How Process Defines Co-Product Quality

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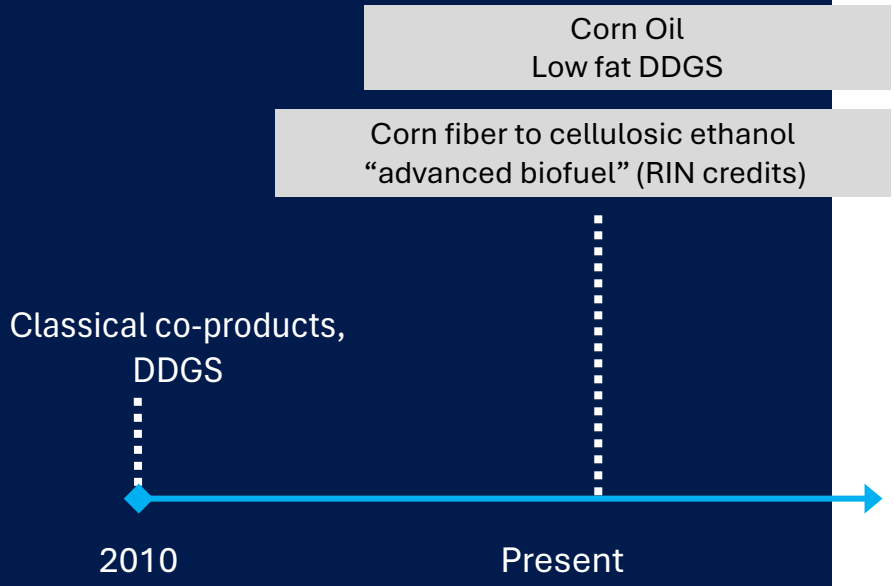
Co-Products Diversification

Opportunities Beyond Traditional DDGS



Ethanol Plants Evolving into Biorefineries

Customize co-product for specific livestock markets

Reduce reliance on commodity DDGS pricing & allow more diversified revenue streams

Qualify for low-carbon credits, especially in California or international markets

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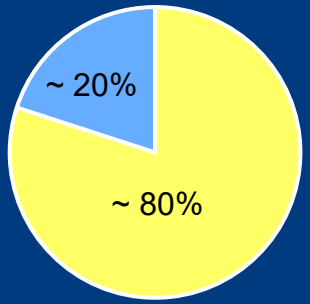
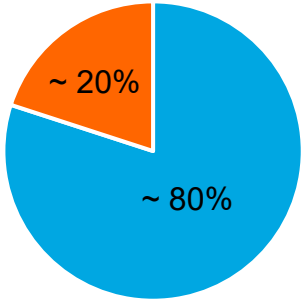
Ethanol Plant Economic: Why Co-products Matter

Operating Cost

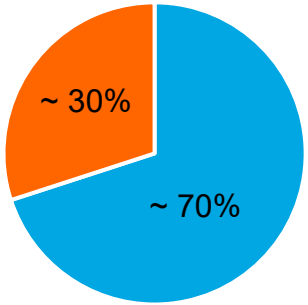


Revenue Mix

Traditional ethanol plant



Ethanol plant with diversified co-products



Co-Products Drive Ethanol Plant Profitability

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Risks

to evaluate during co-product diversification

Nutritional consistency and feed performance

Regulatory, labeling, and market acceptance challenges

Higher CAPEX & OPEX requirements

Operational complexity and workforce readiness

Price Volatility and market dependence

ROI sensitivity to scale, location, and execution

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Challenges

Moisture %

Nutrient Value: protein, fat, fiber, residual sugars, sulfur, etc.

Mycotoxin contamination

Flowability, Granulation

Color

Odor

Standardizing co-product analysis is essential for consistency & market-trust!!!

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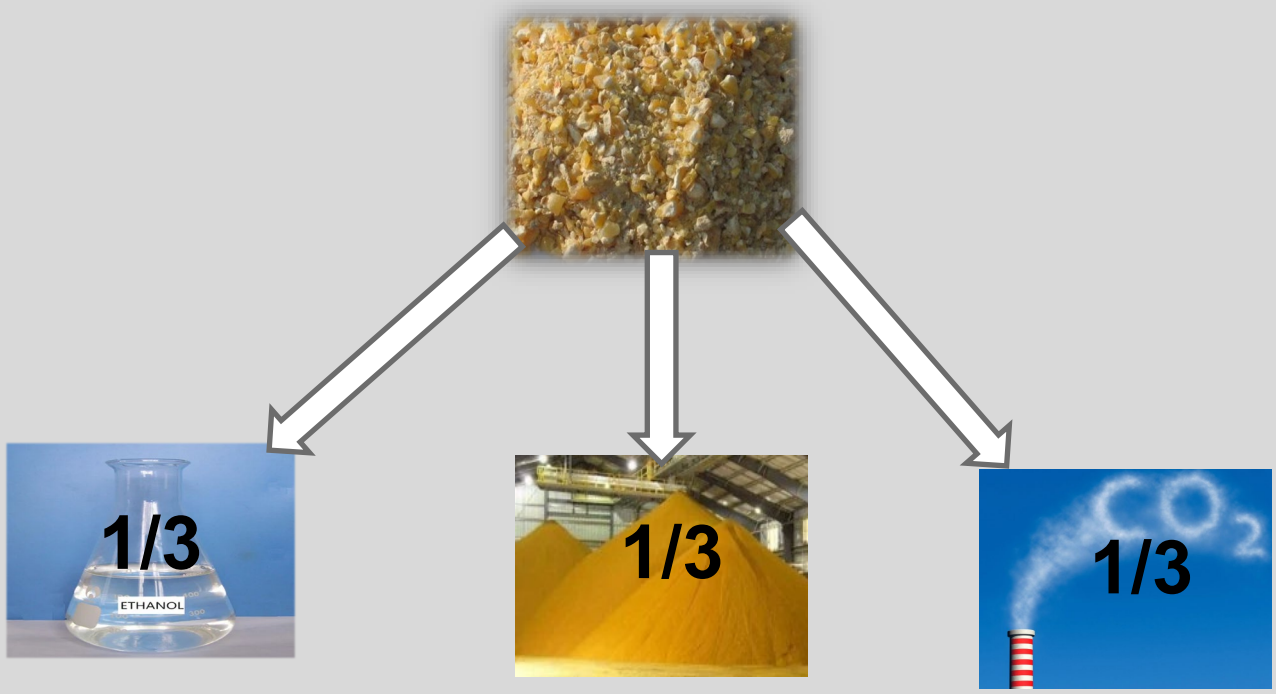
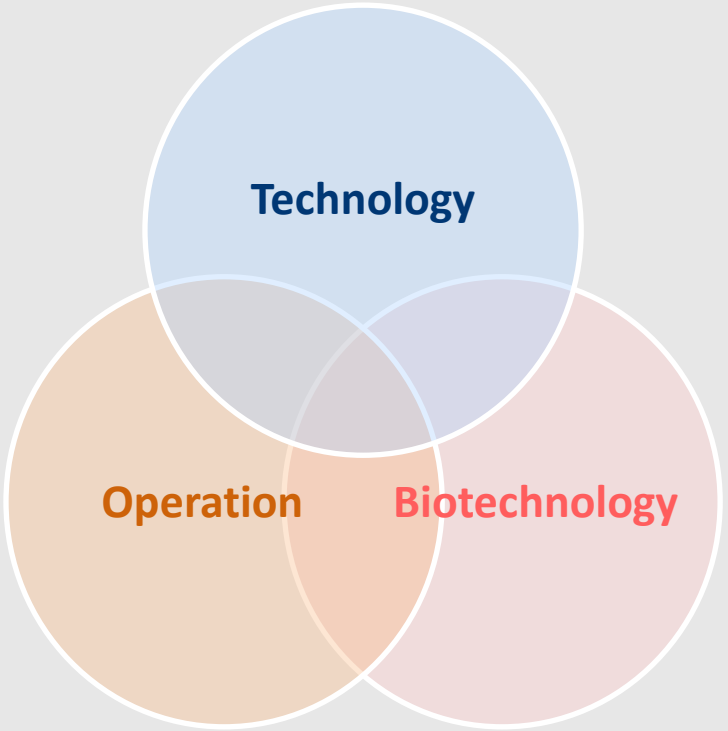
Where Does the Corn go?

1/3 Role of Thumb



What goes into the process is concentrated ~3 × in DDGS

How to Overcome These Challenges?



Ethanol Process Block Flow

Receiving, Cleaning & Storage

Milling / Grinding

Mashing, Cooking & Liquefaction

Fermentation

CO2

Backset

Distillation / Dehydration

Ethanol

Whole stillage

Centrifugation

Thin stillage

Evaporation

Corn Oil

Syrup

Wet cake

Drying

DDGS

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Receiving, Cleaning & Storage

How does it affect my co-product quality?

Corn

Poor quality
Low nutrient content, contamination

Proper storage conditions

Rodent control

Temperature control

Aeration

Checking for leaks, vents

Proper maintenance

First-In, First-Out (FIFO) Corn

Co-product quality starts with corn quality

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Milling & Grinding

How does it affect my co-product quality?

Coarse Milling (~1.0 mm)

Medium Milling (~0.7 mm)

Fine Milling (~0.4 mm)

Very Fine (0.15 - 0.3 mm)

Proper hammer mill maintenance

Reversing / Replacing parts (screens, hammers, etc.) will **impact on:**

Particle size, uniformity, flowability, granulation, nutrient

Centrifugation, evaporation & drying efficiency

Excessive heat generation will impact DDGS color / nutrient quality

Adequate dosing unit helps uniform feeding which will impact DDGS consistency

Finer grind improves ethanol yield but may pose challenges in co-product separation, handling and flowability

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Mashing, Cooking & Liquefaction

How does it affect my co-product quality?

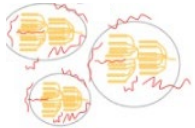
Water / Backset

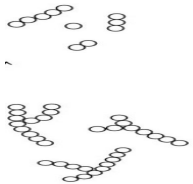
pH Controller

α-amylase

Steam → **Mash/Slurry**

α-amylase → **Liquefaction**





Amylose & Amylopectin

Cooking helps reduce microbial contamination, improve co-product safety and shelf life

Proper enzyme dosage during liquefaction ensures optimal sugar release to feed yeast, not bacteria (SSF)

Effective mashing, cooking, and liquefaction improve fermentation efficiency

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better co-product concentration

Consistant HPLC monitoring

Proper backset addition

↓

affects evaporator and syrup

Proper mixing during mashing

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Uniform and consistent co-products

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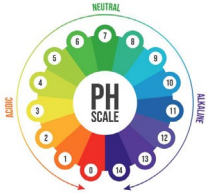
Fermentation

“Simultaneous Saccharification & Fermentation (SSF)”

How does it affect my co-product quality?



“Bio-Focused” Design

Placing biological processes at the heart of system design:

Equipment

Piping

CIP

Less chemical input

Same inputs quantities / same schedule

Antibiotic free

Efficient fermentation boosts ethanol yield, concentrates stillage, reduce energy / load on dryhouse → improves co-product quality

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Poor fermentation leads to incomplete fermentation and low-quality, inconsistent co-products

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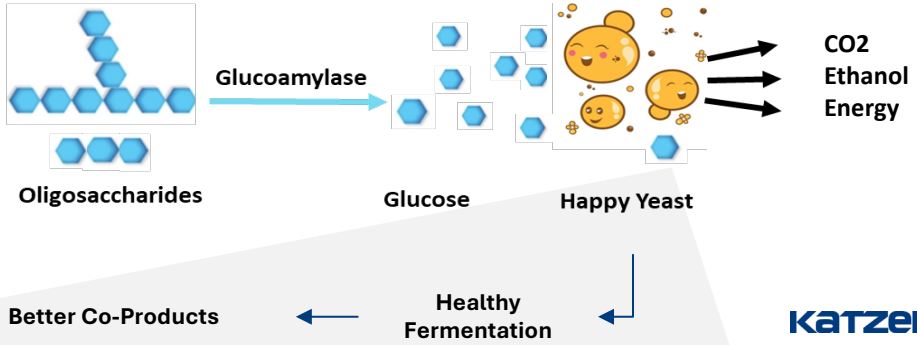
Consistent HPLC → consistent operation → faster troubleshooting → uniform co-product quality



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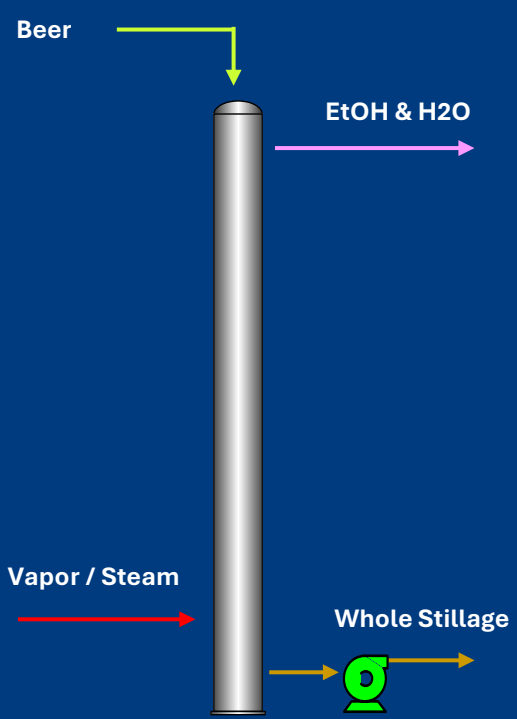
Distillation

How does it affect my co-product quality?

Beer Stripper



Proper Beer Stripper design limits fouling buildup and ensures consistent performance

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Poor distillation control can reduce feed value due to heat damage

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Proper distillation design maximizes ethanol recovery and concentrates nutrients in co-product streams

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Timing in liquefaction and fermentation can impact distillation and evaporation

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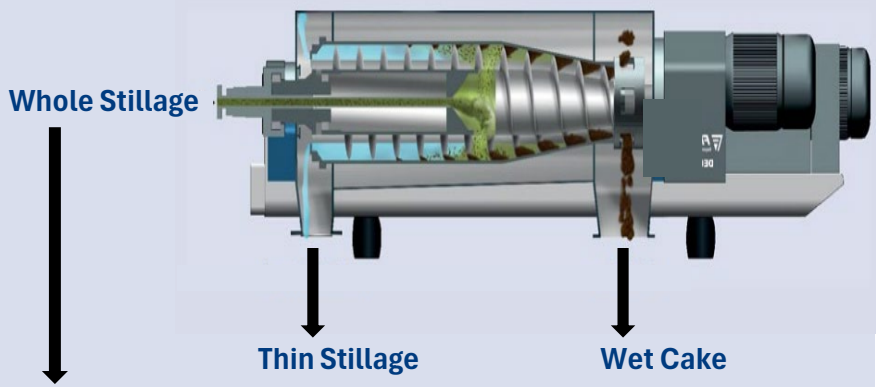
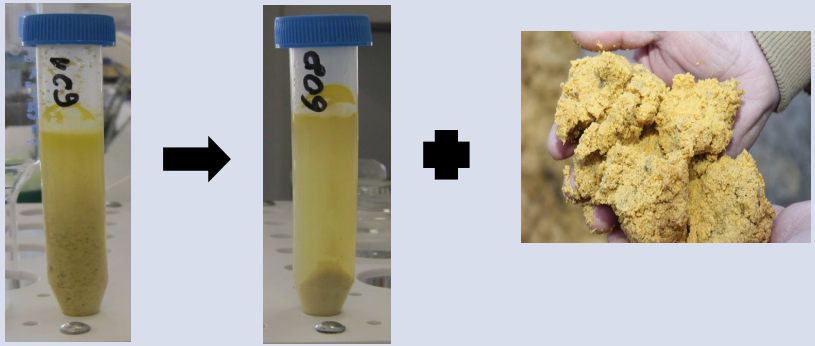
Centrifugation

How does it affect my co-product quality?





Efficient centrifuge:

Wet cake: removes more liquid → drier wet cake

Thin stillage: less suspended solids → good syrup viscosity → efficient drying → better DDGS quality

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Inefficient centrifuge:

Wet cake: leaves too much moisture → longer drying time

Thin stillage: more suspended solids → more viscous syrup → poor mixing in dryer → inconsistent DDGS granularity → more drying energy → inconsistent DDGS quality

Centrifuges, evaporators, and dryers work together to control the moisture, nutrient concentration, and stability of distillers grains

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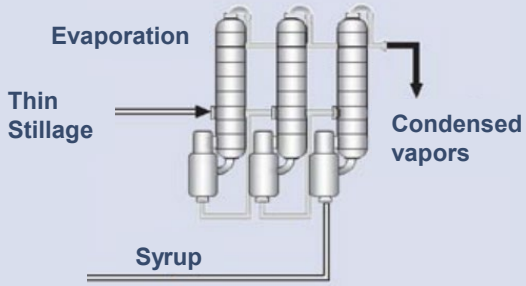
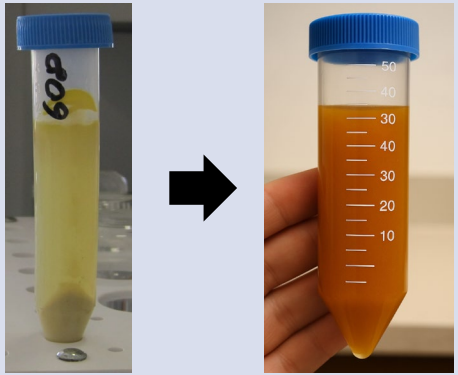
Evaporation

How does it affect my co-product quality?





Thin Stillage **Syrup**

The evaporator concentrates solids in thin stillage (protein, fat, minerals), by removing water through heat

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enriching the final DDGS

Under-evaporation

watery syrup

↓

more energy during drying

↓

lower DDGS quality

Over-evaporation

too thick / sticky syrup

↓

handling issues, uneven mixing/ blending, clog pipes / pumps, foul equipment

↓

lower DDGS color / quality

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Drying & Storage

How does it affect my co-product quality?

Proper Dryer Size / Design

Ensures consistent final moisture levels (10–12%)

Extend DDGS shelf life / prevent mold growth

Low drying temperture: preserve proper nutrient (prevent amino acids degradation) → Maintain a golden color → pleasant aroma

Maintains DDGS uniform texture and granule consistency across batches

Meet production rate (throughput capacity)

Reduces risk of “spontaneous combustion” and ensures the DDGS to be cooled to a safe temperature

Ensuring flowability during Storage & transport

The dryer is the final step in DDGS production and plays a key role in determining product quality

It’s simple — what goes in comes out three times more in the DDGS

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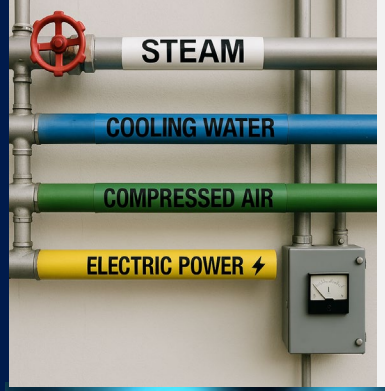
Other Factors

How does it affect my co-product quality?



Reliable utilities for continuous, safe, and efficient plant operation

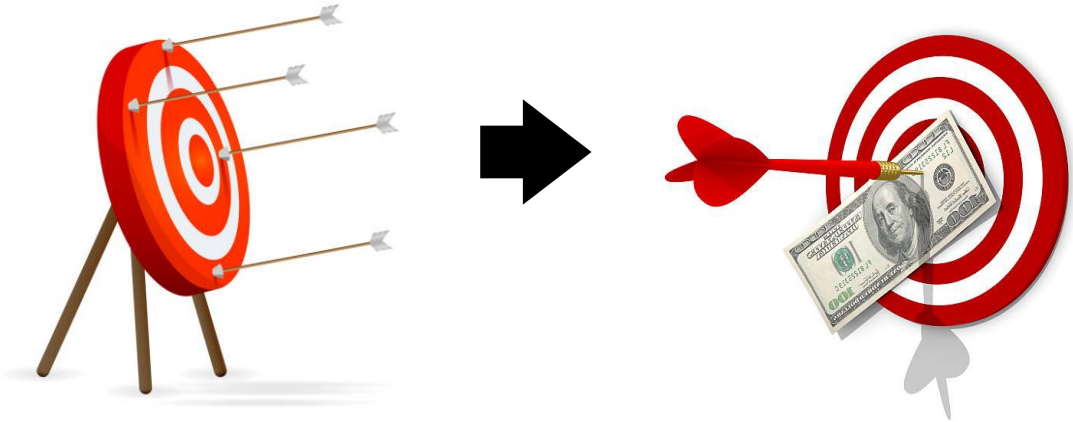
Smart plant design and piping = smoother flow, less energy loss, contamination, downtime
= top quality co-products.

Automation reduces errors & boosts overall efficiency

The lab is the plant's insight engine

Transforming Ethanol Plant Co-products

Inconsistent **to** **Consistent**



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