Proceedings of the Seed Technology Short Course

Volume III

Seed Tech 2017: Cover Crop Opportunities

This collection is assembled for the convenience of the attendees of the Seed Technology Short Course and is not peer-reviewed.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.

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Seed Tech 2017: Cover Crop Opportunities

Tuesday, August 1, 2017

9:30  Registration

10:00  Welcome and Introduction

10:15  Cover Crop Basics and Considerations for Production Agriculture – Alayna Jacobs, USDA-NRCS

11:00  Cover Crops for Grazing & Pasture Management: Impact/benefits, planning – Brett Rushing, MSU Extension/MAFES

11:45  Group Picture

12:00  Lunch – by Mr. Charlie’s Catering Service, Sponsored by LMC Manufacturing & Pennington Seed Inc.

1:00  Wildlife Sector Cover Crops: Impact/benefits, planning – Scott Baker, Specialty Seeds Inc.

1:45  Seed Mixture Considerations: Variety Selections & Theoretical Applications – Wes Burger, MSU MAFES/FWRC

2:30  Break – Snacks & Refreshments, Sponsored by Buck Island Seed Co., La Crosse Seed, & Petcher Seeds

2:45  Seed Mixture Considerations: Soil Health & Fertility – Jac Varco, MSU Plant & Soil Sciences

3:15  Cover Crop Economics – Larry Falconer, MSU Extension

3:45  Company Perspective: Cover Crops for Ag. & Wildlife Mgt. Applications – Jimmy Ray Parish, Pennington Seed

4:15  Q & A Session

6:00  Social/Steak Dinner – by MSU Collegiate Cattlemen’s Association, Sponsored by LMC Manufacturing & Pennington Seed Inc.

Wednesday, August 2, 2017

7:30  Doors Open

8:00  Welcome and Introduction

8:15  Cleaning and Separation Equipment for Cover Crop Seed – Myles Mosely, LMC Manufacturing

9:00  Mixing/Blending Equipment and Considerations for Cover Crop Seed – Dave Ewald, Bratney Companies

9:45  Seed Treatments and Coatings – Kyle Rushing, KW Rushing Consulting, Inc. - Seed Treatment Solutions

10:15  Break - Snacks & Refreshments, Sponsored by Buck Island Seed Co., La Crosse Seed, & Petcher Seeds

10:30  Dormancy & Specialty Crop Seed Physiology – Fawad Shah, Minnesota Crop Improvement Association

11:15  Sampling Seed Mixtures – Randy Vaughan, MAFES Foundation Seed
11:45   Lunch – by Mr. Charlie’s Catering Service, *Sponsored by LMC Manufacturing & Pennington Seed Inc.*

12:45   Testing Seed Mixtures – *James Smith, Mississippi State Seed Testing Laboratory*

1:15    Labeling Mixtures, State Law – *Fabian Watts, Mississippi State Seed Testing Laboratory*

1:45    Labeling Mixtures, Federal Law – *Steve Malone, Seed Regulatory and Testing Division, USDA-AMS*

2:15    Break – Snacks & Refreshments, *Sponsored by Buck Island Seed Co., La Crosse Seed, & Petcher Seeds*

2:30    Panel Discussion: Cover Crop Seed Technology - Emerging Trends & Future Considerations
Panelists:
- *Cooper Hurst - Producer, Woodville, MS*  
- *Coley Bailey - Producer, Grenada, MS*  
- *Dan Prevost - Delta F.A.R.M., Stoneville, MS*

3:15    Summary, Evaluation, & Closing
Cover crop considerations for seedsmen.

Ernie Flint, Ph.D.
Regional Specialist - Agronomy
Mississippi State University Extension Service
July 2017

Abstract:
Recent trends in the management of soils, weeds, and pests have produced a renewed awareness of the value of cover crops in the production of crops. The benefits include improved soil quality, reduced weed competition, suppression of nematodes and insect pests, and sequestration of carbon as an environmental benefit. Many of the crops considered for use as cover crops are suitable for use as alternative forage crops thereby offering an opportunity for diversified producers to take extra value from this part of their cropping system. The most common crops being utilized in the role of cover crops present opportunities for seedsmen to produce, process, and market these seeds to farmers as a means of supporting this progressive trend in agriculture. Although most of the crops being utilized as cover are cool season species, others may be included which are warm season as well.

Introduction:
This paper will seek to offer supporting information on specific considerations about possible benefits as well as challenges associated with the use of some of the more commonly used cover crops species. I will attempt to identify for the readers both the positive and negative factors that may be encountered with these crops in hope that this information will aid them in making decisions about the use of these crops in farming operations as well as issues that may be connected with their production for sale to other growers.

Some of the categories for consideration of cover crops include but are not limited to the following:

1. Soil and water quality benefits
   a. Water relations
   b. Soil organic matter
   c. Rotational benefits
2. Relationship to soil organisms
   a. Mycorrhizae
   b. Plant diseases
   c. Food source for beneficial soil organisms such as earthworms
3. Weed management considerations
   a. Mulch effect
   b. Allelopathy
   c. Suppression of nematode host species
4. Interaction with summer crops
   a. Interference with planting and harvesting
   b. Competition
5. Carbon sequestration
Soil Quality Benefits:

A very comprehensive paper titled Using Winter Cover Crops To Improve Soil And Water Quality by S.M. Dabney, J.A. Delgado, and D.W. Reeves published in Communications in Soil Science and Plant Analysis in 2001, 32(7&8), 1221-1250, reviews literature about the impacts of cover crops in cropping systems that affect soil and water quality. Their abstract comments include that most cover crops are grown during periods when the soil is otherwise not being utilized for crop production. Cover crops increase the harvest of solar energy and carbon in the soil, providing food for soil micro and macro-organisms, while also increasing evapotranspiration from the soil. Cover crops reduce sediment production from cropland by intercepting the kinetic energy of rainfall and by reducing the amount and velocity of runoff. Cover crops increase soil quality by improving biological, chemical and physical properties including organic carbon content, cation exchange capacity, aggregate stability, and water infiltration. Legume cover crops contribute nitrogen to subsequent crops. Other cover crops, especially grasses and brassicas, are better at scavenging residual nitrogen before it can be leached from the soil profile. Cover crops are best adapted to warm areas with abundant rainfall. Water use by cover crops can adversely impact yields of subsequent dryland crops in arid and semiarid regions. Similarly, cooler soil temperatures under cover crop residues can retard early growth of subsequent crops grown near the cold end of their range of adaptation. Development of systems that reduce the costs of cover crop establishment and overcome subsequent crop establishment problems will increase cover crop utilization and improve soil and water quality. Those whose interest is more in-depth than this present document may satisfy should obtain and study this paper to gain a better understanding of all the factors involved.

A well-recognized factor involved with the use of cover crops is that of rotational value. The alternation of differing plant/crop species discourages the development of high populations of pests and disease pathogens associated with monocrop systems. Rotation also encourages diversification of soil organisms, allowing for more appropriate relationships among soil organisms and a wide range of crop species. Crop rotation with both cover and primary crops permits alternation of management strategies for the entire range of techniques including soil fertility, weed management, pest management, and crop utilization.

The following section is drawn from a Penn State Cooperative Extension piece from what is referred to as their Conservation Tillage Series. This piece is number five in a series and is titled Cover Crops for Conservation Tillage Systems. It was prepared by William S. Curran, Professor of Weed Science; Dwight D. Lingenfelter, Program Development Specialist; Lyn Darling, Project Associate; and Peggy Wagoner, formerly of the Rodale Institute.

Relationship to soil organisms:

Increased plant residues and the tillage practices generally associated with cover crop systems may improve the soil environment for many beneficial organisms. Organisms such as earthworms, insects, and microorganisms can improve soil quality and increase nutrient availability by quickly decomposing organic matter and plant residues. Earthworms in particular help improve water infiltration and soil structure. Other insects as well are attracted to cover crop vegetation may provide benefits by feeding on harmful pests.

Weed Management Considerations:

Cover crops partially control some weeds by competing with them for light, moisture, nutrients, and space, which can be helpful for suppressing winter annual weed growth or certain cool-season perennials. Cover crops and their residues can also act as mulches or physical barriers by smothering weeds, suppressing weed seed germination and growth, and lowering soil temperatures thereby discouraging the germination and emergence of weed species. Cover crops may contain allelopathic compounds, which are released from living or decaying plant tissue. These
Compounds act as mild herbicides by chemically interfering with weeds through suppression of germination as well as retarding growth of plants in close proximity. However, all of these qualities can vary depending on the type and quantity of cover crop and the environmental conditions present during the growing season. Despite these potential benefits, physical and chemical effects from cover crops may not be a major factor for weed control.

Possible feed source

Certain cover crops, especially grass species, also can be used for livestock feed. These crops can be grazed directly or mechanically harvested as silage, haylage or hay. Generally, mechanically harvesting the cover will not have a negative impact on erosion control benefits, especially when no-till planting follows. With proper management, grazing will have a similar effect, because even though the tops are harvested or grazed, root mass and stubble remain to provide protection from erosion. However, removal of the cover crop also removes nutrients that eventually must be replaced. Direct grazing is actually preferred in this consideration since grazing animals will recycle nutrients back onto the soil surface as they graze.

Influence of Cover Crops On Beneficial Mycorrhizal Fungi:

The subject of mycorrhizal fungi and their beneficial effects on crops is still in the background for most of the crop production community, not only including farmers and field agronomists, but also research agronomists. The subject has not been recognized for its importance in the uptake of nutrients and water. However, the movement toward reduced tillage and no-till practices has allowed for the expansion of the influence of these unseen organisms to provide their significant beneficial attributes to much more crop acreage than was formerly the case when virtually all of the crop production was done through intensive tillage.

Mycorrhizal fungi associate themselves with almost all plant species with possible exception of the Brassicas. Some crops are more dependent upon them than others, with broadleaf crops such as cotton and soybeans drawing significant amounts of their water and nutrients through these alternative uptake and absorption systems. These principles are especially important for dryland crops where irrigation is not available since mycorrhizae are capable of accessing supplies of water and nutrients far beyond the reach of the plant’s own root system.

Cover crops can act as support crops for mycorrhizal fungi during the cool season or when the primary crop is not growing on a specific field. The mycorrhizal fungal network (or Hartig Network) can then move over to colonize the roots of the primary crop such as cotton, corn, soybean, peanuts, and others. They are especially important for horticultural crops grown without irrigation.

Important cover crops which support the growth and activities of mycorrhizal fungi include the cereals such as wheat, rye, triticale, and oats as well as legumes such as clovers, alfalfa, winter peas, vetch, and others. These crops act as “Companion” crops in that they provide active mycorrhizal communities that move over to the primary summer crop to stimulate growth and the production of vegetative growth and fruiting. The following diagram from Lehman (2012) shows a comparison between soils in which cover crops have been growing and without any crop.

The subject of mycorrhizal fungi has not been generally embraced by the farming community because it is invisible to the unaided eye. Unlike the benefits provided by Rhizobium bacteria in fixing nitrogen in legumes which produce visible nodules, mycorrhizal hyphae are so small that they are not visible for inspection if a plant is pulled from the soil. In order to see these hyphal strands the plant must be dug up and the roots carefully washed. Then the roots can be inspected under microscopic magnification to view colonization sites for the beneficial strands of mycorrhizal fungi.
When the crop is desiccated or harvested the root system soon dies in most cases, leaving the mycorrhizal fungi without a food source. While the fungi can regenerate from spores it is much better to have a cover crop producing new roots onto which the mycorrhizae can colonize and resume its activities in accessing water and nutrients from the soil. This should probably occur within no more than two weeks following the harvest of the summer crop. In this region our most suitable crop for providing the benefits of mycorrhizal fungi to crops like cotton, corn, and soybean are the cereals including wheat, rye, triticale, and oats. Ideally these or mixtures of these and other crops from the legume family should be planted as near to harvest of the summer crop as possible in order for the mycorrhizae to colonize and resume its beneficial function.

Other cover crop species may be blended with the cereals. Legumes are proven for this purpose and can supply nitrogen to summer crops during the following warm season. Brassicas should not be planted alone as a cover crop since they are not host crops for the mycorrhizal fungi and will allow the mycorrhizal culture to be reduced to a very low level of activity before the next growing season. The fungus does regenerate from spores the following year, but benefits will be greatly delayed for the next crop since the hyphal network must completely rebuild itself under those conditions.

Figure 1. The following figure demonstrates the importance of cover crops in support of mycorrhizal fungi.
Disadvantages of Cover Crops:

Additional costs:

There are additional costs above and beyond normal cropping practices that must be considered in systems that include cover crops. Extra expenditures include the cost of the cover crop seed as well as labor and time for planting. Also, special or alternative equipment may be needed to handle the greater amounts of residue present in no-till systems. Cover crops must be managed like any other crop produced in the farm operation.

Interference with primary crop:

Unmanaged cover crops can act as weeds by competing with the primary crop for light, moisture, nutrients, and space. In a dry year, cover crops can rob primary crops of valuable soil moisture. In other years, they may also compete for other resources such as nitrogen if not managed properly. For most cropping systems with cover crops, the use of starter fertilizer during planting of the primary crop should compensate for nutrients used by the cover crop. Immobilization of nitrogen by the cover crop generally is negligible, especially if manure has been applied. However, if large amounts of vegetation are being tilled under, producers raising corn should split the nitrogen requirements between planting (one-third) and side-dressing (two-thirds).

Cover crops also may be affected by the same chemical and physical factors that contribute to weed control. As with weeds, crop species can be hampered by chemicals released from cover crops, cooler soil temperatures, and the smothering effects of cover crop residues. Cooler temperatures may delay the germination and growth of the grain crop. Crop residues also may act as physical barriers, making uniform spray coverage more difficult. These residues also may bind herbicides, resulting in reduced activity. Preemergence herbicide programs may need to be adjusted to account for this interaction.

Pest problems:

Cover crops, like weedy fields, may harbor insects, diseases, and nematodes that could be harmful to the cover crop and detrimental to future crops. Consider specific pest/crop interactions that may become a problem. For example, cereal rye or wheat can attract armyworms. Heavy populations of certain weeds such as chickweed and henbit attract black cutworms and act as off-season hosts for harmful nematode species. In some cases the cost of cover crop establishment may be offset by their capability to reduce populations of reniform and/or root knot nematodes that may be sustained by cool season weed species. Understanding these potential interactions and the conditions that favor them helps producers make proper management decisions.

Carbon Sequestration:

The sequestration of carbon in the soil is a natural occurrence whenever soil organic matter levels are increased by any means whether by reduction of tillage, rotation of crops, the addition of supplemental organic matter such as poultry litter, and in this case the use of cover crops. One of the fundamental principles of agriculture is that the soil should have some kind of vegetation growing on it at all times. As mentioned earlier, the presence of soil cover in almost any form is beneficial since it reduces the kinetic energy of raindrops as they strike the surface, thereby reducing the likelihood that soil particles will be detached and become subject to movement by flowing water and wind.

As plants grow, whether they are considered as a primary crop such as cotton, corn, soybeans, peanuts, rice or a cover crops such as wheat, oats, clover, etc., that crops takes in carbon from the atmosphere and converts it to
carbohydrate materials such as sugars and cellulose, as well as temporary structures like leaves. Much of this biomass can then be incorporated into the soil by decomposing macro and micro-organisms to ultimately raise the carbon content of the soil. This is commonly described as raising the Carbon to Nitrogen or C:N ratio.

The sequestration of carbon is currently a popular topic among environmentalists who ascribe to the belief that carbon dioxide is a major issue for climate. Whether this is accurate or not the sequestration of carbon in the soil is a great benefit for soil quality since it increases soil aggregation and aggregate stability; it raises the cation exchange capacity of the soil thereby allowing it to retain more moisture and nutrients that can be supplied to subsequent crops to be grown in the soil. Higher carbon levels attract and sustain the development of beneficial organisms such as mycorrhizae, earthworms, and many others. And the concept also makes and keeps the environmental community happy as well.

**Summary:**

The production, processing, and marketing of the seed required for establishing cover crops is developing as a very viable opportunity for profit in the seed industry today. Farmers are recognizing the great benefits of using cover crops to improve their soils, to suppress weeds and pests, to provide forage for grazing animals, and to support the very important soil organisms such as mycorrhizal fungi and earthworms which inhabit the soil and aid crops in the uptake of water and nutrients.

This principle of agriculture is far from new, having its beginning in the earliest days of agricultural expansion all over the globe. Today we find ourselves at a crossroads with regard to the use of biotechnology and we have found that many of the genetically engineered plants we have depended upon for some of these benefits are now failing to live up to some of our expectations. Cover crops can be used to bridge some of the gaps that being left open by this reality.

This information piece was prepared for use at the 2017 Seedman’s Shortcourse at Mississippi State University. It is respectfully submitted as such. Thanks for your time.

E. Flint, Ph.D.

**References:**


Glover B. Triplett, Professor Emeritus, Dept. of Plant and Soil Sciences, Mississippi State University, and others. Personal communications.
Cover Crop Basics & Considerations for Production Agriculture

Alayna Jacobs
Manager: USDA-NRCS Plant Materials Center, Coffeeville, MS
Have you ever used cover crops?

- 389 Non-User (19%)
- 1631 Cover Crop User (81%)

(n=2,020)

Annual Report 2015-2016
Cover Crop Survey
July 2016
How many cover crop acres?
Relative Average Value Rating of Cover Crop Benefits
1=Not A Benefit, 3=Major Benefit

- Increases overall soil health: 1.84
- Reduces soil erosion: 1.81
- Increases soil organic matter: 1.80
- Reduces soil compaction: 1.57
- Fibrous rooting systems: 1.50
- Provides nitrogen scavenging: 1.41
- Controls weeds: 1.35
- Deep tap roots: 1.31
- Increases yields in the following cash crop: 1.22
- Winter hardiness / survival: 1.21
- Provides a nitrogen source: 1.20
## Relative Average Value Rating of Cover Crop Benefits

1 = Not A Benefit, 3 = Major Benefit

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<th>Benefit</th>
<th>Rating</th>
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</table>
The Hype Curve

- Technology Trigger
- Peak of Inflated Expectations
- Plateau of Productivity
- Slope of Enlightenment
- Trough of Disillusionment
Outline

• Definition and uses of cover crops
• Overview of cover crop timelines
• Planning your cover crop
• Use of the cover crop selection tool
• Considerations
Recipe for successful cover crops

- Collect essential information: constraints, purpose of cover crop, concerns and desired benefits

- Choose species with care

- Develop and execute timely planting and termination
Outline

• Definition and uses of cover crops
• Overview of cover crop timelines
• Planning your cover crop
• Use of the cover crop selection tool
• Considerations
What is a cover crop?
What is a cover crop?

1. Grown specifically to maintain cropland soil quality, fertility, and productivity
2. Typically not harvested, but terminated on the surface or otherwise incorporated into soil before crop maturity
3. Called a cover crop because they protect the soil when it would normally be bare
4. Support the production of a cash crop

(Magdoff & Van Es, 2009)
What is a cover crop?

↑ living roots

↓ disturbance

↑ soil cover

↑ biodiversity
### Cover crop uses

<table>
<thead>
<tr>
<th>Landowner Problem</th>
<th>Resource Concern(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil compaction/lack of quick water infiltration</td>
<td>Soil Quality Degradation – Compaction Insufficient Water - Inefficient Moisture Management or Inefficient Use of Irrigation Water</td>
</tr>
<tr>
<td>Low soil organic matter, low soil moisture-holding capacity, low herbicide efficacy</td>
<td>Soil Quality Degradation - Organic Matter Depletion Insufficient Water - Inefficient Moisture Management or Inefficient Use of Irrigation Water</td>
</tr>
<tr>
<td>Weeds</td>
<td>Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure</td>
</tr>
<tr>
<td>Nematodes</td>
<td>Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure</td>
</tr>
<tr>
<td>Runoff/erosion</td>
<td>Soil Erosion - Sheet and Rill Erosion and Ephemeral Gully Erosion</td>
</tr>
<tr>
<td>Low N</td>
<td>Degraded Plant Condition - Undesirable Plant Productivity and Health</td>
</tr>
</tbody>
</table>
### Cover crop uses

**Farm input (costs)**

- Soil compaction/lack of quick water infiltration
  - Soil Quality Degradation – Compaction
  - Insufficient Water - Inefficient Moisture Management or Inefficient Use of Irrigation Water
- Low soil organic matter, low soil moisture-holding capacity, low herbicide efficacy
  - Soil Quality Degradation - Organic Matter Depletion
  - Insufficient Water - Inefficient Moisture Management or Inefficient Use of Irrigation Water
- Weeds
  - Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure
- Nematodes
  - Degraded Plant Condition - Undesirable Plant Productivity and Health and/or Excessive Plant Pest Pressure
- Runoff/erosion
  - Soil Erosion - Sheet and Rill Erosion and Ephemeral Gully Erosion
- Low N
  - Degraded Plant Condition - Undesirable Plant Productivity and Health

**Farm output (yield, profit)**

- Soil compaction/lack of quick water infiltration
- Low soil organic matter, low soil moisture-holding capacity, low herbicide efficacy
- Weeds
- Nematodes
- Runoff/erosion
- Low N
Why use a cover crop?

Theory of constraints

“...the capacity of the plant is equal to the capacity of its bottlenecks.”
(Goldratt and Cox, 1984)
Finding and removing resource bottlenecks
Finding and removing resource bottlenecks

- Soil compaction
- Poor water infiltration
  - Crusting
- Low soil organic matter
  - Low water-holding capacity
- Runoff/erosion
  - Poor soil stability
- Pests
  - Weeds
  - Nematodes
Outline

• Definition and uses of cover crops
• Overview of cover crop timelines
• Planning your cover crop
• Use of the cover crop selection tool
• Considerations
Basic cover crop timeline

Plant growth rate

Maximum growth

No growth

cash crop

April  May  June  July  Aug  Sept  Oct  Nov  Dec  Jan  Feb  Mar
Basic cover crop timeline

- **Maximum growth**: The peak growth period for cover crops.
- **Plant growth rate**: The period of active growth.
- **No growth**: The period when growth stops.

Timeline:
- April
- May
- June
- July
- Aug
- Sept
- Oct
- Nov
- Dec
- Jan
- Feb
- Mar

Insert image of cover crops in the field.
Basic cover crop timeline

Cash crop growth timeline:
- Planting: May
- Maximum growth: June to August
- Termination: April

Cover crop timeline:
- Termination: April
Planting

- **Timing**
  - Before harvest
  - At harvest
  - After harvest
  - Prior to Oct 15

- **Method**
  - Aerial broadcast
  - Drill
Termination

• Timing
  • Before planting
  • At planting
  • After planting
  • Prior to competition with cash crop
Termination

- RMA

Latest date at or within 5 days of planting but before crop emergence
Termination

Method
• Herbicide
• Mechanical
  • Roller-crimper
Termination: roller-crimper
Influence of Cover Crops on Palmer Amaranth Emergence in Georgia

Palmer Amaranth Density (#/m²)

- No Cover Crop
- Cereal Rye
- Cereal Rye + Vetch
- Cereal Rye + Crimson Clover
- Cereal Rye + Winter Pea

Early Season

Late Season

Outline

• Definition and uses of cover crops
• Overview of cover crop timelines
• Planning your cover crop
• Use of the cover crop selection tool
• Considerations
Planning a cover crop

- Current & planned crop
- Normal planting and harvest dates
- What are the constraints for cover crop options?
  - Seeding date
  - Amount of residue
  - Pests
  - Handout
Planning a cover crop
Planning a cover crop
Planning a cover crop

- Spring oats/millets
- Cereal rye
- Radish
Planning a cover crop

- What is the bottleneck?
  - Soil compaction
  - Low organic matter
  - Weeds
  - Nematodes
  - Runoff/erosion
  - Low N
Outline

• Definition and uses of cover crops
• Overview of cover crop timelines
• Planning your cover crop
• Use of the cover crop selection tool
• Considerations
Cover crop tool

• Sorts species attributes
  • Ability to address the bottleneck
  • Rotational constraints
  • Cover crop species attributes

Recommended species
### Basic tool recommendations: corn→soybean

<table>
<thead>
<tr>
<th>Possible cover crop species</th>
<th>Runoff/erosion</th>
<th>Weeds</th>
<th>Relative seed cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Residue Persistence</td>
<td>Erosion Control</td>
<td>Residue Persistence</td>
</tr>
<tr>
<td>Radish</td>
<td>Fair</td>
<td>Very Good</td>
<td>Fair</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>Good</td>
<td>Very Good</td>
<td>Good</td>
</tr>
<tr>
<td>Black Oats</td>
<td>Good</td>
<td>Very Good</td>
<td>Good</td>
</tr>
<tr>
<td>Oats</td>
<td>Good</td>
<td>Very Good</td>
<td>Good</td>
</tr>
<tr>
<td>Rye/Triticale</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Wheat</td>
<td>Very Good</td>
<td>Very Good</td>
<td>Very Good</td>
</tr>
</tbody>
</table>
The Mississippi Mix

1. Cereal rye 80 lb/ac
2. Oilseed radish 6 lb/ac
3. Crimson clover 8 lb/ac
Summer cover crops
Outline

• Definition and uses of cover crops
• Overview of cover crop timelines
• Planning your cover crop
• Use of the cover crop selection tool
• Considerations
Considerations

• Pests
• Residue
• Moisture
• Timing of termination
• Winter hardiness
• Cultivar/variety selection
May 2017: soybean planting
Soil volumetric water content at soybean planting: May 16, 2017
(4 inch depth on top of bed)

% volumetric water

- **cover crop**
- **winter annuals**
- **bare**

**no-tillage**  **conventional tillage**
Soil volumetric water content at soybean planting: May 16, 2017
(4 inch depth on top of bed)

- **No-tillage**
  - Cover crop: 35%
  - Winter annuals: 25%
  - Bare: 20%

- **Conventional tillage**
  - Cover crop: 35%
  - Winter annuals: 25%
  - Bare: 20%
Soil volumetric water content at soybean planting: May 16, 2017
(4 inch depth on top of bed)

% volumetric water

- **cover crop**
- **winter annuals**
- **bare**

- **no-tillage**
- **conventional tillage**

Values:
- Cover crop: 37%
- Winter annuals: 25%
- Bare: 22%
Black seeded oats

Avena sativa
## Radish: days to 50% bloom

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Mississippi</th>
<th>Arkansas</th>
<th>New York</th>
<th>Texas</th>
<th>Idaho</th>
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</table>
Outline

- Definition and uses of cover crops
- Overview of cover crop timelines
- Planning your cover crop
- Use of the cover crop selection tool
- Considerations
Recipe for successful cover crops

• Collect essential information: constraints, purpose of cover crop, concerns and desired benefits

• Choose species with care

• Develop and execute timely planting and termination
Start planning

• Use the handout to collect information
• Decide on a primary goal
• Plan timelines
• Start small and adjust
Start planning

- Use the handout to collect information
- Decide on a primary goal
- Plan timelines
- Start small and adjust

“Soil destruction is the most fundamental kind of economic loss which the human race can suffer.”

-Aldo Leopold
Cover Crop Basics & Considerations for Production Agriculture
Alayna Jacobs
662.675.2588 ext. 110  Alayna.Jacobs@ms.usda.gov
Cover crops for grazing and pasture management: Impact, benefits, and planning

Brett Rushing
Assistant Research/Extension Professor
“A cover crop is a plant that is used primarily to slow erosion, improve soil health, enhance water availability, smother weeds, help control pests and diseases, increase biodiversity, and bring other benefits to your farm”

USDA-SARE
Cover Crop Species

• Non-legume
  – Annual ryegrass
  – Barley
  – Brassicas
  – Buckwheat
  – Oats
  – Cereal rye
  – Sorghum sudangrass
  – Winter wheat

• Legume
  – Clover
    • Berseem, crimson, red, white, ball, balansa, etc.
  – Cowpeas
  – Field peas
  – Hairy vetch
  – Medics
Cover Crop Species

- What about perennials?
  - Bermudagrass
  - Bahiagrass
  - Tall fescue
  - NWSG
  - Alfalfa
Outline

• Cover crops in MS beef production
• Integrated crop-livestock systems
• Cover crops and seed technology
Mississippi
Cattle & Calves

940,000 head in 2016
(1/1/16 inventory)

15,940 farms

$315 million value of production in 2016
DAIRY HERDS

85 Grade A Dairy Herds
11,000 milk cows in 2016
$25 million value of production of milk in 2016

HORSES

126,000 horses
72 public arenas
$1.15 billion total economic impact
$890 million value of depreciated investments
39,500 jobs
**HAY**

- 640,000 acres harvested
- 1.41 million tons produced in 2016
- $127 million value of production in 2016

---

### Mississippi Value of Production Estimates December 2016

**by: Division of Agriculture, Forestry and Veterinary Medicine**

**Mississippi State University**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>2015</th>
<th>2016</th>
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<tbody>
<tr>
<td>Broilers/Eggs/Chickens</td>
<td>2,704</td>
<td>2,927</td>
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<tr>
<td>Forestry</td>
<td>1,668</td>
<td>1,412</td>
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<tr>
<td>Soybeans</td>
<td>1,029</td>
<td>1,011</td>
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<tr>
<td>Cotton</td>
<td>253</td>
<td>442</td>
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<tr>
<td>Corn</td>
<td>343</td>
<td>436</td>
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<tr>
<td>Cattle/Calves</td>
<td>412</td>
<td>315</td>
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<td>Catfish</td>
<td>203</td>
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<td>Rice</td>
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<td>Hay</td>
<td>116</td>
<td>127</td>
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<td>Grain Sorghum</td>
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<td>4</td>
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<tr>
<td>Govt. Programs / Misc.</td>
<td>206</td>
<td>253</td>
</tr>
</tbody>
</table>

**Grand Total**

- 2015: $7,480
- 2016: $7,610

---

*Source: MSU Extension Service and Mississippi Agricultural Statistics Service. The 2016 government programs estimate is preliminary. Miscellaneous sales from 2012 Ag Census.*
<table>
<thead>
<tr>
<th>District</th>
<th>Land (ac)</th>
<th>Pasture (ac)&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Hay (ac)&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Forage (ac)</th>
<th>Grass (%)</th>
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<tbody>
<tr>
<td>Northeast</td>
<td>6,849,280</td>
<td>337,969</td>
<td>141,594</td>
<td>479,563</td>
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<td>Northwest</td>
<td>7,157,760</td>
<td>219,904</td>
<td>99,568</td>
<td>319,472</td>
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<td>415,307</td>
<td>155,819</td>
<td>571,126</td>
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<td>7,892,520</td>
<td>516,041</td>
<td>158,710</td>
<td>674,751</td>
<td>8.5</td>
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</table>

Source: Rocky Lemus, Extension Forage Specialist. 2014. Data collected in collaboration with MSU County Extension Offices and County Farm Service Agency (USDA-FSA) Offices.

<sup>1</sup>Pasture: bahiagrass, bermudagrass, mixtures, tall fescue, summer and winter annuals mainly used for grazing.

<sup>2</sup>Hay: bahiagrass, bermudagrass, summer mixtures, tall fescue, ryegrass mainly harvested for hay/baleage, summer annuals used for silage, etc.
<table>
<thead>
<tr>
<th>District</th>
<th>RG¹</th>
<th>SG²</th>
<th>Total</th>
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<tr>
<td>Northeast</td>
<td>116,330</td>
<td>28,665</td>
<td>144,996</td>
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<tr>
<td>Northwest</td>
<td>128,289</td>
<td>20,452</td>
<td>148,741</td>
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<tr>
<td>Southeast</td>
<td>204,456</td>
<td>77,640</td>
<td>282,096</td>
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<tr>
<td>Southwest</td>
<td>94,592</td>
<td>27,676</td>
<td>122,268</td>
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</tbody>
</table>

Source: Rocky Lemus, Extension Forage Specialist. 2014. Data collected in collaboration with MSU County Extension Offices and County Farm Service Agency (USDA-FSA) Offices.

¹Ryegrass: planted either by preparing seed bed or drilling into existing sod.
²Small grains (wheat, rye, oats): planted either by preparing seed bed or drilling into existing sod.
North MS
Bermudagrass, tall fescue, bahiagrass, cool-season annuals

South MS
Bermudagrass, bahiagrass, cool-season annuals
Summary of 16,000 forage samples to UGA between 2003-11. Black bar represents average, green is range of RFQ scores. Grey vertical bar represents RFQ requirements for dry cows and blue vertical bar are for lactating beef cows.
MISSISSIPPI

CORN

119,520,000 bushels produced in 2016

2,022 farms

$436 million value of production in 2016

$93 MILLION above 2015 value of production

Top Producing County: Washington

Map based on 2015 data

Coastal Plain Branch Experiment Station
Outline

- Cover crops in MS beef production
- Integrated crop-livestock systems
- Cover crops and seed technology
Integrated crop-livestock systems

- Integration of crops and livestock was common before 20th century
- Tech advances shifted diverse ag enterprises into specialized production
- Growing awareness of stability/resiliency of ag landscapes impaired by specialization
Integrated crop-livestock systems

• Integration of crop and livestock enterprises may:
  i. Increase natural resource utilization
  ii. Exploit natural pest control processes
  iii. Reduce nutrient concentrations
  iv. Improve soil structure and productivity
Integrated crop-livestock systems

- Concerns:
  i. Large volume of information needed for sophisticated production systems
  ii. Lack of infrastructure
  iii. Lack of information on how chemical usage affects crop/animal/human health
  iv. Balance forage supplies and labor for crop and livestock requirements
  v. Develop market for alternative meat production (consumer preference for grain-fed vs. pasture-fed beef)
Integrated crop-livestock systems

• To shift from specialization to integrated crop-livestock production, major changes are required:
  i. Farming attitudes and how farmers utilize scientific information
  ii. Agribusiness development and marketing
  iii. Government support to balance production with natural resource conservation
Integrated crop-livestock systems

- Cover crops provide short-rotation opportunity for almost any cropping sequence (Franzeluebbers 2007)
- Improve productivity and reduce environmental threats from erosion (Langdale et al., 1991)
- Lots of information available with respect to tillage systems (Hargrove 1991)
- Lack of information on how cover crops have been successfully integrated into crop-livestock systems (Gardner and Faulkner 1991)
Integrated crop-livestock systems

- Moultrie, GA (Hill et al., 2004)
- Cotton/peanut with rye or ryegrass
- Grazed and un-grazed
- 57-84 d grazed
- Lint and seed yield increased w/ grazing (no sig. differences)
- $125/acre greater gross income
- 1.89 ADG for 2 yrs
Integrated crop-livestock systems

• Sod-based rotation (bahiagrass)
  – Add organic matter/nutrient and H₂O holding capacity
  – Reduce nematode populations
  – Subsequent row crops have deeper rooting zones
  – Increase crop yields 50-100%/farm profits (Hartzog and Balkom, 2003)
Integrated crop-livestock systems

• Conventional vs. sod-based rotation in FL (Marois et al., 2002)

• Net profits:
  – Conventional: $15,689/yr
  – Sod-based w/hay: $35,552/yr
  – Sod-based w/grazing: $44,840/yr
Outline

• Cover crops in MS beef production
• Integrated crop-livestock systems
• Cover crops and seed technology
Research

- MAFES variety trials
- Grazing variety trials
  - DM yield
  - Soil characteristics
  - Water retention
  - Establishment/tillage
  - Subsequent crop yield
  - Pests/chemicals
Research

- Seed production
  - Varietal development
  - Blend composition
  - Seeding rates
  - Establishment technologies
References

Questions?

Brett Rushing
601-683-2084
brett.rushing@msstate.edu
Wildlife Sector Cover Crops: Impacts/Benefits and Planning

Scott Baker, CWB®, RF,

Steve Gullledge
Cover Crops: Row Crops
Cover Crops: Agronomic Benefits

+ Wildlife Benefits
Wildlife Cover Crops
Fall/Winter
&
Spring/Summer
Fall Cover Crop Types

Agronomic Types

• Rye
  – Tall plants: Deer vs. Turkeys
Fall Cover Crop Types

Agronomic Types

- Rye
- Oat- Cosaque Black Oat
Fall Cover Crop Types

Agronomic Types

- Rye
- Oat- TAMO
  - 10,400 lbs. of forage
  - 26% protein
Fall Cover Crop Types

Agronomic Types

- Rye
- Oat - TAMO and Cosque
- Triticale
- Hairy Vetch
Fall Cover Crop Types

Agronomic Types

• Rye
• Oat- TAMO and Cosque
• Triticale
• Hairy Vetch
• Austrian Winter Pea
Fall Cover Crop Types

**Agronomic Types**

- Rye
- Oat - TAMO and Cosque
- Triticale
- Hairy Vetch
- Austrian Winter Pea
- Clovers
  - Crimson
  - Subterranean
  - Berseem
Agronomic Types

- Rye
- Oat- TAMO and Cosque
- Triticale
- Hairy Vetch
- Austrian Winter Pea
- Clovers
  - Crimson
  - Subterranean
  - Berseem
- Mustard Spp.
Summer Cover Crop Types

Agronomic Types

• Sunn Hemp
  – Legume – N builder
  – Minds Phosphorus and Potash
Summer Cover Crop Types

Agronomic Types

• Chiwapa Millet
  – Waterfowl food
  – Large amount of biomass
  – 120 day maturity
  – Tolerates flooding during the growing season
Summer Cover Crop Types

Agronomic Types

• Chiwapa Millet
  – Waterfowl food
  – Large amount of biomass
  – 120 day maturity
  – Tolerates flooding during the growing season
Cover Cropping System
Cover Cropping System: Farming Equipment
Cover Cropping System:
Farming Equipment
Cover Cropping System

Forage Soybeans

- April 15 planting date
- Planted no till into glyphosate terminated
  - Tricale
  - Black oats
  - Crimson Clover
  - Balansa Clover
  - Berseem Clover
Cover Cropping System

Forage Soybeans

• Pre-emergent herbicide
  – Prowl H20
  – Metribuzn
  – Valor

• Post:
  – Glyphosate + First Rate
Cover Cropping System
Cover Cropping System

Forage Soybeans
Cover Cropping System
Cover Cropping System
Cover Cropping System
Cover Cropping System
Cover Cropping System
May 2

June 23
Dr. Tom Devine – Plant Breeder

- Tara (MG 5)
- Derry (MG 6)
- Tyrone (MG 7)
Post Harvest Benefits

• Tara (MG 5)
  – 5,828 lbs. of crop residue/acre
Cover Crops for Wildlife

- Hunter objective
- Wildlife preference
- Wildlife manager’s planting/managing abilities
- Taylor the seed choice
- Manage expectations
Seed Mixtures: Variety Selections & Theoretical Considerations for Conservation

L. Wes Burger
Associate Director,
Mississippi Agricultural and Forestry Experiment Station
Forest and Wildlife Research Center
Agricultural Ecosystems
Sustainable and Resilient Systems

• Current model of agricultural intensification:
  – Characterized by:
    • Monocultures of high-yielding varieties
    • Increased chemical and mechanical inputs
  – Produces:
    • High yields
    • Operational efficiencies
  – Resulted in loss of:
    • Biodiversity
    • Ecological function
    • Critical ecosystems services
    • System resiliency
Sustainable and Resilient Systems

• Agricultural intensification:
  – Key consequence
    • Landscape simplification
    • Once heterogeneous landscape contains increasingly fewer crop and non-crop habitats
  – Landscape simplification:
    • Exacerbates biodiversity losses
    • Reduction in ecosystem services on which agriculture depends
      – Pollination
      – Pest suppression
      – Groundwater recharge
Precision Conservation

Interconnected Perspective

Field Perspective

Joseph K. Berry
http://www.wmvauxure.com/basis/present/PAConf_Calgary2014/
Conservation Adoption

- Conservation adoption is a multidimensional, process influenced predominantly by time management, profit, and yields (Osmond et al 2012).
- Conservation practices must make economic sense and fit into production systems.
Motivations of Private Landowners

• Producer Goals – (Kay, Edwards, and Duffy 2004)
  – Survive, stay in business, do not go broke, avoid disclosure
  – Maximize profits, get the best return on investment
  – Maximize or increase standard of living, attain a desirable family income
  – Increase equity, accumulate assets
  – Reduce debt, become free of debt
  – Avoid years of low profit, maintain stable income
  – Pass the entire farm on to the next generation
  – Increase leisure and free time
  – Increase farm size, expand, add acres
  – Maintain or improve the quality of soil, water and air resources
Green and Gold Farmers

• Younger
• Larger operations
• More likely to adopt technology
• Data driven decisions
• More likely to adopt conservation practices
• More profitable

B. Knorr, 2011. Green & Gold. Farm Futures
Cover Crops

- Component of conservation system
- Increase landscape heterogeneity
- Restore ecological function
- Provide ecosystem services
- Enhance system resiliency
- Improve economic and environmental sustainability
Agronomic Benefits

• Erosion prevention,
• Nutrient retention and recycling,
• Improved water quality,
• Weed suppression
• Increased yield,
• Cost savings,
• Carbon sequestration

Photo by Bridget Aleshire
Ecosystem Services

- Food production
- Biomass production
- N supply
- N$_2$O reduction
- NO$_3$ retention
- Soil C storage
- Erosion control
- Microbial Faunal Colonization
- Weed suppression
- Pest suppression
- Beneficial insect conservation (predators and pollinators)
- Wildlife habitat

ILLUSTRATION: ELAYNE SEARS
Mother Earth News
SARE/CTIC Cover Crop Survey

- 2015 – 4th Annual Survey
- 2020 respondents
- 48 states
- 81% self-described cover crop user
- Increasing adoption and acreage
2015 SARE/CTIC Cover Crop Survey

- ~ 50% respondents had 2-5 years experience with cover crops
2015 SARE/CTIC Cover Crop Survey

Acres of Cover Crops per Respondent

Year


(n=1,379)
2015 SARE/CTIC Cover Crop Survey

• Top 3 benefits
  – Increases overall soil health – 86%
  – Reduces soil erosion – 83%
  – Increases soil organic material – 82%
2015 SARE/CTIC Cover Crop Survey

Top 3 motivations

- Increases overall soil health – 86%
- Increases soil organic material – 83%
- Reduces soil compaction – 76%
2015 SARE/CTIC Cover Crop Survey

- Cover Crop Species

Cereals/Grasses Planted in 2015

<table>
<thead>
<tr>
<th>Crop</th>
<th>Acres</th>
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<tbody>
<tr>
<td>Annual Ryegrass</td>
<td>50,033</td>
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<tr>
<td>Cereal Rye</td>
<td>187,044</td>
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<tr>
<td>Triticale</td>
<td>13,212</td>
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<tr>
<td>Winter Barley</td>
<td>11,714</td>
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<tr>
<td>Oats</td>
<td>49,961</td>
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<tr>
<td>Winter Wheat</td>
<td>82,518</td>
</tr>
</tbody>
</table>

(n=1,219)
2015 SARE/CTIC Cover Crop Survey

- Cover Crop Species

**Brassicas Planted in 2015**

- **Radish**: 97,784 acres
- **Turnip**: 36,279 acres
- **Rapeseed**: 57,390 acres
- **Canola**: 9,858 acres

(n=983)
2015 SARE/CTIC Cover Crop Survey

• Cover Crop Species

![Diagram showing total legume acres planted]

- Crimson Clover: 47,235 acres
- Red Clover: 12,300 acres
- Other Clovers: 17,030 acres
- Winter Pea: 30,776 acres
- Hairy Vetch: 20,107 acres
- Other Vetches: 4,373 acres
- Sunnhemp: 4,254 acres
- Cowpea: 14,485 acres

(n=787)
2015 SARE/CTIC Cover Crop Survey

- Cover Crop Species

![Graph showing summer annual non-legumes planted](image-url)
2015 SARE/CTIC Cover Crop Survey

• Increasing use of mixes

[Diagram showing percentages for increasing use of cover crop mixes]

- 5% I started using mixes at first but have decreased since then
- 27% I started using mixes when I first started using cover crops and have maintained similar levels
- 17% I started using mixes at first and have increased my use of mixes since then
- 61% I started using single species then graduated to mixes

(n=775)
2015 SARE/CTIC Cover Crop Survey

- Blends have an important and growing role
  - 12% planned to try mixes in 2016
  - 31% said they have not used mixes in past but plan to in future

![Pie chart showing planting of cover crop mixes](chart.png)
2015 SARE/CTIC Cover Crop Survey

- Increasing use of more diverse mixes

![Diagram showing acres of mixes planted in 2015 and expected 2016 cover crop mix acres.](image-url)
2015 SARE/CTIC Cover Crop Survey

• Source of mixes

**What kind of cover crop mix did you use on your farm in 2015?**

- 22% Custom mix designed by my crop consultant or cover crop salesman
- 18% Pre-Packaged Mix
- 60% Custom mix I designed

**Have your cover crop mixes gotten more complex over the years?**

- 51% No
- 49% Yes

(n=789)
2015 SARE/CTIC Cover Crop Survey

• Seed purity important – 75%
2015 SARE/CTIC Cover Crop Survey

- Timing of Planting

When do you plant cover crops?

- 69% I typically plant cover crops after harvest
- 31% I typically plant cover crops prior to harvest

(n=1,148)
2015 SARE/CTIC Cover Crop Survey

- Effects on yield

**Corn Yields**
- Without Cover Crops: 178.0
- With Cover Crops: 180.2

(n=430)

**Soybean Yields**
- Without Cover Crops: 62.7
- With Cover Crops: 54.3

(n=395)
2015 SARE/CTIC Cover Crop Survey

- Effects on yield

**Increases in Corn Yields After Cover Crops: Years in Cover Crops**

- First (45): 2
- Second (142): 0.3
- Third (77): 1.0
- Fourth (72): 8.4
- After Fourth (82): 8.3

(n=430)
2015 SARE/CTIC Cover Crop Survey

- Effects on yield

![Soybean Yields After Cover Crops: Years in Cover Crops](chart)

- Chart showing increased soybean yield (Bu/acre) after different years in cover crops:
  - First (58): 0.1
  - Second (119): 1.5
  - Third (77): 1.8
  - Fourth (58): 2.3
  - After Fourth (95): 2.4

(n=395)
2015 SARE/CTIC Cover Crop Survey

- Weed Suppression

Impacts of weed control in soybeans planted after a cereal rye cover crop

- 17.8% Cereal rye had no impact on broadleaf weed management
- 26.1% Cereal rye helped with the control of herbicide resistant weeds
- 24.4% Cereal rye occasionally helped with broadleaf weed management
- 31.7% Cereal rye helped with general management of broadleaf weeds

(n=287)
2015 SARE/CTIC Cover Crop Survey

• Factors influencing adoption

"Very Helpful" Ratings on Cover Crop Influences

- More information about cover crop species: 16%
- More knowledge of cover crop benefits: 16%
- Paid technical assistance: 8%
- Free technical assistance: 13%
- Tax credit eligibility: 28%
- Discounted crop insurance premium: 21%

(n=1,001 to 1,017)
Practice Efficacy - Wildlife

• Habitat value species or guild-specific
• Function of:
  – Usable space/Total area/% of landscape
  – Patch size and configuration
  – Landscape context
  – Plant community
  – Connectivity
  – Plant materials
  – Structural and floristic diversity
  – Seasonality and duration of cover
Deer Utilization of Planted Forages

Utilization

Nutritional Stress Periods

Spring

Green-Up

From Griffin and Jacobson
Staggered Maturity Dates
Forage Value

Crude Protein

Data courtesy Bronson Strickland, MSU Deer lab,

College of Forest Resources
Forest and Wildlife Research Center
Annual Forage Requirements

125 pound deer = 4.5 pounds \times 365 \text{ days} = 1,629 \text{ pounds of forage}

150 pound deer = 5.2 pounds \times 365 \text{ days} = 1,898 \text{ pounds of forage}

175 pound deer = 5.8 pounds \times 365 \text{ days} = 2,117 \text{ pounds of forage}

200 pound deer = 6.4 pounds \times 365 \text{ days} = 2,336 \text{ pounds of forage}

250 pound deer = 7.6 pounds \times 365 \text{ days} = 2,774 \text{ pounds of forage}
Oats – January 31st
Wheat – December 7th
Berseem Clover – December 7th
Berseem Clover – December 31st
Brassica Mix – December 7th
Oats, Wheat, Crimson, Rape - December
Oats, Wheat, Crimson - April
Cover Crops

• Component of conservation system
• Increase landscape heterogeneity
• Restore ecological function
• Provide ecosystem services
• Enhance system resiliency
• Improve economic and environmental sustainability
Seed Mixture Considerations: Soil Health & Fertility

Dr. Jac J Varco
Plant and Soil Sciences Dept.
Mississippi State, University
Cover Crop Benefits

- Conserve leachable nutrients
- Add organic matter/C sequestration
- Weed control properties
- Erosion control
- Rooting benefits
- Conserve soil moisture when used as a mulch
- Increase soil biodiversity, microbes, earthworms, etc.
- N₂ fixation (legumes)
- Ecosystems services – wildlife enhancement, bees and other pollinators
Producer Survey - Soil Health Indicators

1. Organic matter
2. Crop appearance
3. Erosion
4. Earthworms
5. Drainage - soil aggregation/structure, compaction etc.
6. Tillage ease, i.e. tilth
7. Surface soil structure, compaction, crusting etc.
8. pH
9. Soil test results
10. Crop yield
Winter fallow/corn stalks

Rye

Residue management/soil health benefits

Hairy vetch
Cover Crop Selection Criteria

- $\text{N}_2$ fixer (legume)? N benefit to subsequent crop
- Soil erosion control
- Soil quality including organic matter
- Cold hardiness – Hairy vetch/Rye vs. Radish
- Weed suppression-competitive/allelopathic effects
- Residual nutrient recovery, especially $\text{NO}_3^{-}$
- Ease of establishment
- Cost and availability
- Ease of termination
- Potential forage or hay
Mixtures/Cocktails

Complementary benefits:
- Soil N depletion by grass = increased N fixation by legume?
- Climbing legume with upright growth companion crop such as rye
- Compatible or competitive
- Be wary of more in the mix is better
Cover Crop Benefits

- Erosion control, %
- N retention, %
- Weed suppression, %
- Cover Crop Yield, %
- Water conservation, %

**Hairy Vetch**

**Rye**
Objectives

1. To determine the effects of legume, non-legume, and cover crop mixtures on nutrient cycling in a corn production system with and without poultry litter.
2. To determine the effects of winter crop systems with and without fall-applied poultry litter on soil quality and health.
3. To determine the value of selected legume cover crops grown with or without either rye or Tillage Radish®
Methods

- Cover crops
  - Plant Oct.
  - Apply Poultry litter application @ 2000 lb (dw basis) Nov.
  - Non-litter plots received lb P₂O₅/acre and lb K₂O/acre from 0-46-0 and 0-0-60
  - Terminated early April

- Corn
  - Strip-tilled, roll plots mid-April
  - Fertilized N rate plots – Ammonium nitrate 0, 50, 100, 150, and 200 lb N/acre
  - Soil sampling
    - Enzyme assay; At planting, 14 DAP, 28 DAP, 0 to 6”
    - Bulk density and total C and N analysis; post corn harvest, Soil core depths 0 to 2”, 2 to 4”, 4 to 6”, and 6 to 12”
<table>
<thead>
<tr>
<th>Plot Treatment</th>
<th>Seed #/ ac</th>
<th>Actual #/ ac (with inert matter)</th>
<th>Total #/ ac</th>
<th># of each seed in 10# Mix</th>
<th>Grams of each seed in 10# Mix</th>
<th>Setting on Drive 1</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persian Clover</td>
<td>6</td>
<td>6</td>
<td>14</td>
<td>5.56</td>
<td>2524.44</td>
<td>18</td>
<td>3.3g</td>
</tr>
<tr>
<td>Crimson Clover</td>
<td>20</td>
<td>40</td>
<td>64</td>
<td>4.44</td>
<td>2019.56</td>
<td>64</td>
<td>22g</td>
</tr>
<tr>
<td>Red Clover</td>
<td>12</td>
<td>24</td>
<td>40.0</td>
<td>1.67</td>
<td>757.33</td>
<td>40.0</td>
<td>13.2g</td>
</tr>
</tbody>
</table>

**Mixed Plot Data**

<table>
<thead>
<tr>
<th>Plot Treatment</th>
<th>Seed #/ ac</th>
<th>Actual #/ ac (with inert matter)</th>
<th>Total #/ ac</th>
<th># of each seed in 10# Mix</th>
<th>Grams of each seed in 10# Mix</th>
<th>Setting on Drive 1</th>
<th>Additional Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persian Clover + Tillage Radish</td>
<td>Persian Clover</td>
<td>5</td>
<td>5</td>
<td>9</td>
<td>5.56</td>
<td>2524.44</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Tillage Radish</td>
<td>4</td>
<td>4</td>
<td>9</td>
<td>4.44</td>
<td>2019.56</td>
<td>18</td>
</tr>
<tr>
<td>Persian Clover + Rye</td>
<td>Persian Clover</td>
<td>5</td>
<td>5</td>
<td>30</td>
<td>1.67</td>
<td>757.33</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Rye</td>
<td>25</td>
<td>25</td>
<td>30</td>
<td>8.33</td>
<td>3786.67</td>
<td>60</td>
</tr>
<tr>
<td>Crimson Clover + Tillage Radish</td>
<td>Crimson Clover</td>
<td>16</td>
<td>32</td>
<td>36</td>
<td>8.89</td>
<td>4039.11</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Tillage Radish</td>
<td>4</td>
<td>4</td>
<td>36</td>
<td>1.11</td>
<td>504.89</td>
<td>55</td>
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<tr>
<td>Crimson Clover + Rye</td>
<td>Crimson Clover</td>
<td>16</td>
<td>32</td>
<td>57</td>
<td>5.60</td>
<td>2544.64</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Rye</td>
<td>25</td>
<td>25</td>
<td>57</td>
<td>4.40</td>
<td>1999.36</td>
<td>95</td>
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<tr>
<td>Red Clover + Tillage Radish</td>
<td>Red Clover</td>
<td>10</td>
<td>20</td>
<td>24</td>
<td>8.33</td>
<td>3786.67</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Tillage Radish</td>
<td>4</td>
<td>4</td>
<td>24</td>
<td>1.67</td>
<td>757.33</td>
<td>44</td>
</tr>
<tr>
<td>Red Clover + Rye</td>
<td>Red Clover</td>
<td>10</td>
<td>20</td>
<td>45</td>
<td>4.4</td>
<td>1999.36</td>
<td>75</td>
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<tr>
<td></td>
<td>Rye</td>
<td>25</td>
<td>25</td>
<td>45</td>
<td>5.6</td>
<td>2544.64</td>
<td>75</td>
</tr>
</tbody>
</table>
Total N yield of cover crops and weeds
2015

- Legume (CC p < 0.0001, PL p = 0.004)
- Rye
- CC*PL NS
- Weeds
2016 cover dry matter yield and N content prior to corn planting

<table>
<thead>
<tr>
<th>Cover Crop/PL</th>
<th>Biomass yield, kg/ha</th>
<th>N kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hairy vetch*</td>
<td>500</td>
<td>13</td>
</tr>
<tr>
<td>Hairy vetch/PL</td>
<td>658</td>
<td>16</td>
</tr>
<tr>
<td>Rye</td>
<td>1335</td>
<td>21</td>
</tr>
<tr>
<td>Rye/PL</td>
<td>1608</td>
<td>26</td>
</tr>
<tr>
<td>HV-Rye</td>
<td>1683</td>
<td>30</td>
</tr>
<tr>
<td>HV-Rye/PL</td>
<td>1880</td>
<td>37</td>
</tr>
<tr>
<td>PL</td>
<td>345</td>
<td>6.5</td>
</tr>
</tbody>
</table>

* - Hairy vetch was infested with root rot (*Phytophthora* sp.)
2017 cover dry matter yield and N content prior to corn planting

<table>
<thead>
<tr>
<th>Cover Crop/PL</th>
<th>Biomass yield, kg/ha</th>
<th>N kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persian Clover</td>
<td>1702</td>
<td>62</td>
</tr>
<tr>
<td>PC/PL</td>
<td>1865</td>
<td>66</td>
</tr>
<tr>
<td>Rye</td>
<td>2342</td>
<td>39</td>
</tr>
<tr>
<td>Rye/PL</td>
<td>2685</td>
<td>48</td>
</tr>
<tr>
<td>PC-Rye</td>
<td>1580</td>
<td>44</td>
</tr>
<tr>
<td>PC-Rye/PL</td>
<td>1705</td>
<td>53</td>
</tr>
<tr>
<td>PL</td>
<td>562</td>
<td>10</td>
</tr>
</tbody>
</table>
### Expt. 2 Cover crop mono- and bi-culture results

<table>
<thead>
<tr>
<th>Cover crop Treatment</th>
<th>Biomass yield 2016/2017, kg/ha</th>
<th>N Yield 2016/2017 kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check, no cover</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Hairy vetch/Persian Clover</td>
<td>1296</td>
<td>1580</td>
</tr>
<tr>
<td>HV/PC plus rye</td>
<td>1740</td>
<td>1390</td>
</tr>
<tr>
<td>HV/PC plus Tillage Radish</td>
<td>1575</td>
<td>2422</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>2398</td>
<td>3225</td>
</tr>
<tr>
<td>Crimson clover plus rye</td>
<td>2884</td>
<td>4405</td>
</tr>
<tr>
<td>Crimson clover plus Tillage Radish</td>
<td>2429</td>
<td>4082</td>
</tr>
<tr>
<td>Red clover</td>
<td>890</td>
<td>508</td>
</tr>
<tr>
<td>Red clover plus rye</td>
<td>1778</td>
<td>1948</td>
</tr>
<tr>
<td>Red clover plus Tillage Radish</td>
<td>1057</td>
<td>2348</td>
</tr>
</tbody>
</table>
Soil bulk density within corn row in fall 2016

Soil bulk density (g/cm³)

Treatments

0 = Hairy vetch; 5 = Cereal rye; 10 = Poultry litter

Legend:
- Red = 0 to 5 cm
- Dark gray = 5 to 10 cm
- Medium gray = 10 to 15 cm
- Light gray = 15 to 30 cm
Total soil N as influenced by treatment, row position, and soil depth following corn harvest in fall 2016.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Within corn row position</th>
<th>Inter-row position</th>
<th>Soil depth, cm</th>
<th>LSD(0.05)</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 5</td>
<td>5 to 10</td>
<td>10 to 15</td>
<td>15 to 30</td>
<td>0 to 5</td>
</tr>
<tr>
<td>N rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Kg N ha⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 0</td>
<td>1.02e</td>
<td>0.82b</td>
<td>0.80a</td>
<td>0.76a</td>
<td>1.39b</td>
</tr>
<tr>
<td>56</td>
<td>1.13cde</td>
<td>0.85ab</td>
<td>0.83a</td>
<td>0.69a</td>
<td>1.47ab</td>
</tr>
<tr>
<td>112</td>
<td>1.05cde</td>
<td>0.82b</td>
<td>0.77a</td>
<td>0.74a</td>
<td>1.45ab</td>
</tr>
<tr>
<td>168</td>
<td>1.17cde</td>
<td>0.83b</td>
<td>0.77a</td>
<td>0.68a</td>
<td>1.38b</td>
</tr>
<tr>
<td>224</td>
<td>1.19bcde</td>
<td>0.84ab</td>
<td>0.78a</td>
<td>0.70a</td>
<td>1.60ab</td>
</tr>
<tr>
<td>CC w/o PL</td>
<td>H</td>
<td>1.26bcd</td>
<td>0.89ab</td>
<td>0.80a</td>
<td>0.76a</td>
</tr>
<tr>
<td></td>
<td>R</td>
<td>1.25bcd</td>
<td>0.92ab</td>
<td>0.83a</td>
<td>0.75a</td>
</tr>
<tr>
<td></td>
<td>H + R</td>
<td>1.26bc</td>
<td>0.95ab</td>
<td>0.85a</td>
<td>0.79a</td>
</tr>
<tr>
<td>PL</td>
<td>H + PL</td>
<td>1.15cde</td>
<td>0.83b</td>
<td>0.73a</td>
<td>0.68a</td>
</tr>
<tr>
<td></td>
<td>R + PL</td>
<td>1.27bc</td>
<td>0.89ab</td>
<td>0.81a</td>
<td>0.75a</td>
</tr>
<tr>
<td></td>
<td>H + R + PL</td>
<td>1.39ab</td>
<td>0.83ab</td>
<td>0.76a</td>
<td>0.71a</td>
</tr>
<tr>
<td>LSD(0.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Treatment differences separated by Fisher’s Protected Least Significant Difference (α = 0.05). H = Hairy vetch; R = Rye; PL = Poultry litter
Soil enzymatic activity within the corn row

LSD(0.05) = 9.124
LSD(0.05) = 7.577
LSD(0.05) = 5.296

Soil enzymatic activity, (μg g⁻¹ soil)

Treatments

0 56 112 168 224 H R HR PL HPL RPLH

H = Hairy vetch; R = Cereal rye; PL = Poultry litter

1ˢᵗ sampling (04/18/16)
2ⁿᵈ sampling (05/05/16)
3ʳᵈ sampling (05/19/16)

Left: 0-5 cm
Right: 5-15 cm
2016 Corn Results

PLCC Grain Yield Based Fertilizer N Equivalence

Grain Yield, bu/acre

Fertilizer N Rates
Plot 1 Regr
Rye
Rye plus PL
Hairy vetch plus Rye
HV Rye plus PL
Poultry litter
Hairy vetch
Hairy vetch plus PL

Fertilizer N Rate/Equivalence, kg/ha
Summary

Cover crops:
• tend to lower soil bulk density
• increase soil C and N
• mixtures provide greater biomass and sometimes more N
• tend to increase enzyme/microbial activity
• increase corn grain yield and N availability when legumes are included
Cover Crop Economics

2017 Mississippi State University
Seed Technology Shortcourse

August 1, 2017

Presented by: Lawrence Falconer - Extension Professor
Introduction

- Empirical data on yield and net returns for cropping systems in Mississippi that utilize cover crops is currently fairly scarce.

- Review data on current use of cover crop practices.

- Present economic tools needed to properly evaluate the economic and financial feasibility of incorporating cover crops into production systems. Example includes the Cover Crop Economics Decision Support Tool developed by Lauren Cartwright and Bryon Kirwan, USDA-NRCS State Economists.
Cover Crop Adoption

- USDA’s Agricultural Resource Management Survey indicated that less than 2% of corn, soybean, wheat and cotton acreage had a cover crop in 2010-2011.

- USDA’s 2012 Census of Agriculture indicated that 8.6% of farms with cropland utilized cover crops on 2.9% of cropland acres.

- EQIP expenditures on cover crops increased from $3.1 million [240,418 acres] in 2006 to more than $48 million [1,120,311] in 2016. (USDA-NRCS, Protracts Database)

Source: Bowman, Maria. USDA-ERS, 2017
Distribution of Cover Crop Use, 2012.

Note: White areas are not cropland or have missing data due to disclosure limitations with Census of Agriculture data.
Economic and Financial Analysis

• To perform a proper economic analysis of a new cropping system we need an economic model that can take into account not only cash and non-cash benefits and costs, but also the timing of the costs and benefits.

• The timing of costs and benefits within a production cycle can be significant financially in addition to the timing of expected costs and benefits over multiple production cycles.

• These models will need to be based on partial budgeting and capital budgeting techniques.
Partial Budget Definition and Procedure

• The partial budget calculates the expected change in revenues and expenses from a proposed change in the farm business.

• The 1st step in the partial budgeting process is to identify the alternatives to be examined.

• Since the partial budgeting framework can only compare 2 alternatives at a time, if multiple alternatives are identified multiple partial budgets must be developed to analyze the alternatives in a stepwise fashion.
Partial Budget Definition and Procedure

- The changes in revenues and expenses needed for a partial budget can be identified with 4 questions, answered on the basis of what would happen if the proposed alternative was implemented (Kay, Edwards and Duffy, 2015).

  • What new or additional costs will be incurred (variable and/or fixed)?
  
  • What current costs will be reduced or eliminated (variable and/or fixed)?
  
  • What new or additional revenue will be received?
  
  • What current revenue will be lost or reduced?
Capital Budgeting (Investment Analysis)

- Capital budgeting is a procedure for evaluating the effects of a farm manager’s investment choices on the businesses’ profitability, risk and liquidity (Barry, Hopkin and Baker, 1988).

- Investment opportunities in agriculture fall into several categories:
  - Maintenance and replacement of depreciable capital items
  - Adoption of cost reducing investments to produce a given volume of output
  - Adoption of income increasing investments
  - A combination of the above
Capital Budgeting (Investment Analysis)

- The net present value method uses the discounting formula for a non-uniform series of payments to value the projected cash flows for each investment alternative at one point in time.

- The sign and size of an investment's net present value determines its ranking and acceptability.

- The net present value criterion directly accounts for the timing and magnitude of the projected cash flows (Barry, Hopkin and Baker, 1988).
Cover Crop Economics - Short Term Analysis

The Short Term analysis assesses the immediate cost and benefits. After completing of the short term analysis, an option is available to expand that information to a long term analysis.

Please refer to the "Instructions" worksheet for more detailed guidance on using the tool and entering data.

To get started with a new model, select the current rotation length and then select the "Start Model" button. Enter/edit information in the white boxes. To open an existing default scenario, select the "Defaults" button and follow the instructions provided.

Button options: "Start New Model" will clear all entries and take you back to the start of the model to select a new rotation length. "Clear Entries" will clear all entries.

Scenario Description

A soybean/corn rotation where producer is establishing fall cover crops every year. Updated w/ 2015 MSU-ES Data.

Rotation

Cover Crop - Cash Crop 1
Enter cash crop name (e.g. corn, soybeans, wheat):
Soybeans

Yield Units (e.g. bu, cwt, ton): bu
Baseline Yield (unit/ac): 65
Value of Crop 1 ($/unit): $9.50

Cover Crop - Cash Crop 2
Enter cash crop name (e.g. corn, soybeans, wheat):
Corn

Yield Units (e.g. bu, cwt, ton): bu
Baseline Yield (unit/ac): 185
Value of Crop 2 ($/unit): $4.03
### Rotation

<table>
<thead>
<tr>
<th><strong>Cover Crop - Cash Crop 1</strong></th>
<th><strong>Cover Crop - Cash Crop 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter cash crop name (e.g. corn, soybeans, wheat):</td>
<td>Enter cash crop name (e.g. corn, soybeans, wheat):</td>
</tr>
<tr>
<td>Soybeans</td>
<td>Corn</td>
</tr>
<tr>
<td>Yield Units (e.g. bu, cwt, ton):</td>
<td>Yield Units (e.g. bu, cwt, ton):</td>
</tr>
<tr>
<td>bu</td>
<td>bu</td>
</tr>
<tr>
<td>Baseline Yield (unit/ac):</td>
<td>Baseline Yield (unit/ac):</td>
</tr>
<tr>
<td>65</td>
<td>185</td>
</tr>
<tr>
<td>Value of Crop 1 ($/unit):</td>
<td>Value of Crop 2 ($/unit):</td>
</tr>
<tr>
<td>$9.50</td>
<td>$4.03</td>
</tr>
</tbody>
</table>

### Costs

#### Cover Crop Establishment and Management

Refer to the cover crop that precedes cash crop 1 if applicable (Use Text Box Below to enter description of cover crop utilized)
cereal rye

- Seeding Rate (lb/ac) | 80
- Seed Cost (include inoculant as needed) ($/lb) | $0.27
- Calculated Seed Cost ($/ac) | $21.60
- Planting Cost ($/ac) | $20.00
- Termination cost ($/ac) | $10.00
- Increased management costs ($/ac) | $0.00

**Total Costs Cover Crop Est. & Mgt. ($/ac)** | $51.60

---

#### Yield Decrease

Enter 0 if no yield decrease is expected

- Crop Yield Decrease (%) | 0%
- Crop 1 Decrease ($/ac) | $0.00

---

#### Other Costs

(Enter Description of Cost in Text Box)

- Other Cost ($/ac) | $0.00
- Total Cost ($/ac) | $51.60

---

#### Cover Crop Establishment and Management

Refer to the cover crop that precedes cash crop 2 if applicable (Use Text Box Below to enter description of cover crop utilized)
cereal rye (35 lbs/acre), crimson clover (8 lbs/acre), brassica (1 lb/acre)

- Seeding Rate (lb/ac) | 44
- Seed Cost (include inoculant as needed) ($/lb) | $0.66
- Calculated Seed Cost ($/ac) | $29.04
- Planting Cost ($/ac) | $20.00
- Termination cost ($/ac) | $10.00
- Increased management costs ($/ac) | $0.00

**Total Costs Cover Crop Est. & Mgt. ($/ac)** | $59.04

---

#### Yield Decrease

Enter 0 if no yield decrease is expected

- Crop Yield Decrease (%) | 0%
- Crop 2 Decrease ($/ac) | $0.00

---

#### Other Costs

(Enter Description of Cost in Text Box)

- Other Cost ($/ac) | $0.00
- Other Cost ($/ac) | $0.00
- Total Cost ($/ac) | $59.04
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>$0.55</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>$0.45</td>
</tr>
<tr>
<td>Potassium</td>
<td>$0.40</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Reduction</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, reduction in purchased N (lb/ac)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P, reduction in purchased P (lb/ac)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>K, reduction in purchased K (lb/ac)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Nutrient Credit Benefit ($/ac)**: $0.00

**Herbicide/insecticide/fungicide input reduction**

<table>
<thead>
<tr>
<th>Cost</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbicide Costs ($/ac)</td>
<td>$20.00</td>
</tr>
<tr>
<td>Insecticide Cost ($/ac)</td>
<td>$0.00</td>
</tr>
<tr>
<td>Fungicide Costs ($/ac)</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reduction</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Reduction</td>
<td>15%</td>
</tr>
<tr>
<td>Percent Reduction</td>
<td>0%</td>
</tr>
<tr>
<td>Percent Reduction</td>
<td>0%</td>
</tr>
</tbody>
</table>

**Total Reduced**: $3.00

**Herbicide/insecticide/fungicide benefit ($/ac)**: $3.00
<table>
<thead>
<tr>
<th>Yield Increase</th>
<th>Yield Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter 0 if no yield increase is expected</td>
<td>Enter 0 if no yield increase is expected</td>
</tr>
<tr>
<td>Crop Yield Increase (%)</td>
<td>Crop Yield Increase (%)</td>
</tr>
<tr>
<td>2%</td>
<td>0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crop 1 Increase ($/ac)</th>
<th>$12.35</th>
<th>Crop 2 Increase ($/ac)</th>
<th>$0.00</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Erosion Reduction</th>
<th>Erosion Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>On Site Lost Fertility Value ($/ton):</td>
<td>$2.10</td>
</tr>
<tr>
<td>Off Site Water Quality Damages ($/ton):</td>
<td>$4.93</td>
</tr>
<tr>
<td>Enter the amount of erosion in tons/ac that is prevented from leaving the field(s) by the addition of cover crops. Erosion Reduction (ton/ac)</td>
<td>4</td>
</tr>
<tr>
<td>Enter other costs prevented due to reducing erosion such as machinery costs to repair erosion in the field or ditches. Erosion Repair ($/ac)</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

|------------------------------|--------|------------------------------|--------|

<table>
<thead>
<tr>
<th>Other Benefit</th>
<th>Other Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter Description of Benefit in Text Box</td>
<td>Enter Description of Benefit in Text Box</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Benefit ($)</th>
<th>$0.00</th>
<th>Other Benefit ($)</th>
<th>$0.00</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Total Benefit ($) /ac</th>
<th>$43.47</th>
<th>Total Benefit ($) /ac</th>
<th>$47.62</th>
</tr>
</thead>
</table>
## Short Term Analysis Results

<table>
<thead>
<tr>
<th>Cover Crop - Cash Crop 1</th>
<th>Results Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost ($/ac)</td>
<td>$51.60</td>
</tr>
<tr>
<td>Total Benefit ($/ac)</td>
<td>$43.47</td>
</tr>
<tr>
<td>Net Benefit ($/ac)</td>
<td>-$8.13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cover Crop - Cash Crop 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Cost ($/ac)</td>
</tr>
<tr>
<td>Total Benefit ($/ac)</td>
</tr>
<tr>
<td>Net Benefit ($/ac)</td>
</tr>
</tbody>
</table>

[Continue to Long Term Analysis]
## Cover Crop Economics (Long Term Analysis)

The long term analysis assumes the continued utilization of cover crops modeled in the short term analysis, and also captures additional benefits that may be realized over time with the continued use of cover crops in rotation. Refer to the "Instructions" worksheet and "References and Citations" worksheet for more information and guidance on entering the long term analysis.

### General Information

*The lifespan refers to the length of time being analyzed and assumes a continued use of cover crop in the farming rotation, based on the information entered into the Short Term Analysis.*

| Analysis Lifespan (years) - up to 50 years | 25 |
| Discount Rate | 3% |
| Current Soil Organic Matter (SOM) (%) | 1 |
| Estimate of years of mgmt change to increase SOM 1% | 10 |
| Estimate of maximum potential SOM (%) | 3 |

*The Analysis Lifespan (years) must be greater than the Estimate of years of mgmt change to increase SOM 1% in order for the long term analysis results to begin capturing the long term benefits.*

### Costs

*The costs shown below are based on the information entered into the short term analysis and amortized over the long term analysis lifespan.*

| Cover Crop Establishment & Mgt ($/ac/yr) | $55.25 |
| Total Cost ($/ac/yr) | $55.25 |
### Benefits

**Short Term Benefits:** The benefits below are based on the information entered into the short term analysis and amortized over the long term analysis lifespan.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct nutrient credit ($/ac/yr)</td>
<td>$7.91</td>
</tr>
<tr>
<td>Herbicide/insecticide/fungicide input reduction ($/ac/yr)</td>
<td>$3.01</td>
</tr>
<tr>
<td>Yield Increase ($/ac/yr)</td>
<td>$6.45</td>
</tr>
<tr>
<td>Erosion Reduction ($/ac/yr)</td>
<td>$28.17</td>
</tr>
</tbody>
</table>
Net Present Value Calculations of Cash Costs and Non-cash Benefits

<table>
<thead>
<tr>
<th>Time</th>
<th>Cover Crop Est Costs Table</th>
<th>Direct Nutrient Input Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost ($/ac/yr)</td>
<td>Present Value ($/ac/yr)</td>
</tr>
<tr>
<td>1</td>
<td>$51.60</td>
<td>$51.60</td>
</tr>
<tr>
<td>2</td>
<td>$59.04</td>
<td>$55.65</td>
</tr>
<tr>
<td>3</td>
<td>$51.60</td>
<td>$47.22</td>
</tr>
<tr>
<td>4</td>
<td>$59.04</td>
<td>$52.46</td>
</tr>
<tr>
<td>5</td>
<td>$51.60</td>
<td>$44.51</td>
</tr>
<tr>
<td>6</td>
<td>$59.04</td>
<td>$49.45</td>
</tr>
<tr>
<td>7</td>
<td>$51.60</td>
<td>$41.96</td>
</tr>
<tr>
<td>8</td>
<td>$59.04</td>
<td>$46.61</td>
</tr>
<tr>
<td>9</td>
<td>$51.60</td>
<td>$39.55</td>
</tr>
<tr>
<td>10</td>
<td>$59.04</td>
<td>$43.93</td>
</tr>
<tr>
<td>11</td>
<td>$51.60</td>
<td>$37.28</td>
</tr>
<tr>
<td>12</td>
<td>$59.04</td>
<td>$41.41</td>
</tr>
<tr>
<td>13</td>
<td>$51.60</td>
<td>$35.14</td>
</tr>
<tr>
<td>14</td>
<td>$59.04</td>
<td>$29.08</td>
</tr>
<tr>
<td>15</td>
<td>$51.60</td>
<td>$33.12</td>
</tr>
<tr>
<td>16</td>
<td>$59.04</td>
<td>$36.79</td>
</tr>
<tr>
<td>17</td>
<td>$51.60</td>
<td>$31.22</td>
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<tr>
<td>18</td>
<td>$59.04</td>
<td>$34.68</td>
</tr>
<tr>
<td>19</td>
<td>$51.60</td>
<td>$29.43</td>
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<td>20</td>
<td>$59.04</td>
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<td>21</td>
<td>$51.60</td>
<td>$27.74</td>
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<td>22</td>
<td>$59.04</td>
<td>$30.81</td>
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<td>23</td>
<td>$51.60</td>
<td>$26.15</td>
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<tr>
<td>24</td>
<td>$59.04</td>
<td>$29.04</td>
</tr>
<tr>
<td>25</td>
<td>$51.60</td>
<td>$24.64</td>
</tr>
</tbody>
</table>
Long Term Benefits: The following two benefit categories, "Overall Soil Fertility Benefit" and "Water Storage Benefit" are exclusive to the long term analysis and are based upon the SOM information entered into the general information section above. The annual value calculation of the benefits of these categories is dependent on the length of analysis, estimated years to increase soil organic matter by 1%, and the maximum potential of the soil.

Overall Soil Fertility Benefit

Cover crops, when utilized as part of a crop rotation over many years may have a significant impact on the physical and biological properties of the soil. The potential for improvement will be dependent on the starting condition of the soil, the inherent properties of the soil and tillage practices. Use this section to capture the estimated quantity and value of the Nitrogen, Phosphorus, Potassium, Sulfur and Carbon available to the crop in the soil for each 1% increase in soil organic matter. This input is intended to capture any additional nutrient value above and beyond the direct nutrient reduction captured above, and represents the long term benefit of improved biological activity in the soil.

<table>
<thead>
<tr>
<th>Nutrient Values</th>
<th>Value ($/lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen ($/lb)*</td>
<td>$0.55</td>
</tr>
<tr>
<td>Phosphorus ($/lb)*</td>
<td>$0.45</td>
</tr>
<tr>
<td>Potassium ($/lb)*</td>
<td>$0.40</td>
</tr>
<tr>
<td>Sulfur ($/lb)</td>
<td>$3.00</td>
</tr>
<tr>
<td>Carbon ($/Ton)</td>
<td>$0.00</td>
</tr>
<tr>
<td>* values entered in short term analysis</td>
<td></td>
</tr>
</tbody>
</table>

Enter the expected plant available nutrient amount per 1% increase in SOM

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Available Nutrient per 1% increase in SOM (lb/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>20</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>2</td>
</tr>
<tr>
<td>Potassium</td>
<td>0</td>
</tr>
<tr>
<td>Sulfur</td>
<td>2.5</td>
</tr>
<tr>
<td>Carbon</td>
<td>0</td>
</tr>
</tbody>
</table>

Total Nutrient Benefit per 1% increase in SOM ($/ac) $19.40

Annual Value of Soil Fertility ($/ac/yr) $12.72

Water Storage Benefit

The water storage benefit is based on the assumption that an increase in soil organic matter increases water storage capacity. This benefit calculation assumes every 1% of soil organic matter holds 1 acre inch of water and crops need about 1 acre inch of water per week for optimal growth. Enter the estimated value of an acre-inch of water. This value serves as a proxy for either avoided irrigation costs (in an irrigated system) or avoided crop yield reduction costs (in a dry land system).

Value of an acre-inch of water ($/ac/yr) $12.50

Annual value of increased Water Storage ($/ac/yr) $8.20

Total Benefits ($/ac/yr) $66.45
### Profitability versus Affordability: (Economic versus Financial Analysis)

The Economic Analysis Results compares the amortized costs and benefits and answers the question, is this management change profitable over the lifespan of the analysis? The answer is yes if the Net Benefits ($/ac/yr) is positive. The Net Benefits equals the total amortized benefits minus total amortized costs. If the Economic Analysis Net Benefits result is negative, then this is not a good investment overall economically.

The Financial Analysis Results answers the question, is this management change affordable? Depending on the variables in the model, on a year to year basis there may be a negative net benefit, especially in the first few years of utilizing cover crops in the rotation until the long term soil benefits are realized. In a partial budget framework, such as this analysis, a short term negative net benefit indicates the cost of the investment in the soil in order to benefit from the long term benefits of improved soil health. The producer can use this analysis to determine if he/she can afford this investment, or use the model to assess alternative to make the investment more affordable for the operation.

### Economic Analysis Results:

<table>
<thead>
<tr>
<th>Summary</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis Lifespan (years)</td>
<td>25</td>
</tr>
<tr>
<td>Short Term Benefits ($/ac/yr)</td>
<td>$45.62</td>
</tr>
<tr>
<td>Long Term Benefits ($/ac/yr)</td>
<td>$20.92</td>
</tr>
<tr>
<td>Total Costs ($/ac/yr)</td>
<td>$55.25</td>
</tr>
<tr>
<td>Total Benefits ($/ac/yr)</td>
<td>$68.45</td>
</tr>
<tr>
<td>Net Benefits ($/ac/yr)</td>
<td>$11.20</td>
</tr>
</tbody>
</table>

### Financial Analysis Results:

<table>
<thead>
<tr>
<th>Year</th>
<th>Costs ($/ac)</th>
<th>Benefits ($/ac)</th>
<th>Net Benefit ($/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$51.60</td>
<td>$43.47</td>
<td>-$8.13</td>
</tr>
<tr>
<td>2</td>
<td>$59.04</td>
<td>$47.82</td>
<td>-$11.42</td>
</tr>
<tr>
<td>3</td>
<td>$51.60</td>
<td>$43.47</td>
<td>-$8.13</td>
</tr>
<tr>
<td>4</td>
<td>$59.04</td>
<td>$47.82</td>
<td>-$11.42</td>
</tr>
<tr>
<td>5</td>
<td>$51.60</td>
<td>$43.47</td>
<td>-$8.13</td>
</tr>
<tr>
<td>6</td>
<td>$59.04</td>
<td>$47.82</td>
<td>-$11.42</td>
</tr>
<tr>
<td>7</td>
<td>$51.60</td>
<td>$43.47</td>
<td>-$8.13</td>
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<tr>
<td>8</td>
<td>$59.04</td>
<td>$47.82</td>
<td>-$11.42</td>
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<tr>
<td>9</td>
<td>$51.60</td>
<td>$43.47</td>
<td>-$8.13</td>
</tr>
<tr>
<td>10</td>
<td>$59.04</td>
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<td>-$11.42</td>
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<td>11</td>
<td>$51.60</td>
<td>$75.37</td>
<td>$23.77</td>
</tr>
<tr>
<td>12</td>
<td>$59.04</td>
<td>$79.52</td>
<td>$20.48</td>
</tr>
<tr>
<td>13</td>
<td>$51.60</td>
<td>$75.37</td>
<td>$23.77</td>
</tr>
<tr>
<td>14</td>
<td>$59.04</td>
<td>$79.52</td>
<td>$20.48</td>
</tr>
<tr>
<td>15</td>
<td>$51.60</td>
<td>$75.37</td>
<td>$23.77</td>
</tr>
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<td>16</td>
<td>$59.04</td>
<td>$79.52</td>
<td>$20.48</td>
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<td>17</td>
<td>$51.60</td>
<td>$75.37</td>
<td>$23.77</td>
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<td>$59.04</td>
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<td>$20.48</td>
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<td>19</td>
<td>$51.60</td>
<td>$75.37</td>
<td>$23.77</td>
</tr>
<tr>
<td>20</td>
<td>$59.04</td>
<td>$79.52</td>
<td>$20.48</td>
</tr>
<tr>
<td>21</td>
<td>$51.60</td>
<td>$107.27</td>
<td>$55.67</td>
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<tr>
<td>22</td>
<td>$59.04</td>
<td>$111.42</td>
<td>$52.38</td>
</tr>
<tr>
<td>23</td>
<td>$51.60</td>
<td>$107.27</td>
<td>$55.67</td>
</tr>
<tr>
<td>24</td>
<td>$59.04</td>
<td>$111.42</td>
<td>$52.38</td>
</tr>
<tr>
<td>25</td>
<td>$51.60</td>
<td>$107.27</td>
<td>$55.67</td>
</tr>
</tbody>
</table>
Conclusion

• Preliminary economic analysis of data generated at the DREC in replicated experimental designs of row crop systems that utilize cover crops is being carried out, but only 1 to 2 years of data is currently available.

• Economic tools based on partial and capital budgeting concepts are appropriate to address the economic feasibility of cropping systems that incorporate cover crops.
Questions?

lamy.falconer@msstate.edu

662-686-3238
Pennington Seed Company Perspective:
Cover Crops for Ag & Wildlife Applications

Jimmy Ray Parish
Regional Sales Manager
August 1, 2017
Soil is our most important natural resource and we must protect it.
Pennington History

• 1945 – Brooks Pennington started retail store
• 1950’s – Moved into wholesale seed business
• 1960’s – Penkote developed
• 1970’s – Focusing on grass seed, seed blends and turf as lawn and garden industry began,
• 1980’s – Partnerships with retailers, Blending of wildlife products started
• 1990’s – Acquired by CG&P
• 2007 – Acquired NexGen Research facility, Breeding for Cover Crops – ER Technology
• 2010 – Marketing Cover Crop Varieties
• 2015 – Field Guard Brand Cover Crop Seed Launched
Pennington is Diversified

COVER CROP
FIND PRODUCTS

FORAGE
FIND PRODUCTS

WILDLIFE
LEARN MORE

Pennington products for agriculture and wildlife management.
Basic in the Seed Business

- We breed, grow and own our seed
- Long established relationship with our growers
- Cover crop type material began with our Wildlife program
- Development and breeding of plant material just for the Cover Crop industry
Capacity

NexGen

Missouri Division

Oregon Division

Seed Production

Seeds West
Variety in the Offering

• Farmers/retailers ask for all types of seed and blends

• Filling the need of the farmers
  – Custom Seed Mixtures
  – House Blends
  – Single Ingredients
Know your Seed

• Proper seed labeling of mixtures

• Cleaned with a germination test
  – A must for the industry
  – Cut down on:
    • Weed transfer, spread of resistant weeds?
    • Low Germ seed = poor stand
    • Stand failure
Plant Breeding

• Development of varieties that enhance the soil
  – Extended Root (ER) Technology
    • Improved Water Infiltration
    • Enhanced Cash Crop Root Elongation
    • Rapid Plant Establishment
    • Improved Nutrient Recycling
    • Decreased Soil Erosion
    • Requires 30% Less Water
Developing Biannual Cover Cropping Systems
Seed Supply

- The Grass Seed industry is consistently losing farmland to other crops
- Volatility in weather trends
- Prices continue a generally increasing trend
- Limited carryover from prior seasons on certain species limit supply availability and increase chance of out-of-stocks
Seed Enhancements

• Is the future of the industry

• Allows us to add biostimulants, surfactants, fungicides, and other technologies

• Increases the establishment rate: more seedlings become mature plants

• Offsets the pH impact that acidifying fertilizers have on soil
Timing

• Weather - Affects everything we do

• Cash Crop planting and harvest dates affects on Cover Crop

• Cover Crop planting and termination dates affects on Cash Crop

• Harvest delays of Cover Crops
Research Needs for the Southeast

• What works in other regions of the country is not consistently working in the Southeast
  – Wrong Mixtures
  – Planting Rates to High
  – Wrong Species
  – Wrong Planting Dates
  – Incorrect Termination of Cover Crop

• Our growing season and environment is different
Research Needs for the Southeast

• Planting Rates
  – Recommendations are various

• Testing Varieties for Cover Crops

• Seed Mixtures
  – What works best
  – Do we really need 9 and 14 species blends?

• Termination dates and methods
Research Needs for the Southeast

• Crop rotation
  – What mixtures fit the crop rotation
  – Does it matter?

• Grazing aspects
  – More row crop farmers are looking at this option
  – Does this enhance the soil or take away?
  – Does this affect the Cash Crop?
Information Transfer

• The industry and government entities must work together

• The flow of research results need to improve

• Farmer challenges need to be quantified and collected
Is the industry ready for enhanced technologies?

• Will the Farmer pay for:
  – Deeper rooted varieties
  – Increased biomass
  – Special seed enhancements
  – Higher N producing legumes
Farmers Embracing Cover Crops

- Treat Cover Crops like a Cash Crop

- One and Done is not an option
  - Stand failure
  - Cannot see immediate results
  - Did not work
  - Was too hard

- Our message must be heard that we must protect our Soil.
Networking

• Farmer to Farmer
• Farmer to Government
• Farmer to Industry
• Learning and communication with one another
• Farmers love to share successes
THANK YOU FOR YOUR TIME
Pennington Seed, Inc.
P.O.Box 290
Madison, GA. 30650
1-800-285-SEED
www.pennington.com
Jimmy Ray Parish
662-813-3755
jparish@penningtonseed.com
Cleaning and Separation Equipment
Types of cleaning and separation equipment:

- Pre-Cleaners
- Debearders
- Air-Screen Cleaners
- Length and Width Graders
- Spiral Separators
- Gravity Separators
- Optical Sorters
Pre-Cleaners

Pre-Cleaners remove inert matter from desirable seed prior to drying, storage, and conventional seed cleaning.
Advantages of using a Pre-Cleaner:

- 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
Types of Pre-Cleaners:

- Aspirators
- Screeners
The Aspirator has proven to be one of the most efficient machines available for pre-cleaning seed. It has a total cleanout design that minimizes contamination during lot, variety, or commodity changes.

The Aspirator allows for product separation by density and aerodynamic profile. Light trash, weed seeds, chaff, dust, and insects are removed from the desirable seed as a streamlined flow vacuum is drawn through the product.

As the air flow is evenly distributed, the separation is easily controlled and very accurate. The user can fine tune the degree of separation with minimal adjustments.
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.

VARIBLE 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.
Aspirator Accepts

Aspirator Rejects
# 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>
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<tr>
<td>486</td>
<td>5000</td>
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<tr>
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<tr>
<td>1206</td>
<td>12500</td>
<td>15000</td>
<td>17500</td>
<td>20000</td>
</tr>
</tbody>
</table>
Twin 1206D Aspirators
Twin 846D Aspirators
Under certain circumstances, it may be necessary to include screening, along with aspiration, to achieve the preferred results from the pre-cleaning process.

Flat screeners and drum style screeners are commonly used to remove over and undersize impurities that are too dense or lack the aerodynamic profile to be removed through air separation.

Screeners can be configured for scalping or a combination of scalping and sifting. The scalping process removes the larger material and the sifting process removes the smaller material from the desirable seed.

Scalping is the most common screening operation used in conjunction with aspiration. Aspiration removes the majority of the smaller, light material reducing the need for sifting screens.
The ADVENT Pre-Cleaners utilize the aspirator before the screening process to increase capacity and screening efficiency.

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

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.
Advent Siftings

Advent Scalps
Scalping Reel
Debearders thresh seed to increase flowability and improve appearance.
The Debearder consists of multiple steel beater arms rotating among similar stationary arms. Debearders are designed to break up grass clusters and alfalfa pods, hull whitecaps in wheat, and clip oats.

Debearders help improve product test weights, enhance appearance, and increase flowability to enable faster cleaning.
Debearder
Air-Screen Cleaners remove inert matter from desirable seed through the utilization of three operations: aspiration, sifting, and scalping.
The Air-Screen Cleaner separates products by density, aerodynamic profile, and size.

Seed is metered into the airstream where light contaminants are removed from the desirable seed as a streamlined flow vacuum is drawn through the product.

As the air flow is evenly distributed, the separation is easily controlled and very accurate. The user can fine tune the degree of separation with minimal adjustments. A good indicator of a proper separation is to see a very small amount of good product in the airlock discharge of the aspirator.

As the seed exits the aspirator, it’s introduced to the screening portion of the cleaner for precise sifting and scalping processes. It is a good practice to graduate the scalping screen hole sizes as the product flows down the deck. This will carry the product as far down the deck as possible before falling through the scalping screens. Screen area will be maximized and large, undesirable material will be prevented from diving through the screens. Using a drag or draper curtain on the scalping screens will also help keep longer material from standing on end and diving through with the good product.

Perforated screen sizes should be adjusted to finely grade the seed while holding the clean-out percentages as low as possible.
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.

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

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.

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.
Aspirator Rejects
SIFTING DISCHARGES
Siftings
SCALPING DISCHARGE
Scalps
Cleaned Seed
Siftings

Cleaned Seed
Screen Types

- Style I Slot
- Style II Slot
- Herringbone
- Round Hole
Length and Width Graders remove undesirable material from good product through the use of indented cylinders, perforated cylinder shells, and pocketed discs. Utilizing these machines in a seed conditioning line produces a more size specific product that can be accurately separated by density in a later process.
Types of Length and Width Graders:

- Indented Cylinders
- Disc Separators
- Precision Sizers
The purpose of the Indented Cylinder is to remove the last small percentage of broken seed or weed seed after the Air-Screen Cleaner. Indented Cylinders rely on centrifugal force and length differences to lift small particles out of the seed mass. The speed of the cylinder holds the small material in the indented pocket until it’s inverted to the point where gravity causes the product to fall out of the indent into the conveying trough. The angle of the trough can be adjusted to obtain the desired cut by not permitting longer, good seed to fall into the trough.
The Disc Separator, like the Indented Cylinder, is a length sizer. Disc separation is not adversely affected by the seed’s bulk density, surface texture, or moisture. Hardened, cast iron discs with undercut pockets revolve through the seed as the pockets pick up the small material. A normal disc arrangement consists of discs with pocket sizes progressively larger from the intake to the discharge end. The smallest particles are removed first and the larger liftings are removed as the seed passes through the machine.
Length Graders

Disc Separator

Indented Cylinders
The Precision Sizer is a width and thickness separator. It consists of a perforated cylinder on a rotating shaft. As the product is fed into the rotating cylinder, the motion of the cylinder tumbles the product and presents it to the perforations from all angles. This enables a precise grade. Particles smaller than the perforation drop through the cylinder and larger material travels inside of the cylinder to be discharged out the end. Round hole perforations are normally used for sizing and slots are used primarily for separating rounds from flats. Wipers under tension contact the outside of the cylinder as it rotates to help keep the perforations clean.
Width Grader

Precision Sizer
Spiral Separators separate by product shape, removing non-round material from round material.
Spiral separators remove damaged, broken or non-round product from desirable round product. The seed is fed onto a banked flight spirally wound around a core shaft. As the material flows, rounds achieve a much greater velocity than non-rounds and are discharged over the outer edges of the flight. The non-rounds that are flowing at a slower rate, never reach the edge of the flights and are discharged from the bottom of the separator.
Spiral Separator
Gravity Separators

- The Gravity Separator offers a definite, accurate separation of product by weight and density.
Gravity Separator

The Gravity Separator is a finishing machine that’s normally utilized after the Air-Screen Cleaner and sizing equipment. The purpose of the Gravity Separator is to remove undesirable seed and contaminants that are similar to good seed in size, shape, and color. These materials sometimes differ from good seed only in density.

As product is introduced to the gravity deck screen, a bottom fan fluidizes the bed by vertically stratifying the product according to its specific density. Lighter material floats to the top of the product bed while the heavier, desirable material stays in contact with the deck screen. The accepts discharge end of the gravity deck is lifted higher than the rejects end. The heavier, good product is pulled uphill by the rippled screen while the lighter discards float downhill to the reject gates.

The eccentric speed of the gravity should be set according to incoming flow rate of product and the desired capacity. The fan speed will be dictated by the product density and bed depth. It is best to operate the fan at a speed barely fast enough to create a fluid bed. The separation will suffer if the fan is running too fast and erratically blowing through the product bed. The deck height should be set as low as possible while not allowing undesirable product to discharge with the accepts.
Maintaining a level bed depth is preferred for the most precise separation. There are several ways to achieve a level product bed. More eccentric speed pulls product uphill and increases the bed depth on the front of the deck. More fan speed pushes product downhill to the rejects end of the deck. Raising the deck lift forces product downhill and lowering it brings the product back to the front. When a level product bed is achieved, the overall bed depth can be adjusted by simply moving the weight on the bellows that controls the automatic discharge gate.

These collective adjustments will achieve a level bed of the proper depth for the most precise, definite separation of the product.
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.
<table>
<thead>
<tr>
<th>MODEL</th>
<th>SMALL SEED</th>
<th>MEDIUM SEED</th>
<th>LARGE SEED</th>
<th>ENERGY</th>
<th>DUST HOOD CFM</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>2,200</td>
<td>54 1/4&quot;</td>
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<tr>
<td>401</td>
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<td>128 BU/HR</td>
<td>160 BU/HR</td>
<td>5 HP</td>
<td>3,000</td>
<td>58 1/2&quot;</td>
<td>64 1/4&quot;</td>
<td>116 1/4&quot;</td>
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<td>641</td>
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<td>200 BU/HR</td>
<td>250 BU/HR</td>
<td>10 HP</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>
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<tr>
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<td>100 BU/HR</td>
<td>240 BU/HR</td>
<td>300 BU/HR</td>
<td>15 HP</td>
<td>8,500</td>
<td>65 1/4&quot;</td>
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<tr>
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<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>
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</table>

<table>
<thead>
<tr>
<th>MARC MODEL</th>
<th>SMALL SEED</th>
<th>MEDIUM SEED</th>
<th>LARGE SEED</th>
<th>ENERGY</th>
<th>DUST HOOD CFM</th>
<th>HEIGHT</th>
<th>WIDTH</th>
<th>LENGTH</th>
<th>WEIGHT</th>
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<tbody>
<tr>
<td>200</td>
<td>55 BU/HR</td>
<td>128 BU/HR</td>
<td>160 BU/HR</td>
<td>2 HP</td>
<td>8,000</td>
<td>81 3/4&quot;</td>
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<td>250 BU/HR</td>
<td>3 HP</td>
<td>10,000</td>
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<td>80&quot;</td>
<td>128&quot;</td>
<td>7050 LBS.</td>
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49
Marc Series Gravity Deck Pattern
Optical Sorter

The Optical Sorter utilizes reflected light and cameras to distinguish color differences between desirable and undesirable product.
The Optical Sorter is often the last step in a conditioning line. The purpose of the Optical Sorter is to remove material with color defects after it has been cleaned, sized, and separated by density.

Vibratory feeders meter the product onto chutes. Product singulates as it accelerates down the chute to the viewing area. The viewing area consists of cameras, filters, and sensors. Lumination is provided by RGB or infrared lighting. As the product passes through the viewing area, the light is filtered to the cameras and the difference between the accepts and rejects are recognized. At the moment the difference is determined, an air operated ejector is activated and the reject is discarded.

A resort feed is usually incorporated in higher capacity operations to reclaim the percentage of good product that is discarded with the rejects when the ejectors are activated on the initial pass.
Optical Sorter
Conveying Equipment
Methods of proper product handling:

- Minimize spout angles
- Reduce product fall in transition areas
- Utilize cushion boxes for direction changes in spouting
- Utilize flow retarders in spouting to reduce seed velocity
- Utilize elevators designed for a slower cup speed
- Minimize the use of screw conveyors
- Minimize the use of drag conveyors after pre-cleaning
- Install bean ladders in bins
- Transfer seed with vibratory conveyors wherever possible
**LMC Easy Dump Elevator**

**DISCHARGE SPOUT OPTIONS**

**Reversible Discharge Spout**
By simply removing the bolts from the spout and cover plate, the discharge direction can be altered without breaking the chain assembly.

**Bi-directional Discharge Spout**
Product can be simultaneously discharged from both sides of the elevator should separate bins or machines need to be fed at the same time.

**Switch Valve Discharge Spout**
Products can be discharged from either side by a manual or pneumatic valve.

**BOLTED ASSEMBLY**
The legging can be shipped broken down, thereby reducing freight costs.

**POSITIVE CLEAN-OUT BOOT**
The boot is tapered to a drawer action assembly which, when opened, completely empties the boot. Built-in boot clearance above the floor enables quicker, more effective clean-outs and maintains proper sanitation.

**LADDERS, CAGES, REST AND SERVICE PLATFORMS**
OSHA compliant ladders, cages, rest and service platforms are all optional features that can be included in your specific design.
LMC Easy Dump Elevator
## LMC Easy Dump Elevator

### Model Specifications

<table>
<thead>
<tr>
<th>MODEL</th>
<th>BUCKET SIZE</th>
<th>CUBIC FT/HR</th>
<th>CAPACITY at 35 lbs/cubic ft (85% fill)</th>
<th>CAPACITY at 48 lbs/cubic ft (85% fill)</th>
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<td>485</td>
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<td>10” x 24”</td>
<td>3,428</td>
<td>119,980 lbs/hr</td>
<td>164,544 lbs/hr</td>
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</table>
Vibratory Conveyors

Standard Single Pan Vibratory Conveyor

Standard Single Pan Vibratory Conveyor With Optional Screening
Myles Mosely
Phone: 229-524-2197
Email: myles.mosely@lmcarter.com
MIXING AND BLENDING
EQUIPMENT FOR COVER CROPS
THE BEGINNING

• Founded in 1964 in Des Moines, Iowa by Ken and Ann Bratney.
• Began business in seed, grain, and food related industries with commitment to integrity, and respect for the relationship with the customer.
• Focus on equipment sales and design. Quickly grew to include engineering and construction services by the mid 1970’s.
• Ken Bratney: “Your word is your bond.”
• We live by this motto even today
EQUIPMENT, ENGINEERING AND DESIGN SERVICES

• Supply of Cleaning, Sizing, Sorting, Treating, Storage and Packaging Equipment

• Design Build Construction Services

• Plant/Equipment Installation

• Process and Material Handling

• Civil/Structural/Mechanical

• 3D Computer Aided Design (AutoCAD & SolidWorks)

• Scheduling and Coordination

• Startup and Commissioning

• After Sales Service and Spares

• Turn Key Supplier
DIVERSE APPLICATIONS

- Wheat seed conditioning plants
- Export wheat cleaning facilities
- Malting Plants for Breweries
- Edible bean conditioning
- Feed Mills
- Hybrid Seed Corn plants
- Native and lawn grass seed plants
- Oat mills
- Grain & process drying facilities
- Edible corn conditioning
- Green coffee bean conditioning
- Popcorn conditioning facility

EXTENSIVE EXPERIENCE

- Rice Milling Systems
- Soybeans – seed, edible & organic
- Breweries – malt storage systems
- Bird Food Plants
- Flour mills
- Hop pelleting plants
- Spice cleaning and blending
- Packaging all types of free flowing materials
- Split pea processing
- Sunflower processing plants
- Almond sizing, sorting and roasting plants
- Mixing and blending systems
MAIN OFFICES IN

Des Moines, Iowa  Boise, Idaho  Colon, Argentina
Sacramento, CA  Kansas City, MO

• Staff of 145 people

• Cover the majority of the agricultural markets (seed, edible whole foods, grain, animal feed, specialty)
CONSIDERATIONS IN A BLENDING PROCESS

The Big Picture

- The seed types or species to be used in the blend
- The volume of each that may be used. Daily / yearly
- How those are to be received and stored
- The “recipes” to be used in the blends
- Accuracies of the ingredients required
- Treatment considerations Pre Blend or Post Blend (Kyle)
- Level of automation in the process
- How the finished blend is to be stored, packaged or shipped
- The available space for this initiative
- Consider future needs. Additional products, blends, etc.
- And.........any established budgets to stay within
SEED TYPES TO BE USED

The Small Picture

• Care and Characteristics
  • Friability. Both of the seed itself but also the treatment / coating of pre blended seed
  • Are the treatments and coatings compatible?
  • Flowability. Buckwheat versus wheat
  • Tendency to stratify or bridge.
  • Knowing the Bulk densities of both the ingredient seed but also what the mix will be. i.e. a 50# bag of mostly Ryegrass blend will be quite large compared to 50# of a mostly clover blend. (Packaging equipment issue)
• Any cleaning or conditioning required?
VOLUME AND HOW SEED WILL BE RECEIVED

The Small Picture

- Efficiency and economies in buying in bulk?
- Will that help justify storage bins
  - Macro and Micro ingredients
  - Racks, inventory management
- Receiving
  - Truck types (end dump, hopper bottom...if by bulk)
  - Bulk bags, bulk boxes, bags, bunkers
  - Proper material handling equipment for the job
    - Bucket elevators, incline conveyors, pneumatic, etc.
- Ability to clean out
The Small Picture

- This how we might categorize these on an individual ingredient basis
- High - We need to go with programmable control system and load cells and accurate feeders. We have to weigh the product to take out the variables.
- Medium - Accurate feeders, proper transitions, consistent flow, consistent seed and done with regular calibration via rheostat or other means to vary delivery.
- Reasonable - So we have some leeway. Maybe use volumetric type feeders (rotary) on rheostat, but really need to know bulk densities. Catch and weigh
The Small Picture

• We also need to be careful on what the mix ratios might be to stay within the capabilities of the dosing / feeder system. There is a maximum and a minimum these can feed.
• Accuracy pays. When the label says something, you better provide to that spec.
• Prices of seed species, especially if already coated or treated can have varying costs. You want to be accurate to stay in line with how you have costed and sold the blend.
• Cannot help what happens in the field, but providing a solid and homogenous blend you can control
Types of Systems Definition

Batch Type System - Simple

- A specific and known amount of material is placed into a blending / mixing system and mixed. Repeat process
- **Advantages** = simple. A pound of this, a 50 pound bag of that, a bulk bag of something else, etc.
  - Accurate. The batch is weighed or more likely, each ingredient is going into the blender.
  - Lowest cost
- **Disadvantages** = time consumption. It takes time to dump each ingredient, time to mix, time to unload before doing it all again.
Continuous Batch Type System

- Automation of the ingredients into a “master” bin or blender
- **Advantages** = still simple. We weigh each product out into a bin / blender. Ingredients will be run one at a time or with automation and a loss in weight system, they can run simultaneous to facilitate quicker loading of the blender.
- **Disadvantages** = Takes some time as this is still a batch. Specifically, the time it takes to blend.
- Costs start to escalate with automation
BATCH TYPE SYSTEM EXAMPLES

Simple = Pre weighed product dumped directly into mixer manually

More complex = Product is gathered and weighed in a scale just before mixer
Continuous Type System

- Automation of all ingredients into a transfer conveyor.
- **Advantages** = fast. Each product is synchronized to feed onto a conveyor that in turn feeds directly into the bagging / load out bin. Conveyor can be belt, drag, screw or combination to help facilitate homogeneous mix.
- Gentle. Little additional mixing needed.
- **Disadvantages** = Higher skill level of operator to be able to program.
- Cost. Automation costs money.
- Regular monitoring and calibration.
This system allows the feeders to all run at the same time, none stop but takes programming to get the feeders to start and stop on time to ensure blend is accurate. i.e. delays set to allow belt to travel.

Load Cells to allow constant monitoring of feed rates.
CONTINUOUS TYPE SYSTEM EXAMPLE

Using electromagnetic feeders or could be rotary feeders

May need to use a mixing device at the end of the conveyor or going into the subsequent bin to mix the layers that are on the belt.
HARDWARE ITEMS THAT ARE OFTEN USED

Vibratory Feeders – Volume over time

Screw Feeders - Volumetric

Rotary Feeders - Volumetric
HARDWARE ITEMS THAT ARE OFTEN USED

Horizontal Mixers – Low potential for mechanical damage

Vertical Mixers – Moderate potential for mechanical damage

Drum Mixers – Very Low potential for mechanical damage
CONTINUOUS TYPE SYSTEM EXAMPLE

Similar system but using minor ingredients and perhaps inoculate
HEADS UP AND BE AWARES

• Volume of the mixer / blender on batch type systems. Often times referred to in tons but a ton of radish is going to take up much less volume than a ton of ryegrass.
• Surge bin after blending. Bigger is always better right???
  • All the hard work you did to get a nice homogeneous mix can come undone through stratification of lighter materials. If that is an issue, “optimize” the bin to keep pace with the prior and post operations.
HEADS UP AND BE AWARES

• We are pretty good at putting the right amount of treatment and coatings on seed. It is what we do. But.....we are not the pharmacist to know if any of these interact negatively with each other.
TAKE AWAYS AND SUMMARY

- Many options to get the job done. Systems are generally customized to meet the needs

- Design in flexibility and adaptability

- Know that there are optimum ranges for the equipment

- Change is certain. What works today perfectly will likely need adjusted tomorrow...... Murphy is still alive and well.
WE WELCOME YOU TO CALL OR CONTACT US:
Dave Ewald  515-974-6083 Direct Line
800-247-6755 Toll Free
Dave.ewald@Bratney.com

www.Bratney.com
Seed Treatments & Seed Coatings:

Seed Applied Actives & Additives

Kyle Rushing

KW Rushing Consulting, Inc
Seed Treatments & Coatings
Seed Application vs. Field Application Of Crop Production Inputs!

As many as 8 -10 Actives & Additives maybe be applied to an individual Seed]

[Fungicides, Insecticides, PGR, Nematicides, Colorants, Disinfectants, Nutritional products, Inoculants, Biologicals, etc.]

Seed Amendments in the form of polymer coatings and binders are applied with these production inputs thus facilitating handlability during application, seed flow, plantability, minimum abrasion/dusting, enhanced seed performance and cosmetic appeal.
Product Forms of Seed Additives

- **Basic Seed Film Coat Liquids**
  - Weight increase 0.2-2%

- **Complete Seed Film Coat Liquids**
  - Weight increase 3-20%

- **Encrusting**
  - Weight increase 1-5X

- **Mini Pill (Pellet)**
  - Weight increase 10-25X

- **Standard Pill (Pellet)**
  - Weight increase 15-100X
Field Corn Treated With Seed Applied Seed Actives and Additives
Functionality of Seed Treatment Film Coating

- Compatible with crop protectants and additives – both chemically and physically. Coating and coating rate selected for a specific seed and chemical cocktail mixture to be applied.
- Minimize dust abrasion of actives and additives from the treated seed. Excellent adherence uniform coverage of each and every seed.
- Ensures safe seed treatment for worker and environment
- Improved appearance (present a cosmetically appealing product.)
- Comply with EPA requirement that pesticide treated seed be color coded.
- Optimize application in all seed treating equipment. Provide uniform coverage, quick drying, and no impediment in seed flow and bagging operations.
- Safe for seeds at the recommended rates (seed toxicity effect is not allowed)
- Provides optimized flow of seed through conveying and planting equipment with minimum abrasion and dust-off of active treatments.
Seed Film Coat Liquids are Formulated to Minimize DUST-OFF of Additives and Actives

Film Coat Liquid  No Seed Film Coat Liquid
Seed Flow as Affected by Film Coating Liquids Applied With Chemical ST Entry (CE) used at 250 mg/seed

% flow of untreated seed

Time After Treatment Applied

CE 250mg (film coating A @ 0.7mg)

CE 250mg (film coating B @ 0.5mg)

CE 250mg (film coating C @ 0.7mg)
Film Coat Liquids Can Affect Seed Flow, Seed Plantability & Placement

Untreated

Film Coat
Film Coat Liquid Reduce Leaching of Active Ingredient A from Seed

Immediate Release

Without Coating

Slower Release

With Coating
Seed Treatment Quality Can Be Affected by Several Factors

- Seed characteristics: size and seed coat texture
- Crop protectant active formulations properties
- Number of additives being applied
- Film coating formulation properties
- Application technology equipment
- Awareness by the operator during the treating process and the final quality of treated seed produced
New: High Performance Seed Film Coat Liquids

- New Enhanced Polymer Technologies
- New Application Technologies
- Improved coverage and seed-to-seed distribution
- Higher binding & film forming properties
- Available in HP Color and HP Pearl

CONTINUAL IMPROVEMENTS IN SEED COATING PRODUCTS AND TECHNOLOGIES ARE ON-GOING!!
Encrusting & Pelleting

(High Valued & Small Seed)
Vegetable and Ornamental
Mr. David Dirkse Developed Seed Encrusting & Pelleting from the Pharmaceutical Tableting Industry.

Used the seed as the center of the Pellet (core)
Brassica;

Lettuce;
Encrusting/ pelleting

Objectives

- To improve plantability and singulation
- To increase seed space to carry more actives and additives
- Over 80 different formulations (Clay blends, lime, fir and wood bark, etc.)
- Adaptations to
  - moisture levels
  - sowing equipment
  - soil medium
  - seed characteristics
Multiple Modes of Action Of Additives and Biological Agents

- Enhanced control of germination
  - Vigor enhancement
  - Stress tolerance
  - Root growth
- Act directly as a beneficial compound (nematicide)
- As elicitors of plant response to pests and fungi
- Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR)
- Act as up down regulator of genes (activating immune systems)
- Symbiotic relationship of multiple additives (fungicides, insecticides, biologicals, & PGR’s)
Mode of action

PGR (Plant Growth Regulating) Compounds

Enhance early growth and a good root development is the foundation of a healthy crop.

Increase the number of root hairs and the root length. This allows the seedling to make the best possible use of the soil nutrients: This PGR is a strong growth stimulant.

Roots treated (left) versus untreated control Roots treated (right) Treated (right) versus untreated control (left)
Performance on Wheat

Yield Increase (average + 4.5%)

Independant trial points
Features and Benefits of another PGR

**Product Features**
- Naturally occurring organic acid (CPPA)
- PGR (Plant Growth Regulator)
- Seed treatment application with DISCO polymers
- Highly concentrated a.i (0.4 oz/cwt)
- Chemically compatible with other actives
- Registered as seed applied fertilizer
- EPA registration as Biopesticide –

**Benefits**
- Increased speed of emergence—especially under stress
- Increased vigor – stronger root growth
- Significant yield increases in several crops
Data comes from 15 locations across 7 states; check treatment varied by location with fungicide and/or insecticide (IPSA trials).
Soybean field trial study

% yield compared to treated check

Data comes from 18 locations across 4 states; check treatment varied by location with fungicide and/or insecticide
Mode of Action: Attracts Mycorhizzæ

- Myconate is the isoflavone — formononetin — originally isolated and identified from P-deficient clover roots
- Recognized as a signalling compound to attract VAM
- Myconate increases the growth and colonization of roots by beneficial Vesicular-Arbuscular Mycorrhizal (VAM) fungi
Root Growth Enhancement

- Check: Root growth enhancement with 35 g a.i.
- MYCONATE FS 350: Root growth enhancement with 77 g a.i.
- MYCONATE FS 350: Root growth enhancement with 100 ml/ha.
# Summary of Corn Field Trial Results

<table>
<thead>
<tr>
<th>YEARS</th>
<th>NO. TESTS</th>
<th>% SUCCESS</th>
<th>AVE. YIELD INCREASE</th>
<th>CONTROL BU/ACRE</th>
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<tbody>
<tr>
<td>PHC - 2004/05</td>
<td>44</td>
<td>91</td>
<td>+12</td>
<td>-150</td>
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<td>Other - 2005</td>
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</tr>
<tr>
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<td>64</td>
<td>+5</td>
<td>-200</td>
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<td>71</td>
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<td>-120</td>
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<td>+3</td>
<td>~170</td>
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<tr>
<td>PHC - 2010</td>
<td>25</td>
<td>57</td>
<td>+1</td>
<td>~160</td>
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<tr>
<td>PHC – 2011: RCB</td>
<td>5</td>
<td>80</td>
<td>+5</td>
<td>160</td>
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<tr>
<td>PHC – 2011: Demo plots</td>
<td>36</td>
<td>78</td>
<td>+4</td>
<td>~175</td>
</tr>
<tr>
<td><strong>AVERAGE ALL</strong></td>
<td><strong>192 tests</strong></td>
<td><strong>71</strong></td>
<td><strong>5.2 (3%)</strong></td>
<td>~160</td>
</tr>
</tbody>
</table>
Pollinator Plus®

What does this revolutionary seed coating bring to the corn seed industry??
Pollinator Plus®

A Seed Coating that delays Male Inbred Parent Germination in hybrid seed production.

Commercial product since 2000

Used on 2 + million acres of US corn seed production

Works consistently across all genetics and maturities.

Has become a Standard production tool in hybrid seed corn production.
Pollinator Plus: Product Features

- **Two coating products:**
  - **MD9050**: Flowering delay of 50-75 HU
  - **MD9100**: Flowering delay of 75-100 HU
- Provides predictable delay in emergence
- Spread of emergence to ensure wider pollen window
- Typically planted by blending with uncoated seeds
Benefits of Pollinator Plus

- Delays germination of male inbred seed
- Expands the pollen shed window
- Eliminates or reduces split plantings
- Eliminates flaming operations
- Minimizes weather related risks
- Improves seed purity
- Enhances yield of Hybrid Corn (Maize) Seed
Consistent Emergence Delay

![Consistent Emergence Delay Chart](image)

- **Delay (HU)**
- **Var 1**
- **Var 2**
- **Var 3**
- **Var 4**
- **Var 5**
- **Average**

- **MD9050**
- **MD9100**
- **UTC**
Wide Emergence Spread of Pollinator Plus (10-90%)

Wide spread in emergence provides wide pollen window.
Pollen Shed Delay

![Bar chart showing Delay (HU) for different variables and averages.](image-url)

- Varieties: Var 1, Var 2, Var 3, Var 4, Var 5, Average
- Varieties with data: MD9050, MD9100
- Units: MD9100, MD9050, UTC
Pollen Spread (10-90%)
Benefits of Wider Pollen Shed Window

- Reduce chances of missed nicks
- Avoid pollination risks where female moves due to weather conditions
- Longer pollination window protects against poor pollination of inside rows
- Reduces risks on new crosses with wider pollen window
- Protects against significant yield losses
- Wider pollen cover from border rows reduces adventitious pollen
Summary & Conclusions

• Seed Treatments provide numerous cost effective benefits to the grower.

• Seed Treatments provide environmentally friendly control of insects – soil & foliar, diseases – root and foliage, root attacking nematodes, SAR & ISR effects on the plant system, as well as controlled delayed emergence.

• As the effects of climate change increase, seed treatments technology advances will become recognized as a potential part of sustainable agriculture.
Thank You !!
Dormancy & Specialty Crop Physiology

Fawad Shah, Ph.D.
Adjunct Associate Professor, U of Minnesota
President / CEO Minnesota Crop Improvement Association
Why seed don’t germinate:

More than likely either they are:
1) Dead - or
2) Dormant
Seed is a flowering plant's unit of reproduction, capable of developing into another such plant. Seeds have been created with the dual purpose

1) Protect the embryo within

2) Enable miniature plant to emerge at the most opportune time for optimum growth

Without the required periods of dry, cold, wet or heat the protective seed coat will not allow the embryonic seed within to break out into life. However, some seeds will still refuse to germinate! This is known as seed dormancy.
Dormancy

• Inability of seed to germinate under conditions normally considered favorable for germination

• Seed containing a block to complete germination is said have dormancy

• It’s a genetically inherited trait, environment too, plays a role

• So dormancy...
  • (Internal factors) relates to the state of seed
  • (External factors) Operation of environmental factors on dormancy & germination
Essential Characteristics of Dormancy

1. Dormancy must block germination under conditions ordinarily favorable.
2. The degree or intensity of dormancy must vary within the population of the species.
3. Dormancy must be released by “Natural” environment/climatic factors or a change in climate.
4. Dormancy must protect the seed against deterioration
Dormancy

Two broad classes:

• Dormancy imposed by exogenous structures (outside embryo)

• Dormancy imposed endogenously (in embryo itself)
Exogenous Dormancy

• Embryo itself is not dormant
• Generally related to physical properties of the seed coat
• Three factors responsible for exogenous dormancy
  • Water impermeability
  • Gas impermeability
  • Mechanical restriction
Exogenous Dormancy

- Hard seeds - impermeable to water
  - Primarily in four families:
    - *Fabaceae* - legume
    - *Malvaceae* - cotton, okra
    - *Chenopodiaceae* - Lambsquarter
    - *Liliaceae* - Lily family
Exogenous Dormancy

- **Gases:** Impermeability of gases through the seed coat
  - Seed coats can be selectively permeable. The best known example is *Xanthium* (cocklebur)
    - Upper smaller seed requires pure O₂ for 100% germination. The lower seed needs only 6% O₂ for complete germination.
  - In cucumber, nucellar membrane, and in coffee seed, Endocarp restrict entry of Oxygen
- Cruciferous seed’s epidermal cells in the seed coat swell when wet, delays oxygen reach to the embryo
- Chemical compounds in the seed coat may consume oxygen thus reducing amount of oxygen to the embryo
Exogenous Dormancy

Mechanical Restriction:

- **Physical restraint by seed coat** on an enlarge embryo, force created by imbibition and growth inadequate to rupture the seed coat and permit germination.

- Examples: pigweed, peach, cherry

- Seed coats when removed, results in elimination of inhibitors

- Seed coats interfere with leaching of inhibitors or restriction of water flow
Exogenous Dormancy

After-ripening during Storage:

• Disappearance of dormancy during storage at room temperature - almost universal in cereals
• Storage at 15° - 20°C for one or two months usually allows maximum germination
• Usually also responsive to stratification (pre-chill)
Endogenous Dormancy

Most prevalent dormancy found in seeds, mainly due to inherent properties of seed. Environmental conditions during seed development and maturation can influence the duration of endogenous dormancy...

- **Day length**: influences dormancy in developing seeds especially in seed maturation final stages

- **Moisture status** of the mother plant or developing seed influences dormancy, water deficit in flowering increases barley seed dormancy

- **Seed position** on mother plant influences dormancy, carrot (Apiaceae family), inflorescence is an umbel produced in sequential order, seeds from primary umbel are heavier, more mature and more dormant than those produced in other parts on the plant

- **Age**: also environmental conditions (nutrients, moisture)
Endogenous Dormancy

• Rudimentary Embryo Dormancy: Seed are shed before they are morphologically mature, immature embryo is unable to germinate, e.g., Plantago, Pinus

• Physiological Dormancy: Dormancy due to presence of growth inhibitors, the absence of growth promoters, or a combination of the two.

• Metabolic Inhibition:
  • Cyanide (apple & peach) - inhibit specific metabolic pathways, suppress germination through effect on respiration.

• 1st dormancy-inducing inhibitor found was Coumarin - (natural germination inhibitor)
• - ABA (abscisic acid) called dormin (discovered in 1966) - active inhibitor of seed germination
**Seed Coat-imposed Dormancy:**
Seed coat acts as an effective barrier to entry of water, and or oxygen through the seed coat or other covering, restraining embryo growth, e.g., wild oats, hard seeded legumes

**Embryo Dormancy:**
Blocks or deficiencies within embryo, while seed coat may have no affect on dormancy, depends upon cotyledons and germination inhibitors that prevents germination, e.g., woody species, or herbaceous plants, e.g., wild oats

- Dormant embryos of many species contain ABA, and/or other inhibitors
- Chemicals such as Abscisic Acid act as inhibitor for seed germination
- Gibberellic Acid (GA3) acts as growth promotor – so higher GA3 and low ABA results in seed germination, but low GA3 and high ABA results in dormancy
Categories of Dormancy

**Epicotyl Dormancy:**
Parts of the embryonic axis differ in the depth of dormancy, e.g., Lilium spp., radicle emerges but the epicotyl fails to grow

**Double Dormancy:**
Two organs differ in the degree of treatment needed to break dormancy, e.g., in Trillium spp., radicle has some dormancy, but its less deep than that of the epicotyl

**Relative Dormancy:**
Expression of Dormancy is strongly dependent upon temperature, e.g., grains of several grasses and cereals are dormant only at temperatures above a particular value
Primary Dormancy:
Dormancy initiated during seed development – seed are dormant when dispersed from the parent plant.

Secondary Dormancy:
Seeds that are non-dormant can be induced to become dormant when the environment is not suitable for germination. This may be caused by exposure of the seed to conditions that favor germination in all respects except one. Secondary dormancy reported in high moisture winter barley after seven day storage at 20°C.
Advantages of Dormancy

• Primary function of seed is to establish a new plant, it may seem odd that seed will not germinate, why?

• Synchronizes germination with seasons – over winters

• If no dormancy - embryos would continue to grow and germinate in field, dormancy stops pre-harvest sprout damage

• Does not allow seeds to deteriorate under adverse field conditions

• Contributes to seed longevity and repository
Disadvantages of Dormancy

• Long periods of time needed to overcome dormancy (for uniform germination)

• Germination drags out over time (uneven stands)

• Interference with planting schedules (must consider dormancy)

• Seed testing problems
**Mechanical Scarification:** Break seed coat with a sharp knife or abrade it with sandpaper to allow imbibition through the hard seedcoat. Also, acid scarification, use of diluted sulphuric acid removes seed coat impermeability e.g., cotton seed.

**Stratification:** Expose the seeds to cold temperatures by putting them in the refrigerator, pre-chilling, simulating a short winter. Depending on seed kind, it may take 2-6 weeks.

**Heat:** Breaks hardseededness by expansion.
Methods to break Hardseededness

• **Hot Water**: Pour boiling water on over seed and let them soak until water cools, e.g., garden pea

• **Fire**: also breaks dormancy, by breaking seed coat

• **Time**: most non-dormant seeds germinate in ~14 days

• **Light**: Exposure to light breaks down the germination inhibitors in some types of seeds, particularly wildflowers that produce small seeds

• **Chemicals**: Gibberellic acid, KNO3 used to break seed dormancy in lab environment by moistening germination paper
How to measure / determine dormancy?

• Paired testing
  • Run 2 germination tests
    • One utilizing dormancy breaking methods
    • One without any dormancy breaking method

• Tetrazolium Testing (TZ)
  • Measures respiration of seed
    • Live tissues stain red
    • Dead tissues remain unstained (~white)
Intended uses of crops

• **Crops:**
  – For harvest
    • Require a uniform stand
  – Little or no dormancy
    • Bred out of species
    • Dormancy not a good trait

• **Natives:** *Not for harvest*
  • Goal is establishment of as many plants as possible: No need to be uniform in maturity
  
  – Dormancy
    • A good trait—more chances to establish
    • Why required to break dormancy and imply such seeds will germinate
Agronomic vs. Natives: Goals

Agronomic and Native Species are Different

Uniform crop

Healthy long-lasting ecosystem
Should We Break Dormancy in Native Species?

Both the ISTA and AOSA Rules require dormancy breaking

- This elevates the reported germination percentage
- This can be misleading to both buyer and seller of the seed lot
  AOSA passed a rule: Option not to break dormancy
Crambe Seed

• Label: 87% Germination
• Planted on 600 acres
  • No growth after 2-3 weeks

• Follow up germ tests using:
  • KNO3: 95%
  • H2O: 3%
Long ago, we had to break dormancy

- Unerminated seeds at the end of the test
  - Before TZ, there was no way to evaluate firm ungerminated seeds
    - Breaking dormancy gave the highest germination possible
    - Today, TZ can be used to evaluate if an ungerminated seed is viable or not

- Technology has changed
A seed is a small embryonic plant enclosed in a covering called the seed coat, usually with some stored food

3 parts of seed

• **Embryo**: Miniature plant, roots and shoots becomes new plant after germination

• **Endosperm**: Provides source of food/energy for first stages of development, until plant is able to produce its food via photosynthesis

• **Seed coat**: Tissue that surrounds the embryo and stored food, protects seed from mechanical damage and from soil insects, fungi, etc.
Germination - definition

“the emergence and development from the seed embryo of those essential structures which, for the kind of seed in question, are indicative of the ability to produce a normal plant under favorable conditions.”

The resumption of active growth by the embryo after quiescence, or rest these definitions include some measure of seedling development, even though this occurs subsequent to the germination event

*Important part is the reproductive ability of the seed, an essential objective in agriculture. Does it have the capacity to produce a normal plant?*
Germination

- Germination begins with water uptake by the seed (imbibition) and ends with the start of elongation by the embryonic axis, usually the radicle.
- Germination does not include seedling growth, its starts after germination finishes
- Seed testers: evaluate establishment of a vigorous plant of agronomic value
- Quiescent Seed: no germination process takes place, seed with low moisture content (5-15%) with metabolic activity to almost standstill
Pennycress weed or crop?

Domestication of Pennycress as a new edible oilseed cover crop
Farming in the Midwest

The land is unnaturally barren nine months of the year, Barren soils are prone to nutrient leaching and soil erosion.
Making the Midwest Landscape “FOREVER GREEN” with pennycress

Winter annual pennycress supplements a normal crop rotation

- Summer corn crop Yr 1
- Pennycress seeded into corn
- Pennycress in late fall
- Summer soybean crop Yr 2
- Pennycress in late spring
- Pennycress in early spring
The potential of Pennycress

• Grows well throughout the Corn Belt
  • Up to 40 million acres could be planted each year, with no displacement of food crops
  • Yields could be as high as 2,000 lbs of seeds per acre (100 gallons of oil / acre)
  • Pennycress yields 100-200 lb/ac ~35% oil
• Fits into alternative cropping systems currently being developed by Dr. Scotty Wells (U of M - Agronomy and Plant Genetics)
• Grows well throughout the Corn Belt
  • Up to 40 million acres could be planted each year, with no displacement of food crops
  • Yields could be as high as 2,000 lbs of seeds per acre (100 gallons of oil / acre)
  • Pennycress yields 100-200 lb/ac ~35% oil
  • Fits into alternative cropping systems currently being developed by Dr. Scotty Wells (U of M - Agronomy and Plant Genetics)
Sampling Seed Mixtures:

Randy Vaughan
MAFES Foundation Seed Stocks
Over the last twenty years, the popularity of seed mixtures has risen dramatically.

Today there is a greater ......

...... **volume** of seed mixtures available than ever before.

...... **variety** of seed mixture choices than ever before.
Just as it is essential to have accurate data related to the quality and content of single crop seed lots, so it is necessary to have this same accurate information for seed mixtures.
The organization that has been designated the authority in the U.S. to establish not only the procedures for testing seed lots but also the procedures for obtaining the samples upon which those tests are conducted is ........
RULES FOR TESTING SEEDS

ASSOCIATION OF OFFICIAL
SEED ANALYSTS
AOSA’s established standards concerning procedures for sampling any seed lot.

- Applies to both single crop lots as well as to seed lots of mixtures
“No matter how accurately an analysis is made, it can show only the quality of the sample submitted; therefore, every effort should be made to insure that the sample submitted for testing represents the bulk of the seed to be tested.”

From the above quote we can deduce that if a seed sample is unrepresentative of the seed lot, then the analysis results for that lot will be inaccurate.
AOSA Sampling procedure:

A. To secure a representative sample, equal portions shall be taken from evenly distributed parts of the quantity of seed to be sampled. Access shall be granted to all parts of that quantity.

Notice the terms underlined:
- equal portions
- evenly distributed
- all parts

* The goal is obtaining a sample that is representative of the whole
AOSA Sampling procedure:  (continued)

A. To secure a representative sample, equal portions shall be taken from evenly distributed parts of the quantity of seed to be sampled. Access shall be granted to all parts of that quantity.

B. For free-flowing seed in bags or bulk, a probe or trier shall be used. For small free flowing seed in bags, a probe or trier long enough to sample all portions of the bag shall be used.
Size of the bag dictates the size of the probe
Trier probe or (12” thief probe):
40” sectioned double tube sampling probe:
As seed packaging becomes larger, larger probes become necessary to effectively sample the seed product.
60” sectioned double tube sampling probe:
AOSA Sampling procedure:  (continued)

A. To secure a representative sample, **equal portions** shall be taken from **evenly distributed** parts of the quantity of seed to be sampled. Access shall be granted to **all parts** of that quantity.

B. For free-flowing seed in bags or bulk, a probe or trier shall be used. For small free flowing seed in bags, a probe or trier long enough to sample all portions of the bag shall be used.

C. Non-free-flowing seed, such as certain grass seed, or screenings, difficult to sample with a probe or trier, shall be sampled by thrusting the hand into the bulk and withdrawing representative portions.
Chaffy seed or some unconditioned products do not flow and may require hand sampling.

Individual hand samples should be taken from numerous and varied locations within the bag.
Submitted sample: The seed sample that is “submitted” to the seed testing entity for evaluation.
AOSA procedure for collection of the submitted sample:

A. For seed in bags:

1. When more than one “core” is drawn from a bag, follow different paths. When one handful is taken from a bag, take from separated points.
AOSA procedure for collection of the submitted sample:

A. For seed in bags:

1. When more than one “core” is drawn from a bag, follow different paths. When one handful is taken from a bag, take from separated points.

2. For lots of one to six bags, sample each bag and take a total of at least five cores or handfuls.
AOSA procedure for collection of the submitted sample:

A. Seed in bags:

1. When more than one “core” is drawn from a bag, follow different paths. When one handful is taken from a bag, take from separated points.

2. For lots of one to six bags, sample each bag and take a total of at least five cores or handfuls.

3. For lots of more than six bags, sample five bags plus at least 10% of the number of bags in the lot. Regardless of lot size, it is not necessary to sample more than 30 bags total.

Examples:

<table>
<thead>
<tr>
<th># of bags in lot:</th>
<th>7</th>
<th>10</th>
<th>23</th>
<th>50</th>
<th>100</th>
<th>200</th>
<th>300</th>
<th>400</th>
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</thead>
<tbody>
<tr>
<td># of bags to sample:</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>
AOSA procedure for collection of the submitted sample:

A. Seed in bags:

B. Bulk seed: Take at least as many cores or handfuls as if the same quantity of seed were in bags of an ordinary size. Take the cores from well distributed points throughout the bulk.
AOSA procedure for collection of the submitted sample:

A. Seed in bags:

B. Bulk seed:

C. Seed in small containers: Take entire unopened containers in sufficient number to supply a minimum size sample as required for the submitted sample of the lot species. (section 1.4)
Since the seed of a conditioned **single crop** package of seed are of **uniform** size, shape, weight, and density “settling” of seed over time through handling and vibration are nearly inconsequential as pertaining to the uniformity of the sample.

Therefore, the contents of samples taken from such lots tend to closely mirror the actual seed contents of the lot.
However, such is frequently not the case when dealing with seed mixtures as the physical properties of each seed species making up a mixture can frequently be quite different.

As such, when subjected to vibration over time, the various seed species tend to stratify or segregate within the seed packaging making collection of a representative sample extremely difficult.
The main difficulty in obtaining a truly representative sample of a seed mixture product arises from the **differing physical characteristics** of the seed species which make up the mixture.
To say it another way ......

...... the problem of drawing a representative sample of a mixture is that the seed of different species frequently do not stay representatively mixed.
example:
Uniformity of distribution:

Uniform distribution of various seed species making up a mixture may be present initially at the time of packaging.

However, as the seed packaging unit is handled in trade, the combined effects of vibration and gravity tend to alter the uniform distribution.

Seed distribution at packaging: Seed distribution after handling:
We even see this “particle segregation” phenomenon occurring in the unconditioned seed mass of single crop species.
Dr. James Delouche of the former Seed Technology Lab at MSU made a presentation in 1975 to the Oregon Seed Processor’s Short Course entitled “Non-Unifority In Seed Lots.”

In that presentation, he made the following comments with regard to particle segregation within single specie seed masses:
“A difficult problem to overcome and one in which contributes greatly to non-uniformity in seed lots is particle segregation or ‘un-blending.’ Particle segregation occurs during several of the handling operations common in the seed industry, especially loading and unloading of bins.

Particles of equal size but differing in weight or density (such as mature or empty florets) tend to segregate wherever they are agitated. The lighter particles remain on top, while the heavy particles migrate to the bottom. Where particles are of the same density but differ in size, the small ones tend to filter through the seed mass and concentrate in the lower portions of the bin.”
In addition to size and density issues, Kyle Rushing pointed out further problems with attempts to blend particles of differing shape and surface texture.

In his Master’s Thesis entitled “Evaluation of Bin Discharge Systems For Blending Free-Flowing Particles” he made the following statements:
“Particle shape also affects flow characteristics of particles. All factors being equal, smooth-surfaced, spherical or ovoid particles tend to flow readily; rough-hewn fractured particles are less mobile; and interlocking filaments, rods, and complex crystals are very immobile.”

* Particles: plastic pellets, not seed
So, long before seed mixtures became popular, problems with segregation and migration of seed or contaminant particles was occurring.
Seed Mixtures over time:

Seed distribution **at packaging:**

Seed distribution **after handling:**
Seed distribution after handling:

- Tend to be larger, less dense, or elongated in shape
- Tend to be smaller, more dense, and not elongated in shape
A few staged examples of non-uniform “settling” of various seed species:
Crimson Cover / Wild Winter Pea:
(immediately following blending, no agitation)
Crimson Cover / Wild Winter Pea:
(following one minuet gentle agitation)

Side View:
Oat / Brassica:
(immediately following blending, no agitation)
Oat / Brassica:
(following one minuet gentle agitation)

Side View:
Obviously handling and transportation of seed are unavoidable fact of the industry. But what is also unavoidable are the effects of vibration associated with that handling and transportation.
The bottom line:

Depending upon the nature of the specific seed mixture, the ability to collect a representative sample can frequently be extremely difficult to achieve.

Subsequently, seed testing results will be impacted to the extent that samples from which those test results come are impacted.
Testing Seed Mixtures
Receiving the sample

• Samples are assigned a laboratory number
• Samples are then divided down to the appropriate weight for purity and noxious exams (if requested)
The Purity Analysis

• Each component of the mixture is separated, weighed and recorded
• Sample is checked for Inert Matter, Weeds, and Other Crops
• Coating material is removed and % coating material is calculated
• All kinds present in excess of 5% must be reported as a component of a mixture. Seed present at less than 5% can be considered as part of the mixture if labelled.
Noxious Weed Exam

- Sample is checked for noxious weeds
- Name and number per pound reported
Germination

• Each component of mixture is planted
• Samples are put in germinators at specific temperatures as specified in the AOSA rules.
• At the end of the testing period each sample is counted and the results are reported
• This includes hard seed and dormant seed depending on the species
Certificate of analysis

• Analysis is issued for each lot tested.
• Each component is listed and pure seed and germination is shown for each.
• Name and number per pound of noxious weeds are listed.
• Other crop seeds are noted as well as coating material percentage and any inert found.
Issues when testing mixes

• When submitting samples, include a tag or a list of components so those present at less than 5% will be included as part of the mixture and not put in other crop.

• Remember, the test is only as good as the sample.
Questions?
Mississippi Pure Seed Law: LABELING MIXTURES
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
The rate of occurrence of noxious-weed seeds
• GERMINATION

PERCENTAGE OF EACH COMPONENT IN EXCESS OF 5% OF THE WHOLE
MIXTURES
KIND AND VARIETY OF EACH AGRICULTURAL SEED PRESENT IN EXCESS OF FIVE PERCENT (5%) OF THE WHOLE AND PERCENTAGE BY WEIGHT OF EACH IN THE ORDER OF ITS PREDOMINANCE
LABELING REQUIREMENTS THAT APPLY TO MIXTURES:
KIND AND VARIETY
NET WEIGHT
ORIGIN — WHERE PRODUCED
% WEED SEED
% INERT MATTER
% HARD SEED IF PRESENT
% DORMANT SEED IF PRESENT
CALENDAR MONTH AND YEAR TEST WAS COMPLETED
NAME AND NUMBER OF EACH RESTRICTED NOXIOUS WEED SEED
NAME AND ADDRESS, OR REGISTERED CODE NUMBER OF LABELER
Lawn and Turf Seed Mixtures
The Word “Mixed” or “Mixture”
The Headings

“FINE-TEXTURED GRASSES” AND “COARSE-TEXTURED KINDS”
THE WORD “NONE” SHALL BE PRINTED UNDER THE APPROPRIATE HEADING “FINE TEXTURED GRASS” OR “COARSE TEXTURED KINDS” WHEN NO KIND IS LISTED UNDER EITHER OF THE HEADINGS
FOR EACH AGRICULTURAL SEED NAMED UNDER “FINE-TEXTURED GRASS” AND/OR “COARSE-TEXTURED KIND”

% PURE SEED
% GERMINATION
% HARD SEED
% DORMANT SEED

CALENDAR MONTH AND YEAR TESTS WERE COMPLETED
THE HEADING
“OTHER INGREDIENTS”

- % WEED SEED
- % INERT
- NAME AND NUMBER OF RESTRICTED NOXIOUS WEED
- LOT NUMBER
- NAME AND ADDRESS OF PERSON WHO LABELED SEED
FINE-TEXTURED GRASSES

a. COLONIAL BENTGRASS (AGROSTIS TENUIS)
b. CREEPING BENTGRASS (AGROSTIS PALUSTRIS)
c. VELVET BENTGRASS (AGROSTIS CANINA)
d. ROUGH BLUEGRASS (POA TRIVIALIS)
e. KENTUCKY BLUEGRASS (POA PRATENSIS)
f. WOOD BLUEGRASS (POA NEMORALIS)
g. CANADA BLUEGRASS (POA COMPRESSA)
h. RED FESCUE (FESTUCA RUBRA)
i. CHEWINGS FESCUE (FESTUCA RUBRA VAR. COMMUTATA)
j. SHEEP FESCUE (FESTUCA OVINA)
k. COMMON BERMUDAGRASS (CYNODON DACTYLON)
COARSE-TEXTURED KINDS

ALL OTHER KINDS NOT LISTED AS "FINE-TEXTURED GRASSES" MUST BE LISTED UNDER THE HEADING "COARSE-TEXTURED KINDS"
OTHER MIXTURES (WILD GAME MIXES)

• WHEN MORE THAN ONE (1) KIND AND VARIETY IS REQUIRED TO BE NAMED THE WORD “MIXTURE” OR THE WORD “MIXED” SHALL BE SHOWN CONSPICUOUSLY ON THE LABEL.
Game Mixture
# Large Antler Mixture Deer Mix Company II

**Lot - 152017**

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Purity</th>
<th>Germ</th>
<th>Grown In</th>
<th>Test Date</th>
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<td>90%</td>
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<tr>
<td>Oat</td>
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<td>80%</td>
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<tr>
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<td>90%</td>
<td>OR</td>
<td>2/17</td>
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<tr>
<td>Ladino Clover</td>
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<td>90%</td>
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<td>Arrowleaf Clover</td>
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<td>OR</td>
<td>2/17</td>
</tr>
<tr>
<td>Rape</td>
<td>1.00%</td>
<td>90%</td>
<td>AR</td>
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<tr>
<td>Weed Seed-.35%</td>
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<tr>
<td>Other Crop-.55</td>
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<td>Inert(including coating material)-3.10%</td>
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<tr>
<td>Noxious Weed-None</td>
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</table>

**Variety**
- Gore Wheat
- Bob Oat
- Dixie Crimson Clover
- Rebel Ladino Clover
- Yuchi Arrowleaf Clover
- Essex Rape

**Net Weight** – 50 pounds

**AMS#5521**
- **Wild Game Mixture**
- **Net Weight** – 50 LB.  Lot No. 1532

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The Word “Mixture” or The Word “Mixed”
• Wild Game Mixture
• Net Weight – 50 LB. Lot No. 1532

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(Includes 1.00% Coating Material)

Noxious Weeds- None

Big Game Seed Company, 1520 Big Seed Rd., Champion, South Carolina
- **Wild Game Mixture**
- **Net Weight** – 50 LB. Lot No. 1532

<table>
<thead>
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Big Game Seed Company, 1520 Big Seed Rd., Champion, South Carolina
- Wild Game Mixture
- Net Weight – 50 LB. Lot No. 1532

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<td></td>
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</tr>
<tr>
<td>Big Game Seed Company, 1520 Big Seed Rd., Champion, South Carolina</td>
<td>% Inert Matter</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Wild Game Mixture
- Net Weight – 50 LB. Lot No. 1532

<table>
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<tr>
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</tr>
</tbody>
</table>

(Includes 1.00% Coating Material)

- Noxious Weeds- None
- Big Game Seed Company, 1520 Big Seed Rd., Champion, South Carolina

% Other Crop
• Wild Game Mixture
• Net Weight – 50 LB. Lot No. 1532

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</table>

% Hard Seed if Present
• Wild Game Mixture
• Net Weight – 50 LB. Lot No. 1532

<table>
<thead>
<tr>
<th>Ingredient</th>
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• Big Game Seed Company, 1520 Big Seed Rd., Champion, South Carolina

% Dormant Seed if Present
- Wild Game Mixture
- Net Weight – 50 LB. Lot No. 1532
- | Grown | Purity | Germ | Test |
- | Wheat 200214 | IL | 59.60% | 80% | 7/17 |
- | Oats Bob | TN | 24.50% | 75% | 7/17 |
- | Annual Ryegrass King | OR | 5.80% | 80% | 3/17 |
- | Winter Peas Austrian | ID | 4.00% | 85% | 7/17 |
- | Reseeding Crimson Clover Dixie | OR | 2.00% | 80% | 7/17 |
- | Other ingredients – Weed Seed- .25% Other Crop- .25% Inert- 3.60% |
- | (Includes 1.00% Coating Material) |
- | Noxious Weeds- None |
- | Big Game Seed Company, 1520 Big Seed Rd. Champion, South Carolina |

Calendar Month and Year Test was Completed
• Wild Game Mixture
• Net Weight – 50 LB. Lot No. 1532

<table>
<thead>
<tr>
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Name and Number Per Pound of Each Noxious Weed
- Wild Game Mixture
- Net Weight – 50 LB. Lot No. 1532

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Oldest Test Date
- Wild Game Mixture
- Net Weight – 50 LB. Lot No. 1532

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These two components are less than 5% of the whole
Any Questions

THE END
MIXTURES:
Federal Seed Act Considerations

Steve Malone
U.S. OECD Seed Schemes Program Manager
USDA, AMS, LPS, Seed Regulatory and Testing Division
Gastonia, NC
Types of Seed Mixtures

- Lawn & Turf grasses
- Pasture mixes
- Reclamation/revegetation mixes
- Wildlife food plots
- Integrated Refuge
- Cover crop
What is a mixture

Federal Seed Act Regulations define a mixture as “seeds consisting of more than one kind or variety, each present in excess of 5 percent of the whole.” (201.2 (p))

A combination of tall fescue, perennial ryegrass, and Kentucky bluegrass would be a mixture by this definition.

So would a combination of two tall fescue varieties.

Many state seed laws would define this as a “blend” but the FSA Regulations don’t mention this term.

Though not defined in FSA Regulations, SRTD would not take issue with using “blend” if it was allowed in the state the seed was being sold in.
Basic Labelling Requirements for Agricultural Seed
Sect. 201.8 – 201.24a – FSA Regulations

- Kind name
- Variety name or Variety Not Stated
- % Pure Seed
- % Other crop seed
- % Weed seed
- % Inert matter
- Noxious Weed Seeds - name and rate per/lb
- Origin (alfalfa, red clover, white clover, non-hybrid field corn)
- Percent Germination and Test Date
- Lot number
- Interstate shippers name and address or AMS #
- Inoculated seed - include expiration date
- Treatment (if treated)
In mixtures,

For Each Kind of Seed in the Mix:

- **Kind name**
- **Variety name or Variety Not Stated**
- **% Pure Seed (if in excess of 5% of the whole)**
  - % Other crop seed
  - % Weed seed
  - % Inert matter
  - Noxious Weed Seeds - name and rate per lb
- **Origin** (alfalfa, red clover, white clover, non-hybrid field corn)
- **Percent Germination and Test Date**
  - Lot number
  - Interstate shippers name and address or AMS #
  - Inoculated seed - include expiration date
  - Treatment (if treated)
**Figure 1. Example seed label**  
*(Company and variety names are fictitious)*

**GrassGrow Seed Company, TURFTOWN, OREGON**

Lot No: 4567-10  
Test Date: (month/year)

<table>
<thead>
<tr>
<th>Purity</th>
<th>Variety</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>44%</td>
<td>Polar Creeping Red Fescue</td>
<td>85%</td>
</tr>
<tr>
<td>31%</td>
<td>Purple Ribbon Kentucky Bluegrass</td>
<td>80%</td>
</tr>
<tr>
<td>9%</td>
<td>Joshua Chewings Fescue</td>
<td>85%</td>
</tr>
<tr>
<td>12%</td>
<td>Gopher Perennial Ryegrass</td>
<td>90%</td>
</tr>
</tbody>
</table>

1.56% Crop  
0.33% Weed  
2.11% Inert Matter  

Noxious Weed Seed: None found.
# Tall Fescue Mixture

**Lot**

<table>
<thead>
<tr>
<th>Pure Seed</th>
<th>Germination/Origin/Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.09% Mystix Tall Fescue</td>
<td>85% OR 7/13</td>
</tr>
<tr>
<td>32.50% Legitimate Tall Fescue</td>
<td>85% OR 7/13</td>
</tr>
<tr>
<td>32.41% Aristotle Tall Fescue</td>
<td>85% OR 7/13</td>
</tr>
<tr>
<td>0.25% Other Crop Seed</td>
<td>*variety not stated</td>
</tr>
<tr>
<td>1.50% Inert Matter</td>
<td>Net Weight: 20 lbs (9.07 kgs)</td>
</tr>
<tr>
<td>0.25% Weed Seed</td>
<td>Noxious weed seeds: none</td>
</tr>
</tbody>
</table>

**Sell by Date**

- DE 7/14
- PA, NJ, VT, NY, NH, OH, MD, VA 10/14
- All other states 4/14

**Bar Code**

0 5357150560
Perennial Brome Fescue Mixture
Lot# TED0008
Pure Seed

44.10% Creeping Red Fescue    Germ.  85%
29.40% L. Perennial Ryegrass    90%
21.25% Kentucky Bluegrass      80%
0.75% Other crop seed
4.25% Inert matter
0.25% Weed seed

Tested 2/29/10

Origin: OR
AMS-
Certified Seed Mixtures

- AOSCA has standards for certification of blends and mixtures
  - Blends/mixtures must be approved by the certifying agency
  - Must be done by an approved conditioner, who has demonstrated the ability to blend/mix within specified tolerances
  - Permission must be obtained to use a protected or private variety
  - Must be comprised of certified seed of each of the component varieties
  - Formulas for the blend/mixture recorded with the certifying agency, and can’t vary between lots and years
  - Conditioner has the option of stating the name of the variety, components, and proportions on the label (may be required to do so in some states)
  - Label must have the word “blend” or “mixture” and meet all other AOSCA labelling requirements
<table>
<thead>
<tr>
<th>Pure Seed</th>
<th>Germination</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>29.91% COYOTE II TALL FESCUE</td>
<td>90%</td>
<td>MD</td>
</tr>
<tr>
<td>29.79% TARNEEL II TALL FESCUE</td>
<td>90%</td>
<td>OR</td>
</tr>
<tr>
<td>29.73% GREENKEEPER DAF TALL FESCUE</td>
<td>90%</td>
<td>OR</td>
</tr>
<tr>
<td>9.84% RAVEN KENTUCKY BLUEGRASS</td>
<td>90%</td>
<td>WA</td>
</tr>
<tr>
<td>0.00% OTHER CROP SEED</td>
<td>LOT #: 12316</td>
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</tr>
<tr>
<td>0.73% INERT MATTER</td>
<td>NET WEIGHT: 50 LBS.</td>
<td></td>
</tr>
<tr>
<td>0.00% WEED SEED</td>
<td>TEST DATE: JANUARY 2009</td>
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</table>

**CERTIFIED SEED**

**INTERAGENCY CERTIFICATION-Mixture SS6000 Mixture**

<table>
<thead>
<tr>
<th>Component</th>
<th>% WT</th>
<th>% Germ</th>
<th>Origin</th>
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</thead>
<tbody>
<tr>
<td>Spartan II Hard Fescue</td>
<td>32.13</td>
<td>85</td>
<td>OR</td>
</tr>
<tr>
<td>Intrigue Chewings Fescue</td>
<td>22.17</td>
<td>85</td>
<td>OR</td>
</tr>
<tr>
<td>Zodiac Chewings Fescue</td>
<td>18.44</td>
<td>85</td>
<td>OR</td>
</tr>
<tr>
<td>Navigator II Creeping Red Fescue</td>
<td>18.42</td>
<td>85</td>
<td>OR</td>
</tr>
<tr>
<td>Enchanted Kentucky Bluegrass</td>
<td>7.12</td>
<td>85</td>
<td>WA</td>
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</tbody>
</table>

This seed was produced and harvested from officially inspected and maintained fields and nurseries for Certified Seed. This label must be accompanied by analysis by certified analysts. The certifying agency makes no warranty or implied. This label is the official Seed Certifying Agency of the New York State Department of Agriculture & Markets.
Certified Mixtures under OECD Seed Schemes

- "Herbage" mixtures allowed of species in the Grass & Legumes, Subterranean Clover, and Cereal Schemes
- Principles are essentially the same as AOSCA
  - Components must be certified seed lots
  - Facility doing the mixing must have adequate equipment and expertise
  - Mixing done under supervision of the National Designated Authority
  - Proper labeling
Agricultural Marketing Service
Marketing and Regulatory Programs