2016 MSU Seed Technology Short Course Proceedings

Daniel Chesser

Follow this and additional works at: https://scholarsjunction.msstate.edu/cals-publications

Recommended Citation
https://scholarsjunction.msstate.edu/cals-publications/4

This Article is brought to you for free and open access by the College of Agriculture and Life Sciences at Scholars Junction. It has been accepted for inclusion in College of Agriculture & Life Sciences Publications and Scholarship by an authorized administrator of Scholars Junction. For more information, please contact scholcomm@msstate.libanswers.com.
Seed Tech 2016: From Bin to Bag

August 2-3, 2016
Proceedings of the Seed Technology Short Course

Volume II

Seed Tech 2016: From Bin to Bag

This collection is assembled for the convenience of the attendees of the Seed Technology Short Course and is not peer-reviewed. All content is the work of the identified author.

Mississippi State University
Division of Agriculture, Forestry, and Veterinary Medicine
Extension
Mississippi Agricultural and Forestry Experiment Station

Mississippi Crop Improvement Association
Platinum Sponsor

Gold Sponsors

FARMJOURNAL FOUNDATION

Silver Sponsors

Bayer CropScience syngenta

Bronze Sponsors

Clark Beverage Group of Starkville
Seed Technology Short Course Planning Team

Bill Herndon, DAFVM         Bennie Keith, Director, MCIA
Ernie Flint, Extension     Dennis Reginelli, Extension
Randy Vaughan, MAFES       Jason Ward, Extension

Mississippi State University Administrators

Mark Keenum, President
Gregory Bohach, Vice-President – Division of Agriculture, Forestry, Veterinary Medicine
Bill Herndon – Associate Vice-President, Division of Agriculture, Forestry, Veterinary Medicine
George Hopper – Dean and Director, CALS/MAFES and CFR/FWRC
Wes Burger, Associate Director, MAFES
Gary Jackson, Director, Extension
Steve Martin, Associate Director, Extension – Agriculture and Natural Resources
Mike Philips, Department Head, Plant and Soil Sciences
Jonathan Pote, Department Head, Agricultural and Biological Engineering
Tuesday, August 2, 2016

10:00  Welcome and Introduction
10:15  Storing for Quality: What Have We Learned – Edgar Cabrera, DuPont Pioneer
11:00  Principles of Seed Separation – Randy Vaughan, MSU Foundation Seed
11:30  Pre-Cleaning – Myles Mosely, LMC Manufacturing
11:50  Group Picture
12:00  Lunch – Mr. Charlie’s Catering Service
1:00   Air-Screen Cleaning – Myles Mosely, LMC Manufacturing
1:45   Dimensional Sizing – Tim Cummings, Carter-Day
2:30   Break
2:45   Specific Gravity Separation – Myles Mosely, LMC Manufacturing
3:15   Color Sorting – Don Uglow, Buhler Group
3:45   Importance of Seed Industry on Mitigating Global Food Insecurity – Danny Murphy, Farm Journal Foundation
4:15   Q & A Panel
5:00   Equipment Demonstration
6:00   Social / Dinner – Sponsored by LMC Manufacturing
       Prepared by MSU Collegiate Cattlemen

Wednesday, August 3, 2016

7:30   Doors Open
8:00   Seed Treatment – Chip Graham, Bayer CropScience
8:45   Standard Testing – Fabian Watts, Mississippi State Seed Testing Laboratory
9:30   Stress and Vigor Testing – Brent Turnipseed, South Dakota State University
10:15  Break
10:30  Seed Labeling – Fabian Watts, Mississippi State Seed Testing Laboratory
12:00  Lunch – Mr. Charlie’s Catering Service
1:00   Federal Seed Laws – Steve Malone, Seed Regulatory and Testing Division, USDA AMS
1:45   Seed Litigation/ Regulation – Matthew Grant/ Megan Galey, Husch Blackwell LLP
2:30   Break
2:45   Labeling Test – Ernie Flint, MSU Extension Service
3:15   Q&A Panel
4:00   Summary, Evaluation, Closing
Importance of Seed Industry on Mitigating Global Food Insecurity
Farm Journal Foundation is dedicated to sustaining agriculture’s ability to meet the vital needs of a growing population through education and empowerment.
Farmers Feeding the World: Farm Team Program

- Established in 2010
- Farmers themselves are the best messengers about need for the U.S. to support global ag development
- First lead farmer visits in March 2014
One in four children is stunted from malnutrition, limiting their physical and mental growth and locking them in poverty.

Stunting in children under 5, 2007-2011

Source: UN, data.un.org
State of global food security

- The UN’s FAO estimates 795 million food insecure people around the world
- Roughly half of those are smallholder farmers and their households
- By 2050, it is estimated that global food production will have to increase by at least 70 percent to feed the more than 9 billion people on the planet
Why should Americans care about global food security?

• Moral obligation
• Create new market opportunities
• National security
• Learning from each other
Feed the Future goals

• Help farmers produce more
• Help farmers get more food to market
• Support research & development to improve smallholder agriculture in a changing climate
• Strengthen regional trade
• Create a better policy environment
• Improve access to nutritious food and nutrition services
Authorization for global food security programs

• In July 2016, Congress passed and the President signed the Global Food Security Act, which provides permanent authority for the *Feed the Future* initiative.

• The initial legislation was introduced in both the House and the Senate in the fall of 2014, and then reintroduced at the beginning of the 114th Congress, in the spring of 2015.
THE BILL WILL:

– establish policy objectives for the legislation, including eradicating hunger and malnutrition, by assisting developing countries to increase agricultural productivity, income, and growth, and helping small-scale producers and women improve their skills and market linkages.

– authorize the President to develop a whole-of-government strategy to address global food insecurity and malnutrition, emphasizing the importance of leveraging resources and expertise from a range of stakeholders.

– require the Administration to improve upon existing monitoring and evaluation practices to ensure the effective use of U.S. taxpayer dollars.
Population growth forecasts

Billions

<table>
<thead>
<tr>
<th>Region</th>
<th>2015</th>
<th>2050</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>7.3</td>
<td>9.7</td>
<td>11.2</td>
</tr>
<tr>
<td>Africa</td>
<td>1.2</td>
<td>2.5</td>
<td>4.4</td>
</tr>
</tbody>
</table>

Source: UN population division forecasts
Global Cereal Yields
Metric tons per hectare, 1960-2014

- North America
- Europe
- South America
- Asia
- Sub-Saharan Africa
Increasing Ag Production

• Farmer Education
Increasing Ag Production

- Farmer Education
- Soil Fertility
Increasing Ag Production

- Farmer Education
- Soil Fertility
- Water
Increasing Ag Production

• Farmer Education
• Soil Fertility
• Water
• Seed
Structural impediments to an African seed industry

• Travel across borders is often slow and cumbersome

• Disparate national seed laws

• Corrupt or inefficient government subsidy structures
Getting started in the seed business

- Establishing a seed company has a high initial cost, requiring access to credit

- This is difficult in Sub-Saharan Africa, where affordable credit is often scarce, especially in rural areas

- The company also needs reliable research facilities and qualified human resources

- This requires access to trained pool of technicians and scientists
New companies often face problems in getting their seed to farmers.

**THEY INCLUDE:**
- Poor retail networks and sales points
- Lack of knowledge by sales agents about the seed products
- Lack of mobility for farmers and sales agents
- Lack of farmer trust in retail businesses
Where is the farmer demand for improved seed?

In some Sub-Saharan countries like Ghana, the adoption rate of improved seed is as low as 20 percent.

**MAJOR REASONS INCLUDE:**
- Lack funds or credit to afford to purchase
- Lack knowledge about the benefits
- Discouraged with past poor results with improved seed
- Easier to use saved seed than to travel long distances to buy improved seed
Africa’s Nascent Seed Industry

Most African smallholder farmers plant seeds saved from the previous year’s crop, meaning that access to improved seed varieties remains low.

But this trend is beginning to change: Kenya, for example, went from having:

- 31 registered seed companies in 2002
- 60 registered seed companies in 2007
- 104 registered seed companies in 2012

Africa’s $1.5 billion seed market is expected to double within the coming decade.

Source: AGRA and Bloomberg NEF
Air-Screen Cleaning
What is air-screen cleaning?

The removal of inert matter from desirable seed through the utilization of three operations: aspiration, sifting, and scalping.
Air-Screen Cleaning

**ASPIRATOR**

The ADVENT Cleaner utilizes the aspirator before the screening process to remove the bulk of light contaminants before they can interfere with the screening process.

**BALL TRAYS**

Screen blinding is prevented by using a self-cleaning system consisting of rubber balls and ball trays.

**SCREENING**

The first screening is normally a sifting process to remove the smallest reject particles.

After the initial sifting the product rides to the scalping area of the top deck. A draper curtain is used over the scalping screens to prevent the sticks, pods, or any oversized particles from standing on end and passing through with the good product.

After leaving the scalping screens, the product is gently discharged to the lower deck. The lower deck will precisely grade the product to any particular count and can be equipped with multiple discharges to satisfy production specifications.

All screens are mounted on tubular steel frames 24” wide and are easily handled.

**DECKS**

ADVENT Cleaners are typically configured with reverse flow decks to maximize screening precision. This design keeps the product in contact with the screens at all times.
Air-Screen Cleaning

**LMC Aspirator**

**EXPANSION CHAMBER**
Allows the reject product to drop out of the air stream. Liftings are conveniently discharged for inspection and, if needed, adjustment to the air stream can be made.

**AIR COLUMN**
Allows the product to be lifted and stratified for a more precise separation.

**OUTFALL HOPPER & AIRLOCK**
Allows the liftings to discharge with no air loss in the separation process.

**VARIABLE SPEED ROLL FEEDER (OPTIONAL)**
Enables the operator to easily and accurately adjust the flow to fit each individual situation.

**ADJUSTABLE IN-FEED**
Introduces the product into the air stream. The feed rate can be adjusted using a vibratory feeder option or slide pan option.
Setting the Cleaner

1. Set the air bleed valve on the aspirator column to the halfway position with the control cable.
2. Open the blast gate (main air valve) on top of the aspirator.
3. Move the roll feeder valve to the open position.
4. Start the airlock, fan, roll feeder or vibratory pan, and shaker. The airlock should always be started first and shut down last to prevent plugging.
5. Introduce product to the aspirator.
6. Adjust the pitch of the slide pan for a consistent feed.
7. Move the in-feed control gate down slightly above the product flow on the slide pan or vibratory pan.
8. Set the roll feeder VFD to the desired flow rate.
9. Adjust the roll feeder valve to allow the roll feeder to meter the flow.
10. Take samples from the airlock discharge.
11. Adjust the main air valve on the aspirator to achieve the desired separation.
**Air-Screen Cleaning**

**Setting the Cleaner**

12. Fine tune the separation with the control cable operating the air bleed valve on the column.

13. The shaker operates at a fixed rpm and does not require adjustments.

14. Monitor sifting and scalping discharges and change screen sizes accordingly.

15. One screen can be changed to manipulate the discharge percentages. It’s not always necessary to change every screen on a deck.

16. Use multiple hole size screens for scalping. Start with the smallest size and increase the size as the product moves down the deck. This will keep the product in contact with the screens longer for a more precise separation. Dropping the entire product flow through the first or second screen renders the remaining screen area of the deck useless.
## LMC Aspirator

### Model Specifications

<table>
<thead>
<tr>
<th>MODEL</th>
<th>AIRFLOW (cfm) at 2500 fpm</th>
<th>AIRFLOW (cfm) at 3000 fpm</th>
<th>AIRFLOW (cfm) at 3500 fpm</th>
<th>AIRFLOW (cfm) at 4000 fpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>246</td>
<td>2500</td>
<td>3000</td>
<td>3500</td>
<td>4000</td>
</tr>
<tr>
<td>366</td>
<td>3750</td>
<td>4500</td>
<td>5250</td>
<td>6000</td>
</tr>
<tr>
<td>486</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
<td>8000</td>
</tr>
<tr>
<td>488</td>
<td>6667</td>
<td>8000</td>
<td>9333</td>
<td>10667</td>
</tr>
<tr>
<td>604</td>
<td>4167</td>
<td>5000</td>
<td>5833</td>
<td>6776</td>
</tr>
<tr>
<td>606</td>
<td>6250</td>
<td>7500</td>
<td>8750</td>
<td>10000</td>
</tr>
<tr>
<td>608</td>
<td>8333</td>
<td>10000</td>
<td>11667</td>
<td>13333</td>
</tr>
<tr>
<td>724</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
<td>8000</td>
</tr>
<tr>
<td>726</td>
<td>7500</td>
<td>9000</td>
<td>10500</td>
<td>12000</td>
</tr>
<tr>
<td>728</td>
<td>10000</td>
<td>12000</td>
<td>14000</td>
<td>16000</td>
</tr>
<tr>
<td>846</td>
<td>8750</td>
<td>10500</td>
<td>12250</td>
<td>14000</td>
</tr>
</tbody>
</table>
Air-Screen Cleaning
Air-Screen Cleaning

ASPIRATOR REJECTS
Air-Screen Cleaning

Pre-Clean Aspirator Rejects

Air-Screen Cleaner Aspirator Rejects
Air-Screen Cleaning

Aspirator Rejects #1

Aspirator Rejects #2

Aspirator Rejects #3
Air-Screen Cleaning

Top Deck Sifts
Air-Screen Cleaning

Advent Top Deck Sifts
Air-Screen Cleaning

Top Deck Scalps
Air-Screen Cleaning

Advent Top Deck Scalps
Air-Screen Cleaning

# 2 Sifts
Air-Screen Cleaning

Advent Bottom Deck Sifts
Air-Screen Cleaning

# 3 Sifts
Air-Screen Cleaning

Advent Bottom Deck Final Sifts
Air-Screen Cleaning

Cleaned Seeds
Air-Screen Cleaning

Advent Cleaned Seeds
Air-Screen Cleaning

Style I Slot

Style II Slot

Herringbone

Round Hole
Air-Screen Cleaning

Screen Change Instructions

STEP 1. RELEASE ALL SCREEN CLAMPS

STEP 2. REMOVE HOLD-DOWN RAILS

STEP 3. UNCLAMP TO ALLOW PUSH BAR TO PIVOT & RELEASE SCREENS.

STEP 4. LIFT UP THE OVERLAPPING LIP OF 2ND SCREEN TO REMOVE. THEN REMOVE OTHER SCREENS.

STEP 5. REVERSE PROCESS AFTER INSTALLING NEW SCREENS AND ENSURE EVERYTHING IS TIGHT BEFORE RUNNING MACHINE.
Air-Screen Cleaning

Preventative Maintenance

1. Lubricate airlock and roll feeder shaft bearings according to manufacturer’s specifications.

2. Monitor airlock gearbox oil and change according to manufacturer’s specifications. Typically after 2,500 hours of operation.

3. Replace airlock wipers annually or as needed.

4. Relagg roll feeder drum annually or as needed.

5. Lubricate shaker eccentric and support bearings according to manufacturer’s specifications.

6. Check bearings for vibrations and set screws for tightness while machine is down for lubrication. Check eccentric rod jam nuts for tightness. Replace any bearings when necessary.

7. Check leg springs for cracks or breaks. Replace every 3 years.

8. Replace drive belts annually. Inspect sheaves.

9. Check screen hold-downs for tightness.

10. Visually inspect machine daily and listen for any unusual noises.
Air-Screen Cleaning

- Airlock Wipers
- Roll Feeder Shaft Bearing
- Roll Feeder Drum
Air-Screen Cleaning

Leg Springs & Hold-Down Rail Clamps

Eccentric Rods

Eccentric Bearing
Air-Screen Cleaning

Mobil Grease™

- FM222 Multipurpose grease for food processing equipment
- Unirex N Series lithium-complex bearing grease

SUMMIT®

- Syngear FG Series synthetic gear oil for food processing equipment
### Lubrication Guide

*Use a No. 2 Lithium complex base grease or equivalent*

<table>
<thead>
<tr>
<th>Hours Run per Day</th>
<th>1 to 250 RPM</th>
<th>251 to 500 RPM</th>
<th>501 to 750 RPM</th>
<th>751 to 1000 RPM</th>
<th>1001 to 1500 RPM</th>
<th>1501 to 2000 RPM</th>
<th>2001 to 2500 RPM</th>
<th>2501 to 3000 RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>10</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*For EZ-Kleen series bearings, use a polyurea base grease.*
Thank you for your time!

Air-Screen Cleaning
Agricultural Seeds
Optical Sorting.
An integral partner of the seed industry.

Bühler is a leading global supplier of optical sorting solutions to the food and non-food processing industries and has been at the forefront of optical sorting technology for over 65 years.

Bühler’s commitment to and substantial investment in R&D ensures that its advanced optical sorting technology produces excellent results in removing even the most challenging of seed defects and foreign material.

Flexible to handle small to large capacities, the innovative SORTEX A range is able to sort many varieties of agricultural seeds - field crops, vegetable and herbage seeds and many others.

Our product offering for seed sorting includes models that are available from one to five modules and offer customizable options tailored to customer needs.

**Why Bühler?**
- Maximizes germination and enhances the appearance in seed lots
- Improves product value and yield
- Delivers consistent performance and stability
- Increases productivity and lower operational costs

**Optical sorting solutions for:**

**Untreated Seeds**
*(Before Mechanical Grading)*

On certain applications, SORTEX optical sorting can be used before or instead of mechanical grading to maximize yield by reducing the loss of good seeds from mechanical processing.

**Untreated Seeds**
*(After Mechanical Grading)*

SORTEX optical sorting can also be used after mechanical grading to remove defects which have been missed or not targeted by the mechanical process, achieving a homogenous appearance and high germination level.

**Field crop seeds**

- **Corn (maize)**
- **Soya**
- **Wheat**
- **Rapeseed**
- **Paddy**
- **Sunflower**
Treated Seeds  
(After Coating)

Subject to treatment type and seed condition, SORTEX optical sorting can also be used after coating to remove partially coated seeds, refuge seeds from the ones that have been chemically treated and it also reduces the level of cross contamination (by color separation).

Batch Processing  
(Small capacities)

SORTEX optical sorting can also cater to smaller capacities as low as 100kg per hour for analysis. The sorters also require only a short time for mode change and clean down between seed types to facilitate the change of product for seed processors.
Increasing profitability through innovation.

Maximizing germination and enhancing appearance in seed lots
- SORTEX optical sorters help to improve the appearance in seed lots by ensuring the seed is homogeneous in size, shape and color
- The combination of Bühler’s advanced inspection system with PROfile™ (shape) and InGaAs technology ensure the selection of the highest quality seed and reduce cross contamination

Consistent and stable performance
- Consistent performance and a reliable operation with automatic calibration and Broadband LED lighting while maintaining a clean optical viewing area
- The Climate Control System maintains a constant temperature in the optical and control cabinets in the extreme ambient temperature ranges between 0°C - 50°C (32°F - 122°F)

Improving product value and yield
- The high precision ejection system minimizes false ejection of good seeds, delivering a highly-concentrated reject stream
- Careful handling of the seed also improves the overall levels of germination which increases product value
- Simultaneous re-sorting and reverse sorting capability allows extensive recovery of good product

Increased productivity and lower operational costs
- The SORTEX range can handle multiple capacities with its modular design. While a single module can be used to run small batch samples for lab analysis, as low as 10kg batches on vegetable seeds, a multi-module machine can handle up to 20 tons per hour throughput on corn seeds
- SORTEX optical sorters are designed to enable fast product changeovers for multi-product sorting for a minimum down-time across a range of seeds
- Remote monitoring with SORTEX Anyware to offer support across the globe
Technology leadership in seed sorting.

Damaged, diseased and discolored seeds can all reduce germination, whereas sticks, stones and cross contamination will affect product value. SORTEX technology significantly reduces these issues to maximize yield and profitability of good product.

<table>
<thead>
<tr>
<th>Accept</th>
<th>Reject</th>
</tr>
</thead>
</table>

**Soya**
SORTEX optical sorters can process high levels of contamination in soya seeds providing excellent yield and reduced waste. PROfile™ (shape) technology can separate oblong from round seeds.

**Sunflower**
Black, striped or white sunflower seeds can all be processed with high efficiency. The use of Bühler proprietary Enhanced InGaAs and PROfile™ technology ensures the removal of the most difficult defect types such as sclerotia.

**Corn (maize)**
Field corn, popcorn and sweet corn can all be processed with highly efficient defect removal and elimination of cross contamination from different corn varieties and other seeds.

**Carrot seeds**
High-resolution cameras allow the detection and removal of even the smallest size seeds. The open design of SORTEX optical sorters allows easy clean down and removes risk of cross contamination in batch processing.
SORTEX A.
Sophisticated optical sorters for seed sorting.

Available in four variants including the MultiVision™ and ColorVision™ inspection systems, the SORTEX A demonstrates a commitment to providing seed processors with dedicated customized options to handle unique and most challenging sorting requirements.

Showcasing Bühler innovation with new advanced inspection and lighting systems, this state-of-the-art technology provides the ultimate seed sorting solution, whatever the difficulty of the application.
Technical excellence and flexibility.

Process engineered with flexibility to handle small to large capacities, the SORTEX A range is available in one to five module versions, in three different frame sizes.

Empowering sorting performance
The SORTEX A range inspection technologies provide the most profitable sorting performance in removing subtle color variations and foreign material, reducing toxins including mycotoxin, and color grading/grouping.

The SmartEject™ system and simultaneous resorting capabilities ensure accurate product rejection and the highest reject concentration, thereby minimizing loss of good product.

Ensuring consistent reliable operation
Auto-calibration and product tracking features provide consistent product quality through their unique to Bühler ability to effortlessly handle both changes in input and product color variation.

Optimizing productivity, lowering cost of ownership
The SORTEX A range optimizes productivity with durable broadband LED lighting and long-life serviceable ejectors.

The auto-filter changer and different product modes handle multiple products, while the quick chute release system allows anyone to remove chutes without the need to re-align the optics, helping to facilitate different applications.

Multiple sorting capabilities
Customized configurations for primary, secondary and tertiary sorting.
Innovative technologies and customer care.

Inspection system with broadband LED lighting
Bühler’s high-resolution cameras are designed and built in-house to deliver the color registration needed to detect defects and foreign material. When combined with broadband LED lighting, Bühler optical sorters can target defects within the entire visible spectrum.

InGaAs technology
Enhanced InGaAs technology can detect defects which cannot be seen in the visible spectrum providing much better separation of good product from foreign material of the same color.

High speed ejectors
The Bühler ejectors are custom-designed and precision built for high speed, easy serviceability and long life. Through constant development, the ejector’s life span has been increased significantly. This efficiency of operation and maintenance enables the low cost of ownership of SORTEX sorters.

PROfile™ technology
PROfile™ (shape) technology distinguishes objects such as sticks, stones and other foreign material from a wide range of applications using shape characteristics.

SORTEX Customer Care.
SORTEX Total Care offers customers the opportunity to create their own service package, composed of individual service features, to best suit their needs. Customers can tailor their individual package from the following options:

- WearCare - Preventative Maintenance
- RepairCare - Emergency Repair
- EjectorCare - Ejector Service and Repair
- AnywareCare - Anyware Health Check and Alerts

SORTEX Spares Kits
For customers who require spare parts available on site, Bühler’s technologists have created appropriate spares kits for the different machinery available.

SORTEX Upgrade Kits
Customers seeking the latest technology available on their optical sorter - whether software or extra functionality - benefit from a range of upgrade kits available.

Visible camera    InGaAs camera

High speed serviceable ejectors

PROfile™ technology
Bühler inspection systems and options.

### Inspection systems

<table>
<thead>
<tr>
<th>System</th>
<th>Good Product</th>
<th>Visible Defect 1</th>
<th>Visible Defect 2</th>
<th>Visible Defect 3</th>
<th>Visible Defect 4</th>
<th>Visible Defect 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>MultiVision™</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ColorVision™</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DualVision™</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **MultiVision™**: Detects the subtlest color variation by using multiple visible wavelengths.
- **ColorVision™**: Detects light, dark and other color variations simultaneously by using up to two visible wavelengths.
- **DualVision™**: Detects both light and dark defects simultaneously by using two visible wavelengths independently.
- **Standard**: Detects either light or dark defects using one visible wavelength.

* Available for SORTEX A range only

### Product options

<table>
<thead>
<tr>
<th>Product Options</th>
<th>MultiVision™</th>
<th>MultiVision™ InGaAs</th>
<th>ColorVision™</th>
<th>ColorVision™ InGaAs</th>
<th>DualVision™</th>
<th>DualVision™ InGaAs</th>
<th>SORTEX A</th>
<th>SORTEX A InGaAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible Color Cameras</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard InGaAs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enhanced InGaAs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROfile™ Technology</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LED Lighting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IR Lighting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remote Access</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CE Certification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATEX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Standard: Included as standard feature
- Optional: Available as an optional feature

For the full feature list and product specifications contact your local representative.
Seed Tech 2016 – Short Course
Dimensional Sizing
Tim Cummings - Carter Day
Vice President – US Ag Equipment Sales
Dimensional Sizing Options

Length Grading
- Disc Machines & Uniflows

Width Grading
- Sizers
Length Grading - Equipment

- Disc Machine
- Uniflow
Length Grading – Uniflow Key Factors

The UniFlow Length Grader indented cylinder separator relies upon centrifugal force, the shorter material is lifted by indent pockets that line the inside surface of the cylinder.

Critical Performance Factors...

- Indent Diameter Size – Is bigger really better?
- Capacity – Product “kidney”
- Trough position
- Cylinder speed
- Retarders
- Cylinder Pocket Size & Wear
Length Grading - Disc Machine Key Factors

The Disc Separator consists of a series of discs mounted on a horizontal shaft. The discs, each with hundreds of undercut pockets, revolve through the mass of material, lifting the shorter material into a discharge trough at the front of the machine. While the disc blades convey the longer rejected material to the discharge at the end of the machine.

Critical Performance Factors...
- Capacity - Product “burden depth”
- Pocket Size & Wear
Width Grading - Equipment

- Sizer
Width Grading - Sizer

The Carter Day Precision Sizers have the performance efficiencies and capacities for virtually any sizing/separating requirement for seed corn, sunflower, barley, wheat, oats, rice, shelled peanuts, soybean, and most other free flowing granular material. The Modular Precision Sizers utilize four different styles of sizing cylinders with over 125 different size apertures. As the product enters the cylinders of a width Sizer, the rotating action presents the material in the most efficient manner to the close tolerance perforations to provide a precise separation.

Aperture (Perforation) Options...
- Round Hole Funnel
- Round Hole Ribbed
- Punched Slot
- Tri-Bar
Width Grading – Sizer Key Factors

Critical Performance Factors...

- Hole/Slot Size Tolerance
- Capacity – Product “burden depth”
- Velocity of incoming product
- Cylinder Speed (higher/lower rpms)
- Hole/Slot Cleanout during operation (“blinding”)
The Federal Seed Act & SRTD: Regulatory and Testing Activities

Steve Malone, Ph.D. CCA/CPAg

U.S. OECD Seed Schemes Program Manager
USDA, AMS, LPS, Seed Regulatory and Testing Division
Gastonia, NC
Est. 1895– Federal Seed Laboratory
- Purchase seed on the open market to test for mislabeling.
- Supply reliable seed to American farmers

Enacted 1939– Federal Seed Act
- Support the states in enforcing their seed laws
- Introduce minimum requirement for agricultural and vegetable seed sold in interstate commerce (business/legal certainty)
- Applies across State lines
The Federal Seed Act is a truth-in-labeling law that regulates agricultural and vegetable seed shipped in *interstate commerce*.

It is directed towards seed for seeding purposes that is used in the agricultural production of food, feed, fiber, and turf.

FSA does not regulate flower, tree, shrub, or seeds used primarily for re-vegetation purposes. Kinds listed in FSA that are sold as native or in native mixes are subject to FSA.
Purpose of the FSA

Promote the accurate labeling of seed thereby protecting seed customers

- Enforcement of seed laws
  - State
  - Federal
- Create a level playing field
  - Same rules for all companies
Enforces interstate commerce provisions of the Federal Seed Act.

Provides the U.S. seed industry with services that promote the truthful marketing of seed.

- Seed Service Testing (Agricultural Marketing Act 1946)
  - Unbiased User-fee Testing Services
  - Issue Federal Seed Analysis Certs and ISTA Orange Certs

Tests seed samples for purity, germination, noxious weed seeds, pathogens, and variety verifications.

- PCR-GMO detection
- Electrophoresis
- Seed Health Bioassays
- Greenhouse grow-outs
Services

Regulatory Agencies/Laboratories-

• No cost quality/validation checks for regulatory tests.
• Weed seed identifications.
• Conventional and advanced testing services for commercial samples.
• Training for seed analysts and samplers
• Assistance with building quality systems.
Services

Non-Government entities-

• No cost quality checks for regulatory tests when requested through your State regulatory agency.
• No cost weed seed identifications.
• No cost herbarium samples.
  • Online herbarium under construction.
• No/Low cost training for seed analysts
• Assistance with building quality systems
• Testing services for service samples.
• Process Verified Program accreditations
• Variety Name Clearance
Federal Seed Act
Enforcement

• Any citizen can submit an FSA labeling complaint

• Cooperative Agreements
  – AMS and State Departments of Agriculture
  – Interstate provisions

• Memorandum of Understanding
  – AMS and AOSCA
  – Certification standards and procedures
AMS Support Role/Responsibility:

--Provide Assistance to States

- Seed Inspector Training
- Authorize seed inspectors (QA)
- Federal Seed Schools
- Publications
- Informational and support resource
- Trueness-to-Variety Field Tests
- Quality assurance (test results, training, check test, ASL program)
Cooperative Agreements
AMS and State Departments of Agriculture

AMS Support Role/Responsibility:

--Promoting Uniformity

- Comparative proficiency testing for QA purposes
- USDA Process Verified Programs for Seed.
  - Encourages continual improvement of Quality Systems
  - Validation and recognition of testing competence for specific tests, measurements, and calibrations.
  - Ensures stakeholders and potential customers of the laboratories ability to meet minimum industry standards as verified by an unbiased source
- Effective marketing tool for testing programs
- A way for regulatory agencies to lead by example
Cooperative Agreements
AMS and State Departments of Agriculture

States Responsibility:
- Obtain & Test Official Samples
  - Submit sample
- Submit Documentation
  - Sampling Documentation (Inspectors Report)
  - Test Reports
  - Labeling Information
- Obtain Information From In-state Company
Cooperative Agreements
AMS and State Departments of Agriculture

AMS Responsibility:

- Investigate interstate shipments
  - Retest State sample (State can use Federal results for QA purposes)
    - In tolerance – proceed with investigation
    - Out of tolerance – address problem
  - Request & evaluate company records
    - Receiving, variety, processing/handling, lab tests, file sample, labeling, sales and shipping.
- Kept for 3 yrs.
Cooperative Agreements
AMS and State Departments of Agriculture

AMS Responsibility: Take Action

- No action
  - No interstate shipment
  - No interstate violation
- Warning letter
  - Technical violation
  - Minor violation
  - No record of other violations
- Charge sheets – describe the violation
  - Serious violations
  - Company has record of prior violations
AMS Responsibility: Take Action

- Charge sheets sent – company response (OPV)
- Penalty action – Debt Collection Act (DCA)
  - Assign $ value per charge – Company’s past history
  - Signed monetary settlement (US Treasury)
  - Information on Settlements released in SRTD Items of Interest Publications and USDA/AMS Web site.
Shippers perspective

During the OPV phase of FSA settlements:

- Shippers may request to meet with SRTD representatives to discuss charges issued by SRTD.

State Violations

- Shippers may also request that State regulators send interstate or intrastate violation samples to SRTD for 3rd party testing.
Seed Shipment Subject to FSA

Seed shipped in interstate commerce.

Does not include:

- seed shipped in intrastate commerce.
- imported seed until shipped in interstate commerce.
- seed shipped for export.
The term “label” means the display of written, printed, or graphic matter upon or attached to the container of seed (Sec 101.17).

The term “labeling” includes all labeling, and other written, printed, and graphic representations, in any form, accompanying and pertaining to any seed whether in bulk or in containers, and includes invoices (Sec 101.18).
FSA Agricultural Seed Labeling Requirements

- Kind name
- Variety name or Variety Not Stated
- % Pure Seed
- % Other crop
- % Weed seed
- % Inert matter
- % Germ. and Test Date
- Noxious weed seeds (name and rate)
- Origin
- Lot number
- Interstate shippers name and address or AMS #
- Inoculant expiration date
- Treatment (if treated)
Other Labeling Information

• Section 201.8 of FSA Regs. – The label may contain information in addition to that required by the FSA, provided such information is not misleading.
SRTD International Activities

• **International Seed Testing Association**
  • US Delegated Authority--Standardize procedures for sampling and testing seeds in global markets.

• **OECD Seed Schemes**
  • US Voting Member/ National Designated Authority-
  • Certify and label seed for varietal purity for international movement through cooperative agreements with state seed certifying agencies.
  • Help resolve seed shipment issues

• **US/Canada Seed Trade**
  • Administer the Canadian seed grader program

• **USDA Process Verified Programs**
  • Administer and audit for PVP seed programs
Questions or Comments
Gravity Separation

“Keeping It Simple”
Gravity Separation
What is gravity separation?

A process in which product is vertically stratified in a rising air column according to its specific density or mass.

Simultaneously, the layers of product are being separated horizontally by the eccentric action of the deck.
## Gravity Separation

<table>
<thead>
<tr>
<th>MODEL</th>
<th>SMALL SEED</th>
<th>MEDIUM SEED</th>
<th>LARGE SEED</th>
<th>ENERGY ECC</th>
<th>FAN</th>
<th>DUST HOOD CFM REQ.</th>
<th>HEIGHT</th>
<th>WIDTH</th>
<th>LENGTH</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>241</td>
<td>18 BU/HR</td>
<td>40 BU/HR</td>
<td>50 BU/HR</td>
<td>3 HP</td>
<td></td>
<td>2,200</td>
<td>54 1/4&quot;</td>
<td>48 1/2&quot;</td>
<td>91&quot;</td>
<td>1650 LBS.</td>
</tr>
<tr>
<td>401</td>
<td>55 BU/HR</td>
<td>128 BU/HR</td>
<td>160 BU/HR</td>
<td>5 HP</td>
<td></td>
<td>3,000</td>
<td>58 1/2&quot;</td>
<td>64 1/4&quot;</td>
<td>116 1/4&quot;</td>
<td>2350 LBS.</td>
</tr>
<tr>
<td>641</td>
<td>85 BU/HR</td>
<td>200 BU/HR</td>
<td>250 BU/HR</td>
<td>10 HP</td>
<td></td>
<td>6,500</td>
<td>65 1/4&quot;</td>
<td>78 1/2&quot;</td>
<td>131 1/4&quot;</td>
<td>3550 LBS.</td>
</tr>
<tr>
<td>642</td>
<td>100 BU/HR</td>
<td>240 BU/HR</td>
<td>300 BU/HR</td>
<td>15 HP</td>
<td></td>
<td>8,500</td>
<td>65 1/4&quot;</td>
<td>78 1/2&quot;</td>
<td>146 1/4&quot;</td>
<td>3990 LBS.</td>
</tr>
<tr>
<td>681</td>
<td>170 BU/HR</td>
<td>400 BU/HR</td>
<td>500 BU/HR</td>
<td>2 HP 20 HP</td>
<td></td>
<td>12,000</td>
<td>69 1/2&quot;</td>
<td>97 3/4&quot;</td>
<td>173 1/4&quot;</td>
<td>6000 LBS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MARC MODEL</th>
<th>SMALL SEED</th>
<th>MEDIUM SEED</th>
<th>LARGE SEED</th>
<th>ENERGY ECC</th>
<th>FAN</th>
<th>DUST HOOD CFM REQ.</th>
<th>HEIGHT</th>
<th>WIDTH</th>
<th>LENGTH</th>
<th>WEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>55 BU/HR</td>
<td>128 BU/HR</td>
<td>160 BU/HR</td>
<td>2 HP 5 HP</td>
<td></td>
<td>8,000</td>
<td>81 3/4&quot;</td>
<td>63 1/2&quot;</td>
<td>80&quot;</td>
<td>3800 LBS.</td>
</tr>
<tr>
<td>300</td>
<td>85 BU/HR</td>
<td>200 BU/HR</td>
<td>250 BU/HR</td>
<td>3 HP 7.5 HP</td>
<td></td>
<td>10,000</td>
<td>81 3/4&quot;</td>
<td>68&quot;</td>
<td>85 11/16&quot;</td>
<td>4600 LBS.</td>
</tr>
<tr>
<td>400</td>
<td>102 BU/HR</td>
<td>240 BU/HR</td>
<td>335 BU/HR</td>
<td>3 HP 10 HP</td>
<td></td>
<td>14,000</td>
<td>82 1/4&quot;</td>
<td>68&quot;</td>
<td>104&quot;</td>
<td>5550 LBS.</td>
</tr>
<tr>
<td>500</td>
<td>170 BU/HR</td>
<td>400 BU/HR</td>
<td>500 BU/HR</td>
<td>3 HP 15 HP</td>
<td></td>
<td>17,000</td>
<td>82 1/2&quot;</td>
<td>80&quot;</td>
<td>128&quot;</td>
<td>7050 LBS.</td>
</tr>
</tbody>
</table>
Gravity Separation
The Three Basic Rules of Gravity Separation

1. Particles that have the **SAME SPECIFIC GRAVITY** but **DIFFER IN SIZE** **WILL** be graded according to the size of the particles.

2. Particles that **DIFFER IN BOTH SPECIFIC GRAVITY** and **SIZE** **CANNOT** be separated as well by a gravity table. Always pre-size prior to the gravity.

3. Particles of the **SAME SIZE** but **DIFFER IN SPECIFIC GRAVITY** **CAN** be separated.
The Six Major Adjustments

1. **Deck Height**
2. Product in-feed rate
3. Eccentric speed
4. Air control
5. Discharge rate
6. Bed depth
Gravity Separation
Gravity Separation

The Six Major Adjustments

1. Deck Height
2. **Product in-feed rate**
3. Eccentric speed
4. Air control
5. Discharge rate
6. Bed depth
Gravity Separation
Gravity Separation

The Six Major Adjustments

1. Deck Height
2. Product in-feed rate
3. Eccentric speed
4. Air control
5. Discharge rate
6. Bed depth
Gravity Separation
Gravity Separation

No Air

Proper Air

Too Much Air

Lights

Heavies
Marc Series Gravity Deck Pattern
(Plan View)
Gravity Separation

The Six Major Adjustments

1. Deck Height
2. Product in-feed rate
3. Eccentric speed
4. Air control
5. **Discharge rate**
6. Bed depth
Gravity Separation

The Six Major Adjustments

1. Deck Height
2. Product in-feed rate
3. Eccentric speed
4. Air control
5. Discharge rate
6. Bed depth
Gravity Separation
Three Common Problems with Gravity Separators

1. Inexperienced or improperly trained operators

2. Lack of consistently sized product

3. Exceeding the recommended capacity
Gravity Separation
Preventative Maintenance

1. Clean deck screen daily with compressed air.
2. Remove and pressure wash deck insert every 2-3 weeks.
3. Clean filter doors as needed.
4. Lubricate eccentric and support bearings according to manufacturer’s specifications.
5. Check deck cap clamps for tightness.
6. Check bearings for vibrations and set screws for tightness while machine is down for lubrication. Check eccentric rod jam nuts for tightness. Replace any bearings when necessary.
7. Lubricate rod ends on automatic discharge gate with spray lubricant.
8. Replace worn rippled screens as needed.
9. Check leg springs for cracks or breaks. Replace every 3 years.
10. Check interior and exterior curtains. Replace as needed.
12. Monitor rear deck pivot shaft and bearings. Listen for unusual noises.
   a. Misalignment of deck
   b. Breaking or cracking leg springs
   c. Breaking or malfunctioning deck lift
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation
Gravity Separation

- FM222 Multipurpose grease for food processing equipment
- Unirex N Series lithium-complex bearing grease
## Gravity Separation

### Lubrication Guide

**Use a No. 2 Lithium complex base grease or equivalent**

<table>
<thead>
<tr>
<th>Hours Run per Day</th>
<th>Suggested Lubrication Period in Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 to 250 RPM</td>
</tr>
<tr>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>24</td>
<td>10</td>
</tr>
</tbody>
</table>

*For EZ-Kleen series bearings, use a polyurea base grease.*
Gravity Separation
Gravity Separation

Thank you for your time!
Crop Seed Production/Sale Chain:

- Trait/Genetics Development and/or Licensing
- Inventory Production (production growers)
- Seed Testing, Packaging and Labeling
- Seed Distribution via Dealers
- Seed Planting, Harvesting and Grain Delivery
Crop Seed Production/Sale Chain (cont’d):

- Possibility of disputes and litigation loom at every step!
Trait/Genetics Development and/or Licensing

Does the crop seed contain Intellectual Property (IP)?

If so, what kind(s)?
- Section 101 Utility Patents
- Section 161 Plant Patents
- Plant Variety Protection Act
Trait/Genetics Development and/or Licensing (cont’d)

- If traits/genetics are licensed, who is the licensor?
  - Does the licensor actually have the rights purportedly granted to you?
    - institution example

- If you are a licensee, do you have the right to use and sell and/or sublicense?
  - What are your obligations as a licensee?
Trait/Genetics Development and/or Licensing (cont’d)

License language is critical:
- Exclusive license vs. non-exclusive license
- Geographically limited license?
- What rights are granted to the licensee?
  - “Make” (e.g., grow seed for sale)
  - “Make” (e.g., grow seed as bulk-up/production seed)
  - “Have made”?
    - Is the licensee authorized to use its own production growers?
      - Be clear to avoid disputes later!
      - Any qualifications or terms required to be included in production grower contracts?
      - What controls are in place to protect your IP
      - QA/QC? Right to inspect and audit?
Inventory Production (production growers)

Contracts are in good shape, what could go wrong?

- Production Grower foreclosure
  - Bank likely has a first, blanket lien on all assets
  - Are the crops the bank’s collateral or your inventory?
    - What about your right to purchase the harvest?

- Production Grower bankruptcy filing
  - Are the crops an asset of the bankruptcy estate or your inventory subject to IP rights?
    - IP rights vs. U.S. Bankruptcy Code, which wins?
Seed Testing, Packaging and Labeling

- What regulations apply and what labeling is recommended v. mandatory?

Stay Tuned……..
License language is critical (cont’d):

- Labeling to provide notice of IP?
- What language must be used?
  - Bags? Bulk?
- What is listed?
  - Non-expired Patent/PVPA Number(s)
  - Website address
  - All patent numbers applicable to the seed?
  - Corn hybrid scenario

Is the solution to list all of my Patent/PVP numbers?
Seed Distribution via Dealers

- Are your dealers purchasing for resale?
  - Dealer foreclosure/bankruptcy:
    - Can your seed be auctioned to the highest bidder regardless of license status?
    - What if it is treated seed from a prior year (low germ)?
      - Can’t go to the elevator…where does it go?

- Are your dealers acting as an agent and holding possession of your seed (bailment)?
  - Have you filed anything (UCC-1) to put bank on notice that inventory is your asset [bailment] and not that of the dealer?
Seed Distribution via Dealers (cont’d)

- What do your dealer contracts include?

- If licensed trait/genetics, what must they include?
  - What dealers can be used?
  - Can the licensee sublicense and set up its own distribution network?

- What should the dealer contracts address?
  - Dealer obligated to understand stewardship requirements?
  - Dealer obligated to educate its customers?
  - Dealer obligated to report misuse/infringement?
Seed Planting, Harvesting and Grain Delivery

- I’ve done everything right and I’ve sold the seed, no more concerns, right?
  - Crop performance issues?
    - Is arbitration available/mandatory? Did you address on label?
  - What have you done to ensure proper stewardship?
  - What have you done to avoid/deter infringement?
Seed Planting, Harvesting and Grain Delivery (cont’d)

- If education/deterrence fails, should I address infringement?
  - Yes? What are your expectations on cost/recovery?
    - Do you have a comprehensive infringement program?
    - Does it fall under the supervision of an in-house or outside lawyer?
  - No? You might waive the right to enforce later.
# Our Members

## FULL MEMBERS

- AIB
- AgReliant
- AOSC A
- American Takii
- California Seed Assoc.
- CPTA
- Cold Spring Harbor Labs
- Cochrane Freund & Young
- South Dakota AgriBu
- AMSA C
- Illinois Seed Trade Association
- NYS Agribu s. Assoc.

## MEMBERS

- Ahern Seeds
- AIB
- AgReliant
- AOSC A
- American Takii
- California Seed Assoc.
- CPTA
- Cold Spring Harbor Labs
- Cochrane Freund & Young
- South Dakota AgriBu
- AMSA C
- Illinois Seed Trade Association
- NYS Agribu s. Assoc.

- Germain Seeds
- Holiday Seeds
- Husch Blackwell
- Incotec
- Kansas Wheat Alliance
- Keithly Williams Seeds
- IPSA
- Morris on Foerst er
- Oregon Seed Assc
- Wyo AgriBu s
- Eurofin s STA Labs
- Faegre Baker Daniel s
- Barnes & Thorneburg

- Swanson and Bratschun
- Thompson Coburn
- Tozier Seeds
- University of Missouri
- Becks Hybridd
- Cott
- Shelston IP
- Cooley LLP
- Shamrock Seeds
- All-America Sectio ns
- Nebraska AgriBu si. Assoc.
- Ohio AgriBu si. Assoc.
- Missouri Seeds men
Current Value Add to Member Companies

SIPA Resources:

1. Educational materials on the SIPA Website seedipalliance.com
2. SIPA IP Readiness Checklist
3. SIPA tip line: 1-844-Seed-Tip
4. Event schedules
5. Brochures and electronic materials on the value of innovation
6. Presentations from previous educational units
7. SIPA Logo and SIPA Tip Line logo with usage guidelines
8. Answers to frequently asked questions about IP
Seed Labeling and Testing

- General Requirements
- Variety
- Mixtures
- Test Date Labeling
- Arbitration
- Treated Seed
General Labeling Requirements

**Identification**
- Name & address of seller
- Kind and/or variety name
- Lot number
- Origin
- Treated seed info

**Contamination**
- Pure seed %
- Other crop seed %
- Inert matter %
- Weed seed %
- Noxious weed seeds

**Viability**
- Germination %
- Hard seed %
- Germination test date
Seed Labeling: Variety

- **Federal:** Label must include the variety name or "Variety Not Stated" for the kinds of agricultural seeds listed.

- A few states do not allow the use “Variety Not Stated,” but one of them allows the variety to be left blank.

- Some states allow the use of “VNS” in addition to “Variety Not Stated.”

- A few states have expressly identified kinds of agricultural seeds which must be identified as to variety, but others have taken broader approaches or provide limited exceptions to a general requirement to identify variety. For example:
  - Ala. requires variety identification “for crops for which commercial varieties have been developed.”
  - Conn. requires the variety name if known.
  - Ga. provides an exception for mixed cowpeas or southernpeas.
  - In La., wheat and oat seeds may be labeled “Variety Not Stated.”
Seed Labeling: Mixtures

- **Federal Seed Act:** Mixtures of kinds or blends of varieties may be assigned a mixture or blend name. A variety name cannot be used as a name of a mixture or blend, even if the variety is a component of the mixture or blend. Labeling of mixtures and blends must not create the impression that the seed is a single variety. 7 C.F.R. § 201.36b.

- Several states require “mixture” or “mixed” to be stated conspicuously on a seed label.

- Ill. requires the use of “mixture” or “mixed,” but a blend of two or more varieties of a kind may be sold as a blend mixture with a label that states the kind name followed by “Varieties Not Stated” if the seed may be labeled as “hybrid.”

- In Va., seed mixtures may be sold by kind name alone provided the seed is not for production of agricultural crop and the label clearly states "NOT FOR AGRICULTURAL PRODUCTION."
Seed Labeling: Test Date

- **Federal Seed Act:** “No more than 5 calendar months shall have elapsed between the last day of the month in which the germination test was completed and the date of transportation in interstate commerce.”

- Many states require seed to be sold within or less than 9 months, excluding the month of testing.
  - La. includes the month of testing in the 9-month period.

- N.Y. requires seeds to be sold during the “calendar year” the seed was tested.

- A few states provide one time limit for seeds intended for wholesale and another for those intended for retail purposes.

- A few states provide shorter or longer time frames – ranging from 7 to 15 months.
Seed Labeling: Arbitration

• Some states have mandatory arbitration, and some have optional arbitration. Others do not have arbitration programs.

• In other states, the use of an arbitration labeling statement is optional, but for different reasons.
  • Ill. versus Ind., for example.

• Some states require a notice of arbitration to be on the label or attached to or printed on the seed package.
  • A few states have suggested or mandatory language.

• Example – Washington:
Seed Labeling: Treated Seed

• Federal Requirements
  • The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) – EPA
    • Treated article exemption
  • The Federal Food, Drug & Cosmetic Act – EPA & FDA
  • The Federal Seed Act – USDA

• State Requirements
  • Tend to track the FSA, but there are variations:
    • Size of font, color of font, precise wording of warning, etc.
Questions?

Matt.Grant@HuschBlackwell.com
Megan.Galey@HuschBlackwell.com
According to the Mississippi Pure Seed Law, which of the following should be on the label…
1. Agricultural Seed or Vegetable Seed?

NO

Type of seed does not have to be stated on label
2. Kind and Variety?

YES

In excess of five (5) percent of the whole
3. Brand?

No

Only if it is misleading as to variety
4. Hybrid?

NO

Hybrids shall be labeled with the name and/or number by which the hybrid is commonly designated.
5. Name and number per pound of each kind of prohibited noxious weed seed?

NO

Prohibited noxious weeds are not allowed in any amount
6. Lot Number?

YES

You must have some sort of designation system to track the lot
7. Origin?

**YES**

Seed must be labeled with place of production
8. Percentage by weight of inert matter?

YES
9. Germination percentage?

YES
10. Abnormal seed percentage? NO
11. Other crop seed percentage?

YES
12. Calendar month and year the test was completed to determine such percentages

YES
13. Net weight

Yes

Some seed are sold by seed count but this is not required to be on the label, if seed are labeled with seed count then this falls under “truth in labeling” and the seed count must fall within tolerances or a Stop Sale may occur.
14. T/F: When more than one kind or variety are required to be named, the word “mixture” or the word “mixed” shall be shown on the label?

TRUE

When more than one kind or variety exceeds 5%
15. T/F: If varieties have been blended which were grown in different years the word “blended” shall be shown on the label?

FALSE

Upon request, records shall be made available to the purchaser of such lots to show year of production and blending components.
16. T/F: Varietal mixtures of southern peas, oats and wheat may be sold when the label includes the words “variety not stated” or “VNS”? 

TRUE

Label must state “Mixed Southern Peas,” “Mixed Oats,” or “Mixed Wheat.”
17. T/F: No seed shall be sold in Mississippi which contains more than 1 percent by weight of weed seed including noxious weed seed?

TRUE

More than 1 % of weed seed is prohibited in any seed being sold in MS
18. T/F: No agricultural seed shall be sold in Mississippi unless the combined germination, hard seed and/or firm seed is at least 50% of the total?

False

The combined germination, hard seed and/or firm seed must be at least 60%
19. T/F: No seed shall be sold within Mississippi when a period of more than eight (8) calendar months has elapsed, exclusive of the calendar month in which the test was complete.

False

A period of more than nine (9) calendar months
20. T/F: Every seedsman, before selling seed in Mississippi, must secure an annual permit to engage in such business?

True

Permits must be purchased or renewed annually.
21. T/F: If you sell seed only in the State of MS, are you liable if that seed is shipped by someone else into another State?

True

If your name is on the label you are responsible for the information on the tag regardless of what State it is in.
Mississippi Pure Seed Law Labeling Requirements
Every seedsman, before selling seed in Mississippi, must secure an annual permit to engage in such business.

Permits must be purchased or renewed annually.
According to the Mississippi Pure Seed Law, the following should be on the label.
Kind and Variety
When more than one kind or variety exceeds 5%, the word “mixture” or the word “mixed” shall be shown on the label.
Exception

Varietal mixtures of southern peas, oats and wheat may be sold by labeling such mixtures as “Mixed Southern Peas,” “Mixed Oats,” or “Mixed Wheat.”

Such varietal mixtures may also be sold when the foregoing labeling includes the words “variety not stated” or “VNS.”
“Lot of seed” means a definite quantity of seed identified by a lot number or other identification mark, every portion or bag of which is uniform for the factors which appear on the label, within permitted tolerances.
Net weight

Some seed are sold by seed count but this is not required to be on the label, if seed are labeled with seed count then this falls under “truth in labeling” and the seed count must fall within tolerances or a Stop Sale may occur.
Origin

Seed must be labeled with place of production
Percentage by weight of all weed seed, including noxious weed seed.
No seed shall be sold, exposed for sale, or offered for sale in Mississippi which contain more than 1 percent by weight of weed seed including noxious weed seed.
Percentage by weight of Inert matter
Percentage by weight of other Crop Seed
Percentage of Germination, exclusive of hard seed or firm (dormant) seed
Percentage of hard seed, if present
Percentage of firm (dormant) ungerminated seed, if present
No agricultural seed shall be sold in Mississippi unless the combined germination, hard seed and/or firm seed is at least 60% of the total.
The calendar month and year the test was completed to determine such percentages.
No seed shall be sold, exposed for sale, or offered for sale within this state when a period of more than nine (9) calendar months has elapsed, exclusive of the calendar month in which the test was completed, between the germination test date and the time the seed are offered or exposed for sale, except for seed in hermetically sealed containers.
The name and number per pound of each kind of restricted noxious weed seed
The name and address, or the registered code number, of the person who labeled the seed, or who sells, offers or exposes the seed for sale within this state
Label

Big Creek Seeds
PO Box 222
Highland, TX 22310
Lot # A351

Kind and Variety Wheat
PR1520

Pure Seed -------- 99.00% Germ. ------ 85%
Inert -------------- 0.50%
Weed Seed -------- 0.50% Tested – March 2016
Other Crop -------- 0.00%
Noxious Weed Seed NONE Origin – TX
Net Wt. 60lbs.
Kind and Variety
Big Creek Seeds
PO Box 222
Highland, TX 22310

Kind and Variety
Wheat
PR1520

Lot # A351

Pure Seed-----------99.00%  Germ. ------85%
Inert ------------- 0.50%
Weed Seed ------- 0.50%  Tested – March 2014
Other Crop ------- 0.00%
Noxious Weed Seed NONE  Origin – TX

Net Wt. 60lbs.
Lot Number
Big Creek Seeds
PO Box 222
Highland, TX 22310

Kind and Variety: Wheat, PR1520

Pure Seed: 99.00%
Inert: 0.50%
Weed Seed: 0.50%
Other Crop: 0.00%
Noxious Weed Seed: NONE

Germ.: 85%
Tested: March 2016
Origin: TX
Net Wt.: 60lbs.
Net weight
Big Creek Seeds
PO Box 222
Highland, TX 22310

Lot # A351

Kind and Variety
Wheat
PR1520

Pure Seed--------99.00%
Germ. -------85%

Inert --------------- 0.50%

Weed Seed ------ 0.50%
Tested – March 2016

Other Crop ------- 0.00%

Noxious Weed Seed  NONE
Origin – TX

Net Wt. 60lbs.
Origin

Seed must be labeled with place of production
Big Creek Seeds
PO Box 222
Highland, TX 22310
Lot # A351

Kind and Variety
Wheat PR1520

Pure Seed---------99.00%
Germ. -------85%

Inert --------------- 0.50%

Weed Seed ------- 0.50%
Tested – March 2016

Other Crop ------- 0.00%

Noxious Weed Seed NONE
Origin – TX

Net Wt. 60lbs.
Percentage by weight of all weed seed, including noxious weed seed
Big Creek Seeds
PO Box 222
Highland, TX 22310

Lot # A351

Kind and Variety
Wheat
PR1520

Pure Seed--------99.00%
Germ. ------85%

Inert --------------- 0.50%

Weed Seed ------- 0.50%
Tested – March 2016

Other Crop ------- 0.00%

Weed seed %

Noxious Weed Seed NONE Origin – TX

Net Wt. 60lbs.
Percentage by weight of Inert matter
<table>
<thead>
<tr>
<th>Kind and Variety</th>
<th>Wheat</th>
<th>PR1520</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Seed</td>
<td>99.00%</td>
<td></td>
</tr>
<tr>
<td>Germ.</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Inert</td>
<td>0.50%</td>
<td></td>
</tr>
<tr>
<td>Weed Seed</td>
<td>0.50%</td>
<td>Tested – March 2016</td>
</tr>
<tr>
<td>Other Crop</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Noxious Weed Seed</td>
<td>NONE</td>
<td>Origin – TX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Net Wt. 60lbs.</td>
</tr>
</tbody>
</table>
Percentage by weight of other Crop Seed
<table>
<thead>
<tr>
<th>Label</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Creek Seeds</td>
<td>Lot # A351</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PO Box 222</td>
<td></td>
<td>Highland, TX 22310</td>
<td></td>
</tr>
<tr>
<td>Kind and Variety</td>
<td>Wheat</td>
<td>PR1520</td>
<td></td>
</tr>
<tr>
<td>Pure Seed</td>
<td>----</td>
<td>99.00%</td>
<td></td>
</tr>
<tr>
<td>Germ.</td>
<td>----</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Inert</td>
<td>----</td>
<td>0.50%</td>
<td></td>
</tr>
<tr>
<td>Weed Seed</td>
<td>----</td>
<td>0.50%</td>
<td></td>
</tr>
<tr>
<td>Tested</td>
<td></td>
<td>Tested – March 2016</td>
<td></td>
</tr>
<tr>
<td>Other Crop</td>
<td>----</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Noxious Weed Seed</td>
<td>NONE</td>
<td>Origin – TX</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Net Wt. 60lbs.</td>
<td></td>
</tr>
</tbody>
</table>
Percentage of Germination, exclusive of hard seed or firm (dormant) seed
Label

Big Creek Seeds
PO Box 222
Highland, TX 22310
Lot # A351

Kind and Variety
Wheat
PR1520

Pure Seed--------99.00%
Inert -------------- 0.50%
Weed Seed ------ 0.50%
Other Crop ------ 0.00%
Noxious Weed Seed  NONE

Germ. --------85%
Tested – March 2016
Origin – TX
Net Wt. 60lbs.
Percentage of hard seed, if present
Big Creek Seeds
PO Box 222
Highland, TX 22310

Kind and Variety: Wheat PR1520

Pure Seed: 99.00%
Inert: 0.50%
Weed Seed: 0.50%
Other Crop: 0.00%
Noxious Weed Seed: NONE

No hard seed declared

Germ.: 85%

Tested – March 2016
Origin – TX
Net Wt. 60lbs.
Percentage of firm (dormant) ungerminated seed, if present
Big Creek Seeds
PO Box 222
Highland, TX 22310

Lot # A351

Kind and Variety
Wheat PR1520

Pure Seed--------99.00% Germ. ------85%
Inert -------------- 0.50%
Weed Seed ------ 0.50% Tested – March 2016
Other Crop ------ 0.00%
Noxious Weed Seed NONE Origin – TX

Net Wt. 60lbs.
No Dormant seed declared
The calendar month and year the test was completed to determine such percentages
Big Creek Seeds
PO Box 222
Lot # A351
Highland, TX 22310

Kind and Variety: Wheat, PR1520

- Pure Seed: 99.00%
- Germ.: 85%
- Inert: 0.50%
- Weed Seed: 0.50%
- Other Crop: 0.00%
- Noxious Weed Seed: NONE

Tested: March 2016
Origin: TX
Net Wt.: 60lbs.
The name and number per pound of each kind of restricted noxious weed seed
Big Creek Seeds
PO Box 222
Highland, TX 22310
Lot # A351

Kind and Variety
Wheat PR1520

Pure Seed 99.00%
Germ. 85%

Inert 0.50%

Weed Seed 0.50%
Tested – March 2016

Other Crop 0.00%

Noxious Weed Seed NONE

Net Wt. 60lbs.

Origin – TX
The name and address, or the registered code number, of the person who labeled the seed, or who sells, offers or exposes the seed for sale within this state.
Big Creek Seeds
PO Box 222
Highland, TX 22310

Kind and Variety: Wheat PR1520

Pure Seed: 99.00%
Germ.: 85%
Inert: 0.50%
Weed Seed: 0.50%
Tested: March 2016
Other Crop: 0.00%
Noxious Weed Seed: NONE

Origin: TX
Net Wt.: 60lbs.
<table>
<thead>
<tr>
<th></th>
<th>Wheat</th>
<th>PR1520</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure Seed</td>
<td>99.00%</td>
<td>Germ. 85%</td>
</tr>
<tr>
<td>Inert</td>
<td>0.50%</td>
<td></td>
</tr>
<tr>
<td>Weed Seed</td>
<td>0.50%</td>
<td>Tested – March 2016</td>
</tr>
<tr>
<td>Other Crop</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Noxious Weed Seed</td>
<td>NONE</td>
<td>Origin – TX</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Net Wt. 60lbs.</td>
</tr>
</tbody>
</table>
Big Creek Seeds
PO Box 222
Highland, TX 22310

Kind and Variety
Wheat
PR1520

Pure Seed %
99.00%

Inert %
0.50%

Weed seed %
0.50%

Other crop %
0.00%

Noxious Weed Seed
NONE

Germ. %
85%

Tested – March 2016

Origin – TX
Net Wt. 60lbs.
A statement in no less than eight (8) point type indicating that the seed has been treated.
Treated Seed

The commonly accepted coined, chemical or abbreviated chemical name used in such treatment in type no smaller than eight (8) points.
A caution statement if the substance used in such treatment in the amount remaining with the seed is harmful to humans or other vertebrate animals, as follows:
Seed treated with a mercurial or similarly toxic substance, if any amount remains with the seed, shall be labeled to show a statement such as “Poison,” Poison Treated,” or “Treated with Poison.”

The word “Poison” shall be in red letters on a distinctly contrasting background.

In addition, the label shall show a representation of a skull and crossbones at least the size of the type used for the name of the substance and the statement indicating that the seed has been treated.
Seed treated with other harmful substances (other than mercurials or similarly toxic substances), if the amount remaining with the seed is harmful to humans or other vertebrate animals, shall be labeled to show a caution statement, in type no smaller than eight (8) points, such as “Do not use for food, feed or oil.”
Additional information may be on the label as long as it is not misleading.

Example: Brand Name
Not misleading
Brand -------High Yield      Variety -------PR1520

Misleading
Variety -------High Yield PR1520
QUESTIONS?
Pre-Cleaning
Pre-Cleaning
What is pre-cleaning?

The removal of inert matter from desirable seed prior to drying, storage, and conventional seed cleaning.
Methods of pre-cleaning:

- Aspiration
- Screening
Pre-Cleaning

Advantages of pre-cleaning:

- Increase aeration
- Increase bulk storage space
- Increase capacity of conventional cleaning line
- Increase seed quality
- Increase cleanliness of processing facility
- Decrease down-time
- Decrease contamination
- Decrease insect damage
- Decrease drying costs
Pre-Cleaning

**LMC Aspirator**

**EXPANSION CHAMBER**
Allows the reject product to drop out of the air stream. Liftings are conveniently discharged for inspection and, if needed, adjustment to the air stream can be made.

**AIR COLUMN**
Allows the product to be lifted and stratified for a more precise separation.

**VARIABLE SPEED ROLL FEEDER (OPTIONAL)**
Enables the operator to easily and accurately adjust the flow to fit each individual situation.

**OUTFALL HOPPER & AIRLOCK**
Allows the liftings to discharge with no air loss in the separation process.

**ADJUSTABLE IN-FEED**
Introduces the product into the air stream. The feed rate can be adjusted using a vibratory feeder option or slide pan option.
Pre-Cleaning

Setting the Aspirator

1. Set the air bleed valve on the aspirator column to the halfway position with the control cable.
2. Open the blast gate (main air valve) on top of the aspirator.
3. Move the roll feeder valve to the open position.
4. Start the airlock, fan, and roll feeder or vibratory pan. The airlock should always be started first and shut down last to prevent plugging.
5. Introduce product to the aspirator.
6. Adjust the pitch of the slide pan for a consistent feed.
7. Move the in-feed control gate down slightly above the product flow on the slide pan or vibratory pan.
8. Set the roll feeder VFD to the desired flow rate.
9. Adjust the roll feeder valve to allow the roll feeder to meter the flow.
10. Take samples from the airlock discharge.
11. Adjust the main air valve on the aspirator to achieve the desired separation.
12. Fine tune the separation with the control cable operating the air bleed valve on the column.
Pre-Cleaning

DUST / LIFTINGS FLOW

PRODUCT FLOW

TRASH / REJECT FLOW

AIR FLOW
Pre-Cleaning

#1 Accepts

#1 Rejects
Pre-Cleaning

#2 Accepts

#2 Rejects
Pre-Cleaning

#3 Accepts

#3 Rejects
Pre-Cleaning

Pre-Clean Aspirator Rejects #1

Pre-Clean Aspirator Rejects #2

Pre-Clean Aspirator Rejects #3
## LMC Aspirator Model Specifications

<table>
<thead>
<tr>
<th>MODEL</th>
<th>AIRFLOW (cfm) at 2500 fpm</th>
<th>AIRFLOW (cfm) at 3000 fpm</th>
<th>AIRFLOW (cfm) at 3500 fpm</th>
<th>AIRFLOW (cfm) at 4000 fpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>486</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
<td>8000</td>
</tr>
<tr>
<td>488</td>
<td>6667</td>
<td>8000</td>
<td>9333</td>
<td>10667</td>
</tr>
<tr>
<td>604</td>
<td>4167</td>
<td>5000</td>
<td>5833</td>
<td>6776</td>
</tr>
<tr>
<td>606</td>
<td>6250</td>
<td>7500</td>
<td>8750</td>
<td>10000</td>
</tr>
<tr>
<td>608</td>
<td>8333</td>
<td>10000</td>
<td>11667</td>
<td>13333</td>
</tr>
<tr>
<td>724</td>
<td>5000</td>
<td>6000</td>
<td>7000</td>
<td>8000</td>
</tr>
<tr>
<td>726</td>
<td>7500</td>
<td>9000</td>
<td>10500</td>
<td>12000</td>
</tr>
<tr>
<td>728</td>
<td>10000</td>
<td>12000</td>
<td>14000</td>
<td>16000</td>
</tr>
<tr>
<td>846</td>
<td>8750</td>
<td>10500</td>
<td>12250</td>
<td>14000</td>
</tr>
<tr>
<td>966</td>
<td>10000</td>
<td>12000</td>
<td>14000</td>
<td>16000</td>
</tr>
<tr>
<td>1086</td>
<td>11250</td>
<td>13500</td>
<td>15750</td>
<td>18000</td>
</tr>
<tr>
<td>1206</td>
<td>12500</td>
<td>15000</td>
<td>17500</td>
<td>20000</td>
</tr>
</tbody>
</table>
**Pre-Cleaning**

**ASPIRATOR**

The ADVENT Pre-cleaners utilize the aspirator before the screening process to increase capacity and screening efficiency.

**BALL TRAYS**

Screen blinding is prevented by using 2” rubber balls in removable ball trays.

**SCREENING**

The product is evenly distributed between both decks of the double flow units.

The first screening is normally a sifting process to remove the smaller reject particles. After the initial sifting, the product rides to the scalping area of the deck.

The decks can be equipped with multiple discharges to satisfy production specifications. All screens are mounted on tubular steel frames 24” long and are easily handled.

**DECKS**

ADVENT Pre-cleaners are typically configured with double flow decks to meet the demands of high capacity operations.
Pre-Cleaning

Advent Sifting

Advent Scalping
Pre-Cleaning

Receiving at the site
Pre-Cleaning

Twin 1206D Aspirators
Pre-Cleaning

Twin 846D Aspirators
Pre-Cleaning

Twin 846D Aspirators
Thank you for your time!

Pre-Cleaning
Principles of Seed Separation:

Randy Vaughan
MSU Foundation Seed Stocks
The principle of using the wind to separate seed from chaff exists from ancient times.
In some parts of the world, the ancient technique known as “winnowing” has changed very little with time and still occurs today in some countries.
Gradually, advancements came

Added elevation enhanced the capabilities of the wind.
But what was the ancient seed producer to do on a calm day with no wind?
Eventually, mechanized winnowing came on the scene and is also still used today.
Of course the use of the wind (air in motion) is just one principle of many that we can artificially create today in order to separate seed from its undesirable contaminants.
For many years within the seed industry, the process of separating good seed from various types of undesirable material within a rough seed mass (*the condition of seed as it arrived from harvest*) was known as .......... “seed cleaning.”
Over time, with the incorporation of chemical “seed treatments” as part of the process to improve a seed lot from its initial state when arriving from the field, the term gradually evolved to become known as “seed conditioning.”
The goal of the cleaning component of seed conditioning:

............... to remove as much foreign material or undesirable seed from the rough seed mass as possible.
What are the categories of undesirable material that seed producers universally seek to “clean out” of any given rough seed mass?

- Inert matter (broad category)
Inert Matter:

- Any material other than a seed
- or ........ a seed fragment, if it is of 1/2 its original size or smaller.

(seed fragment: can be a crop seed or weed seed)
Examples of inert matter:

- Plant parts (sticks, stems, pods, leaves)
Plant parts:
Examples of inert matter:

- Plant parts (sticks, stems, pods, leaves)
- Rocks or dirt
Rocks: (vary in size, weight, and shape)
Dirt: (vary greatly in size, weight, and shape)

(clods or soil particles)
Examples of inert matter:

- Plant parts (sticks, stems, pods, leaves)
- Rocks or dirt
- Insect / crustacean / animal parts
Insects / Crustacean / or Animal parts:
Examples of inert matter:

- Plant parts (sticks, stems, pods, leaves)
- Rocks or dirt
- Insect / Crustacean / Animal parts
- Man made objects
Man made objects:

- Metal (machine parts)
- Glass
- Paper
- Ceramic
- Rubber / Plastic
Examples of inert matter:

- Plant parts (sticks, stems, pods, leaves)
- Rocks or dirt
- Insect parts
- Man made objects
- Any seed fragment of 50% its original size, or less
Seed parts which are considered inert:
(those 50% of original size or less)
A second category of an undesirable material that seed producers seek to "clean out" of any given rough seed mass:

- Inert matter
- Immature, diseased, or broken seed
A third category of an undesirable material that seed producers seek to “clean out” of any given rough seed mass:

- Inert matter (broad category)
- Immature, diseased, or damaged seed
- Weed seed
Success in separation of weed seed from crop seed can vary greatly:
From a relatively simple separation ....
...... to a considerably more difficult one.
Weed seed separation:

Downy brome (a noxious weed) found in a sample of tall fescue.

*It is likely that even with the best equipment, these seeds cannot be separated.*
A fourth category of an **undesirable material** that seed producers seek to "**clean out**" of any given rough seed mass:

- Inert matter (broad category)
- Immature or diseased seed
- Weed seed
- **Other crop seed**
Separation of other crop seed:

Can range from relatively simple to difficult
What are the **categories of undesirable material** that seed producers universally seek to "**clean out"** of any given rough seed mass?

- Inert matter (broad category)
- Immature or diseased seed
- Weed seed
- Other crop seed
- Other varieties of the same crop species
Physical differences among varieties are usually very slight and make separation very difficult:
The bottom line:

Seeds and their associated contaminants come in all sizes, shapes, weights, colors, and surface textures.

So, .................
So, ........

by what means do seed producers separate any undesirable material from the seed mass?
....... by those same means.

By **exploiting the differences** in one or more physical characteristics of seeds or contaminants.

- size
- shape
- weight
- density / specific gravity
- surface texture
- color
Let’s look at them one by one.
1. **Size:**

(larger seed or material can be separated from smaller seed or material)
2. Shape:

(Seed or material **wider, thicker, longer, or more round** can be separated from seed or material **narrower, thinner, shorter, or less round**)

---

![Image of seed shapes]
3. Weight:
(seed or material that is **heavier** can be separated from seed or material that is **lighter**)

**Oats:**
Size and shape = Rice
Bushel **weight = 32 lbs**

**Rice:**
Size and shape = Oats
Bushel **weight = 45 lbs**
4. Surface texture:

(Seed or material that has a smooth surface can be separated from seed or material that has a rough surface)

Vetch
(seed surface smooth)

Austrian winter pea
(seed surface dimpled / rough)
5. Color:
(Seed or material of one color can be separated from seed or material of a contrasting color)
6. Density: (specific gravity)

(Seed or material that is more dense can be separated from seed or material that is less dense)
Physical characteristic differences utilized in seed cleaning (separation):

1. **Size:** (larger seed or material can be separated from smaller seed or material)

2. **Shape:** (seed or material wider, thicker, longer, or more round can be separated for seed or material narrower, thinner, shorter, or less round)

3. **Weight:** (seed or material that is heavier can be separated from seed or material that is lighter)

4. **Surface texture:** (seed or material that has a smooth surface can be separated from seed or material that has a rough surface)

5. **Color:** (Seed or material that are lighter in color can be separated from seed or material that are darker in color)

6. **Density: /Specific Gravity** (Seed or material that is more dense can be separated from seed or material that is less dense)
All commercial seed cleaners are designed to take advantage of differences in **one or more** of these characteristics.

- Size
- Shape
- Weight
- Surface texture
- Color
- Density
So, how are these principles of seed separation applied in practice?
When a rough seed mass is ready to be brought into the seed cleaning facility, for processing ......

1st: Draw a small (but representative) sample of the rough seed.
When a rough seed mass is ready to be brought into the seed cleaning facility, for processing ..........

1st: Draw a small (but representative) sample of the rough seed.

2nd: **Evaluate** all the components present (pure seed, inert matter, immature or diseased seed, weed seed, and other crop seed).
Some questions to consider:

- Is the bulk of the cleanout material larger or smaller than the good seed?
- Is the ratio of cleanout to good seed large or small?
- What is the degree of diseased or immature seed?
- What are the species and volumes of weed seeds that are present?
When a rough seed mass is ready to be brought into the seed cleaning facility, for processing ...........

1\textsuperscript{st}: Draw a small (but representative) sample of the rough seed.

2\textsuperscript{nd}: Evaluate all the components present (pure seed, inert matter, immature or diseased seed, weed seed, and other crop seed)

3\textsuperscript{rd}: **Develop a strategy** for cleaning out the contaminants based upon what you observe based on the separation principles, (size, weight, shape, surface texture, or color).
In order to explore the capabilities of the most basic and general seed separation equipment (the air-screen cleaner) the rough seed sample should be evaluated through the use of ……

- A complete set of hand screens
- A small, variable speed air source (aspirator or blower)
Hand Screens:
Utilize trial and error to find desired sizes for scalping and grading screens:

By keeping good records of previous seed cleaning events, (by crop and variety) you should be able to minimize trial and error in screen selection.
Model size blowers:

“South Dakota” blower

Aspirator
When a rough seed mass is ready to be brought into the seed cleaning facility, for processing ........

1st: Draw a small (but representative) sample of the rough seed.

2nd: Evaluate all the components present (pure seed, inert matter, immature or diseased seed, weed seed, and other crop seed)

3rd: Develop a strategy for cleaning out the contaminants based upon what you observe based on the separation principles, (size, weight, shape, surface texture, or color).

4th: **Select the appropriate screens** for your seed cleaner based on your evaluation of the rough seed sample. The percentage of the material removed within the sample should accurately predict the percentage of material removed in practice.
Types of screens and perforations used in seed cleaning:

- Oblong Holes
- Round Holes
- Triangle Holes
- Wire Mesh

Images of various perforation patterns and dimensions are shown.
In addition to utilizing screens, the air-screen cleaner also employs the use of **air in motion** to separate seed from its contaminants.
Aspiration:
Passing seed material through a stream of air for the purpose of making a separation by weight.
Aspirator:

Clean seed

Material lighter than seed
Air-Screen cleaner:

- Utilizes three of the primary physical differences available for seed separation ...
  - size
  - shape
  - weight

screens

air flow (aspiration)
The air screen cleaner is usually the first piece of equipment used upon a (rough seed mass) since it does a good job in removing the bulk of objectionable material.

However, ..........

just because 95% of objectionable material may be removed by one piece of equipment, often the remaining 5% is enough to disqualify a seed lot from certification, or even legal sale.
Example: (morning glory seed present in rice crop)
  The air-screen machine is unable
to remove most morning glory seed?
  Why?
Because the rice seed and morning glory seed are
of very similar size and thickness, so both round
and slotted screens can not tell them apart.

What about the weight difference in rice and
morning glory?
Rice seed is heavier, but because morning glory
seed are not as long, suspension in the air stream
is about the same.
When a rough seed mass is ready to be brought into the seed cleaning facility, for processing ........

1st: Draw a small (but representative) sample of the rough seed.

2nd: Evaluate all the components present (pure seed, inert matter, immature or diseased seed, weed seed, and other crop seed)

3rd: Develop a strategy for cleaning out the contaminants based upon what you observe based on the separation principles, (size, weight, shape, surface texture, or color).

4th: Select the appropriate screens for your primary seed cleaner based on your rough seed sample evaluation.

5th: **Select additional appropriate equipment** capable of utilizing other means of separation to further improve seed purity.
Secondary (supporting) seed conditioning equipment:

- Usually one or more additional machines are required (after the air screen cleaner) to fine tune the finished seed product.

- These secondary machines employ some other physical property difference as a means of seed separation.

  - Shape, surface texture, color, or specific gravity
Physical characteristic differences utilized in seed cleaning (separation):

1. **Size:** (large seed or material can be separated from smaller seed or material)

2. **Shape:** (seed or material wider, thicker, longer, or more round can be separated for seed or material narrower, thinner, shorter, or less round)

3. **Weight:** (seed or material that is heavier can be separated from seed or material that is lighter)

4. **Surface texture:** (seed or material that has a smooth surface can be separated from seed or material that has a rough surface)

5. **Color:** (Seed or material that are lighter in color can be separated from seed or material that are darker in color)

6. **Density:** /Specific Gravity (Seed or material that is more dense can be separated from seed or material that is less dense)
Shape:

- Length
- Width
- Thickness
- Roundness
Length separators:

1. Disk separator:
2. Indented cylinder separator:

- Both remove shorter seed contaminants out of a “seed lot” of longer seed characteristics.
1. Disk Separator:
Let’s go back to the example of pitted morning glory seed present in a long grain rice seed lot:

The air-screen machine was unable to remove most morning glory seed? Why?

Because rice seed and morning glory seed were of very similar thickness, so both round and slotted screens could not uniformly differentiate them.
But the two species do differ significantly in seed length:
Disk Separator:

Example: effectively lifts and removes morning glory seed from rice
Length separators: (continued)

- 2. Indented Cylinder separator

Round pocket indentions on inner surface
**Indented cylinder:** (principle of operation)

Utilizes centrifugal force to keep short particles in contact with the cylinder until dumping into center trough.

(A) Indented cylinder
(B) Adjustable trough
(C) Point of separation
(D) Seed mass (feeds from one end of cylinder to the other)
Shape:

- Length
- **Width**
- **Thickness**
- Roundness
Width – Thickness Separators:

- Precision Grader

Like the disk, the precision grader also utilizes centrifugal force to keep seed or particles in contact with the cylinder until they either pass through the perforations, or pass along the length of the inner wall of cylinder, and discharge.
Round ribbed cylinders

.... have ribs that run the length of the cylinder between each of several rows of round perforations. These ribs provide gentle agitation that up-ends the material for proper presentation to the perforations. **Separates seed by width.**
Slotted hole cylinders: Selects for seed thickness

Slotted cylinders
Shape:

- Length
- Width
- Thickness
- Roundness
Seed cleaners based on separation principle of seed *roundness*:

Cleaners such as the "*spiral separator*" capitalize on specific seed kinds ability or inability to roll.
How do spiral separators work?
Rotary Spirals:

Offers enhanced effect of centrifugal force as spirals spin while seed are fed through
Separation by **Specific gravity**: (Capitalizes on minor differences in seed density)

**Gravity table:**
Uses a cushion of air to lift lighter density seed and direct it down the slope while heavier density seed are directed up the slope through table vibration
Separation by **surface texture:**

(Seed or material that has a **smooth** surface can be separated from seed or material that has a **rough** surface)

**Vetch**
(sMOOTH surface)

**Austrian winter pea**
(sURFACE dimpled / rough)
Roll Mill:

Primarily used to clean rough or sharp angled weed seed from smooth clovers and alfalfa.
Draper: (Separation by seed shape / texture)
Magnetic Separators: (modified) surface texture separation

In their natural state, seeds have little if any magnetic attraction.

However, if exposed to a finely ground iron powder, seeds with a rough or porous seed coat surface will stick to the iron powder thereby altering the seed coat surface to display a magnetic attraction.

The iron powder will not adhere to seed with a smooth seed coat.

After seeds exit the iron powder mixing chamber and are brought into contact with a powerful magnet, the iron powder coated seeds can effectively be removed from the smooth seeds.
Magnetic Separator:

Type 1: Overfeed
Type 2: Underfeed

Most magnetic cleaners pass the seeds over a revolving drum which has a high intensity magnetic field. Seeds which are coated with iron powder are attracted by the magnet and adhere to the drum until overcome by gravity as the drum rotates. Seeds which are relatively free of iron powder are not attracted by the magnet and will fall into a separate discharge.
The color sorter uses an electronic eye that can pick up different colors according to the way the machine is adjusted. As seed falls down a shoot, it passes through an electric eye. If the color of the seed is different than the desired color, the eye will activate a sudden burst of air that pushes the seed into a reject bin while the rest of the seed passes through to a cleaned seed bin.
Seeds that are very similar in size, shape, and weight can successfully be removed by means of a substantial color difference.
To summarize........

........ the basic principles of seed separation revolve around the differences in some physical characteristic of the seeds and their associated contaminants.
Once you have thoroughly evaluated the rough seed sample, formulate your strategy for cleaning out contaminants based upon what you observe as related to the various separation principles, ..........(size, weight, density, shape, surface texture, or color).
End
PVP AND UTILITY PATENTS

JIM MITCHELL

Licensing Associate
August 3rd 2016
Seed Tech From Bin To Bag
PLANT VARIETY PROTECTION

“PVP”
“PVPO”
“PVPA”
“PVPC”

ENACTED IN 1970

www.ams.usda.gov/services/plant-variety-protection
PVP

PURPOSE

to "encourage the development of novel varieties of sexually reproduced plants" by providing their owners with exclusive marketing rights of them in the United States. The requirements of protection are that the variety be uniform, stable, and distinct from all other varieties.
Prior to 1970
Dec. 24th

There were no retained rights by the developer
it was open and free reign

IT WAS ALL UNPROTECTED!

we lived on farmer caught seed
PVPA

Incentivized private institutions to accelerate rapid development

Which variety was your first PVP memory?

It became the beginning of value capture in the seed industry
The PVPA became a change agent.

It was harder to accept than many social and political reforms of the time as we tread an uncharted path.

Feelings were hurt, relationships damaged and some destroyed.
PVPO
Responsible for administering the PVP Act.

Some certificates are no longer in effect due to being abandoned, withdrawn, or expired, 20 years seed, 25 vines and trees.

No PVP Certificate of Protection has been overturned in a court of law.
PVPO Facts:

Overall certificates issued since 1970: 11,100
Average number of applications/year: 480
Kinds of crops examined: greater than 180
Top Incoming Crops: soybean, Corn, Wheat, Cotton, Potato
Average number of abandonments: 39
PVP application processing time: 1.5 years
Current application backlog: 312
PVPO
Strives to be user friendly

It does not require an Attorney
Charges to file can run to $5150
Based off applicant conducted
field trials.
No annual maintenance fees like
patents
Provisional protection upon application receipt.
There were initial exemption Crops on PVP

Carrots, Celery, Cucumbers, Okra, Peppers and Tomatoes were amended for inclusion in 1980
F1 hybrid corns and tuber propagated plants were amended likewise in 1994
PVPO
Reviews For:
  Is it New?
  Is it distinctly different compared to the Most Similar Variety?
  Is it uniform?
  Is it Stable?
  Details of Origin?
  Does it have novelty?
  Who is claiming owner?
A PVPC

BOTH

RESTRICTS USERS RIGHTS

PROTECTS OWNERS RIGHTS
For the owner
a PVP excludes others from:

Selling, Marketing, Offering for sale, Delivering, Shipping, Consigning, Exchanging or Exposing the variety for sale, soliciting an offer to buy or transfer it in any way

Importing and Exporting it
Sexually multiplying it
Producing a hybrid
Conditioning for the purpose of propagation
PVP allows for the end user to:

save seed for his own plant back acreage

save seed for commodity sale in on farm bins and pods
PVP
Allows for breeders exemption:
to use in breeding new cultivars.
to use for experimental purposes

Essentially derived rules apply.
1991 UPOV Convention
PVP Challenges:
When similar varieties are involved:
The PVP Commissioner has no record of this occurring since his tenure in office since 2001
Filling a petition of protest proceeding $4118
Only two case have been challenged on the basis of novelty as far as “New” criteria
BACK CROSS BREEDING:

IC VAR. A X VAR. B = AB 50/50
BC - AB X B = 75B/25A BC1F1
BC1F1 X B = 87.5B/13.5A BC2F1
BC2F1 X B = 93.75B/6.25A BC3F1
BC3F1 X B = 96.87B/3.125A BC4F1

Resulting VARIETY IS Now 96.87% OF Proteted VARIETY B
I USED IT TO MAKE Mine A, BETTER
DID I MAKE IT LOOK EXACTLY LIKE YOU?
Should you want to breed with a PVP’d variety

Buy your own seed
do not request from the breeder

Advice—Keep the receipt and the bag.
Rights come with purchase!
Who can file a PVPA

Any Breeder of a sexually reproduced or tuber propagated plant

US Citizens as well as peoples of UPOV nations

Applicants Are:
Individuals, Public Institutions & Corporations
The most critical step in filing for a PVPC:

It can be filed anytime before sale, BUT!

It must be filed within a year of “date of first sale!”

Protection is barred if not
When does PVP start?

Officially from the date it is received in the PVPO.

Insured protection is essentially in effect.
PVP Enforcement
The Owner may:

Bring civil action for infringement

Ask the court for an injunction to prevent further violations

The owner must bring suit in each case
PVPA Authorities
Can I buy a variety?
Yes
The PVPO allows for transfer of Certificate ownership in filing Form ST 473
the cost is $41
Occurs when companies are bought or you want to buy from a breeder.
Trace of ownership
PVP

www.ams.usda.gov/services/plant-variety-protection/issued-certificates

Potential business development opportunity through licensing.
PVPA
For full information Visit

www.ams.usda.gov/sites/default/files/media/Plant Variety Protection Act.pdf
Plant Patents, PPA, are not Plant Related Utility Patents
Do not confuse the two
Both are administered by the USPTO
PPA For asexually produced plants
Initiated in 1930
last for 20 years
most of the time include only one claim
think of clone production and stability
if you can pinch or snip it or graft it
Plant Related Utility Patents

Include

Plants, Roots, Seeds, Plant Parts, Combinations thereof, Foodstuffs, Formulation or Product Process

Issued by:

www.uspto.gov
Plant Related Utility Patents

Inventor is the applicant

Assignee can be an Individual, Public Institution or Corporations
Plant Related Utility Patents

Cover

A plant variety
A class of plant having one or more traits
Plant parts, cells, seed, plasmids
Methods of producing/breeding
Methods of identifying
Methods of using plant varieties
Composition/extracts made from varieties
Plant Related Utility Patents

Protection is available when: Novel, Non Obvious, Sold or Offered for Sale
Within 12 months of filing
Plant Related Utility Patents May Include:

One or more invention claims i.e. Herbicide and Insect traits or Other novel traits of agronomic benefit.
Plant Related Utility Patents
GRANT THE OWNER:
THE ABILITY TO EXCLUDE OTHERS FROM MAKING, USING, SELLING Or Offering For Sale THE CLAIMED INVENTION FOR 20 YEARS FROM DATE OF FILING
Cross breeding by others prohibited!
The beginning of the end for germplasm exchange
Plant Related Utility Patents Are Used when:

The Invention is not related to a particular variety
i.e. applies to multiple cultivars and crop types for the same patented trait.
Covered under multiple patents with as many genes as may contain.
Plant Related Utility Patents

Require a license to use or hold in our Seed industry,
Limited to one use cycle,
Prohibited from propagation and breeding with by others,
Limits who can sell and offer for sale

All explained in the fine print
Plant Related Utility Patents Are:

- Strict and enforceable in a court of law.
- Highly upheld by the courts.
- Damages can lead to bankruptcy.
- Allow the owner a strict bundle of rights.
- Licensable to others by the owner under an agreement.
- Very restrictive to the end user.
- Void of any farmer exemptions!
Opportunities on protected varieties!

Seek a license from owner.
Ask for the Legal department
or Tech Transfer office of Institution.
Negotiate term and duration of agreement.
Pay the required royalties negotiated and
structured in the license.
Questions?
Seed Treatment: Innovation Driven, Environmentally Friendly, Committed to Plant Health

Chip Graham   Bayer CropScience
What is a “Seed Applied Product”?

Seed application, as defined, relates to the placement on the seed of those products (i.e., fungicides, insecticides, nematicides, minor elements, herbicide safeners, dyes, plant growth regulators, etc...) which are considered beneficial or necessary in maintaining or enhancing genetic yield potential of a crop. Those products being applied are termed seed applied products.
Seed Treatment - The Principle

1. Active ingredient is released from the seed immediately after planting, quickly surrounding it with a protective halo.

2. The plant absorbs active ingredient from the protective halo through the roots.

3. Active ingredient is transported to the aerial parts of the plant and uniformly distributed in the tissue.

"Contact effect" against soil pests & diseases
Control of soil pests & diseases
Control of foliar pests & diseases
# Evolution of Seed Treatment

## Seed borne

**Prior to 1980s**
- Primarily seed disinfection

**1980s**
- Seedling protection

**Prior to 1980:**
- Dependence on contact fungicides such as captan and thiram and mercury based products.
- Use of systemics fungicides such as carboxin and chloroneb in the late 1970s.

**1980s**
- Introduction of low rate highly effective systemic fungicides, e.g., (triadimenol, metalaxyl).
- First seed treatment herbicide safener developed.

## Soil borne

**1980s**
- Plant protection

## Foliar

**Early 1990s:**
- Systemic insecticides (**Gauchó**® - imidacloprid).

**2000 – Current**
- Introduction of first seed treatments that provide protection against nematodes
- Significant Yield Increases
- Abamectin from Syngenta
- **VOTIVO** (biological) from Bayer CropScience

## Nematode Protection

**2000 - Current**
- Improved root health

## Application Technology

**2000- Current**
- In-Plant Handling, Dust Abrasion, Plantability

## Delivery systems

- Adoption of new seed treatment technology has lead to the development of innovative new seed treatment application equipment and coating technology.

## Innovation

- New round of Seed Treatment innovation

---

**Application technology becomes more important**
- More seed treatment usage on high value transgenic seed
- More product being applied.
- Product retention
- Handling
- Plantability
Early History
Seed Treatment
(Prior to 1984)

The contact
fungicides .............. Captan, Thiram, TCMTB, PCNB, Ethazole, Fenaminosulf

The systemic
fungicides .............. Carboxin (Vitavax®), Chloroneb (Demosan®)
# Evolution of Seed Treatment

<table>
<thead>
<tr>
<th>Seed borne</th>
<th>Soil borne</th>
<th>Foliar</th>
<th>Nematode Protection</th>
<th>Application Technology</th>
<th>Delivery systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prior to 1980s</strong></td>
<td><strong>1980s</strong></td>
<td><strong>1990 - 2005</strong></td>
<td><strong>2000 - Current</strong></td>
<td><strong>2000- Current</strong></td>
<td><strong>Early 1990s:</strong> Seedling protection</td>
</tr>
<tr>
<td>Primarily seed disinfection</td>
<td>Seedling protection</td>
<td>Plant protection</td>
<td>Improved root health</td>
<td>In-Plant Handling, Dust Abrasion, Plantability</td>
<td>Adoption of new seed treatment technology has lead to the development of innovative new seed treatment application equipment and coating technology.</td>
</tr>
</tbody>
</table>

## Prior to 1980:

Dependence on contact fungicides such as captan and thiram and mercury based products.

Use of systemics fungicides such as carboxin and chloroneb in the late 1970s.

## 1980s

- Introduction of low rate highly effective systemic fungicides, e.g., (triadimenol, metalaxyl).
- First seed treatment herbicide safener developed.

## Early 1990s

- Systemic insecticides (Gauchò® - imidaclopridiid).
- Significant Yield Increases

## 2000 – Current

- Introduction of first seed treatments that provide protection against nematodes
- Abamectin from Syngenta
- VOTiVO (biological) from Bayer CropScience

## Applications
- More seed treatment usage on high value transgenic seed
- More product being applied.
- Product retention
- Handling
- Plantability

## Innovation
Since 1984…

Metalaxyl - (Allegiance®, Apron®)

Triadimenol – (Baytan®)

Myclobutanil – (NuFlow® M)

Fludioxonil – (Maxim®)

Axozystrobin – (Protégé®, Dynasty®)

Trifloxystrobin - (Trilex)

Penflufen & other SDHI – (Energol Energy and others )

Flupyradol - (ILeVO)
Untreated
Potato Seed Treatments

Untreated

Standard
Peanut Fungicide Trial
Tim Brenneman  Tifton, GA

Standard Seed Treatment

Untreated
Healthier Leaves with ILeVO®

Always read and follow label instructions. Bayer, the Bayer Cross, and ILeVO are registered trademarks of Bayer.
Sudden Death Syndrome

BASE Fungicide

Always read and follow label instructions. Bayer, the Bayer Cross. and ILeVO are registered trademarks of Bayer.
# Evolution of Seed Treatment

<table>
<thead>
<tr>
<th>Seed borne</th>
<th>Soil borne</th>
<th>Foliar</th>
<th>Nematode Protection</th>
<th>Application Technology</th>
<th>Delivery systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prior to 1980s</strong></td>
<td><strong>1980s</strong></td>
<td><strong>1990 - 2005</strong></td>
<td><strong>2000 - Current</strong></td>
<td><strong>2000 - Current</strong></td>
<td><strong>Adoption of new seed treatment technology has lead to the development of innovative new seed treatment application equipment and coating technology.</strong></td>
</tr>
<tr>
<td>Primarily seed disinfection</td>
<td>Seedling protection</td>
<td>Plant protection</td>
<td>Improved root health</td>
<td>In-Plant Handling, Dust Abrasion, Plantability</td>
<td>New round of Seed Treatment innovation</td>
</tr>
<tr>
<td><strong>Prior to 1980:</strong> Dependence on contact fungicides such as captan and thiram and mercury based products. Use of systemics fungicides such as carboxin and chloroneb in the late 1970s.</td>
<td><strong>1980s</strong> Introduction of low rate highly effective systemic fungicides, e.g., (triadimenol, metalaxyl). First seed treatment herbicide safener developed.</td>
<td><strong>Early 1990s:</strong> systemic insecticides (Gauch® - imidacloprid). <strong>2005:</strong> new generations systemic insecticide (Poncho – clothianidin) <strong>Significant Yield Increases</strong></td>
<td><strong>2000 – Current</strong> Introduction of first seed treatments that provide protection against nematodes Abamectin from Syngenta VOTIVO (biological) from Bayer CropScience</td>
<td><strong>Application technology becomes more important</strong> • More seed treatment usage on high value transgenic seed • More product being applied. • Product retention • Handling • Plantability</td>
<td></td>
</tr>
</tbody>
</table>
Insecticide development -

Disulfoton – Di-syston

Acephate - Orthene

Imidacloprid - Gaucho

Thiamethoxam - Cruiser

Clothianidin – Poncho

Rynaxyspyr/Cyazypyr – Dermacor & others
2002 Wireworm Injury
Elizabeth City, NC

Untreated Control

Poncho 250
2016 Soybean IST
Don Cook   Stoneville, MS

Base Fungicide
Pea weevil damage

Base Fungicide + Insecticide
Evolution of Seed Treatment

<table>
<thead>
<tr>
<th>Seed borne</th>
<th>Soil borne</th>
<th>Foliar</th>
<th>Nematode Protection</th>
<th>Application Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prior to 1980s</strong></td>
<td><strong>1980s</strong></td>
<td><strong>1990 - 2005</strong></td>
<td><strong>2000 - Current</strong></td>
<td><strong>2000 - Current</strong></td>
</tr>
<tr>
<td>Primarily seed disinfection</td>
<td>Seedling protection</td>
<td>Plant protection</td>
<td>Improved root health</td>
<td>In-Plant Handling, Dust Abrasion, Plantability</td>
</tr>
</tbody>
</table>

**Prior to 1980:**
Dependence on contact fungicides such as captan and thiram and mercury based products.
Use of systemics fungicides such as carboxin and chloroneb in the late 1970s.

1980s
Introduction of low rate highly effective systemic fungicides, e.g., (triadimenol, metalaxyl).
First seed treatment herbicide safener developed.

Early 1990s:
- Systemic insecticides (Gaucho® - imidacloprid).
- New generations systemic insecticide (Poncho – clothianidin)

**Significant Yield Increases**

2000 – Current
- Introduction of first seed treatments that provide protection against nematodes
- Abamectin from Syngenta
- Fluopyram from Bayer CropScience

Application technology becomes more important
- More seed treatment usage on high value transgenic seed
- More product being applied.
- Product retention
- Handling
- Plantability

Innovation

Delivery systems
Adoption of new seed treatment technology has lead to the development of innovative new seed treatment application equipment and coating technology.

New round of Seed Treatment innovation
Seed Applied Nematicides

Currently registered

- **Syngenta**
  - Avicta – Abamectin

- **Bayer**
  - AERIS - Thiodicarb
  - VOTiVO – Bacillus firmus
  - COPeO Prime- fluopyram
Charles Overstreet LSU

AERIS+COPeO Prime
MELGIN galling on tomato at 6 WAT

CONTROL. Mean Gall Rating (Zeck) = 4.0
MELGIN galling on tomato at 6 WAT

Seed Treatment Insecticide + Nematicide
Mean Gall Rating (Zeck) = 2.4
What’s On The Seed

- 70+ Seed Treatment Brands
- 30+ Different AI’S
- 20+ Fungicides
- 10+ Insecticides
- 2 Herbicide Safeners

Seed:
- Slip Agent
- Fungicide Insecticide
- Polymer Colorant

Presentation • August 8, 2016 • Slide 28
# Scope of Seed Applied Products

## Seed Enhancements  
**i.e. Fungicides, etc**

- Coatings
- Colorants
- Inoculants
- Services  
  **(i.e. custom coating & priming)**

## Major Crop Markets

<table>
<thead>
<tr>
<th>Grains</th>
<th>Oilseeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Soybean</td>
</tr>
<tr>
<td>Sorghum</td>
<td>Canola</td>
</tr>
<tr>
<td>Wheat</td>
<td>Peanut</td>
</tr>
<tr>
<td>Barley</td>
<td>Sunflower</td>
</tr>
<tr>
<td>Rice</td>
<td>Pulses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Forage/Turf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>Alfalfa</td>
</tr>
<tr>
<td></td>
<td>Clovers</td>
</tr>
<tr>
<td></td>
<td>Grasses</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Horticultural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugarbeet</td>
</tr>
<tr>
<td>Potato</td>
</tr>
<tr>
<td>Vegetables</td>
</tr>
<tr>
<td>Flowers</td>
</tr>
</tbody>
</table>

---

Presentation • August 8, 2016 • Slide 30
Seed Application Technologies & Definitions

Seed + Active + Application Technology

SEED DRESSING
TST

FILM COATING

Encrusting/Sizing

Nutrient Coating

BioCoating

PELLETING

PELLETING + COATING

MULTILAYER COATING
Key Areas of Evaluation

- Formulation
- Efficacy
- Product Development
- Seed Safety
The uniqueness of seed treatment formulations

**Seed is the target**: seed are living organisms so there is no tolerance for a delivery system that negatively affects the health and/or contributes to an untimely death of seeds and/or seedlings.

**Seed is the carrier** of the pesticide(s).

Treated seeds must be robust enough to withstand **handling multiple times** after application. From the time the application is made, to packaging in bags and/or bins and finally in transport to the final destination... **the grower**!

Since seeds are a **3-dimensional**, they must be treated uniformly so that the active ingredients are evenly distributed to provide optimum protection in the growing environment.

Seed treatment products can be quite sophisticated in that they may be formulated with one or more fungicides in combination with one or more insecticides, i.e., they can be **multi-functional products** delivered in a single container.
Application Advancements

- Newer technology targets +/- 2% accuracy to high volume facilities
- Seed testing for treatment quality characteristics.
- Improvement of quality is a combination of equipment, process controls and materials applied to the seed.
- Seedsmen are upgrading equipment training and stewardship initiatives.
- Seed coatings are becoming a standard with heavier loadings
- Seedsmen are more frequently engaging seed coating and applications experts to improve their product quality

High Volume Batch Treater

Seed Pelleting
Different film coatings on corn seeds lead to different losses of active substances after abrasion.

<table>
<thead>
<tr>
<th>Seed Treatment</th>
<th>Film Coating / Quality of Film Coatings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated</td>
<td>0%</td>
</tr>
<tr>
<td>No film coating</td>
<td>19.67%</td>
</tr>
<tr>
<td>Film coating A</td>
<td>19.59%</td>
</tr>
<tr>
<td>Film coating B</td>
<td>2.80%</td>
</tr>
<tr>
<td>Film coating C</td>
<td>8.25%</td>
</tr>
<tr>
<td>Film coating D</td>
<td>4.56%</td>
</tr>
<tr>
<td>Film coating E</td>
<td>17.30%</td>
</tr>
<tr>
<td>Film coating F</td>
<td>7.54%</td>
</tr>
<tr>
<td>Film coating G</td>
<td>0.46%</td>
</tr>
<tr>
<td>Film Coating Z</td>
<td>19.67%</td>
</tr>
</tbody>
</table>

% losses of actives

Legend: Film Coating / Quality of Film Coatings
Advantages of Seed Treatment

Seed treatment is one of the most focused chemical crop protection methods available to date: a relatively small amount of the active substance is needed to provide the seed & seedling with a high level of protection against a wide variety of fungal diseases and insect pests.

Specialized equipment is used to deliver very small quantities of active ingredients to the surface of a seed, which in some instances is no larger than the point of a ball point pen. Advances in application technology have resulted in very little exposure to workers in seed conditioning plants.

Seed treatments can be applied at rates of active ingredients per seed, assuring protection to each seed planted, as well as minimizing environmental contact.
Advantages of Seed Treatment

Seed treatment is also interesting from an environmental point of view: compared with spraying, it effectively reduces the treated area.

- While spraying 1 acre of land puts 4049 sq.m of soil in contact with the active ingredient, this shrinks to a mere 24 sq.m (less than 1 percent), when using seed treatment

- Moreover, seed treatment has less impact on non-target organisms

- Seed treatment is compatible with Integrated Pest Management (IPM)
The Future For Seed Applied Chemicals

Fungicides
- SDHI Chemistry still being developed

Insecticides
- No new ai’s on the horizon!!

Nematicicides
- Activity against Root knot and Reniforme nematodes
Seed Applied Products

- Products that enhance Cool test results
- Products that induce ISR – Induced Systemic resistance in plants
- Products that promote early season vigor
- New Herbicide Safener products
- New drought tolerant products
SUMMARY

Industry/Academics is committed to developing seed applied products that will provide benefits to the grower.

There is active research underway evaluating fungicides, insecticides, nematicides, PGR’s, and polymer/coatings designed to enhance emergence, stand establishment, plant health, and yield.

If the next 10 – 20 years are as productive as the last, the agricultural industry has a lot to look forward to in terms of new developments that will provide new tools to enhance stand establishment, plant health, and yield potential.
Stress and Vigor Tests

Brent Turnipseed
Professor/Manager
South Dakota State University Seed Testing Lab
WE APPRECIATE YOUR CONCERN, BUT AS I'VE TOLD YOU MULTIPLE TIMES, MR. TURNIP, YOU JUST CAN'T HELP US.

GIVE TODAY! OUR GOAL

©Scott Hilburn/Distributed by Universal Uclick via CartoonStock.com
Seed Vigor

• Seed Vigor is defined as “Those properties which determine the potential for rapid, uniform emergence and development of normal seedlings under a wide range of field conditions.”
Why do we need a stress/vigor test?

• Labeled germination most often will overestimate field emergence.

• We want fast, uniform emergence under existing field conditions (cold, wet, hot, wet & cold, etc.).

• A standard germination test can be inadequate
  – Germination determined under optimum conditions
  – No distinction between weak or strong seedlings as long as all essential structures present.
Relationships among seed vigor, viability (germinability) and deterioration, and the area for application of vigor tests. The x and y points on the viability and vigor curves illustrate the increasing “gap” between germinability and vigor with increasing deterioration. From Delouche and Caldwell (1960).

← Highest at physiological maturity
Figure 1. There are two different varieties in this field. The variety on the right had poor seed quality, and this resulted in poor emergence. Photo by Jim Shroyer, K-State Research and Extension.
Consider a seed vs. human

**Humans**
- A year old baby
- A 18-25 year old
- A 101 year old

**Seeds**
- Immature
- Fully mature, no weathering, proper storage conditions
- 2-5 year old seed

**Put it to work and you’ll find out which has energy!**

**Plant it, which will come up faster and more vigorous?**
• Often we see vigor problems in:
  – Dicots – soybeans, cotton
  – Monocots – corn

• Why? \(\Rightarrow\) Mechanical damage
Seed coat damage on soybeans. Can occur when the moisture content is low. Producers can see chips, cracks, and splits from mechanical damage.

Maize kernels with zero to multiple stress cracks as placed from left to right. FGIS photo.

Fast green test on corn to identify mechanical damage. ISU photo.
Factors influencing Seed Vigor

1. Genetic make-up - (Genetic Constitution)
   some varieties are different and less vigorous
   - Hybrid vigor
   - plant breeders have improved seed quality

2. Seed Maturity -
   - Highest germination & highest vigor at physiological maturity
     • Soybeans – approximately 55% MC. Vigor starts declining after physiological maturity reached
Factors influencing Seed Vigor

3. Environment (fertility level)
   - soil moisture
   - water availability
   - rainfall
   - temperature
   - available nutrients

Environmentally arid irrigated regions - Oregon, Idaho, etc. are better suited to produce high quality seed.

Peanuts - Ca++ is a must for pod formation and seed development.

Moisture stress during seed maturation - light, shriveled seed with lower vigor.

Fertility stress - less seed produced, will not lower vigor of seed.
Factors influencing Seed Vigor

4. Postmaturation - preharvest environment
   – rainfall
   – Temperature

5. Susceptibility to mechanical damage
   – under genetic control (somewhat)
   – soybeans - some varieties more susceptible than others (size influences)
Factors influencing Seed Vigor

6. Seed Chemical Composition
   - high lysine corn breeding caused an increase in seed quality problems (small shrunken kernels)

7. Density of seed
   - It has been shown that seeds separated into density classes have different performance levels.
   - As density increases the higher performance you can expect.
Factors influencing Seed Vigor

9. Age and Deterioration

10. Dormancy (hard seed)
   - primarily interested in hardseededness
   - slows down aging
   - protects against warm, wet weather.
   - lower leakage of nutrients during imbibition
   - Breeding towards dormancy

Now let us look at a probable sequence of vigor loss or seed deterioration!
Similar to a human being as they age
Probable sequence of changes in seed during deterioration

Loss of germinability

- Abnormal seedlings increases
- Yield decreases
- Uniformity decreases
- Storability decreases
- Respiration & Biosynthesis decreases
- Membrane degradation

- Energy & Synthesis mechanisms impaired
- Rate-Growth & Development decreases
- Plant resistance decreases
- Emergence (field) decreases

From J.C. Delouche and C.C. Baskin, 1973
Seed Vigor Tests

• Direct Tests - (Simulate unfavorable field conditions)
  – hard to duplicate from lab to lab (country to country)

• Indirect Tests - (Measure physiological attributes of seed)
  – more easily reproducible
  – still, see variation in interpretation, equipment, etc.

• Biochemical tests – i.e. – tetrazolium, etc.
Seed Vigor Tests

**Cold Test- (direct test for vigor!)**
Most widely used vigor test

Stresses applied:
- microorganisms from soil - *Pythium* (involved in complex of damping off)
- Restricted O$_2$ availability (70% saturation)
- Low temperature - 10°C (~50°F) for seven days, then 25°C (~77°F) for five days.

Towels with soil or plastic pans with soil.

Effectively used for:
- measure field performance potential
- evaluate fungicide efficiency
- select genetic material
- evaluate physiological deterioration
- provide basis for adjusting planting rates

*also used on Soybeans*
Rolled towel method - SDSU
Tray Method with Kimpak
http://seedlab.oregonstate.edu/importance-seed-vigor-testing
Seed Vigor Tests

• **Saturated Cold Test** – used on corn – most stressful (widely used in corn industry)
  
  – Seeds are placed embryo down into saturated soil
  – Soil is maintained at 100% saturation
  – Low $O_2$ availability
  – Tests are run at 10C for 7 days, then transferred to a 25C chamber for another 3-4 days.

More severe test than the cold test, with usually lower rates.

http://www.indianacrop.org/Lab-Services/Seed-Quality-Purity-Testing/Saturated-Cold
Seed Vigor Tests

- **Accelerated Aging Test** - (Soybeans 1°)
  - Stresses applied:
    - high temperature 40 - 45°C
    - high RH (~ 100% RH)
    - 48 - 96 hours depending on crop
Seed Vigor Tests

- **Cool Germination Test - (Cotton 1°)**
  - Most widely used vigor test in cotton
  - germination at 18°C (temperature crucial)
  - only make one count on the seventh day
  - normal seedlings 4 cm (1 ½ inches) are vigorous.
  - remaining seedlings not counted.

http://csd.net.au/media/20-seed-vigour-index-to-be-replaced
Seed Vigor Tests

• Seedling Growth Rate Test
  – evaluates the rate of transfer of stored food material into seedling material.
  – dark germinator at 25C for seven days
  – abnormal and dead discarded
  – normal seedlings - cut free from kernels or cotyledons, dry at 80C for 24 hours.

\[
\text{Dry weight (normal seedlings/towel)} = \text{SGR (mg/seedling)}
\]
\[
\text{Number of seedlings}
\]
Seed Vigor Tests

• **TZ test** (vigor and viability test)
  – Categorize the staining pattern
    • - strong to weak
  – slim difference, needs lots of analyst experience
  – seed treatment phytotoxicity and dormancy cannot detected
Good membrane (cell wall) integrity - limits stain to edges.

- plumule/Epicotyl

Viable soybean seed (high vigor)

Break would cause abnormality or death of seedling

Break (mechanical damage)
Break in the hypocotyl
(evaluated as non-viable)
Extends into conducting tissues - the stele.
radicle

break extending all the way through - breaking off the root (non-viable) seed

death area
Seed Vigor Tests

• **Speed of Germination test** (Soybeans 1°)
  - soybean four day germination test

• **Conductivity test** – measures seed leachates, thus membrane permeability

Figure 4.29 The electrode should not touch the seeds. Left picture is incorrect procedure, right picture is correct procedure. Photographs from P. Bahlaki.

AOSA Seed Vigor Testing Handbook, 2009
Seed Vigor Tests

- Germination Temperature - (low or high temp. as a vigor test)
  - use gradient table
  - high vigor - will germinate over a wider range of temperatures
  - low vigor - will germinate in a narrower range of temperatures.
Relationships among seed vigor, viability (germinability) and deterioration, and the area for application of vigor tests. The x and y points on the viability and vigor curves illustrate the increasing “gap” between germinability and vigor with increasing deterioration. From Delouche and Caldwell (1960).

### Soybeans

<table>
<thead>
<tr>
<th>Germ %</th>
<th>AA%</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>97</td>
</tr>
<tr>
<td>93</td>
<td>81</td>
</tr>
<tr>
<td>88</td>
<td>74</td>
</tr>
<tr>
<td>94</td>
<td>50</td>
</tr>
<tr>
<td>86</td>
<td>38</td>
</tr>
<tr>
<td>89</td>
<td>23</td>
</tr>
<tr>
<td>88</td>
<td>1</td>
</tr>
</tbody>
</table>

### Corn

<table>
<thead>
<tr>
<th>Germ %</th>
<th>Cold %</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>97</td>
</tr>
<tr>
<td>96</td>
<td>84</td>
</tr>
<tr>
<td>94</td>
<td>75</td>
</tr>
<tr>
<td>93</td>
<td>61</td>
</tr>
<tr>
<td>93</td>
<td>47</td>
</tr>
<tr>
<td>90</td>
<td>38</td>
</tr>
<tr>
<td>78</td>
<td>1</td>
</tr>
</tbody>
</table>
Characteristics of a vigor test

- Inexpensive
- Rapid
- Not complicated
- Objective
- Reproducible
- Correlated with field emergence
Try to determine the vigor

Seed Deterioration = Seed Vigor = Aging
STANDARD TEST

Purity and Germination
The laboratory analysis for law enforcement, labeling, and general information as to seed quality, should determine the following for the sample analyzed:
The purity composition
Purity
Determine the physical composition of the working sample
Purity is: Identification of the kind under consideration, and all contaminating species and inert matter
The rate of occurrence of noxious-weed seeds
<table>
<thead>
<tr>
<th>Variety</th>
<th>Kind</th>
<th>Lot Number</th>
<th>Test Requested</th>
<th>Lab # (for office use only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR 341</td>
<td>Wheat</td>
<td>15-122</td>
<td>Purity &amp; Germination</td>
<td></td>
</tr>
</tbody>
</table>
### Unofficial Transcript

Name and Address
Big Seed Co., Inc.
123 wheat Road
Little Bend, MS 39701

Phone 662-325-5575
Fax __________

MS Dept. of Agriculture
Bureau of Plant Industry
P.O Box 5207
State Seed Lab
Ms. State, MS 39762

Shipping info:
State Seed Lab
705 Stone Blvd.
Ms. State, MS 39762

Comments: ________________

<table>
<thead>
<tr>
<th>Variety</th>
<th>Kind</th>
<th>Lot Number</th>
<th>Test Requested</th>
<th>Lab # (for office use only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR 341</td>
<td>Wheat</td>
<td>15-122</td>
<td>Purity &amp; Germination</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


## Unofficial Transcript

**Name and Address**
- Big Seed Co., Inc.
  - 123 wheat Road
  - Little Bend, MS 39701
- Phone 662-325-5575

**MS Dept. of Agriculture**
- Bureau of Plant Industry
  - P.O Box 5207
  - State Seed Lab
  - Ms. State, MS 39762
  - Phone 662-325-5575

**Shipping info:**
- State Seed Lab
  - 705 Stone Blvd.
  - Ms. State, MS 39762

**Fax**

**Comments:**

**Variety** | **Kind** | **Lot Number** | **Test Requested** | **Lab # (for office use only)**
--- | --- | --- | --- | ---
TR 341 | Wheat | 15-122 | Purity & Germination | U-0572

**Date:** 7-15-15
AOSA
RULES FOR TESTING SEEDS
a. Mechanical dividers. – This method is suitable for most kinds of seeds. The apparatus divides a sample into two approximately equal parts. The submitted sample is mixed by passing it through the divider, recombining the two parts and passing the whole sample through a second time and similarly a third time. After mixing, the sample shall be reduced by passing the seed through the divider repeatedly, removing half the sample on each occasion. This process of successive halving is continued until a working sample of approximately, but not less than the minimum weight(s) stated in Table 2A is obtained.
<table>
<thead>
<tr>
<th>Kind of seed</th>
<th>Minimum weight for purity analysis(^a)</th>
<th>Minimum weight for noxious-seed examination</th>
<th>Approximate number of seed per gram(^b)</th>
<th>Approximate number of seeds per ounce(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Trifolium dubium</em> Sibthorp</td>
<td>Grams</td>
<td>Grams</td>
<td>Number</td>
<td>Number</td>
</tr>
<tr>
<td>small hop clover (suckling clover)</td>
<td>2</td>
<td>20</td>
<td>1,950</td>
<td>55,225</td>
</tr>
<tr>
<td><em>Trifolium fragiferum</em> L.</td>
<td>5</td>
<td>50</td>
<td>635</td>
<td>18,000</td>
</tr>
<tr>
<td>strawberry clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium glomeratum</em> L.</td>
<td>1</td>
<td>10</td>
<td>2,925</td>
<td>82,895</td>
</tr>
<tr>
<td>cluster clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium hirtum</em> Allioni</td>
<td>7</td>
<td>70</td>
<td>360</td>
<td>10,280</td>
</tr>
<tr>
<td>rose clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium hybridum</em> L.</td>
<td>2</td>
<td>20</td>
<td>1,500</td>
<td>42,525</td>
</tr>
<tr>
<td>alsike clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium incarnatum</em> L.</td>
<td>10</td>
<td>100</td>
<td>330</td>
<td>9,360</td>
</tr>
<tr>
<td>crimson clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium lappaceum</em> L.</td>
<td>2</td>
<td>20</td>
<td>1,500</td>
<td>42,525</td>
</tr>
<tr>
<td>lappa clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium pratense</em> L.</td>
<td>5</td>
<td>50</td>
<td>600</td>
<td>17,010</td>
</tr>
<tr>
<td>red clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium repens</em> L.</td>
<td>2</td>
<td>20</td>
<td>1,500-2,000</td>
<td>42,000-55,000</td>
</tr>
<tr>
<td>white clover and ladino clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium resupinatum</em> L.</td>
<td>2</td>
<td>20</td>
<td>1,415</td>
<td>40,145</td>
</tr>
<tr>
<td>Persian clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium semipilosum</em> Fresenium</td>
<td>2</td>
<td>20</td>
<td>145</td>
<td>4,000</td>
</tr>
<tr>
<td>Kenya clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Trifolium subterraneum</em> L.</td>
<td>25</td>
<td>250</td>
<td>120</td>
<td>3,375</td>
</tr>
<tr>
<td>sub clover, subterranean clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triticosecale triticale</td>
<td>100</td>
<td>500</td>
<td>25</td>
<td>710</td>
</tr>
<tr>
<td>Triticum aestivum L. and other spp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wheat (also durum, emmer, and spelt)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia arvensis</em> H. semenens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia minima</em> var. <em>arvensis</em> H. semenens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia pannonica</em> Crantz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungarian vetch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia sativa</em> L. subsp. <em>nigra</em> (L.) Barthart</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia sativa</em> L. subsp. <em>vaillantiana</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia vilmorinii</em> Frieson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Vicia villosa</em> Frieson</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The image shows a stainless steel container filled with seeds, placed on an electronic scale. The scale displays a weight of 105.4 grams.
<table>
<thead>
<tr>
<th>Lab #</th>
<th>Kind</th>
<th>Purity</th>
<th>Nox.</th>
<th>Pure</th>
<th>Inert</th>
<th>Crop</th>
<th>Weed</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>U0572</td>
<td>Wheat</td>
<td>104.32</td>
<td></td>
<td>0.135</td>
<td>0.68</td>
<td>0.27</td>
<td></td>
<td>1 - Johnson Grass</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 - Morning Glory</td>
<td>105.4g 504.7g</td>
</tr>
<tr>
<td>Lab #</td>
<td>Kind</td>
<td>Purity</td>
<td>Nox.</td>
<td>Pure</td>
<td>Inert</td>
<td>Crop</td>
<td>Weed</td>
<td>Noxious Weeds</td>
</tr>
<tr>
<td>-------</td>
<td>----------</td>
<td>--------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>-------</td>
<td>----------------------</td>
</tr>
<tr>
<td>U0572</td>
<td>wheat</td>
<td>104.32</td>
<td>98.97%</td>
<td>0.13</td>
<td>0.13%</td>
<td>0.68</td>
<td>0.27</td>
<td>4 - Johnson grass</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 - morning glory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>105.4 g</td>
</tr>
<tr>
<td>Lab #</td>
<td>Kind</td>
<td>Purity</td>
<td>Nox.</td>
<td>Pure</td>
<td>Inert</td>
<td>Crop</td>
<td>Weed</td>
<td>Notes</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>--------</td>
<td>------</td>
<td>------</td>
<td>-------</td>
<td>------</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>U0572</td>
<td>wheat</td>
<td>104.32</td>
<td></td>
<td>0.13</td>
<td>0.68</td>
<td>0.27</td>
<td></td>
<td>4-Johnson 6155 1-morning glory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>99.97%</td>
<td></td>
<td></td>
<td></td>
<td>2-morning glory</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Lab #</th>
<th>Kind</th>
<th>Purity</th>
<th>Nox.</th>
<th>Pure</th>
<th>Inert</th>
<th>Crop</th>
<th>Weed</th>
<th>Noxious Weeds</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>U0572</td>
<td>Wheat</td>
<td>104.32</td>
<td>98.97%</td>
<td>0.135</td>
<td>0.68</td>
<td>0.27</td>
<td>1-morning glory</td>
<td>4-Johnson 6/26/16</td>
<td>105.4g  504.7g</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.13%</td>
<td>0.65%</td>
<td>0.25%</td>
<td></td>
<td>2-morning glory</td>
<td>3-morning glory/16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4-Johnson 6/26/16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Date 5-14-16 Analyst FW
Table 3. Methods of testing for laboratory germination and hard seeds, AGRICULTURAL SEEDS (continued)

<table>
<thead>
<tr>
<th>Kind of seed</th>
<th>Substrata (See Sec. 4.9-a-b)</th>
<th>Temperature° C. (See Sec. 4.9-c)</th>
<th>First count days (See Sec. 4.9-d)</th>
<th>Final count days</th>
<th>Specific requirements and photo numbers (See Sec. 4.9-b-e-f)</th>
<th>Fresh and dormant seed (See Sec. 4.2-e and 4.9-e-f)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trifolium repens</strong></td>
<td>B, T, S</td>
<td>20</td>
<td>3</td>
<td>7a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td>white and ladino clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trifolium resupinatum</strong></td>
<td>B, T</td>
<td>20</td>
<td>3</td>
<td>7a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td>Persian clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trifolium semipilosum</strong></td>
<td>B, T, S</td>
<td>20</td>
<td>3</td>
<td>7a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td>Kenya clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trifolium subterraneum</strong></td>
<td>B, T</td>
<td>20</td>
<td>4</td>
<td>14a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td>sub clover</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>X Triticosecale</strong></td>
<td>B, T, S</td>
<td>20; 15</td>
<td>4</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>triticale</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Triticum aestivum and other species</strong></td>
<td>B, T, S</td>
<td>20; 15</td>
<td>4</td>
<td>7</td>
<td>Photos 2507, 2520-2522.</td>
<td></td>
</tr>
<tr>
<td>other than T. durum wheat (including spelt and emmer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prechill at 5° or 10° C for 5 days or predry (refer to sec. 4.2-g).
<table>
<thead>
<tr>
<th>Kind of seed</th>
<th>Substrata (See Sec. 4.9-a-b)</th>
<th>Temperature* C. (See Sec. 4.9-c)</th>
<th>First count days (See Sec. 4.9-d)</th>
<th>Final count days</th>
<th>Specific requirements and photo numbers (See Sec. 4.9-b-e-f)</th>
<th>Fresh and dormant seed (See Sec. 4.2-e and 4.9-e-f)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Trifolium repens</em> white and ladino clover</td>
<td>B, T, S</td>
<td>20</td>
<td>3</td>
<td>7a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td><em>Trifolium resupinatum</em> Persian clover</td>
<td>B, T</td>
<td>20</td>
<td>3</td>
<td>7a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td><em>Trifolium semipilosum</em> Kenya clover</td>
<td>B, T, S</td>
<td>20</td>
<td>3</td>
<td>7a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td><em>Trifolium subterraneum</em> sub clover</td>
<td>B, T</td>
<td>20</td>
<td>4</td>
<td>14a</td>
<td>See section 4.9-c.</td>
<td>15° C.</td>
</tr>
<tr>
<td>X <em>Triticeale</em> tritcile</td>
<td>B, T, S</td>
<td>20; 15</td>
<td>4</td>
<td>7</td>
<td></td>
<td>Prechill at 5° or 10° C for 5 days, or predry (refer to sec. 4.2-g).</td>
</tr>
<tr>
<td><em>Triticum aestivum</em> and other species other than <em>T. durum</em> wheat (including spelt and emmer)</td>
<td>B, T, S</td>
<td>20; 15</td>
<td>4</td>
<td>7</td>
<td>Photos 2507, 2520-2522.</td>
<td>Prechill at 5° or 10° C for 5 days or predry (refer to sec. 4.2-g).</td>
</tr>
</tbody>
</table>

- T: Tape
- B: Barren
- S: Soil

*Note: Temperature requirements vary depending on the specific conditions and requirements for each seed type.*
The percentage germination of the pure seed under consideration
Germination

In seed laboratory practice, germination is defined as the emergence and development from the seed embryo of those essential structures that, for the kind of seed in question, are indicative of the ability to produce a normal plant under favorable conditions.
Normal seedlings
Seedlings possessing the essential structures that are indicative of their ability to produce plants under favorable conditions.
Abnormal seedlings
All seedlings that cannot be classified as normal seedlings.
Hard seeds
Seeds that remain hard at the end of the prescribed test period because they have not absorbed water due to an impermeable seed coat. Seeds known and recognized to contain hard seed are indicated in either the "Specific Requirements and notes" column or “Fresh and Dormant Seed” column of Table 6A. The percentage hard seed is to be reported in addition to the percentage germination.
**Dormant seed**

Viable seeds, other than hard seeds, that fail to germinate when provided the specified germination conditions for the kind of seed in question. Viability of firm, ungerminated seeds of all species (see note below for clarification) must be determined by any appropriate method or combination of methods. Refer to section 6.9 m. The percentage of dormant seeds, if present, must be reported in addition to the percentage germination. If germination is over 90%, dormancy determination is not mandatory, unless it is a species sold on a pure live seed basis.
Dead seeds
Seeds that at the end of the test period are neither hard nor dormant nor have produced any part of a seedling.
POACEAE, GRASS FAMILY I - Cereals

*Avena sativa*, oat
*Hordeum vulgare* subsp. *vulgare*, barley
*Secale cereale* subsp. *cereale*, rye
*Secale strictum* subsp. *strictum*, mountain rye
*Triticum* spp., wheat
*×Triticosecale* spp., triticale

GENERAL DESCRIPTION

**Seedling type:** Hypogeal monocot.

**Food reserves:** Endosperm. The scutellum is a modified cotyledon that is in direct contact with the endosperm. During germination the scutellum remains inside the seed absorbing nutrients from the endosperm and transferring them to the growing seedling.

**Shoot system:** The shoot consists of the coleoptile and enclosed leaves that grow from the meristematic region at their base and the mesocotyl. The shoot elongates and pushes through the soil surface; the mesocotyl may elongate depending on the variety and light intensity, but is usually not discernable. Splitting of the coleoptile tip occurs naturally as a result of expansion of the leaves inside.

**Root system:** A primary root and seminal roots. The primary root is not readily distinguishable from the seminal roots, therefore all roots arising from the seed are referred to as seminal roots.

![Cereal Diagram](image-url)

Fig. 1 Cereal.
**ABNORMAL SEEDLING DESCRIPTION**

**Shoot:**
- missing.
- no leaf.
- leaf extending less than halfway up into the coleoptile.
- leaf badly shredded or longitudinally split.
- coleoptile split for more than one-third the length from the tip.
- thin, spindly, pale or watery.
- badly frost-damaged (characterized by graininess, spiral twisting and shredding, and loss of vigor).
- deep open cracks in the mesocotyl.
- (see also notes 1 and 2).

**Root:**
- less than one strong seminal root.

**Seedling:**
- decayed at point of attachment to the scutellum.
- one or more essential structures impaired as a result of decay from primary infection.
- albino.
- endosperm obviously detached from the root-shoot axis (e.g. kernel lifted away by the growing shoot).
- seedlings with badly thickened and shortened roots and shoots due to injury from chemical treatment (see note 3).

**NOTES**

1. Seedlings grown in the dark or in low intensity light will exhibit increased elongation of the coleoptile and in some cases the mesocotyl. In towels, there may be considerable twisting of the shoot.

2. Splitting of the coleoptile tip occurs naturally as a result of expansion of the leaves inside and occurs after emergence and after the coleoptile ceases to elongate upon exposure to light.

3. Seedlings with badly thickened and shortened roots and shoots due to injury from chemical treatment are to be classified as abnormal. If such seedlings are difficult to evaluate on paper substrata, the interpretation should be based on the seedling performance in sand or soil.
**Fig. 2** Root defects.

2a. Two strong seminal roots.
2b. One strong seminal root.
2c. Less than one strong seminal root.
2d. Less than one strong seminal root.

**Fig. 3** Shoot defects.

3a. Shoot slightly deformed.
3b. Leaf less than half the length of coleoptile.
3c. Shoot not developing.

**Fig. 4** Detached endosperm.
Fig. 5 Leaf defects.

5a. Coleoptile split for more than one-third of the length from the tip.
5b. Coleoptile damaged with leaf emerging through side split.
5c. Coleoptile split near base, with leaf bursting out.

5d. Leaf tip split, but shoot otherwise healthy.
5e. First leaf badly split
5f. Leaf shredded.
6a. Double oat.

6b. Seedling with elongated mesocotyl. Note that this gives the seedling the appearance of being "spindly".

6c. Spiraling shoot, from being trapped in confined space such as towel or closely planted seeds.

Fig. 6 Seedlings.
<table>
<thead>
<tr>
<th>Lab #</th>
<th>Kind</th>
<th>Date Planted</th>
<th>Rep. 1</th>
<th>Rep. 2</th>
<th>Rep. 3</th>
<th>Rep. 4</th>
<th>Sample Out</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>572</td>
<td>Wheat</td>
<td>6/16</td>
<td>88</td>
<td>94</td>
<td>86</td>
<td>90</td>
<td></td>
<td>90% Germination</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
THE
END
Storing For Quality: Successfully Progressing From Seed Stabilization To Conditioning

Edgar Cabrera
DuPont Pioneer
Objectives

- Review key concepts regarding maturation and harvest
- Define seed “stabilization”
- Consider main components of the stabilization process:
  - Drying
  - Bulk storage
- Set the stage for successful plant operations
Seed maturation and harvest
Soybean seed development

SOYBEAN TIMELY HARVEST
Seed maturation

- **Physiological maturity (PM)**
  - Maximum dry weight accumulation
  - High seed moisture content (corn, sorghum, rice ~ 30-35%; soybeans ~55-60%)
  - Maximum potential physiological quality

- **Harvest maturity (HM)**
  - Lower seed moisture for appropriate mechanical collection and threshing
  - Timing influenced by weather conditions
  - From PM to HM seed stored in the field
  - Seed deterioration
Typical harvest moistures

- Seed corn: 30-35%
- Sorghum seed: 15%
- Rice seed: 18-20%
- Soybean seed: 12-14%
Harvest timeliness

- Very critical to quality
- Weather is a key element
- Within field and within plant variability
Seed stabilization
Seed stabilization

- Process to bring seed into a metabolically stable, steady, and secure condition
- Key factors that determine seeds’ metabolic activity
  - Genotype
  - Seed moisture
  - Seed temperature
Influence of genotype

- Not all species have the same ability to maintain physiological quality.
Seed moisture

- The higher the moisture, the faster seed will deteriorate
- Typical seed moisture level for storage of common row crops:
  - Cereals: 12 – 13%
  - Oil seeds: 9 – 12%
- In moisture-proof containers: 2-3 points of moisture lower
- Seed moisture declines during development; after PM it will be dictated by ambient conditions in the field
Seeds are hygroscopic

- After PM moisture in the seed is in vapor form
- How much moisture is retained in the seed is a function of water vapor pressure (WVP)
- Water vapor molecules behave in response to the WVP gradient
- Over time WVP of seed = WVP of air – equilibrium moisture content (EMC)
Seeds are hygroscopic

A

Water molecules

WVP in seed > WVP in air

B

WVP in seed = WVP in air

Initial EMC
Determined using Chung-Pfost equation
Determined using Chung-Pfost equation
Determined using Chung-Pfost equation
Stabilization – mechanical drying
Mechanical seed drying

- Process by which seed moisture is reduced down to levels needed for safe storage
- Involves exposing seed to dry (warm) air to evaporate moisture
- Typically done in deep-bed batches, continuous flow dryers, or rotary drum driers
- For vegetable and flower seed packaged in moisture-proof containers, drying may involve desiccant products
Continuous flow dryers

- Sorghum seed
- Rice seed
- Soybean seed
DPR ear corn dryer
SPR ear corn dryer
Box driers
Drying – a time-dependent process
Drying in a deep-bed dryer
Drying in a deep-bed dryer
Drying in a deep-bed dryer
Drying in a deep-bed dryer
Drying in a deep-bed dryer
Practical implications

- The higher the seed moisture, the longer it will take for the whole batch to dry
- The lower the airflow rate (CFMs), the slower the advancement of the drying front and the shallower the drying zone will be
- The deeper the bed, the longer it will take for the drying front to reach the other end
- Applying the airflow in only one direction will create a substantial final seed moisture range
Practical implications

- Airflow rate: typically greater than for grain
- Appropriate movement of the drying front
- Prevents deterioration of seed on the opposite end of air inlet
- Reversing airflow direction will reduce seed moisture range at end of drying
Seed temperature

- Drying air is typically heated
- Adding heat:
  - Reduces relative humidity of the air
  - Increases differential in WVP
- Excess heat may damage seed – max. 110°F
  - Rely on psychrometric calculations
  - High moisture seed is more susceptible than lower moisture seed
  - Drying rate will be more aggressive with high moisture seed
Stabilization – bulk storage
Bulk storage

• Storing seed in transition to conditioning
• Bulk storage will not improve quality
• Good housekeeping is a pre-requisite
• Length of storage period is important
• Critical elements:
  • Seed moisture
  • Seed temperature
Appropriate bulk storage requires affective aeration

- Purpose of aeration
  - To manage seed TEMPERATURE
  - To avoid moisture issues
Aeration best practices

- Appropriate airflow rate
  - 0.1 – 0.5 CFM/bu
  - Allow cooling front to move all the way through
- Cool seed within 15°F of season ambient temperature
- Maintain seed mass temperature within 5°F
- Monitor temperature
- Sample for seed moisture
- If necessary, move the seed
When to aerate?

- ASAP!
- During cool and dry periods
- Remember: the main target is to lower the temperature
- Consider using automatic aeration and monitoring systems
- Typically aeration is not just one event
Aeration dynamics - temperature

Cooling front
Aeration dynamics - temperature

Cooling front
Aeration dynamics – when to stop
Other tools

- Fixed thermocouples
- Manual or digital thermometer
- Sling psychrometer
- Your sense of smell
- Automated grain bin management systems
Setting the stage for successful plant operations
Key concepts to keep in mind

- Adopt a mindset that recognizes operations to be systemic in nature
- Processes involve people, inputs, equipment, outputs, procedures, and IT systems
- When dealing with one of these processes, consider impact up- and down-stream
Key concepts to keep in mind

- Managing operations involve balancing throughput with product quality – neither one at the expense of the other.
- Seed quality is multi-faceted, dynamic, and directly tied to customer expectations.
- Adopt a “continuous improvement” mindset or aptitude.
- “What we care about we should measure”
- Operational safety is paramount.
- Operators training is essential.
  - Technical skills
  - Soft skills