BIOMASS PROGRAM
OVERVIEW
American farmers have embraced a new role as producers of food, feed and fuel, making the most of an opportunity to find new value in U.S. crops while meeting the nation’s energy security, economic and environmental needs.

POET-DSM is taking the next step by producing cellulosic ethanol, expanding the country’s supply of domestic, renewable fuel while creating new opportunities for American farmers by tapping into a previously unused resource: crop residue.

Crop residue is plant material left in the field after harvest. This material can be used to make biofuel. Allowing crop residue to be collected on your land through a conservative and responsible management plan will provide a second valuable crop from the same acres and allow you to be at the forefront of the new agricultural economy.

We have commissioned extensive research since 2008 from experts at Iowa State and the U.S. Department of Agriculture and spent a great deal of time and resources to ensure that farmers are collecting crop residue in a way that is sustainable.

I hope you take the time to review the important information in this document. If you have any questions, we encourage you to reach out to us.

For additional information, you can also go to www.projectliberty.com.

We hope you consider being part of this exciting venture.

Adam Wirt
Biomass Logistics Director – POET Biomass
Project Overview

A POET-DSM cellulosic ethanol project will use the Project LIBERTY specific EZ Bale as its primary feedstock to produce cellulosic ethanol and various co-products.

Project LIBERTY will:
• Produce 20 million gallons of cellulosic ethanol per year
• Consume over 285,000 bone-dry tons of local biomass each year
• Generate additional economic development in rural communities
• Support the Renewable Fuel Standard (RFS)
• Be replicable across the Corn Belt

EZ Bale™ – EZ to Harvest. EZ To Store. EZ on Your Land:
• Project LIBERTY EZ Bale will be used as feedstock
• Bales made of cobs, husk, leaf and minimal stalk
• Modified stover collection process (reference Collection Process section)
• 20-25% of the residue is removed (~1 bone-dry ton/acre)
• Low nutrient replacement needed
• Think of this as the new way to pick ear corn

Benefits:
• Residue management
• Additional revenue per acre
• Potential for yield increases
• Potential reductions in disease pressure
• Farm inlet for younger family members
• Diversification for farming operation

Collection Process

The POET-DSM process is built around using the EZ Bale. This differs dramatically from the traditional stover or 3-pass collected bales. The EZ Bale is a 2-pass system that focuses on collecting mainly material from the ear and above, while trying to minimize dirt and stalk intake. The removal rates from this are found to be sustainable on
most acres and leaves adequate residue to protect from wind and water erosion.

**Combine Setup**

1. **Corn Head**
   - Stalk Stompers or Rollers are required on the inside four rows (Figures 1 & 2).
   - The entire head can be outfitted with stompers or rollers without concern.
     - This includes chopping corn heads as well.
   - Goal is to disturb the standing stalk integrity prior to baling.

Figure 1: Stalk Stompers on the four center rows of the corn head

Figure 2: Stalk Rollers on a corn head
2. Discharge
   • Chopper/Spreader mechanisms need to be disengaged to form a biomass windrow (Figures 3 & 4).
   • If the discharge of the combine is larger than 60”, some shielding should be added to form a windrow that is less than 60” in width.

Figure 3: Combine forming EZ Bale Windrow

Figure 4: View of a EZ Bale Windrow
Baler Setup

1. Baling
   - Biomass should be baled no sooner than 24 hours after it has been placed into a windrow.
   - Most biomass should be baled 24-48 hours after harvesting, if weather permits.
   - Baling should not start until the dew has burned off.
   - If biomass is impacted by moisture (i.e. rain), it should be left to dry until the windrow feels dry and no dampness is felt.
   - All round bales should be formed to 5’8”-5’10” tall bales.
   - All round bales are required to be wrapped with a minimum of 4 wraps of netwrap.
   - 3’ x 4’ x 8’ is the desired square bale size.

2. Baling Direction
   - The baler should travel in the same direction that the combine traveled.
   - The stalks should be leaning away from the baler pickup, which will help to limit damage to the baler’s pickup.

3. Baler Pickup Height
   - The baler pickup should be set so the tines leave 1 1/2 - 2” of ground clearance (Figure 5).
   - To set, place the baler on level ground. Using a 2x4, set the tooth height to the point of the teeth just touching the 2x4 to minimize the pickup of rocks and dirt.
   - If the field conditions are soft, the pickup height may need to be adjusted.
   - If tine marks can be seen in the dirt, the baler pickup is positioned too low and needs to be adjusted.
   - Continuous monitoring of the pickup height is needed.
4. Baling Speed
   • The ideal baling speed is between 6-8 mph. (Figures 6 & 7)
   • Higher speeds lend to inefficiencies and less material being collected per acre.

EZ Bales leave sustainable levels of crop residue on the field to minimize impacts of erosion.
Tips

1. Do not rake stover to form the windrow. POET-DSM does not desire this product currently.
2. Make sure the baler pickup is not running in the dirt. This leads to bales with higher dirt levels that may be docked or rejected and increases wear and tear on the baler.
3. Do not use twine on round bales. All bales are required to be wrapped with a minimum of 4 wraps of netwrap.

The New “Ear Corn”

Generations ago, ear corn was picked and the grain, cobs, and husks were all removed from the fields. The POET-DSM EZ Bale is very similar and uses essentially the same materials (cobs, leaves, husk, and minimal stalk) to form a bale.

![Figure 8: EZ Bales – The new “ear corn”](image)

Harvesting a portion of the non-grain biomass from fields is not a new idea. In fact, early 20th century farmers regularly removed cobs and husks from the very soils we farm today.
Agronomics/Soil Health

POET-DSM has strived to make its feedstock supply sustainable. We not only need productive fields to produce biomass, but to help provide food, feed, and fuel for the world.

Therefore, starting in 2008, POET-DSM aligned with Iowa State University and the USDA to look at how removing residue impacts the soil health, crop yield, soil organic matter, biomass nutrient removal, soil nutrient levels, and fertilizer requirements.

General outcomes from this work include:

• Do not harvest residue from areas subject to severe erosion.
• Know your soils: Greater variability is created from differences already found in the field’s soils vs. those caused by removing residue.
• Routine soil testing and plant tissue analysis should be used to monitor effects to changing soil conditions on all farming operations.
• 1.5-2.0 bone-dry tons of residue removal is sustainable at yields above 175 bu/acre.
• Erosion potential is not increased with the EZ Bale collection process.
• No decrease to grain yield is seen when residue was removed and a few instances showed yield benefits.
• Results seen are consistent with regional results associated with the USDA’s REAP (Resilient Economic Agricultural Practices) Stover removal work.
**Grain Yield**

Table 1 – Grain Yields at Emmetsburg Plot

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012 (corn)</th>
<th>2012 (beans)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>180.1</td>
<td>165.5</td>
<td>151.8</td>
<td>157.6</td>
<td>173.0</td>
<td>56.0</td>
<td>162.4</td>
</tr>
<tr>
<td>Cob Only</td>
<td>178.0</td>
<td>153.5</td>
<td>150.9</td>
<td>158.5</td>
<td>185.0</td>
<td>54.0</td>
<td>162.1</td>
</tr>
<tr>
<td>EZ Bale</td>
<td>185.8</td>
<td>152.8</td>
<td>152.6</td>
<td>157.1</td>
<td>176.5</td>
<td>53.0</td>
<td>164.1</td>
</tr>
<tr>
<td>Rake &amp; Bale</td>
<td>174.6</td>
<td>170.0</td>
<td>150.2</td>
<td>146.1</td>
<td>181.0</td>
<td>55.0</td>
<td>160.1</td>
</tr>
<tr>
<td>Average</td>
<td>181.8</td>
<td>161.8</td>
<td>155.0</td>
<td>151.1</td>
<td>179.5</td>
<td>54.0</td>
<td>163.4</td>
</tr>
</tbody>
</table>

Table 1 shows how the yields are variable from year to year. The growing seasons of 2010 and 2011 brought challenges to the study plot with drown out spots and wind damage for these years respectively. Certain years (2008, 2009, and 2012) provided more normal conditions with yields that were much more consistent and in certain instances showed advantages in grain yield where residue was removed.

**Residue Yields**

Table 2 – Biomass Yields at Emmetsburg Plot

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cob Only</td>
<td>0.5</td>
<td>0.7</td>
<td>0.5</td>
<td>0.2</td>
<td>--</td>
<td>0.5</td>
</tr>
<tr>
<td>EZ Bale</td>
<td>1.0</td>
<td>1.1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Rake &amp; Bale</td>
<td>2.3</td>
<td>1.5</td>
<td>1.4</td>
<td>2.9</td>
<td>1.2</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Table 2 shows how biomass yields progressively get higher as you work from cob, to EZ Bale, to Rake & Bale collection methods. There is variability from year to year in the yields based upon the grain yields, weather conditions and field conditions.
Another variable closely monitored has been the soil nutrient levels and the resulting replacement levels needed. From this data, no significant removal of phosphorus has been seen with residue removal. However, reasonable amounts of potassium removal have been noted and are variable by removal level. As the removal rate goes up, so too does the level of potassium removed and the amount needed to be added back. The outcome of the studies thus far indicates that when removing 0.7-1.5 BDT/acre, 10-15 lbs per acre of additional potassium are needed (Figure 9).

Additional nitrogen is not required because any nitrogen that is left will be used to help breakdown the residue. When this happens, nitrogen gets tied up (immobilized) and is unavailable until conversion to organic matter happens. Therefore, by taking residue off, less nitrogen is needed in the breakdown process and no additional nitrogen is needed.
Bale Storage

Bales are needed throughout the year. This commodity is perishable and needs to be stored properly to maintain quality and minimize losses. Losses have a big impact to both the grower and the biorefinery. With some simple approaches to storage, you can greatly minimize the dry matter loss that occurs throughout the year.

Round Bale Storage

Round bales stored outdoors typically store better than square bales that are not tarped. Both stack orientation and the stack direction play big roles in how bales are affected by moisture and the dry matter loss associated with it.

Two very common stack designs seen with round bales are: single rows and 2-high pyramids stacks.

Pyramid stacks hold the advantage of minimizing the foot print needed by 31%, but have higher dry matter loss when compared to single rows.
Single row bale storage holds an advantage in dry matter loss throughout the year (Figure 10). Even though the dry matter losses are very similar for the first half of the year, we would still not advocate stacking bales in pyramid stacks. Bales placed in a pyramid with netwrap on them tend to freeze together if ice or sleet is received, causing issues with bale handing and netwrap tearing if you try to move them.

The bale’s shape is also generally affected when stacked in a pyramid. This makes the bales harder to load when their round shape is not maintained. Furthermore, bales on the bottom rows of a pyramid stack can have much higher moisture levels because the top bales shed rain onto those bales that then infiltrates into the crevices between the top and bottom bales. This moisture can cause bale loads to fall into dockage or rejection zones.

Simply put, single rows hold advantages in each of these areas.
Seeing that the single row stacks are the most ideal, consideration needs to be put into the direction of these stacks. Stacks should always be built in a north/south orientation to allow for a more even sun distribution across the stack. This helps to dry out stacks faster and minimize the associated effect moisture has on dry matter loss. Stacks that face east/west show losses that are at least 5% higher past spring thaw (Figure 11). This is directly due to the north side of the stack not receiving sun light and bales not drying as fast.

**Recommendation:** For round bale storage, the best stack configuration is to place bales into single row stacks or single rows aligned with at least a 2 ft. gap between rows and for the stacks to be aligned in a north/south orientation to allow for equal sun exposure. We encourage growers to not put bales in pyramid or other stacking configurations as they lead to higher dry matter losses. Other observed advantages include fewer issues with netwrap freezing to other bales, less bale deformation and less chance of having high moisture levels in bales after precipitation events (Figure 12).

![Round Bale Dry Matter Loss Percentage](image)

Figure 11: Dry matter loss by round bale stack direction and time.
Square Bale Storage

When it comes to square bale storage, there is only one question: To Tarp or Not to Tarp. The answer is pretty straightforward.

Figure 13: Dry matter loss by square bale stack coverage and time.
Figure 13 emphasizes the common theme we see across all storage, that storage is really a story of two periods: the first six months and the last six months. Storage losses are comparable in Feb. with untarped bales holding the advantage, but this advantage is quickly lost as we enter the warm, wet summer months. While the temperatures are low, there is minimal biological activity leading to low dry matter losses and no economic benefit in covering the bales. But once the weather warms and precipitation increases, dry matter loss quickly accelerates when biomass is not covered (Figure 14).

**Recommendation:** For square bale storage, the storage length gets dropped into two time frames: short term (Fall-March) or long term (April–Oct). If bales are to be delivered before April, the use of a tarp would not be worth the investment. But for bales coming in after March, tarping of the square bale stacks is our recommendation. The dry matter savings created from having the tarp installed will more than pay for the investment in covering the stack. In addition, weathered bales are very difficult to handle and lead to increased broken bales, again adding to the tarping advantage.

*Untarped Bales*  *Tarped Bales*

Figure 14: Square bales stored for 12 months.
Bale Quality

What is a Bone-Dry Ton?

POET-DSM pays for all biomass on a bone-dry ton basis; which is simply looking at the total volume of dry material. This is accomplished by taking both a weight of the biomass and sampling it for moisture. Once you have those, both the weight of the biomass and the moisture level, you multiply the bale weight times \((1 - \% \text{ moisture})\) to calculate the dry weight. This gives you the dry weight, which can also be converted to tons.

Ash

Ash is minerals that cannot be converted into ethanol. These consist of both structural minerals that are naturally found in corn plants and non-structural minerals, or soil, that are collected in the field. The non-structural minerals are usually collected during the collection process. These inorganics are not fermentable and have no value to a biorefinery (Figure 15). This material takes up space and is not desired in the conversion process. In addition, higher levels of inorganics tend to lead to higher rates of maintenance needed on baling equipment. It is beneficial for both the grower and biorefinery if this number is minimized. This is best achieved by following the EZ Bale SOP (Figure 5) and monitoring field conditions as baling occurs.

Figure 15: Bale samples from different bale setups.
**Moisture**

Bale moisture is an important variable for two reasons. First, it is important for the grower to harvest the biomass dry and to keep it dry in storage to create the most ideal storage conditions where minimal dry matter losses will be seen. For the biorefinery, it is important to have a dry product that will size easier and require less energy from a mechanical perspective.

**Testing and Penalties**

All bales are tested as they are delivered to the site for both moisture and ash levels. Each metric has dockage and rejection zones. For the most up to date metric levels, please contact the Biomass Team or see the scale house for posted dockages.

**Transportation**

- Deliveries of biomass are based on contract period.
- Normal delivery times will be Monday-Friday from 7:30-4:00, unless otherwise posted or communicated.
- Self-dumping trailers are not allowed to dump bales.
- Be sure to understand the federal, state, and local Department of Transportation (DOT) regulations for hauling bales and associated standards. Ensure that proper rated straps are used, you have all of the needed permits and work to keep the general public safe when you deliver bales.
Contracting Options

POET-DSM offers two types of biomass contracts for growers to market their biomass: the Grower Model or Custom Model. These two models are setup differently to provide a variety of options that best fit the conditions of each operation and allows the grower to participate in the way that best fits their operation.

Grower Model:
Through a Grower Model Contract, the grower is responsible for aligning the baling, staging, storage and transportation of biomass from the field to the biorefinery. The grower can do all of these activities themselves, can custom hire the job or have a mix of both. It doesn’t matter; it is the end result that the grower delivers the material to the biorefinery.

Custom Model:
Through the Custom Model Contract, the grower is responsible for harvesting the grain and forming the windrow. Once the field has been completely harvested, the grower calls the POET-DSM biomass team and informs them that the field is ready to be baled. Once that call occurs, POET-DSM takes over and aligns the baling, staging, storage and transportation of biomass. POET-DSM is aligning with custom balers and transporters to perform these activities and is prepared to be your biomass harvesting service.

Contract Pricing (see insert or POET-DSM representative)
Frequently Asked Questions

What is your feedstock?

POET-DSM is focused on utilizing corn residue due to its concentrations and volumes. POET-DSM has created its own collection method for collecting corn residue that produces the EZ Bale. This process removes roughly 20-25% of the above ground residue and focuses on collecting mainly cobs, leaves and husks; with minimizing the update of stalks and dirt.

How much biomass will the facility need each year?

The 20 – 25 million gallon cellulosic plant will consume roughly 285,000 bone-dry tons (BDT) of corn residue biomass annually.

How much land and how many growers will be needed?

With the POET-DSM EZ Bale collection method, roughly 1 BDT of residue is collected per acre. At this rate, roughly 300,000 acres will be needed annually with around 400-500 growers participating.

How does the EZ Bale differ from Stover Bales?

A traditional stover bale is collected using a 3-pass process involving either a rake or flail shredder to form a windrow. The bale usually consists of roughly 9% cob, 42% husk/leaf, 35% Stalk and 14% Ash. The removal rates vary from 40-70% removal per acre. The nutrient replacement cost for stover bales is roughly $20/ton removed.

The EZ Bale uses a 2-pass process and does not involve the use of a rake or shredder. The bale makeup is roughly 33% cob, 43% husk/leaf, 16% stalk and 8% ash. The removal rate is between 20-25% removal per acre. The nutrient replacement cost for EZ Bales is roughly $5-$8/ton removed. EZ Bales remove a smaller portion of residue, focus on removing the upper portions of the plant and take
less nutrients off of the field. Because of this removal rate, residue removal can be done year after year on the same acre sustainably.

**Why are the nutrient replacement costs so much lower for EZ Bales vs. Stover Bales?**

The biggest reason there is a dramatic difference is due to the EZ Bales focusing on removal of the upper portions of the plant. As the corn plant goes through senescence (dry down), the plant begins to move the nutrients from the plant back to the root system. The first areas to be affected are the higher portions of the plant such as the cob and leaves. The stalk is generally the last area to be affected by this as it acts as the highway for moving those nutrients back to the root. So by lowering the amount of stalk included, the nutrient replacement costs can be minimized drastically.

**How does this affect next year’s corn yield?**

POET-DSM has been aligned with Iowa State University and the USDA-ARS since 2008 jointly studying the effects of different residue removal levels on soil nutrients and grain yield. The clear answer is that there has been no negative effect seen to crop yield, and there have been a few instances where yield bumps of 1-5% have been seen. Many growers have been reporting positive yield responses following residue removal, especially in a corn-on-corn rotation.

**What do we do in a wet fall?**

POET-DSM is continuously looking at risk mitigation steps to help work through all situations. Currently, POET-DSM is assembling a list of all balers in the 60 mile area around the facility along with aligning with regional groups that have multiple baling units. This will allow for more balers to cover a larger area when conditions warrant. At the same time, we continue to look at various collection methods that may be more convenient in that time.
Will you allow me to bring you stover bales?

At this point, the answer is no. The EZ Bale is more desired at the biorefinery due to its low ash content and is also a more sustainable approach to biomass collection. There may be a point in time when we do accept stover bales, but that will be communicated at that time.

Where will most of the bales be stored?

Most of the bales will be stored on the grower’s property until they are delivered. The Project LIBERTY site does have a 22-acre stackyard. When completely full, this will hold roughly three weeks of run time. For safety reasons, it is much better to keep the biomass spread out to minimize the opportunities for large loss.

At the same time, the pricing structure for biomass is built with storage considerations in mind. You will get paid more per ton the longer you store it and in most cases it is more economical to store the biomass rather than grow the crop.

If I produce more tons than my contract, will there be a spot market?

Yes, POET-DSM will post a spot market for overrun tons. The price for this will vary based on contracted volumes and market prices. Check with the POET-DSM biomass team to get the most up to date spot prices.

Can round or square balers be used?

Yes, POET-DSM will accept both round and square bales. We leave that decision up to the grower to use the system they see best fits into their operation. As it relates to the Custom Model, POET-DSM will most likely use both and manage those products based on their inherent strengths and weaknesses.
Do round bales have to have netwrap or can twine be used?

Round bales must have netwrap. All round bales should have a minimum of 4 wraps on them. Bales with twine will not be accepted.

How will deliveries to the biorefinery work?

This process is very similar to that of delivering grain. Your biomass will be delivered during the period stated on the contract. Once to the site, the load will be identified by owner of the biomass. The load will have samples taken for moisture and ash testing. The truck will then be weighed to gather a gross weight. The scale house will then indicate where the truck will be unloaded (receiving building or stackyard), the truck will then be unloaded, the truck will then weigh out and a ticket will be created showing the total product delivered.