Evaluation of Maize Drying Systems to Aid Smallholder Farmers with Post-Harvest Loss Reduction in Sub-Saharan Africa

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Improve On-Farm Grain Drying

- Millions of poor SHF obtain their food and income farming small lots of land (<5 Ha)

- One of the biggest obstacles SHF face is drying their crop to a safe storage moisture content
  - 12-13% for maize in Sub-Saharan Africa

- Reducing moisture content is essential to prevent post-harvest loss due to spoilage from mold, mycotoxins and insects.
**Key Design and Operations Considerations**

A drying system for SHF must be:

- utilizable by farmers, farmer based enterprises, and drying service providers
- affordable, easy to operate
- constructed with locally available materials & equipment
- allow for easy assembly, operation, transportation and maintenance
- utilize renewable energy sources (solar, biomass)
- reduce drying time and improve drying efficiency
  - sufficiently high capacity and low operating costs
- good prospect for acceptance, adaptation and adoption

**Objectives**

- Build and test two burner and heat exchanger designs to heat the drying air and use a blower to force the air through the grain mass
  - burner must utilize biomass (e.g., wood, corn cobs, rice hulls)
  - blower must draw a minimum of electric power

- Build and evaluate performance of two dryer designs (i.e., Vietnamese-developed STR dryer and Kenyan-developed AflaStop dryer) that can be built with inexpensive, locally available materials
Shallow Bed Dryer (AflaSTOP Design)

Crossflow Column Dryer (Vietnamese STR Design)
Modified Enclosed Burner at Iowa State

- Testing was carried out in the Fall of 2015 using a novel biomass burning stove that requires no electricity and burns environmentally clean.
- Burner was placed inside a cinder block enclosure that serves as the heat exchange chamber.
- Fan pressurizes the chamber with ambient air and pushes the heated air through a duct and into the drying bed plenum.

AflaStop Burner Design at Iowa State

- The Kenyan developed AflaStop drying air supply unit is a steel enclosure that utilizes two fans, a heat exchanger and a biomass burner.
- The center fan forces ambient air across the heat exchanger into the dryer plenum and through the drying bed.
- The second fan draws ambient air through the firebox of the biomass burner across the indirect heat exchanger and then exhausts the air up and out the chimney.
Modified AflaSTOP Drying Bed at Iowa State

- Shallow drying bed is a 6’x6’ box with perforated screens suspended half way up
- Drying bed constructed from corrugated steel panels connected with 2”x4” wood
- Hot air from burner enters via a 14” duct through hole into plenum of drying bed
- Plastic tarp is used to keep bottom half air tight and force heated drying air up through the grain mass

Modified STR Dryer at Iowa State

- STR column dryer consists of two concentric circles made from galvanized hardware cloth
- Small inner circle is placed inside the larger one with grain held in-between
- Top of drying column is sealed and hot air from the burner is forced down the empty center and through the grain
- The perforated hardware cloth allows hot air to exchange heat and moisture with the grain
AflaStop Burner Testing at Iowa State (Fall 2016)

- Due to lack of sufficient performance of biomass burner, focus for testing in Fall 2016 was directed towards the AflaStop burner and STR column dryer combination
- When compared to the biomass burner and the shallow bed dryer, the AflaStop burner and STR column dryer were considerably more portable and implementable in our intended application
- Early testing of AflaStop burner showed remarkable potential re both air flow and heat produced
- Testing was carried out on shelled corn with wood pellets as the biofuel

Crossflow Column Dryer (Iowa State STR Design)

- AflaSTOP burner + STR drying bed
- Insulated duct
Modified STR Burner at Iowa State
Drying Rate 8” and 14” Duct

EasyDry M500 in Kenya

- The Portable Shallow-Bed Batch Maize Dryer, called the EasyDry M500, has been designed to meet the needs of Kenyan smallholder farmers.
- The Easy-Dry M500, has moved from the final field testing stage into piloting and commercialization activities (Kenya, Rwanda, Tanzania, Ghana).
- The dryer will sell for $750-$800 US, have a batch capacity of 500 kg of wet maize and be capable of reducing the moisture content 4.5% in 3.5 h.
Conclusions

- The fire box on the modified STR with AflaSTOP burner unit needs some modification to bring air directly through the fire/coals.
- Achieved a dryer efficiency of 4,400 BTUs/lb of H₂O removed.
- 600 lbs of shelled corn dried from 18.8 to 14.7% in 2 hours.
- We saw a slight increase in BCFM (about 1 to 4%).
- ISU modified dryer system combines the mobility of the AflaSTOP burner and STR concentric-ring drying bed.
- Labor intensive to load and unload grain.
  - Could be the target of future research and development.

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