Floating Fish Feed and Ingredient Selection

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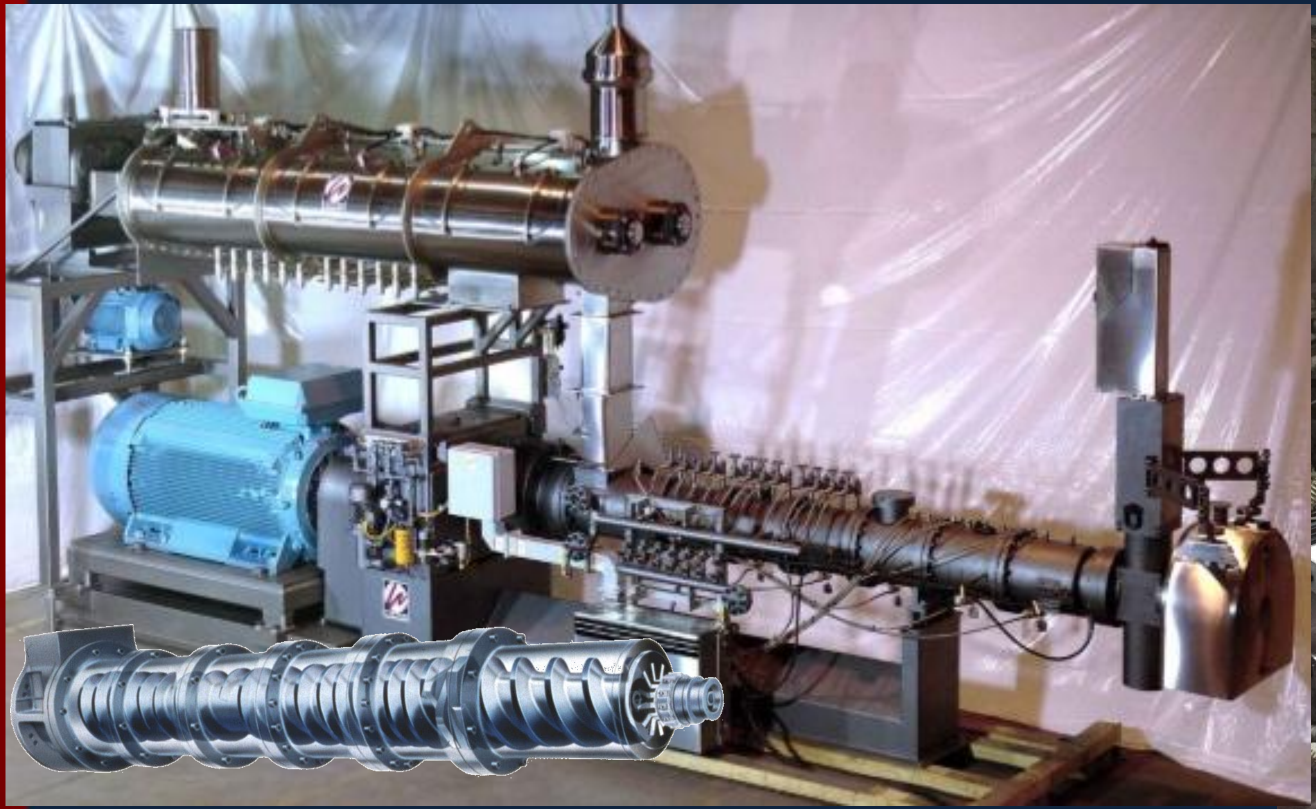
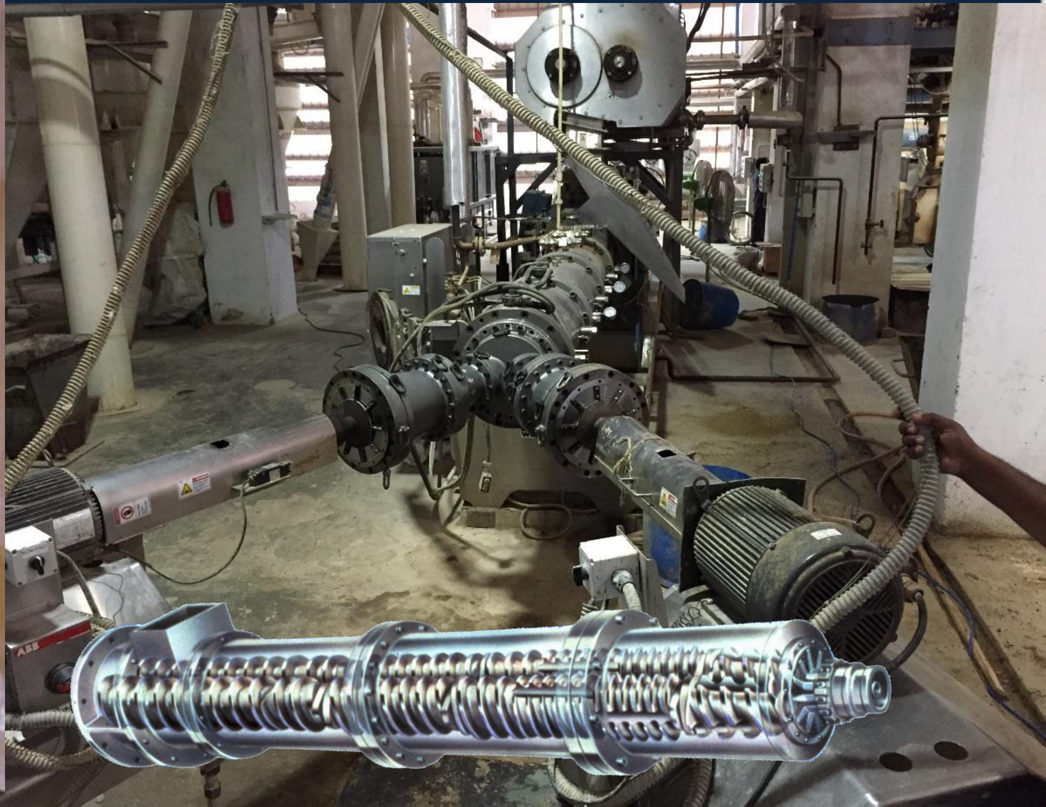
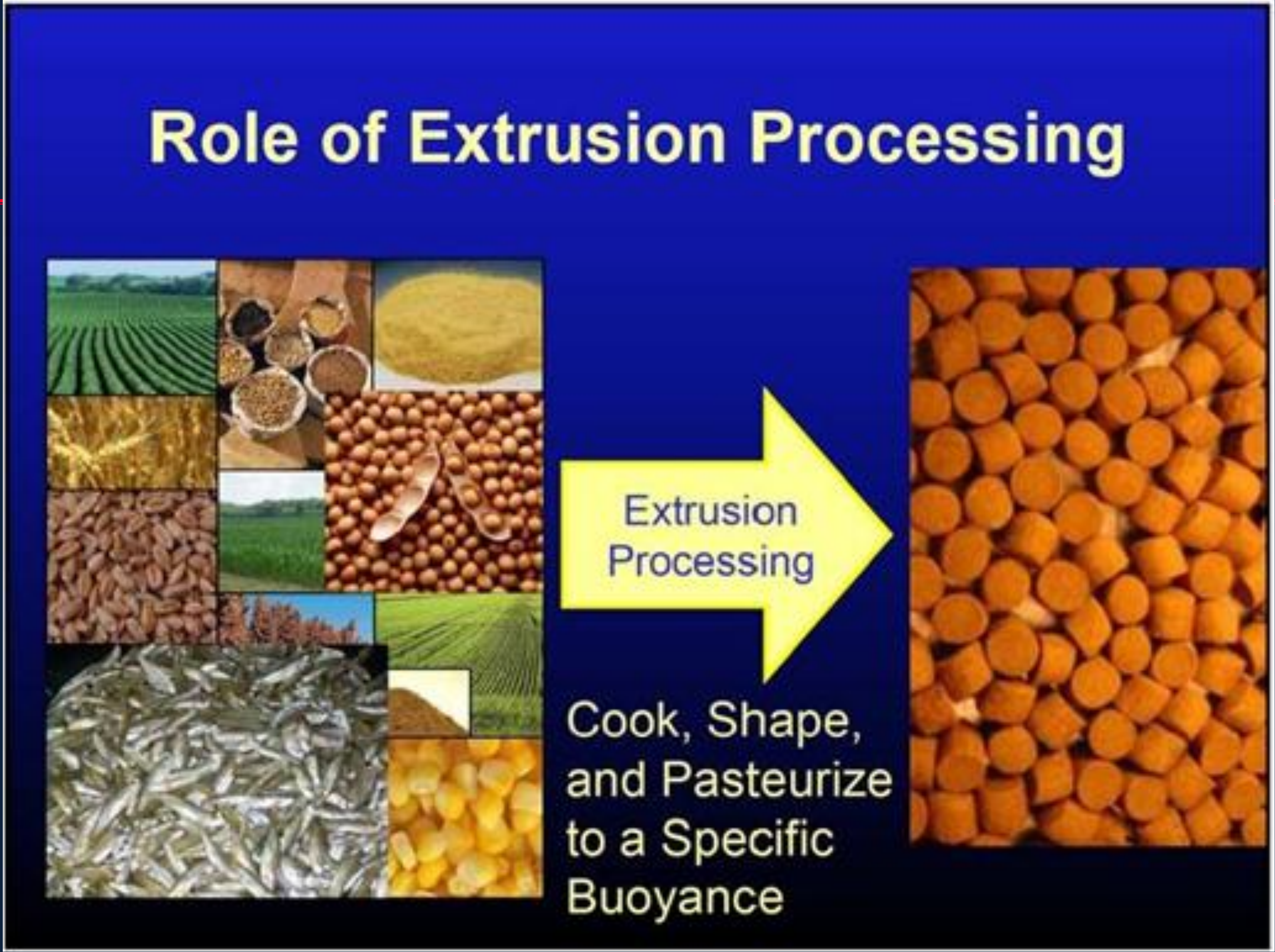
FENACAM & LACQUA / SARA(WAS)'15

16 A 19 DE NOVEMBRO
CENTRO DE EVENTOS DO CEARÁ
FORTALEZA - CE

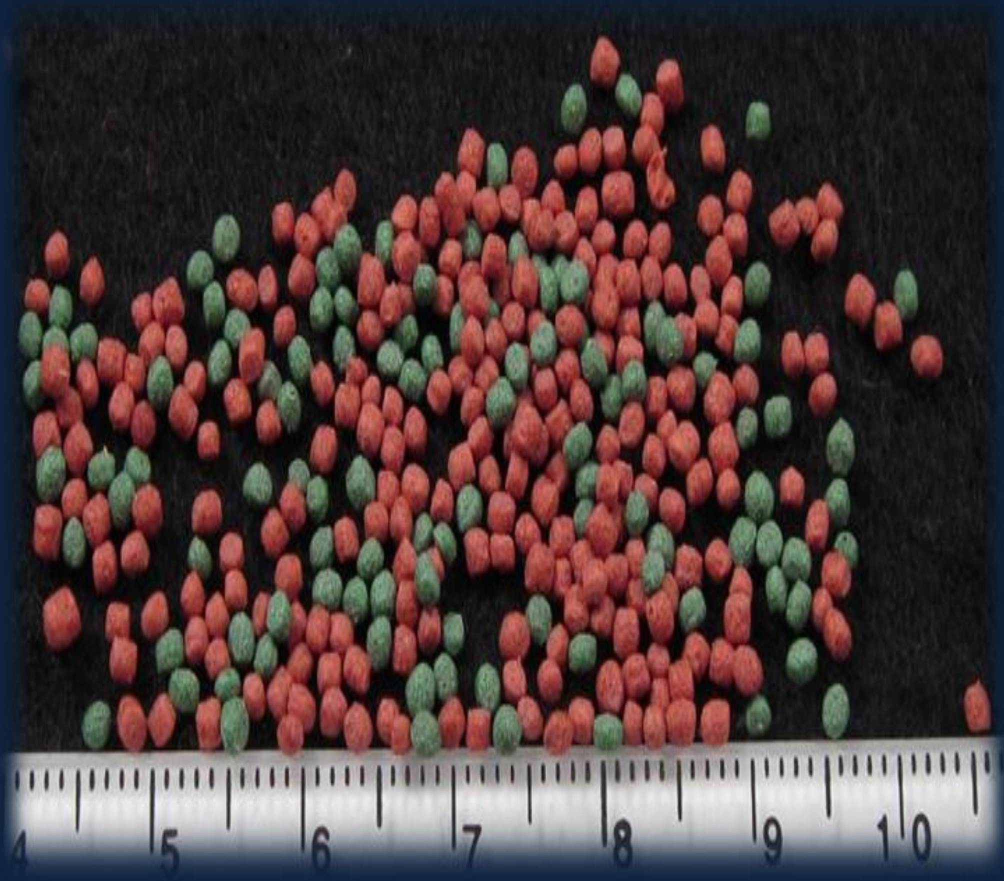





Role of Extrusion Processing
Extrusion Processing
Cook, Shape, and Pasteurize to a Specific Buoyance

Floating Feeds

Floating Micro Feeds – Ornamental



Floating Feeds
High Fiber

75% Fish Soluble Inclusion

Floating Feed Coated and Uncoated

Very Uniform Shape Floating Feed

Proteins

1) Plant sources

Soy, Legumes, Wheat/Corn Glutens

- Good functional properties
- Low cost
- Amino acid profile requires supplementation

2) Animal sources

Meat, Fish, Poultry, Blood, Gelatin

- Poor functional properties unless fresh or spray dried
- Higher costs but usually more palatable
- Good amino acid profile

Benefits of Vegetable Proteins in Aquatic Diets

1) More expansion potential for floating diets
2) More binding potential for improved durability
3) Reduced ingredient costs
4) Lower incidence of white mineral deposits in screw and die area
5) Higher oil absorption levels possible in coating operations
6) Reduce dependence on fish meal

With variances seen in plant protein ingredient quality this needs to be understood when purchasing ingredients.

Ingredient Sources and Specifications

Is Soybean Meal the same in all cases or are there some variations between sources and locations of purchase etc?

Is Wheat Midds available with a standard specification or does the starch level vary between millers?

Is it possible to have a ingredient that has the same nutritional spec but be prepared in a different fashion?

Extruded Floating and Sinking Diets Containing High Levels of Vegetable Protein and Good Water Stability

Made from base recipe containing 70% soybean meal, 20% wheat flour, and 10% fish meal.

After coating, these products contained 22% fat and 35.5% protein


494 g/l product density


750 g/l product density

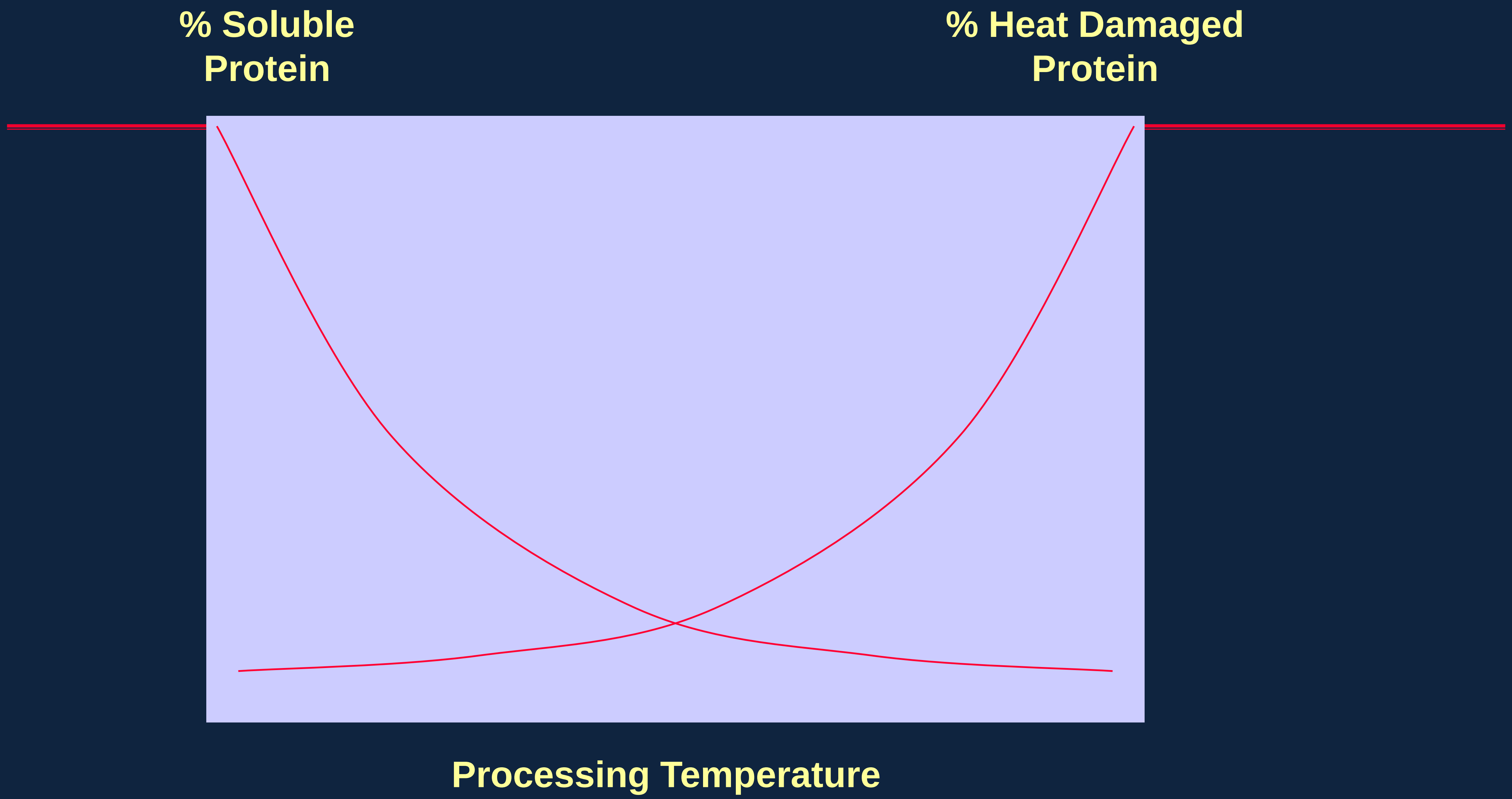
Processing Effects on Proteins:
Wet Chemistry Methods

1) Denaturation of Proteins

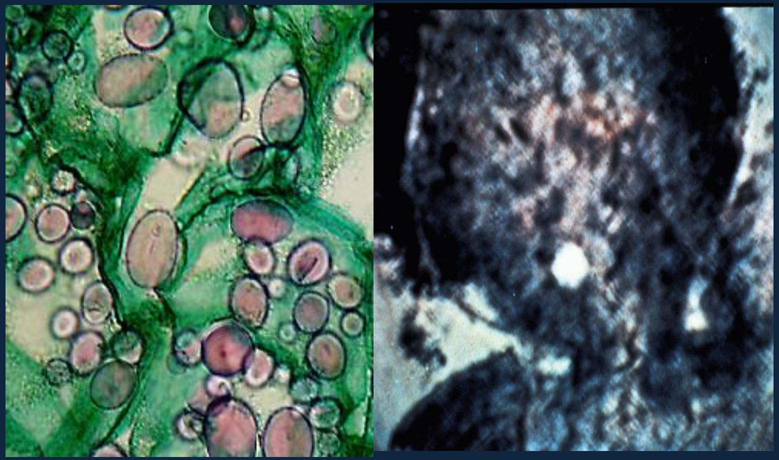
- Begins to occur at 55°C (130°F)
- Measure PDI (Protein Dispersibility Index) digestible in acidic environment

2) Heat- Damaged Proteins (poor digestibility)

- Can begin at 150°C (302°F)
- Measure N_2 in acid detergent fiber fraction
- Poor digestion in acidic environment

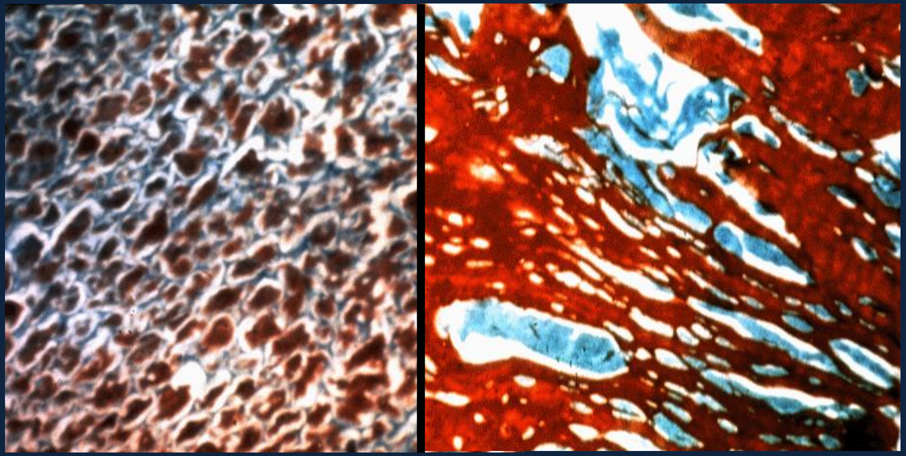

% Soluble Protein
% Heat Damaged Protein
Processing Temperature

- Protein denatures at 60 - 70^{0}C
  - As protein denatures, it becomes insoluble (non-functional)
- Starch gelatinizes at 55 - 75^{0}C
  - As starch gelatinizes, it becomes soluble



Raw After Extrusion

Starch



Raw After Extrusion

Protein

Effect of Raw Material Protein Quality

7 PDI 12 PDI 30 PDI 54 PDI

PRODUCT COLOR

Very Dark

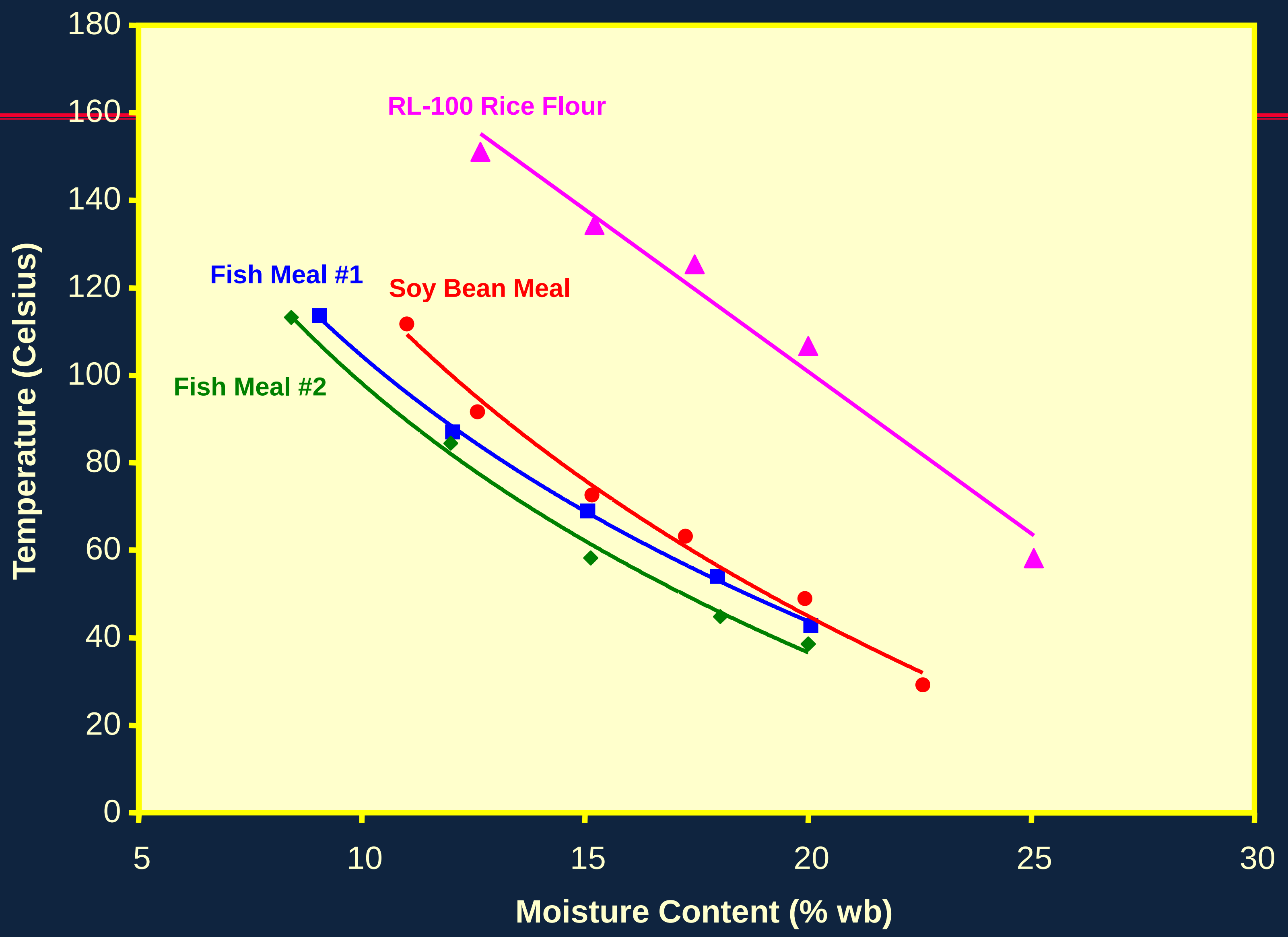
Very Light

Soy Proteins used for FEED
(Soybean Meal)

Soy Proteins used for FOOD
(Flour, concentrate, isolate)

Comparison of Protein and Starch Flow Curves

SBM and some starches are harder to cook then fish meal. Chart shows higher temperature and water are needed.



SBM

Dried Distillers
Grains with Solubles
(**DDGS**)

Protein Source
Samples in Meeting

Quick test, placed in water and let's see what they do, predicted they would sink and not soften quickly and act like sand. Client called the bluff, brought in samples and water.

By no means is this test conclusive. Lab test suggested.

Laboratory Tests to Indicate Protein Functionality

1) PDI (Protein Dispersibility Index)
2) NSI (Nitrogen Solubility Index)

These are a measure of the protein's solubility in water and are indicative of the level of heat treatment. The PDI test is a more rapid test and will usually give slightly higher results.

AOCS Standard Procedure Ba 10b-09

Revised 2011

Protein Dispersibility Index (PDI)

Laboratory Procedure

Protein Dispersibility Index (PDI)

This method determines dispersible protein in soybean products under conditions of test. In contrast to alternate slow-stir method for Nitrogen Solubility Index (NSI) (AACC Method 46-23), the faster-stirring technique used in this method will give generally higher results.

Equipment

1. Hamilton Beach Drinkmaster No. 30, modified to accommodate Waring Blendor blade and cup.
2. Blade assembly with Cenco-Pinto blades. Central Scientific Co., No. 17251-L55. Use two blades, one horizontal and one with tips pointing down with cutting edge in direction of rotation.
3. Waring Blendor cup, 1-qt. Capacity; bottom sealed with No. 3 stopper.
4. Glassware; 300ml Volumetric flask, 15ml Pipet, 600ml Beaker.
5. Centrifuge; International type SB size 1,2,700 rpm, with 50ml tubes or any equivalent, capable of delivering 1,400 r.c.f. at tip.
6. Balance, 0.1g accuracy.
7. Timer, interval, alarm.
8. Variable transformer.
9. Standard Kjeldahl equipment (AACC Method 46-10).
10. Tachometer, range to 10,000 rpm.
11. Voltmeter.

Standardization of Blender

Measure 300 ml of water into blender cup and place in position on mixer. Remove chrome cap, which covers top of the drive shaft. Using proper tip, place tachometer in position on rotation shaft. With switch in high position gradually increase transformer setting until shaft shows 8,500 rpm on tachometer. Note voltmeter reading and transformer setting, and use for blending of sample. Standardization of machine should be done before each series of test to eliminate errors on account of fluctuation in line voltage.

Method:

1. Weigh 20.0g of soy product.
2. Fill 300ml volumetric flask with water at 25°C. Pour approximately 50 ml water into the blender cup. (Note: Water-dispersible protein is related to temperature, so blender cup should be at room temperature.) Transfer weighed sample quantitatively to blender cup. Stir with spatula to form paste. Add remainder of water in increments, with stirring, to form smooth slurry. Use last of water to rinse spatula and blender cup walls. Place cup in position for blending.
3. Turn blender on with switch in high position and gradually adjust variable transformer to point indicated by water standard at 8,500 rpm. Blend at this speed for 10 minutes.
4. Remove blender cup and pour slurry into 600 ml beaker. After slurry has separated, decant or pipet portion into 50 ml centrifuge tubes and centrifuge 10 minutes at 2,700 rpm.
5. Pipet 15 ml of supernatant liquid into Kjeldahl flask, and determine protein by using AOCS Method Ac 4-41 (15ml = 1.0g sample)

Crown Iron Works
Down Draft Desolventiser for High PDI Soya

- Flakes are handled gently throughout the process, producing a final product with a maximum amount of whole flakes and a minimum amount of fines.
- Higher attainable PDI than with conventional systems (potentially 80-85).
- Flexibility in operation to fine tune the system for the ideal combination of PDI, residual hexane, and steam consumption.

Starch in Formulation

- 10% Required for Sinking
- 20% Required for Floating

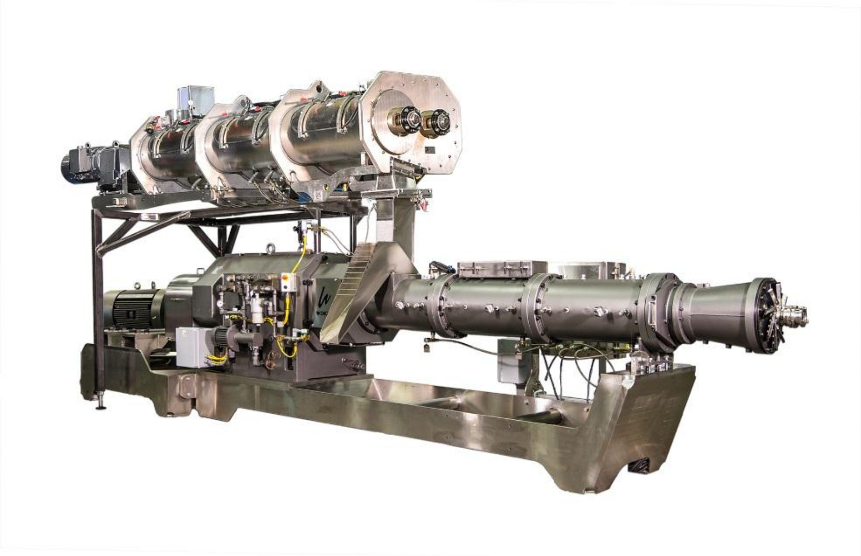
- Concrete included gravel and sand as well as cement.
- The better the concrete the more cement you use.

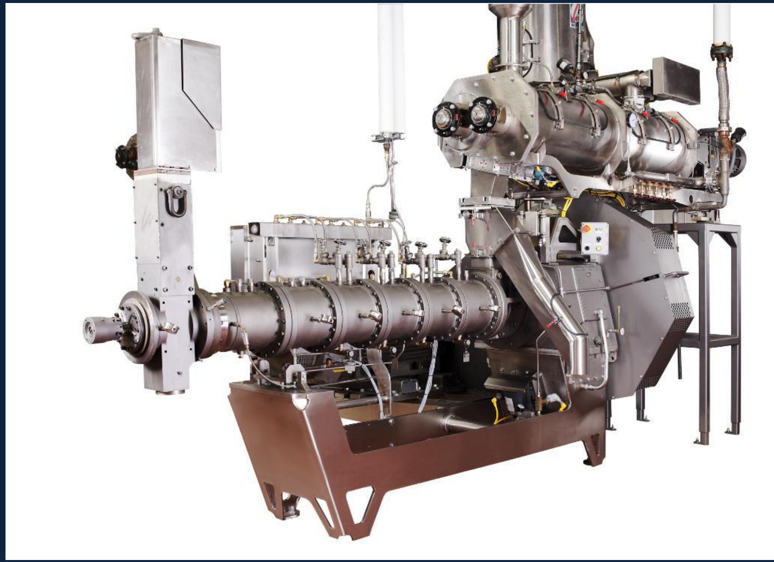
Starch Content of Common Cereal Grains

Cereal Grain	% Starch (Dry Basis)
Corn	73
Winter Wheat	65
Sorghum	71
Barley	60
Oats	45
Unpolished Rice	75

The 4 Rules of Extrusion Cooking

1. Raw Materials, including quality specs.
2. Hardware arrangement
3. Running Conditions or software requirements
4. Finished Product Specifications





Guidelines for Proper Grind of Recipe Prior to Extrusion

- Maximum particle size = 1/3 die opening
- Not to exceed 1.2 mm

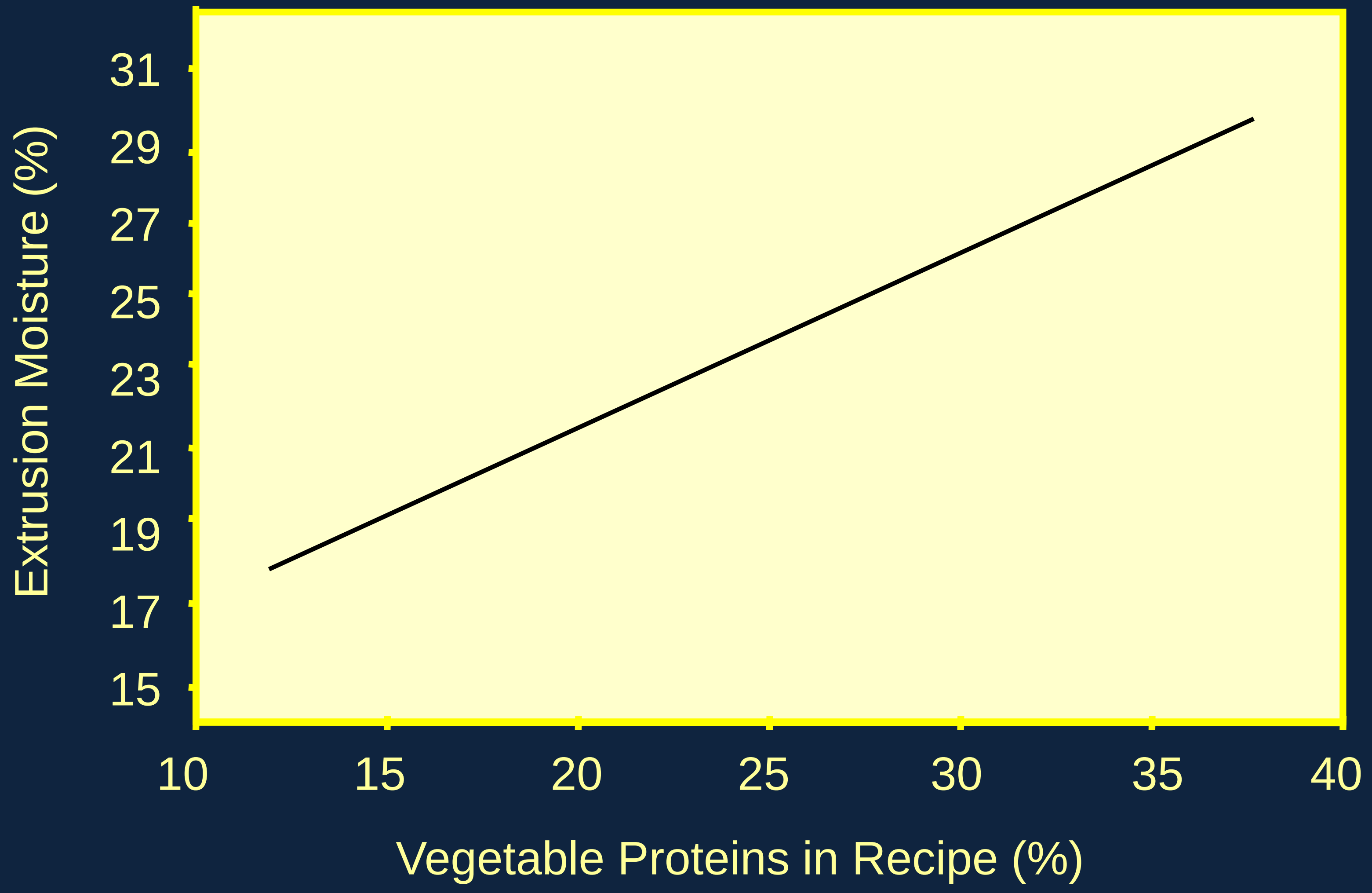
Benefits of Proper Particle Size

1) Improved product appearance
2) Reduced incidence of die orifices plugging
3) Ease of cooking
4) Reduced product breakage and fines
5) Increased water stability
6) Improved retention of liquid coatings due to small cell structure

Effect of Raw Material Particle Size on Final Product Appearance

1.0 mm grind   1.5 mm grind

Effect of Vegetable Protein Levels On Extrusion Moisture



Objectives of preconditioning are to **hydrate**, **heat**, and **mix** recipe.

The **efficiency of a preconditioner** is how well the above objectives are accomplished:

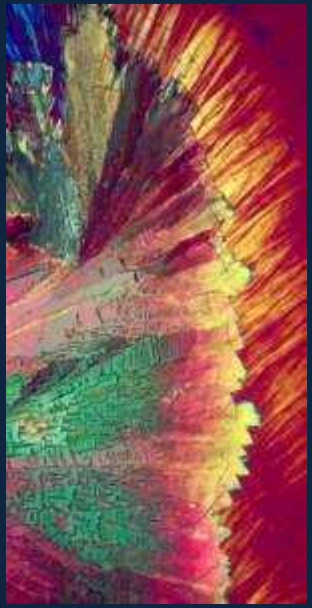
1) Hydration: uniformity
2) Heating: energy inputs equal useful energy out plus losses
3) Mixing: coefficient of variation

High Intensity Preconditioner

1) Mixing intensity controlled by speed and rotational direction of each shaft (individual VFD drives)
2) Increased shaft speed increases radial and distributive mixing
3) Up to 2 times more beater contacts than original DDC
4) Instant display of retention time
5) Retention time can be varied

Retention of Heat Sensitive Nutrients

Nutrient retained (%)	Lysine	Vitamin A	Vitamin C
	100%	79%	83%



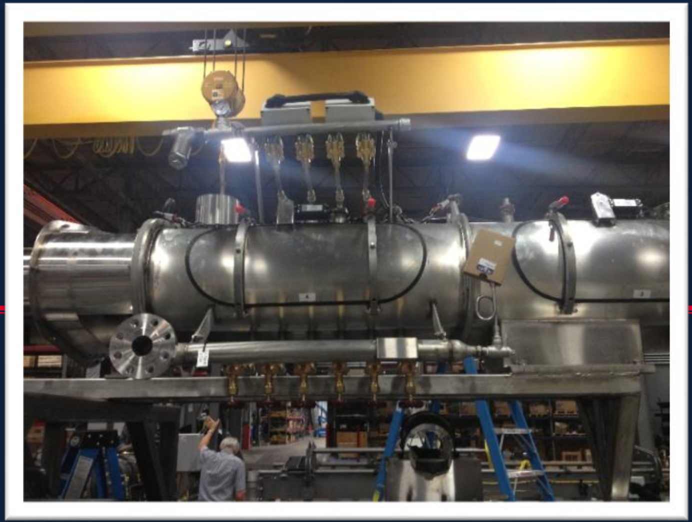
New HIP Shaft/Beater Design

Hygienic design without threaded beaters

Comparison of Particle Size Off Preconditioner at 70% Meat Addition

High Mixing Intensity

Low Mixing Intensity



Before

10% Steam – 14% Water

With and Without Mixing System

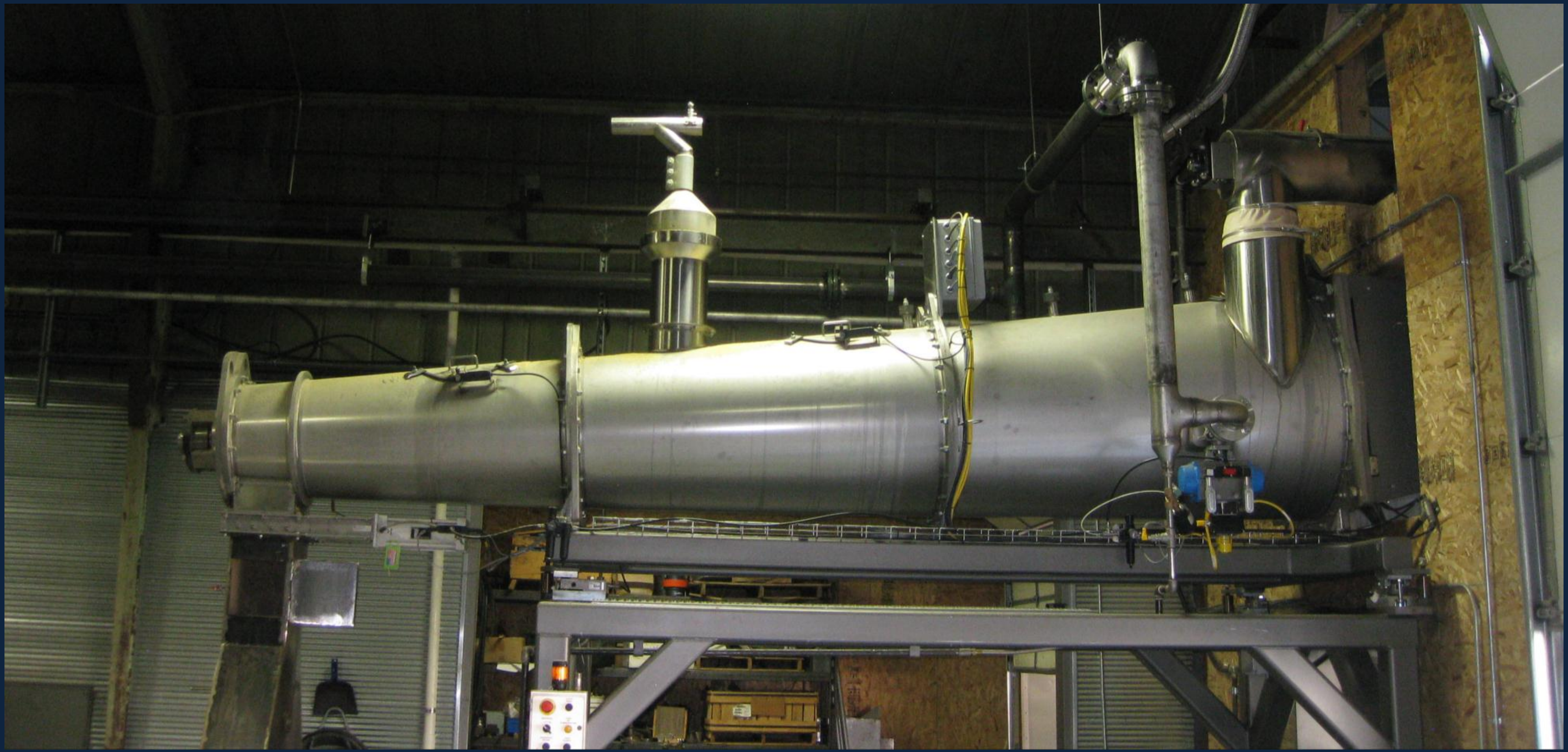
Greatly Improved Energy
Utilization

HSC (High Shear Conditioner)

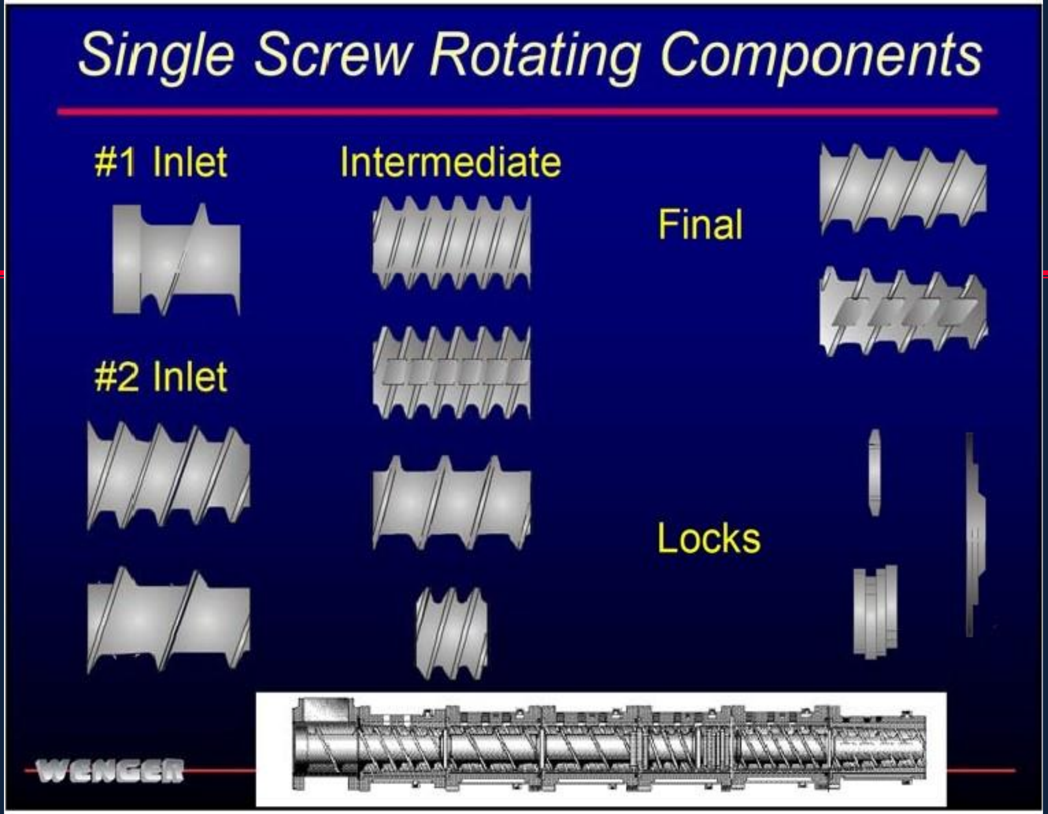
1) High shaft speeds create dispersive and distributive mixing

2) Tapered design increases fill at discharge to seal in steam and create additional shear forces

High Shear Conditioner with New Steam Injection Valve



Effect of Protein on SME


Single Screw Rotating Components
#1 Inlet
Intermediate
Final
#2 Inlet
Locks
WENGER


Guideline: "Anything that disrupts conveying will increase cook!"
WENGER

Specific Mechanical Energy in kJ/kg

(Actual Load – Idle Load) (Actual Speed / Base Speed)
(Available Power of Motor) (36)

Mass Flow Rate

Can Convert to the Standard Kilowatt Hours / Ton by Dividing by 3.6

Example, Increased Capacity

Historically:

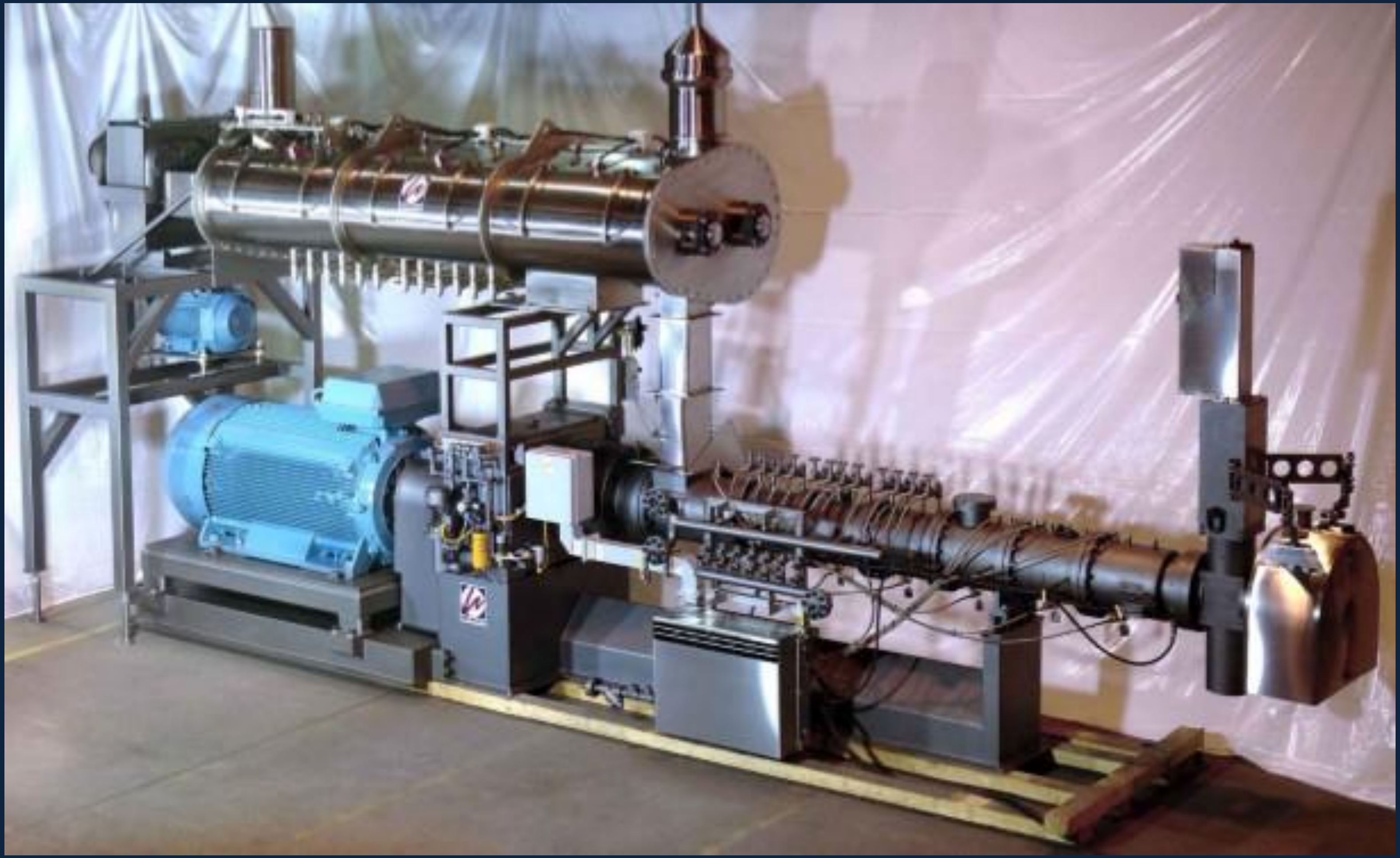
$$\frac{(90-15)\,(300/300)\,(186)\,(36)}{8000}$$

SME = 17.4 kWh / ton

Current:

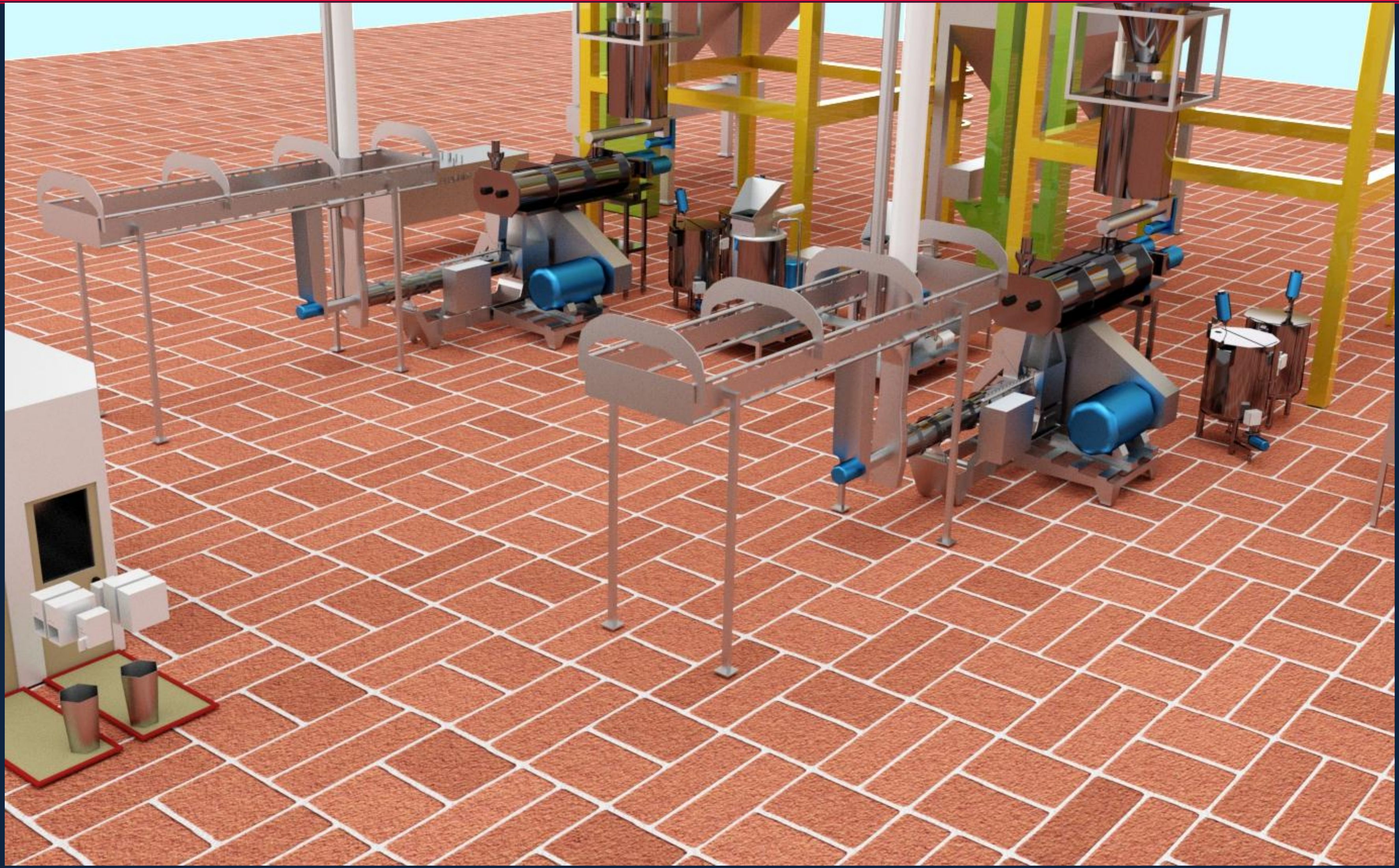
$$\frac{(90-15)\,(300/300)\,(298)\,(36)}{12{,}000}$$

SME = 18.6 kWh / ton

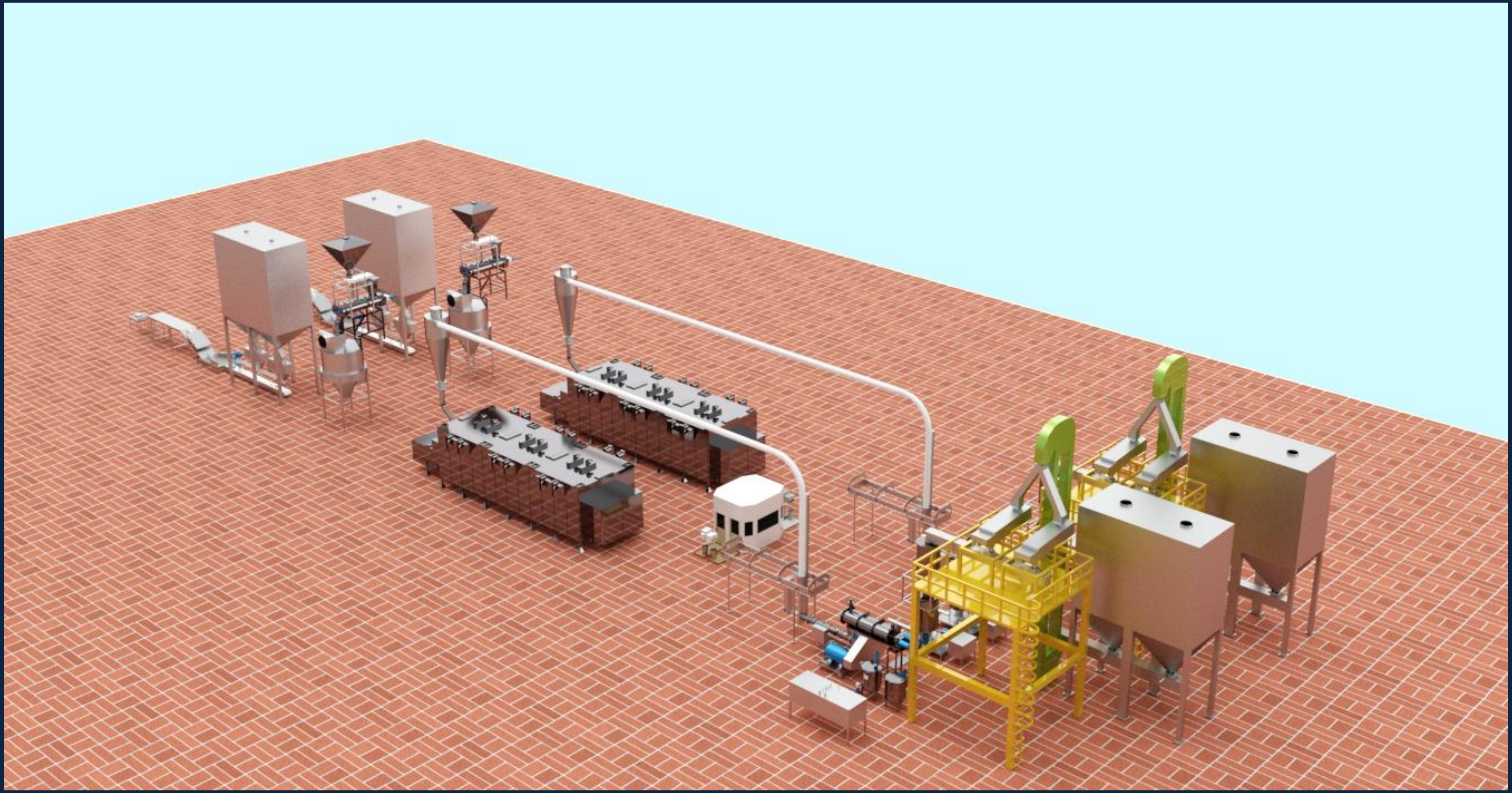


If higher temperatures, better starch sources and more water are needed to cook lower grade raw materials, then how much does it cost to extrude and dry these ingredients over purchasing a better quality ingredient? The calculations can be made to see the best most cost effective approach. Higher temperatures and more water usually mean lower capacity as well as higher energy use.

Plant Designs and Value in Scale



Cost to produce is lower as Equipment gets Bigger



Cooperatives Work Well in Aquatic Industry

- Cost of Equipment and plant lower per ton of product produced per hour as capacity increases.
- When Aquaculture works in an area generally there will be more then one farm in the same area.
- Power of purchasing in volume, easier and more effective method to buy raw materials.

Coop Plants in Catfish Country in USA