Increasing Irrigation Efficiency by Taking the Steps to Make Tech Successful

Pat Janssen

11-8-24

1. Pressure

- If a pivot has low operating pressure the sprinkler package **WILL NOT** function as designed!
- Packages are designed to operate at a specific flow rate, and pressure to compensate for elevation changes etc.

Pressure Monitoring

On the left while checking pivot monitor readings we noticed that this unit had dropped from a normal operating pressure of around 35 PSI to down to 17 PSI. This would indicate either a large leak on the machine, or a problem with the pump. This machine is equipped with 15 PSI regulators that require 20 PSI to operate so this is a problem. On the right the problem progressed to the point that we only had 4 PSI on the pivot. The problem was determined to be in the pump. It turned out that we needed to lower the pump as the water level in the well had gotten to a point that the pump was sucking air. We also needed to lower the flow rate to a sustainable level.

We assembled the team to change orifices lowering the flow rate from 850 GPM to 720 GPM

Pressures affect on flow rates

At 6 psi this small orifice will flow .85 gallons per minute.
At 15 psi this orifice will flow 1.34 gallons per minute.

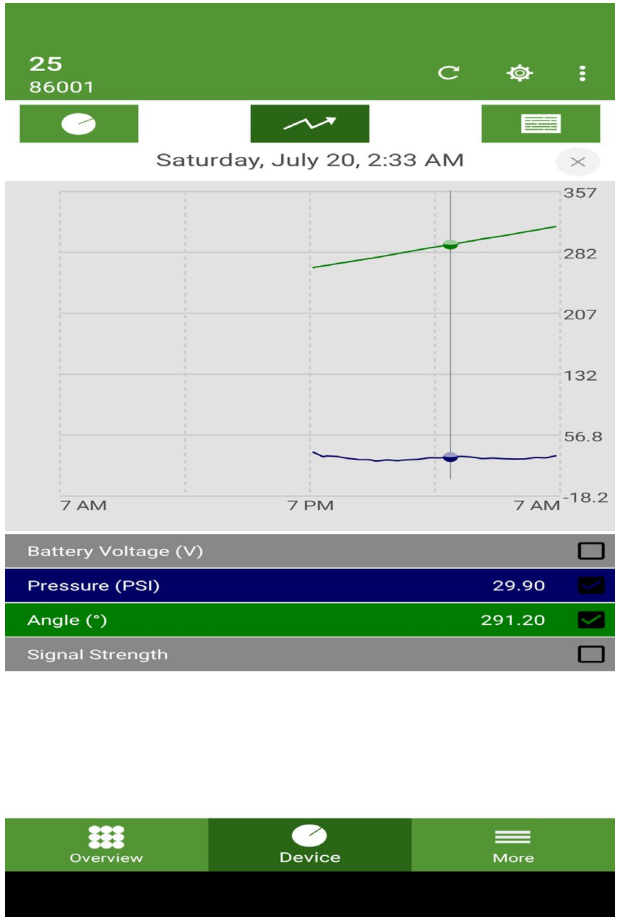
At the low of 6 psi this orifice is only flowing 63% of what the package is designed for.

Pressure loss due to elevation changes will have the same effect on flow rates making the top of hills drier than the rest of the field.

At 6psi this orifice will flow 6 gallons per minute.
At 15 psi this orifice will flow 9.5 gallons per minute.
This is 63% of designed flow.

The package on this pivot has 150 outlets starting with the small green orifice at the center graduating up to the large purple orifice on the left at the very end of the pivot.

The team was successful!!



The team changed all 150 orifices on this pivot to lower the flow rate.

By lowering the flow rate we were able to increase the operating pressure to 39 PSI. This may seem excessive since we only need 20 PSI to satisfy the requirements of the regulators, but the other factor is elevation effects pressure. An increase of 10 feet in elevation will reduce pressure by 6 PSI. This field has some positive elevations of 25 feet. On those high spots we only achieve an operating pressure of 25 PSI leaving a nice margin of 5 PSI.

Without the pivot monitor, and PSI transducer we may not have caught this issue.

Other pressure issues

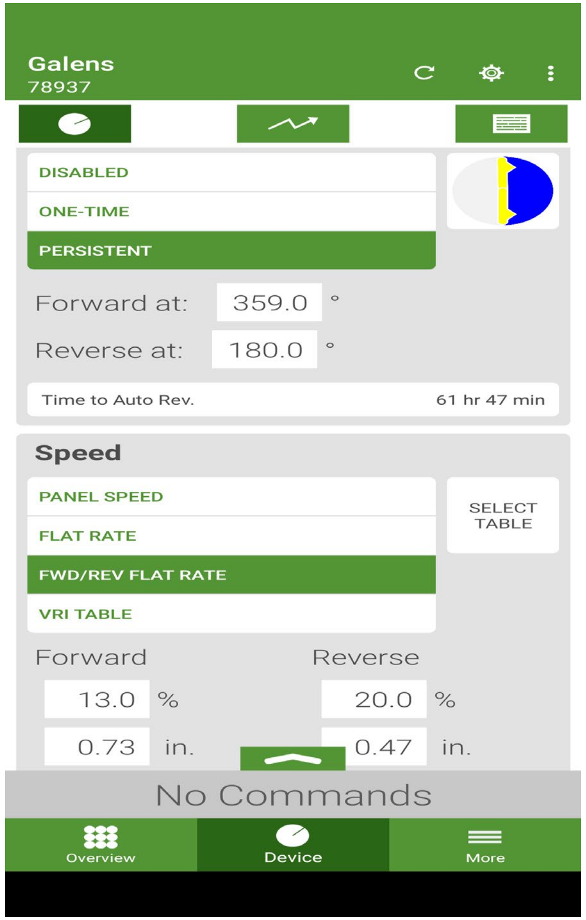
On this pivot we were having to operate the engine on the pump at a higher RMP than we would like to achieve adequate pressure.
Driving in one afternoon I saw that the water pattern was visually irregular.
This was caused by worn pressure regulators flowing more water than they should and increasing the delivery pressure to the nozzle resulting in a greater flow rate.
The total variation from the designed flow rate was only about 5% but as you can see a little variation makes a big difference.

Pivot Monitors & Their Benefits

You have seen that we use our pivot monitors to track system operating pressure. This is a very efficient way for us to keep tabs on the health of our pumps and packages.

The contribution to labor efficiency is a huge benefit of the monitors. It takes ten man hours, and approximately 125 miles driven to check all of our pivots once. Before we had the monitors we would do this twice a day in season. If we irrigated for 45 days this is a savings of 450 man hours, and 5,600 miles driven. With the cost of labor and trucks this is a significant savings.

With the monitors we can also control the speed and direction of our pivots. The example on the right is a windshield wiper pivot (only making half passes). With the monitor we are able to speed it up going one direction, and slow it down on the other. This prevents overapplying water on ground the pivot just covered after it reverses. The monitor automatically reverses the pivot at set points using GPS positioning.



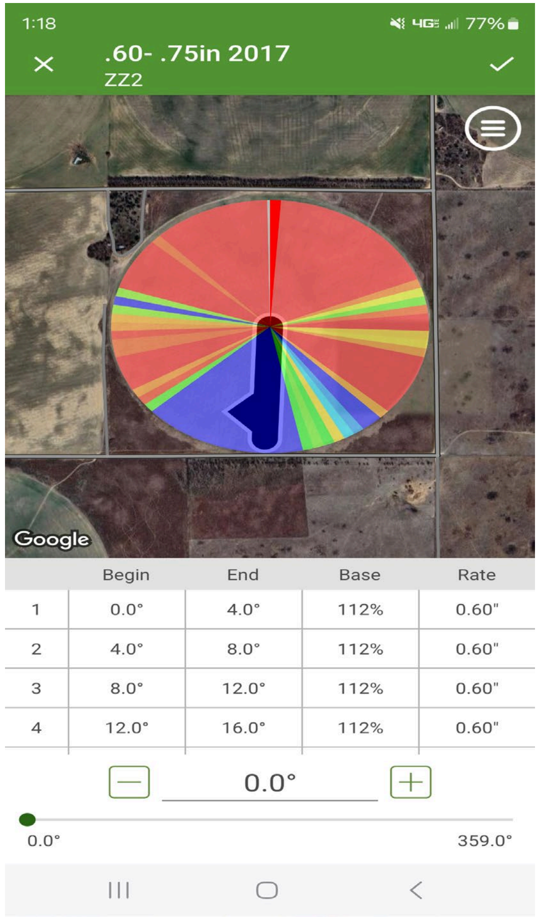
Variable Rate Irrigation

At the right is an example of using the pivot monitor to control the speed/application rate of a center pivot to re-establish a soil moisture deficit.

The soil on the top of the map is a heavier soil with a water holding capacity of 1.2 inches of water per foot of soil. The soil on the bottom half of the map is very sandy with a water holding capacity of only .75 inches per foot of soil.

After a rain event we will set the pivot to travel faster across the heavier soils applying less water, and slowing down on the sandier soils where the plants will use the available moisture more quickly. Over the course of a couple of passes this will even out the available moisture in the soil, while having made use of the extra moisture available in the heavier soils.

Net water savings of approximately 1.8 acre feet in two passes.



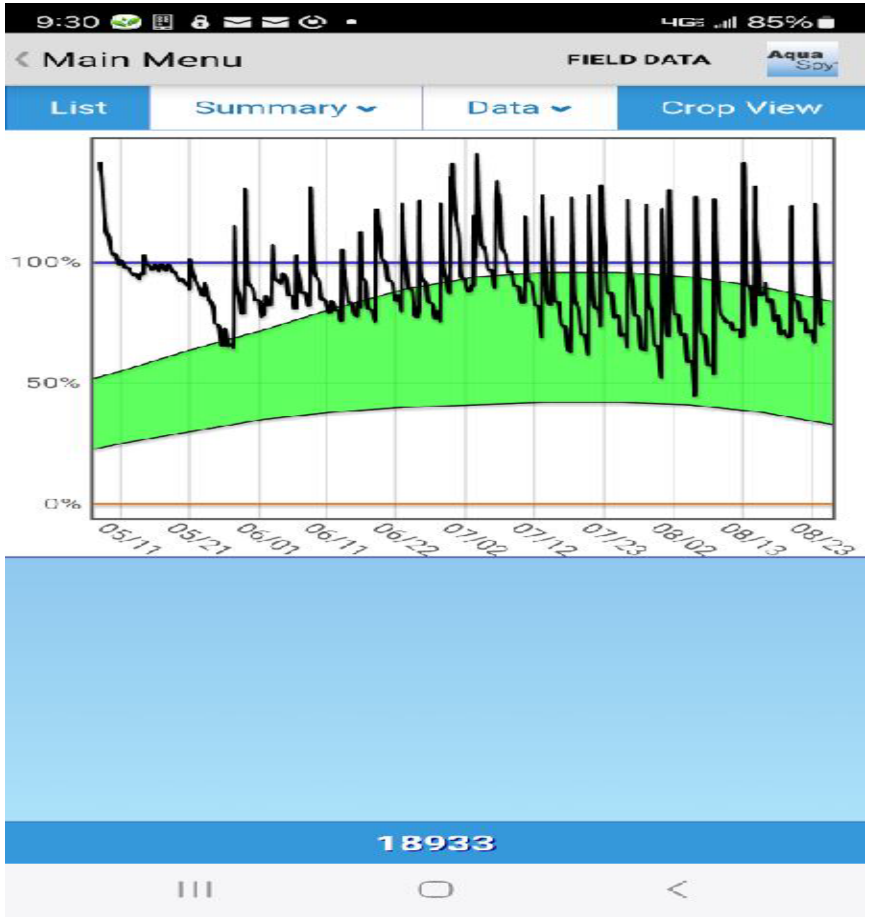
Soil Moisture Probes

Remote soil moisture monitoring one of the most valuable tools that we have to manage irrigation. The ability to check moisture in real time, identify trends, and make decisions based on real time data is invaluable.

---------BUT!------

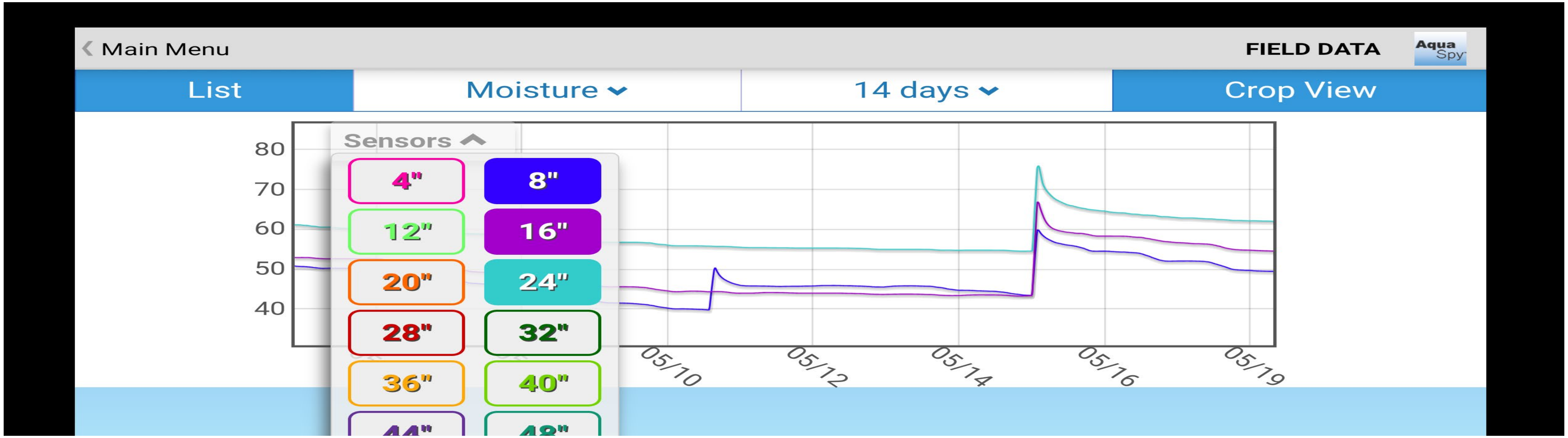
Soil moisture probes have a very steep learning curve. It took us two years to get comfortable with what the probes were telling us, and figure out how to use that data to make good decisions.

As you can see the picture on the right is very noisy, and few conclusions can be drawn from this data alone.



How to use Soil Moisture Probes

(In My Opinion)



This picture is taken from the same probe as the previous one. The reading is broken down to a two week window, and only three of the sensors are turned on so that a specific range can be analyzed.

The first bump on 5/11 shows a .70" irrigation pass that soaked in to a soil depth of 8-16" as expected.

The second bump shows a 1.3" rainfall event that soaked in to a soil depth of 24", you can then see the moisture stepping down as the plants use the moisture in the top 8-16" soil zones.

The Probe/Probee Relationship

To get the most out of a soil moisture probe you will have to verify what it is telling you from time to time.

If you get a large rain event with soils saturated beyond field capacity the probe will recalibrate, and use this as the new full point even though the tank is running over. This will give you false dry readings until the soil moisture returns to normal, and the probe adjusts itself to normal levels.

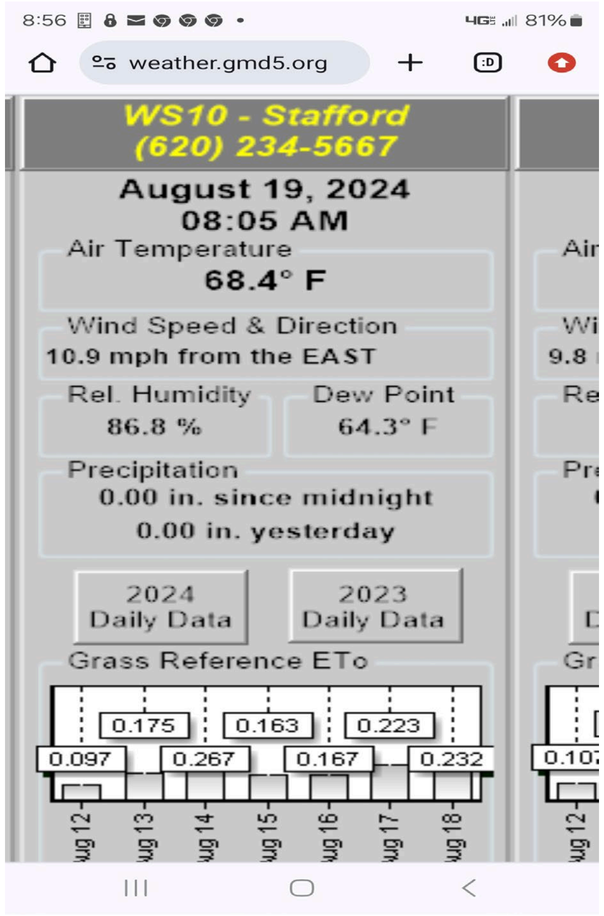
Soil temperatures will also cause the probes to show drying trends as the soil warms an loosens around the probe. This is only an issue with fall seeded crops such as wheat.

Little quirks like those above make it critical that producers new to probes have someone with experience to help them through at least the first season to realize the value of this tool.

Use All the Tools Together

There is no single silver bullet to increasing water efficiency!!

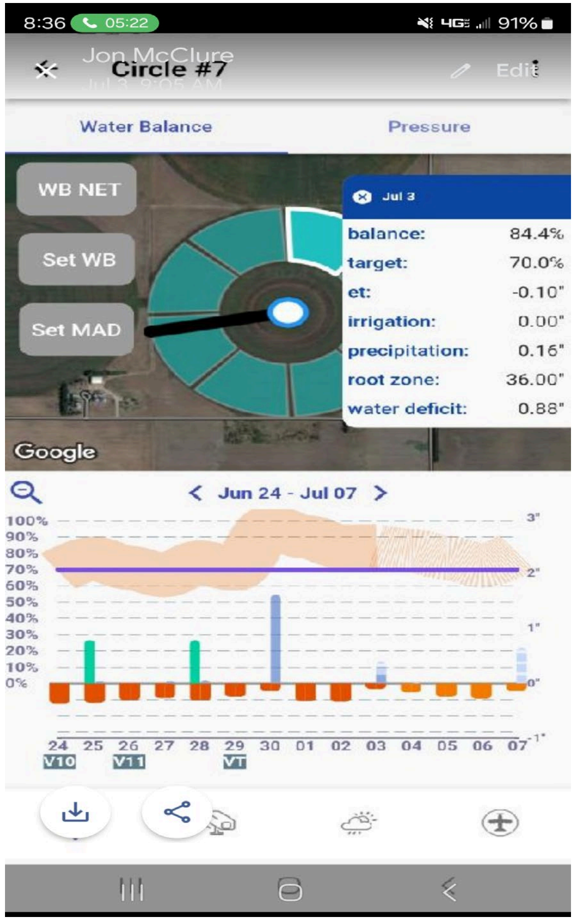
On the right is weather station data from a GMD 5 station. From it you can determine the past crop water use based on their evapotranspiration readings. Then look at the weather forecast to see what crop water use will be for the next 5-7 days.
What is your soil water holding capacity, and current level. How much is in your tank.
Look at your probe to determine if you are gaining, losing, or maintaining over the last 5-7 days. Hand probe at intervals to verify.
Know your irrigation capacity. How quickly can you refill the tank if needed?
Make sure your pivot is operating as designed with correct pressures.
Leave room in the soil moisture profile for beneficial use of rain. This can be tricky at peak crop water use, but it can be done.



ET Based Scheduling Tool

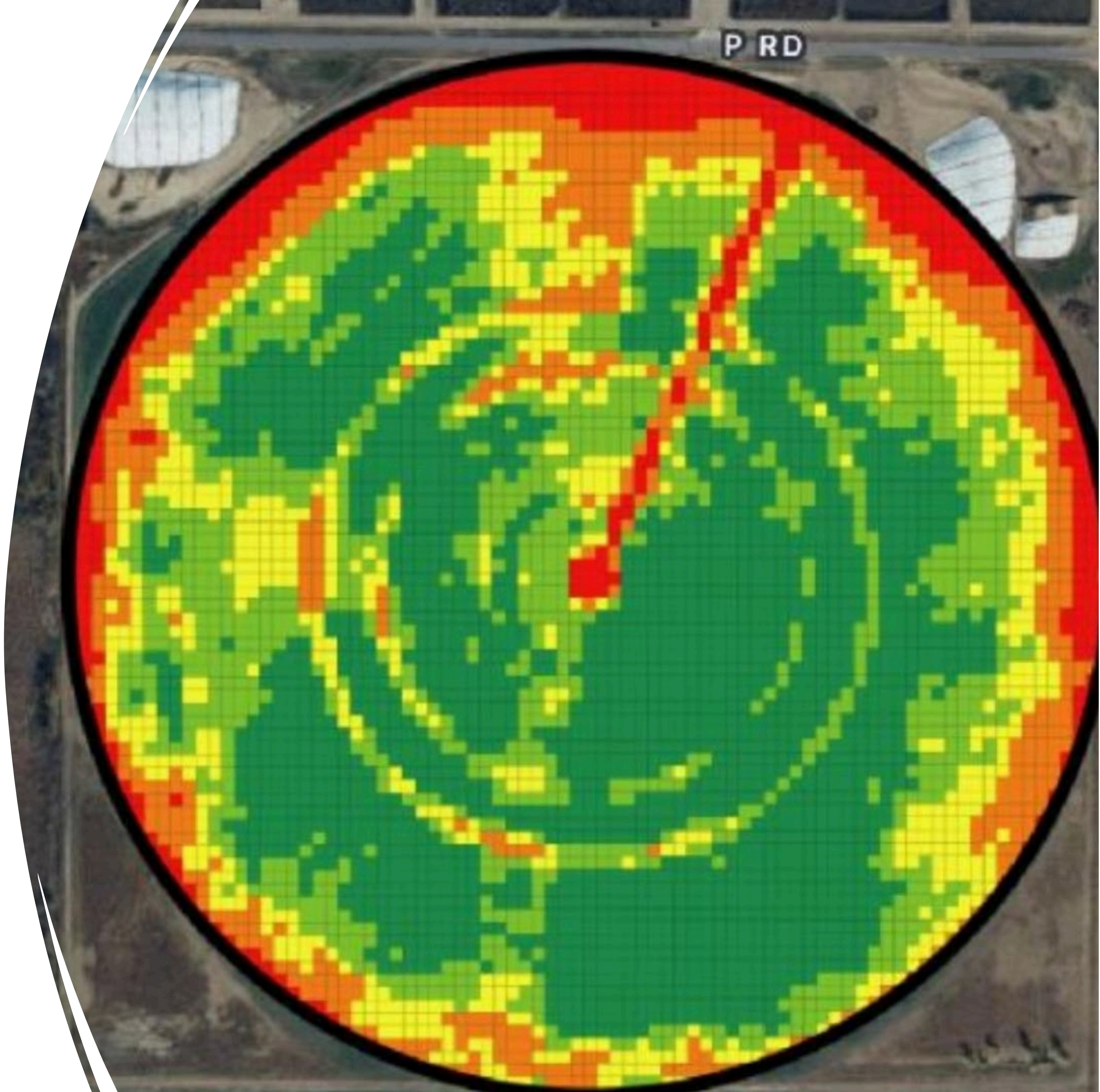
This scheduling tool is something we have only been playing with for a year, but it shows great promise.

The curvy tan bar shows a range of soil moisture based on soil type in the field. This is based on crop growth stage, temperature, humidity, soil moisture at installation, irrigation amounts, and rainfall amounts.
The green vertical bars show irrigation amounts.
The unit has an acoustic rain gauge with the amounts of rainfall displayed on vertical blue bars.
The prescribed irrigation quantities, and timing are displayed in the broken green vertical bars.
The pies show a predicted soil moisture in eight segments. Blue is too wet, brown is too dry, green is just right.
This platform has been very accurate over this season.
The producers that I have worked with on it developed a comfort level with this technology much quicker than they did with the probes.



Imagery

- Satellite and arial imagery are great tools to see how well a pivot is preforming, and to find other issues as well.
- Two plugged nozzles in the center, and compacted soils on the outside of the north half resulting in extreme plant stress due to shallow rooting.



Water Infiltration, and Evaporation

Over the past few years cover crops have come into vogue in for various reasons.
I personally use them for several reasons.
They provide pathways for water to travel into the soil both in irrigation, and rain events.
Providing mulch for weed suppression, and reducing evaporation compared to bare soil.
Helping increase fertilizer efficiency by tying up nutrients and releasing them throughout the decomposition cycle.
Cows like to eat them.

Soil Structure/Reaching Deeper

For the past two years we have been using radishes in combination with our rye for cover crop.
As the tap root on the radish moves down in the soil the roots of the rye plan follow right along.
This has greatly increased our water infiltration rates on these fields.
The acres of water holes on this farm has been reduced by 95% because the water enters the soil where it fell rather than running into the low spots and ponding.
The effects of this deeper rooting have also shown themselves in better soil tilth, improved corn stands, and the ability to better manage water.
Where crop roots used to pancake and stop penetrating at an 8" depth we are now rooting to 20" inches and deeper, more than doubling the soil moisture we can access.

Bad Morning!!

Have a Great Day!