



Successful Storage of By-Products

***“What do I **REALLY** need to
know?”***

Oklahoma Ag Expo

Oklahoma City

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The Plan...



- What's a **by-product** anyway?
- **WDG, WDGS, DDG, DDGS**,... abc, xyz, ...Huh???
- Examples of **uses**
- Storage Issues...the **do's** and **don'ts**
- “Non-traditional” crop storage, on going research - your **tax dollars at work!!!**

By-Products????

Definition:

Material produced during the process of producing something else.



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Some Examples

- [soap stock](#) - from the refining of vegetable oil
- [bran](#) and [germ](#) - from the milling of whole grains into refined grains
- [brewer's yeast](#) - from fermentation
- [stover](#) - residual plant matter after harvesting of corn
- [glycerol](#) - from the production of biodiesel
- [molasses](#) - from sugar refining
- [orange oil](#) and other citrus oils - recovered from the peels of processed fruit
- [pectin](#) - recovered from the remains of processed fruit
- [sawdust](#) and [bark](#)- from the processing of logs into lumber
- [straw](#)- from grain harvesting



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Some Examples

distiller's grain –



from ethanol fermentation

Alphabet Soup Dictionary

WDG = Wet Distiller's Grain

WDGS = Wet Distiller's Grains with Solubles

DDG = Dry Distiller's Grain

DDGS = Dried Distiller's Grains with Solubles

MWC = Modified Wet Cake

(Blend of Wet and Dry Distillers Grains)

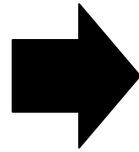
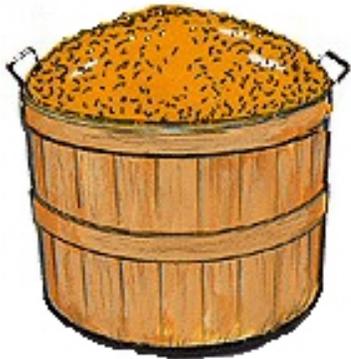
CDS = Condensed Distillers Solubles



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Distillers Grains

1 bushel corn



~2.8 gal
ethanol



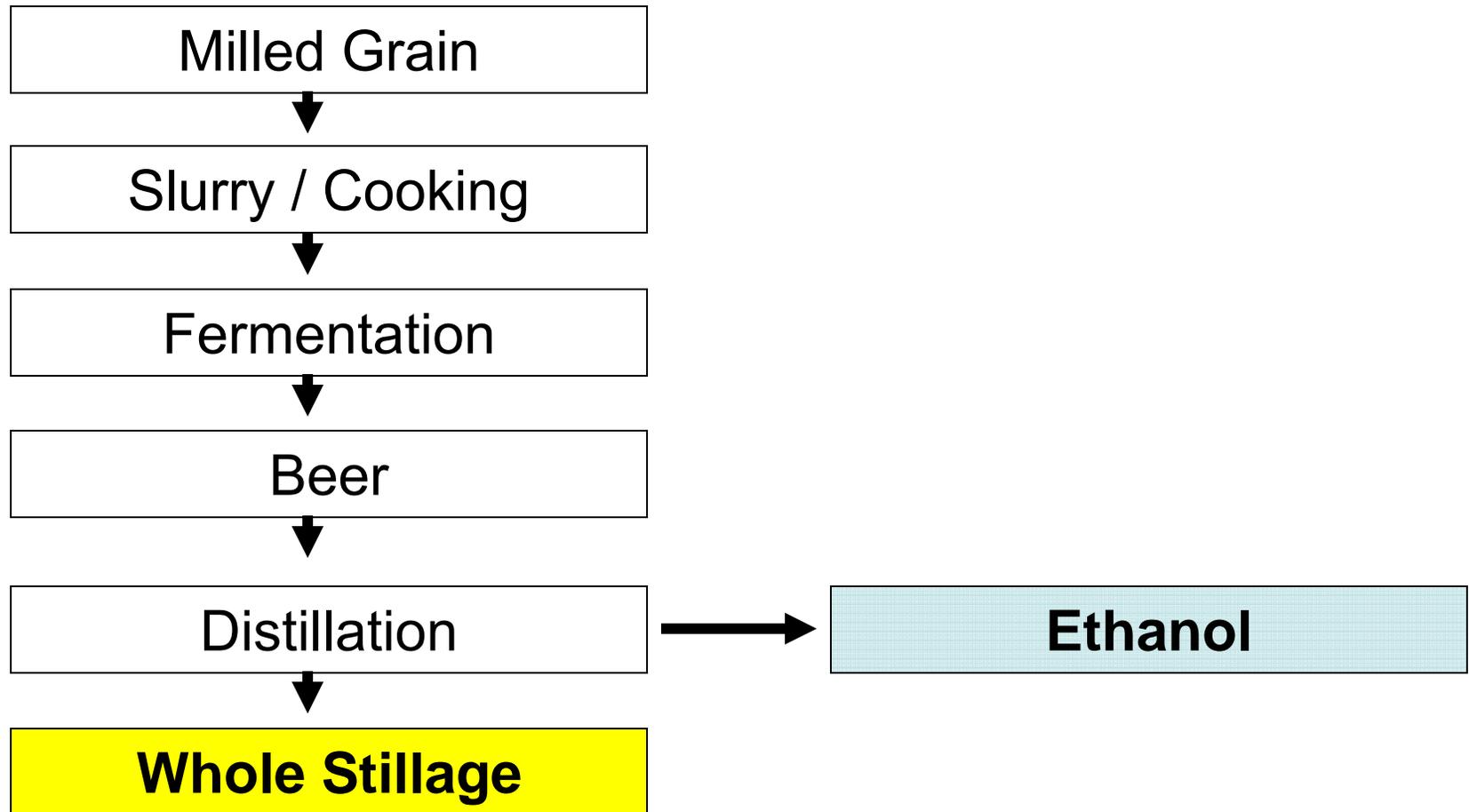
~18 lb
CO₂



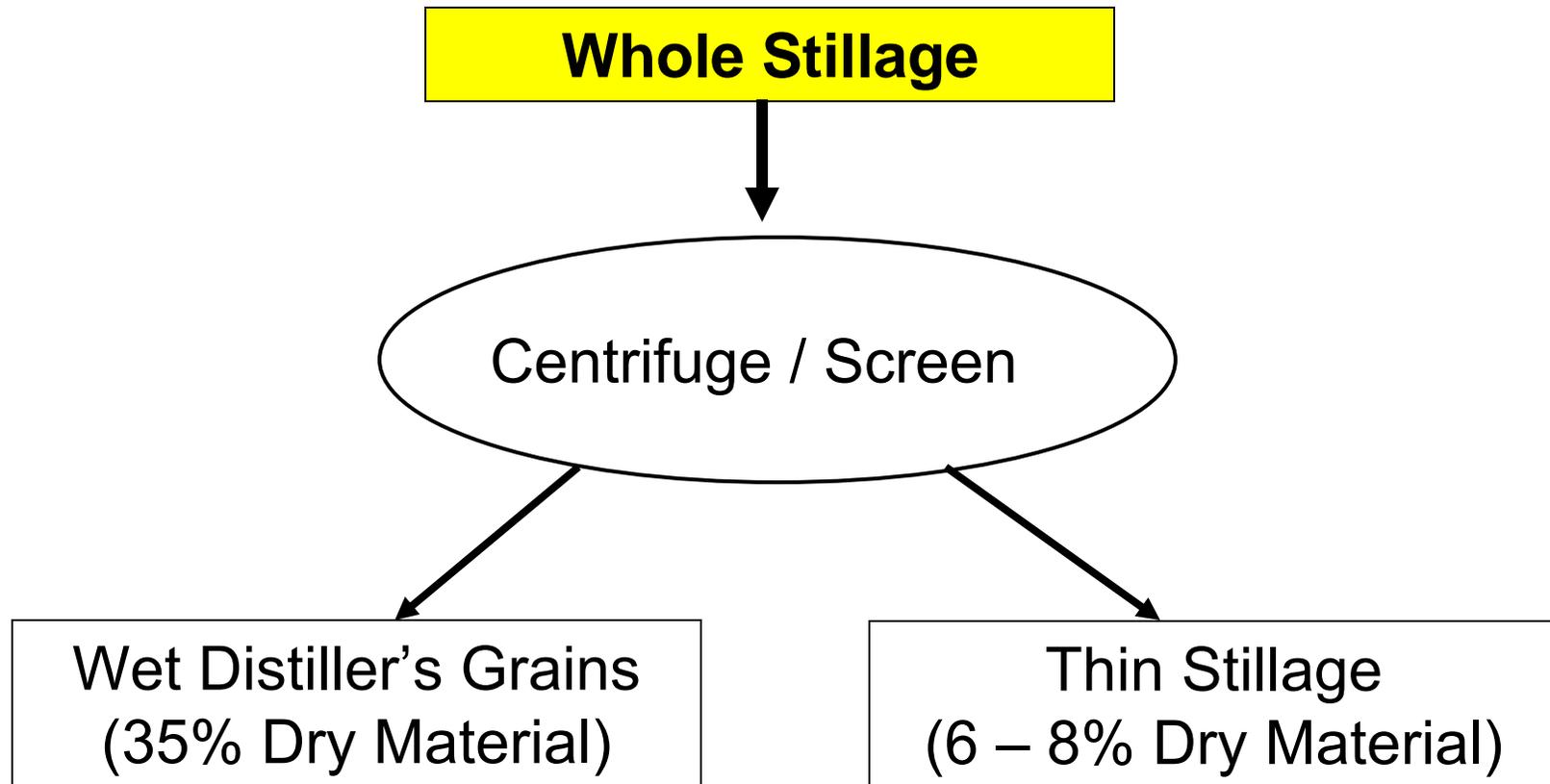
~17 lb
Distillers
grains



The Process...



The Process... WDG



WDG and DDG

Distillers Grains with or without solubles



Wet



Dried



Nutrient Estimates

	Corn	DDGS
Dry matter, %	88	89
TDN, %	88	99
NEm, Mcal/lb	0.98	1.13
NEg, Mcal/lb	0.65	0.75
Crude protein, %	9	30
Crude fiber, %	2	8
Crude fat, %	4.3	11
Calcium, %	0.02	0.05
Phosphorous, %	0.30	0.90
Potassium, %	0.4	1.0
Sulfur, %	0.12	0.90



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Wet Distillers Grains with Solubles

WDG plus solubles pressed out
(45 – 50% dry material)

Advantages

Mixes well

Palatable

High in nutrients

Lower cost

Disadvantages

Storage

Spoilage

Transportation

Variability



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Wet Distillers Grains with Solubles

Major issues:

Transport via truck

Use within 1 week (depending on weather conditions)

Mold grows quickly

Crusts

Freezes

Very low pH (3.0 to 4.0)



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Wet Distillers Grains with Solubles

The Key to Storage of WDGS:

Seal and eliminate exposure to air



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Wet Distillers Grains with Solubles



Mixed with forage
(65% moisture content)

Bagging successful at 50%
moisture content



Pictures from University of
Nebraska



Mixing WDGS - Forage

WDG can be stored when packed with dry forages

Minimum level of roughage to mix in WDGS for storage

	Bag ^a	Bunker
Grass hay	15%	30-40%
Wheat straw	12.5%	25-32%
Alfalfa hay	22.5%	45-55%
DDGS	50%	---

^a300 PSI. Source: Adams et al. - UNL

Bunker Storage Mixes 70:30 WDGS:Soybean hulls
50:50 WDGS:Corn



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DDGS



- Approximately 12% moisture or less.
- Can be stored in overhead bins, flat storage, silos...much like bulk feed commodities
- Flowability agents to enhance finely ground DDGS.
- Mold inhibitors and antioxidants not required if properly processed and stored

Dry Distillers Grains with Solubles

Variation in particle size, color, bulk density, nutrient values from refinery to refinery due to...

- Different drying equipment, temperatures
- Corn sources
- Ratio of wet DG to liquid solubles

Typical bulk density = 35-36 lb/cu foot

Typical color = “golden yellow”

Dark brown can indicate overheating



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DDGS vs. WDGS ????

If DDGS = \$150/ton

Then

WDGS = \$49/ton



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Why such a difference ?????

DDGS	WDGS
11 – 12% MC	50 – 60 % MC
	Transportation of water
Traditional Storage	Sealed storage and mixing
No Shrinkage	Shrinkage
	98% nutrient value of DDGS
Long storability	Very short storability



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Decisions...

Cost vs. Storage life and Convenience

Which by-product works in your operation?



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More New Tools for your “Toolbox”

Winter Canola storage

- Canola Handbook
- Keep cool
- Bin at 10 – 12 % moisture content
- Requires aeration to reduce temperatures
- Limited insect risk



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Storing Oklahoma Winter Canola

Carol Jones
Research Engineer

John Solie
Sarkis's Professor

Oklahoma Cooperative Extension Fact Sheets are also available on our website at: <http://osufacts.okstate.edu>

With the development of winter hardy canola varieties, Oklahoma producers have the option of rotating canola with wheat to break the weed and disease cycle, while potentially increasing wheat yields. Production of canola also provides an income source outside of the typical grain market. The interest in canola production has prompted many questions about storage methods for Oklahoma conditions.

Successful canola storage requires cool, dry conditions. Therefore, storing canola in Oklahoma requires aeration. Potential risks of improper storage include heating and spontaneous combustion, insect infestation, clumping due to molding, and free fatty acid (FFA) development.

Ripe canola varies in moisture and oil content. When placed in storage, moisture content and seed temperature determine the amount of drying and cooling necessary to prevent spoilage. Canola undergoes a period of extended respiration or "sweat," producing heat and moisture for six to eight weeks after harvest. Aeration and intensive monitoring are required to prevent quality loss.

showed no loss of quality for five months. While optimum storage conditions are 55° F and 7 percent seed moisture, every reduction of 10° F below 77° F and 1 percent seed moisture below 9 percent will double the storage life. Storage below 6 percent seed moisture may result in seed damage during handling.

Cleaning Canola Seed

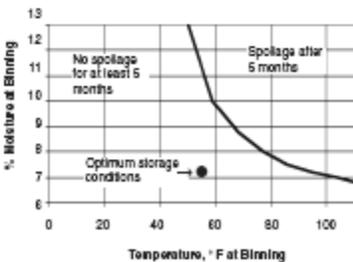
Broken seeds, pods, dirt, and other debris (also known as "dockage") make aeration more difficult by reducing airflow through the seed and can affect seed moisture content. Surface debris in storage also attracts insects. Insect development and activity cause excess heat and moisture which encourage mold growth. Broken seeds provide additional opportunity for mold growth, which increases respiration rate. Therefore, seed should be cleaned to less than 2.5 percent foreign material before storage. Canola can be cleaned by a number of different methods, including air aspiration, indent cylinder cleaning, sieve screening, or a combination of these methods.

Optimum Storage Conditions

When stored, Canola seed may be conditioned using aeration to reduce moisture and temperature to safe levels for long-term storage. Figure 1 shows the moisture content and temperature relationship for safe storage up to five months. Seed stored at conditions below and to the left of the curve

Moisture, Oil Content, and Storability

Equilibrium relative humidity (ERH) is the point at which there is no exchange of moisture between the seed and the surrounding air. Mold begins to grow when the ERH is above 80 percent. Temperature and seed oil content determine the ERH of the stored canola. Canola varieties available for Oklahoma usually contain oil between 35 percent and 45 percent. Table 1 shows the ERH for canola with 40 percent seed oil content at various temperatures and seed moisture. The shaded area shows the seed moisture content percentage for optimum conditions to prevent mold growth and seed damage due to handling. For example, a seed temperature of 80° F must have a moisture content of 7.6 percent or less to have an ERH less than 80 percent.



Higher oil contents require lower seed moisture levels for successful storage. For example, at 60° F canola with 50 percent oil content can be safely stored at 6.5 percent moisture content or less as compared to 8.4 percent moisture content for seed with 40 percent oil content as shown in Table 1. As the oil content increases, the safe moisture level decreases.

Lower seed moisture and lower oil content allow storage at higher temperatures. However, at temperatures greater than 77° F for longer than a year, excessive free fatty acid may form.

Figure 1. Safe and spoilage conditions for canola adapted from Mills (1996).



More On-going Research

- Closed Loop Fumigation
- Non-Chemical Insect Deterrents and Insecticides
- Sensors for insect detection, identification
- Sensors for non-destructive quality assessment
- Harvest, packaging, storage and transportation of biofeedstock for ethanol production



Info-Site

[http://www.biosystems.okstate.edu/
home/jcarol/](http://www.biosystems.okstate.edu/home/jcarol/)

QUESTIONS ?????



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Distiller's Supplementation

- Distiller's grains with solubles (DGS) can compliment forage diets
 - DGS is low in starch, therefore, little or no negative effect on fiber digestion
 - DGS is high in undegradable (by-pass) protein, therefore, can balance protein supply with forages that are typically high in degradable protein
 - DGS is high in energy (similar to corn), therefore, can increase energy content of forage-based diets (i.e. hay, crop residues)

Storage of WDGS - Bunker

- Can be mixed with other feedstuffs and ensiled
 - 70:30 WDGS:Soybean hulls
 - 50:50 WDGS:Corn silage

	Spoilage	Recovery
Covered bunker silo 91.5%	3-4 in.	



Uncovered bunker silo 12 in.

- Field report of WDG stored in piles, 90.4%
 Some red and white mold
 Covered with salt
 (1 lb/ft²) and plastic. Kept "very well".

Recommendations for Cow/calf & Stocker Beef Cattle

- **Fed as a creep feed ingredient**
≤50% DDGS in creep feed diet
- **Fed as a supplement to stocker cattle (~500-800 lb)**
Based on supplemental cost of gain, ≤ 6 lb/hd/d of DDGS
- **Fed as a supplement to late gestation bred heifers/beef cows**
Paired with low quality forages (corn stalks, low quality hay, etc.)
3-5 lb/hd/d DDGS
or 8-14 lb/hd/d WDGS
- **Fed as a supplement to lactating beef cows**
Paired with low quality forages (corn stalks, low quality hay, etc.)
6-8 lb/hd/d DDGS
or 17-23 lb/hd/d WDGS
- If feeding for long periods, may consider a custom mineral/vitamin mix – minus phosphorous and sulfur

