Fortification at the Mill - Premix and Feeders

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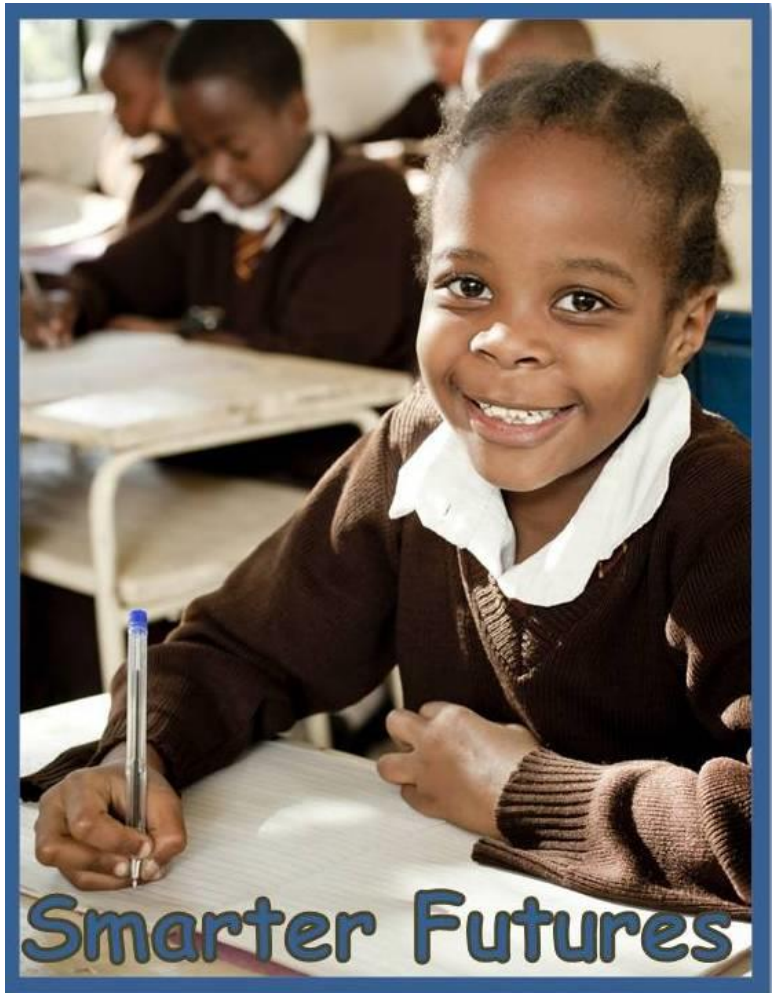
(with contributions from Philip Randall)



Food Fortification Initiative
Enhancing Grains for Healthier Lives

AkzoNobel

Helen Keller INTERNATIONAL

IFSBH

Ministerie van Buitenlandse Zaken

Premix: General Requirements

- Bio-availability of micronutrients
- No change of organoleptic features
- Affordable cost
- Acceptable colour, solubility and particle size
- Commercially available ingredients
- No interaction of active ingredients
- Safety

Premix considerations

- Definition
- Choice of Fortificant
- Formulation

Fortificant choice depends upon:

- Identification and Prevalence of Deficiencies
- Consumption pattern of target food
- Single or multiple fortificant
- Bio-availability of micronutrients
- Distribution and storage conditions
- Affordability

Micronutrients for flour

- Minerals
  - Iron; Electrolytic, Ferrous Fumarate, Ferrous Sulphate, NaFeEDTA
  - Calcium; Calcium Carbonate or Calcium Sulphate
  - Magnesium; Magnesium Sulphate
  - Phosphorus; Calcium Phosphate
  - Zinc; Zinc Sulphate or Zinc Oxide

Micronutrients for Flour

- Vitamins
  - Vitamin A
  - Vitamin B1, B2, B3, B6, B12
  - Folic Acid B9
  - Vitamin D
  - NOTE: Vitamin C should not be used as a fortificant in cereal flours as it reacts with cereal proteins and is destroyed

Properties of Iron Compounds

Iron source	Conc %Fe	Cost $/kg	Cost $kg Fe	Colour	Magnetic
Ferrous Sulphate	32	1.30	4.06	Tan	No
Ferrous Fumarate	32	2.40	7.50	Brown	No
Ferric O. Phosph	29	2.50	7.81	Red	No
Iron, Electrol.	98	4.00	4.10	Black	Yes
NaFe EDTA	14	8.50	60.70	Tan	No

Electrolytic Iron Specification

- Must USP/FCC grade, very fine particle size
- Assay
  - 96.0% Fe minimum
  - Particle Size Thru 200 mesh 99% min, Thru 325 mesh 95%
  - Arsenic 8ppm, Lead 25ppm, Mercury 5 ppm maximum for all above

Ferrous Sulphate/Ferrous Fumarate

- Dried, Tan powder meeting USP/FCC grade
- Assay
  - As $FeSO_4$ 86-89% As Fe 31.6-32.6%
  - As FeFumarate 90% As Fe 32.0 – 33.0%
  - Particle size Thru 100 mesh 99.5%, Thru 200 mesh 90%
  - Arsenic 3 ppm, Lead 10 ppm, Mercury 3 ppm maximum for all above

Sodium Iron EDTA: NaFeEDTA

- Yellow Green Powder
- Assay
  - As EDTA 65.5-70.5%, As Fe 12.5-13.5%
  - Differences between JECFA and FCC standards on Iron content
    - JECFA 12.5%
    - FCC 13.5%
  - Arsenic 1 ppm, Lead 1 ppm max
  - Free Iron content
  - Particle Size 100% through 140 micron screen

Premix types: Iron Folic Acid

- Used in WHO-EMRO region
- Composition
  - Elemental Iron 60%
  - Folic Acid 1.5%
  - Carrier 28.5%
- Dosage 100g per MT
- Adds 60 ppm Fe and 1.5 ppm Folic Acid

Premix types:
Ferrous Sulphate Folic Acid

- Used in WHO-EMRO region - Egypt
- Composition
  - Dried Ferrous Sulphate 52.00%
  - Folic Acid 0.75%
  - Carrier - starch 94.50%
- Dosage 200g per MT of flour
- Adds 30 ppm Fe and 1.5 ppm Folic Acid
- Based on WHO-EMRO Guidelines of 30 ppm and 1.5 ppm Folic Acid

Premix: To meet US/Can/Mexico Regulations

- Used in North American mills
- **Ingredient** **Amount per kg Flour**
- Thiamine B1 5.2 mg
- Riboflavin B2 3.6 mg
- Niacin B3 42 mg
- Folic Acid 1.5 mg
- Iron 35 mg
- Dosage 160 g per MT flour

Premixes and Standards

- Standards in US and Canada set based on Addition and natural levels e.g.

Ingredient	**Added**	**Natural**	**Total**	**Standard**
B1	5.2	1.3	6.5	6.3
B2	4.0	0.4	4.4	4.0
B3	46	12	58	52
FA	1.5	0.2	1.7	1.5
Iron	38	11	49	44

Processing Losses

- Vitamin levels are lost during processing

Vitamin	Bread	Flat bread	Noodles
A	0-20%	28%	-
B1	16-24%	-	42%
B2	8-10%	-	30-40%
B3	5-10%	-	39-50%
Folic Acid	10-20%	-	-
Minerals	0-20%	0-20%	-

Process Losses

- Standards for processed foods must reflect processing losses
- Premixes should contain overages of minerals and vitamins to compensate for processing variations

Sources of Premix:

- International Suppliers Europe: CSM, DSM- Fortitech, Eurogerm, Muhlenchemie,
- International Suppliers Americas: Corbion, Granotec, Research Products
- International Suppliers Asia: Hexagon, Nicolas Piramal
- GAIN premix facility www.gpf.org

NOTE: Smarter Futures and FFI provide a supplier list only. Millers and stakeholders must follow internationally accepted procurement procedures and carry out due diligence procedures

Frequency of procurement

- Depends upon shelf life of premix, usage rate by millers and flour demand
- Premix delivery lead times are about 3-4 months depending upon origin
- Premix shelf life is usually 9 to 18 months depending upon composition – Kosovo premix is simple and will have 12-15 months shelf life
- Sufficient stocks must be in country at mill level to ensure continuation of fortification

Procurement of Premix – Who is responsible?

- If there is mandatory fortification and flour prices can be adjusted, then millers are responsible for procurement just as they are for buying wheat.
- Key is long term sustainability – cannot rely on outside sources of funding for premix
- Options in practice today in other countries: Millers, Millers association, MoH.

Equipment for Fortification Process - Feeders

Flour Fortification Method

- **DRY POWDER BLENDING:** The controlled blending of premix containing vitamins and minerals with wheat flour
- **TECHNICAL FEASIBILITY:S**imple process because wheat flour and vitamins and minerals are:
  - Dry free flowing powders.
  - Have similar particle size profiles.

Large Scale Milling

- Continuous addition and blending method:
  - Micronutrient premix can be added to flour as it is milled.
  - Both the amount of flour milled and premix added is controlled accurately.
  - Flour collection system acts as built in blender

Large Scale Milling; Equipment needs

- Flour collection conveyor
- Premix feeder with adjustable feed system
- Discharge system to deliver premix to flour
- Scale to measure addition rate of premix to flour
- Laboratory Chemicals for Iron Spot Test

Large Scale Milling: Premix Addition Methods

- **Volumetric addition**
  - Volume of material added has specific weight
  - Weight of premix depends upon bulk density
  - Iron types have a higher bulk density than flour or vitamins
- **Gravimetric addition**
  - Based on weight of material to be added
  - Weigh belts deliver premix to flour
- **Loss of weight addition**
  - Continuous readings of premix and feeder using load cells.
  - Expensive and complex system

Feeder Placement

- Top of Flour Collection Conveyor
- Floor above Flour Collection Conveyor
- Top of Flour Conveyor to Storage Bins
- Blowline discharge to Flour Spouts or Conveyor
- Feeder must be located 3 metres from discharge end of Flour Conveyor
- Feeder must be interlocked with conveyor or mill control panel

Mill Requirements for Proper Fortification

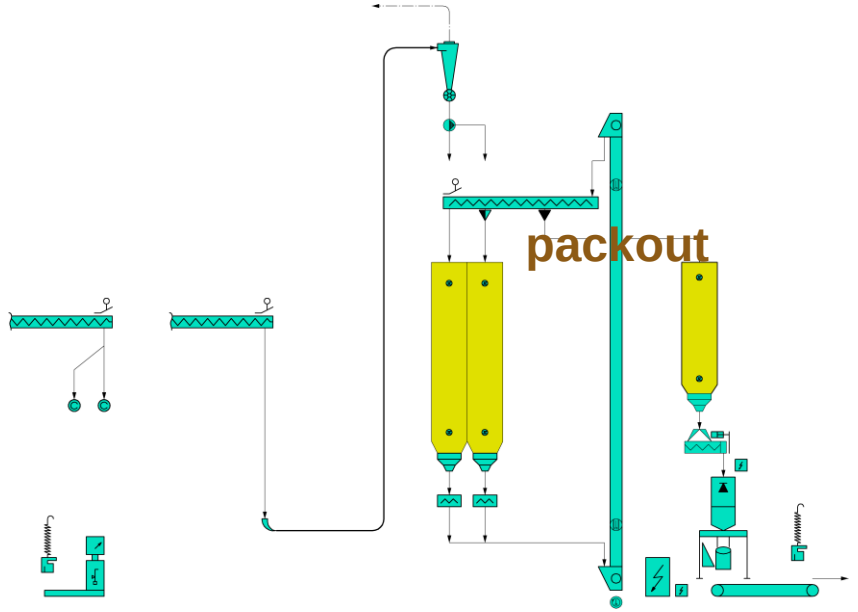
A premix feeder to measure out the correct dose of premix and its placement at a point in the production line where if delivers the premix into the production line to mix with flour

Sometimes a small chute or tube is fabricated and installed to carry the premix from the feeder to flour line. This should be at a steep angle to insure it drops down cleanly without stoppage of premix

Mill Requirements for Proper Fortification

2. Mechanisms to assure that the premix is uniformly mixed into the flour after the point of addition and before packing. This can involve mixing during the normal transport of flour from the conveyor to packing, or insertion of special mixing equipment.

Addition of premix at flour collection conveyor



Methods Used to Add Premix to the Flour

- *Continuous Systems:* Most larger and newer mills operate within a continuous system. The premix is continuously metered or fed into the flour flow using a precision micro *"feeder"* (also referred to as a dosifier). The dosage rate is controlled and depends on the rate of flour production of flour flow.

Methods Used to Add Premix to the Flour

The vast majority of flour and maize mills use continuous processing systems incorporating a collection conveyor (shown on right) where premix can be continuously and easily added. This is particularly true for all new mills.

The majority of the information presented here refers to such milling systems. However, additional information about alternative fortification systems is also provided.

Considerations Regarding Sizing Feeders to the Capacity of the Mill

- Mills generally need one feeder per flour line to be fortified. Larger milling units with multiple products may require additional feeders including spares.

- Feeders used for flour fortification need to deliver only relatively small amounts of material. The size and number of feeders will depends on the hourly throughput of flour in the mill or "load-out system." Hopper size on the feeder is also an important consideration, since you do not want to filling it constantly, nor do you want to let it go for many days without filling.

(Source of photos: Research Products Company)

Feeder Sizing

- Powder premix feeders are available in different sizes.
  - A small feeder may discharge premix at levels as low as 25 g per hour (0.4 g/min)
  - The largest can discharge up to 32 kg per hour. This would only be needed with calcium fortification.
- Volumetric feeder and hopper capacity are normally given in Liters/min and Liters. This can be converted to weight units by knowing the bulk density of the premix (in g/cc)

Mill Capacity (MT/day)	Flour flow rate* (kg/min)	Premix** Add rate (g/min)
5	2.5	0.4
20	10	1.5
50	25	3.8
100	50	7.5
200	100	15
400	200	30

*** At 72% extraction rate**
**** At 150 g/MT**

Delivery Mechanisms

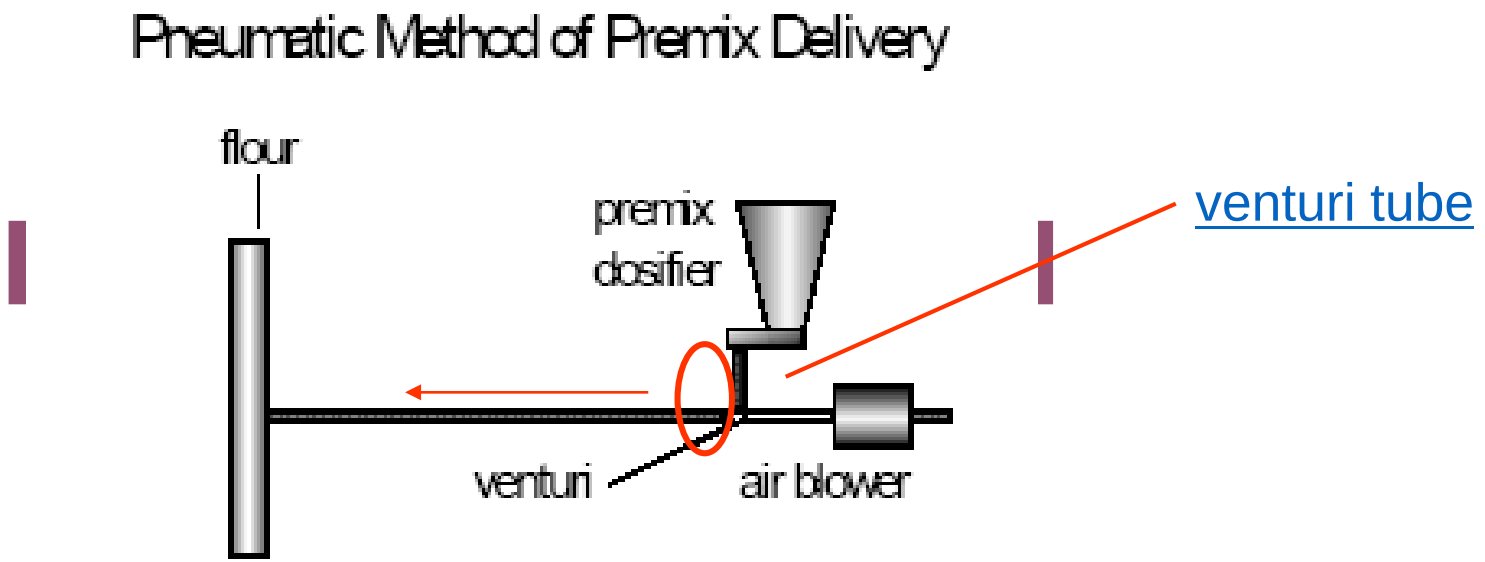
There are two main ways to deliver the premix to the flour:

- pneumatic and
- gravity feed

Pneumatic System

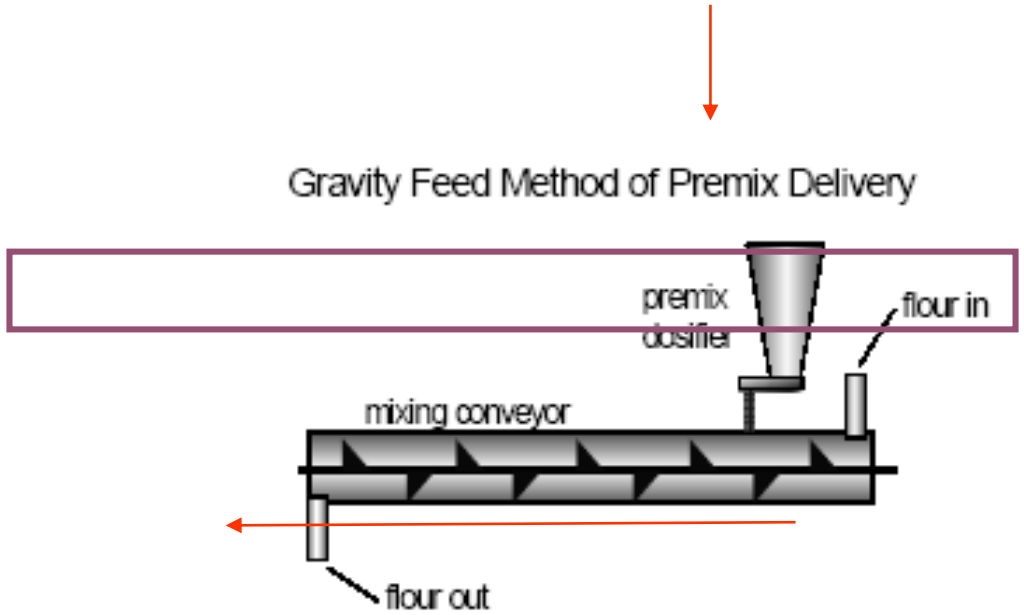
In a pneumatic system the premix drops into a ***venturi*** tube, that injects the premix into an air stream. The material is blown by positive pressure or sucked by a vacuum through a pipe into the flour collection conveyor.

If this can not be set up, some downstream location in the flour flow can be used to add premix provided it will be well mixed with the flour.



Gravity Feed System

With this system, the feeder is placed above a flour conveyor. The premix is dropped directly into the flour as it flows through the conveyor. Most often the feeders is placed above or near the flour collection conveyor that blends the various flour streams.

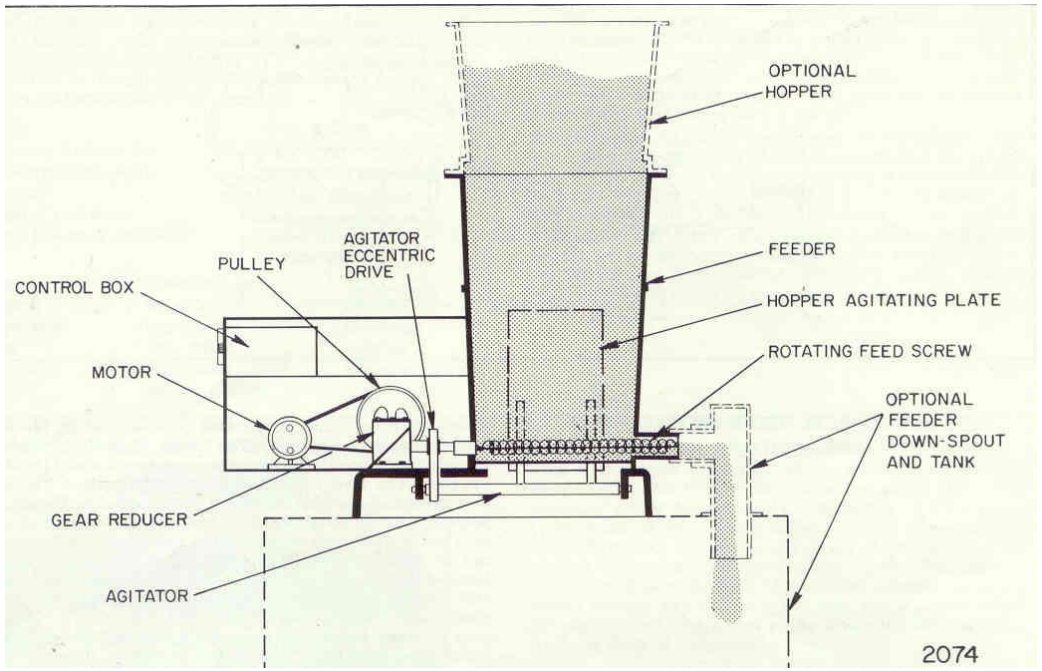


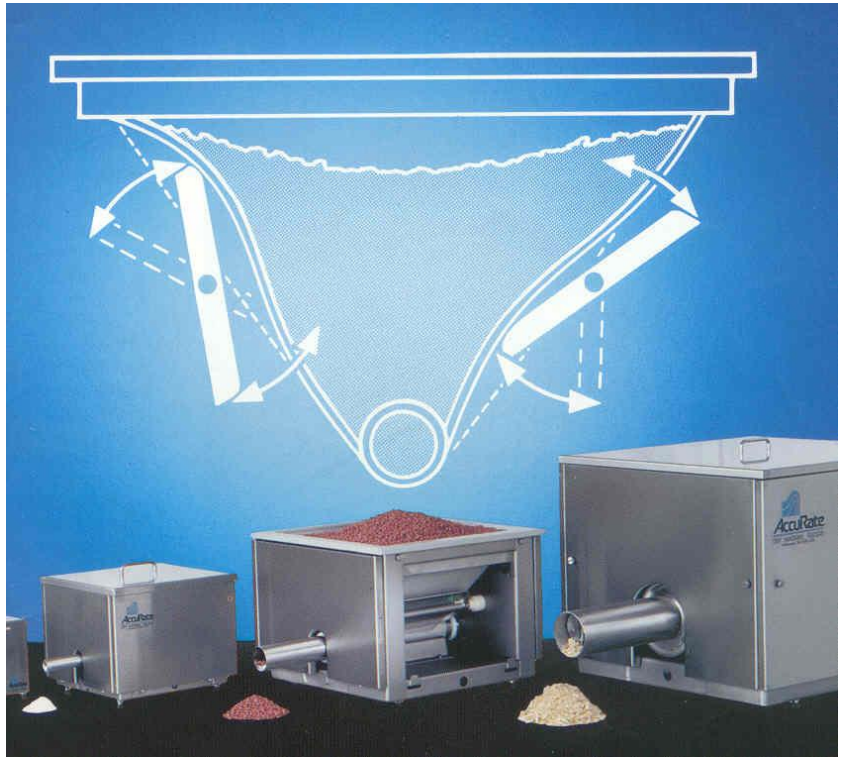
Gravity Feed Method of Premix Delivery

Feeder Types

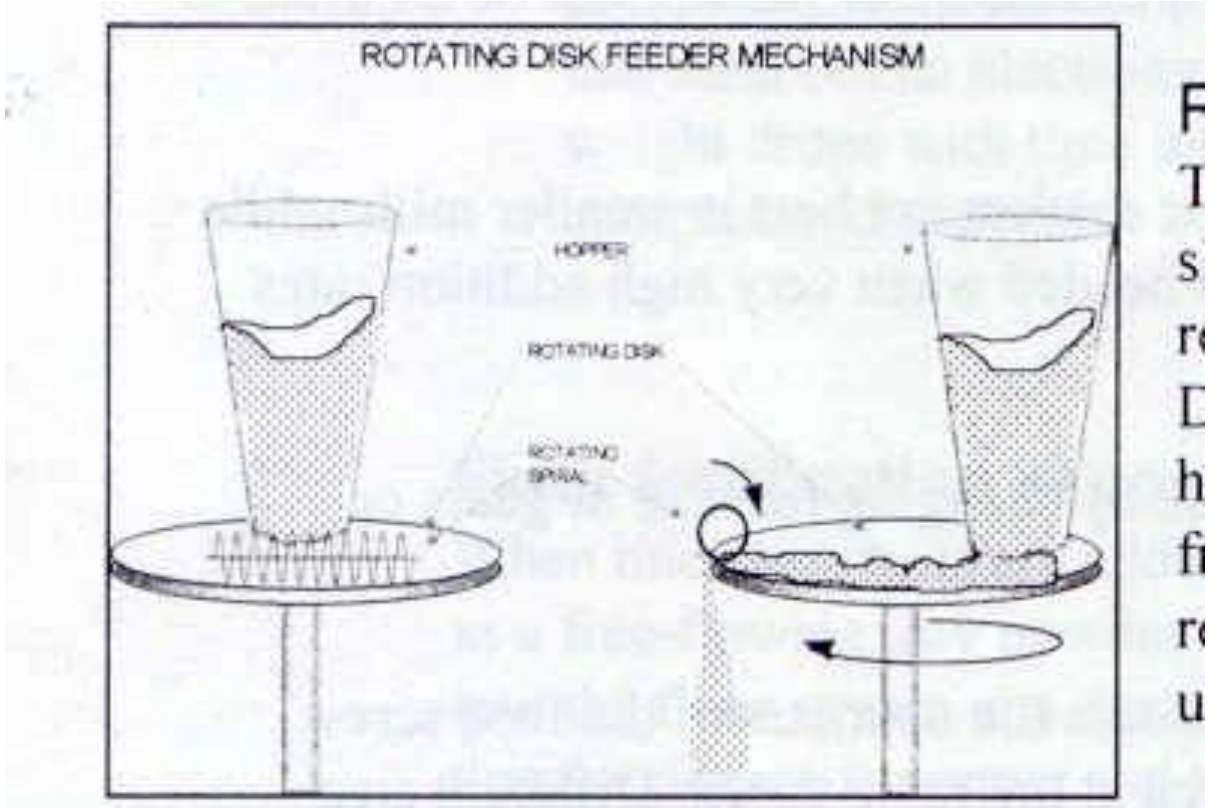
- SCREW FEEDER
  - Discharge and agitator screws
  - Variable speed drive DC motor
- REVOLVING DISK FEEDER
  - Variable Speed drive DC motor
- DRUM FEEDER
  - Adjustable feed gate

Feeders:Screw type





Feeders: Disc type



Feeder: Loss in Weight type

Large Scale Mill: Feeder installation
El Fayoum mill Egypt

Large Scale Mill: Feeder Location Peshawar Pakistan