An Overview of the Milling Industry in China

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Education Background

B.S. Grain Science (Milling option), 2004
M.S. Grain Science (research area: Wheat milling, cereal chemistry), 2008
Henan University of Technology, China

PhD. Biological and Agricultural Engineering (research area: protein chemistry and bio-processing), 2013
Kansas State University

Professional experience

- Design flour mills
- Zhixin was founded by the professors in Department of Grain Science at Henan University of Technology in 2001.
- Zhixin designed more than 600 flour mills in China and other countries.

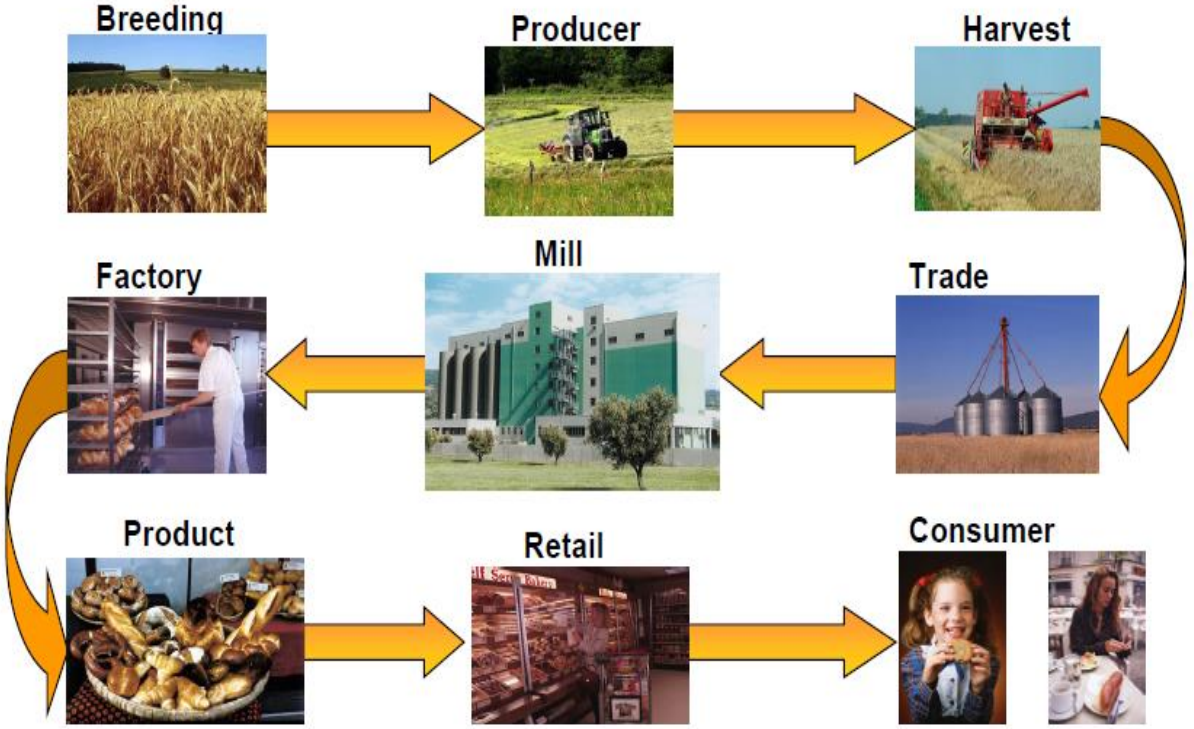
Zhixin Grain Engineering Technology CO., LTD

Outline

- Overview of the milling industry in China
- Development of China milling Technology

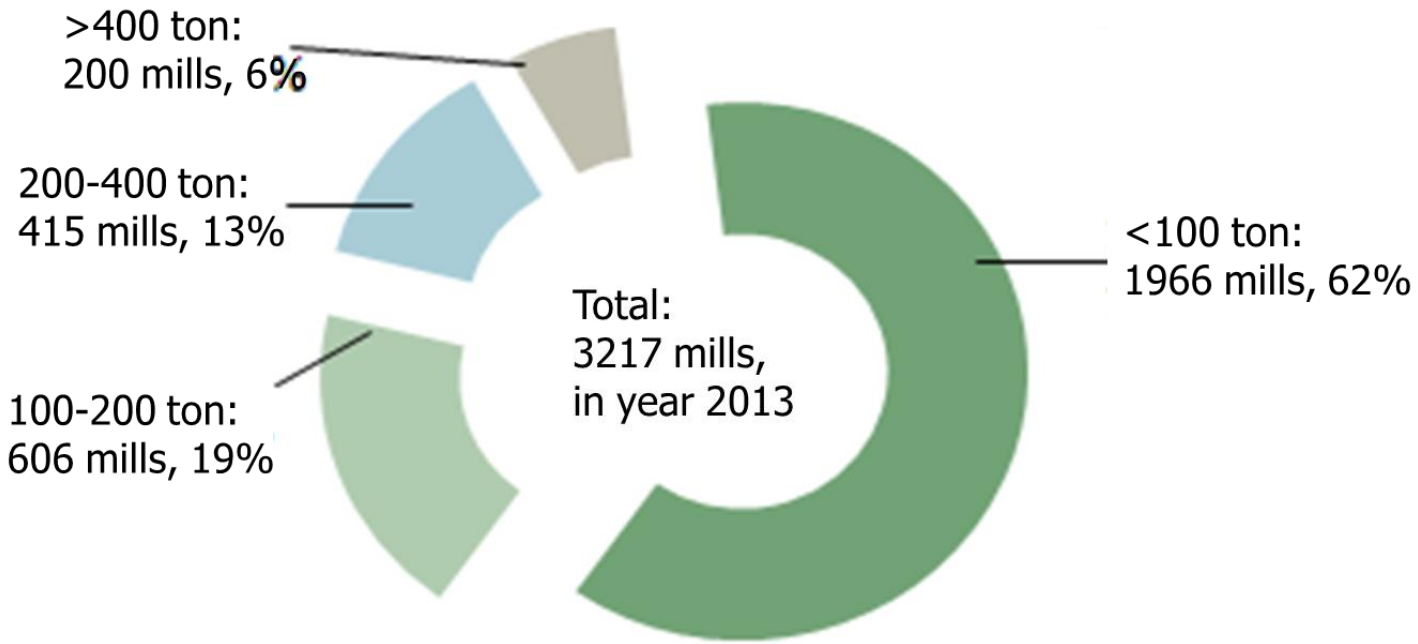
China Crop Production Data

- Population: 1.4 billion
- Largest grain producer (500 MT annually) (US: 360 MT, India: 220 MT)
- Annual grain production:
  - Rice: 150 MT
  - Corn: 120 MT
  - Wheat: 100 MT (US: 55-60 MT)
  - Soybean: 15 MT
- Annual import:
  - Wheat: 9.6 MT (US, Canada)
  - Soybean: 80 MT (US, Brazil, AR)
  - Corn: 7.2 MT (US, Ukraine)
  - Rice: 5.3 MT



China Flour Mills Data

- More than 4,000 flour mills
- Large/middle size mills are the minority



China Milling Industry Data

Largest flour mill in world is in China (Wudeli Flour Group)

- Wudeli Flour Group:
  - Capacity: 62,000 tons/day (1.1 million cwts/day)
  - Market share: 21%.
  - 36 mills (83 line)
  - Employees: >5,000
- Ardent Mill:
  - Capacity: 26,000 tons/day (475,800 cwts)
  - Market share: 31%.
  - 40 mills
  - Employees: 2,400

Wudeli Flour Group

Capacity is projected to 62,000 tons/day by 2017 (1.1 million cwts).

Zhixin designed more than 15,000 ton/day for Wudeli

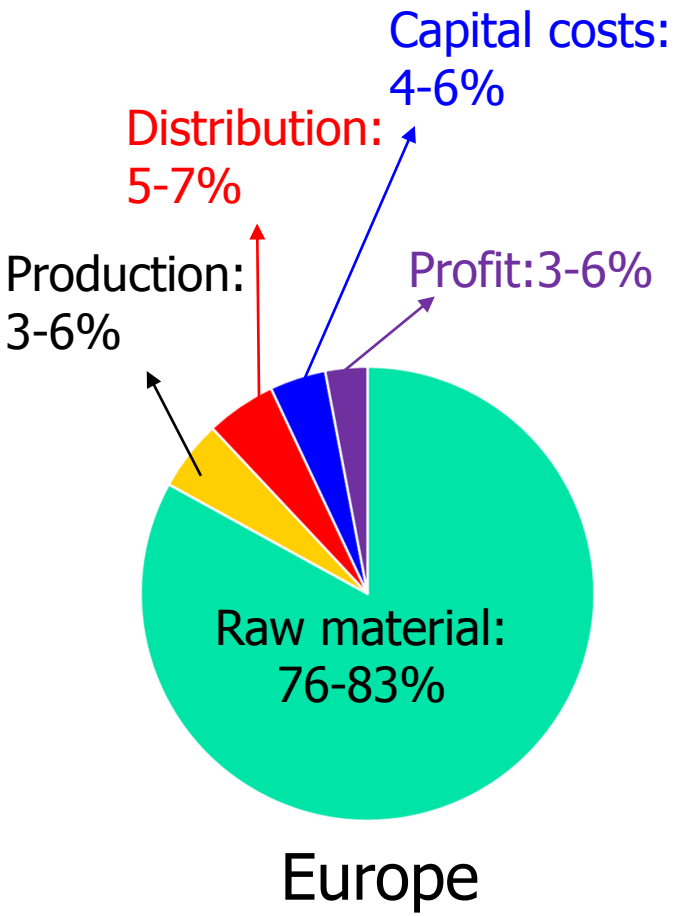
Mill size vs profit model

- Class I: large mill + large storage capacity (>12 month)
  - Profit: wheat trade and processing
- Class II: large mill + intermediate storage capacity (3-12 month)
  - Profit: wheat processing and trade
- Class III: middle mill (300-500 t/d) + small storage capacity (1 month)
  - Profit: wheat processing only
- Class IV: small mill (<300 t/d) + small storage capacity (10 days)
  - Profit: wheat processing only

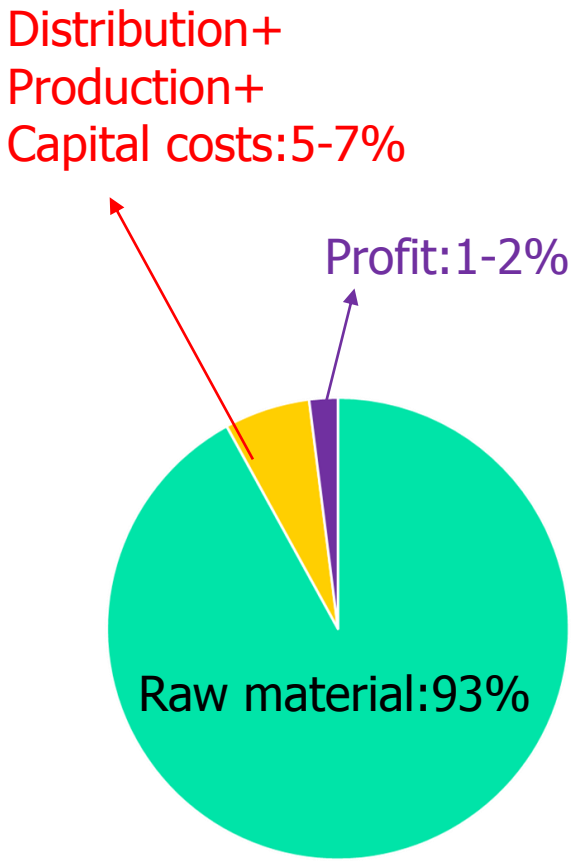
China Milling Industry Data

- Profit is low: 1% (2015-2016), mainly caused by the “cliff-like drop” of price of wheat bran (from 15 cents/lb to 8.7 cents/lb).

Cost structure of EU and China mills



Europe



China

Example: Cost structure of China Flour Mills. (operating time is 80%)

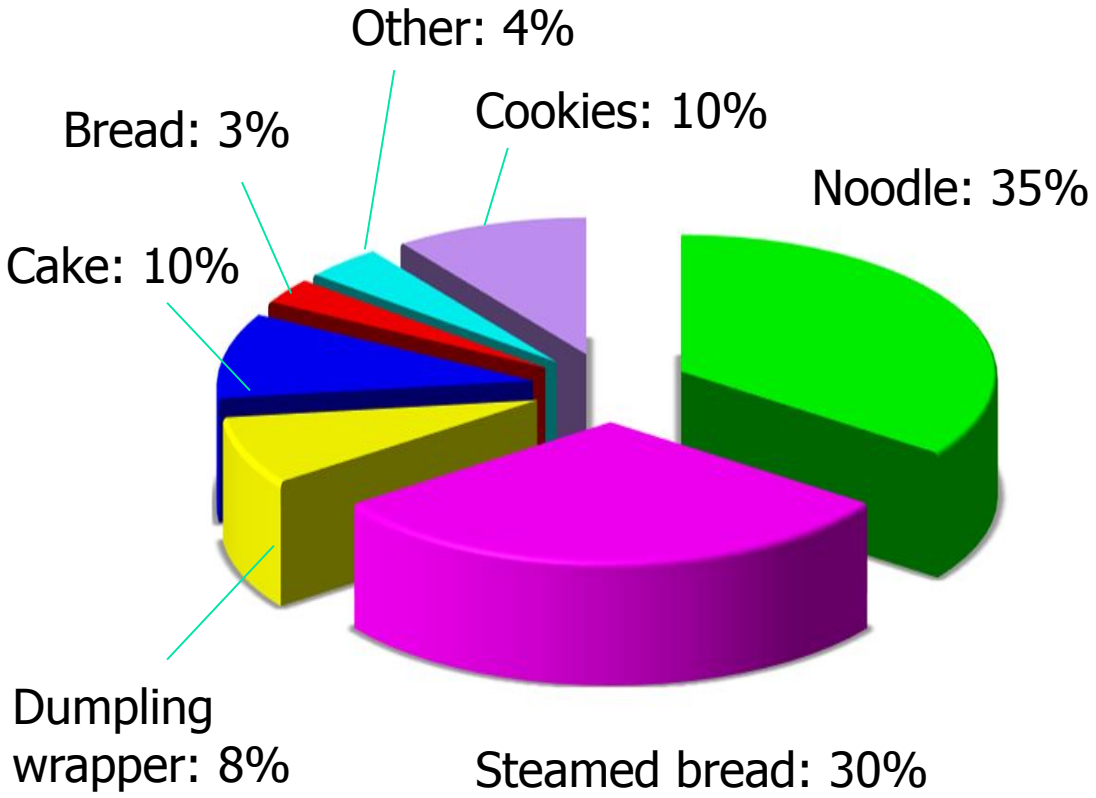
Cost structure to process one Ton of wheat (36.74 bushel)				
	￥/Ton	$/Ton	$/ Bushel	Structure
Wheat	￥2800	$355.00	$9.67	91.50%
Production, Distribution, Capitial cost	￥147-170	$25.00	$0.68	6.50%
Profit	￥30-60	$7.60	$0.21	2.00%

China Milling Industry Data

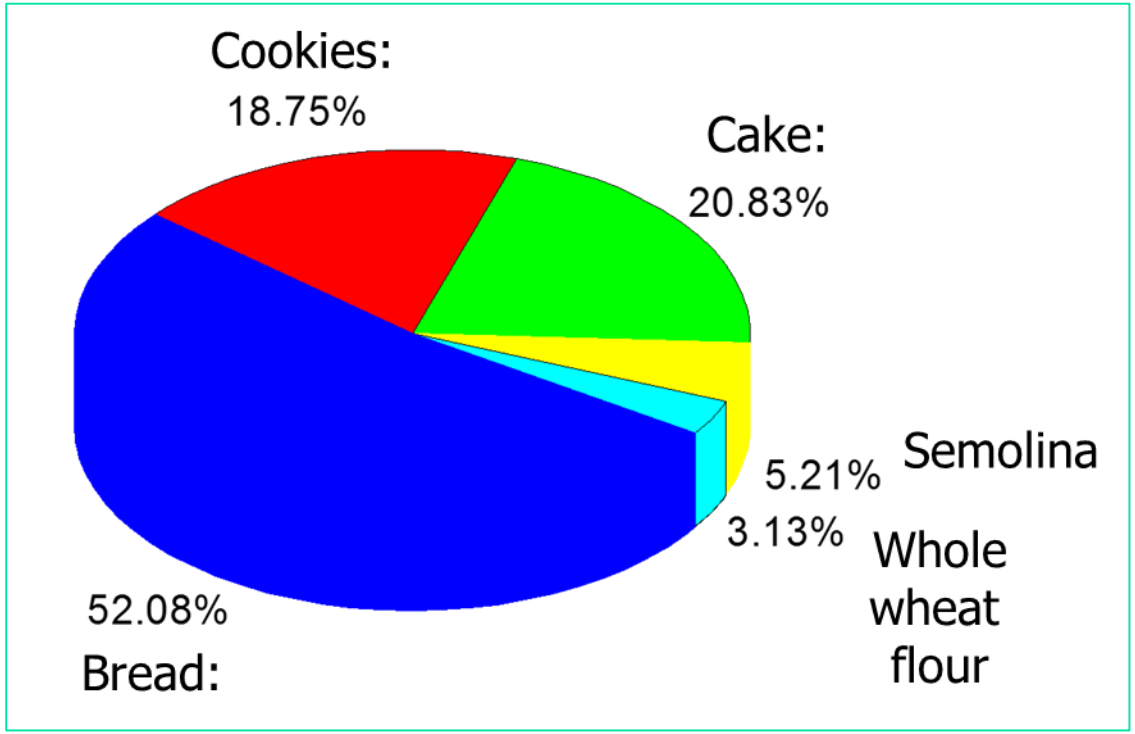
- Serious overcapacity (milling capacity:250 million tons per year, which is 2.5 times of the wheat production)
- Small mills are closed because they are less competitive.
- Big mills are getting larger and larger.

Country	Peak	Operating time	Stable	Operating time (target)
US	?	n/a	190	90%
France	1,400	n/a	360	
Japan	1,000	n/a	110	
China	>4,000	**<50%**	?	

Wheat flour based food in China



China



US

Wheat flour based food in China

Streamed bread: 30%

stuffed bun

Twisted cruller

Bread: 3-5%

Noodles: 35%

Dumpling: 8%

China Milling Technology

Milling technology innovation:

- Optimum low-ash flour extraction rate
- Optimum total flour extraction rate
- Optimum the quality of finished products
- Optimum the capacity of the mill
- Flour safety
- Maintain flour quality consistence
- Manufacturing cost (Power consumption)
- Automation
- Others

China Milling Technology – history

- 1950-1980: short flow diagram (straight flour, ash is high)
- 1980-2000: medium flow diagram (purifiers, flour graded by ash)
- 2000-2008: medium flow diagram (ash content and electricity cost)
- 2009-present: long and wide flow diagram (low-ash flour, particle size, flour quality)

Period I: 1950-1980

- Break and reduction systems
- 1-3B, or 4B, 1-3 M:
  - 1B produces up to 25-50% of flour; 1B break release: 50-70%; 1M produce 25% flour
- Extraction: 83.6%, Ash: 0.97%,
- Particle size: 210 µm
- Corrugated rolls
- Electricity: 40 kw/ton

Period II: 1980-2000

- Medium lenghth flow diagram (Buhler, Ocrim, Satake)
- B: Corrugated roll; M: Smooth roll
- 1-4 B, 1-7 M, 2S, 2T, 4-5 P
- Roll length: 12 mm/100 kg/24 h
- Sifting area: 0.08 m^2/100 kg/24 h
- 1B break release: 30-40%, flour extraction of 1B: 4%
- Total extraction rate: 74-75% (F1: 53%, 0.53% ash; F2: 19.8%, 0.66% ash)
- Particle size: 12-13 XX (108 µm)
- Electricity: 75 kw/ton (17.8 cwt)

Period III: 2000-2008
-- how to reduce energy consumption

- Medium flow diagram (Zhixin, Golden Grain, Buhler)
- 1-4 B, 1-8 M, 2S, 2T, 4-5 P
- Roll length: 10-12 mm/100 kg/24 h
- Sifting area: 0.08-0.09 m2/100 kg/24 h
- 1B break release: 30-36%, flour extraction: 3-4%
- Total extraction rate: 75-76% (F1: 30-35%, 0.43% ash; F2: 35-40%, 0.58% ash; F3: 6%, 1.2 ash)
- Particle size: 12-14 XX (100 μm)
- Electricity: 60 kw/ton (60 kw/17.8 cwt)

Impactor

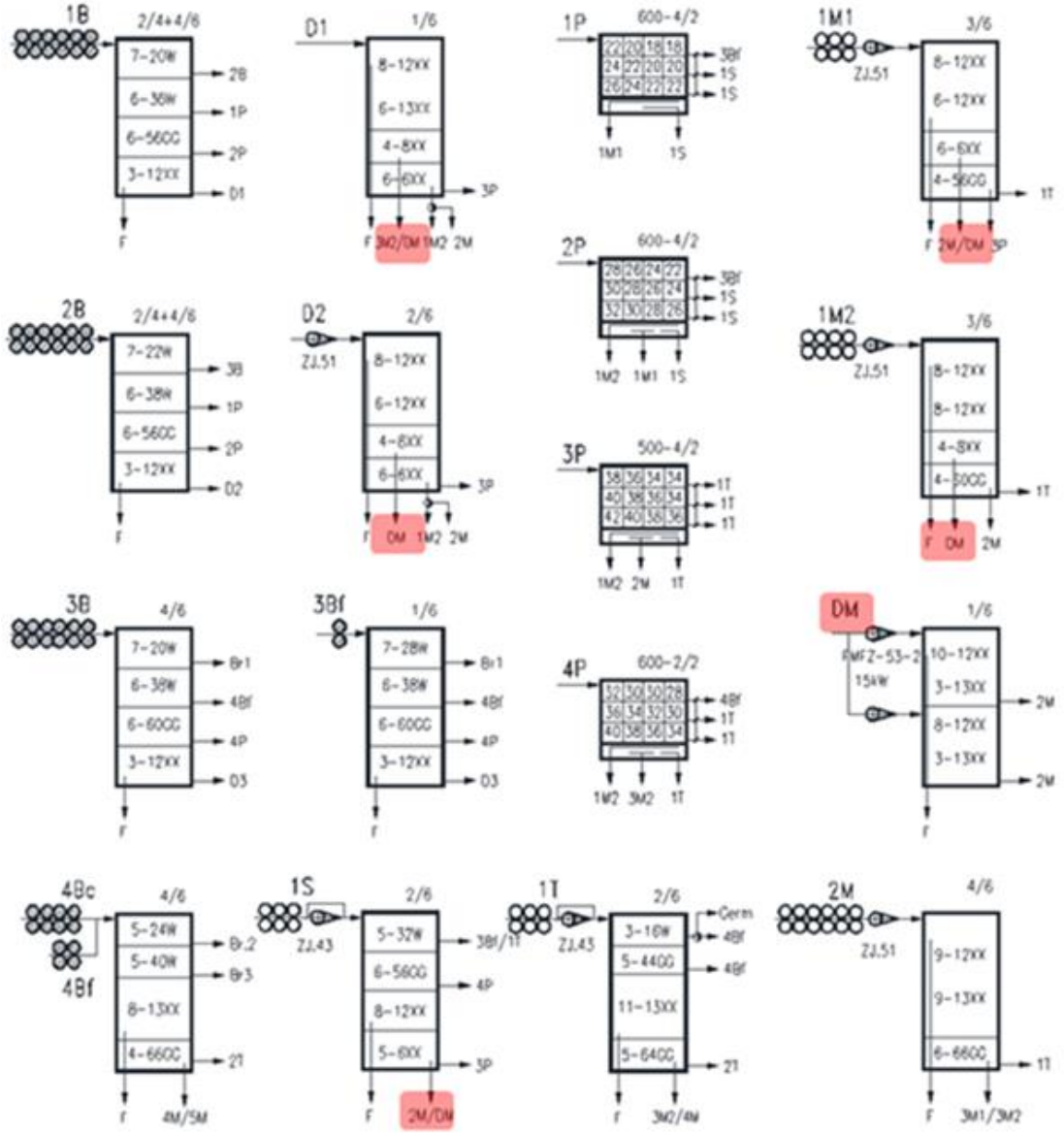
Period III: 2000-2008

Impactor (DM):
D1, D2, 1S, 1M, 2M

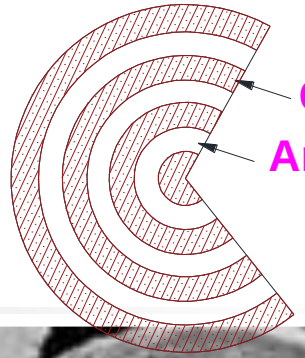
Particle size:
108-181 μm

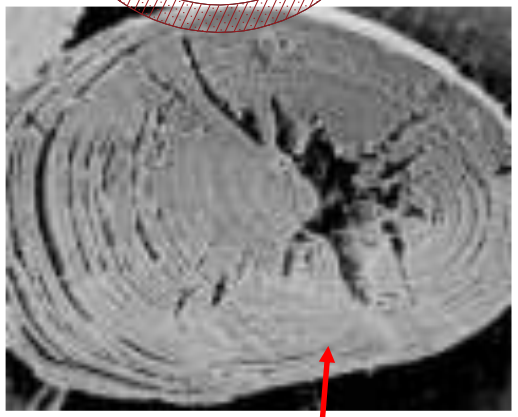
If capacity: 600 T

- DM: 600 x 12% =72 T/D
- 2M capacity: =20 T/D
- 2M motor: = 15 kw/h x 4
- Impactor motor: = 15x1 kw/h



Period III: 2000-2008



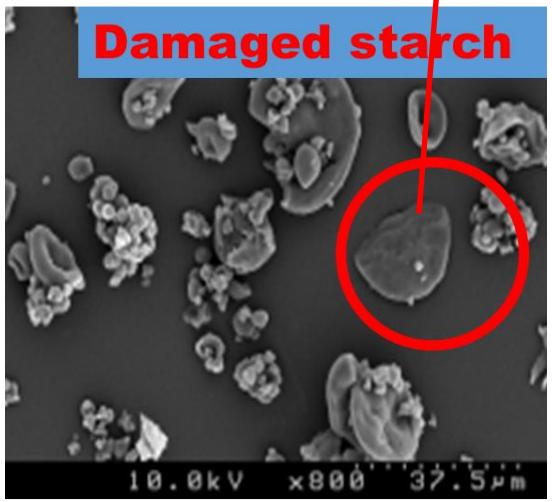


Advantage:

- Energy consumption is low (60 kw/ton)

Disadvantage:

- Particle size is too small (100 μm)
- Ash content is high



Li et al. 2009 (MS thesis)

Small particle size results in high damaged starch

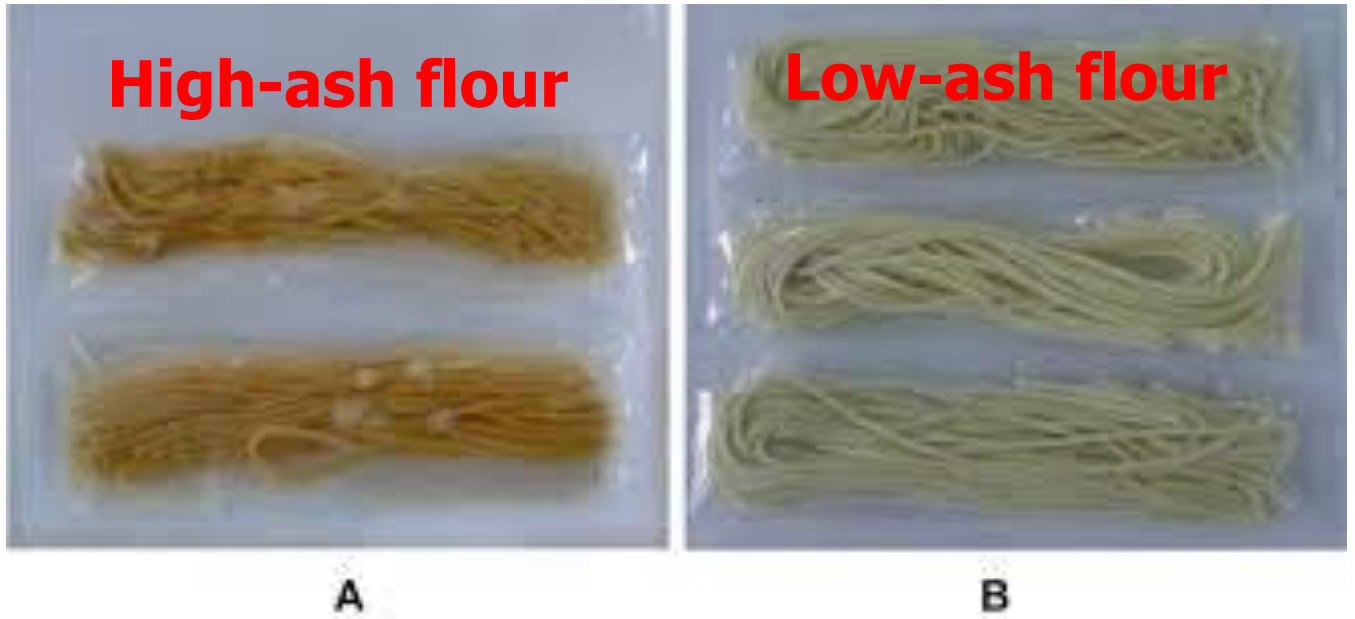
<160 µm, DS 16 UCD **<123 µm, DS 21 UCD** **<90 µm, DS 27 UCD**

- Flour with particle size 11xx (123 µm) and DS 20.8 UCD (hard wheat) makes the best bread.
- Low DS results in coarse and non-uniform crumb texture.
- High DS lead to low volume and sticky crumb structure.

Li et al. 2009 (MS thesis)

Noodle and cake need low-ash flour

Effect of ash on noodle quality



- High-ash flour noodle is darker than low-ash flour.
- High-ash flour has higher polyphenol oxidase (PPO) content.

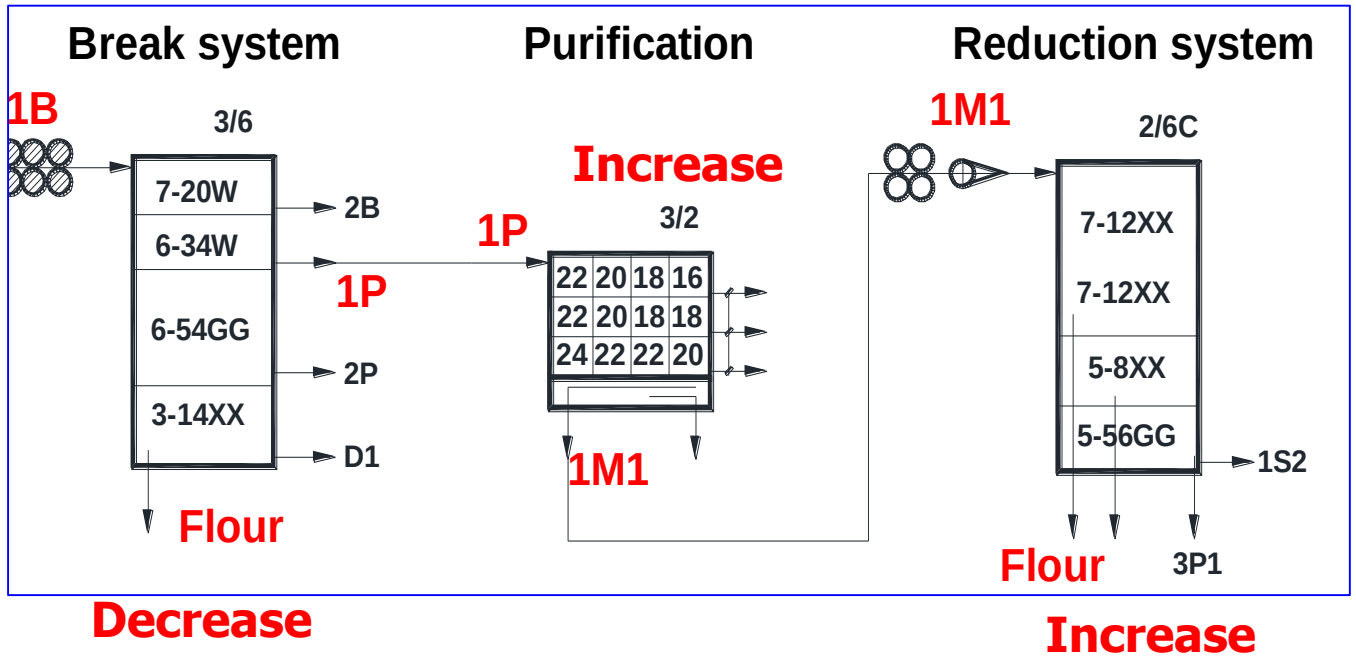
Period IV: 2009-present
--*Significant improvement*
(Zhixin, Golden Grain, Buhler)

Objectives:

- Increase low-ash flour yield
- Increase total flour yield
- Particle size

Period IV: How to increase low-ash flour yield?

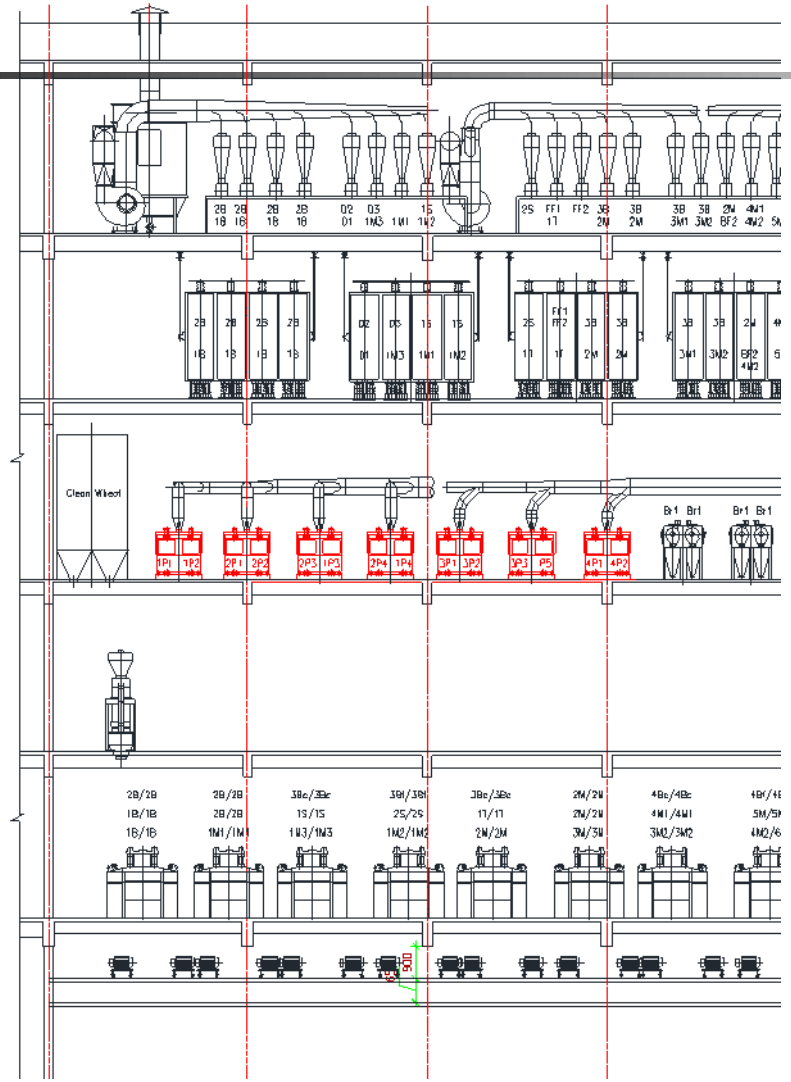
Milling diagram



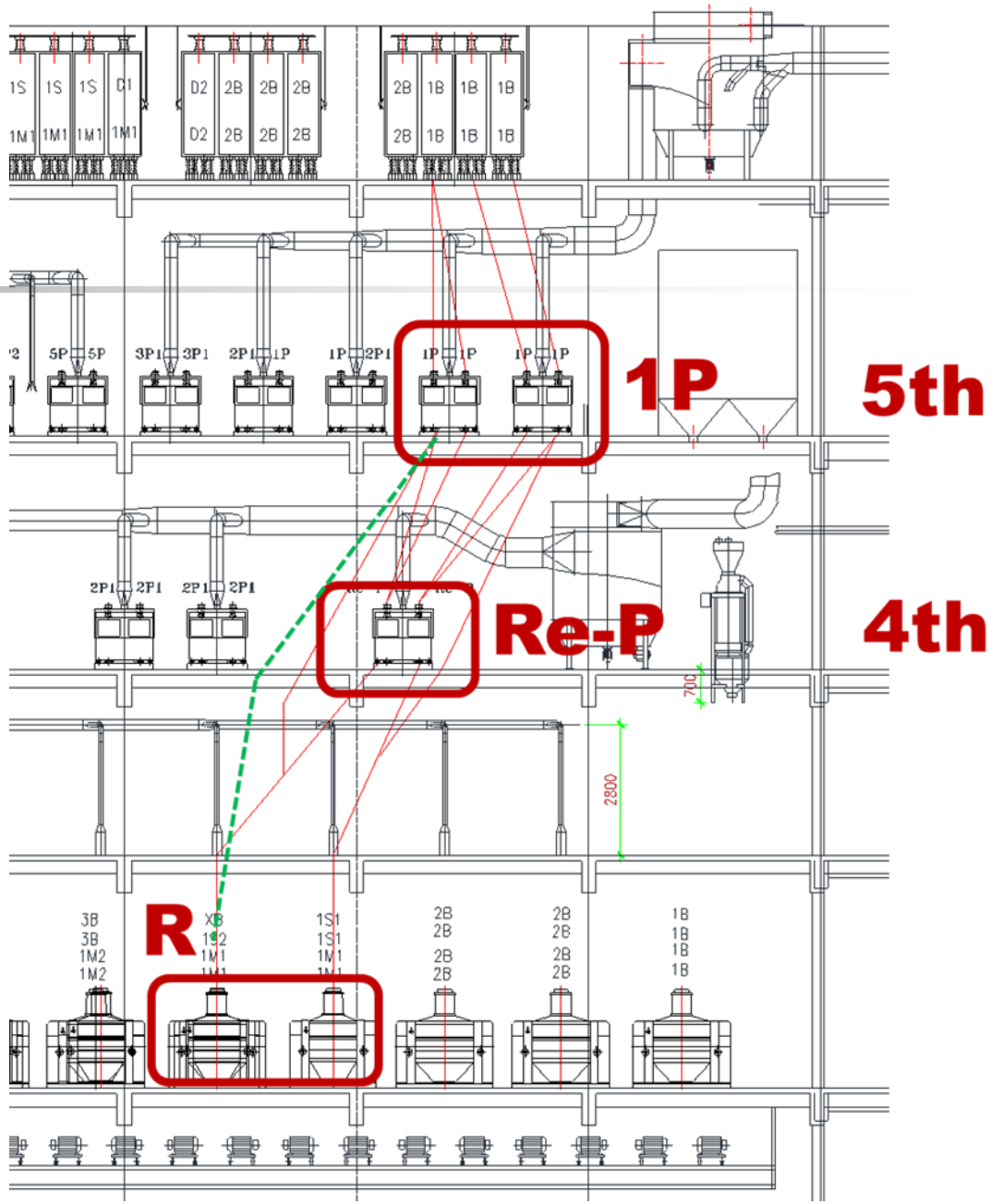
- Minimum the flour yield from the break system (B).
- Maximum the high quality middlings from break system to the purification system.
- Must improve the break release quality.

Li et al. 2009 (MS thesis)

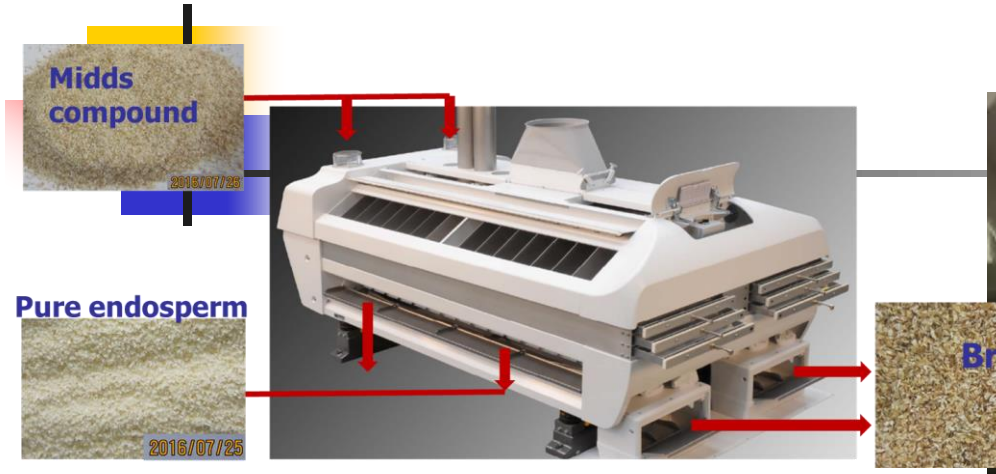
Mill A



Mill B

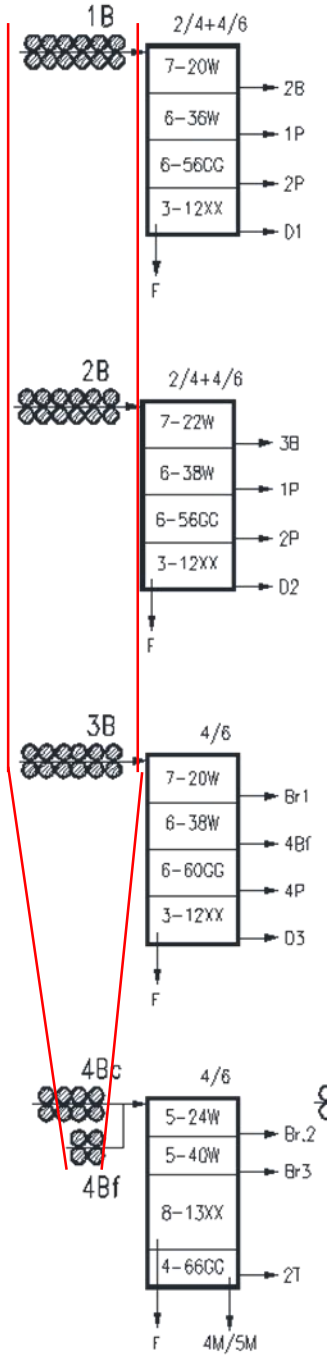


Period IV: Re-purification



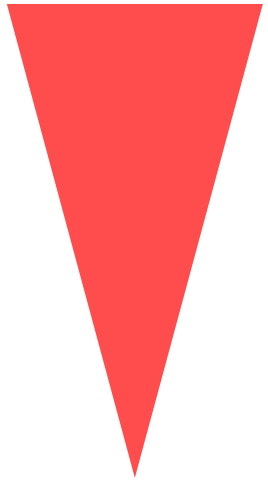
Wudeli Flour Group:
750 x 4 ton/day
(13,500 x 4 cwts/day)

Period IV: Roller length

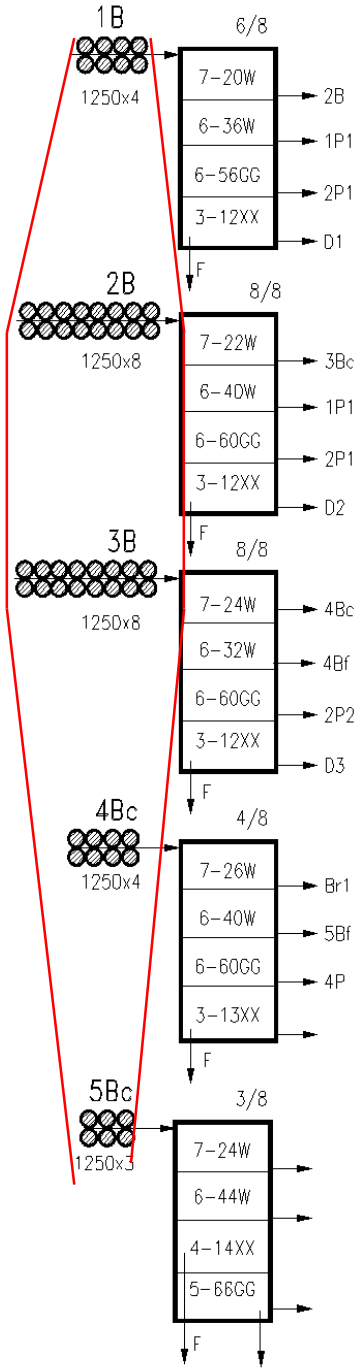


Mill A

Medium flow sheet (wedge)



Mill A: medium flow sheet.
Mill B: long flow sheet.



Mill B

Long flow sheet (football)

Summery of Period IV: 2009-present

- Longer and wider flow sheet (5B, 8M, 2S, 2T, 45-17P)
- Roll length: 14-16 mm/100kg/24h
- Sifting area: 0.1-0.12 m^2/100kg/24h
- Break release quantity vs quality
- Purification: 3.5 mm (up to 17 P; middlings :150-950 μm); Re-purification
- Roll parameters
- Total flour yield: 78-80%. F1: 55% with ash content of 0.4-0.45%
- Energy consumption: 74 kw/t

Future trend

- Merge: mills number will decrease.
- Flour safety: Vomitoxin (mycotoxin, DON) fast detection and removing technology.
- Automation (clean, blending, milling, post-treatment optimization and modelling).
- Special flour development.
- Whole grain milling (wheat, barley, buckwheat) (currently 1%) (taste, safety, quality, color, nutrition, stability).
- Value-added products development from high-ash flour and by-products.

Thank you !