# EXTRUDERS FOR SOY PROCESSING

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# DRAW BACKS OF RAW SOYBEANS FOR ANIMALS & HUMANS

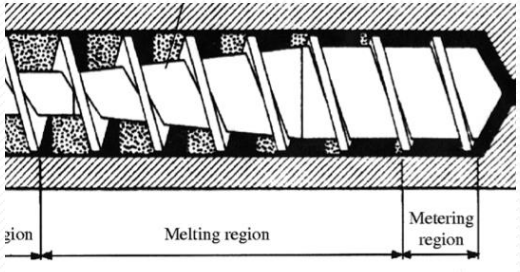
Soybeans are the most important crops in the world and are grown for a variety of agricultural and industrial uses. There are eight major oilseed meals in the world. Soybean meal represents more than 50% of the total oilseed meal production. Raw soybeans cannot be used as such for animal feed or human food, because they contain several different antinutritional factors.

These factors are

a) Trypsin and chymotrypsin inhibitors;
b) Phytohaemagglutinins (Lectins);
c) Urease;
d) Allergenic factors; and
e) Lipases and Lipoxygenases.

These factors affect the digestion of soybeans in the stomach. All can be deactivated, modified or reduced through proper heat treatment to minimize or eliminate their adverse effect.

# EXTRUSION




- The single screw extruder is a bioreactor which transforms variety of raw food materials like maize, starch, wheat, rice, soy, etc. into products such as Snack foods, pet feeds, pasta products, soy products, etc. It can be used for heat treatment and processing of natural soy beans by increasing pressure and temperature.
- Extruder produces continuous shaped product of food material. Cutter is used at die for cutting product into small lengths.
- The single screw extruder consists of a precision screw rotating inside a smooth bore or grooved barrel (pipe). The mechanical energy for rotation is supplied from a Reduction gear and variable speed electric motor.

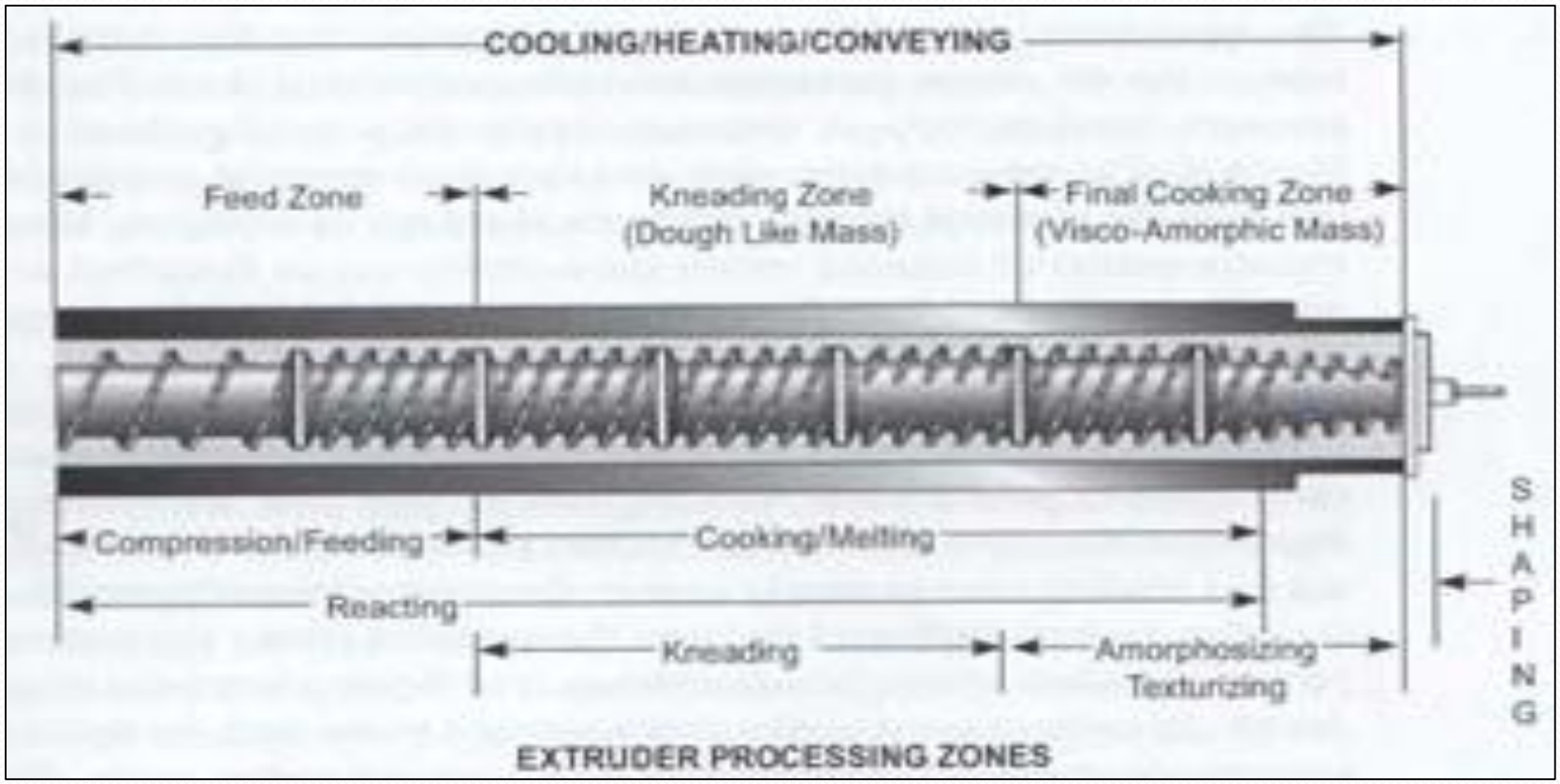
# EXTRUDERS – SINGLE & TWIN SCREW

- Single screw Extruders consist of a single screw rotating inside a grooved or smooth bore cylinder. The screw helps to feed, convey and cook the food materials as it passes through a suitably shaped die. The compression ratio determines the degree of cooking or shear to the food materials. Shear can be changed by changing the pitch of various screws sections on the shaft.

- Advantages of single screw Extruder:
  1. Simple construction.
  2. Low capital cost.

# EXTRUDERS – SINGLE & TWIN SCREW

- Single screw Extrusion Cooker showing various processing zones

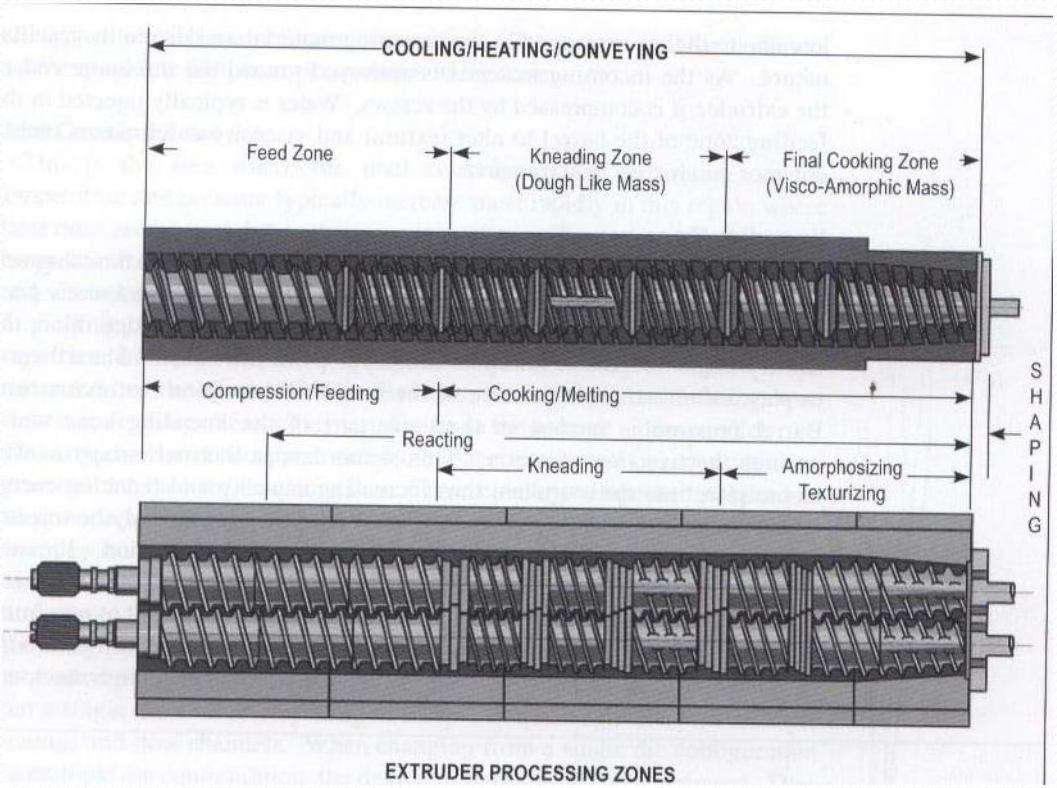


# EXTRUDERS – SINGLE & TWIN SCREW

- Twin screw Extruders have twin screws rotating inside a single twin bore cylinder. Twin screws fully intermesh with each other and rotate in same direction (corotating).

- Advantages of twin screw Extruder:
  1. Improved mixing of ingredients.
  2. Better shear control. Positive feeding force of screws to die.
  3. Better product quality (texturisation, etc.)
  4. Self cleaning action due to self wiping screws.
  5. Versatile in use. Cannot be limited to one application.
  6. Improved productivity with low production cost.

# EXTRUDERS – SINGLE & TWIN SCREW




# Corotating Twin screw Extrusion cooker

# EXTRUDERS – CLASSIFICATION

**Low shear:**

- Used for processing mainly pasta & pellet type products.
- Low screw speed and low shear, temperature on ingredients.
- Least friction. Used with high moisture (>30%-45%)
- Used as former/shaper. No expansion in product.
- Screw has high free volume (deep flights).
- Least wear of working parts. Least SME.

# EXTRUDERS – CLASSIFICATION

**Medium shear:**

- Used as wet Extruder.
- Uses friction (mechanical work) plus heat from steam to cook the ingredients.
- Moisture content varies between 20-35%.
- Used to produce Soy TSP, Meat analogue, Soy Dal Analogue, Aqua pellet (sinking/floating) etc.
- Wear on working parts is not so high due to low SME-Specific Mechanical Energy.

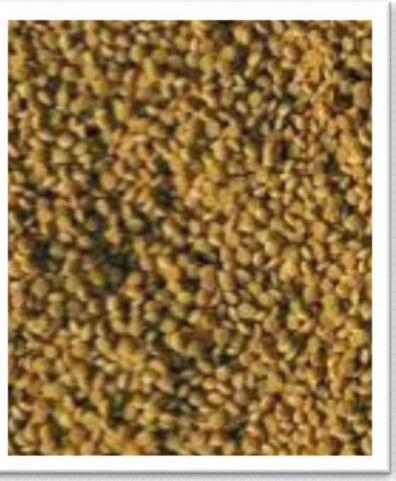
# EXTRUDERS – CLASSIFICATION

**High shear:**

- Used as “Dry” Extruder. High RPM e.g 550 RPM.
- Moisture content not greater than 15-18%.
- Relies on friction energy to cook ingredients.
- No additional heat source. Very high shear & temperature on food product.
- Used to produce direct expanded products Viz.Nugget, chunks, full fat soy meal, etc. Also floating Aquafeed pellet.
- Wear on working parts is high.
- Needs highest mechanical energy (SME).

# EXAMPLES OF SOY PRODUCTS FROM EXTRUSION

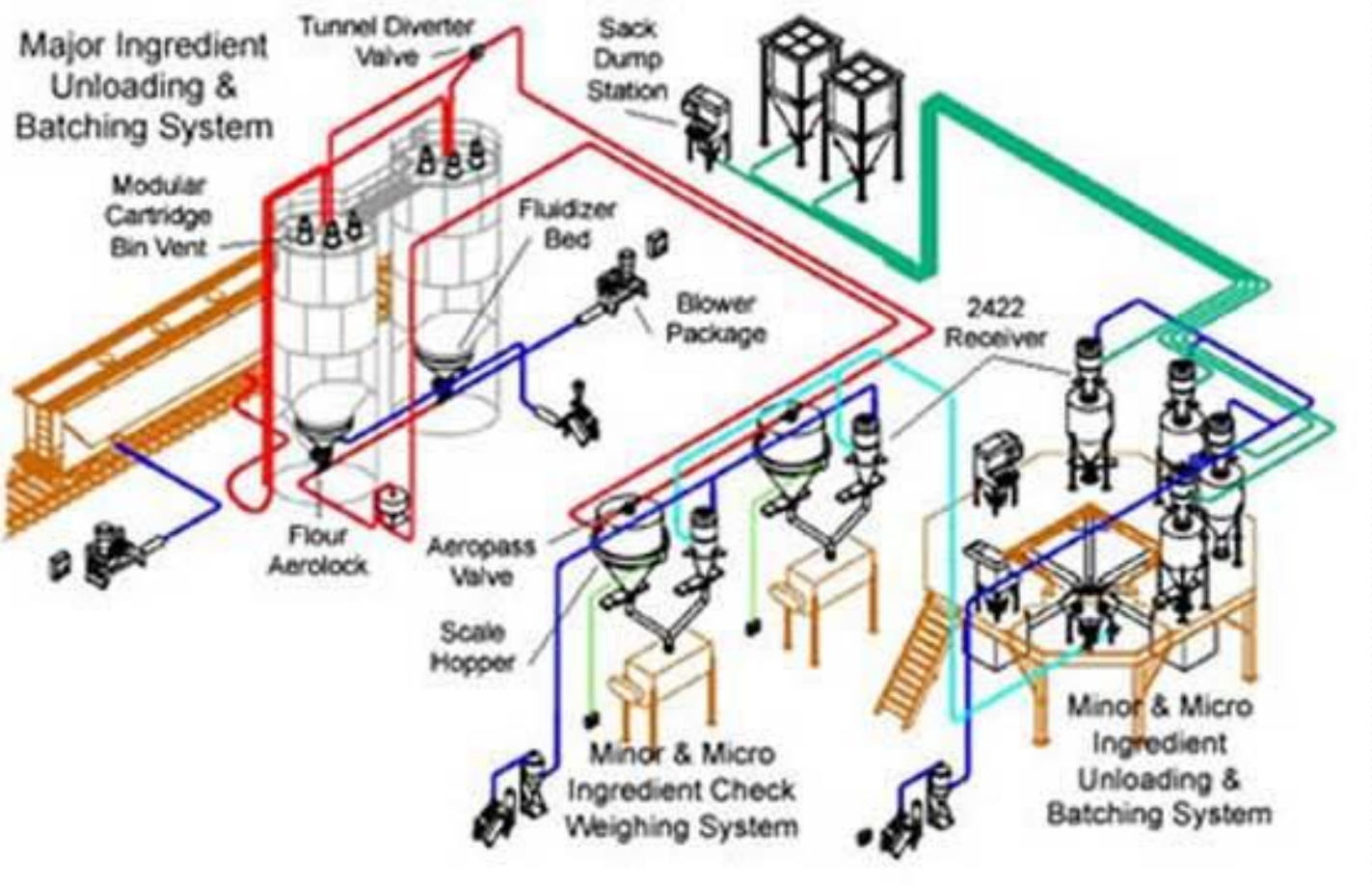
- High fat soy meal.
- Chunks, nugget & meat analogue. (TSP-texturised soy protien)
- Soy dal analogue.


# Single screw Extrusion with Preconditioning

- Preconditioning is useful for producing close quality product. Preconditioning involves treating the ingredients with live steam at around 100 C before feeding to extruder.
- Without the use of preconditioning, it is difficult to make good laminar-structured, textured soy protein. Unpreconditioned vegetable proteins have a strong tendency to expand rather than laminate due to non uniform moisture penetration which does not allow uniform alignment of protein molecules. Uniform moisture penetration of raw ingredients significantly improves the stability of the extruder and final product quality.
- Preconditioning helps to reduce energy requirement and reduce the wear on working parts of Extruder.

# Raw material Bulk feed system in Extrusion plant



# Single screw Extrusion with Preconditioning

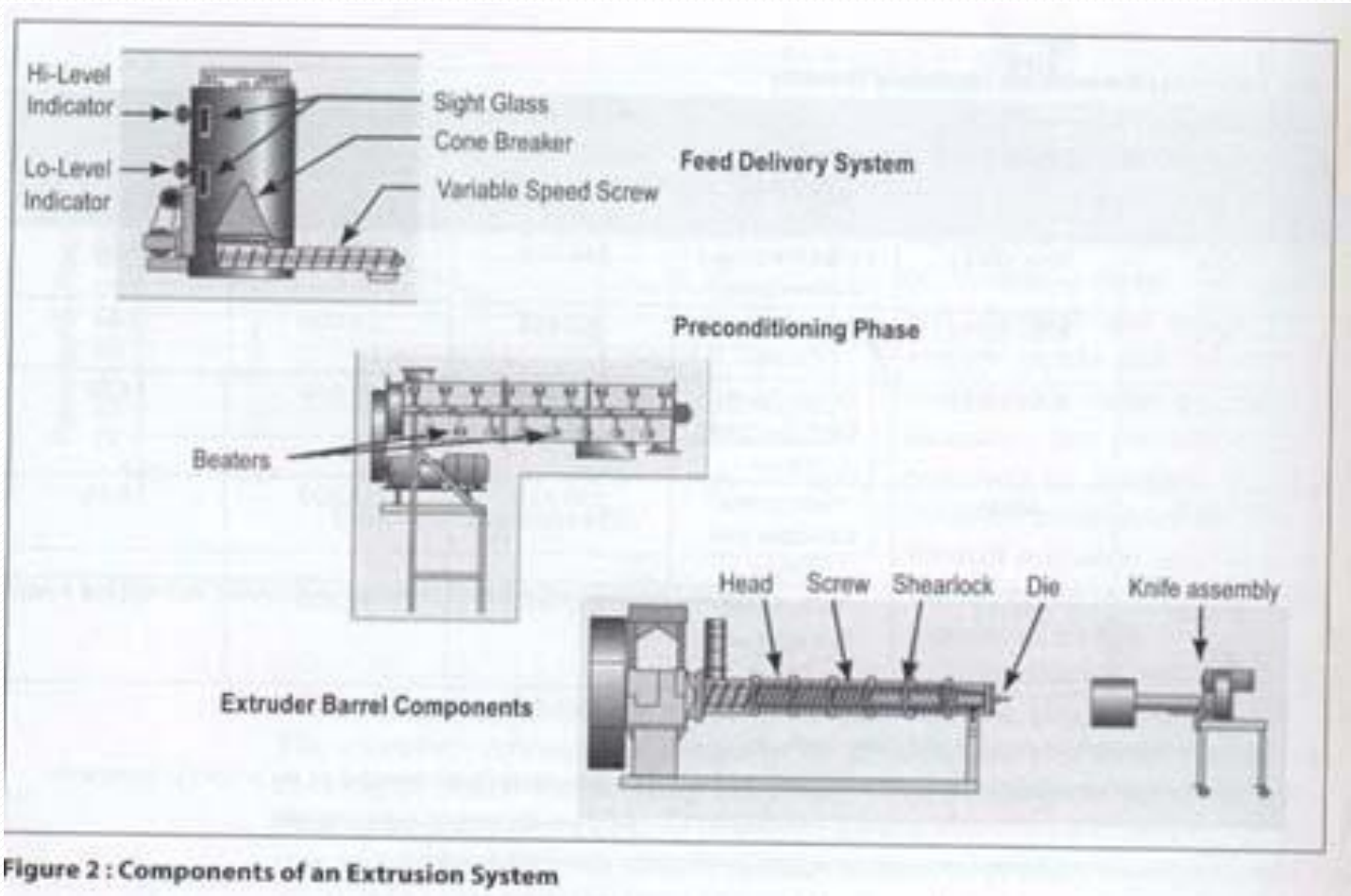
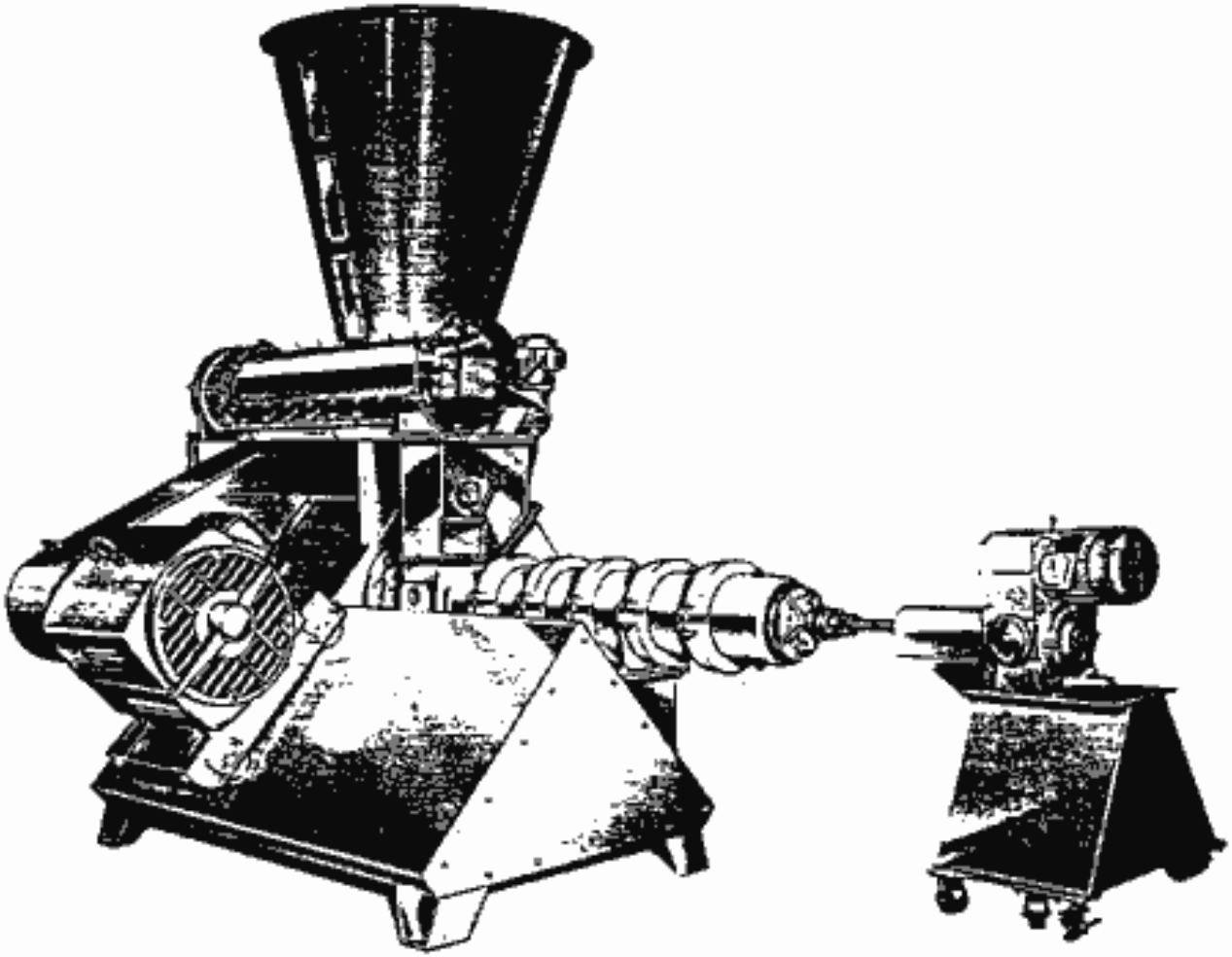



Figure 2 : Components of an Extrusion System

# Advantages of Extrusion

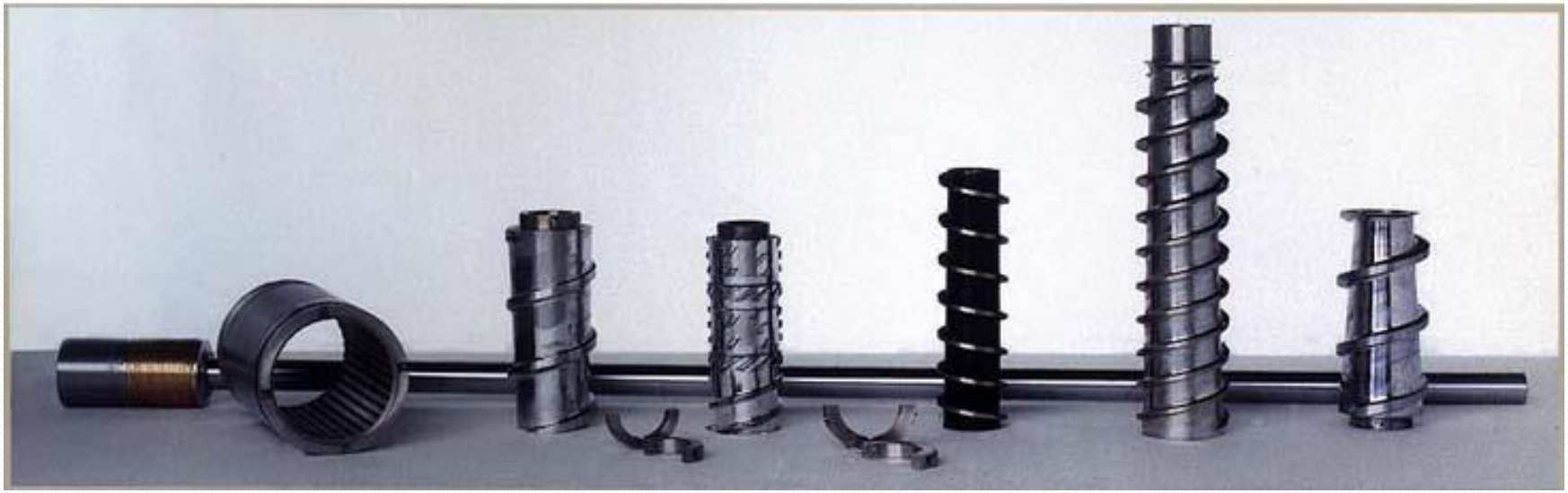
- The defatted thermoplastic proteins are heated to 150-200°C, which denatures them into a fibrous, insoluble, porous network that can soak up as much as three times its weight in liquids. Denaturation of protein "lowers solubility, renders it digestible and destroys the biological activity of enzymes and toxic proteins".
- In Extrusion, natural protein is re-oriented and aligned to form a laminar texturised structure, giving a meat like taste to the protein.
- Extrusion texturisation helps to reduce cost of meat product by allowing use of TSP as extender.
- Extrusion cost of producing TSP is low compared to "spinning" process which uses ISP (costly).
- Soy Dal Analogue is a recent product and scores favorably over natural "tur" dal in terms of nutrition and cost.

# Single Screw Cooker with Cutter

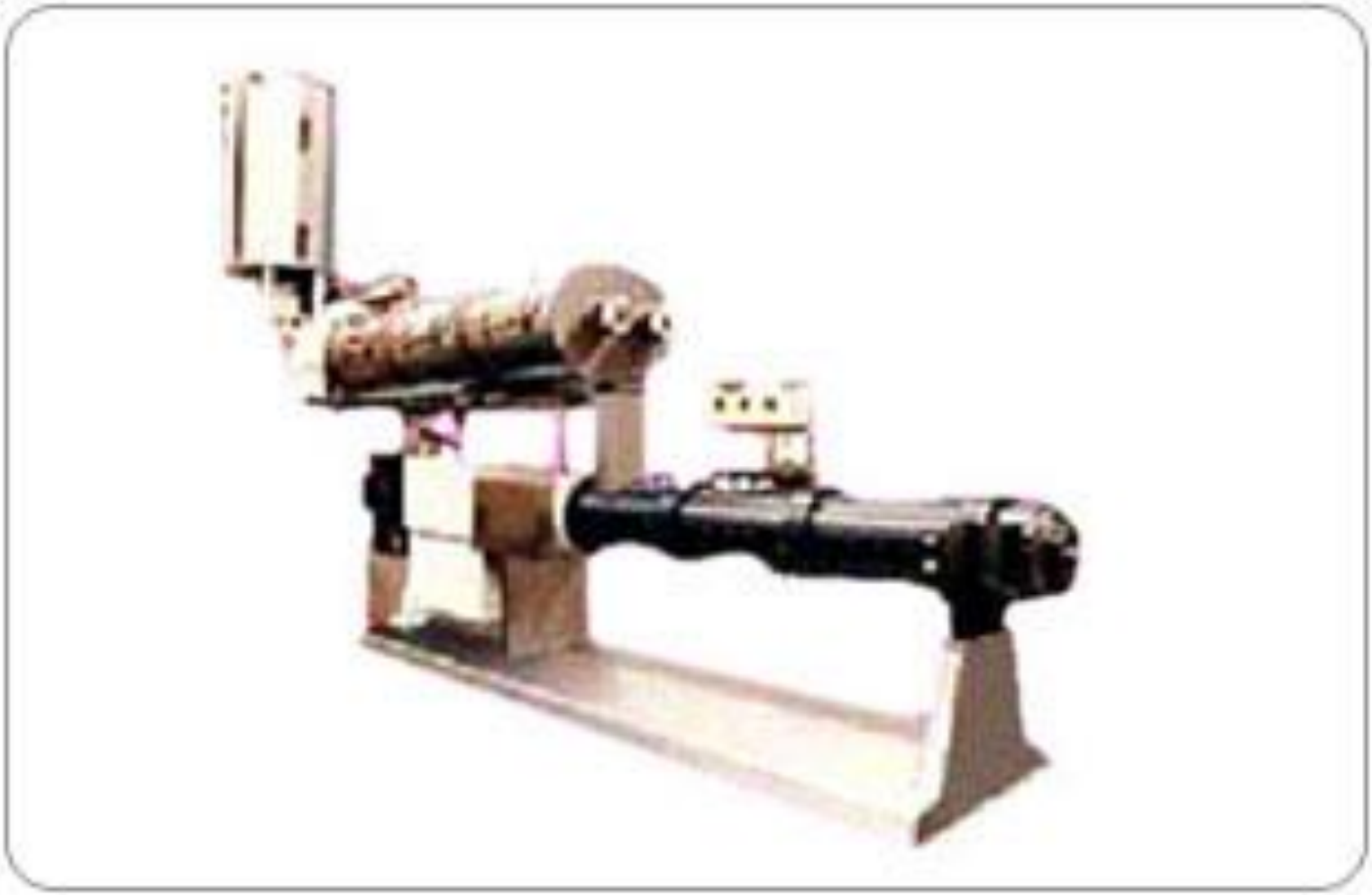


# Medium shear Extruder

# Single screw
# Cooker Screw Parts



# Twin Screw Cooker with Pre-conditioner



# Twin Screw Cooker with Pre-conditioner

# Full Fat Soy Extruder

# Soy nugget Production

# Die for Soy Nugget

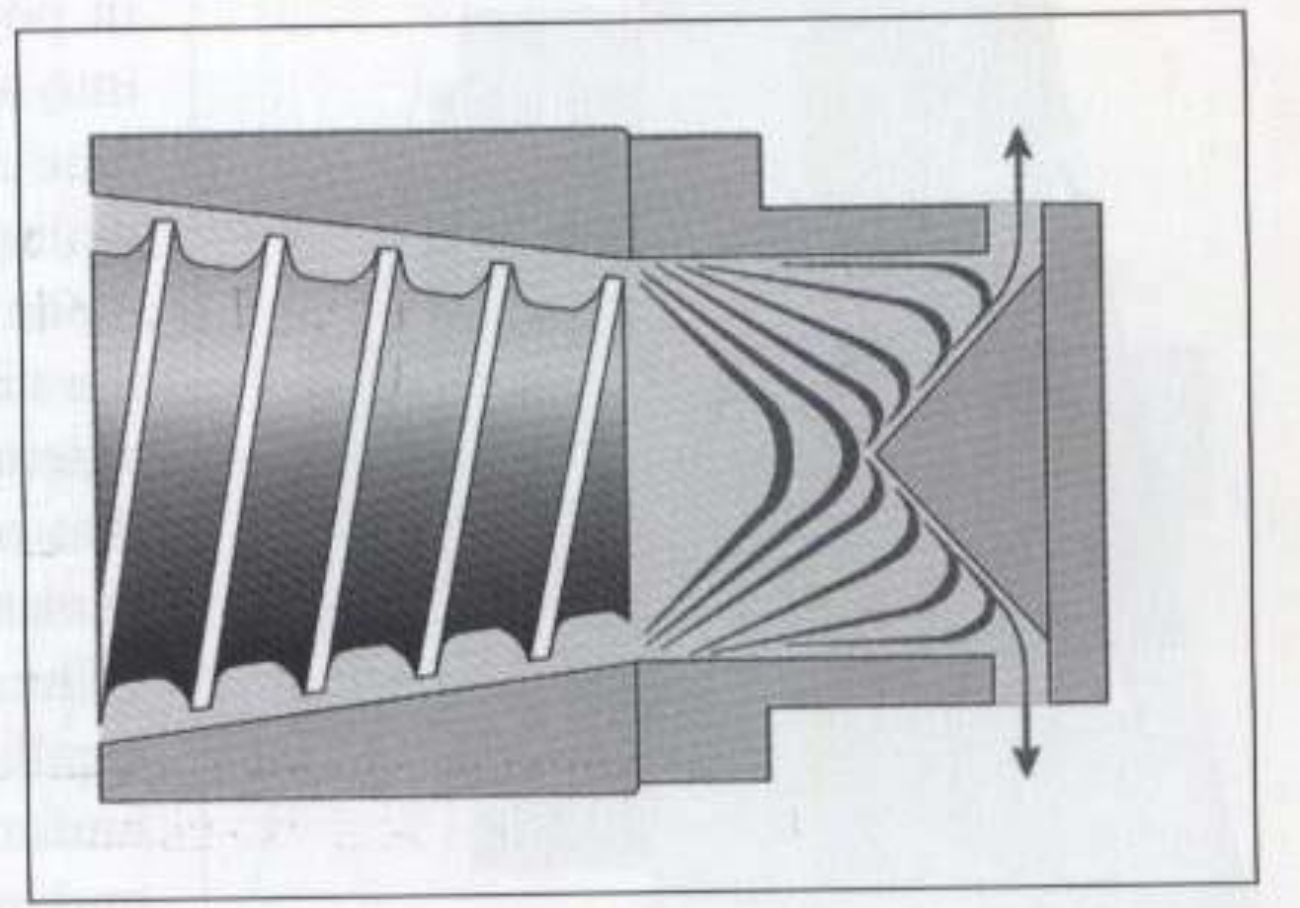


Figure 4: Peripheral Die

# Cutter Assembly

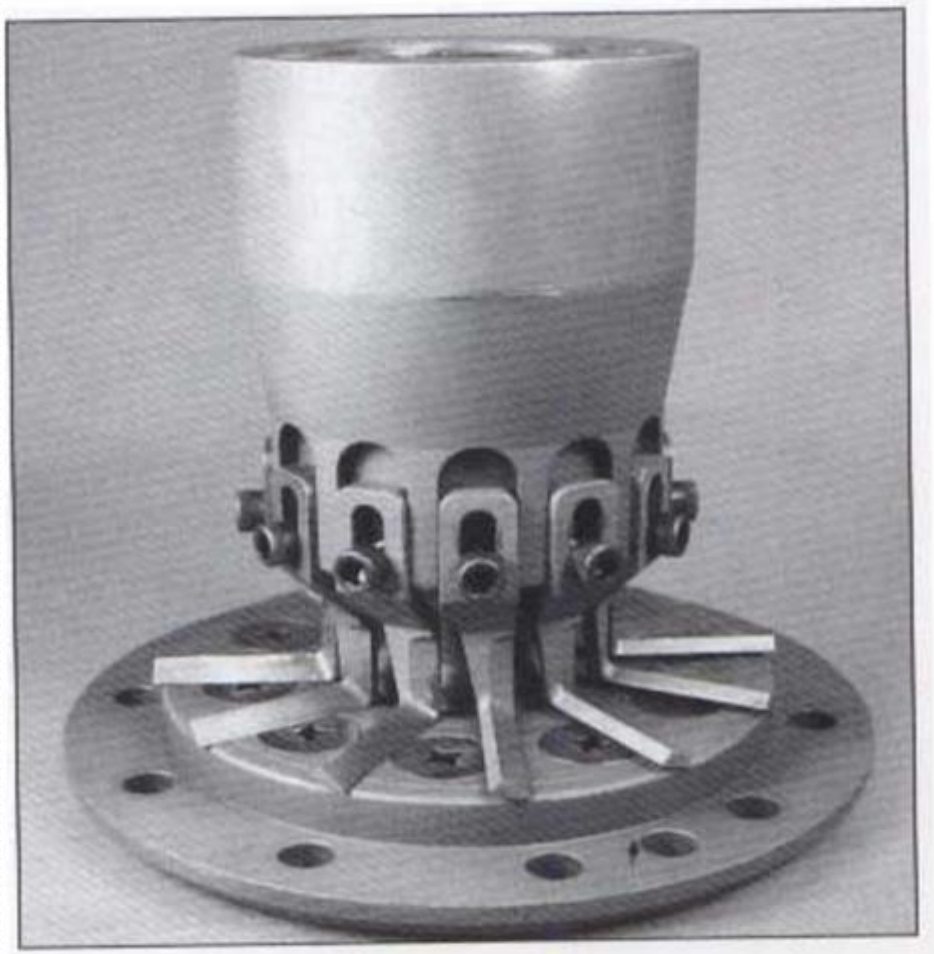
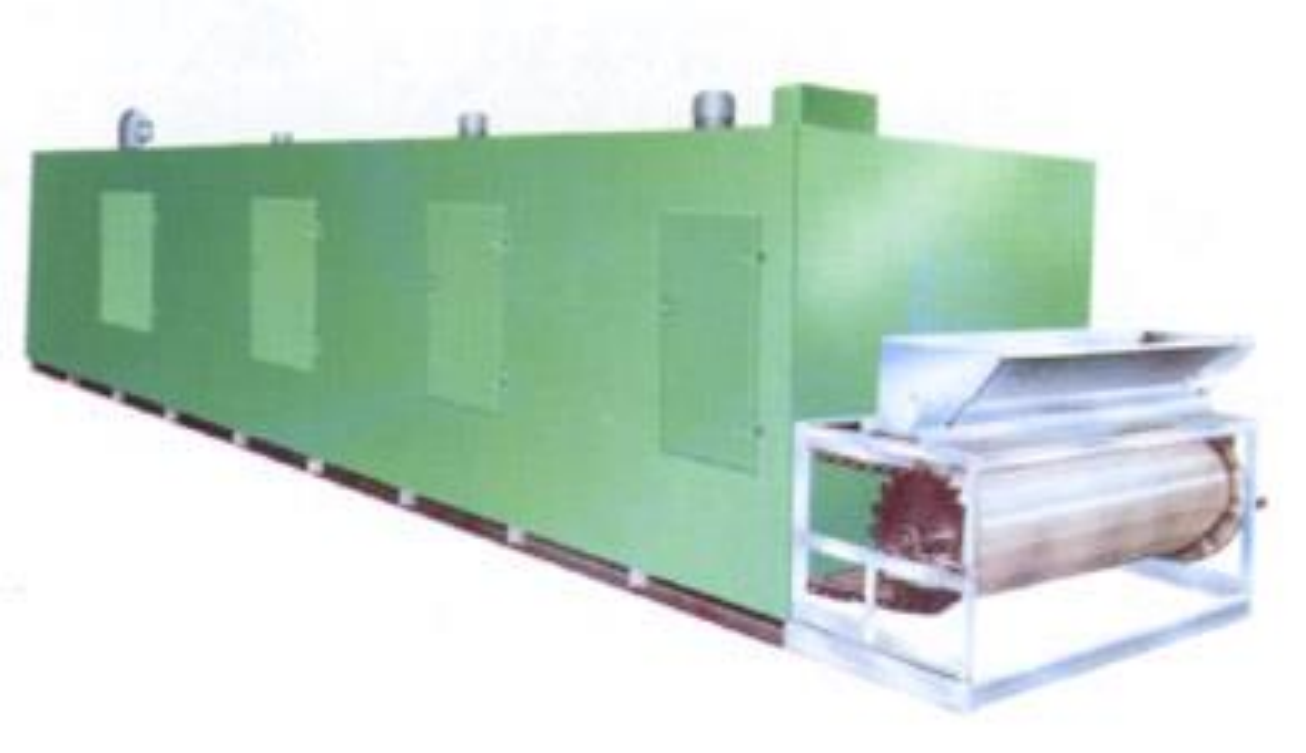
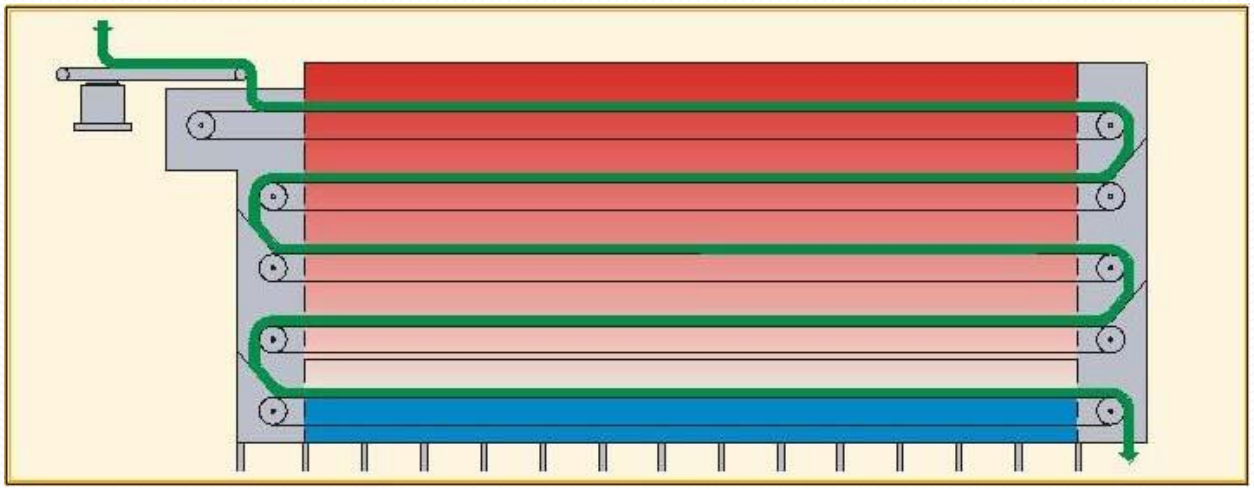


Figure 3: Insert holder with cutter





Schematic of 3 pass drier

# Soy chunk making line

1) Single screw Extruder MESEB-90 (200 Kg/hr)
2) Pneumatic Conveyor
3) 3-deck Belt Continious dryer

# Products of Soy from Extrusion

1. Soy Nugget, chunks, meat analogue or TSP.
2. Soy Dal Analogue.

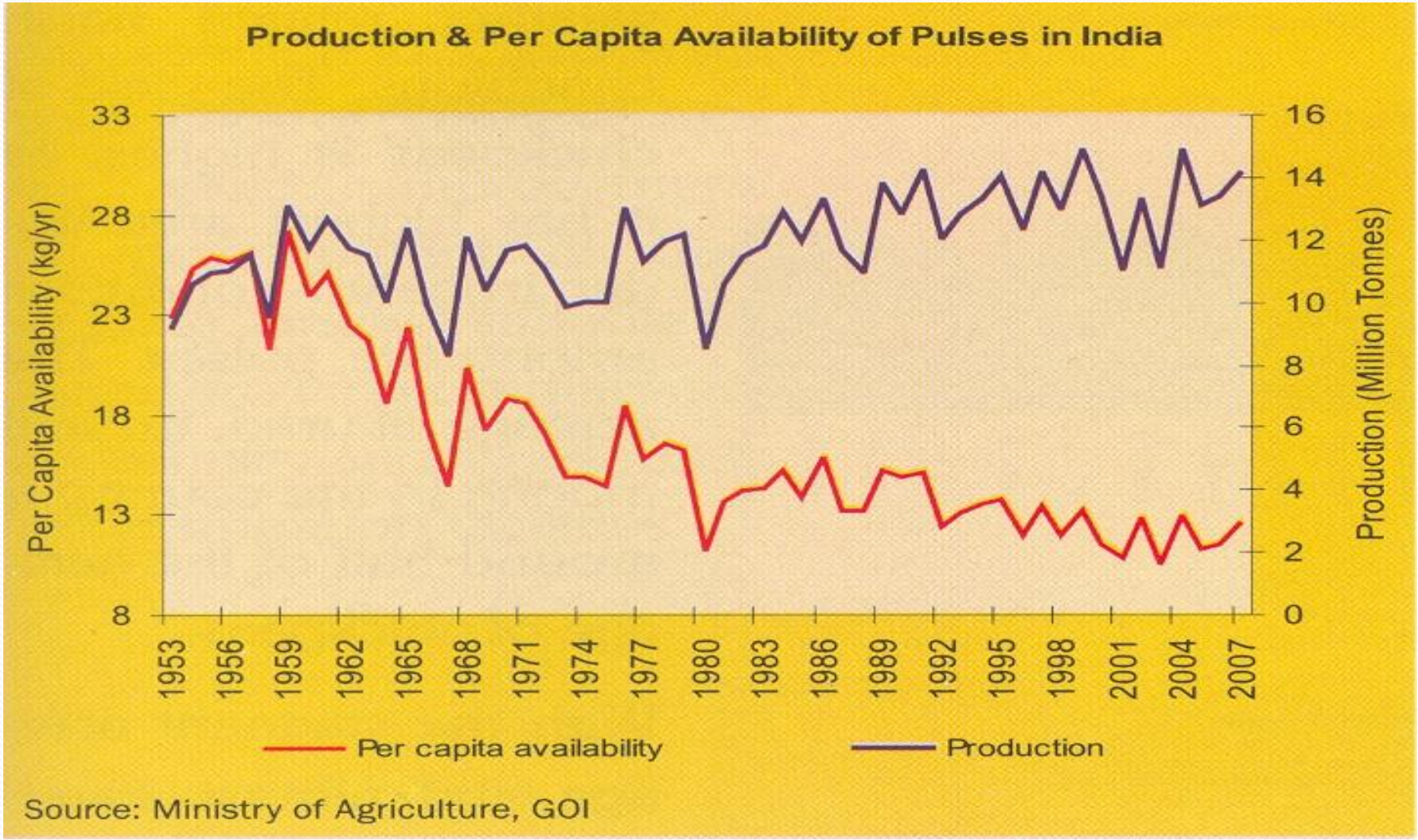

# Raw material for Soy Chunks

For producing Soy TSP:

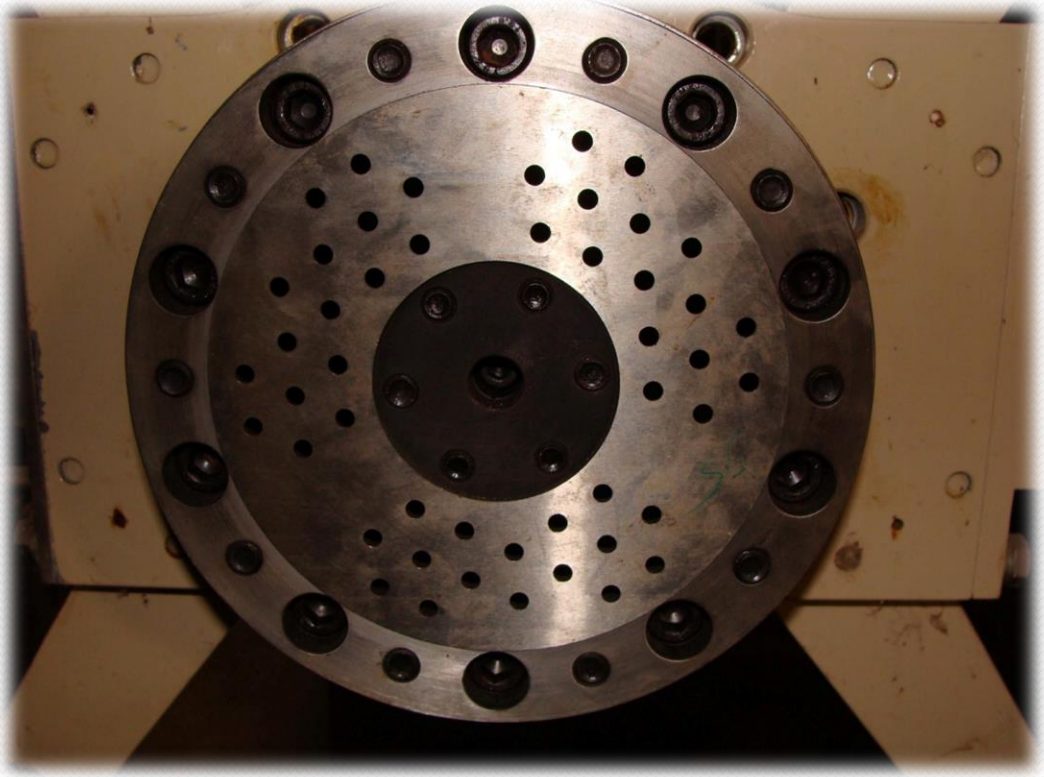
1. Slightly toasted defatted soy flour, usually with 50% protein minimum, 3.5% Fiber maximum, 1.5% fat maximum and PDI of 60 to 70. Particle size upto 8 mesh. Low fat gives full expansion on product.

The use of twin screw extruders has increased the material specification range To include raw-materials that include PDI 20-70, fat levels 0.5 to 6.5%, fiber Levels upto 6% and particle sizes upto 8 mesh. High shear on TSE makes Possible to use materials with high fiber levels.

# Production & Availability of Pulses in India



# 5mm Dal Analogue Die



# Raw materials for Soy Dal Analogue

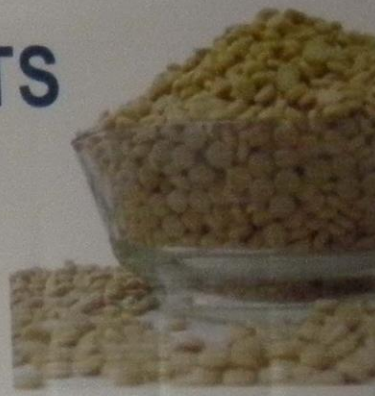
Soy Dal Analogue is a processed product based on **defatted Soy Flour and Wheat flour/Rice flour/Corn flour**. The product resembling Tur Dal in physical and cooking characteristics is produced by HTST Extruder. The product cooks very fast than Tur Dal without pressure cooking. It can be cooked to prepare all traditional food dishes like '**Dal Tadka**', '**Dal with vegetables**', '**Rasam**', '**Sambar**' **etc** depending on regional preferences. Soy based Dal Analogue produced with 50% defatted Soy flour and 50% of Wheat or Rice or Corn flour or a combination of wheat/ rice/corn flours contains **more protein (30%)** as compared to **Tur dal (22-23%)**. The product after cooking has a pleasant and agreeable flavor. It is available at cheaper cost than Tur Dal.

# Soy Dal Analogue Die


KINLEY

SRI SRINIVASA SOYA FOOD PRODUCTS

NIZAMABAD



# PROJECT IMPLEMENTATION PRODUCTION CUM TRAINING CENTER FOR SOYA BASED DAL ANALOGU

Technology Support : MALIK ENGINEERS - MUMBA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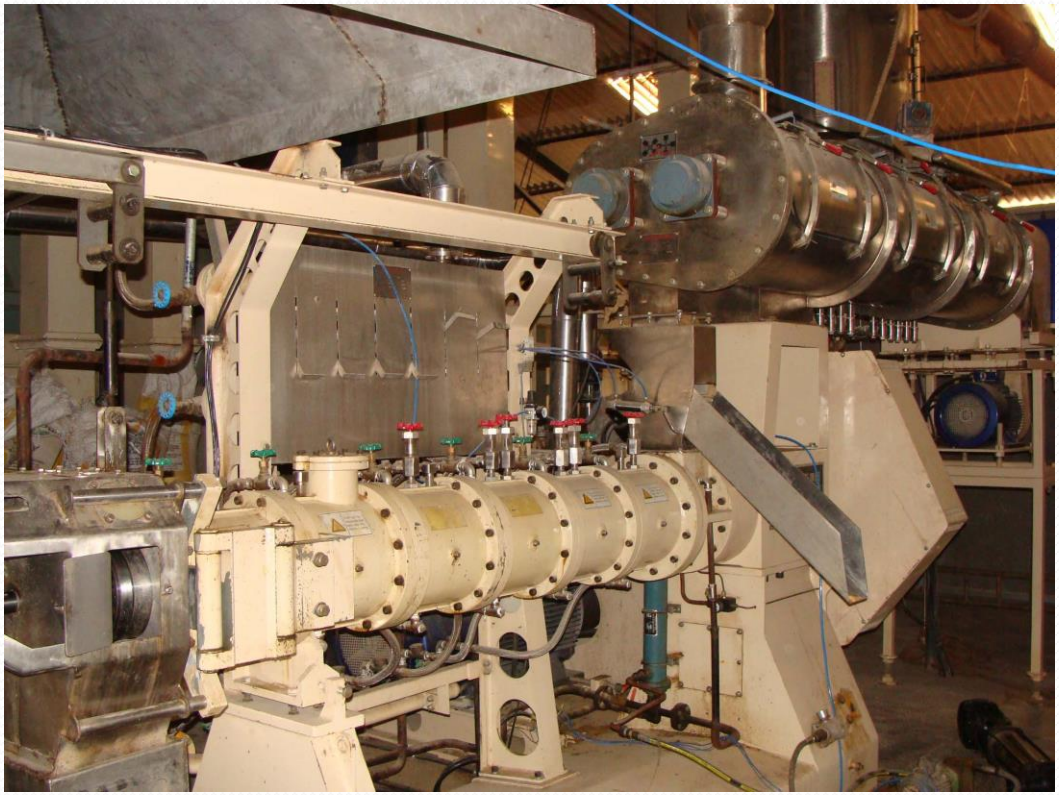
# Dal Analogue Extruder



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- Thank you!