ROI and Soybean Production

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Establish uniform plant stand (plants/acre)
Set and retain more pods (pods/plant)
Increase number of seeds/pod
Maximize seed weight (seeds/lb.)

Seeds/acre
Seed weight

What can be done to **POSITIVELY** influence these yield components and **minimize Yield Limiting Factors at field-scale**
Managing Soybean for higher Yield/Profit

Focus today on #2-5 (Planting decisions)
Planting Progress - Variability over years

% Soybean Planted Before 1st Week May

\[ y = 0.2771x - 546.29 \]
\[ R^2 = 0.0802 \]

USDA NASS Date from 1982 – 2021, Week 18
Increase in extreme precipitation
(during top 1% of severe storms)

GLISA, 2019
<table>
<thead>
<tr>
<th>Planting Time</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early Season</strong></td>
<td>• Cool, wet soil - can lead to uneven stands</td>
</tr>
<tr>
<td>(before early-May)</td>
<td>• <strong>Extended Growing Season</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Mid Season</strong></td>
</tr>
<tr>
<td></td>
<td>• Typically, adequate soil temp. and moisture</td>
</tr>
<tr>
<td><strong>Late Season</strong></td>
<td>• Lack of soil moisture</td>
</tr>
<tr>
<td>(June)</td>
<td>• <strong>Restricted Growing Season</strong></td>
</tr>
</tbody>
</table>
Soybean Planting Date


Risk Management Agency’s (RMA) earliest planting dates for soybeans in Michigan
Planting Time Impacts Yield in Michigan

Data from 2018-2021 across multiple trials
On-farm Soybean Trials

- Conducted 2019 - 2021
- 2 plant dates (*early, typical*), ~3 weeks apart, in strips
  - Fungicide/insecticide at R3 in few fields in 2019 in early planting
- Yield from each strip
- Seed quality samples
Yield: 2019-20 data across states

Reference is Typical planting time
Improved is Early Planting + other management (e.g., fung./insect. spray, late-MG, lower seed rate)
**Yield: 2019-20 data across states**

**Improved** is Early Planting (+ fung./insect. spray in few fields)

**Reference** is Typical planting

- **Season 2019**: n=42 paired comparisons, Mean difference = 51 $/ac
- **Season 2020**: n=51 paired comparisons, Mean difference = 31 $/ac

- Treated seed cost: $60/140k seeds
- Non-treated seed cost: $54/140k seeds
- Foliar insecticide (product only) = $3/ac
- Foliar fungicide (product only) = $10/ac
- Foliar fungicide and/or insecticide application (excluding product cost): $6.50/ac
Seed Quality - 2019

Left: Oil - Improved (%)
- n=44 paired comparisons
- Mean difference = 0.27%
- p=0.002

Right: Protein - Improved (%)
- n=44 paired comparisons
- Mean difference = -0.34%
- p<0.001
Yield: 2019 - 2021 Michigan Data

Yield diff. = Early planting - Normal planting time

* Denotes significant differences at P < 0.10
+ denotes fung./insect. spray at R3 in early planting in 2019
Planting Time: change other management?

How to Improve Yield Potential
OR Minimize Input Cost
= Increased Profit
Optimal Maturity Selection: Role of planting date?

- Based on one planting date (mid-season)
- Does NOT account for early/late planting
Optimal Maturity Selection: by planting date
Yield Components

# 1: Planting Time x Variety Maturity

Late-April PD

![Graph showing yield vs seed weight]

- Yield (bu/a)
- Seed Weight (g/100 seeds)
- $p=0.4$

Late-April PD

![Graph showing yield vs seeds/m²]

- Yield (bu/a)
- Seeds/m²
- $R^2 = 0.5552$
- $p<0.001$
# 1: Planting Time x Variety Maturity

## Phenology

<table>
<thead>
<tr>
<th>Date</th>
<th>MG 1.0</th>
<th>MG 2.0</th>
<th>MG 3.0</th>
<th>R7 Date</th>
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<tbody>
<tr>
<td>April 26</td>
<td>25</td>
<td>42</td>
<td>24</td>
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<td></td>
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<td>May 15</td>
<td>18</td>
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<td>20</td>
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<td>27</td>
<td>45</td>
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<td>June 4</td>
<td>11</td>
<td>30</td>
<td>25</td>
<td>34</td>
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<td>30</td>
<td>41</td>
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<td>4</td>
<td>29</td>
<td>28</td>
<td>32</td>
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<td></td>
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<td>38</td>
<td>19</td>
<td>48</td>
</tr>
</tbody>
</table>

### Day of Year

- **P-VE**: Plant Emergence
- **VE-R1**: Vascular Bundle Emergence - R1
- **R1-R5**: Heading - R1 to R5
- **R5-R7**: Maturity - R5 to R7
Physiology of Yield Increase

- Adjust planting date and soybean maturity in order to:
  - Harvest more light prior to the onset of reproductive development
  - Maximize number of nodes/pods/seed per acre, longer reproductive phase
  - Minimize the impact of periods of extreme heat and/or moisture stress during flowering and pod set

# 1: Planting Time x Variety Maturity
2020 & 2021 Results - late planted soybean

# 1: Planting Time x Variety Maturity

Mid-June PD

\[ R^2 = 0.00 \]
\[ R^2 = 0.0018 \]
Maturity/Quality concerns

2020 - 1st killing Frost on Oct. 16

2021 - 1st killing Frost on Nov. 3
Optimal Maturity Selection: Double Crop systems

- Location: KBS, 2018-19
- Planted 1st week of July after winter barley harvest
- Seed rate- 140 k and 200k per acre

Letters show comparison among 3 variety maturities within each year and water level.
Plant date/ Maturity selection Summary

- Combine early planting with other management for higher yields
- Optimal maturity varies with time of planting
- For mid-season planting, mid- and early- maturity varieties have competitive yield, and low moisture
- Benefits of early-season planting can be expanded upon with the use of late-maturity variety
- Select early-maturity variety to minimize yield loss/ moisture issues in delayed/replant situations
- **Portfolio approach** in maturity selection
  - Plant late-maturity variety first (30-40% acres)
  - Plant mid- and early-maturity varieties in sequence to “stack” flowering/pod set/fill
  - Plant ~20-30% acres to each of mid- and early-maturity variety
Soybean Seeding Rate

- 50,000 Seeds/A
- 90,000 Seeds/A
- 130,000 Seeds/A
- 170,000 Seeds/A
- 210,000 Seeds/A

Seed rate: ~20% higher

# 2: Planting Time x Seed Rate
Seeding Rate

Soybean Seeding Rate- Agronomic vs Economic Optimal

- Agronomic Optimal Seed Rate
- Economic Optimal Seed Rate

30-40k seeds/ac difference

Agronomic Optimal Seed Rate
Economic Optimal Seed Rate

15-inch rows
4 site-years data
Seeding Rate - Plant architecture

Yield Distribution / Plant

\[ y = -0.643 \ln(x) + 7.7011 \]

\[ R^2 = 0.58 \]

More yield from branches

More yield from main stem

Final Plant Stand (thousand plants / acre)
# 2: Planting Time x Seed Rate

## Seeding Rate - Plant architecture

![Low Seed Rate](image1)

![High Seed Rate](image2)

### 2021 Low Pod Height

![Graph showing correlation between final plant stand (plants/acre) and low pod height](graph)

- **R² = 0.25**
Seeding Rate Summary

- For max yield: final plant stand of 100-120,000/ac for May planting, 120-150,000 plants/ac for June planting (~20% higher for seeding rate)

- Economic optimum rates are lower (30-40k) than agronomic optimum rates

- Lower seeding rate in high yielding areas/fields, higher rate in low yielding areas

- Higher seeding rate for northern locations, early-maturity varieties

- Early planted uniform stand of >50k/ac can produce high yield, plant into existing stand below that stand rather than replanting

- Stand count is important for evaluating yield potential
# 3: Planting Time x Row Spacing

Row Spacing

2014-17 farmer survey data

Andrade et al., 2019
# 3: Planting Time x Row Spacing

Soybean Row Spacing

- **30” spacing**
  - Canopy cover: 79%

- **15” spacing**
  - Canopy cover: 95%

**Graphs:**
- **Late-April**
  - 15” row: 80%
  - 30” row: 95%

- **Mid-June**
  - 15” row: 90%
  - 30” row: 95%
Optimal Seeding rate did not differ between the two row spacings.
Optimal Seeding rate did not differ between the two row spacings

Economic optimal seeding rate, across both row spacings
- Early PD – 86,890 plants/acre
- Mid PD – 85,281 plants/acre
- Late PD – 118,081 plants/acre
# 3: Planting Time x Row Spacing

Row Spacing Summary

- **Narrow rows**: faster canopy closure, >95% light interception, moisture conservation, weed control

- **Yield benefit** under narrow rows: Limited time for vegetative growth before flowering
  - Northern production regions
  - Delayed planting/ Double crop
  - Early-maturing varieties

- **Yield loss**: Disease pressure- white mold
# 4: Planting Time x other factors

## Planting Method

### Broadcast Incorporation (BI)

### Winter Wheat Data - 2021

<table>
<thead>
<tr>
<th>Yield (bu/ac⁻¹)</th>
<th>Drill</th>
<th>BI @ 130k</th>
<th>BI @ 180k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm 1</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Farm 2</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Farm 3</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Farm 4</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm 5</td>
<td>A</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

### Soybean 2021 at Lansing

<table>
<thead>
<tr>
<th>Yield (bu/a)</th>
<th>Planter</th>
<th>Drill</th>
<th>BI @ 130k</th>
<th>BI @ 180k</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>81.5</td>
<td>78.2</td>
<td>74.3</td>
<td>77.7</td>
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</tbody>
</table>

* p = 0.53

Spread the Wealth

Broadcast-seeding soybeans can help increase yields and reduce cost.

By Matthew Wilde,

An unconventional method of sowing may be all about yield. One of the easiest and most practical ways to do so is to use a planter instead of broadcasting the seeds.
Soybean Seed Priming

Hydropriming

Solid Matrix Priming

Planting Date x Priming Method

- Early PD - Control
- Early PD - Hydro
- Early PD - SMP
- Late PD - Control
- Late PD - Hydro
- Late PD - SMP
No response to rhizobia inoculation in fields with soybean history
Co-inoculation with Azospirillum didn’t improve yield
In-season application (V3 or R2) had no impact on yield
Fertility- 2021 data

- Adequate P and K soil test levels at study site
- No interaction between plant date and fertility treatments
- Fertility (at-plant or in-season) and inoculation had no impact on yield
- Effect of plant date was significant

### Soybean Fertility

- **Late-April**
  - Control: A
  - In-Season Inoc: B
  - MAP@Plant: A
  - Seed Inoc: B
  - Urea@Plant: C

- **Mid-May**
  - Control: B
  - In-Season Inoc: B
  - MAP@Plant: A
  - Seed Inoc: B
  - Urea@Plant: C

- **Mid-June**
  - Control: C
  - In-Season Inoc: C
  - MAP@Plant: C
  - Seed Inoc: C
  - Urea@Plant: C

Field Soil pH P K Mg Ca CEC
PP3 6.3 63 140 235 1050 8.8

$p=0.28$
Fertility: in-season foliar

- 46 site years, 2019-20
- Products applied at R3, prophylactic
- There were no significant diff. in yield among treatments ($p=0.998$)
- No difference in grain composition
- No difference in N, P, K, Ca, Mg, Fe concentrations
- Difference in Mn, Cu, and B conc,
Seed Treatment

➢ **No yield improvement** from using a seed treatment at any plant date, across 4 site-years (minimal pest pressure)

➢ Using a seed treatment **reduced net returns** (-$11/acre)
  ➢ Treated: $322/acre
  ➢ Control: $333/acre

2018-19 data, 4 site years
Take Home Messages

➢ Combining improved genetics (variety selection) with management can increase yield (reduce on-farm yield gap), quality, and profits

➢ Specific practices dependent on field specific conditions:
  ➢ **Plant date**: early planting in optimal moisture, change other management
  ➢ **Maturity selection**: later-maturity variety with early planting
  ➢ **Seeding rate**: lower seeding rate with minimum yield penalty
  ➢ **Row Spacing**: narrow row spacing
  ➢ Others- planting method, fertility, crop rotation, pest management

➢ Not every practice will affect yield in a given field or year
  ➢ Minimize field-specific yield limiting factors (**light**, **water**, nutrition, pests) to best utilize the growing season
2020 On-farm Trials Report

Boots on the Ground: Validation of benchmarking process through an integrated on-farm partnership

IN A BEAN POD:

https://soybeanresearchinfo.com/#
Do you grow soybeans?
Will you help us develop specific recommendations by sharing your field data?

We are seeking info from your Soybean Fields!
USING DATA-DRIVEN KNOWLEDGE FOR PROFITABLE SOYBEAN MANAGEMENT SYSTEMS

- We would like to get historic yield and management data from a field or two on your farm
- We're looking for over 1000 fields overall to make the survey robust
- We'd like information about your field management, costs, and yields
- We'll add soil data, weather data, and satellite image data to your yield data
- It's completely confidential

Here's our goal!
To develop a new online cropping system optimization decision tool that uses the data collected in the survey.

Ready to go?
- Participate in our survey!
- The survey is online and will take about 10-20 minutes to complete
- We can come to your farm office and will help you complete the survey

For more information:

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Tom Siler
Research Assistant II
silertho@msu.edu
989-817-8570
Cropping system optimization

Use the left and middle columns to fill your typical cropping system information and the management options you want to test. Then press 'submit' one time. In the left column you will see the results of the algorithm (AI) and how it compares with your system.

<table>
<thead>
<tr>
<th>Trait of Your Typical Seed</th>
<th>GMO</th>
<th>Conv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed Treatment of Your Typical Seed</td>
<td>UTC</td>
<td>FIN</td>
</tr>
<tr>
<td>Maturity Group of Your Typical Seed</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>How Much That Seed Costs Per 140,000 Seeds</td>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Option 1 Seed Trait (Hint: Choose NA if you don’t want to test another seed):

- GOMO
- Conv
- NA

Option 1 Maturity Group (Hint: Choose NA if you don’t want to test another seed):

- UTC
- FIN
- NA

Option 2 Seed Trait (Hint: Choose NA if you don’t want to test another seed):

- GOMO
- Conv
- NA

Option 2 Maturity Group (Hint: Choose NA if you don’t want to test another seed):

- UTC
- FIN
- NA

Soybean Selling Price ($/bu): 12.5

How Much Does Nitrogen Fertilizer Costs ($/A): 0.35

How Much Does Nitrogen Application Cost ($/A): 10

How Much Does Foliar Fungicide Application Product Costs ($/A): 25

Your Cropping System:

- Planting date: 110
- Trait, seed treatment and maturity: Conv UTC 2.5, Seeding rate (seeds/acre): 240, Row spacing (inches): 15, Foliar Fungicide: yes, Nitrogen rate (lb/ac): 0

AI Recommended for Highest Yield System:

- Planting date: 110
- Trait, seed treatment and maturity: Conv UTC 2.5, Seeding rate (seeds/acre): 240, Row spacing (inches): 15, Foliar Fungicide: yes, Nitrogen rate (lb/ac): 0

High Yield AI System - Yield and Profit Difference (AI vs Your System):

- Profit ($/acre): 29.76
- Yield Difference (AI minus yours cropping system yield): 6.32

AI Recommended for Highest Profit System:

- Planting date: 110
- Trait, seed treatment and maturity: Conv UTC 2.5, Seeding rate (seeds/acre): 240, Row spacing (inches): 15, Foliar Fungicide: yes, Nitrogen rate (lb/ac): 0

High Profit AI System - Yield and Profit Difference (AI vs Your System):

- Profit ($/acre): 54.65
- Yield Difference (AI minus yours cropping system yield): 2.64
New NCSRP project 2022-24: Farmer Survey

- 2 drawings for cash prize of $1,000 and $500
- Each field will be one entry in the drawings (e.g., 4 fields = 4 entries)
- Provide your contact information in the sign-up sheet
- We will contact you based on your selected preference

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Phone</th>
<th>Street</th>
<th>City</th>
<th>State</th>
<th>ZIP</th>
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<tr>
<td>John Doe</td>
<td><a href="mailto:doejohn@gmail.com">doejohn@gmail.com</a></td>
<td>(999)123-4567</td>
<td>123 Farm Ln</td>
<td>East Lansing</td>
<td>MI</td>
<td>48823</td>
</tr>
</tbody>
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How would you like to receive survey?

- Email
- Mailed

x
➢ Technicians:
  ➢ Tom Siler
  ➢ Micalah Blohm

➢ Graduate Students
  ➢ Harkirat Kaur
  ➢ Patrick Copeland
  ➢ Benjamin Agyei

➢ Undergrad students
  ➢ Past students
  ➢ Mike Particka
  ➢ Paul Horny
  ➢ Charles Scovill (Syngenta)

➢ Farmer cooperators

➢ Mike Staton
➢ Dr. Laura Lindsey (OSU)
➢ Dr. I. Ciampitti (KSU)
➢ Dr. Shawn Conley (UW)
➢ Dr. Marty Chilvers
➢ Dr. Chris Difonzo
➢ Dr. Dechun Wang
➢ Dr. Christy Sprague
➢ Dr. Kurt Steinke

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Seed companies