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Tom Vanacore
Rock Dust Local, LLC
1445 Hemenway Road
Bridport, VT 05734

Tom,

I am sending results for field trials that we have conducted using Rock Dust Local products as part of the Vermont Phosphorus Innovation Challenge (VPIC) project. We field applied several products as demonstrations including St George Black (SGB) ground rock, Swanton Black (SWB) ground rock, Phos-Cap, a mixture of 90/10 by weight of SBG and Biochar and RichMix, a 50/50 mix of SGB and Biochar.

The Phos-Cap material appears to be more effective than the SGB or SWB materials by themselves for reducing Water soluble P levels in the soil. The original spreading rates of less than 1 ton/acre for the RichMix and Gypsum products was definitely too low to show any effect on reducing P. The data would be improved by the application of several rates (0, 1X, 2X 4X) with replicated plot-size applications for statistical analysis of trial data.

Whole-field demonstrations

The SGB and Phos-Cap were spread on 3 farm fields in Addison (6.0 ac) , Bridport (44.5 ac) and Ferrisburgh (40.1 ac), VT at a rate of 2 ton/acre as recommended in October or November 2018. The soils were sampled before materials application and again in April 2019. All three sites in Addison County received applications of dairy manure after application in fall 2018, two corn silage fields with cover crop and one grass hay field.

The SWB product was spread on 2 farms in fall 2018 on two corn silage fields in St. Albans (17 ac) and Swanton (25 ac) at a rate of 2 ton/acre. Dairy manure was spread at the Swanton site after SWB application and no manure was spread at the St Albans Site.

At all five field demonstration sites we took soil samples to determine pre- and post-treatment Phosphorus (P) levels using the following analyses conducted by UVM Analytical Testing Lab:

1.) UVM modified-Morgan reserve P analysis (Res-P) that measures all P in the soil,

2.) UVM modified-Morgan available P analysis that measure plant available P (Avail-P) for crop production recommendations, and

3.) UVM water soluble P analysis (Water-P) to measure soluble P that would move off-site with rainfall and overland water flow.

The soil samples were collected from a depth of 0-3”, 3-6” or 0-6” levels to determine if there were different effects at field surface and subsurface within the normal 0-6” soil sampling depth for nutrient recommendations. There is also evidence that in fields managed for no-till

production (2 of the 3 fields) soil sampling should focus on the surface 2 to 3 inches as P stratification in the soil profile can become pronounced over time.

In fall 2018 we had analyses completed for all three parameters and in spring 2019 reduced the analysis to include only the Avail-P and Water-P tests. At the SGB and Phos-Cap sites there were two separate sampling areas, whole-field and sub-field, which provided a total sample (n=4) for each treatment. The SWB sites in Franklin County were sampled whole-field only (n=2) so statistical analysis of results did not show differences due to low number of samples for each treatment.

Results and Discussion

In October 2018, soil sampling and analysis at three depths of 0-3", 3-6" and 0-6" demonstrated that at all sampled field sites the P concentrations were so non-uniformly stratified in the soil profile that the 0-6" sampling depth was discontinued in spring 2019. The critical measurement for focus at all sites was the analysis for Water-P at 0-3" depth, which should represent the potential runoff concentrations of field water that may affect surface water streams. There is no current UVM interpretation of Water-P soil test levels for crop recommendations.

St George Black (SGB)

Two field sites in Addison and Bridport (Figures 1 and 2) received applications of St George Black (SGB) at a rate of 2 ton/acre broadcast application on November 16, 2018. Soil samples were collected for analysis October 26-31, 2018 and again in mid-April before 2019 field activities started. Both sites were Vergennes Clay soil. The average Avail-P soil test level in the 0-3" sample depth was excessive at the Addison site (35.9 ppm) and optimum at the Bridport site (8.3 ppm). At the Addison site the 0-3" depth showed a decrease in both Water-P and Avail-P while the deeper soil at 3-6" was not affected by the surface application of SGB (Table 1).

Table 1. **SGB, Addison site** - No-till corn silage with cover crop and fall broadcast manure.

Site	Sample depth	Pre-Treatment Soil Test		Post-Treatment Soil Test		Change in Soil Test (Oct-April)	
		Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)
Addison	0-3"	6.7	35.9	6.4	28.8	-0.2	-7.1
	3-6"	0.6	8.3	1.3	8.2	0.7	0.0

3.55 pounds/Ton as Phosphorous.
10.9 pounds/Ton as Phosphate.
8.15 Pounds/Ton as P2O5

At the Bridport site the Water-P at 0-3" did not change while the Avail-P had increased significantly from the added P from surface manure application (Table 2).

Table 2. SGB, Bridport site - Grass hay with fall broadcast manure.

Site	Sample depth	Pre-Treatment Soil Test	Post-Treatment Soil Test	Change in Soil Test (Oct-April)

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		Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)
Bridport	0-3”	0.9	5.2	0.9	22.6	0.0	17.5
	3-6”	0.3	2.6	0.8	14.3	0.5	11.7

Phos-Cap (SGB/Biochar Mix)

Two field sites in Addison and Ferrisburgh (Figures 1 and 3) received applications of Phos-Cap (SGB/Biochar 90/10 mix by weight) at a rate of 2 ton/acre broadcast application on October 31 and November 16, 2018. The Ferrisburgh site was a Swanton fine sandy loam soil. The average Avail-P soil test level in the 0-3” sample depth was excessive at the Addison site (44.8 ppm) and excessive at the Ferrisburgh site (72.3 ppm).

At both sites with Phos-Cap application showed a decrease in both Water-P and Avail-P test levels, more so at the Ferrisburgh site where chisel plow tillage was performed after manure application in the spring (Table 3 and 4). At the Addison site with excessive Avail-P, both SGB and Phos-Cap products were applied in the same field side-by-side. The P reduction of Water-P at 0-3” depth was much greater with Phos-Cap, a 60% reduction versus a 3% reduction with straight SGB. The Avail-P reductions at 0-3” depth were not as pronounced, but still showed that the P reduction was 41% in the Phos-Cap area and 20% in the SGB area of the field.

At the Addison site a control strip was monitored where no P-reduction materials were spread and the basic field practices of no-till, cover crop and manure application were the same. The control strip 0-3” depth soil tests showed a 48% increase in Water-P and 71% increase of Avail-P at the April sampling date (Table 5). The 3-6” depth showed little change as anticipated with a no-till field situation.

Table 3. Phos-Cap, Addison site - No-till corn silage with cover crop and fall broadcast manure.

Site	Sample depth	Pre-Treatment Soil Test		Post-Treatment Soil Test		Change in Soil Test (Oct-April)	
		Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)
Addison	0-3”	14.0	44.8	5.7	26.5	-8.3	-18.3
	3-6”	1.0	14.7	1.7	9.3	0.7	-5.4

11.85 Pounds/Ton as Phosphorous (P)
36.31 Pounds/Ton as Phosphate
27.2 Pounds/Ton as P2O5

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Table 4. Phos-Cap, Ferrisburgh site - corn silage with cover crop and broadcast manure.

Site	Sample depth	Pre-Treatment Soil Test		Post-Treatment Soil Test		Change in Soil Test (Oct-April)	
		Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)
Ferrisburgh	0-3”	13.5	72.3	8.6	55.8	-4.9	-16.5
	3-6”	6.1	50.0	3.0	2.7	-3.1	-17.3

16.9 Pounds/Ton as Phosphorous (P)
51.79 Pounds/Ton as Phosphate
38.8 Pounds/Ton as P2O5

Table 5. Control, Addison site - No-till corn silage with cover crop and fall broadcast manure.

Site	Sample depth	Pre-Treatment Soil Test		Post-Treatment Soil Test		Change in Soil Test (Oct-April)	
		Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)
Addison	0-3”	5.2	23.6	8.4	26.6	3.3	3.0
	3-6”	0.8	11.7	1.4	7.7	0.6	-4.0

No meaningful change

Swanton Black (SWB)

Two field sites in Swanton and St. Albans (Figures 4 and 5) received applications of Swanton Black (SWB) at a rate of 2 ton/acre broadcast application in October, 2018. Both sites were no-till corn fields and the Swanton site received manure in fall 2018 after SWB application. Soil sampling at 3-6” depth was not consistent for both fall and spring so the 0-3” depth results are presented here for both sites (Table 6).

The average Avail-P soil test level in the 0-3” sample depth was excessive at the Swanton site (31.8 ppm) and high at the St. Albans site (12.3 ppm). The Water-P at 0-3” depth was reduced by 20% and 16% at the two sites in spring 2019 soil samples.

Table 6. SWB, Swanton and St. Albans site - No-till corn silage with cover crop.

Site	Sample depth	Pre-Treatment Soil Test		Post-Treatment Soil Test		Change in Soil Test (Oct-April)	
		Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)	Water-P (ppm)	Avail-P (ppm)
Swanton	0-3”	6.7	31.8	5.7	23.4	-1.1	-8.4
St. Albans	0-3”	4.8	12.3	3.8	*	-1.0	*

*data missing

Swanton Black: 8.4 Pounds/ton as Phosphorous. 25.74 Pounds/ton as Phosphate

19.33 Pounds/ton as P2O5

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RichMix and Gypsum replicated small plot trials

Prior to the fall availability of SGB and Phos-Cap products in bulk quantities, The RichMix (SGB/Biochar) product was spread in replicated and randomized complete block trials at two sites using three different rates (583, 900 and 1,436 lb/ac) plus a zero control to determine a rate response curve for the products. The two sites were one alfalfa hay and one grass hay field in Cornwall and Addison, VT. These results were compared to a paired replicated rate response trial at the same site in Addison using three different rates of Nutrisoft DG Natural Gypsum (628, 970 and 1,547 lb/ac) plus a zero control and in Cornwall three different rates of Black Ag Gypsum DG (570, 880 and 1,404 lb/ac) plus a zero control to determine a rate response curve for the products which were provided by Rock Dust Local. Gypsum is also currently recommended as a P reduction soil amendment by USDA NRCS and is also being used in a separate on-going study in Addison County that is comparing Nutrisoft DG natural gypsum, flue-gas gypsum and Black Ag Gypsum DG for comparative P reduction effects at 0-6', 6-12" and 12-18" depths in the soil.

For these replicated trials we used all three soil tests for 0-3" depth and the Avail-P and Res-P analyses for 3-6" depths to increase understanding of the relationship between the Water-P, Avail-P and Res-P results. The Water-P test seems most appropriate for the surface 0-3" layer as this simulates rainwater P runoff levels that would be experienced in the field affecting water quality in surface waters.

The RichMix and Gypsum materials were field applied in June 2018 and the soil samples were taken post-application in October 2018. Biosolids from Casella Organics was spread on the grass hay field in summer 2018 as a fertilizer source and no manure was applied to the alfalfa field. Reported here are only the high treatment rate and zero control for each of these trials.

There was no statistically significant difference between treatments and controls for any of the applied materials. Two factors may have contributed to a NS finding; the sites selected had low and optimum Avail-P test levels and the spreading rates were too low at 0.75 ton/acre.

Any further replicated trials should be done with higher rates applied on fields with a high to excessive Avail-P soil test.

Table 7. RichMix, Addison site - Grass hay with biosolids applied.

Site	Sample depth	Post-Treatment Soil Test	
		Water-P (ppm)	Avail-P (ppm)
RichMix	0-3"	0.8	1.3
Control	0-3"	0.5	2.1

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Nutrisoft Gypsum	0-3”	1.5	2.7
Control	0-3”	1.8	3.3

Table 8. RichMix, Cornwall site - Alfalfa hay

Site	Sample depth	Post-Treatment Soil Test	
		Water-P (ppm)	Avail-P (ppm)
RichMix	0-3”	0.5	3.5
Control	0-3”	0.5	2.7
Black Ag Gypsum	0-3”	0.8	3.9
Control	0-3”	0.6	8.1

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Field Demonstration Site Maps - St George Black (SGB) and Phos-Cap (SGB/Biochar Mix)

Figure 1. Addison field site.

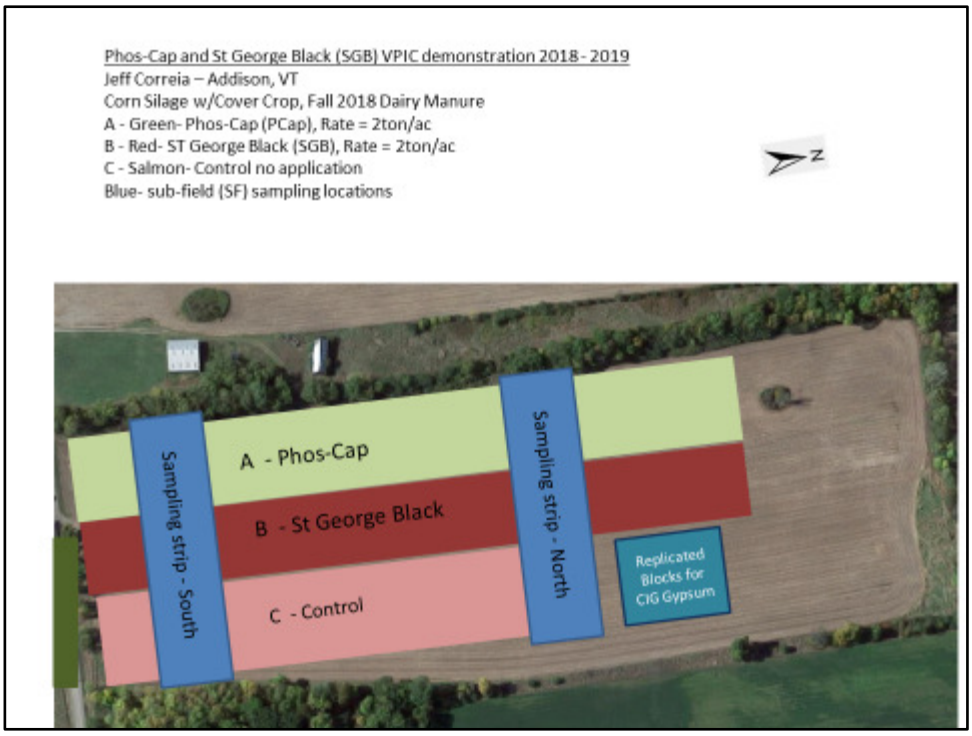

Figure 2. Bridport field site.

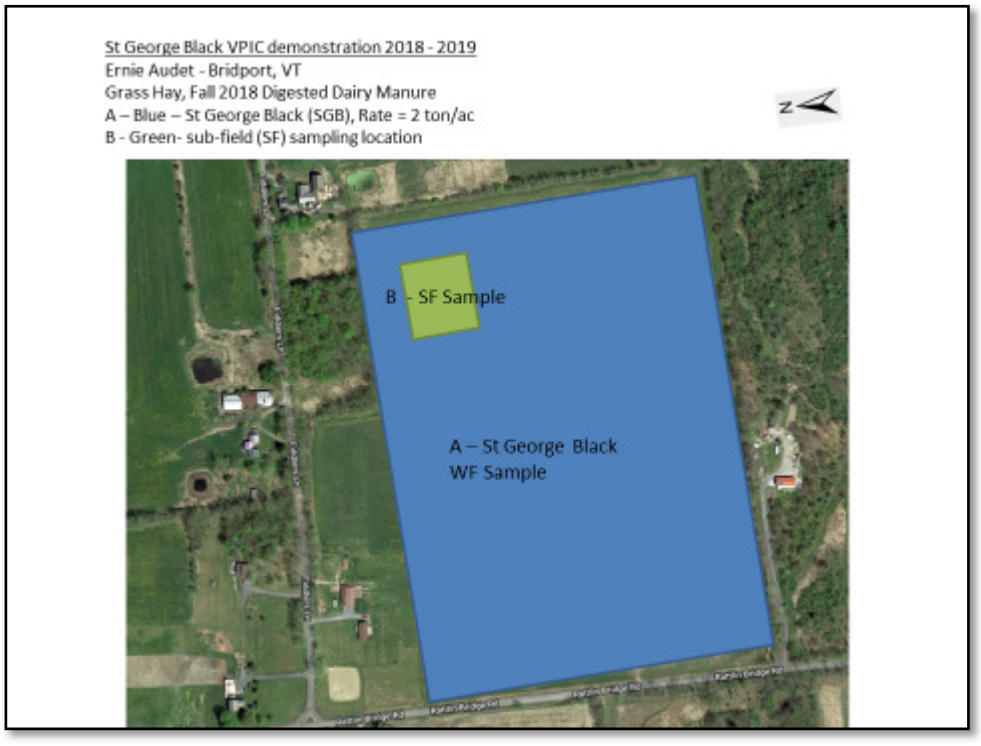

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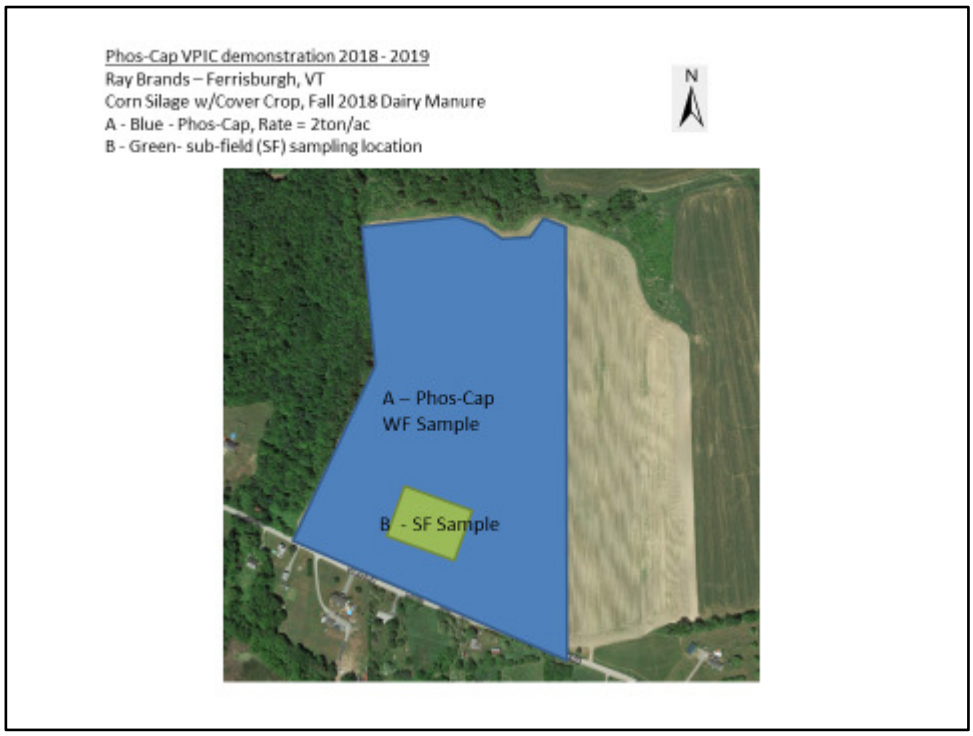
Figure 3. Ferrisburgh field site.



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Field Demonstration Site Maps - Swanton Black (SWB)

Figure 4. St. Albans field site.

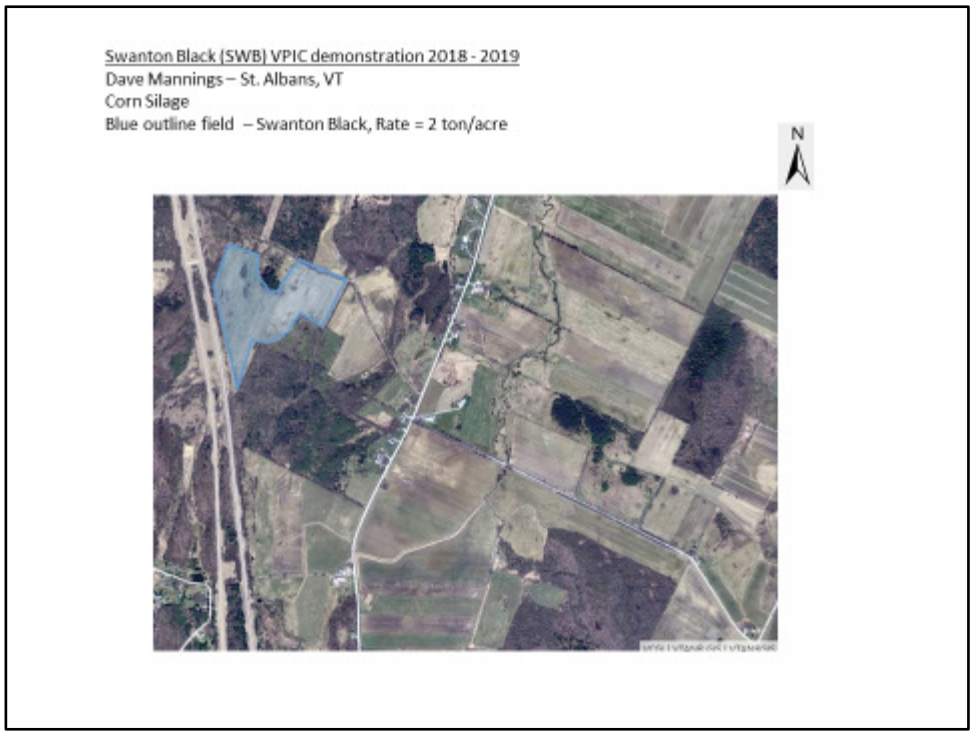
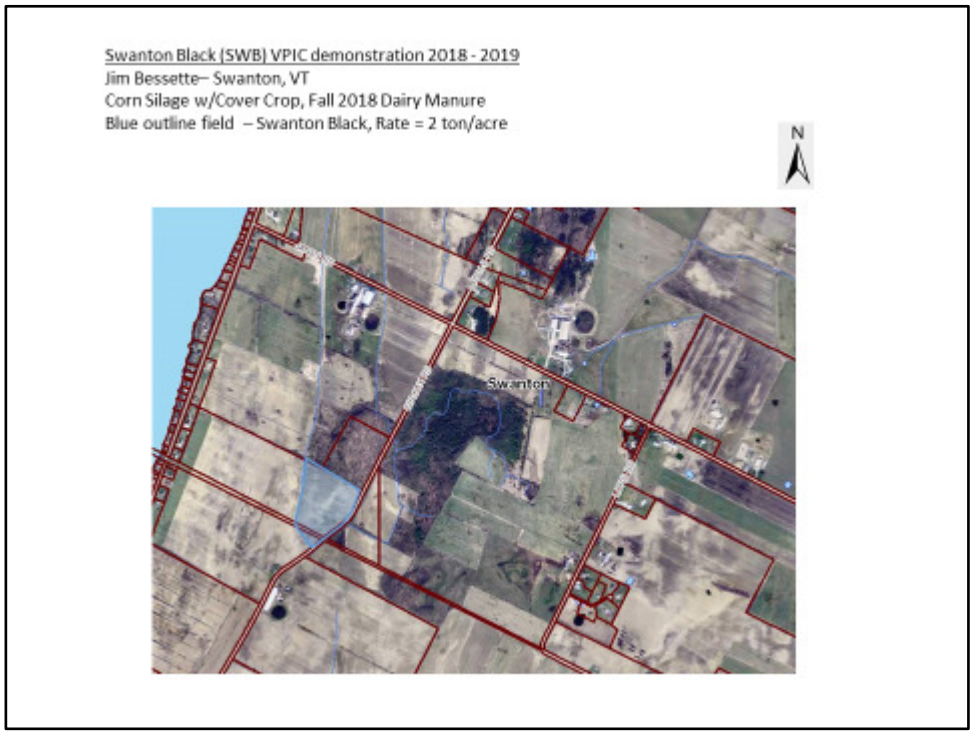


Figure 5. Swanton field site.



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Replicated Trials Site Maps - RichMix (SGB/Biochar), Nutrisoft Gypsum, Black Ag Gypsum

Figure 6. Addison field site.

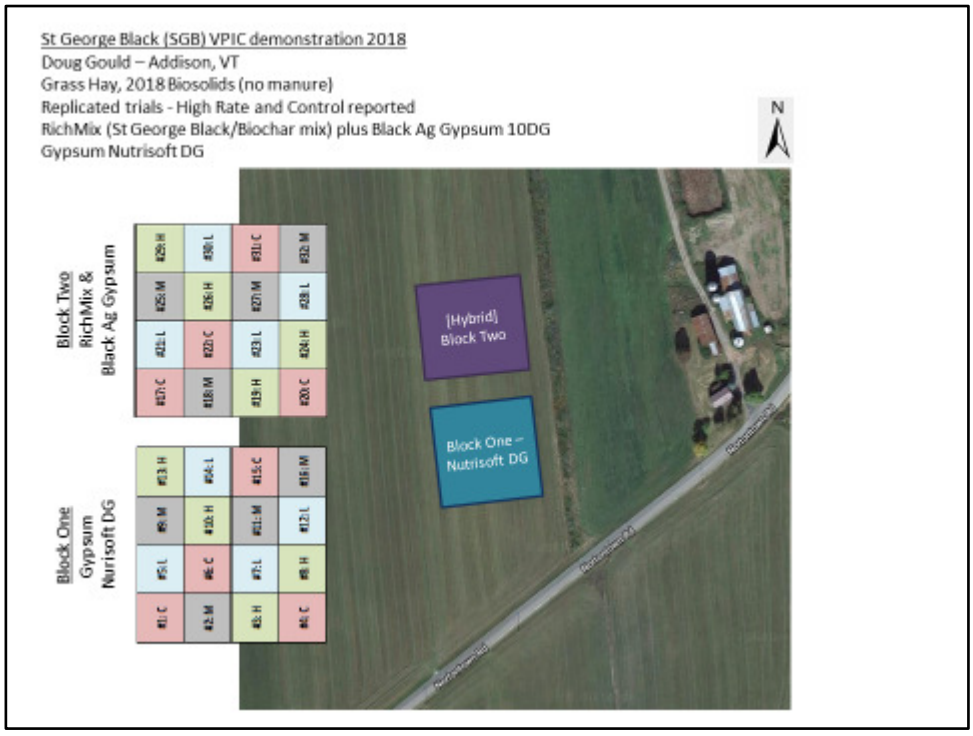
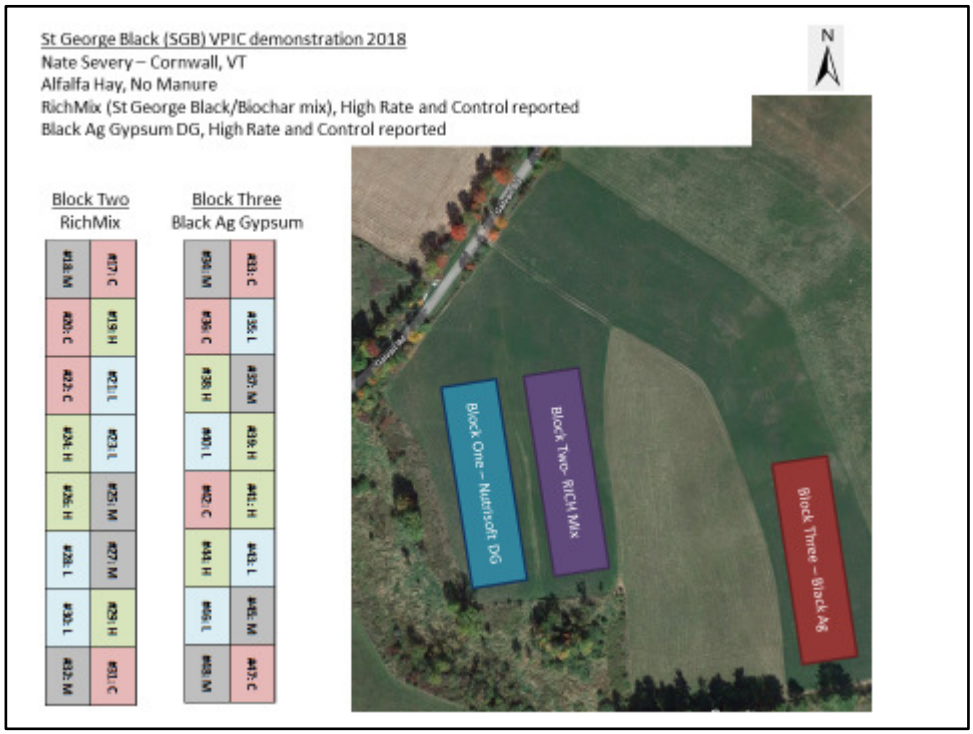


Figure 7. Cornwall field site.



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