are also anticipated.*)

We found significant seasonal variability in WEOC and PMC (Table 1) over the two growing seasons of the study. Specifically, these microbially-available C pools were lower at summer samplings in both years. Summer may be a lower time for microbially-available C as in the spring, microbes can access stores of labile C left undecomposed over the winter, and in the fall, microbes have a pulse of C from post-harvest residue inputs. In addition, dry conditions (especially in 2021) may make the conditions somewhat unfavorable for microbes. PMC was overall slightly greater in undrained plots, especially at 0-30 cm. This may partially be due to lower microbial activity in lower-oxygen undrained plots. However, no water flowed through tile drains in all of 2021, and the effect of drainage on PMC in summer 2021 samples was correspondingly minimal..

Table 1:

Season	Depth (cm)	WEOC (ppm)		PMC (ugC/g/day)	
		Drained	Undrained	Drained	Undrained
Fall 2019	0-30	18.91 (5.25)	22.04 (6.83)	84.50 (26.93)	129.83 (23.70)
	30-60	15.46 (4.36)	16.00 (4.48)	45.56 (28.36)	76.06 (27.86)
	60-90	10.96 (4.85)	10.73 (2.82)	26.74 (13.36)	42.12 (19.60)
Spring 2020	0-30	20.80 (4.41)	25.50 (6.84)	124.32 (15.70)	108.62 (14.99)
	30-60	15.57 (5.01)	14.22 (3.28)	73.28 (16.02)	56.84 (18.41)
	60-90	9.32 (1.87)	11.41 (3.59)	34.61 (18.45)	46.68 (15.91)
Summer 2020	0-30	17.08 (6.53)	17.57 (3.31)	78.18 (14.95)	85.16 (11.29)
	30-60	10.13 (2.87)	10.73 (2.13)	45.26 (10.99)	50.50 (7.99)
	60-90	8.48 (3.14)	8.05 (1.06)	40.97 (19.96)	39.19 (5.20)
Fall 2020	0-30	NA	NA	58.67 (9.85)	66.20 (18.10)
	30-60	NA	NA	33.64 (3.89)	35.29 (7.42)
	60-90	NA	NA	24.77 (3.18)	26.91 (5.86)
Spring 2021	0-30	NA	NA	114.78 (28.88)	144.15 (52.31)
	30-60	NA	NA	22.38 (16.28)	39.93 (19.71)
	60-90	NA	NA	10.43 (6.97)	13.39 (4.20)

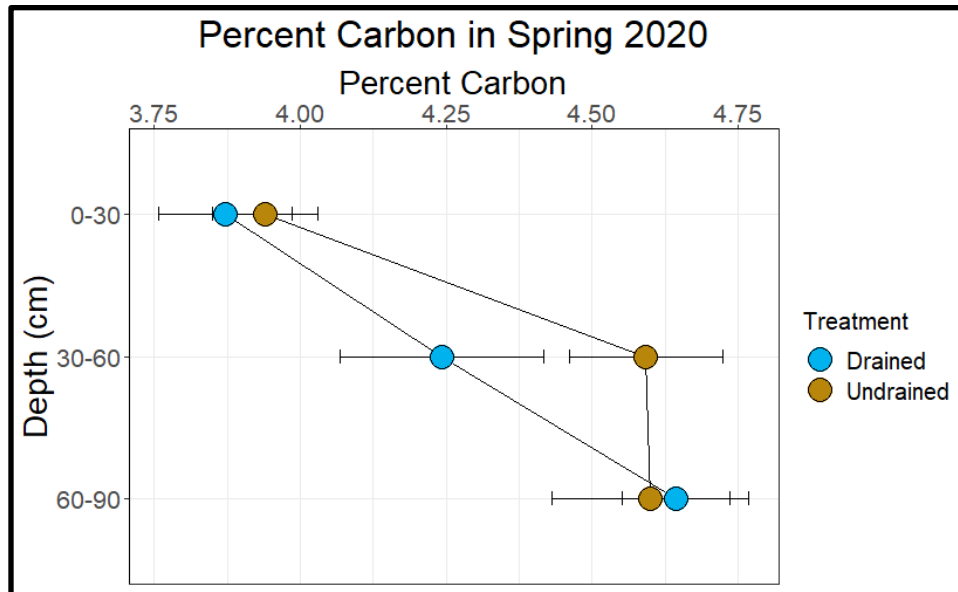
Summer 2021	0-30	NA	NA	60.39 (19.05)	63.33 (26.87)
	30-60	NA	NA	31.45 (22.67)	19.37 (9.58)
	60-90	NA	NA	14.33 (5.53)	12.79 (5.88)

Total carbon was shown to be highly spatially variable, ranging from 2.53-5.53% in the surface soil (Fig 1). This confirms the importance of grid-sampling at 1-ac density throughout these plots. Interestingly, C increased with depth, probably due to more saturated conditions regardless of drainage treatment during a very wet cycle in NW MN. We expect, in the coming years, to see that this depth shows decreased C in drained treatments as the soil oxygen content increases. In Spring 2020, collected prior to any drain tile running, there were no significant differences between drained and undrained plots except at 30-60 cm, where %C was slightly greater in undrained plots (Figure 2). This may represent the natural variability across the field, as the NW corner, part of a drained plot, shows consistently lower values than other sections at all depths. While this is not ideal for research goals, tracking loss relative to the starting point will still provide a clear picture of the effects of drainage on Red River Basin soil C.

Figure 1: Soil carbon (%) across the 64-acre research plot. Each cell represents one sample, taken approximately 1/acre.

		Spring 2020							
0-30 cm		3.64	3.59	3.30		3.61	4.71	3.48	3.07
		2.53	3.12	3.55	3.88	4.87	3.56	4.90	4.43
		2.88	3.95	3.91	3.84	4.89	3.26	4.28	3.88
		3.35	4.70	3.87	3.02	4.79	5.09	3.54	3.97
		3.23	3.32	4.62	3.80	3.93	3.68	5.52	3.85
		4.43	3.72	4.14	3.69	4.41	4.14	4.10	4.35
		3.50	3.19	3.72	4.04	3.67	3.91	3.94	4.46
		4.00	3.63	3.62	3.79	4.69	3.92	3.62	3.96
			Drained		Undrained		Drained		Undrained
30-60 cm			3.81	3.58	4.82	4.30	5.18	3.22	1.71
		2.44	3.37	4.78	4.51	5.25	2.67	4.66	5.16
		2.87	3.72	4.26	5.07	5.16	3.31	4.71	5.41
		1.98	5.25	4.45	5.45	6.18	4.99	4.81	4.46
		3.69	4.29	4.52	5.35	5.25	4.36	5.37	4.27
		4.35	3.82	5.25	4.91	4.22	4.75	4.88	4.45
		4.41	3.46	4.80	3.87	4.96	5.03	5.44	4.79
		5.17	4.09	4.64	4.90	5.17	4.02	4.09	4.36
			Drained		Undrained		Drained		Undrained
60-90 cm			4.39	2.90	4.89	4.71	5.57	2.54	4.08
		3.80	4.40	4.88	5.60	5.17	3.92	5.05	4.95
		4.01	4.51	5.18	5.51	5.00	4.94	4.33	5.08
		3.34	3.83	0.62	4.61	5.04	4.67	4.30	4.55
		4.04	5.07	4.98	4.62	5.13	4.25	5.14	4.27
		4.61	4.38	4.80	5.04	4.72	4.72	4.92	5.25
		4.80	5.09	4.84	4.81	5.11	5.15	5.04	4.83
		4.98	5.16	5.12	4.89	5.00	4.45	4.65	4.92

Figure 2: Difference in % C between drained and undrained plots in spring 2020.



3.) CHALLENGES ENCOUNTERED. *(Describe any challenges that you encountered related to project progress specific to goals, objectives, and deliverables identified in the project proposal.)*

Dry conditions minimized the treatment effects in 2021, but a rapid mineralization of C (the Birch effect) is likely to occur when the soil profile fills with moisture again, regardless of drainage treatment. This will make it challenging to evaluate the effects of drainage treatment on soil organic matter in the early years of drainage. Essentially, all the potential C mineralization of 2021 may occur in one or two rapid bursts after rain events. However, we anticipate that these samples will still provide a valuable baseline dataset for these long-term research plots.

We also plan to measure inorganic C in all these samples, so the results of total C should be considered preliminary, until we are able to differentiate between inorganic and organic C pools.

4.) EDUCATION AND OUTREACH ACTIVITIES. *(Describe any opportunities to engage with farmers, influencers or the media about your project.)*

None in this period, but Sherbine and Frankl will both present their work at the Crops/Soils/Agronomy Annual meetings in November.

5.) HOW CAN WE HELP? *(Please let us know how we can improve the experience for the next generation of projects.)*