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Improvements in Sorghum Milling Technologies

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Endless possibilities in food research

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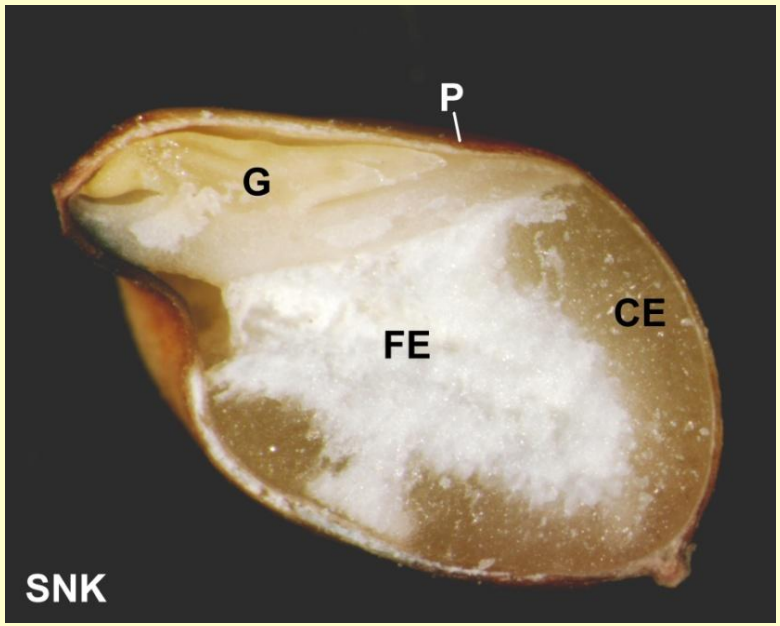
Introduction

- Sorghum is staple food for millions in African and Asian countries
- It ranks 5th in production worldwide, but is 2nd most important after maize in Africa
- The crop is adapted to drought conditions and therefore could be a strategic grain for food security in Sub-Saharan Africa

Limitations

- Sorghum has been neglected until recently; Little R&D efforts compared to other common cereals
- Sorghum food industry is non-vibrant (largely traditional products)
- Generally there is lack of suitable sorghum food processing technologies
  - Low production capacity
  - High milling loses
  - Variable product quality

Sorghum milling



Cross section of the sorghum kernel

P = Pericarp
FE = Floury endosperm
CE = Corneous endosperm
G = Germ

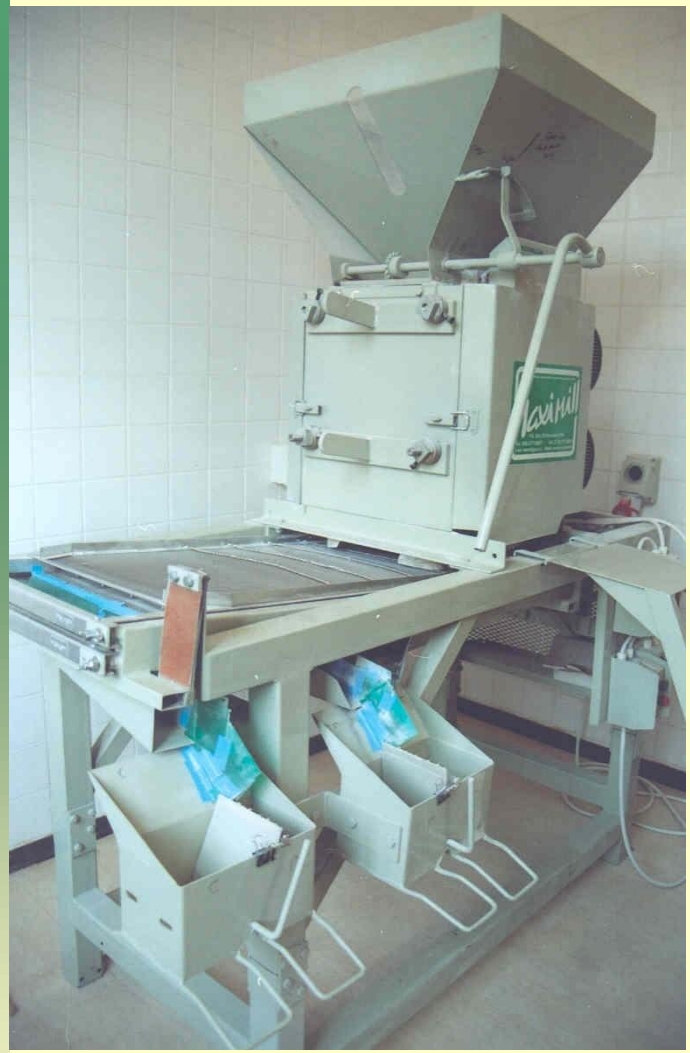
Purpose of milling is to;

- Separate the starch-rich endosperm (84 %) from the pericarp (6 %) and the germ (10 %)
- Reduce the “clean” endosperm to small particles (meal)
- Critical considerations – efficiency (economics) of milling technology and meal quality

Two basic approaches to cereal grain milling

- Break open kernel, then scrape endosperm from bran
  - Mainly used for wheat milling (roller milling)
  - Multiple grinding and separation steps (sifting, aspiration and gravity separation)
- Pericarp (bran) and germ are first removed by degerming or decortication, then endosperm is reduced to grits or flour
  - Typically used for maize
  - Conventional Beall-type degerminator cause breakage of sorghum endosperm; bran contamination (integral germ and spherical shape)
- Both approaches have been tried for sorghum

Trends in development of milling technologies



- Perten 1983 - Adaption of wheat roller milling technology for sorghum
  - Uneconomical low yields
  - Products of inferior quality (bran contamination)
- Lately small roller mills (2-3 roller pairs) are gaining popularity
  - Optimisation of milling process with respect to roller gap, tempering, and sieving
  - Improved yields but bran contamination still high

Roller milling cont.

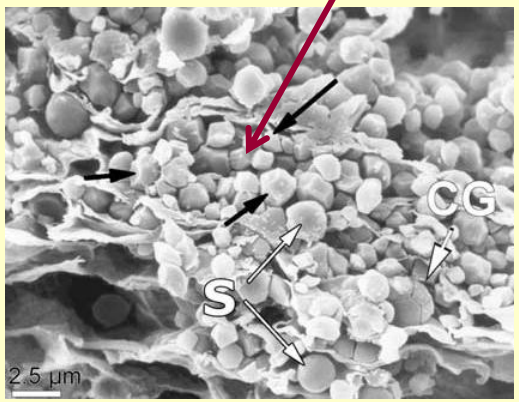
Comparison of milling performance of abrasive decortication and roller milling using 10 sorghum varieties with different physico-chemical properties

Parameter	Abrasive Decortication	Roller Milling
Meal extraction (%)	75.7a	83.7b
Ash (%)	1.18a	1.29b
Oil (%)	2.46a	2.64b
L	84.6b	82.4a
C_{ab}	10.8a	11.6b
h_{ab}	70.5b	68.6a

Other considerations;

- Roller mill – narrow particle size distribution; wide for hammer mill
- Roller mill has significantly higher meal output (about 195% higher than abrasive and hammer milling system
- Roller mill has high energy efficiency (32 kg meal/1kwh), while abrasive hammer mill produced 12.9 kg meal /1kwh

Difficulties with separation of bran



Source: Earp et al (2004)

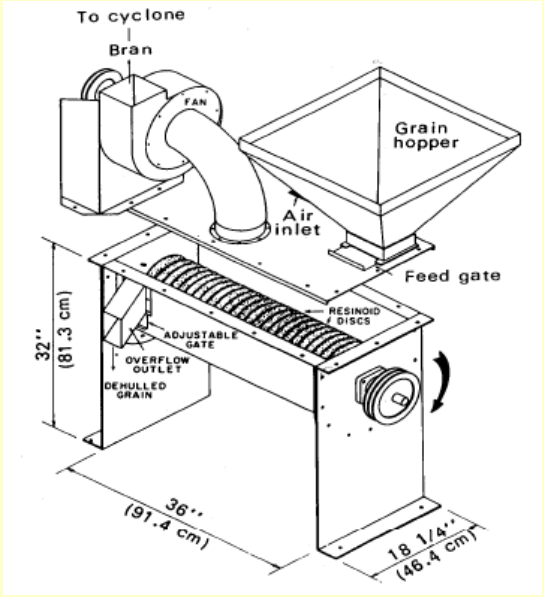
- Starch granules in mesocarp makes pericarp very friable
- Forms small bran flakes which are difficult to separate from meal
- Bran layer should be toughened to separate as large flakes

- Focus on tempering
  - Best tempering moisture content
  - Treatment temperature
  - time

Other technologies considered

- German Schule
- Swiss Decomatic
- Danish United Milling System
- Prairie Research Laboratory (PRL) Dehuller
- PeriTec system

PRL Dehuller and hammer mill

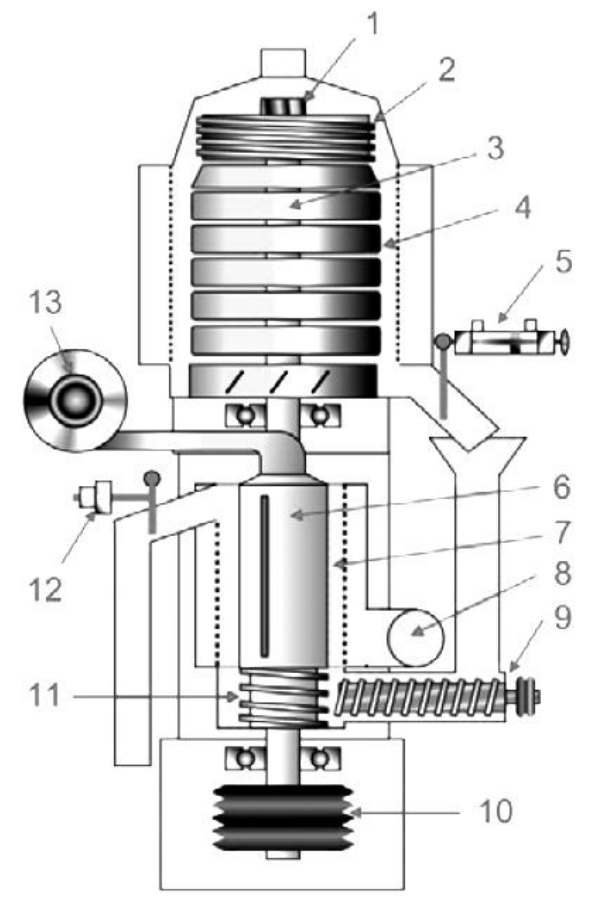


- Canadian PRL dehuller was adapted for local conditions in West, Eastern ad Southern Africa, and India
- Dry grain is decorticated by abrasive carborundum disks revolving at high speed in a barrel (fine bran removed by aspiration)
- Milling package (dehuller & hammer mill) was technically and economically viable
- Gave rise to sorghum industry in the region (service milling for villagers)
- Adequate technical support by RIIC contributed to industry success in Botswana

Imrpovements in production capacities

- Increasing demand for sorghum meal require higher production capacities
- Attempts to build larger dehullers compromised milling efficiency and meal quality
- Commercial mills now install normal PRL dehullers in series and/or in parallel
- 4-5 dehullers feed one hammer mill
- Typical capacities are 2 to 2.5 tons per hr

Production capacities



PeriTec system; Used with Satake Corporation's permission

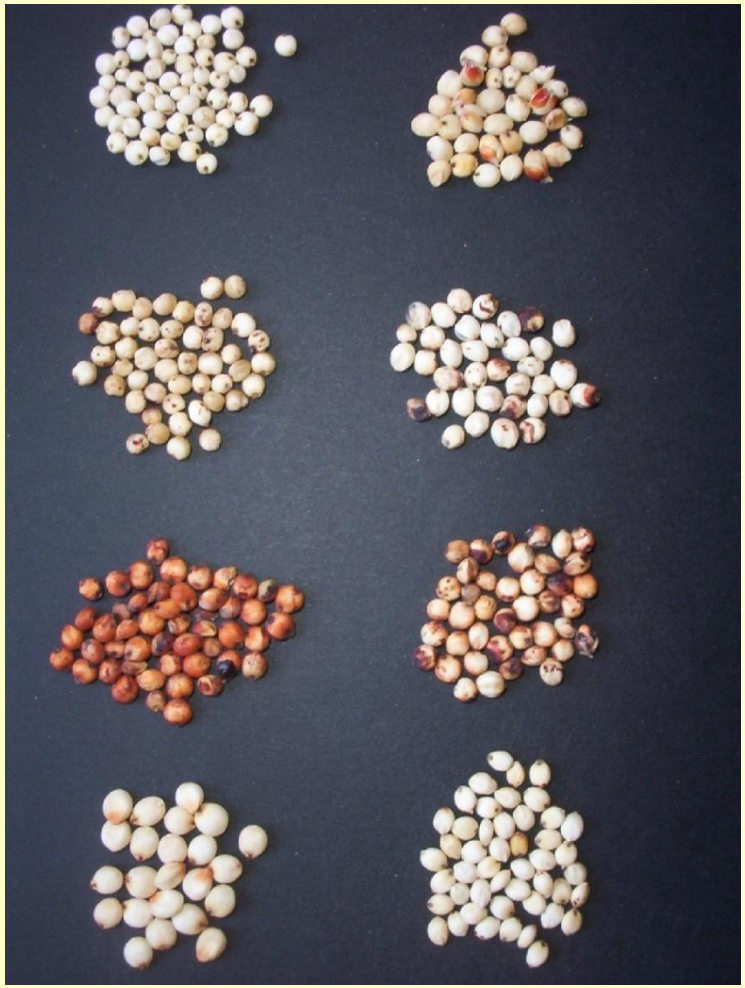
- Some mills now using PeriTec decorticator – Vertical Debranner VCW(Satake Corporation)
- Debrans by abrasion using revolving carborundum wheels and hexagonal slotted screen (stage 1) and friction (stage 2)
- Bran is removed by blowing air through the system from bottom to top outlet
- Requires conditioning of grain with 1-3% moisture (by weight) for 3-5 min before debranning – permits gradual stripping of pericarp layers
- Offers controlled rate of bran removal, uniformly debranned grains and improved power efficiency
- High input capacities – 2 to 10 tons

Grain cleaning

- Millers now installing grain cleaning equipment (sieving, aspiration and metal removal)
- Necessary for high production capacities

Selection of varieties

- Meal quality varies with sorghum varieties used
- Millers aim to meet consumer demands
- Blending of different varieties commonly practiced
- Typically hard to intermediate endosperm texture preferred
- Light coloured meals with medium course texture preferred in Botswana
- Taste is also important



Conclusions

- Abrasive decortication is still the only appropriate technology for decorticating sorghum to meet consumer preferences
- Roller milling has potential as an alternative sorghum milling process but still requires optimisation of the tempering process

THANK YOU!