Grow: your field knowledge

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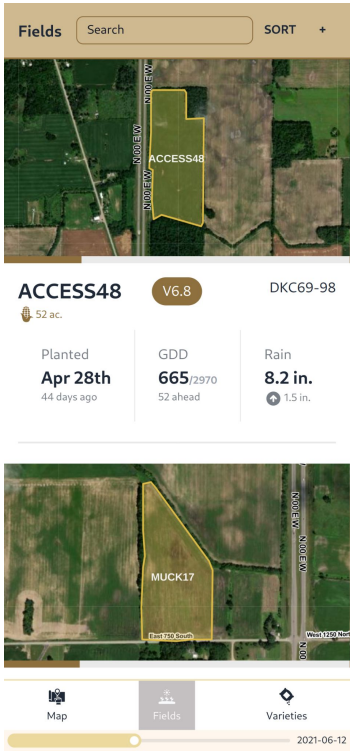
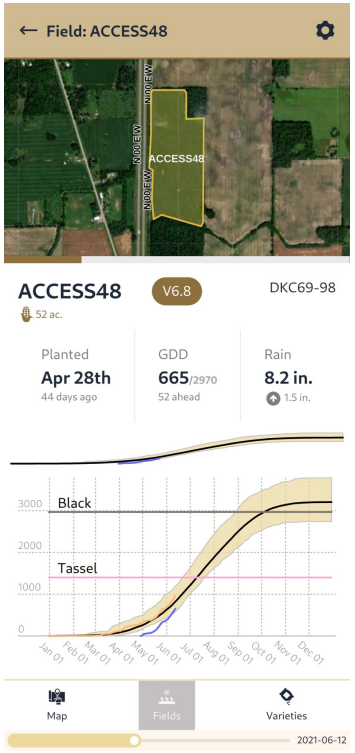
OATS

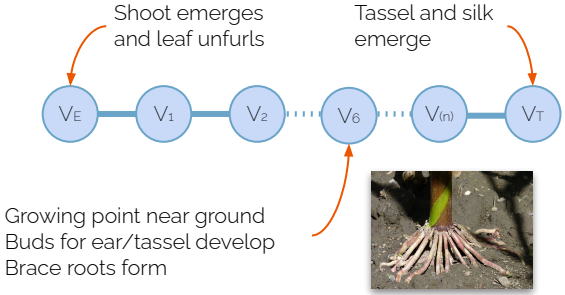
This is **Grow,** our *open source* solution to tracking field state

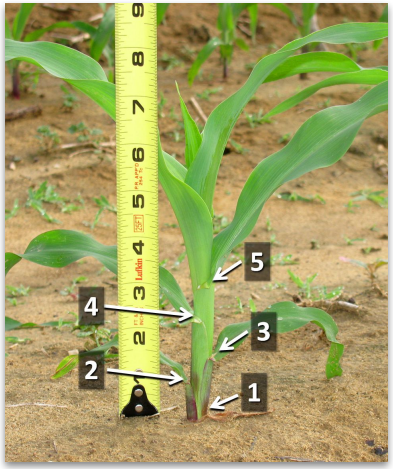




I really **want to hear your feedback**, but first, let me explain the core concepts...

Corn growth stages





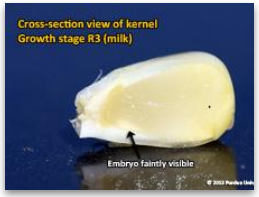
R1: Silk

R2: Blister

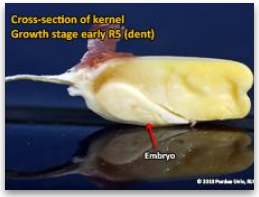
R3: Milk

Yum!

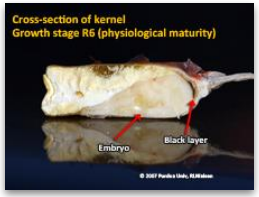
R4: Dough

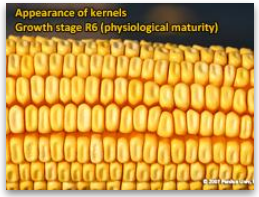


R5: Dent



R6: mature





Source Erick Larson
https://www.mississippi-crops.com/2019/05/25/how-to-determine-growth-stages-of-young-corn-or-sorghum

Source RL Nielsen
https://www.agry.purdue.edu/ext/corn/news/timeless/GrainFill.html

The point?

Farm logistics are driven by plant progress.

Products with label restrictions

- Can I spray that field anymore?
- Where **should** we be spraying?

Late planting

- How many GDDs are left?
- Which variety to plant?

Disease and pest control

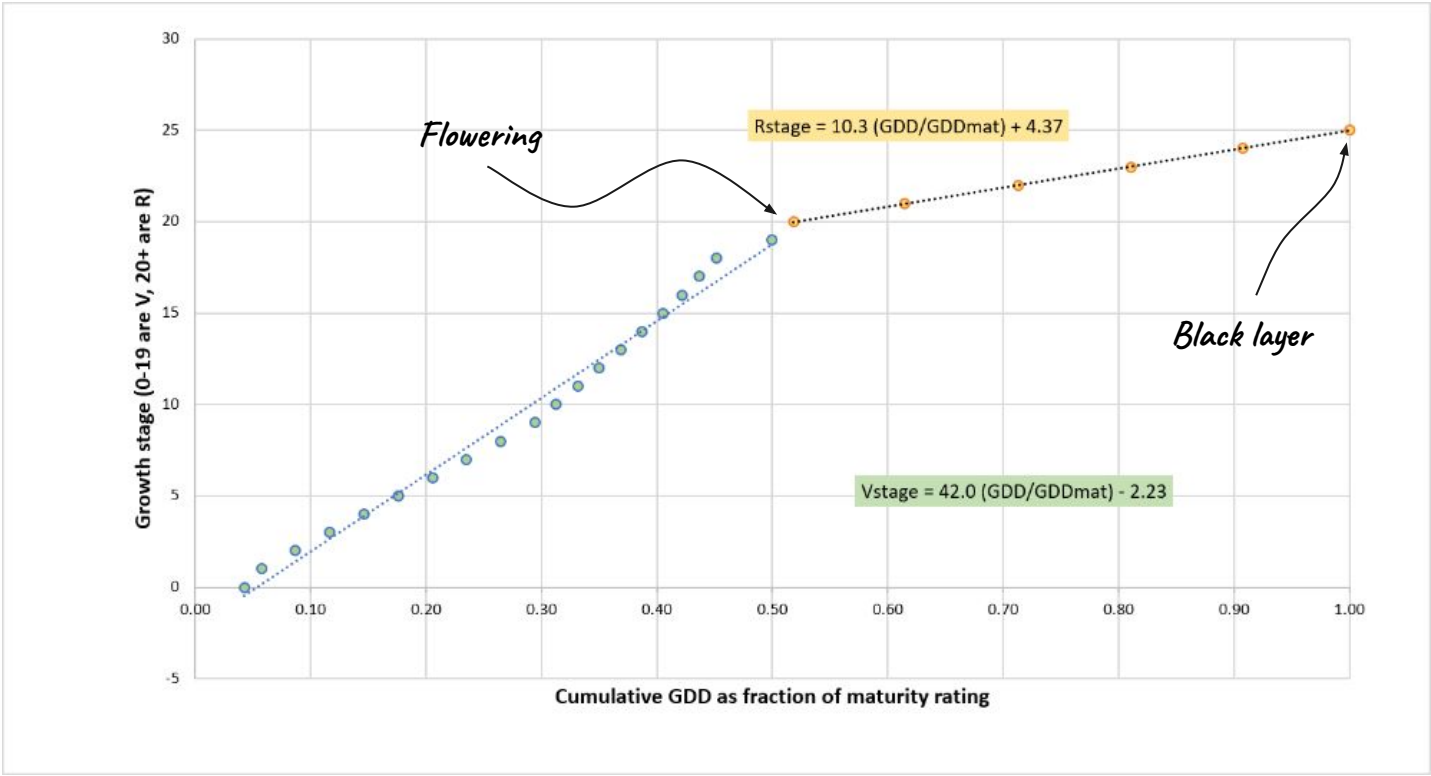
- Where + what should I be scouting?

Harvest

- Harvest order?

I bet you have even better ideas!
Please be thinking of them.

Folks have noticed that GDD is a decent approximation



Ahem,
what is a GDD?

It's a *rough* measure of "growth energy"

A *Growing Degree Day* (GDD) or *Growing Degree Unit* (GDU) or *Heat Unit* (HU) is the average number of degrees the plant **experienced in a day.**

$$\mathrm{GDU} = \frac{T_{\mathrm{high}} + T_{\mathrm{low}}}{2}$$

Note: The unit is "degree" x "day"

However, studies show that plants do not appreciably grow when below a certain "base" temperature

So, the formula is adjusted to reflect that::

$$\mathrm{GDU} = \frac{T_{\mathrm{high}} + T_{\mathrm{low}}}{2} - T_{\mathrm{base}}$$

(50 °F for corn)

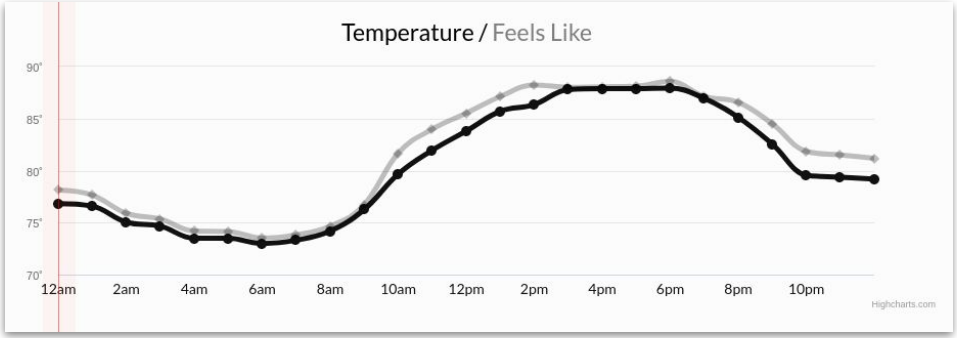
Studies *also* show that plants do not appreciably grow any *faster* when over a certain temperature.

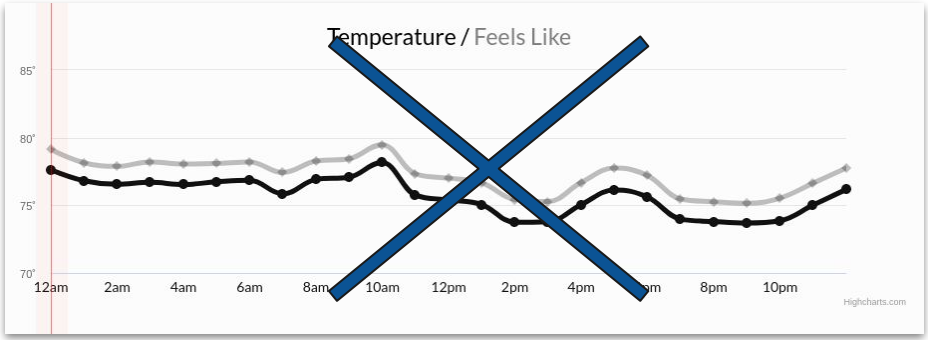
(86 °F for corn)

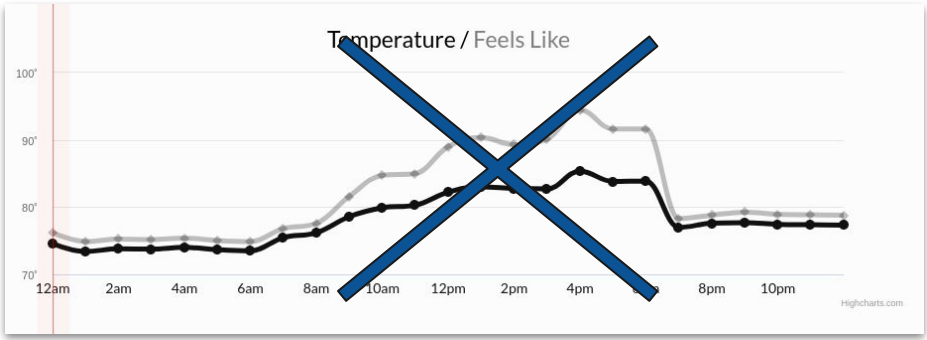
$$\mathrm{GDU} = \frac{\min\left(T_{\mathrm{high}}, T_{\mathrm{max}}\right) + T_{\mathrm{low}}}{2} - T_{\mathrm{base}}$$

Where did that come from?

Here are some example temperature profiles in West Lafayette

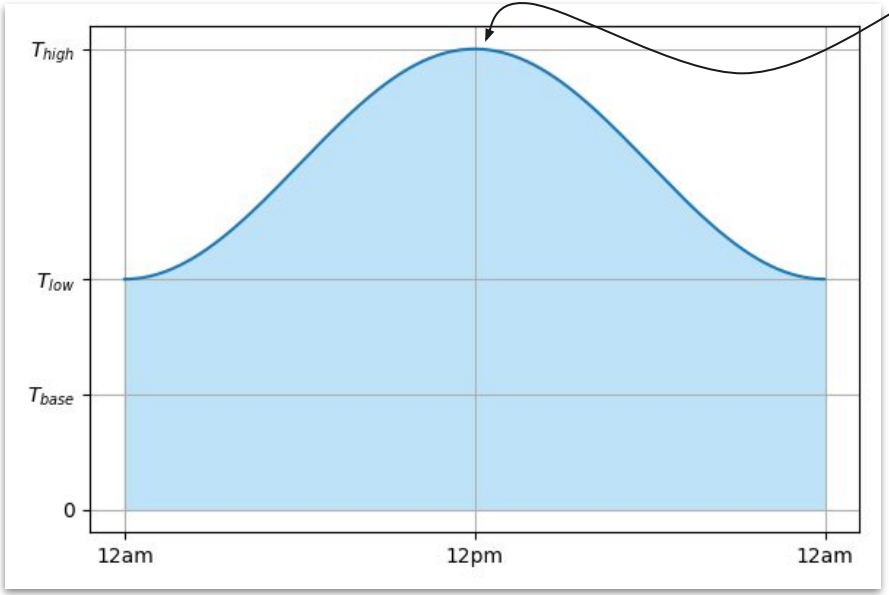






Where did that come from?

Just assume all the days are nice



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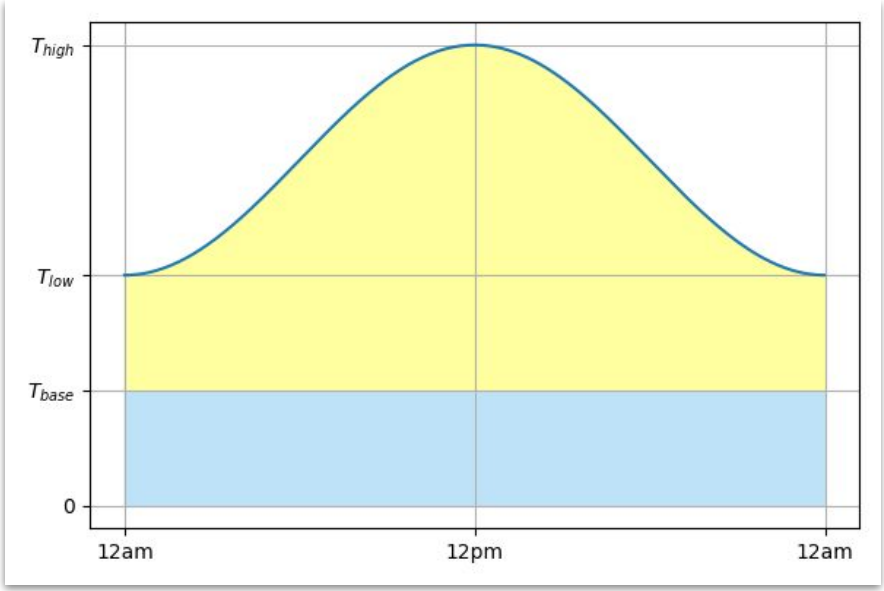


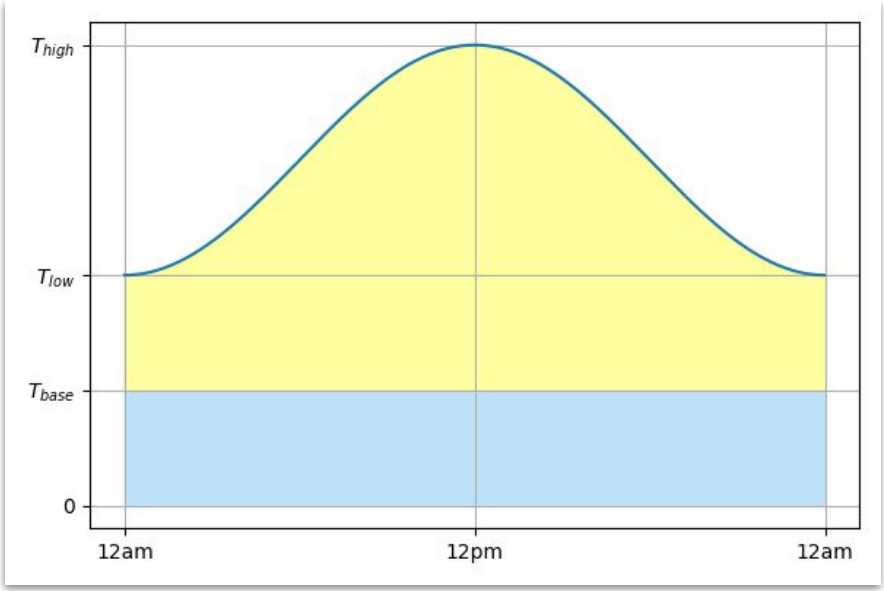
Assume T_{high} is less than T_{max}

Then the total "heat" (above Tbase) for the day is the area under the curve and above Tbase

$$\mathrm{GDU} = \int_0^1 \left(\frac{T_{\mathrm{high}} - T_{\mathrm{low}}}{2} \sin\left(\frac{2\pi}{1\ \mathrm{day}} x \right) + \frac{T_{\mathrm{high}} + T_{\mathrm{low}}}{2} \right) \mathrm{d}x - T_{\mathrm{base}}$$

Where did that come from?

Just assume all the days are nice



Then the total "heat" (above T_{base}) for the day is the area under the curve and above T_{base}

$$\mathrm{GDU} = \left(\frac{T_{\mathrm{high}} + T_{\mathrm{low}}}{2} - T_{\mathrm{base}} \right) \times 1\mathrm{day} = (T_{\mathrm{avg}} - T_{\mathrm{base}}) \times 1\mathrm{day}$$

Some caveats

What if GDD is negative?

Generally we just assume it to be zero. Certainly the plant didn't grow backwards?!

Impact: In practice this is reversed for early season when GDD accumulation per day is small anyway and is largely ignored in analysis.

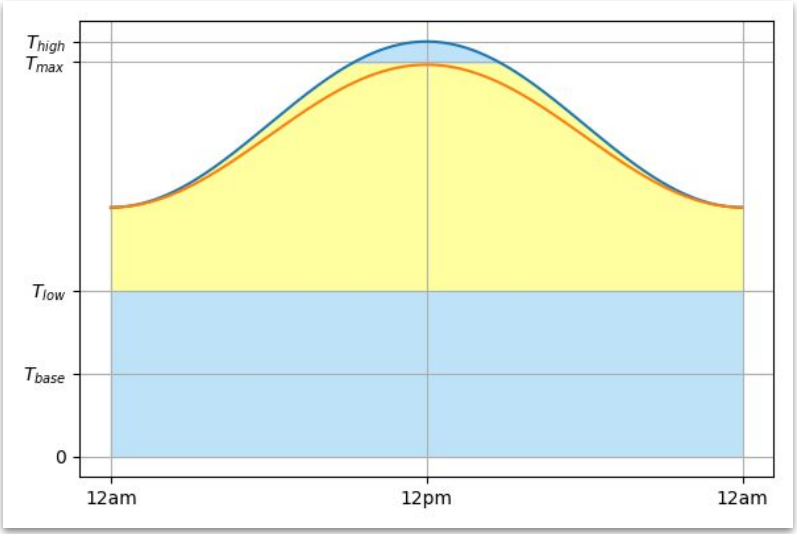
What if $T_{high} > T_{max}$ and we clamp it?

Well, actually we are *still* counting too much heat.

Impact: It's a small amount of heat, and is included in model calibrations anyway.

Could use hourly/minutely data?
- Historic data is not very available.

Is part of the V10 "speed" up?
- Perhaps, but either way the models account for this (and so does the regional marketing of genetics)



It has some limitations

GDU is simply a *heuristic* that we use to measure progress. It's not a fundamental truth.

Do consider other factors when evaluating a GDU total. Growth also requires, at least:

1. Sunlight energy/intensity
2. Water availability
3. Nutrient availability
4. Pest and weed pressures
5. Drainage
6. Genotype factors
7. Soil temperature
8. ….

But, experience does tell that the GDU and growth stage relationship is fairly useful in practice.

There are a lot of 'em

- U2U@MRCC: Corn GDD
- Climate FieldView
- Granular
- Pioneer GDU Calculator
- Growing Degree Day Calculator – Oklahoma State University
- Ag PhD GDU Calculator
- Climate Smart Farming Growing Degree Day (GDD) Calculator - Cornell
- GDD Tracker – Michigan State
- Crop Calculators – University of Wisconsin
- DataOnTouch – Co-Alliance
- *… just to name a few …*

So why Grow?
Current tools either make it a bit too *manual* or lock you into a platform/service.

Most offerings suffer from at least one of the following:

- Don't store fields
- Don't store planting dates
- Isn't hybrid specific
- Isn't free / noncommercial

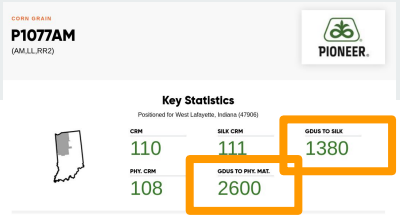
Our goals for Grow are:
- ***open source*** (read: noncommercial) web + app that makes field state estimation ***trivial.***

- ***Offline first*** (works in the field without cell service).

- uses only ***public data sources***

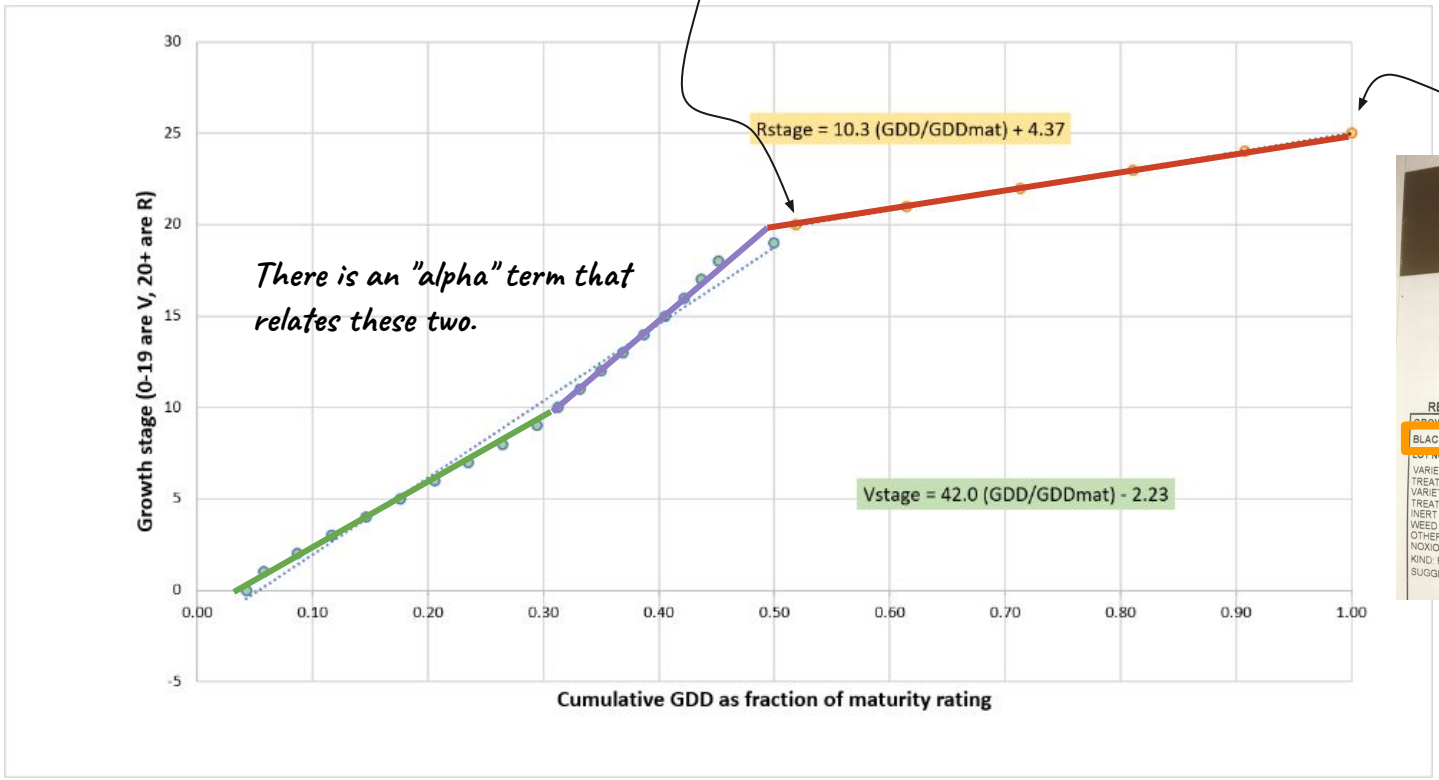
- Has no (required) ***backend.*** All data is stored only on your device by default.

Grows internal model



GDU to silk

GDU to black/maturity



Demo time

(a.k.a. somethings not going to work...)

Some ideas we had / do you have any?

1. Pull week/2 week weather forecasts to do short term forecasting.
   Rick 120 will reach V3 by Thursday.
2. Use a weather generator model to provide projection uncertainties
   Back 40 will finish between the dates of X and Y with 95% confidence (or 5% ...)
3. Adjust growth model based on in-person stage measurement.
   East 20 is already v4, so adjust the future estimates.
4. Additional views on rain data (irrigation purposes?)
   Inches in past 3 days/7 days/2 weeks. Compare to prior seasons?

What are some decisions you might make with the use of a tool like this?

What would it need to do to support that decision properly?

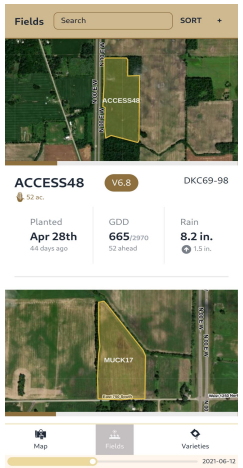
+

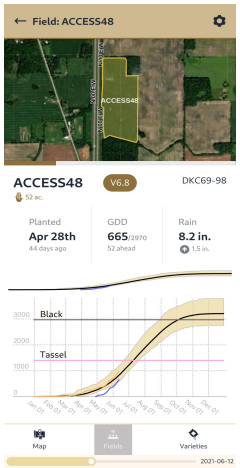
What would you change about the current design?

How do I get it?

We are adding the final touches and addressing today's feedback.

We are soon planning a beta release and minimally buggy v1.0 for planting.





https://github.com/oats-center/grow

If you want to be on a mailing list to hear about the release, **please let me know now.**

Otherwise, keep an eye on the Digital Ag Resources website for a release announcement
https://ag.purdue.edu/digitalag/


Questions?