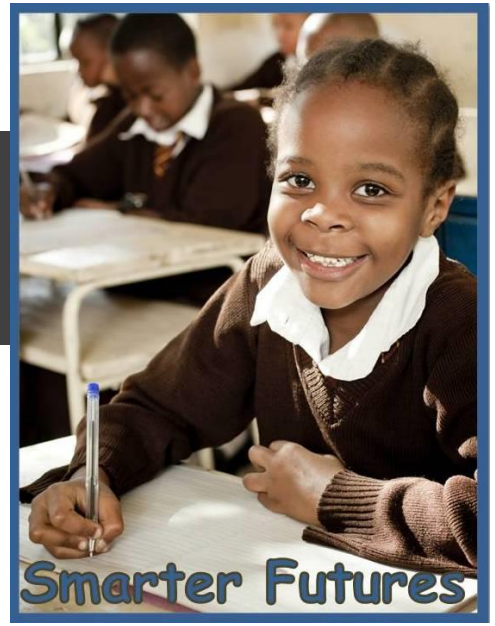
Maize Milling Technologies



Small, Medium and Large Scale Mills

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Enhancing Grains for Healthier Lives

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Maize kernel composition
Weight distribution of main parts of the kernel

Structure	Percent weight distribution
Pericarp	5-6
Aleurone	2-3
Endosperm	80-85
Germ	10-12

The endosperm is the main component of de-hulled maize flour

Source: FAO

Typical Extraction Rates for Maize meal

Mill size	Maize meal Extraction Rate %	Kernel Components for conversion to maize flour
Large	70 - 75	Endosperm with some pericarp and germ
Medium	65 - 70	Endosperm, pericarp and germ
Small	60 - 65	Endosperm little or no pericarp and germ

NOTE:

Pericarp and germ components can influence the taste of the cooked porridge

Bitterness is one of the characteristic tastes from the pericarp and germ

The purer the endosperm used to mill into flour the lower the bitterness taste

Criteria for establishing the cut-off points

Mill Size	Criteria	Cut-off point/Category
Large	Rated capacity*, Registered business with regulatory bodies (FDA, NBS, Revenue agency, etc.)	50* tons per day grinding Branded flour product for sale
Medium	Rated capacity*, Registered business with regulatory bodies (FDA, NBS, Revenue agency, etc.)	20 – 50* tons per day grinding Branded flour product for sale
Small	Rated capacity*, Registered business with regulatory bodies (FDA, NBS, Revenue agency, etc.)	Less than 20* per day grinding Branded flour product for sale
Small	Rated capacity*, May be registered	Less than 20* per day grinding Toll milling (fee for service) Unbranded flour

*Based on 24 hour operation per day

Maize Milling Rated Capacities and Development Partners

Mill Size	Rated Capacity (MT per day)	Development partners
Large Scale	50	FFI, GAIN
Medium Scale	20 - 50	FFI, HKI, MEDA, PHC, Sanku, WFP
Small Scale	Less than 20*	Sanku, WVI, UNICEF, other

* In the case of maize milling the cut-off point needs to be clarified based on official status of mills (registered or not with regulatory bodies such as FDA, Bureau of standards, etc.)

Large Maize Mill (Registered business) Process Flow - Automated

1. Maize Reception and storage
2. Cleaning
3. Dehulling (Degermination)
4. Roller Milling and or Hammermill
5. Sifting
6. **Fortification (**Conventional feeder/conveyor)
7. Quality Control Laboratory
8. Packaging in labelled bags and registered with Bureau of Standards or country FDA
9. Warehousing and Distribution

Large Maize Mill - Feeders

Medium Maize Mill Flow Chart (Commercial registered business)

1. Maize Cleaning
2. Dehulling (degermination)
3. Roller Milling and or Hammermill
4. Sifting
5. **Fortification** (conventional feeder/conveyor or **Sanku System** machine post dehulling)
6. Limited Quality Control testing
7. Packaging in labelled bags and registered with Bureau of Standards or country FDA
8. Limited distribution within country and at district level

NOTE: Medium mills can be both automated and separate dehulling and milling operations

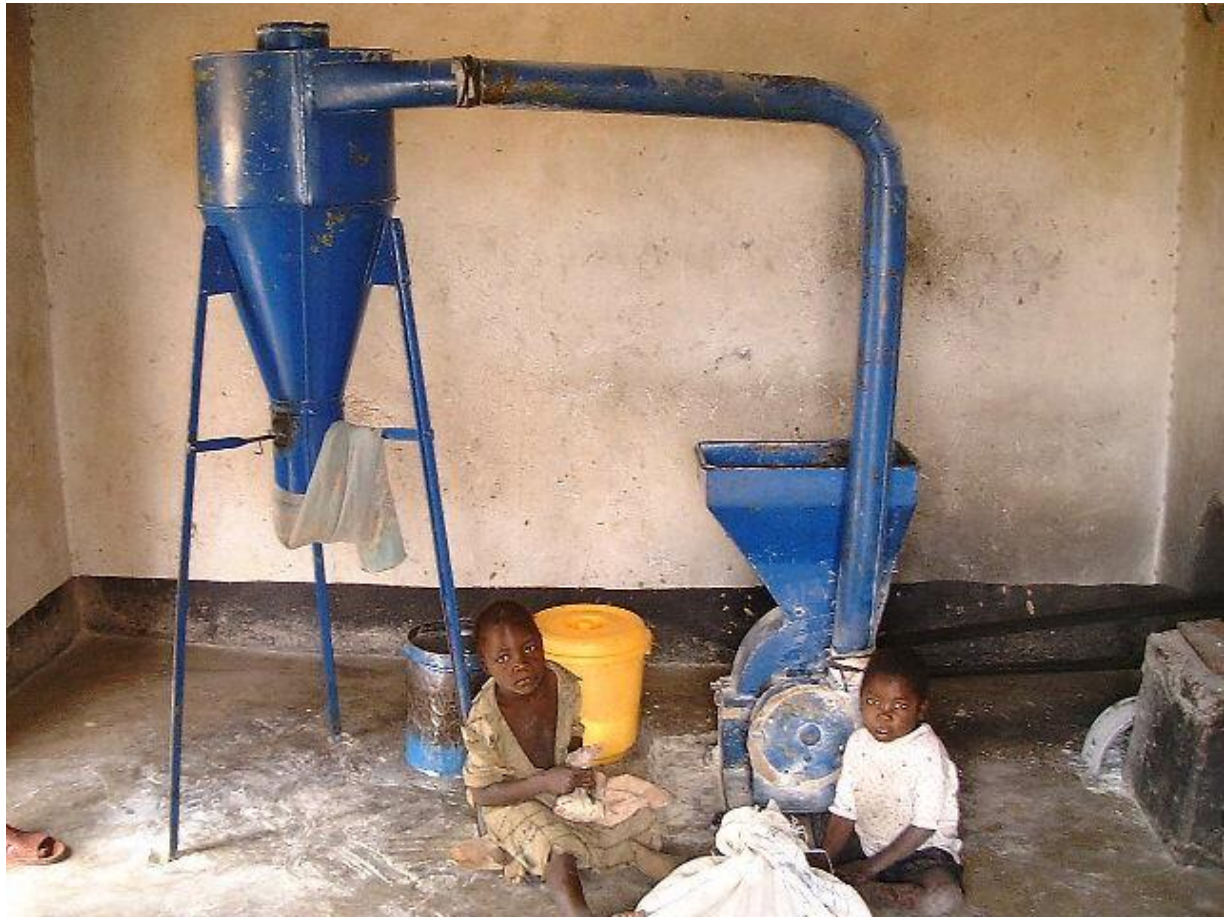
Medium Size Mills – maize storage and cleaning

Medium Size Mills – Milling and Feeder

Small Scale Milling
(Commercial registered business – Manual operation)

1. Maize cleaning (machine or by hand)
2. Dehulling
3. Single hammermill (or roller mill)
4. Fortification (**Sanku System** or scoop and bucket method)
5. Packaging in bags with trade name and registered with bureau of standards or FDA)
6. No Quality Control laboratory and or limited testing
7. Selling flour in branded label bags at mill site or distributed to retail shops – Local urban and peri-urban areas

Small Scale Mill – Posho mill



Maize Milling: Product extraction rates from dehulling

- Whole Grain: 100%
- De-hulled Maize grits, small mill dehuller: 65-70% extraction
- De-hulled Maize grits, large mill dehuller: 75-85% extraction
- Small mill de-hullers remove a proportion of the endosperm with the germ and some bran fractions.
- The degree of de-hulling will change the characteristics of the final maize flour in terms of cooking properties, flavour, taste and nutritional value.
- The lower the extraction rate from de-hulling the lower the nutritional value of the final flour for porridge in terms of protein, essential amino acids, minerals, and vitamins

Maize Grain – Vitamin Content (typical)

Vitamin	Concentration (mg/kg)	Comment
A	2.5	Oil soluble found in germ
E	30 (IU)	Oil soluble found in germ
B1	3.8	Water soluble
B2	1.4	Water soluble
B3	28	Water soluble
Folic Acid	0.3	Water soluble

B12 is not found in maize

Source: AACC et al

Maize Grain– Mineral Content (typical)

Mineral	Concentration (mg/100 g)	Comment
P	299.6 ± 57.8	80% as Phytate
K	324.8 ± 33.9	
Ca	48.3 ± 12.3	
Mg	107.9 ± 9.4	
Na	59.2 ± 4.1	
Fe	4.8 ± 1.9	Key mineral (WHO)
Cu	1.3 ± 0.2	
Mn	1.0 ± 0.2	
Zn	4.6 ± 1.2	Key mineral (WHO)

Source: FAO

Nutrient Losses during milling – Maize Meal

Nutrient	Large Mills	Medium Mills	Small Mills*
Protein	20%	20%	30-35%
Fat	60%	60%	65%
Iron	66%	66%	75%
Zinc	66%	66%	70%
Folic Acid	50%	50%	65%
Vitamin A	69%	69%	75%

* The losses are higher in small mills due to the greater degree of dehulling

Conclusions

- Roller milling of maize produces maize flour with different organoleptic characteristics from flour milled in hammer mills
- The preference for low extraction maize flour has a significant influence on the nutritional value of the final cooked porridge as consumed particularly low intrinsic values for minerals and key vitamins such as vitamin A and folic acid
- Maize flour fortification is an essential tool to help address micronutrient malnutrition in the African context