Some observations on Mechanized Processing of Small Millets

for

Expert Consultation on Millets Processing Machines

WASSAN, Secunderabad

by

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In this presentation

- **Challenges in SM processing**
- Available hulling technologies for SMPUs
- Ease of use criteria for comparing hulling technologies
- Conclusion

Foxtail millet hulls discarded by a bird after eating up the kernel inside; note the beautiful single split in the hull

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Challenges in SM processing

- Size ! They are small !!
- Varieties – classic eg. of localization
- Variations due to cultivation practices & micro climate
- ***Infestation Free processing !!***

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Grain properties

- Used in processing
  - Size
    - Cleaning
    - Grading
  - Mass / Weight
    - Cleaning
    - Destoning
    - Grading
  - Coefficient of Friction
    - Cleaning
    - Removing unhulled grains from millet rice
- Cannot grip/get a hand on
  - Elastic Modulus
    - Husk
    - Kernel
  - Hardness
    - Husk
    - Kernel
  - Other props
    - Adhesion coefficient of husk to kernel
    - Moment of inertia (a function of shape of the grain)

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Machines for SM processing

- Graders / Shakers
  - Size based segregation
- Destoners
  - Weight based segregation
- Air classifier / Aspirator
  - Weight & buoyancy based segregation
- Hullers
  - Separate the edible (kernel) and non edible (husk)

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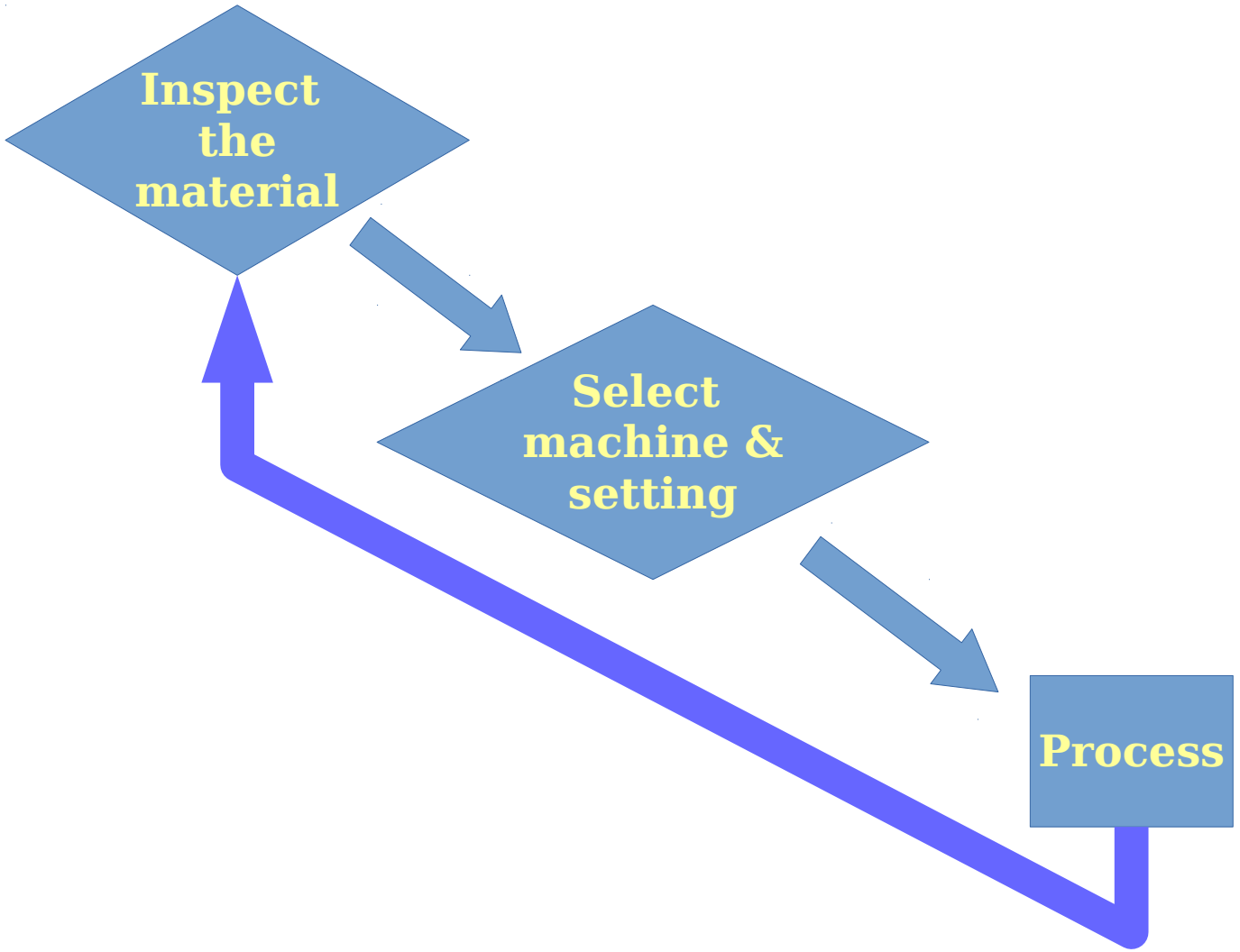
At each stage of SM processing



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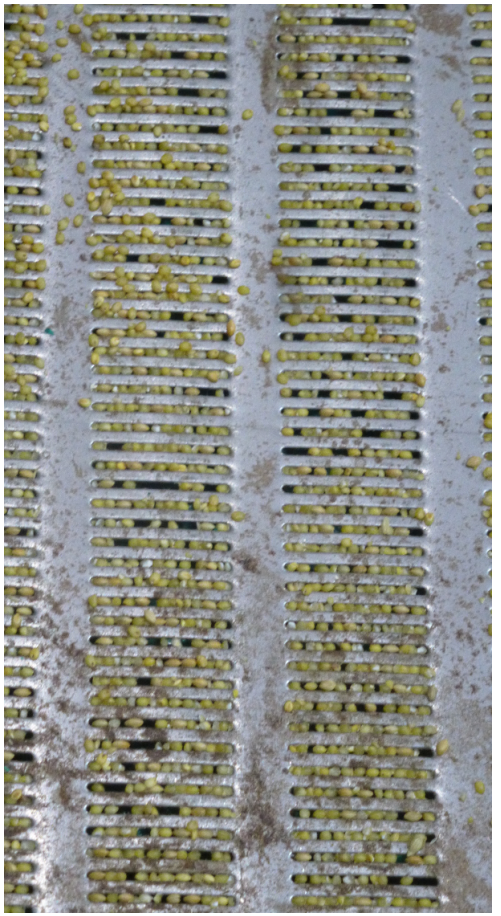
Challenges in Grading

- Sieve selection strongly dependent on material on hand
- Need to use a slightly different sieve size ... if 1.5mm is getting clogged
  - Use a 1.45 mm sieve or
  - Use a 1.55 mm sieve
- One set of sieves for all varieties of a grain is a compromise ... sometimes its ok, sometimes it is not!



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Challenges in Destoning

- Bed mesh selection and tuning
- Removing mud balls from clay rich soil areas
  - Almost same density as grains

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Challenges in Aspirating

- Tuning the aspirator to not remove even broken grains
  - Strongly dependent on grain shattering coefficient
  - Dampener design should cover the full range

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Challenges in Hulling

- Unhulled grains
  - Grains in output
- Incomplete hulling
  - hull getting loosened but not removed
- Broken Grains
  - Kernel shattering

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Hulling Technologies

- Abrasion – Emery
- Abrasion – Rubber roller
- Impact – Centrifugal

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Abrasion – Emery

- Grains pass through two ‘dressed’ emery surfaces – one stationary and the other rotating
- Shear force used to dehusk grains
- Critical grain parameter – size

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Abrasion – Rubber roller

- Grains pass in between two (or more) rubber rollers rotating at slightly different speeds
- Shear forces used to dehusk grains
- Critical grain parameter – size

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Impact – Centrifugal

- Grains thrown at an appropriately prepared surface
- Impact force used to dehusk
- Critical grain parameter – weight

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Ease of use criteria

- Drudgery
  - Number of iterations to get quality output
- Flexibility
  - To handle variations in input material
- Ease of Cleaning
  - To avoid pest infestation
- Maintenance & repair
  - Reliability of the unit

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Competing interests

- Hulling efficiency
  - Number of hulled grains as a percentage of total grains in the output
- Shattering loss
  - Number of grains that are broken as a percentage of total grains in the output
- Bran loss
  - Number of grains that are white as a percentage of total grains in the output

Hulling force	Hulling efficiency	Shattering & bran loss
Too high		
Too low		

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Drudgery

- Higher the hulling efficiency fewer iterations
- In all technologies
  - does not get done in a single pass
- Iterating only the unhulled grains
  - Reduces shattering loss
  - Reduces bran loss
- Requires separating hulled and unhulled material
  - Grader and destoner are machines of choice
  - Better results observed when input is well graded **before hulling**
- Final manual cleaning for premium grade or when input material is sub-par

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Flexibility

- To handle variations in input material
- In all technologies
  - Flow rate of input material
- Emery & Rubber roller
  - Spacing between surfaces to accommodate different size grains
- Impact huller
  - Change speed of impeller
    - Variable Frequency Drive
    - Change pulley(s)

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Ease of Cleaning

- Millets are good for not just humans
- Highest probability of pest infestation is at the processing unit
- Design needs to be such that when cleaned after each shift / usage no material should be left within the machine
- **Currently NONE of the machines in the market meet this criteria**

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Maintenance & repair

- Critical to reliability of the unit
- Maintenance & trouble shooting by operators
- Trained local mechanics
- Availability of parts and components
  - Generic, off the shelf parts
  - Specialized vendor dependent parts
- Down time for
  - period maintenance
  - repair

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Conclusion

Technology	Capital investment	Flexibility	Ease of cleaning	Maintenance & repair
Abrasion – Emery	Lowest	Reasonable	Challenging	Easiest
Abrasion – Rubber roller	High	Reasonable	Challenging	Fairly high cost
Impact – centrifugal	High	Not as easy	Do-able, but not there in available machines	Reasonable

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Thank you !

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