September, 2018

powerpollen℠

PRESERVE. ENHANCE. GROW.

A breakthrough in yield and quality enhancement in maize hybrid seed production

WHY, HOW, WHAT

Increase Ag Productivity	Improve the Seed	Enable More Effective Cross-Pollination
WHY	HOW	WHAT

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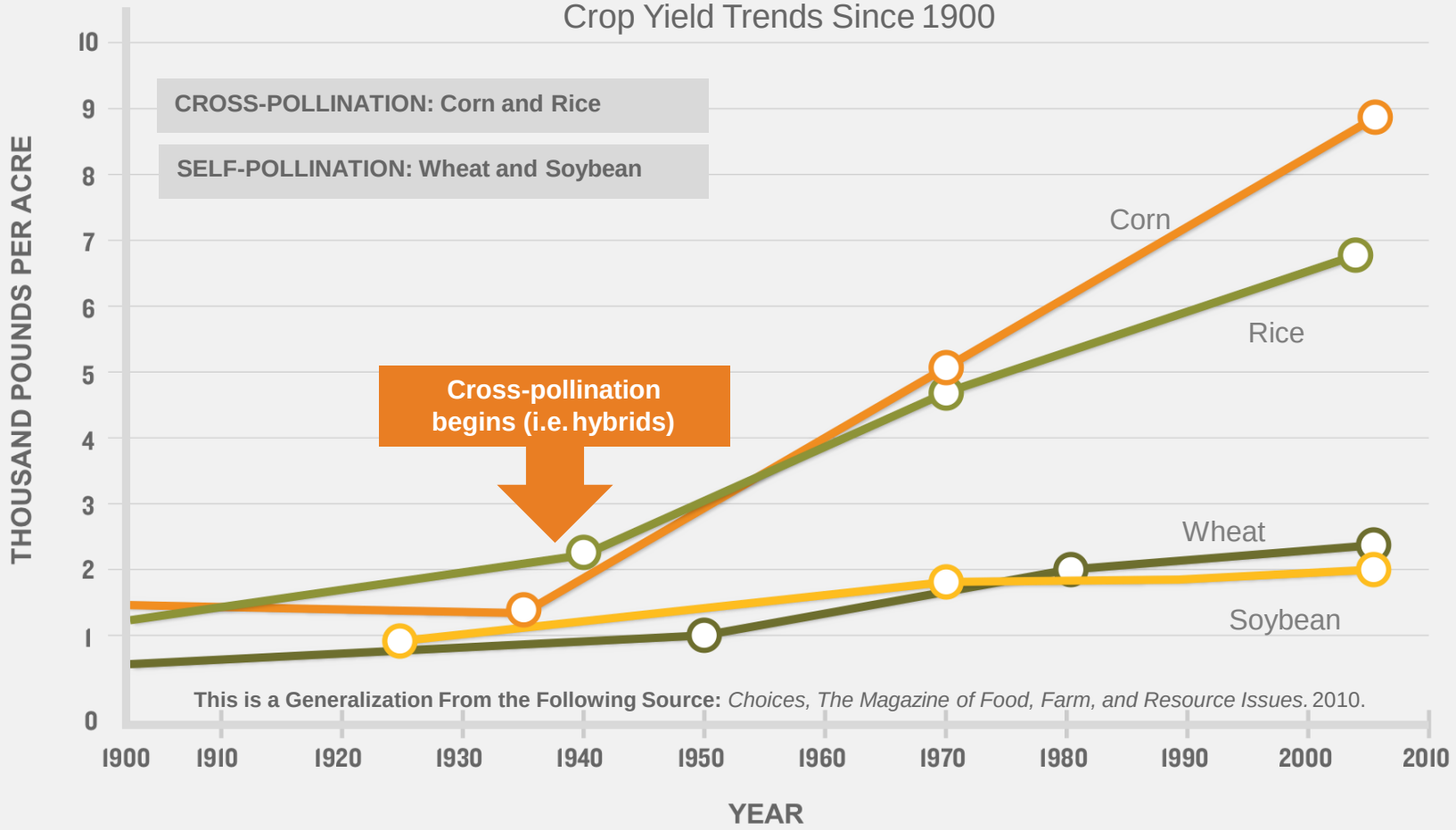
CROSS-POLLINATION = HIGHER PRODUCTIVITY



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IT'S ALL ABOUT THE POLLEN

PROBLEM

Enabling cross-pollination is difficult and expensive
COST PROHIBITIVE IN WHEAT/SOYBEANS

SOLUTION

Delivering desired viable pollen
to the right location, at the right time
while avoiding undesired contaminant pollen

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Corn Hybrid Seed Production

Must de-tassel the ♀'s to enable cross pollination

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CORN HYBRID SEED PRODUCTION

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CORN HYBRID SEED PRODUCTION

HAS NOT CHANGED

AN AVERAGE OF
>20% SEED YIELD LOSS

HIGH CONTAMINATION
HIGH DISCARD RATE
(ABOUT 7%)

HIGH LABOR / RESOURCE COSTS

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NEW SEED PRODUCTION SYSTEM

DIRECT COMPARISON IN CORN (1MM ACRES U.S.)

Process	Traditional	PowerPollen™
Pollen Timing	3 hour window	**On-demand: 24/7**
Pollen Delivery	Weather Dependent	**Weather Resilient**
Field Isolation	Large Tracts of Land	**Minimized**
De-tasseling Female Rows	Labor Intensive	**Labor almost eliminated**
Male Presence (zero yield)	Required: 15-40%	**Minimized/eliminated**
Risk Management	~30% Over-Production	**<15% Over-Production**
Seed Yield	~70 Saleable Units/A	**>85 Saleable Units/A**

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THE BREAKTHROUGH

Industry's first maize pollen preservation method

Rigorous & at scale. Non-regulated, accelerated go-to-market strategy

On-demand method to "preempt" contamination

Less discard, higher yield and lower cost of goods

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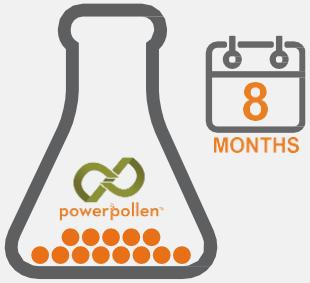
HOW IT WORKS

FOR CORN

POLLEN PRODUCED

VIABILITY = 1 HOUR

POLLEN REQUIRED



PRESERVED >8 MONTHS

Corn Produces More Pollen than Needed

PRESERVED pollen **DIRECTED** to the female **ON-DEMAND**

RESULT:

PREEMPT CONTAMINATION

- Decrease expensive practices

INCREASE SEED YIELD

Silks receptive 24-7

Less Discard & More Yield = More Product to Sell

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HOW IT WORKS

PRESERVATION AND STORAGE: Method Development

Ampha Z32 provides instant feedback on treatments

Iterations of experiments results refine experiments, are very fast

Two methods developed:

1. **Short Term: <20 days**
2. **Long Term: >8 months**

HOW IT WORKS - CORN

Pollen Collection

Mobile Pollen
Preservation and Storage

On-Demand Pollen
Dispersal

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HOW IT WORKS

FOR CORN

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HOW IT WORKS
FOR CORN

Applying pollen at night

Eastern Iowa pollen applied in Central Nebraska

First time in history!

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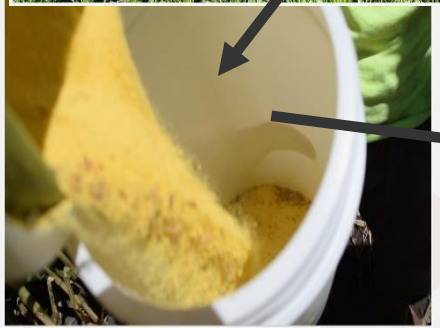
HOW IT WORKS

COLLECTING POLLEN



CRITICAL: START WITH HIGH QUALITY POLLEN

Micro sub-sample

On-site measurements

Instant viability measurements with Ampha Z32

- **Confirm that the fresh pollen is high quality**

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HOW IT WORKS

PRESERVATION AND STORAGE: High Throughput

Large conditioning and storage methods: 100s of acres

Ampha Z32 measurement during storage – sub-sample over time

- **Confirm that the stored pollen is viable and storage conditions are adequate**
- **Adjust as appropriate**

Micro sub-samples

HOW IT WORKS

DISPERSING POLLEN TO TARGET

CRITICAL: Confirm viable pollen right before application

Micro sub-sample

On-site measurements

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3 SEASONS

OF FIELD RESULTS IN CORN

MORE THAN 20%
YIELD INCREASE

CUT DISCARD
RATE BY >50%

>5000x

POLLEN VIABILITY DURATION
1 hour **5760 hours**

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REAL SEED PRODUCTION EXAMPLE – 2017

IN-SEASON ADJUSTMENT TO MITIGATE DROUGHT EFFECTS

OPEN-POLLINATED
~July 19-20
Peak pollen available ~July 16

A single pollen application returned most of the yield

PowerPollen℠
on July 23
Sample ear harvested on Aug 7

OPEN-POLLINATED
~July 19-20

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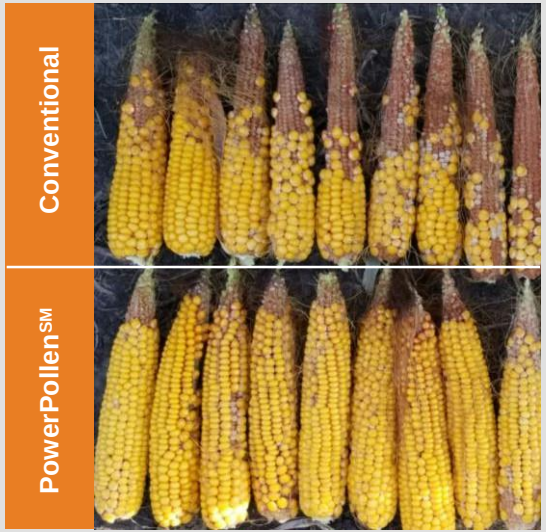
REAL SEED PRODUCTION EXAMPLE – 2017



In-season adjustment to mitigate drought effects

2019-2025 GROWTH OPPORTUNITIES

Market	Year
Corn Seed US	2018
Corn Seed OUS	2019-20
Corn Grain	2021
Rice Seed	2021-22
Wheat Seed	2022-23

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What About Other Crops?

Corn: Most Productive Crop	Wheat: Most Widely Grown	Rice: Most Valuable Crop
1,000MM MT	740MM MT	482MM MT
180 MM Ha	**221MM Ha**	160 MM Ha
$140B	$70B	**$250B**

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Can Better Cross-Pollination Improve Wheat and Rice Seed & Grain Yield?

YES

TBD

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Other Applications of Preserved Pollen

- Breeding, research and development applications
  - Greenhouse, isolated crossing blocks
  - Breeding crosses, line increases
  - Viable pollen when it is needed for critical crosses, while saving space
- Enabling wide cross hybrids
  - More diversity in the breeding programs
- All inbreds/varieties can work as males
- New breeding to maximize xenia effect (grain yield)
- Many other related applications

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