

Soil Structure Assessment

Organization: Doe Farms

Field : Jane's 30

Tillable Acres: 32

Date : December 1 2023



Thank you for choosing Terraform Tillage to map the physical characteristics of your soil. Subsurface soil structure has a massive impact on both the health of the soil and the overall crop health. Increases in soil density (compaction) correlate directly to yield losses, with severe cases of compaction attributing a range of 10 - 60% decrease in overall yield.

[Soil compaction may be cutting into your yield | Integrated Crop Management](#)

[Soil compaction | UMN Extension](#)

In this survey we measured compaction with digital soil penetrometers at a rate of 1 probe per acre. We logged readings at 4", 8", 12", 16", 20", and 24" depths and plotted the severity of each data point with our software. This assessment will go over our findings and provide you with an actionable plan for addressing the identified root restricting layers.

The goal of this assessment is to provide direction toward the long term goals of your operation. By managing compaction efficiently, growers can expect direct increases in profitability. We will highlight areas in your field that should see a considerable increase in yield from subsoiling. The yield increase estimates are based on averages from meta analysis sourced from different institutions and could range based on soil texture, yearly precipitation, and crop type, as well as other factors.



Growers should expect to not have to reprobe the entire field after addressing the areas with root restriction. Proactive traffic management should then be a primary focus following the survey, in order to get the best long term results. Doing this effectively will allow for successful reduced till management moving forward, where the grower can also expect considerable savings in time, fuel, maintenance and repairs. Based on the results of the survey, growers may want to consider implementing a cover crop. Subsoiling can only provide a substantial benefit in heavier soils that have become compacted. Whereas lighter soils with poor structure tend to see a substantial benefit from covers. Fields with larger ranges in topography tend to see a greater benefit from a combination of both subsoiling and cover cropping.

Raw Compaction Measurements

Doe Farms - Jane's 30 - December 1st 2023



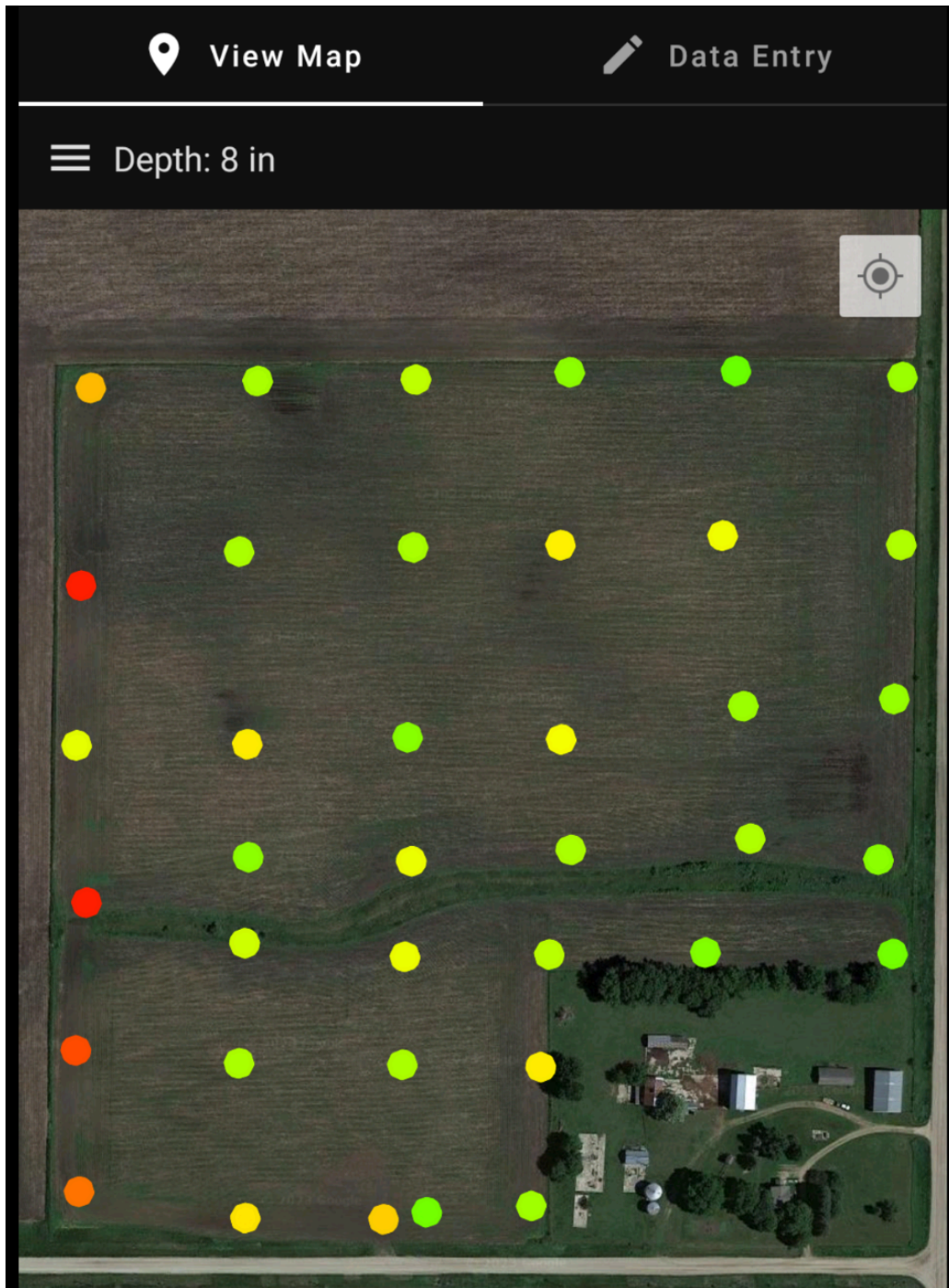
Lat	Lon	4 in	8 in	12 in	16 in	20 in	24 in
42.5004578	-93.0902348	585	618	410	574	448	479
42.5010278	-93.0902527	312	685	750	712	587	438
42.5016234	-93.0901942	615	750	750	366	315	302
42.5022574	-93.0902486	515	363	621	424	397	434
42.5029017	-93.0902238	463	750	605	637	559	422
42.5036991	-93.0901707	631	508	742	515	556	441
42.5037269	-93.0892571	277	273	342	405	329	444
42.5037328	-93.0883906	385	302	333	322	388	523
42.5037615	-93.0875484	341	232	392	452	452	467
42.5037669	-93.0866378	63	172	266	329	269	298
42.5037422	-93.0857265	238	250	303	279	227	210
42.5030662	-93.0857324	205	280	276	179	174	156
42.5024448	-93.0857709	249	242	223	225	172	150
42.5017973	-93.085858	231	224	314	302	237	262
42.501416	-93.0857802	376	185	212	218	179	179
42.5014224	-93.0868048	383	212	363	442	298	484
42.5014137	-93.0876605	672	298	289	332	306	245
42.5009603	-93.0877069	534	427	616	532	430	352
42.5003999	-93.0877589	436	259	485	459	417	685
42.5003743	-93.088332	523	180	368	419	310	431
42.5003461	-93.0885684	750	476	382	439	346	323
42.5003513	-93.0893247	330	445	384	357	251	300
42.5009756	-93.0893589	376	277	302	351	358	367
42.5014595	-93.089329	187	332	318	402	373	361
42.5022618	-93.0893141	354	429	317	411	375	622
42.5030385	-93.0893586	214	278	241	198	192	203
42.5030555	-93.0884063	309	273	265	309	338	525
42.5022894	-93.0884359	391	217	314	319	287	393
42.50179	-93.0884164	217	376	401	418	417	433
42.5014055	-93.0884507	429	374	368	225	212	309
42.5009691	-93.0884648	176	275	337	332	338	605
42.5018359	-93.0875426	301	276	324	223	210	212
42.5022809	-93.0875951	423	391	351	346	332	314
42.5030648	-93.0875985	351	426	434	420	750	750
42.503103	-93.0867106	409	383	377	319	313	407
42.5024153	-93.0865975	191	252	322	266	483	361
42.5018813	-93.0865598	296	280	312	217	227	258
42.5018063	-93.0893092	318	231	334	314	378	525
Average		370	347	387	368	348	386

This field is doing very well overall. There are only around 8 acres that are showing signs of substantial root restriction. Every field is expected to lose some yield to compaction where you enter and exit the driveways. For a field of this size, this is a pretty standard percentage of total acres. The subsurface depths of the field are looking fairly strong for the Des Moines Lobe, but may see a structural benefit from integrating a cover crop.

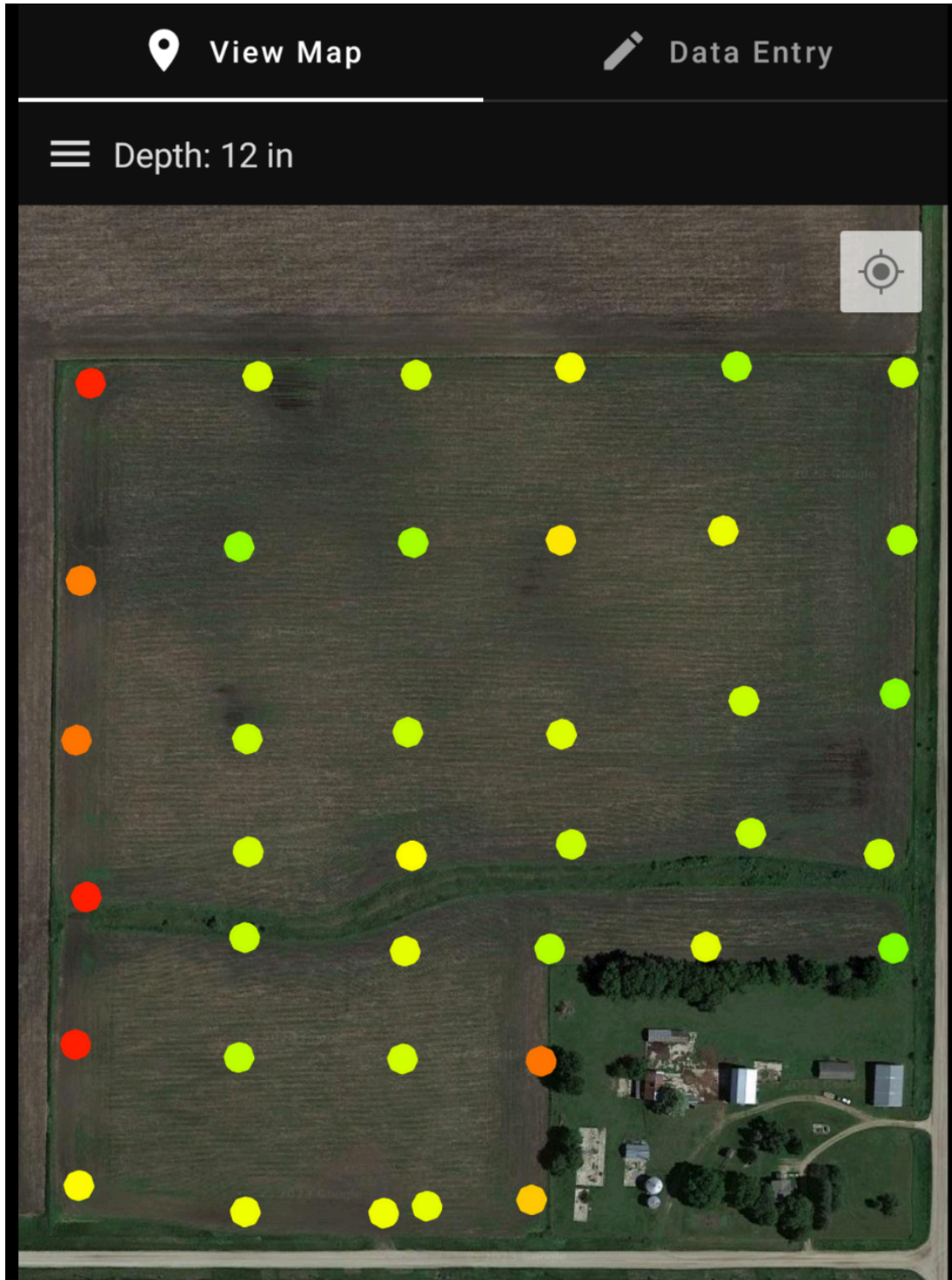
Compaction Severity Maps



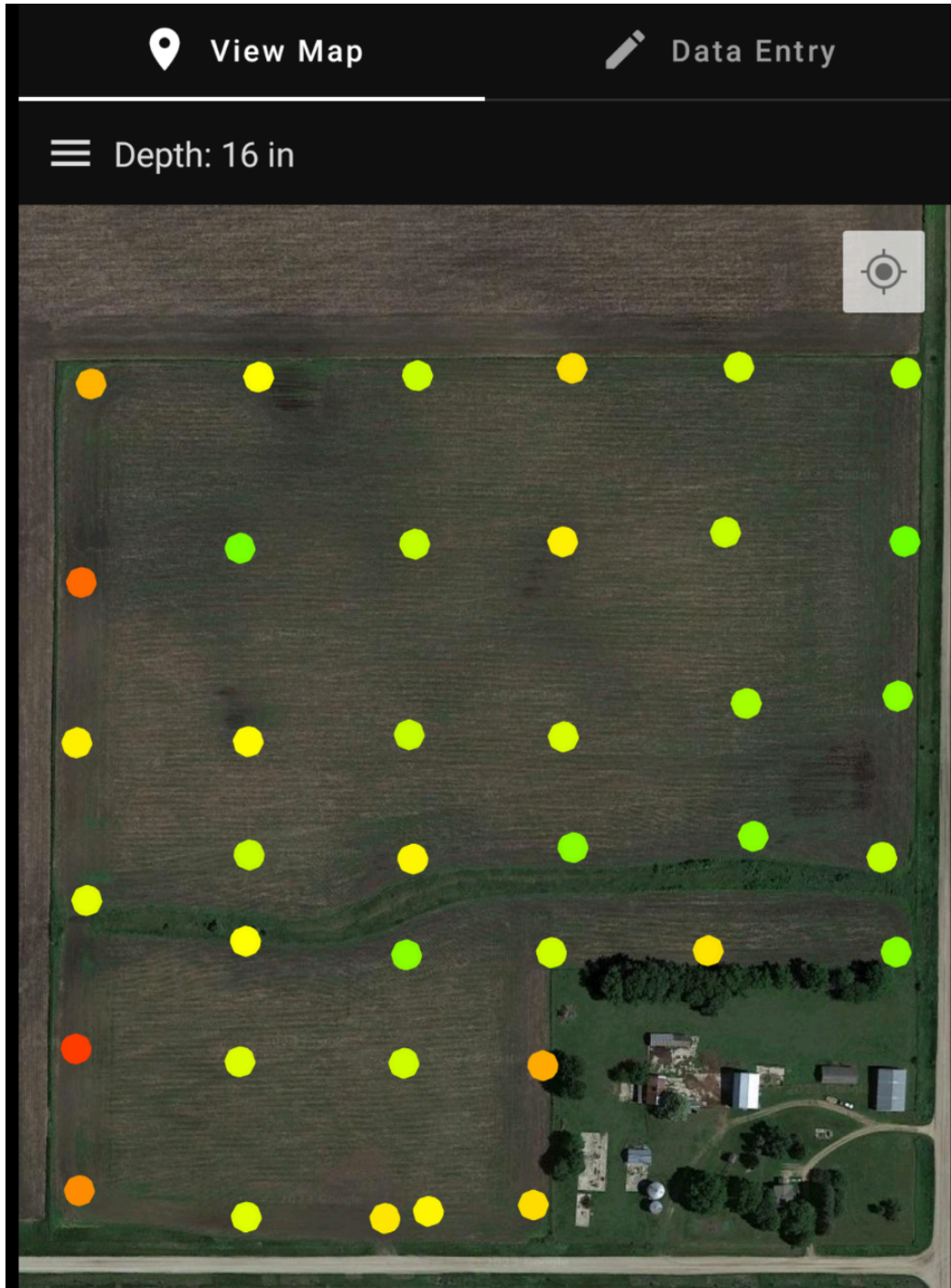
The 4 inch depth looks pretty standard for the current soil saturation. You'll notice the dark red dot in the primary driveway, with compaction present in the most trafficked headlands surrounding it. Additionally, there appears to be a correlation showing some yellow dots in the lighter soils (sandier hilltops). This is fairly common and can't necessarily be fixed with tillage. Increases in organic matter should help address this overtime.



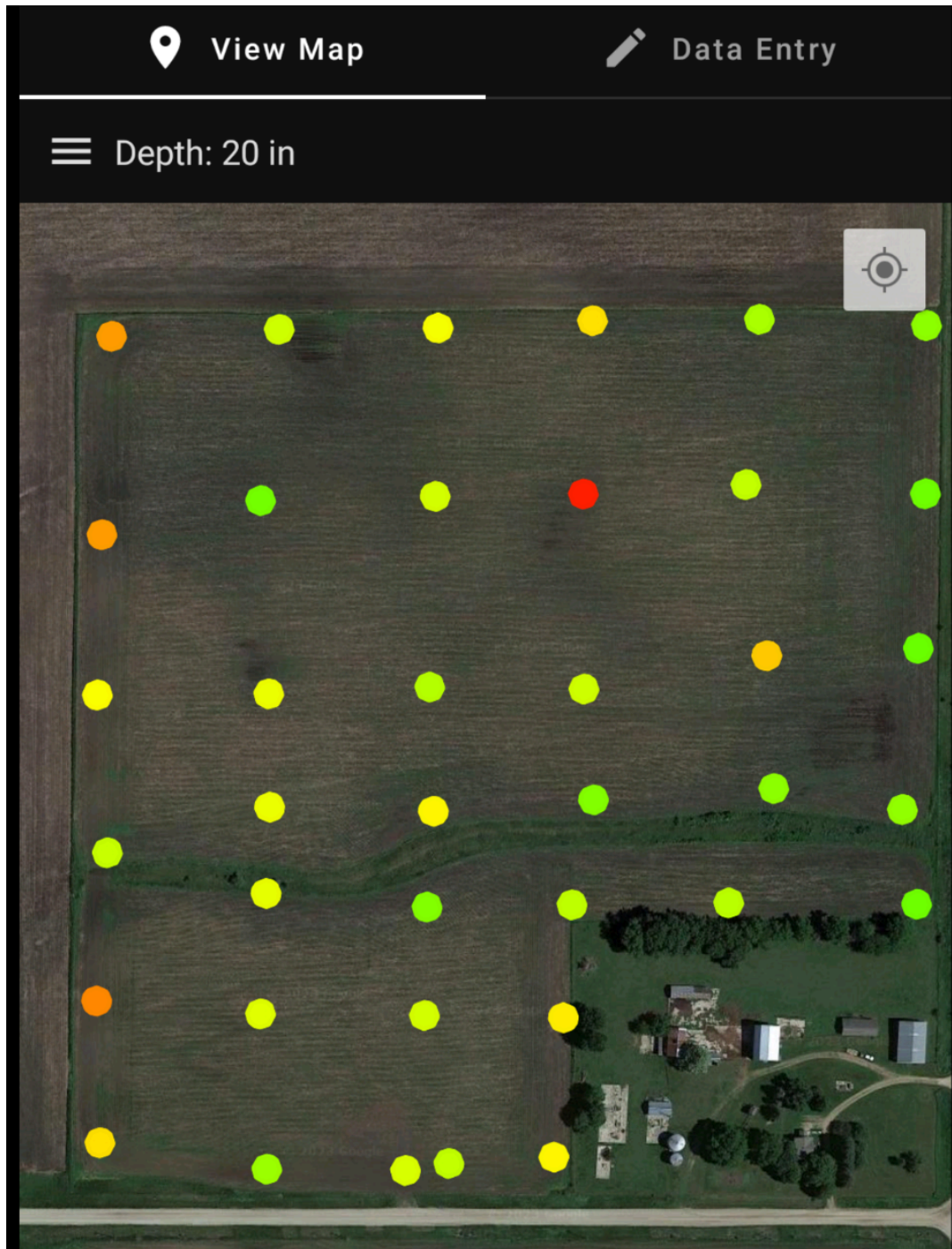
The 8 inch depth again looks pretty standard. Here, it is showing signs of severe compaction mostly in the West headland, with some lighter orange points in the South headland. You're also likely losing some yield to poor structure in the lighter and sandier soils. Addressing this textural issue may help you over time.



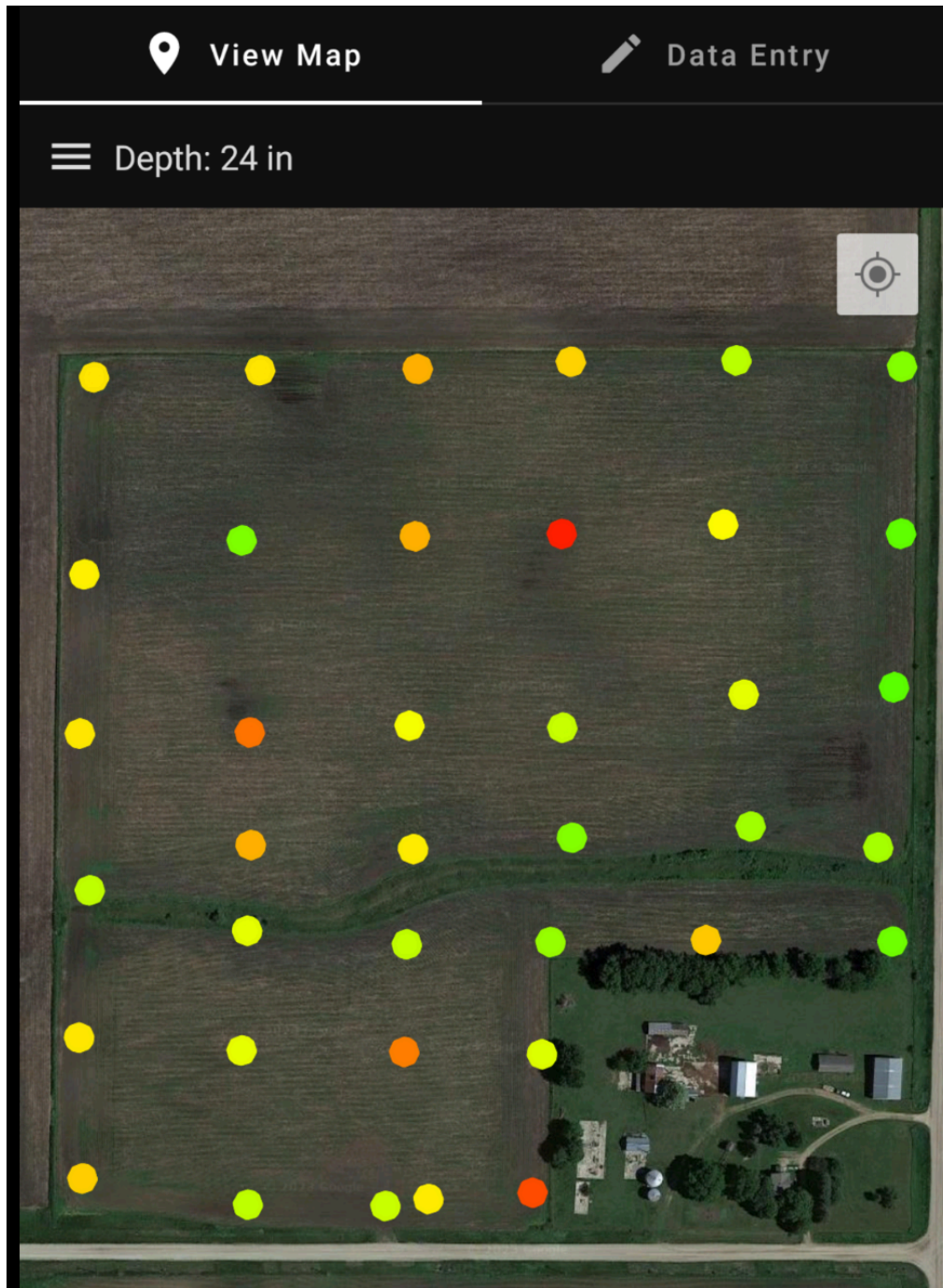
The 12" depth is looking very similar to the 8" depth. The same regions of the field are still losing yield to compaction and poor soil structure. Here at this depth, the South headland is beginning to loosen from a density standpoint. This shows evidence of a hardpan.



The 16" depth is looking fairly different from the 12". The field is showing clear signs of a hardpan now in the West headland. This is a good indicator that a subsoiling pass could do a lot of good in fixing your root striction issues. There are still some signs of compaction in the West, South and SouthEast headlands. If you're able to run your subsoiler at this depth, I would recommend doing so.



The 20 inch depth is carrying on the same trend we've been seeing at the previous depths. The hardpan caused by wheel traffic is now continuously easing up as we move down the soil profile. Again if you have the ability to subsoil this deep, you may see additional benefits in the aforementioned headlands. The structural issues we've noticed at the previous depths in the lighter soils are continuing to show evidence of root restriction and negative crop impacts.



Lastly at 2 feet deep we're seeing more variances in soil density. When analyzing measurements at this depth, it's more likely that high levels of compaction are more likely to be attributed to soil structure than being caused by traffic. Ripping cannot necessarily help these issues but I have seen from experience that cover crops can. Compaction is less likely to have as severe of an impact on yield at 2 feet deep than it would in the shallower depths. You'll want to factor everything I've mentioned here as well as the costs associated with incorporating a cover crop before making your final management decision.

Action Plan



Above is a map highlighting the areas in the field that I highly suggest you subsoil. I estimate that you should expect a 20% or greater increase in yield from addressing the root restricting layers in this zone. On these 8 acres, a 20% increase in yield with \$4.50 corn, would bring the total increase in revenue to \$1,440. When subtracting the cost of the structural assessment (\$160) and cost of subsoiling (\$202.4) your total estimated profit in the first year would be **\$1,077**

If you were to incorporate a cover crop, I would expect an increase in yield to be between 5-10% from improvements in soil structure as well as moisture retention and biological activity. You'll want to consider the additional challenges and costs before making your final decision.

Field Report Summary

Without knowing too much about the field's history. I wasn't sure what to expect from a soil structure standpoint. When I first entered the field from the south driveway and took the first couple probes along the headland, I was worried that the ground was still frozen because of how hard the soil was. Next, I did the West headland and was still getting surprisingly high compaction readings. The one positive thing I noticed was that there is clear evidence of a hard pan. This means you can fix these problem acres with your inline ripper fairly easily. I would expect you to get a 20% or greater yield increase from this pass on the highlighted areas (8 acres). After getting through those areas, I'm confident that the soil conditions were right for probing and the high readings can be truly attributed to compaction.

The North East part of your field looks great! I would not expect any substantial benefit from subsurface tillage on any of the non-highlighted areas from the action plan. It seemed fairly evident that you're taking soil moisture into consideration before running your manure tanks. I believe this is the best tanked field I've done so far. Keep up the good work with proactive traffic management and keep your grain cart traffic to the green highlighted areas of the field as best you can, and you shouldn't have to worry about re-probing. There is one interesting spot in the inland, that I couldn't quite figure out. If you look at the soil map, I believe it's in the L55 Nicollet Loam. Without digging it up it's hard to tell, but my guess is that there is either a thick clay layer or a massive rock down at 20". Not much you can do to fix that, but I just wanted to bring it to your attention.



On many of the fields I've done in the Des Moines lobe, we see a lot of structural issues in the subsurface (16-24"). Typically, in these situations, subsurface tillage can't fix these issues. The high penetrometer readings are more likely attributed to changes in soil type than man-made compaction. The best way I've found for fixing these issues is with cover crops. The fibrous root

structures in cereal rye have helped us get more organic matter down in the subsurface on our farm. We were able to see drastic improvements in subsurface soil density in the first year. There are also many other benefits that you could expect in addition to fixing soil compaction issues.

Lastly, there are some great government and private programs that can help pay for the majority of the expenses with implementing a cover crop. If that's of interest to you, I'm also a Soil and Water Conservation District Commissioner here in Hardin county, and I'd be happy to help answer any questions you may have. Additionally, I can help get you connected with a carbon company that will pay you to incorporate reduced till and cover crops. We've gone this route on our farm based on pay out and contract length. With a contract length of only 1 year, there's no long term commitments if you ever decide to change your mind. The way I view things is that if you're going to be making these sustainable operational changes you might as well get paid for the additional carbon you're sequestering.

I hope this helped to clear up any questions and assumptions you may have had with your field and I'd be happy to help you with any other fields down the road! Please feel free to share your report and experience working with Terraform Tillage with others.

Thank you for your business!