Grain Chain Analysis

Grain Chain Analysis Goals

- The primary Goal is to analyze grain flow from the farm to elevator and feed mill
- Commodities grain flow of corn, soybean, wheat, oats, barley and rice are diagramed to show movement to first level processing production of animal feed and human food
- Grain Chain analysis notes Potential Hazards along the grain chain

Grain Supply Chain – Farm to Processor

Potential Hazards

Chemical Residues

- Fungicides
- Herbicides
- Insecticides

Diseases

- Fungi
- Bacteria
- Viruses

Quality

- Lack of Laboratory analysis
- Lack of Record keeping- recall traceability

Pests

- Birds
- Rodents
- Insects

Environmental

- Conditions of weather

Maintenance

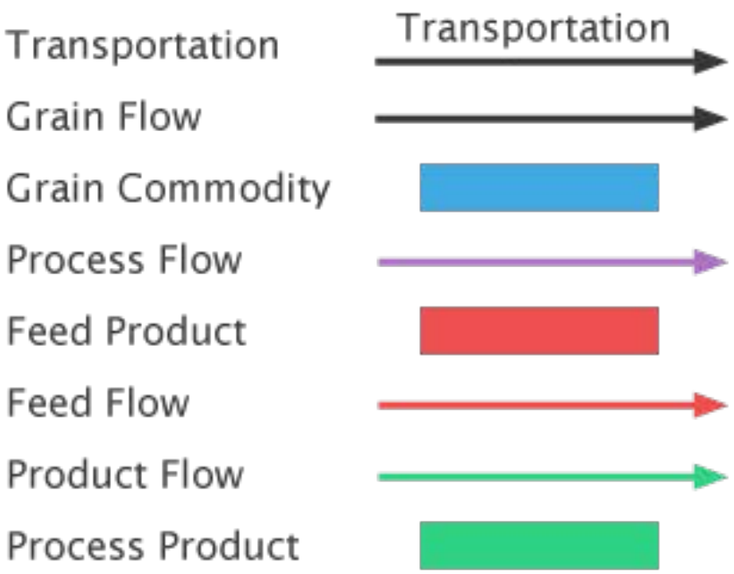
- Building and equipment

Cross Contamination

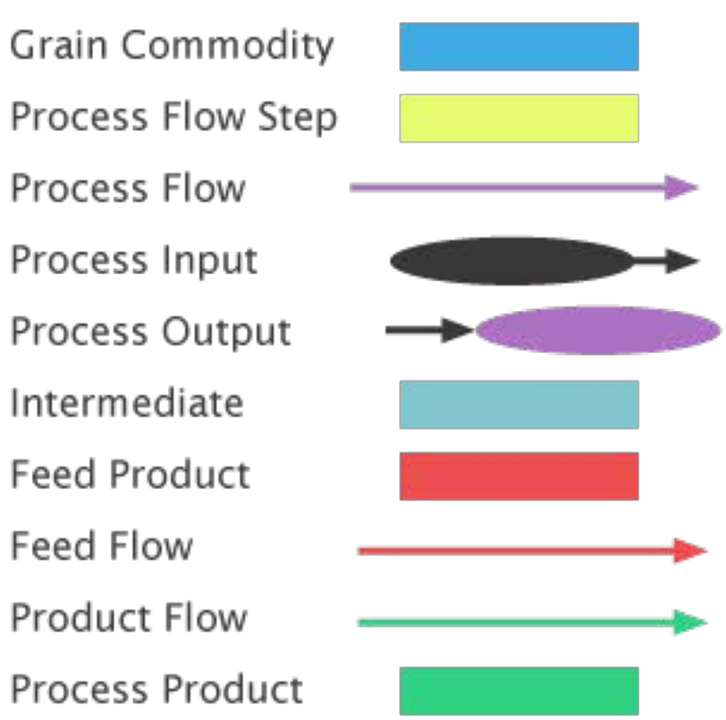
- During transport or processing – Prohibited material (PM), animal waste, agriculture chemicals, petroleum, oil, and lubricants (POL)

Legend

Commodity Flow Scheme

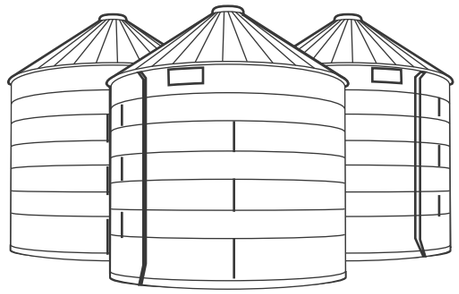


Processing Flow Scheme



Grain Chain Analysis

Farm Grain
Harvest Storage

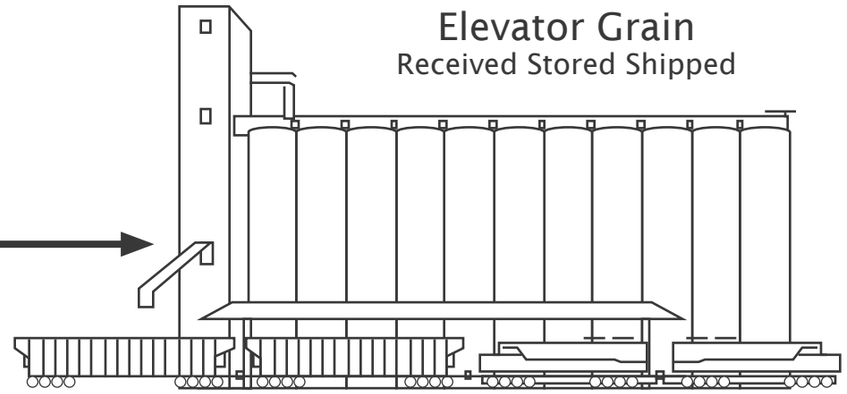


PH

Transportation

PH

Elevator Grain
Received Stored Shipped

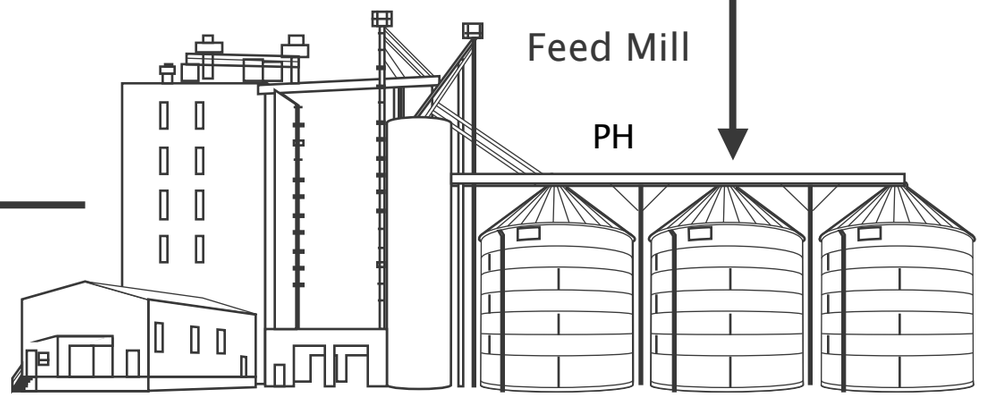


PH

Transportation

PH

Feed Mill



PH

Transportation

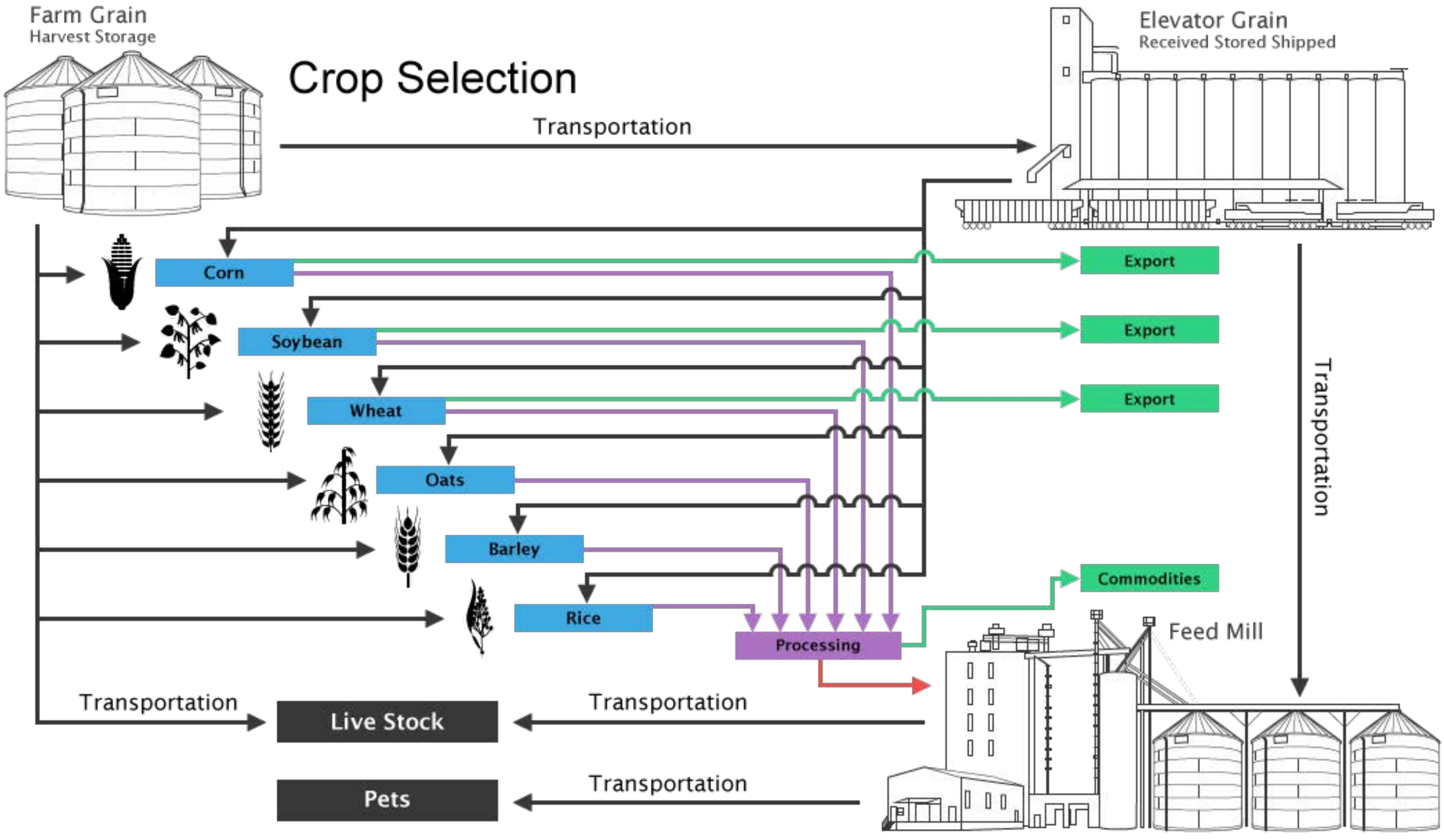
PH

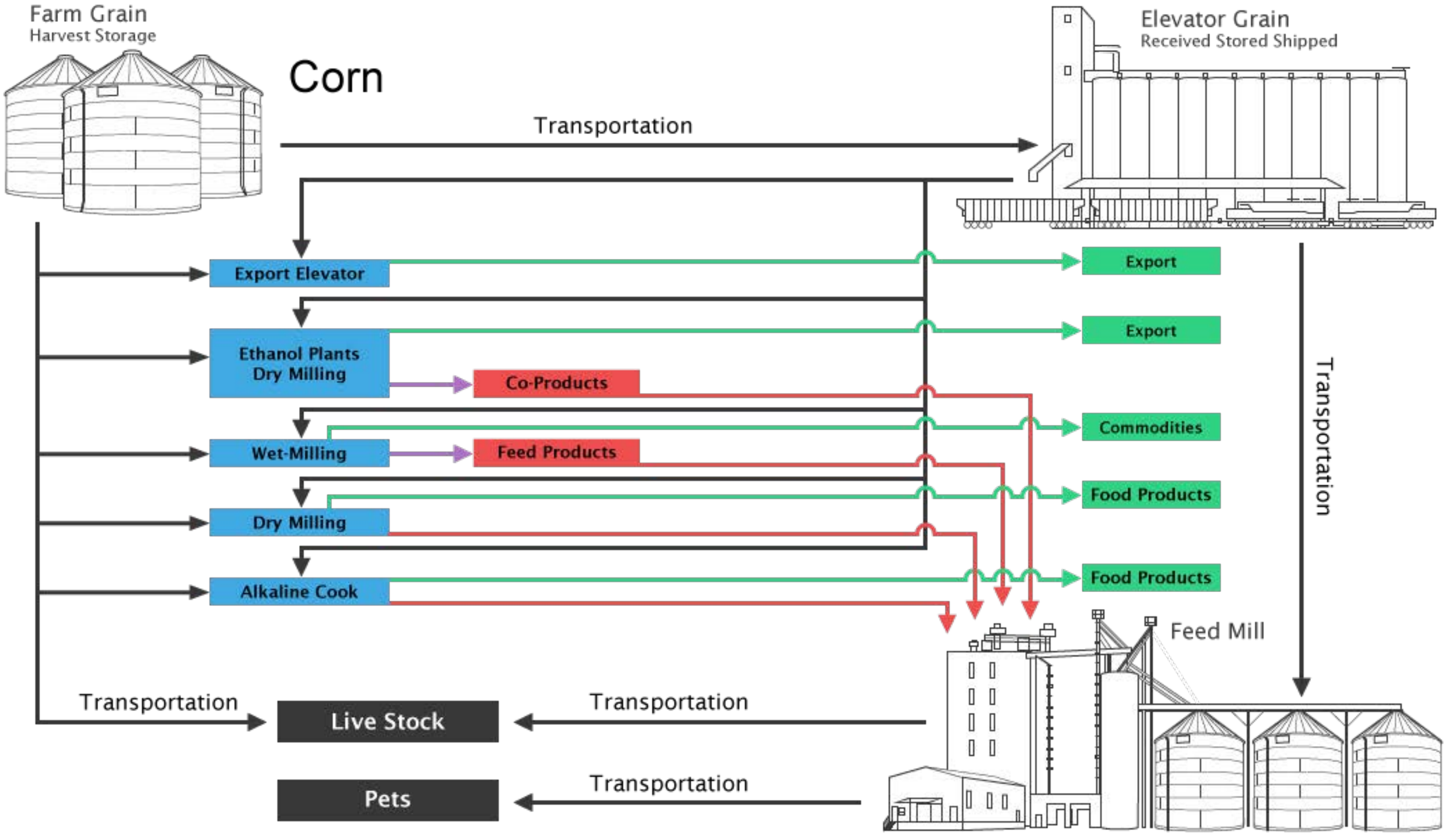
Transportation

PH

Live Stock

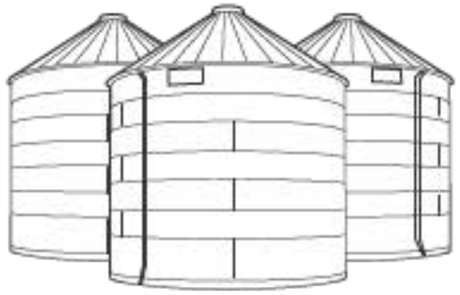
Pets


Farm Grain
Harvest Storage
Crop Selection
Transportation
Elevator Grain
Received Stored Shipped
Corn
Soybean
Wheat
Oats
Barley
Rice
Export
Export
Export
Commodities
Processing
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Transportation
Pets

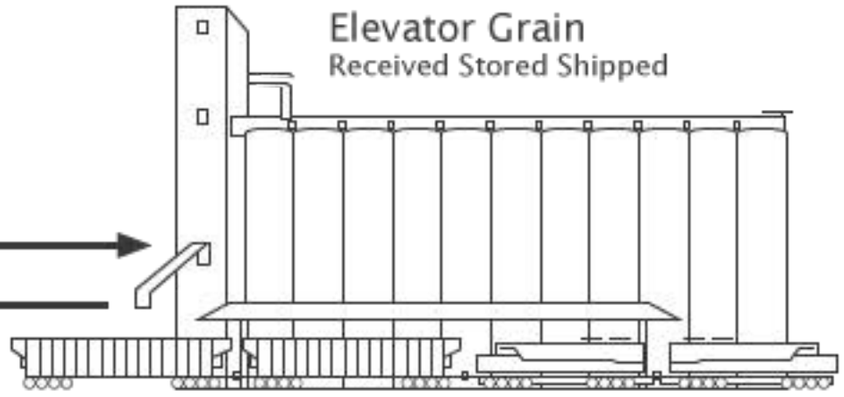

Farm Grain
Harvest Storage
Corn
Transportation
Elevator Grain
Received Stored Shipped
Export Elevator
Export
Ethanol Plants
Dry Milling
Co-Products
Export
Wet-Milling
Feed Products
Commodities
Dry Milling
Food Products
Alkaline Cook
Food Products
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Transportation
Pets

Corn / Export Elevator

Farm Grain
Harvest Storage



Transportation

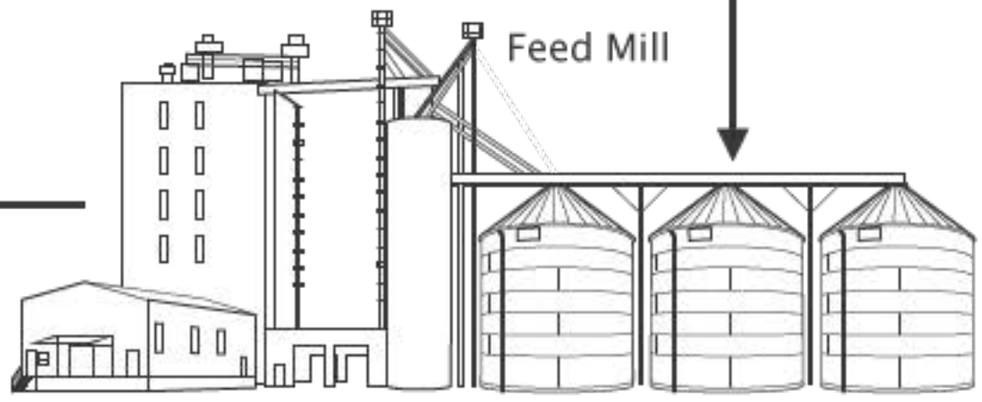


Elevator Grain
Received Stored Shipped

Export Elevator

Export

Transportation



Feed Mill

Transportation

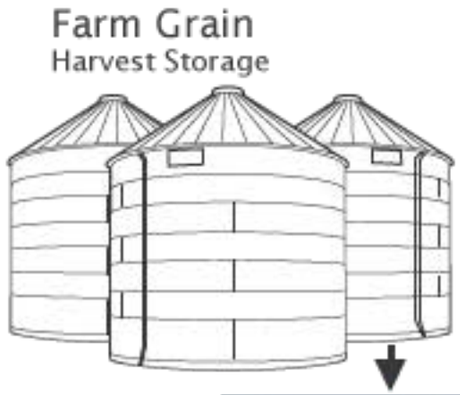
Live Stock

Transportation

Transportation

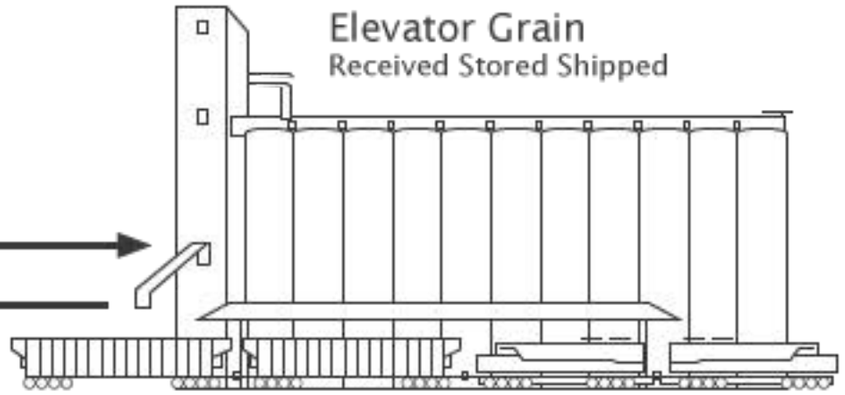
Pets

Corn / Ethanol Plants Dry Milling



Farm Grain
Harvest Storage

Transportation



Elevator Grain
Received Stored Shipped

Ethanol Plants Dry Milling

Grinding

Slurrying

Water

Hot Liquefying

a-Amylase

Saccharifying

Glucoamylase

Yeast Propagating

Yeast

Fermenter

Carbon Dioxide

Backset 50%

Distilling

Ethanol

Whole Stillage

Centrifuge

Wet Cake

Thin Stillage

Evaporator

Water

Condensed Distillers Soluble

Mixing

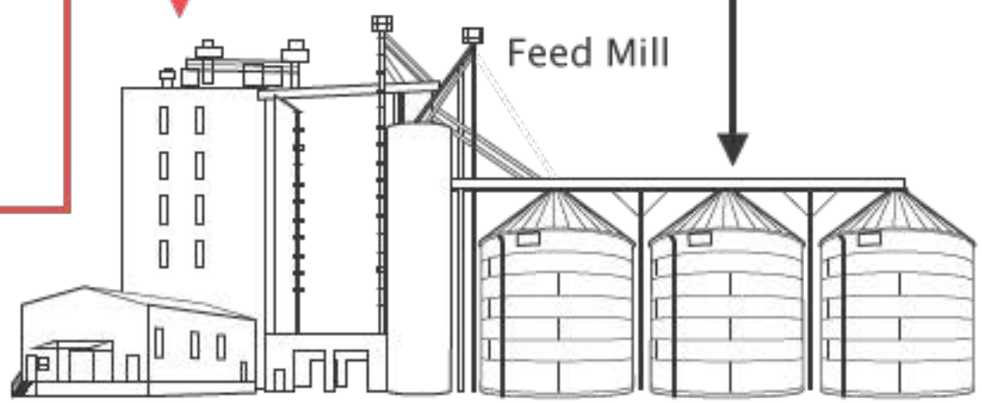
Drying

Dried Grain with Soluble

Export

Transportation

Feed Mill

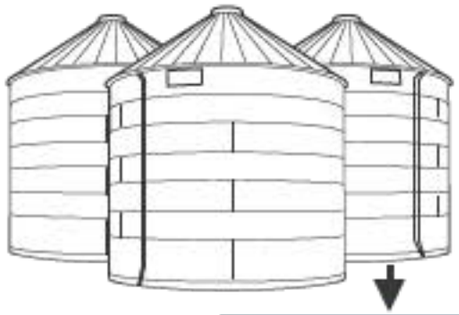


Live Stock

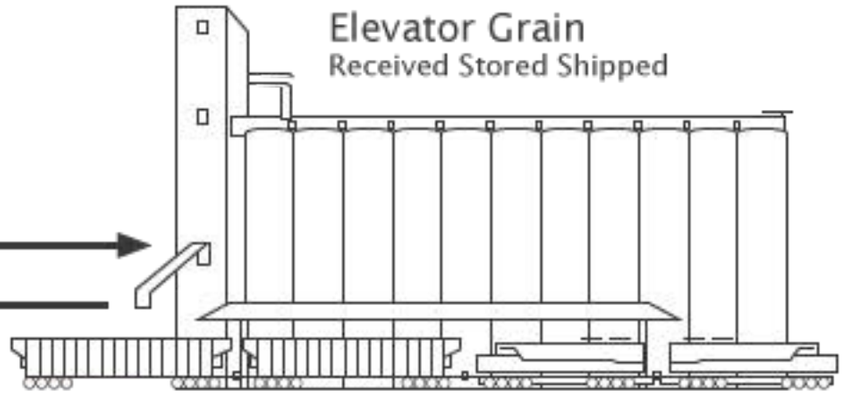
Transportation

Corn / Dry Milling

Farm Grain
Harvest Storage



Transportation



Elevator Grain
Received Stored Shipped

Corn Dry Milling

Dirt, Broken Kernels, Other Cleanings

Dry Cleaning

Water

Wet Cleaning

Cleanings

Water

Tempering

Degerming

Drying & Cooling

Sieving

Hominy Stock

Aspirating

Cleanings

Gravity Tabling

Roller Milling

Sieving

Roller Milling

Sieving

Germ

Flaking

Conditioning

Pressing

Germ Press Cake

Hominy Feed

Crude Oil

Cereal Grits

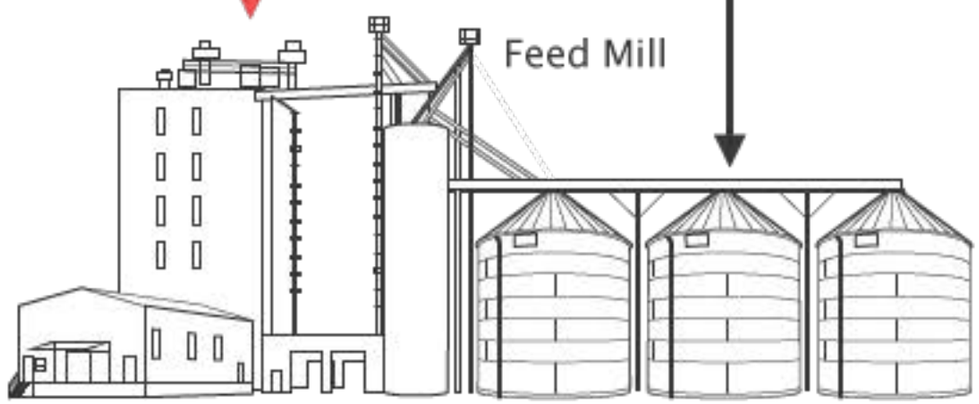
Brewer Grits

Corn Meal

Corn Cones

Corn Flour

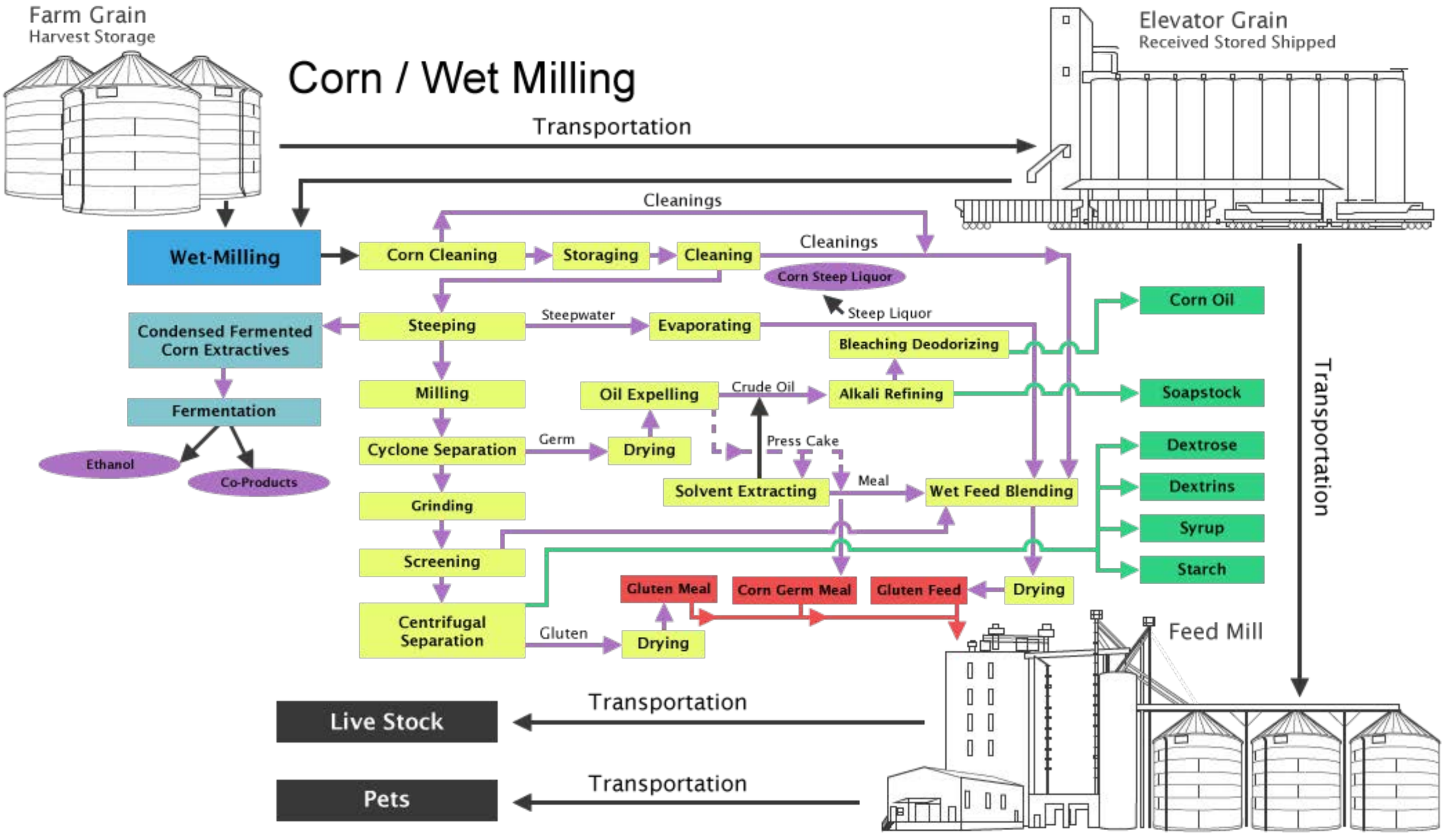
Transportation



Feed Mill

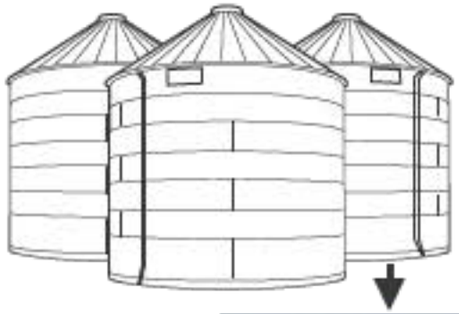
Transportation

Live Stock

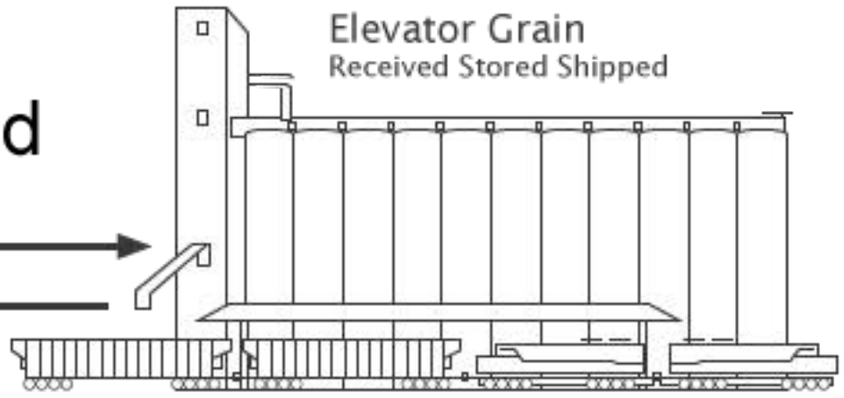

Farm Grain
Harvest Storage
Corn / Wet Milling
Transportation
Elevator Grain
Received Stored Shipped
Cleanings
Wet-Milling
Corn Cleaning
Storaging
Cleaning
Cleanings
Corn Steep Liquor
Steep Liquor
Corn Oil
Condensed Fermented Corn Extractives
Steeping
Steepwater
Evaporating
Bleaching Deodorizing
Fermentation
Ethanol
Co-Products
Milling
Oil Expelling
Crude Oil
Alkali Refining
Soapstock
Cyclone Separation
Germ
Drying
Press Cake
Dextrose
Dextrins
Syrup
Starch
Solvent Extracting
Meal
Wet Feed Blending
Grinding
Screening
Gluten Meal
Corn Germ Meal
Gluten Feed
Drying
Centrifugal Separation
Gluten
Drying
Transportation
Feed Mill
Live Stock
Transportation
Pets
Transportation

Corn / White Corn Alkaline Cooked

Farm Grain
Harvest Storage



Transportation



Elevator Grain
Received Stored Shipped

White Corn Alkaline Cooked

Lime and Water

Nejayote - Cooking Liquor

Water

Boiling → Steeping → Draining → Nixtamal → Washing → Draining

Draining → Wash Water

Draining → Stone Milling → Dough Mixing → Masa → Sheeting and Cutting

Stone Milling → Hominy Stock

Water → Sieving

Flavors → Blending

Drying

Sheeting and Cutting → Frying

Sheeting and Cutting → Baking

Sheeting and Cutting → Frying → Forming → Frying

Hominy Stock → Boiling

Hominy Stock → Baking

Hominy Stock → Frying

Hominy Stock → Frying

Hominy Stock → Instant Masa

Hominy Stock → Nixtamalized Atole

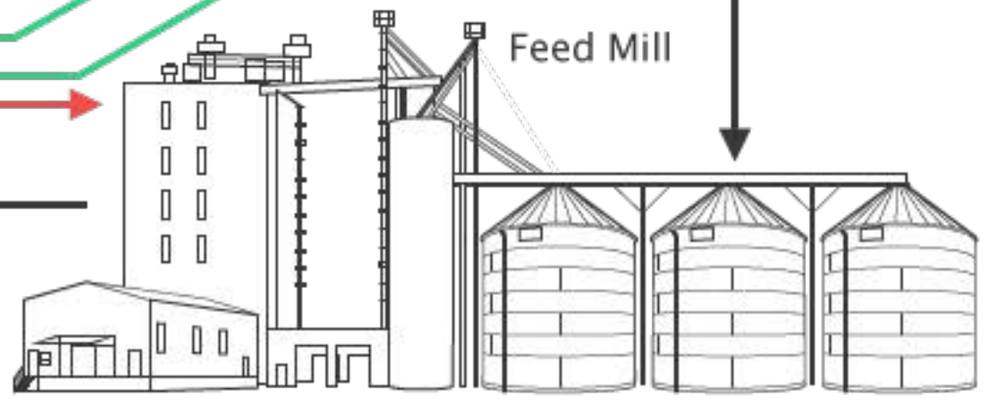
Hominy Stock → Table Tortillas

Hominy Stock → Taco Shells

Hominy Stock → Tortilla Chips

Hominy Stock → Corn Chips

Transportation



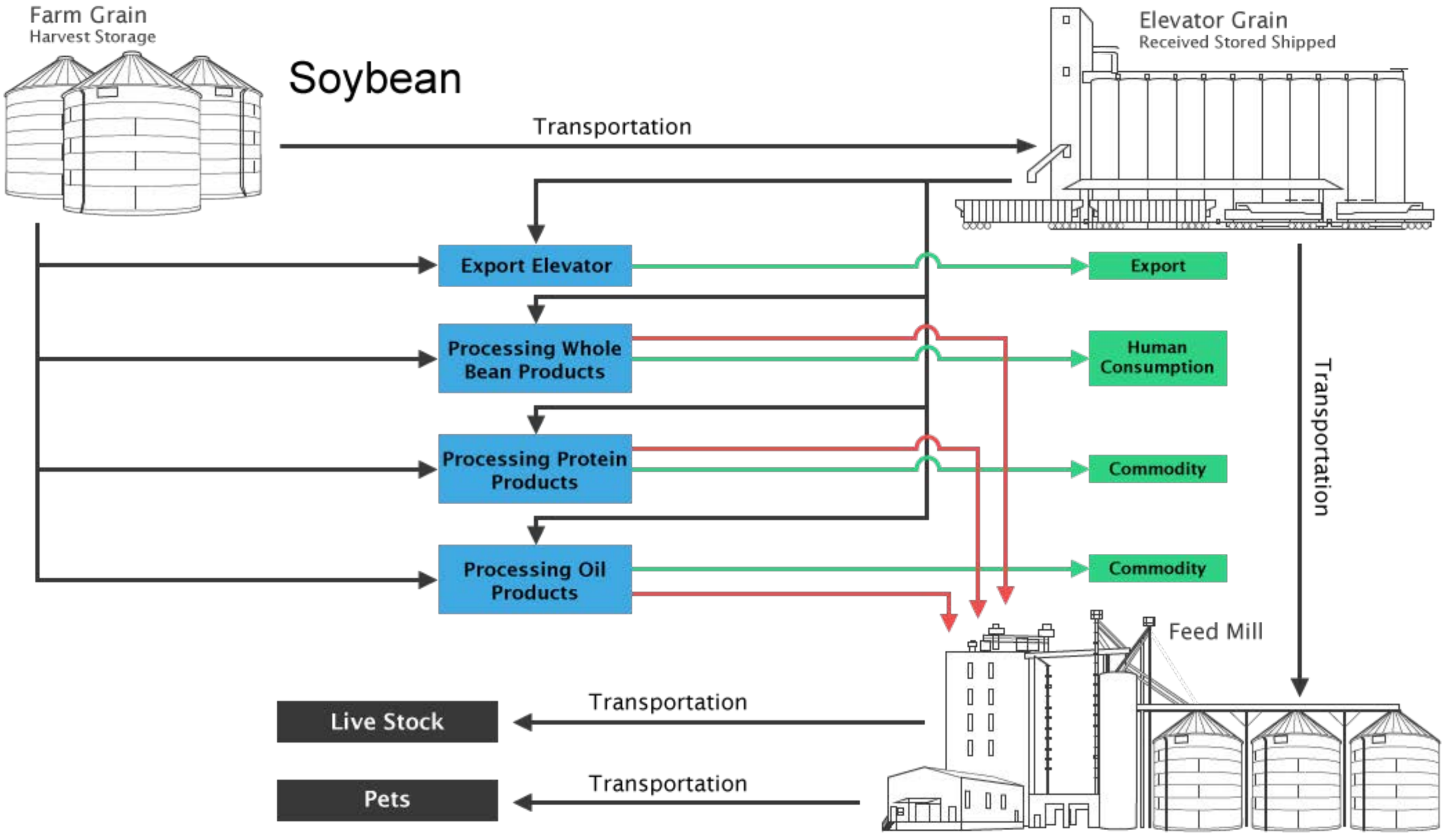
Feed Mill

Transportation

Live Stock

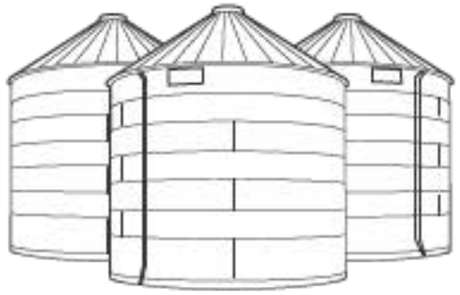
Transportation

Pets


Farm Grain
Harvest Storage
Soybean
Transportation
Elevator Grain
Received Stored Shipped
Export Elevator
Export
Processing Whole Bean Products
Human Consumption
Processing Protein Products
Commodity
Processing Oil Products
Commodity
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Pets

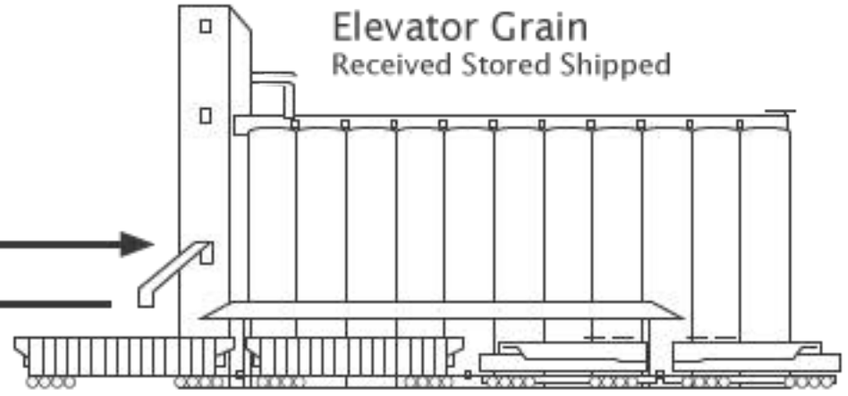
Soybean / Export Elevator

Farm Grain
Harvest Storage



Transportation

Elevator Grain
Received Stored Shipped

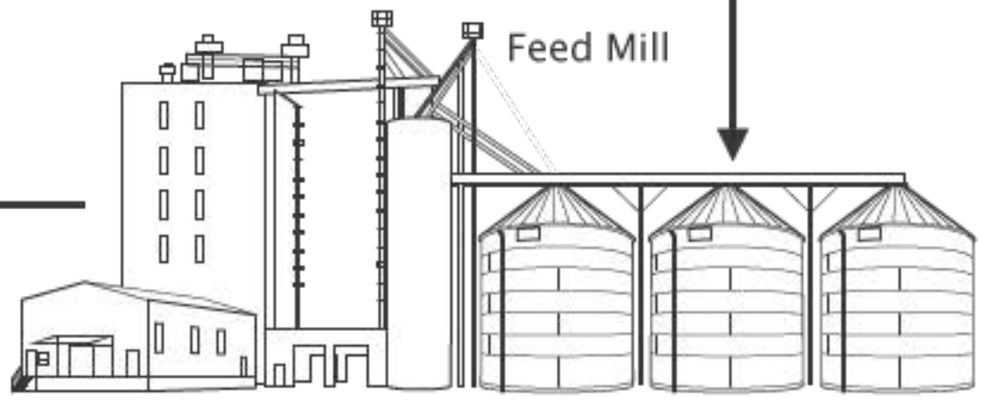


Export Elevator

Export

Transportation

Feed Mill



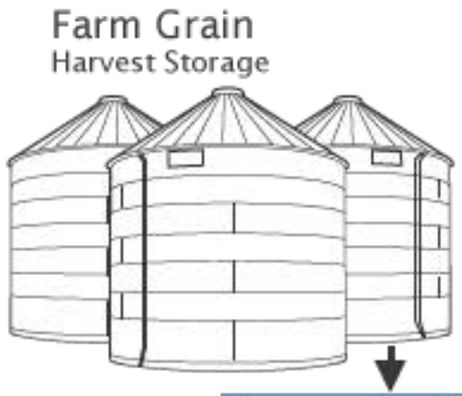
Transportation

Live Stock

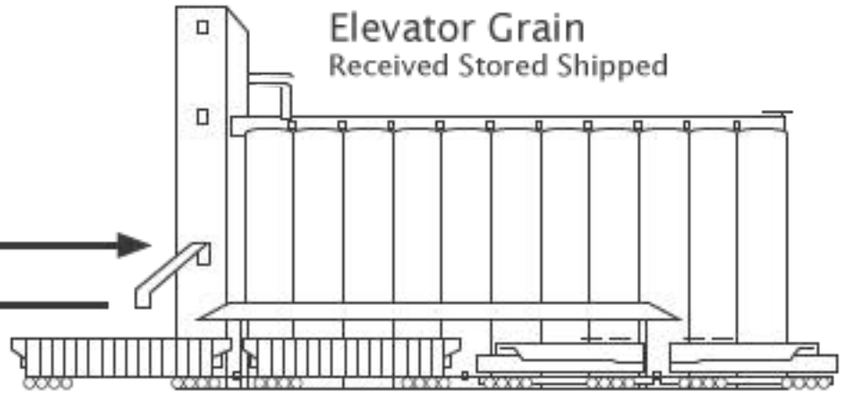
Transportation

Pets

Soybean / Oil Processing



Transportation



Processing Whole Bean Products

Boiled, Dehulled, Soaked, Cooked

Soybean Hulls

Soybean Meal

Soaked, Wet Milled

Fermented, Soaked In Salt Solution

Boiled, Extracted Filtered

Sugar and Spices Added, Boiled

Soy Sauce

Inoculated

Wrapped, Fermented

Tempe

Add Roasted Rice Flour, Fermented

Soaked in Salt Solution

Dried, Evaporated

Tauco

Continuously Boiled to Form Protein Layers

Yuba

Filtered, Boiled

Coagulated

Pressed, Molded

Tofu

Sugar and Flavor Agent Added

Boiled

Soy Milk

Transportation

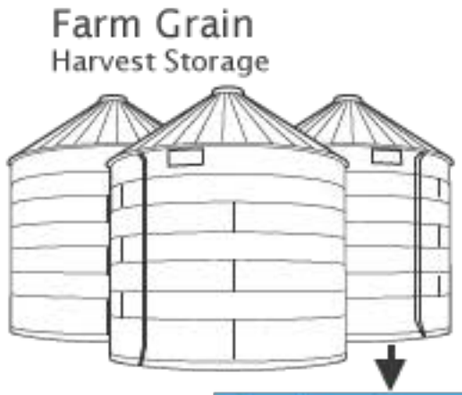
Transportation

Live Stock

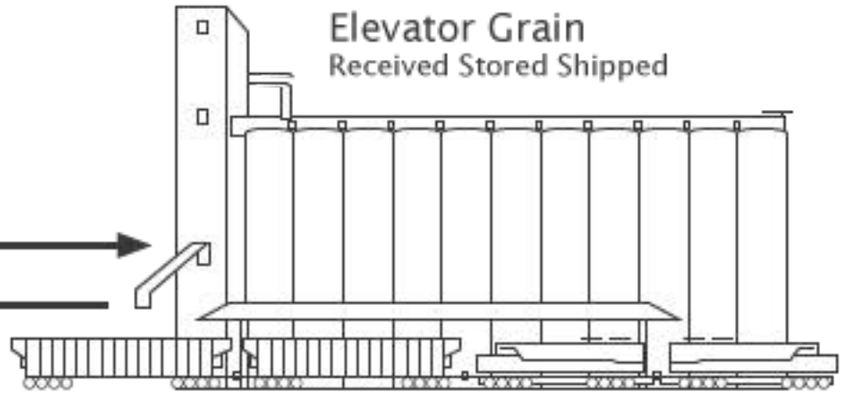
Transportation

Pets

Soybean / Processing Protein



Transportation



Soybean Processing Protein Products

Cleaning, Cracking, Dehulling

Soy Chip Meat

Conditioning and Flaking

Full Fat Flakes

Solvent Extraction

Soybean Oil

Solvent Removal Controlled Heat & Moisture

Edible Deflatted Flakes

Grinding Sizing

Soybean Hulls

Soybean Meal

Sugar Removal

Protein Extraction

Soybean Feed

Drying

Protein Precipitates

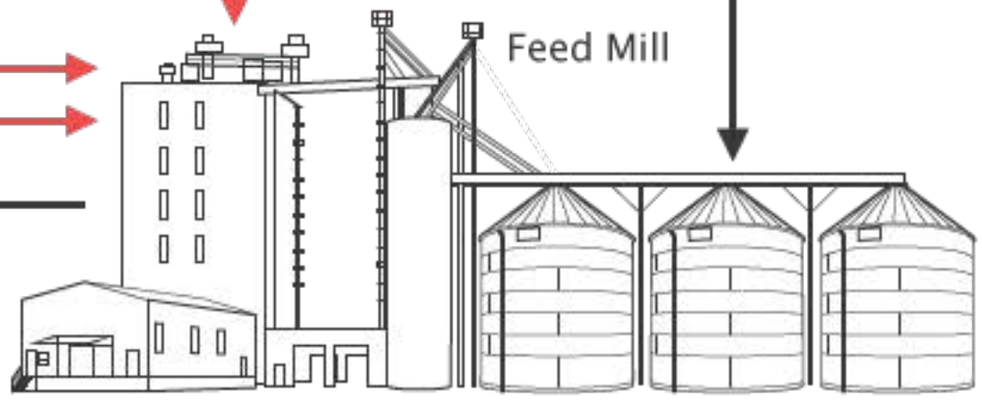
Condensing and Drying

Isolated Soy Protein Products

Soy Protein Concentrate Products

Soy Flour

Transportation



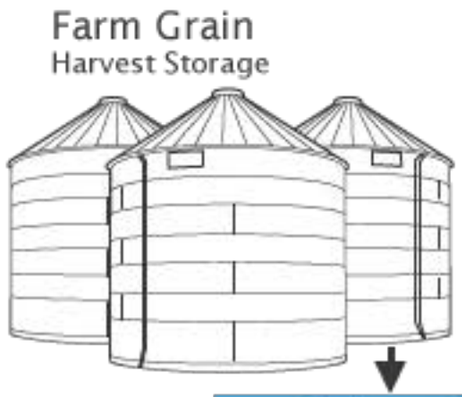
Transportation

Live Stock

Transportation

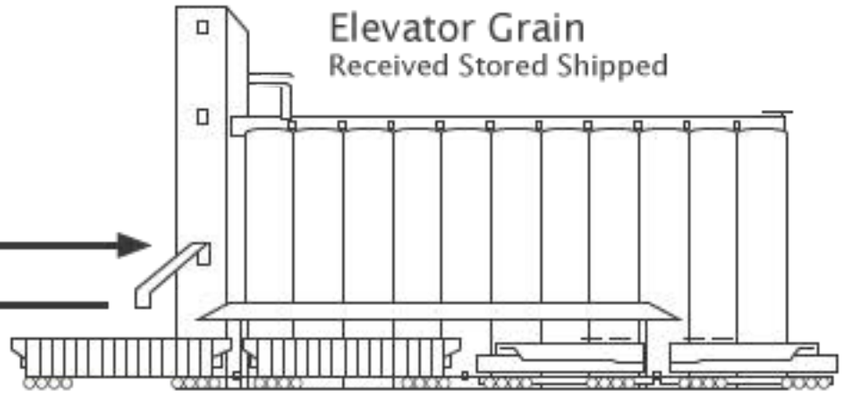
Pets

Soybean / Oil Processing



Farm Grain
Harvest Storage

Transportation



Elevator Grain
Received Stored Shipped

Soybean Oil Processing

Cleaning, Cracking, Dehulling

Soy Chips

Conditioning and Flaking

Full Fat Flakes

Crude Soybean Oil

Solvent Extraction

Industrial Use

Shortening

Degumming

Degumming Soybean Oil

Refined Soybean Oil

Refined, Bleached, Deodorized Soybean Oil

Lightly Hydrogenated

Food Use

Soybean Gums

Refining

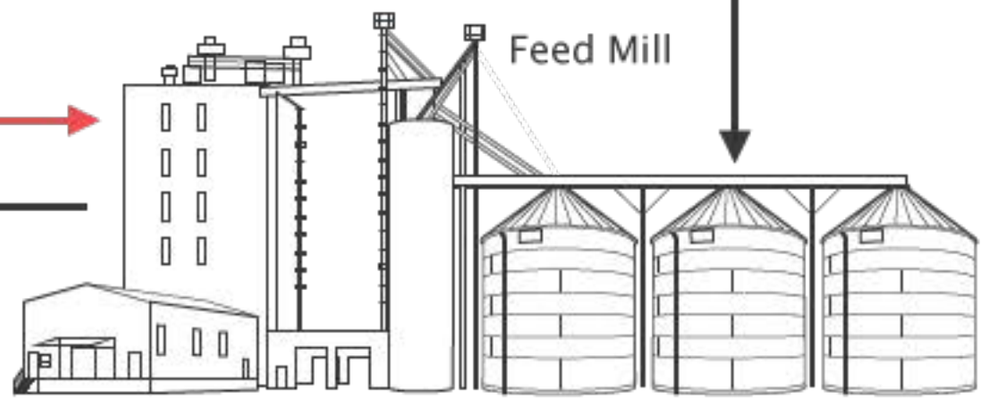
Crude Lecithins

Bleached Lecithins

Lecithin

Soybean Hulls

Transportation



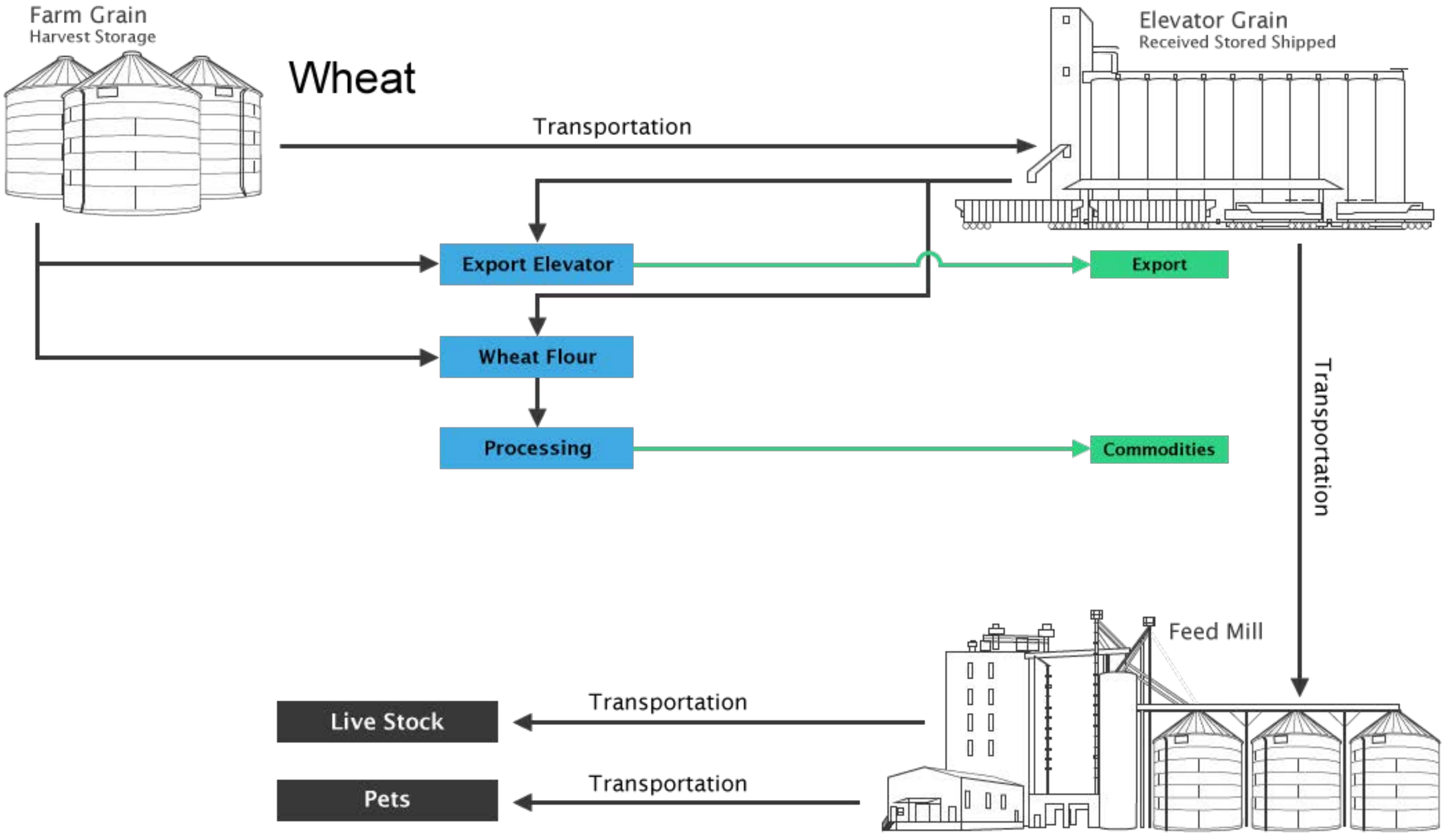
Feed Mill

Transportation

Live Stock

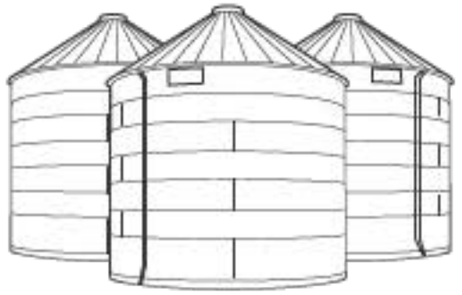
Transportation

Pets

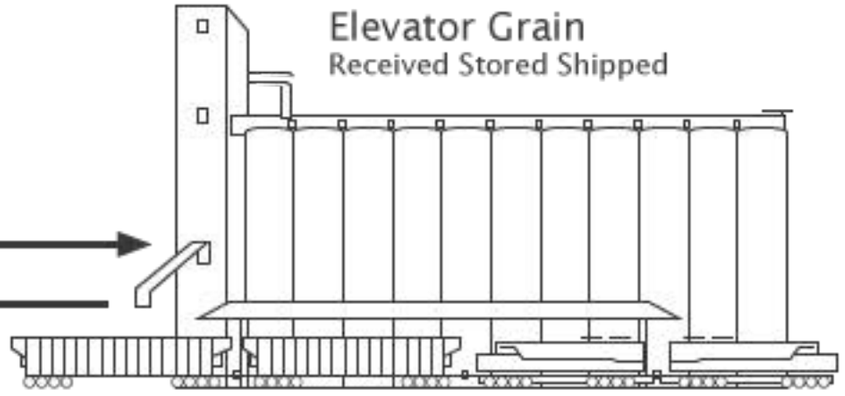

Farm Grain
Harvest Storage
Wheat
Transportation
Elevator Grain
Received Stored Shipped
Export Elevator
Export
Wheat Flour
Processing
Commodities
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Pets

Wheat / Export Elevator

Farm Grain
Harvest Storage



Transportation

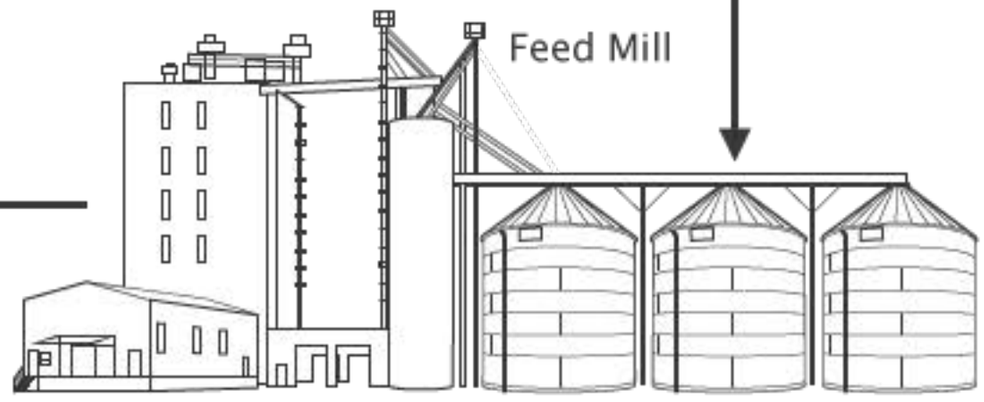


Elevator Grain
Received Stored Shipped

Export Elevator

Export

Transportation



Feed Mill

Transportation

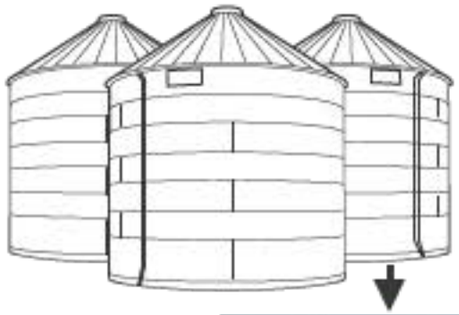
Live Stock

Transportation

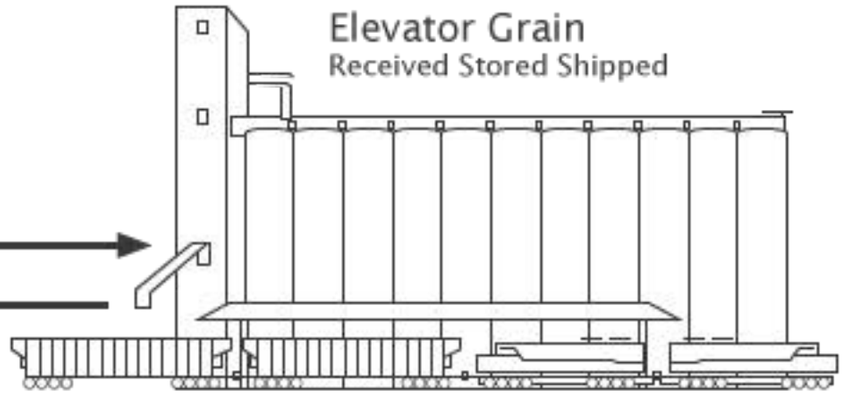
Pets

Wheat / Wheat Flour Processing

Farm Grain
Harvest Storage



Transportation



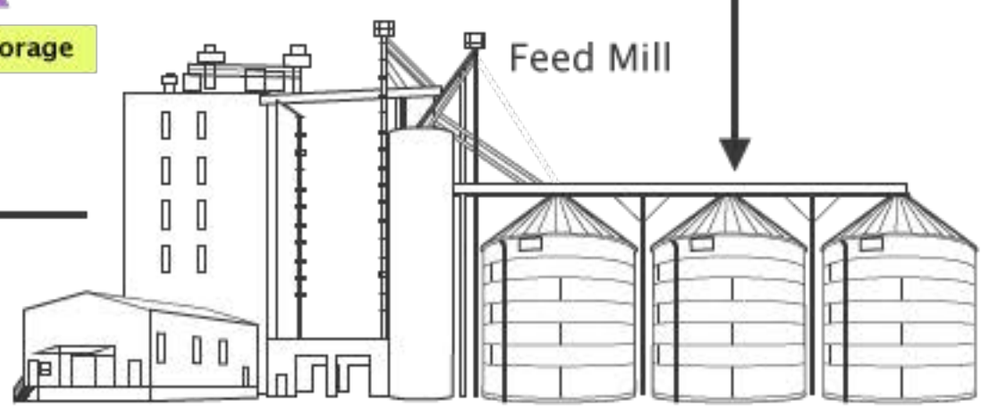
Elevator Grain
Received Stored Shipped

Wheat Flour Processing

- Product Control Inspect, Classify, Blend
- Separator Remove Materials
- Aspirator Remove Materials
- Disc Separator Remove Materials
- Scourer
- Magnetic Separator
- Washer Stoner
- Tempering
- Entoleter
- Grinding Bin
- First Break Brake Wheat
- Sifter
- Purifier
- Reducing Roller
- Purifier
- Reducing Roller
- Sifter
- Purifier
- Reducing Roller
- Sifter
- Purifier, Roll, Sift
- Bleaching
- Enriching
- Bulk Storage
- Bran
- Shorts
- Clean Flour
- Germ
- Flour

Transportation

Feed Mill



Transportation

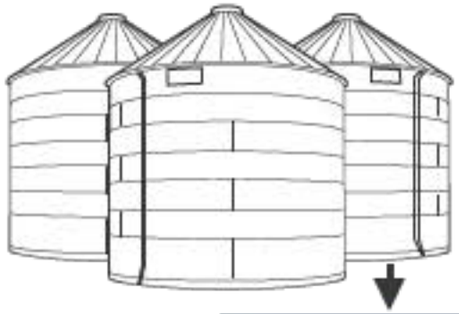
Live Stock

Transportation

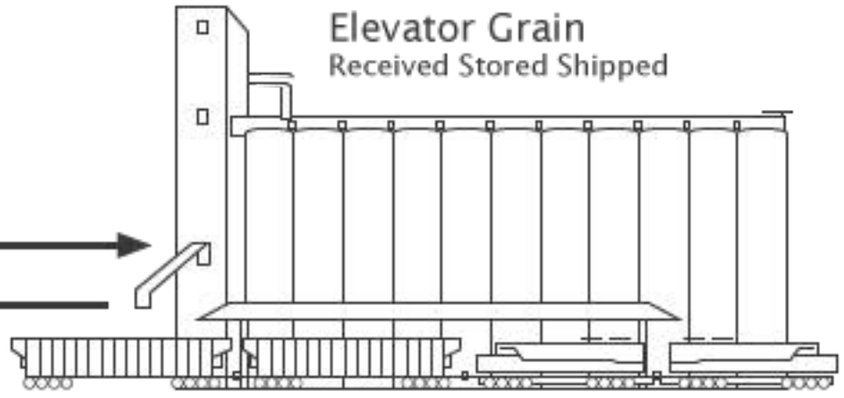
Pets

Oats Processing

Farm Grain
Harvest Storage



Transportation



Elevator Grain
Received Stored Shipped

Oat Processing

Cleaning

Grading

Dehulling & Husk or Fluff Separation

Groat Separation

Kilning

Screening or Aspiration

Cutting

Grinding

Milling

Steaming

Cut Groats

Flaking or Rolling

Mixer

Additives

Flakes

Instant

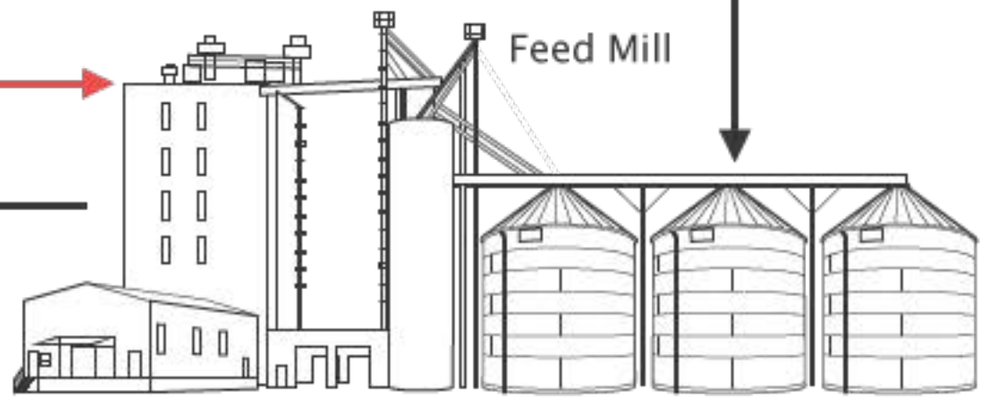
Quick

Bran

Flour

Oat Hulls

Transportation



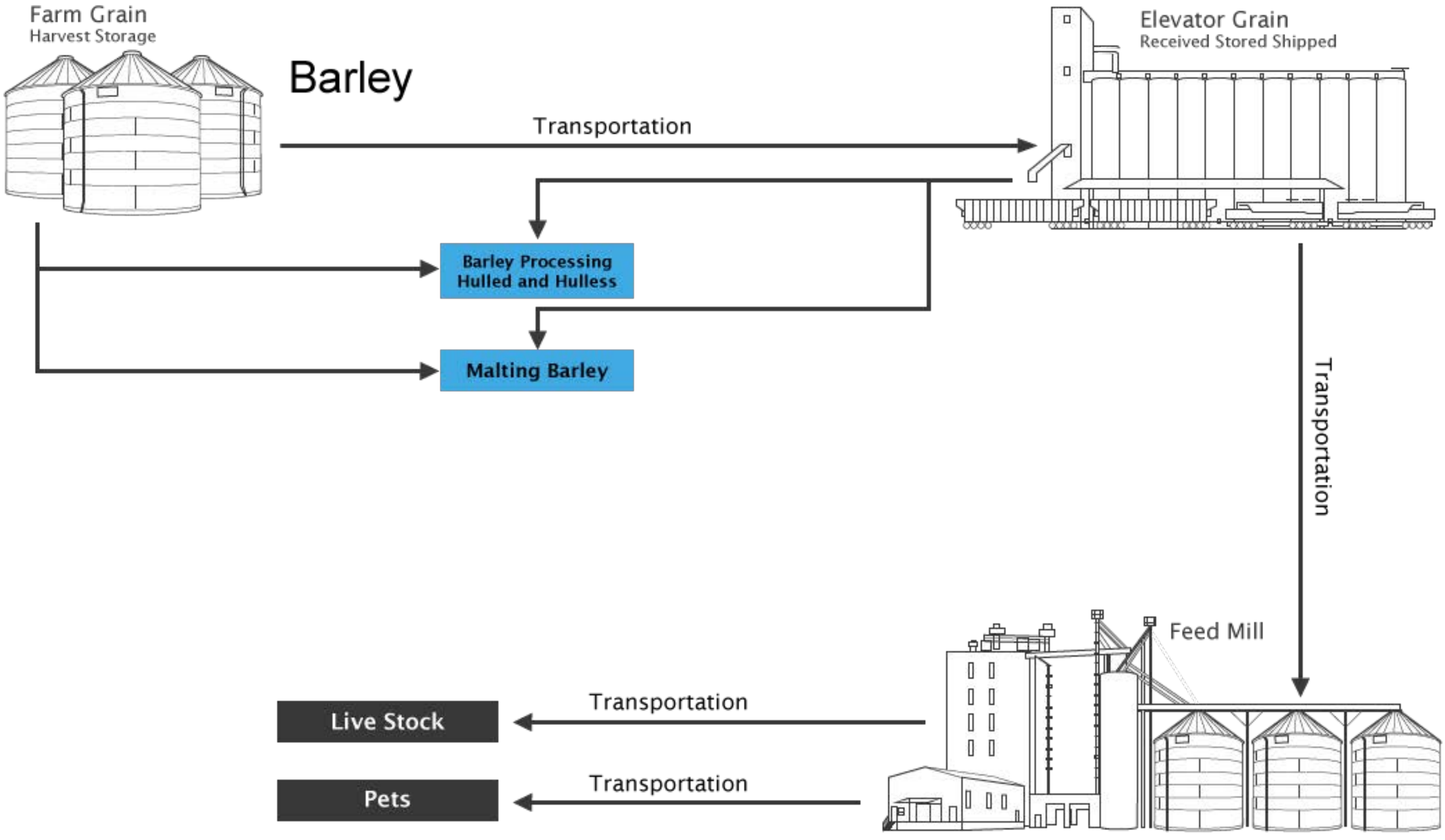
Feed Mill

Live Stock

Transportation

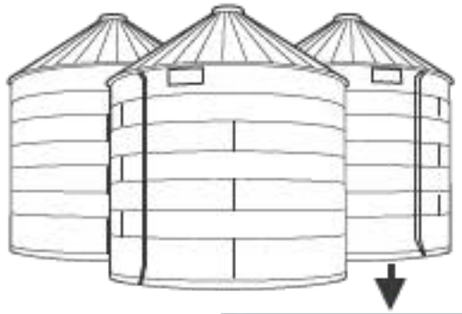
Pets

Transportation


Farm Grain
Harvest Storage
Barley
Transportation
Elevator Grain
Received Stored Shipped
Barley Processing
Hulled and Hulless
Malting Barley
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Pets

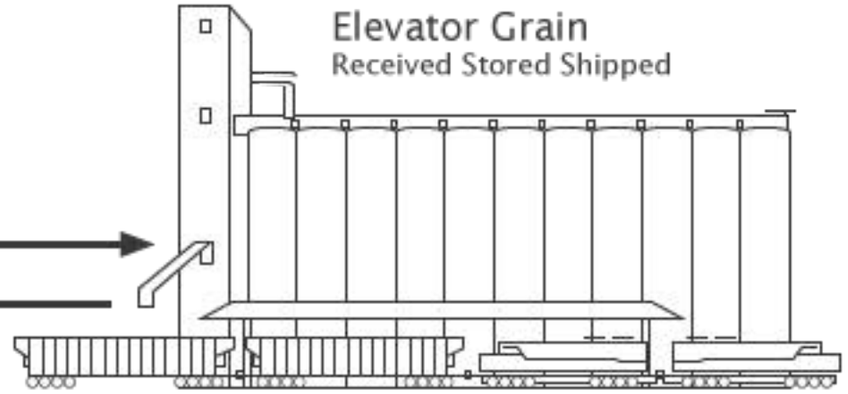
Barley / Barley Processing

Farm Grain
Harvest Storage



Transportation

Elevator Grain
Received Stored Shipped



Barley Processing
Hulled and Hulless

Cleaning

Conditioning
Drying or Dampening

Bleaching
Steam + CO_2
(30 min.)

Binning
(24 Hour)

Dry Rolling Barley

Blocking

Aspiration

Cutting

Grits

Milling

Pealing

Aspiration

Polishing

Too 67% of
Whole Barley

Steam Cooking
and Flaking

Drying to
10.5% Moisture

Breads

Soups

Dressing

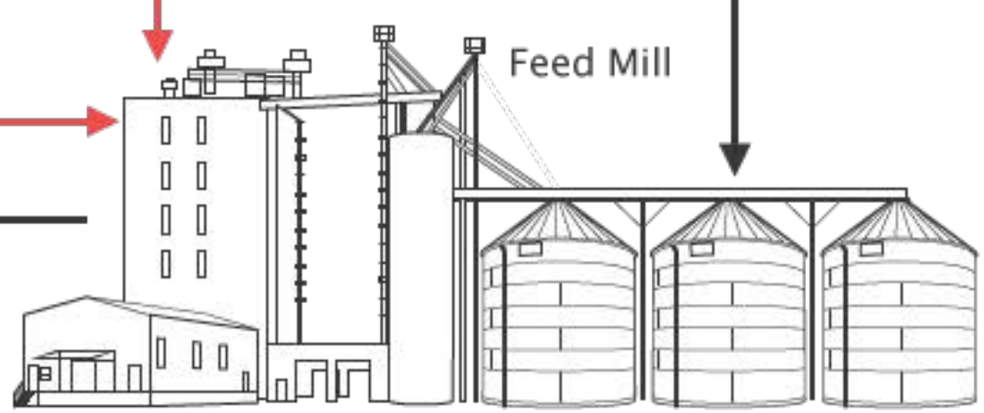
Cereal

Flat Bread
Infant Food

Flour

Transportation

Feed Mill

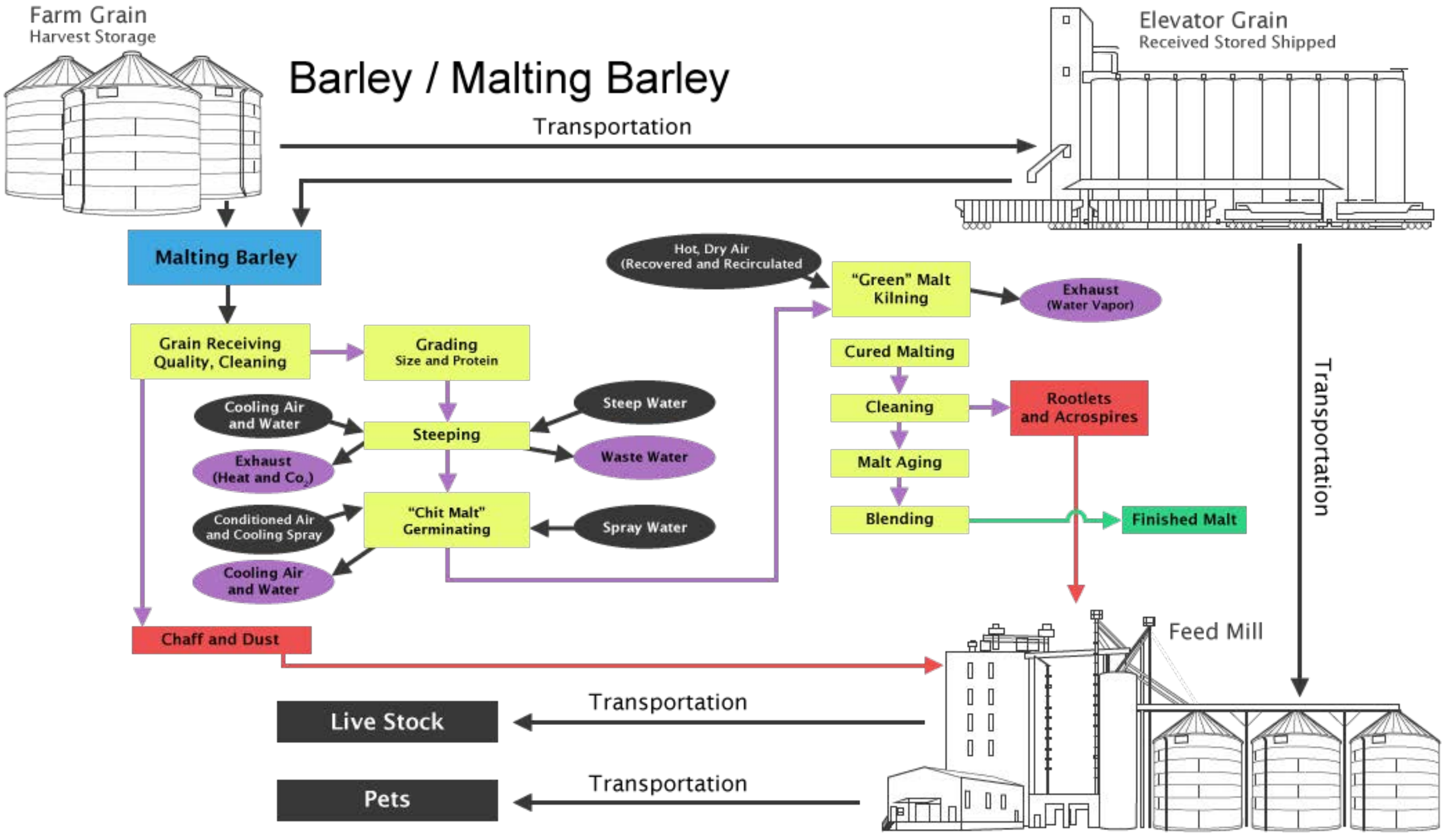


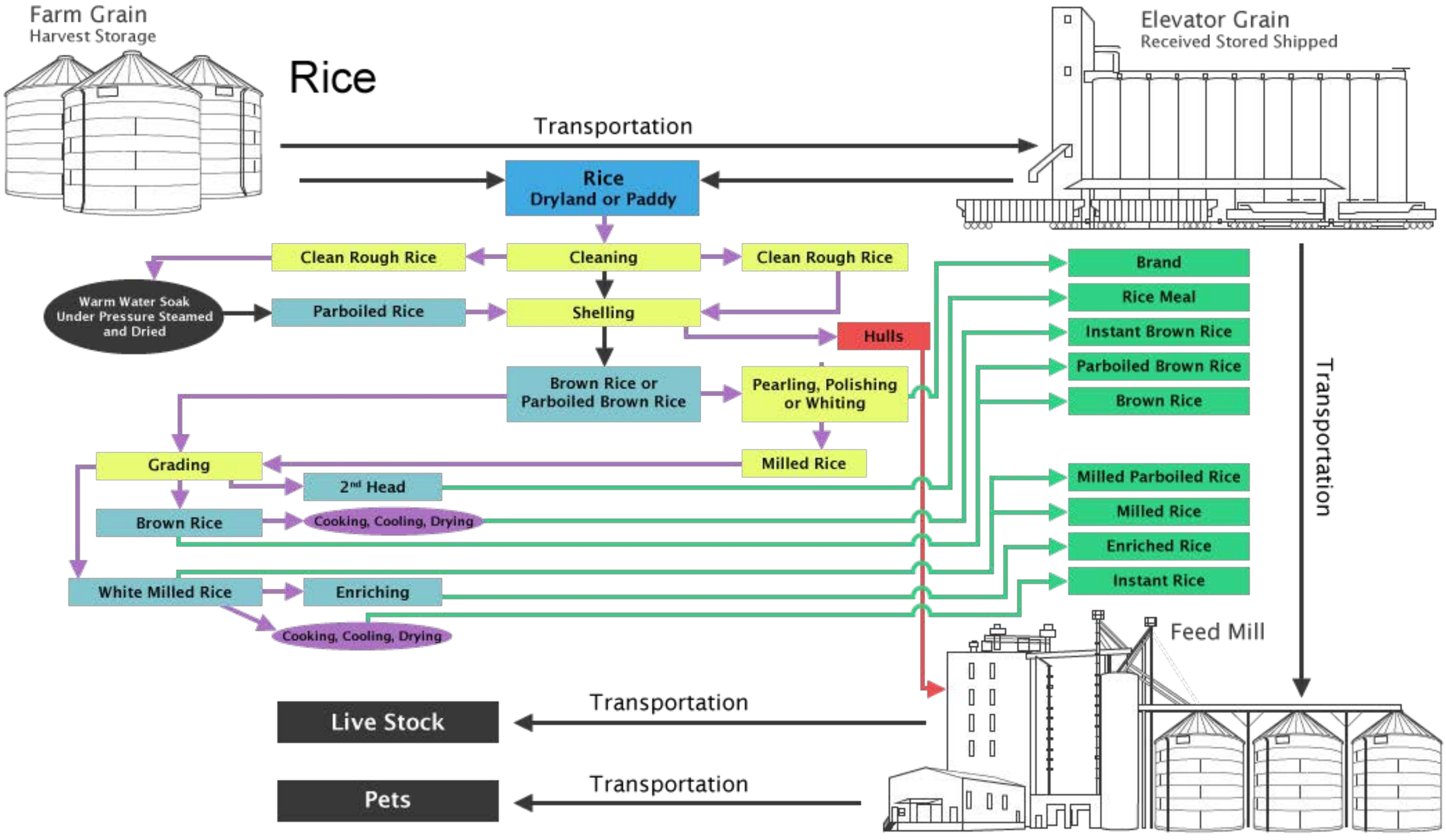
Live Stock

Transportation

Pets

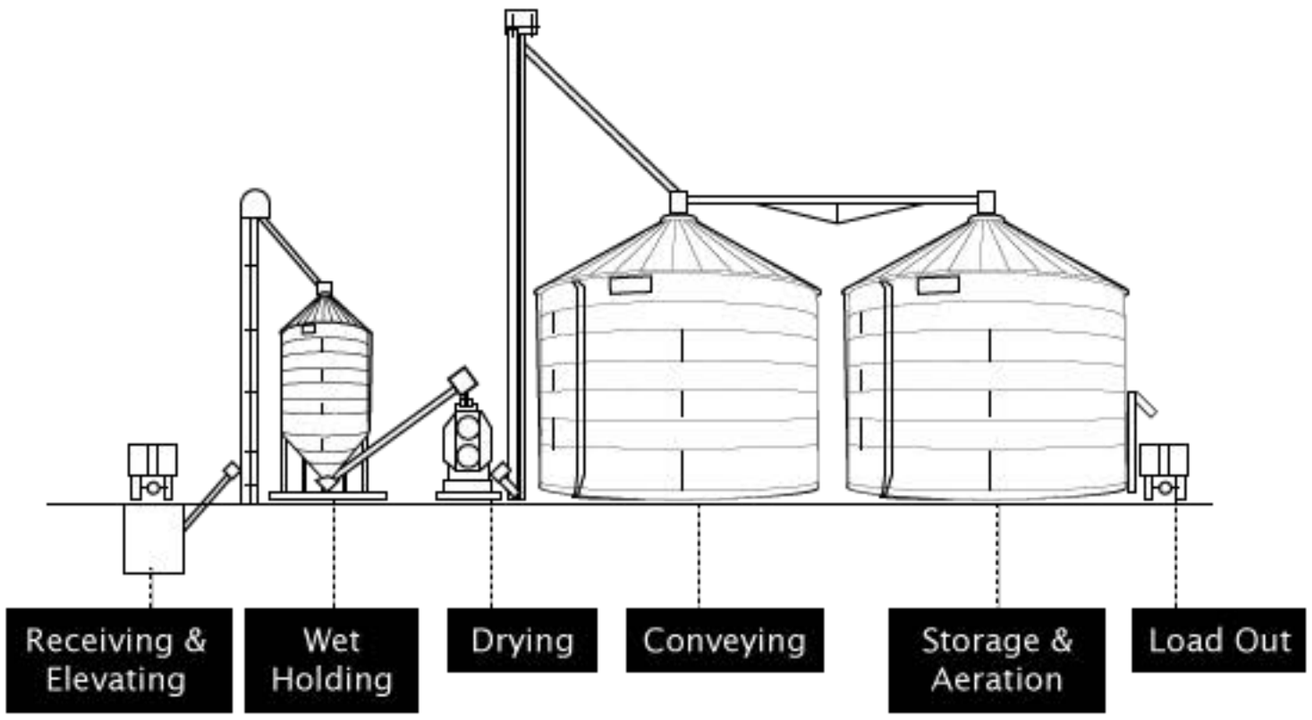
Transportation


Farm Grain
Harvest Storage
Barley / Malting Barley
Transportation
Elevator Grain
Received Stored Shipped
Malting Barley
Grain Receiving
Quality, Cleaning
Grading
Size and Protein
Cooling Air
and Water
Steeping
Steep Water
Waste Water
Exhaust
(Heat and Co2)
Conditioned Air
and Cooling Spray
"Chit Malt"
Germinating
Spray Water
Cooling Air
and Water
Chaff and Dust
Hot, Dry Air
(Recovered and Recirculated
"Green" Malt
Kilning
Exhaust
(Water Vapor)
Cured Malting
Cleaning
Rootlets
and Acrospires
Malt Aging
Blending
Finished Malt
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Pets


Farm Grain
Harvest Storage
Rice
Transportation
Elevator Grain
Received Stored Shipped
Rice
Dryland or Paddy
Clean Rough Rice
Cleaning
Clean Rough Rice
Warm Water Soak
Under Pressure Steamed
and Dried
Parboiled Rice
Shelling
Hulls
Brown Rice or
Parboiled Brown Rice
Pearling, Polishing
or Whiting
Milled Rice
Grading
2nd Head
Brown Rice
Cooking, Cooling, Drying
White Milled Rice
Enriching
Cooking, Cooling, Drying
Brand
Rice Meal
Instant Brown Rice
Parboiled Brown Rice
Brown Rice
Milled Parboiled Rice
Milled Rice
Enriched Rice
Instant Rice
Transportation
Feed Mill
Transportation
Live Stock
Transportation
Pets

FARM

Farm



Receiving & Elevating
- Dump pit
- Bucket Elevators
- Large Portable Augers

Wet Holding
- Hopper bins
- Grain bins

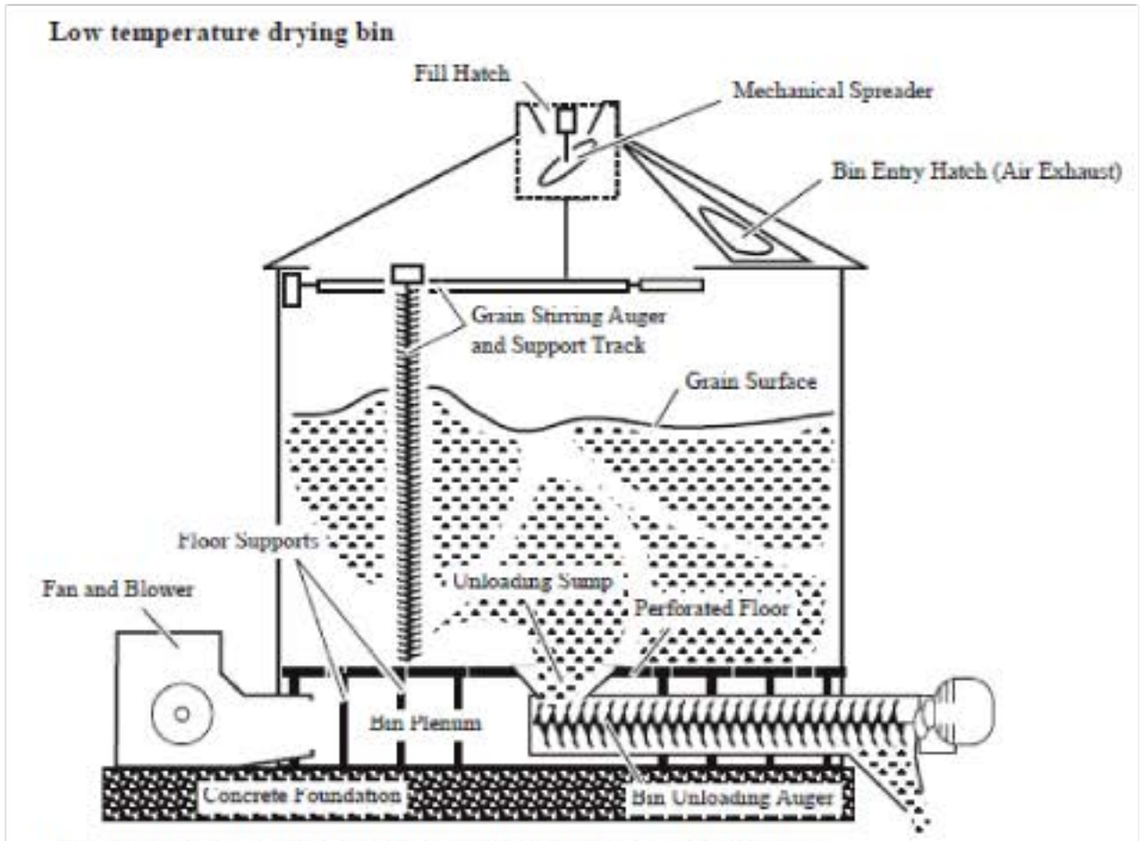
Drying
- In Bin Dryers
  - Stirring
  - Continuous flow
- External Dryers

Conveying
- Augers
- U Trough
- Drag Conveyor
- Pneumatic Conveyor

Storage & Aeration
- Bins & Tanks
- Axial or Centrifugal Fans
- Controllers
- Monitoring

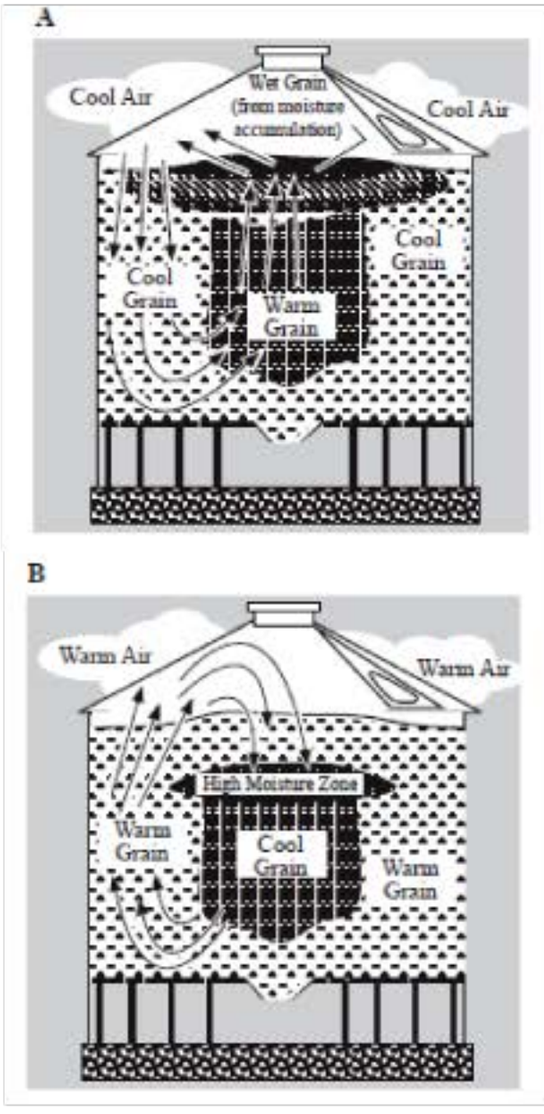
Load Out
- Bin Un-loaders
- High capacity portable auger
- Reclaim conveyor to leg
- Overhead tank and structures

Farm Bin Diagram



Moisture migration in stored grain when outdoor temperatures are cooler (A) and warmer (B) than the grain.

Based on figures from Hoseney R. *Principles of Cereal Science & Technology*. St. Paul, MN: American Association of Cereal Chemists.



Farm Potential Hazards

- Dump pit
  - Dirt and Pest access
  - Drips and Leaks – petroleum, oil and lubricants
- Receiving and elevating
  - Grain – Mycotoxin – Aflatoxin
  - Grain – Treated seed
  - Grain – Pesticide residues
  - Grain – Flood contamination
  - Grain – GMO – unregistered
- Conveying
  - Pest access – rodents and insects
- Storage
  - Roof and Foundation – Water leaks
  - Aeration – Moisture and Heat
  - Pest access – insect, rodent and birds
- Transportation
  - Clean and covered

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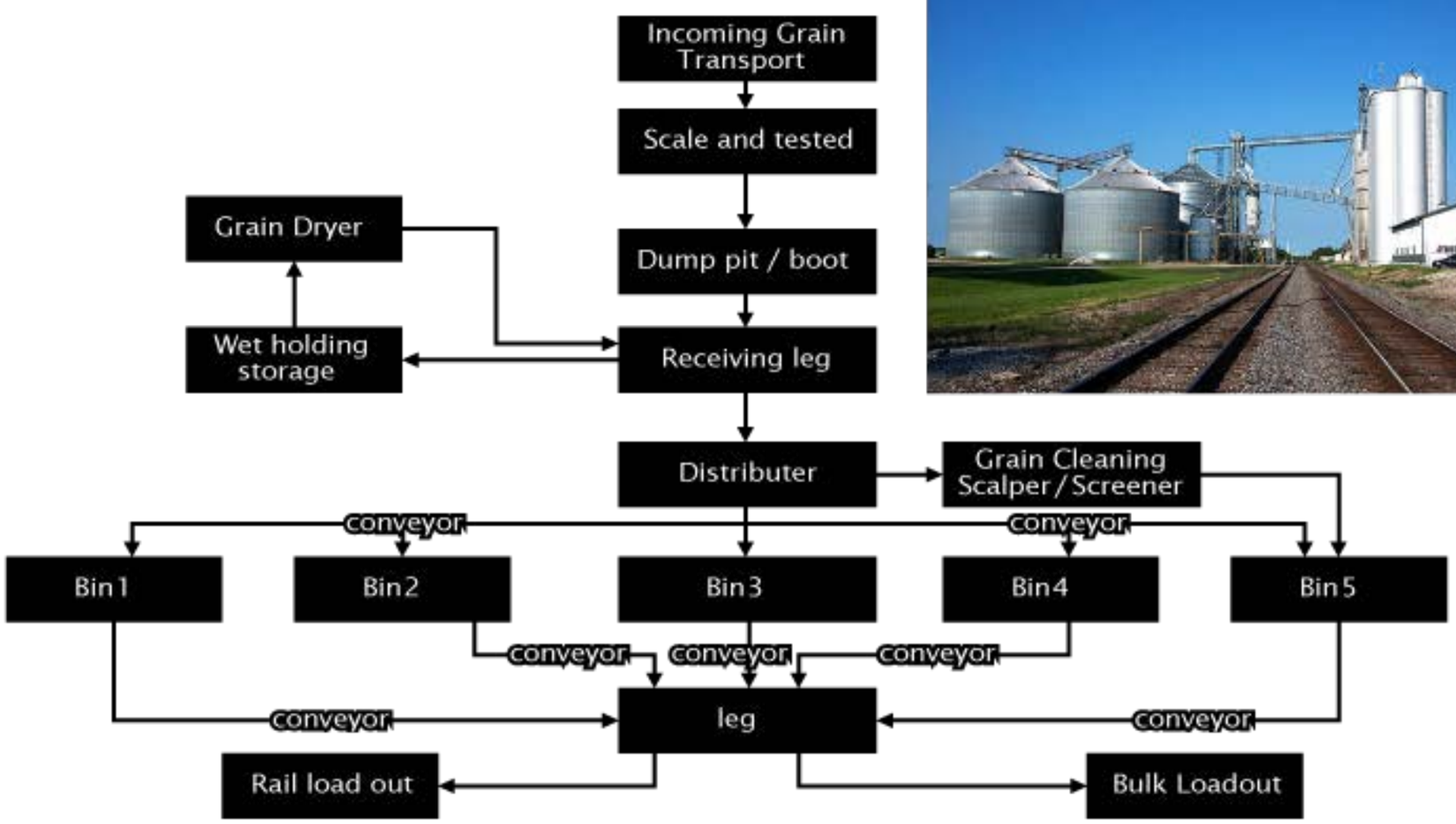
ELEVATOR

Elevator



Receiving & Elevating
- Dump pit
- Bucket Elevators

Wet Holding
- Hopper bins
- Grain bins

Drying
- External Dryers

Conveying
- Augers
- U Trough
- Drag Conveyor
- Pneumatic Conveyor

Storage & Aeration
- Bins & Tanks
- Axial or Centrifugal Fans
- Controllers
- Monitoring

Load Out
- Bin Un-loaders
- Reclaim conveyor to leg
- Overhead tank and structures

Elevator Potential Hazards

- Dump pit
  - Dirt and Pest access
  - Drips and Leaks – petroleum, oil and lubricants
- Receiving and elevating
  - Grain – Mycotoxin – Aflatoxin
  - Grain – Treated seed
  - Grain – Pesticide residues
  - Grain – Flood contamination
  - Grain – GMO – unregistered
- Conveying
  - Pest access – rodents and insects
- Storage
  - Roof and Foundation – Water leaks
  - Aeration – Moisture and Heat
  - Pest access – insect, rodent and birds
- Transportation
  - Clean and covered

Back to S 6

FEED MILL

Feed Mill

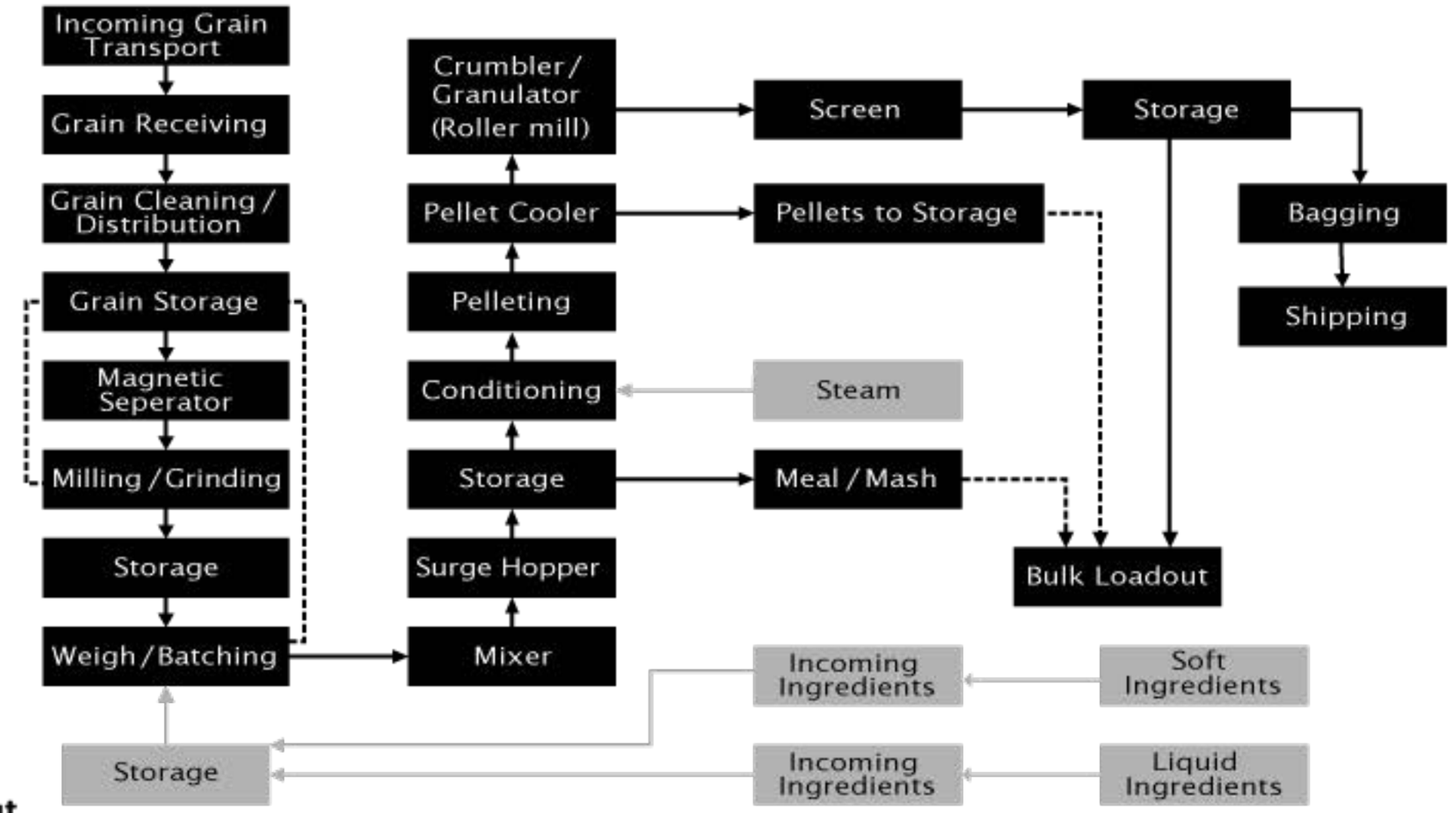
Receiving & Elevating
- Dump pit
- Bucket Elevators
- Large Portable Augers

Drying
- External Dryers

Conveying
- Augers
- U Trough
- Drag Conveyor
- Pneumatic Conveyor

Storage & Aeration
- Bins & Tanks
- Axial or Centrifugal Fans
- Controllers
- Monitoring

Manufacturing
- Mixer
- Scales, load-cells
- Grinders, hammer mill, roller mill
- Pellet mills
- Boiler (steam)
- Controllers, monitors



Load Out
- Bin Un-loaders
- Reclaim conveyor to leg
- Overhead tank and structures

Feed Mill Potential Hazards

- Receiving
  - Dirt and Pest access
  - Drips and Leaks – petroleum, oil and lubricants
  - Transportation – Clean and covered
  - Grain – Treated seed – Pesticide residues
  - Grain – Flood contamination – unregistered GMO
  - Grain – Mycotoxin – Aflatoxin
  - Ingredients – keep dry and separate
- Conveying
  - Pest access – rodents and insects
- Storage
  - Roof and Foundation – Water leaks
  - Aeration – Moisture and Heat
  - Pest access – insect, rodent and birds
  - Keep ingredients dry (flooding/leaking roof)
  - Cross contamination (PM, antibiotics, chemicals, etc.)

Feed Mill Potential Hazards

- Bulk Load Out
  - Cross contamination
  - Transportation – Clean and covered
- Manufacturing
  - Roof and Foundation – Water leaks
  - Pest access – insect, rodent and birds
  - Cross contamination (PM, antibiotics, chemicals, etc.)
  - Keep ingredients dry (flooding/leaking roof)
  - Records management (for medicated feeds & recalls)
  - Sampling program (Aflatoxin, micro, pesticide, antibiotics, nutrition)

Feed Mill – Grain Mycotoxin Potential Hazard

Use of Contaminated Grains

- Action, guidance and advisory levels were established, **in part**, to protect public health.
- Grains with mycotoxin(s) that exceed the appropriate action, advisory or guidance levels **may be** considered as adulterated.
- Grains with mycotoxin(s) exceeding the highest action, advisory or guidance levels **may be** considered as unfit for use in animal feed.

Feed Mill – Grain Mycotoxin Potential Hazard

Aflatoxins

- produced by *Aspergillus sp*. (*A. flavus* and *A. parasiticus*)
- common feed substrates such as corn, cottonseed, peanuts, and sorghum.
- occur most commonly in warm, humid regions of the south and central regions of the U.S.
- high levels of aflatoxins are associated with above-average temperature and below-average rainfall (micro-climate)
- four major aflatoxins in feed: B1, B2, G1 & G2 (B1 + B2 + G1 + G2 = total aflatoxins)
- one major aflatoxin in milk: M1
- inhibits protein synthesis, one of the most potent carcinogens - interacts with DNA
- young animals more susceptible than adults
- monogastric animals more susceptible than ruminants

Feed Mill – Grain Mycotoxin Potential Hazard

Fumonisins

- produced by *Fusarium sp*. (*F. verticillioides*)
- found worldwide, mainly in corn and particularly corn screenings
- high levels associated with hot and dry weather, followed by periods of high humidity
- three major fumonisins in feed are B1, B2 & B3 (B1 + B2 + B3 = total fumonisins)
- most susceptible species are horses (equine leukoencephalomalacia) and rabbits
- suspected carcinogens

Feed Mill – Grain Mycotoxin Potential Hazard

Vomitoxin

- produced by members of genus *Fusarium* (especially *F. graminearum*)
- commonly found on wheat, barley, rye and oats
- reported most frequently in cool, temperate regions (northern U.S. and Canada)
- member of the trichothecene family of mycotoxins
- inhibitor of protein synthesis, affecting GI tract and immune system
- swine most susceptible -- causing vomiting and feed refusal

Feed Mill – Grain Mycotoxin Potential Hazard

Blending Grain

- Blending of “clean” grain with adulterated grain is **generally** not permitted and the final product resulting from blending is unlawful, regardless of the level of the contaminant.

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TRANSPORTATION

Transportation Potential Hazards

Contamination of Transportation containers

- Prohibited Material (PM) – animal bone meal
- Agriculture chemicals – Fertilizer, pesticides, insecticides, herbicides
- (POL) – petroleum, oil and lubricants
- Cross contamination – non-food and feed

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