Biological Systems Engineering

UNIVERSITY OF WISCONSIN–MADISON

Planter setup and precision agriculture components for optimal emergence

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Planter Terminology

https://www.deere.co.za/en_US/products/equipment/planting_and_seeding_equipment/planters/row_units/row_units.page

Overall Theme of the Presentation

- Plant at the right depth!
- Cover the seed/Close the furrow
- SEED TO SOIL CONTACT

Planter Latest and Greatest

- Variable Rate Seeding
- Multi-Hybrid Seeding
- Variable Down Force (Air and Hydraulic)
- Automatic Depth Control
- In-Row Sensing (Moisture)
- Automatic Closing Wheel Depth
- Speed planting
  - Dead drop vs. seed rolling?

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Luck Lab Current Planter Setup

- 4-row Deere Max Emerge 2 Vacuum Row Units
- AgLeader InCommand Field Computer
- AgLeader Electric Seed Plate Drive
  - AgLeader Generator
- Dawn Equipment Hydraulic Down Force
- Dawn Equipment Variable Depth Control (Hydraulic)
- Dawn Equipment Variable Closing Wheel Depth/Pressure (Pneumatic)

- Plant at 5 mph with guidance


NEW HOLLAND

Active Downforce Systems
Why?

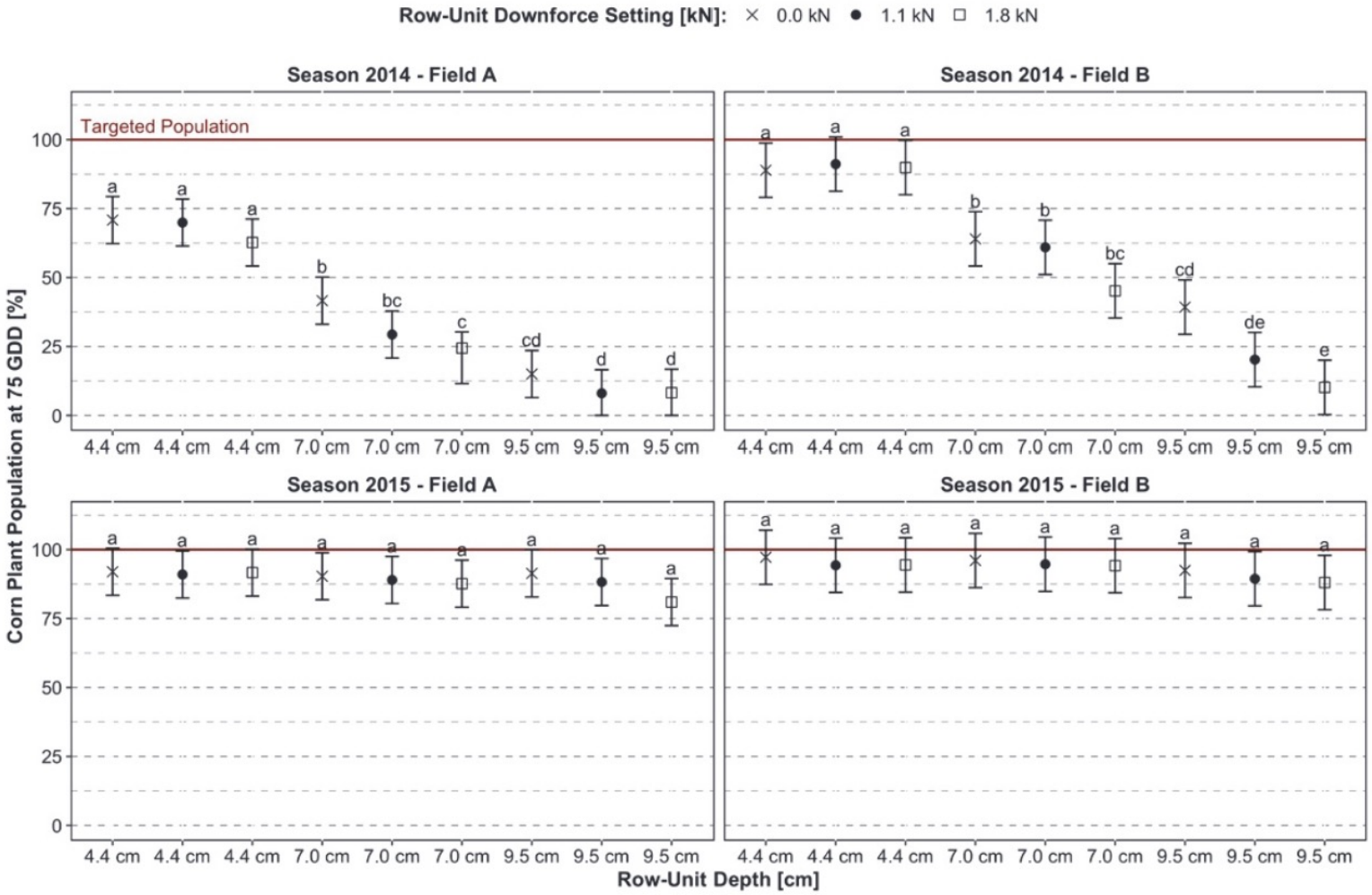
- Depending on your soil type it might be difficult to get consistent down pressure with springs
- Active systems measure gauge wheel load and maintain that across the terrain
- Retrofit for most planters
- Most have lift and down pressure
- With variable soil types you can vary the down pressure spatially to achieve consistent seeding depth and seed/soil contact

Planter Down Force Study (Alabama)
Poncet et al. (2017)

- Springs were used in this study
- Three planting depths:
  - 1.7”, 2.8”, and 3.7”
- Three down force settings:
  - 0, 247 lb, and 405 lb
- Emergence was counted at 75 and 100 Growing Degree Days after planting.

Planter Down Force Study (Alabama)

Poncet et al. (2017)



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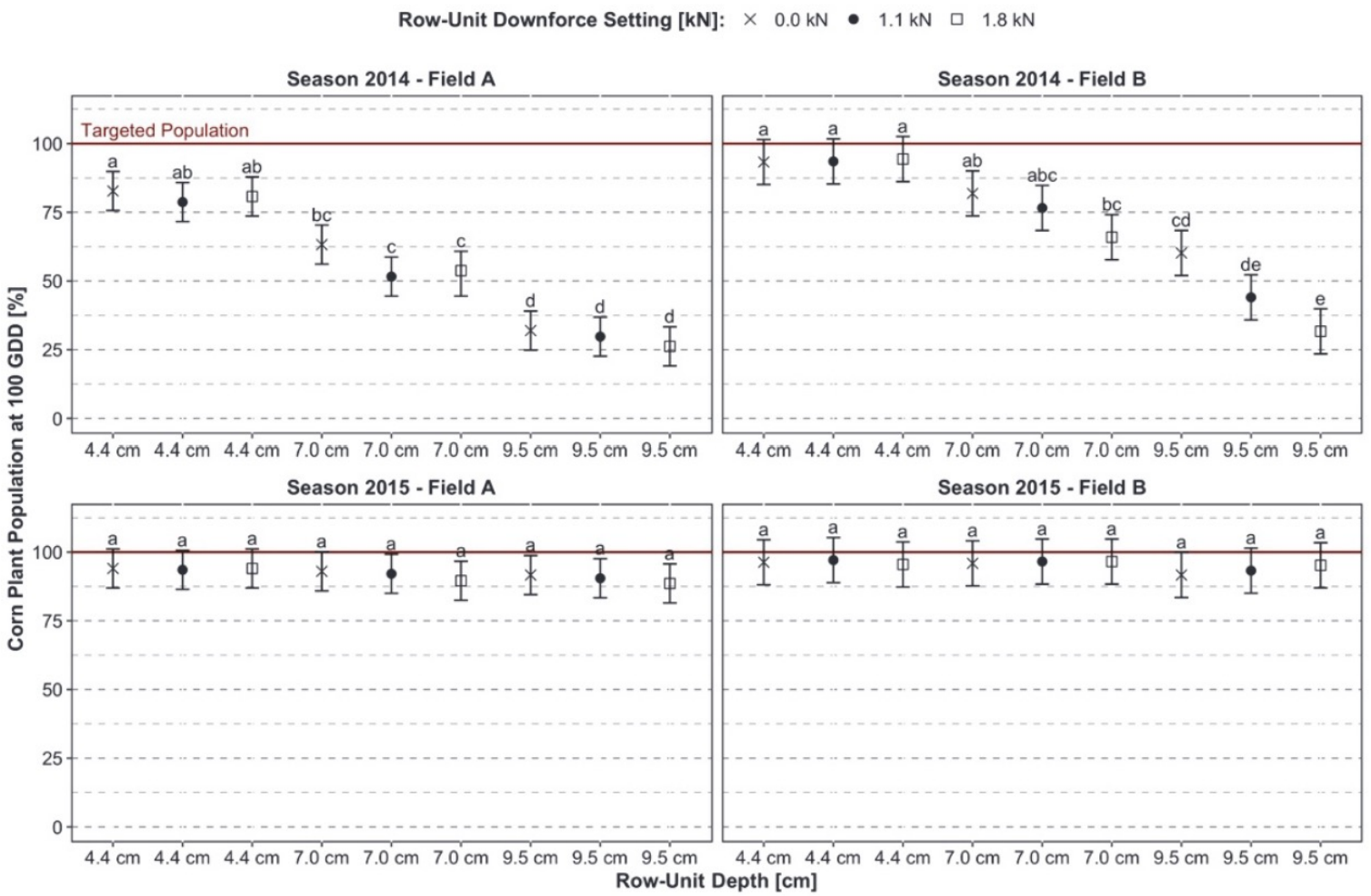

Planter Down Force Study (Alabama)
Poncet et al. (2017)

- Weather was the driving factor for corn emergence in this study
  - At normal temperatures, the down pressure and depth did not have an effect
  - With cooler temperatures, shallower seeding depth achieved higher emergence
- Emergence and treatments had little effect on crop yield
  - Field conditions, weather, and management practices all impacted yield

Gauge Wheel Soil Loading (Iowa)
Hanna et al. (2010)

- Many variables measured:
  - Spacing, spacing variability, depth, emergence rate, plant dry matter, final stand, growth stage, extended leaf height.
- Soil contact loads (down pressure applied)
  - 40 – 110 lb, 110 – 200 lb, and over 200 lb
- Three soil moisture contents (dry, moist, and wet)
- Emergence Rate Index (ERI)

Gauge Wheel Soil Loading (Iowa)

Hanna et al. (2010)

Table 2. Emergence rate and speed of emergence indices at different load levels of planter depth-gauge wheels on the soil surface.

	Emergence Rate Index			Speed of Emergence Index		
Load	17 May	1 June	15 July	17 May	1 June	15 July
Low	12.7	18.6	22.5	0.0369	0.0509	0.0540
Medium	11.6	16.6	22.9	0.0362	0.0440	0.0517
High	10.9	16.0	25.1	0.0326	0.0439	0.0566
Control	10.9	16.0	21.0	0.0339	0.0430	0.0509
$LSD_{0.05}$[a]	0.6	1.9	1.6	0.0027	0.0057	NS

[a] Least significant difference between treatments at a 95% level of confidence.

Gauge Wheel Soil Loading (Iowa)

Hanna et al. (2010)

Table 4. Plant dry matter and seed depth at different load levels of planter depth-gauge wheels on the soil surface.

	Plant Dry Matter, g/plant			Seed Depth, mm (in.)		
Load	17 May	1 June	15 July	17 May	1 June	15 July
Low	0.865	1.796	1.544	46 (1.80)	42 (1.64)	38 (1.51)
Medium	0.711	1.635	1.504	53 (2.09)	47 (1.85)	42 (1.67)
High	0.691	1.475	1.693	59 (2.32)	49 (1.94)	49 (1.92)
Control	0.743	1.665	1.538	57 (2.24)	49 (1.94)	41 (1.23)
$LSD_{0.05}$[a]	NS	NS	NS	4 (0.15)	5 (0.21)	6 (0.24)

[a] Least significant difference between treatments at a 95% level of confidence.

Downforce Summary

- While variable downforce may not directly effect yield it plays an important role in depth control
- Various depths at different soil moistures yield different emergence results.
- Growing degree days (5 and 10 day forecast) could impact the depth and pressure you need to plant at!
- Some other work suggests Soil EC (water holding capacity) might be a good tool for creating a down pressure prescription map.

Closing Wheel Studies

- Replicated across years and site locations in Wisconsin
- 2017
  - Rock County, Dane County, Dunn County, and Marathon County
  - 4-row John Deere 1700 planter
  - Wheels applied to a single row (NASCAR Pit Crew change pass to pass)
  - Emergence counted
- 2018
  - Rock County, Grant County, Monroe County, Adams County, and Marathon County
  - Similar planter except hydraulic down force instead of pneumatic
  - Full planter of closing wheels
  - Emergence counted
- 2019
  - Rock County, Grant County, Monroe County, and Marathon County
  - Same planter setup as 2019
  - Emergence counted

2017 Closing Wheel Study

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2017 Closing Wheel Study Results

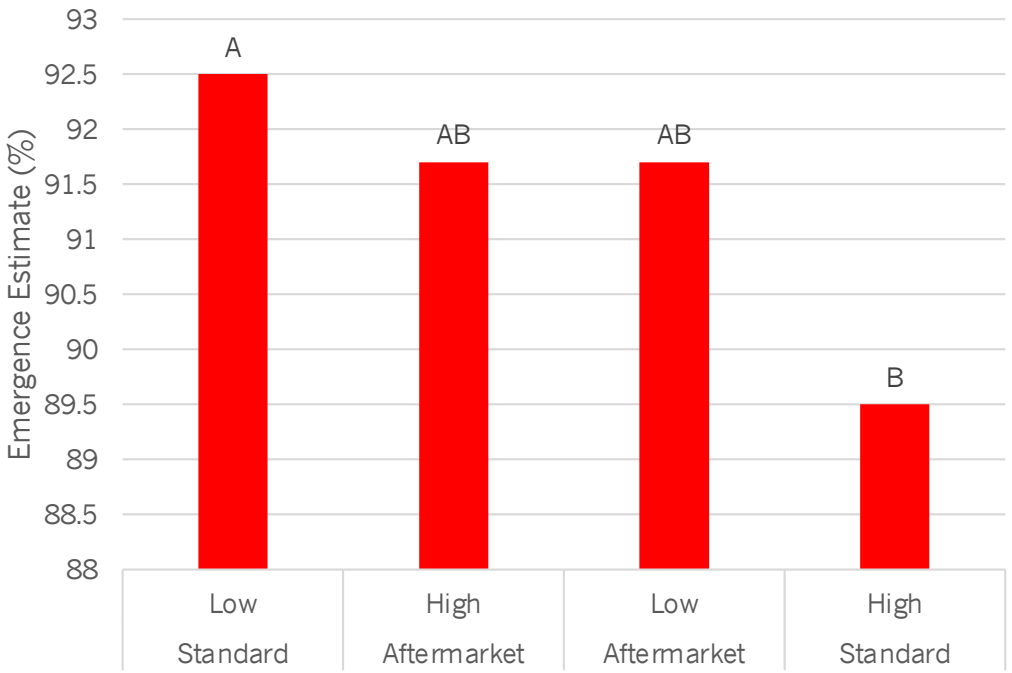
- Aftermarket closing wheels provided 2% better emergence than the standard closing wheel (alpha = 0.1, P-value = 0.06)
- Promising?

Drewry, J. L., B. D. Luck, F. J. Arriaga. 2020. Impact of planter closing wheels on corn emergence in no-till systems. Applied Engineering in Agriculture 36(5): 727-732.

https://doi.org/10.13031/aea.13957

2018/2019 Planter Study

- Results from 2018/2019 combined data showed that down pressure and closing wheel had a combined interaction effect. (alpha = 0.05)
- Wet planting season showed lower down pressure provided better emergence.



Down Pressure	Emergence Estimate	Emergence Standard Error	Letter Group
Low	92.1	3.2	A
High	90.7	3.2	B

Drewry, J. L., F. J. Arriaga, and B. D. Luck. 2021. Closing wheel type and row unit downforce can affect corn germination in no-tillage production systems. Agronomy Journal 113(5): 4037-4046. https://doi.org/10.1002/agj2.20774

Closing Wheel Recommendations

- 2% better emergence with aftermarket closing wheels in 2017.
- Aftermarket closing wheels will help with preserving emergence when down force settings are too high (2018 -2019).
- Soil type and conditions influence closing wheel performance
  - Heavier soils require more aggressive closing wheel settings
  - Soil moisture plays a role in performance as well
  - Get out and check performance and adjust down pressure accordingly
- Get a few to try on your soils before investing
- ½ planter could provide enough tillage and side-wall compaction elimination

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CIG Organic No-Till Study Pre-Results (alpha = 0.05)

- Soybeans
  - Seeding rate showed significantly different emergence (higher rate = more plants) at all locations.
  - Roller crimpers suppressed weeds better than mowing (numerically), but not statistically different
  - Yield was not different across all treatments
    - Can we reduce seeding rate?
- Corn
  - A no-till coulter produced better emergence than not using a no-till coulter (2.8%). Average emergence was 85% with the coulter.
  - Yield was higher with the standard closing wheel than with aftermarket (wet year + other external factors might explain this result).

Planter Technology

Row Unit Shutoff/VRT Seeding
Why?

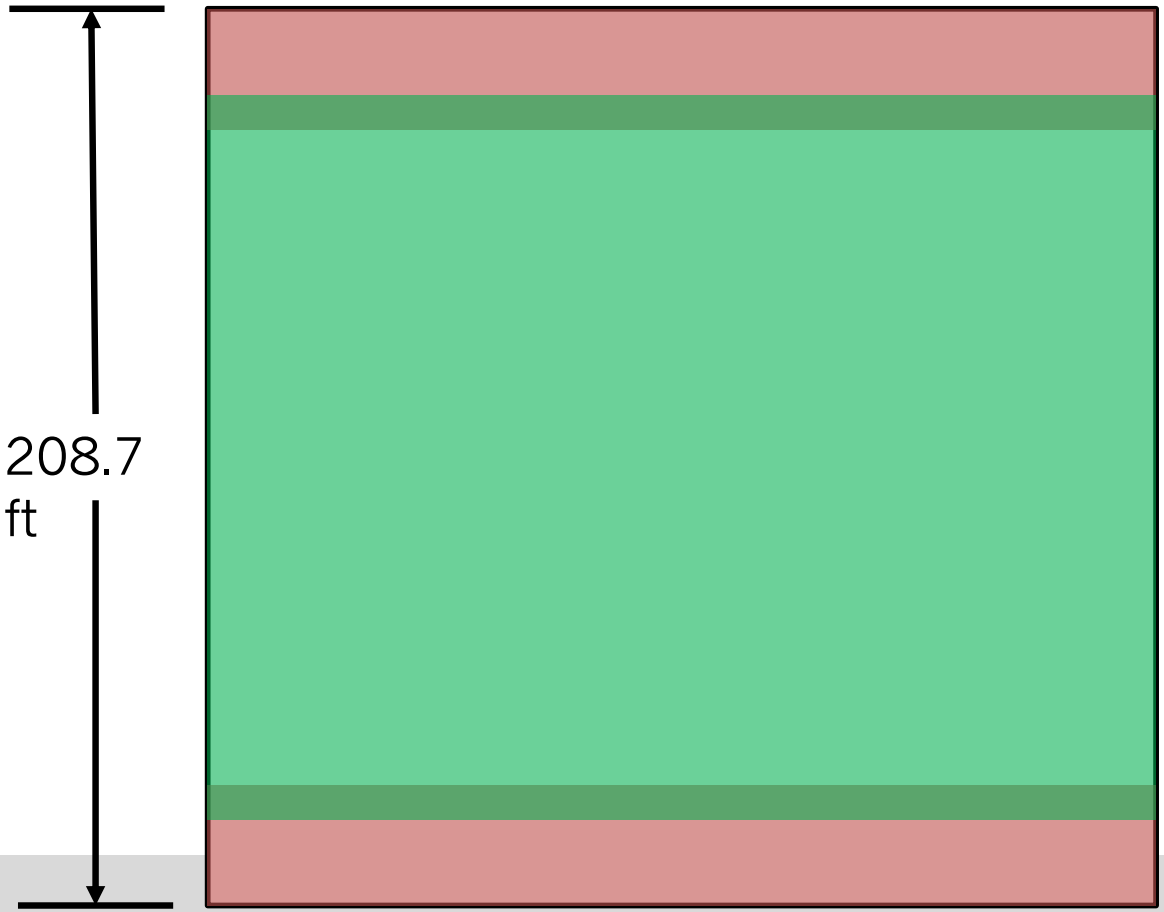
Photo courtesy of Alabama Precision Ag.

Example – Row Shut-Off

- Theoretical 12 row corn planter @ 30 in. row spacing
- Perfectly square 1 ac field (209 x 209 ft) = ~7 passes with the planter.
- Plant into the first end-row every time (30 in over planting on each end-row).
- How much do we over plant?

Example – Row Shut-off

- 1044 ft^2 overplanted (0.024 ac)
- @ 30,000 seeds/ac = 720 seeds wasted
- Assuming 80,000 seeds/50 lb bag ~= 2.4% of seed wasted
- Assuming $230/bag Round-Up ready = $5.52/ac cost (Seed Alone!)



What happens to yield when we double the plant population?

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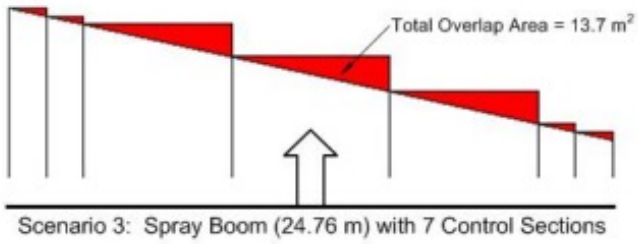
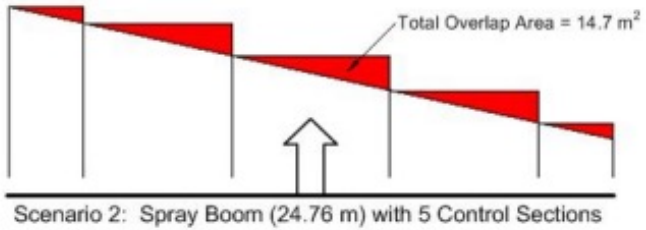
Row/Section Control

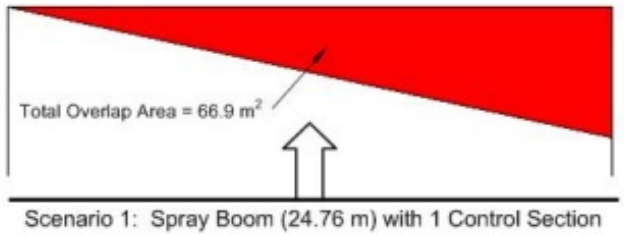
147.5 ft^2



158.2 ft^2



720.1 ft^2



80 ft boom

Luck, J.D., R. S. Zandonadi, B. D. Luck, and S. A. Shearer. 2010. Reducing pesticide over-application with map-based automatic boom section control on agricultural sprayers. Transactions of the ASABE 53(3): 685-690.

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Variable Rate (Row Shut-off) Payback
Velandia et al. (2013)

- Categorized fields in Perimeter to Area Ratio
  - High = > 5% double planted
  - Medium = 2% - 5% double planted
  - Low = < 2% double planted

Variable Rate (Row Shut-off) Payback

Velandia et al. (2013)

Table 3
Savings from ASC adoption based on field type by crop.

Field type	Average savings from ASC adoption (USD/ha)[a]		
	Cotton	Corn	Soybeans
Low double-planted	2.9	2.7	1.2
	(2.1)	(2.0)	(0.8)
Moderate double-planted	11.6	10.9	4.7
	(2.9)	(2.8)	(1.2)
High double-planted	38.1	35.6	15.1
	(9.1)	(8.5)	(3.6)

[a] Standard deviations are in parenthesis.

Table 4
Savings from ASC adoption on planters based on distribution of field types.

Field type	Average savings from ASC adoption (USD/ha)[a]		
	Cotton	Corn	Soybeans
60% – 25% – 15%	10.4	9.7	4.1
	(2.0)	(1.9)	(0.8)
30% – 40% – 30%	16.9	15.8	6.7
	(3.0)	(2.9)	(1.4)
15% – 25% – 60%	26.2	24.4	10.3
	(5.5)	(5.2)	(2.1)

[a] Standard deviations are in parenthesis.

Variable Rate (Row Shut-off) Payback

Velandia et al. (2013)

Table 7
Annual savings from ASC on planters and minimum number of years to pay back investment with yearly cash inflows larger than cash outflows by farm size and distribution of field types for corn and soybean combination.

Farm size (ha)	Distribution of double-planted fields (Low – moderate – high)		
	60% – 25% – 15%	30% – 40% – 30%	15% – 25% – 60%
	Annual savings/(years to pay back investment)		
400	$2746 (10)	$4491 (5)	$6943 (3)
600	$4118 (6)	$6737 (3)	$10,415 (2)
800	$5491 (4)	$8982 (3)	$13,887 (2)

Section Control Summary

- Automatic Section Control pays!
- Perimeter to Area Ratio!!!
- Variable rate seeding??? Maybe
  - All depends on variability in the field and advantages to population changes

Planter Setup Considerations

!!!Urgent Message!!!
Working on the left side of the row unit means?

- LEFT HANDED THREADS!!!

Safety while Working on Machinery

- Lock out hydraulic cylinders if possible
- Block up the planter and row units
- Never get under a piece of machinery that is not mechanically supported
  - Don't trust hydraulics
- Planter components are sharp by nature
  - Wear gloves and safety glasses when working on these compnonents
- Accidents happen when you lease expect them
  - "I'll just be under there a minute."

Planter Checks and Setup for No-Till

- Check your owners manual for specific tolerances and adjustments for your machine
- Wear on components has a big influence on planter performance
- Proper lubrication helps reduce wear (obviously)
- Quite a few things to check to ensure proper performance of your planter
- Following the Yetter Equipment generic guide for planter setup

Planter Checks and Setup for No-Till

- Parallel Link Arms
  - Ensure bolts are tight and torqued to specification
  - Ensure side-to-side movement isn't excessive
  - Replace wear parts/bushings to tighten link arms
  - Also ensure the arms aren't bent or binding
- Seed Tubes
  - Make certain they are installed properly and not cracked or broken
  - Check seed sensor functionality with monitor

Planter Checks and Setup for No-Till

- Double Disc Openers
  - Should have 2 inches of contact at soil engagement location
    - Check owner's manual
    - Shims can be installed or removed to adjust engagement
    - Worn or cracked blades should be replaced
      - Over worn blades will not achieve 2 inches of contact
    - Lubricate the bearings
    - REMEMBER! Left side of the planter has left handed threads

Planter Checks and Setup for No-Till

- Gauge Wheels
  - Can be worn too far and can not be set properly
  - Adjust in or out to ensure the gauge wheel is touching the double disc opener
  - Check the bearings and ensure no wobble is present
  - Make sure they are free to move and interact with the depth stop
- Seed Boxes
  - Cleanliness is next to Godliness
  - Foreign material in the seed boxes can plug the meter and cause problems
  - Cracks or broken parts can cause problems as well.
  - When hauling the planter, take the lids off too (ask me how I know)

Planter Checks and Setup for No-Till

- Closing Wheels
  - Bearings again
  - Left handed threads again
  - Pivot bushings should be checked too for wear and replaced
- Seed Meters
  - Finger meters have springs and moving parts that all must be checked and cleaned
  - Vacuum or Pressure meters should be checked and cleaned as well
  - Ensure vacuum and pressure system is clean and free of debris

Planter Checks and Setup for No-Till

- Chains, Shafts, and Transmissions
  - Check everything for tightness and proper adjustment
  - Replace worn chains that might slip
  - Lubricate the system
- Row Cleaners and Front Coulters
  - Check for wear
  - Check the bearings

Setup Thoughts

- Row Cleaners
  - Set to where they're skimming and moving residue
  - Not doing tillage
  - Keep an eye on these as soil conditions change
- Front Coulters
  - Should be set 1 inch shallower than planting depth
  - Leading coulter cuts residue laying across the row
  - Additional draft force
  - Additional down force required

Technology Checks

- Update everything annually at least
- Check wiring connections and wires
  - A chewed wire (animals) can be hard to track down
  - Wire insulation is soy based and rodents love it (ask me how I know)
- Most monitors have a calibration mode to spin the seed plates
  - Catch seed and count in the shop
  - Calibrate other liquid and dry products too to ensure functionality
  - Follow safety protocols for interaction with chemicals

When you get to the field
Check, check, and check again

- Planting depth
  - Function of gauge wheel setting, row unit down-force, planter attachments (front coulters), and planter speed
  - Test passes should be with the planter in the ground and functioning properly.
  - Make certain to get the planter up to speed before stopping to check seeding depth.
  - Heavier soils require more pressure to keep the row unit in contact with the soil
  - Planters without central fill will "lose weight" as the seed boxes empty
- Seed Spacing
  - Dig multiple locations across the planter to ensure seeding rate is accurate
  - Monitors in the cab indicate spacing, but I still like to check

Other BSE Machinery Extension News! Shameless Plugs

- Website available!

  wimachineryextension.bse.wisc.edu
- 2021 Promoted to Associate Professor!
- Keep tabs Badger Ag. Tech. Lab on Twitter!
  - @BadgerLuck

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