Feed the Future Food Processing and Post-Harvest Handling Innovation Lab Annual Meeting

July 12, 2017

Year 3 Review Year 4 Plan

Roll Call – Collaborators by Institution

CIMMYT – Kenya

- Hugo De Groote

KALRO – Kenya

- Patrick Ketiem

University of Eldoret

- Violet Mugalavai
- Augustino Onkware

ITA - Senegal

- Djibril Traore
- Fallou Sarr

ISRA - Senegal

- Ibrahima Sarr
- Moussa Sall

University of Pretoria – South Africa

- John Taylor
- Johanita Kruger
- Gyebi Duodu
- Riette DeKock

North Carolina A&T

- Guibing Chen

North Carolina State Univ.

- Mario Ferruzzi

San Diego State Univ.

- Cheryl O'Brien

A to Z Textiles

- Hubert Kofi
- Johnson Odera

Purdue

- Betty Bugusu
- Suzanne Nielsen
- Bruce Hamaker
- Klein Ileleji
- Jake Rickert-Gilbert
- Jonathan Bauchet
- Arvind Raman
- Richard Stroshine
- Julie Hancock
- Lonni Kucik

Advisory Council

- Angela Records (USAID-Washington)
- Bruce Maunder (Retired Dekalb Genetics)
- Tahirou Abdoulaye (IITA-Nigeria)
- John Bustle (Retired – John Deere Foundation)
- Dirk Maier (Iowa State)
- Joseph Mpagalile (FAO-Rome)

FPL Management Changes/ Y4 Expectations

- FPL Steering Committee
  - Jess Lowenberg-Deboer - retired
  - Jacob Ricker-Gilbert – lead for drying and storage/impact assessment
- Management
  - Heather Fabries (program manager) and Laura Bergdoll (business Manager) left
  - Julie Hancock (Program Manager); Beth Siple (Business Manager)
- North Carolina State University added as a sub

- Focus on technology adoption and scale-up efforts
- USAID Mid-term Performance Review expected
- Revisit Face-to-face annual meeting for Year 4
  - preferably in Dakar, Senegal

FPL Management Updates

Challenges

- Delay in release of funds
  - 2-month by USAID
  - 2-month by Purdue - “Trafficking of persons”
- Visits to Mission offices
- Sub-awardee accounting – still a problem for some

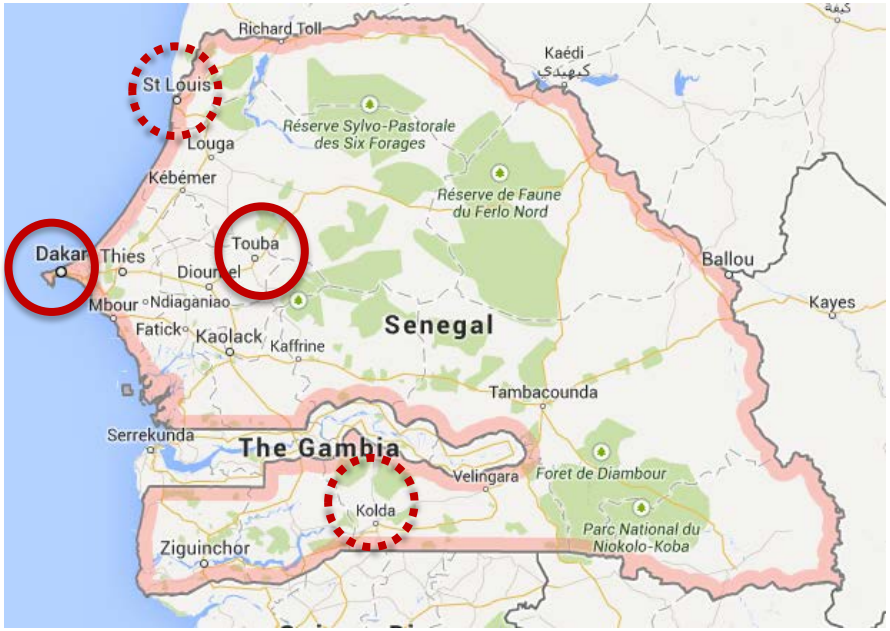
Opportunities

- Many opportunities related to nutrition improvement
- Showcasing results/outcomes
  - Newsletters:
    - Feed the Future
    - FPL
  - Conferences
  - Publications

Processing/Nutrition Team

- Senegal – Institut de Technologie Alimentaire (ITA)
  - Djibril Traore, Fallou Sarr
- Kenya – University of Eldoret
  - Violet Mugalavai, Augustino Ongware
- University of Pretoria
  - John Taylor, Gyebi Duodu, Johanita Kruger
- CIMMYT
  - Hugo DeGroote
- Purdue University
  - Bruce Hamaker (PI), Mario Ferruzzi (co-PI)

Processing/Nutrition Sites in FtF Countries



Value Chains

Millet (pearl/Senegal, finger/Kenya, sorghum, maize, grain legumes, and nutrient-rich plants

Food Processing/Nutrition: Approach

- Product development, marketing, and promotion
  - Develop high-quality, safe, competitive food products
  - Disseminated through Incubation Training Centers; processing enterprises
  - Identify consumer drivers, make nutritious products to meet them
- Processing technology innovation
  - Appropriate, cost-effective technologies
  - Development/refinement
- Improvement of nutritional quality of products
  - Fortified products using local nutrient-rich plant sources
  - Maximized micronutrient (iron, zinc, pro-vitamin A) delivery to the body
  - Cereal processed foods providing fullness and satiety feeling
- Impact assessment: product and nutritional

Processing/Nutrition to-date achievements (including Year 3 Workplan objectives)

- **Drive the value chain through processing to increase commercialization and improve nutrition**
  - **Cost analysis of extruded, instant products; further quantitative assessment of market demand and drivers for processed food products, with and without nutritional enhancement**
    - *Conducted "willingness-to-pay" and sensory studies in Senegal (2 – rural and urban) and Kenya on instant flours, whole grain instant flours, artificial and natural fortified instant flours (200 participants in each study)*
    - *Cost analysis of extruded, instant products – process and ingredient costs (Kenya done)*
  - **Develop and/or refine products and processes to drive Senegal and Kenya markets**
    - *Built new Incubation Center at University of Eldoret, conducted consumer preference study and in-home use study*
    - *Shipped and installed two extruders (Touba, Senegal and U Eldoret, Kenya)*
    - *In Touba, nearly completed building improvement for extrusion processing to meet sanitation/hygiene standards*
    - *Instant thin and thick millet and maize/sorghum blend flours successfully developed – consumer tests positive*
    - *Transfer of extruder to entrepreneur in Touba, Senegal (Mme. Mbacke); training of processors (and through collaboration with USAID-ERA)*
    - *Worked on prototypes of fermented products (U Pretoria); blended products (U Eldoret); sensory analysis*
    - *Study comparing decorticated and whole grain millet products – Purdue U and U Pretoria*

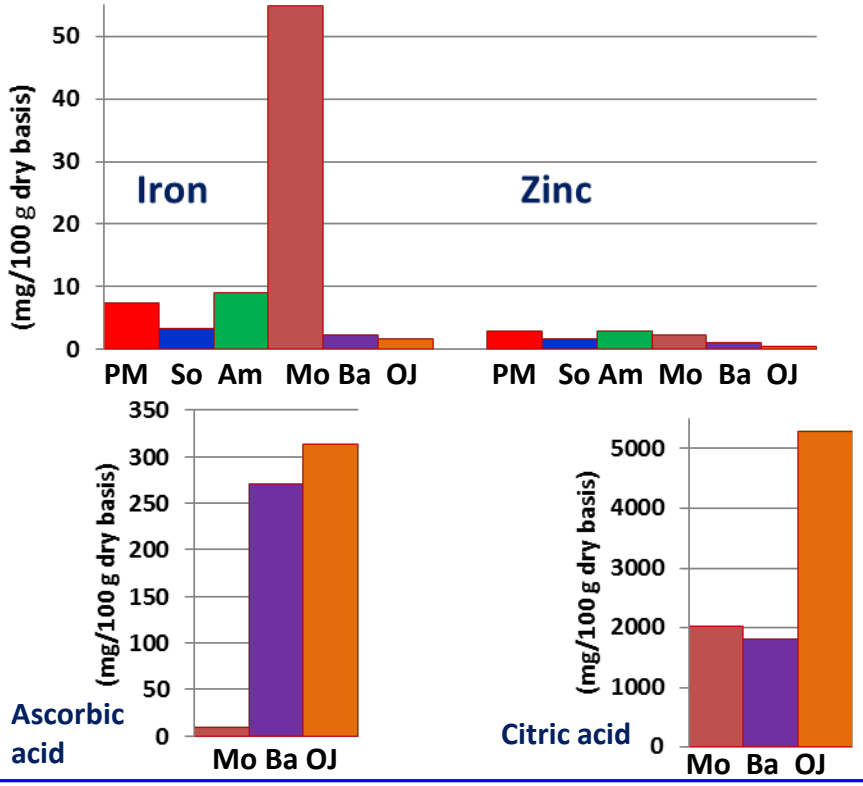
Processing/Nutrition Year 2 Workplan achievements

- **Leverage local agriculture commodities to produce nutritionally-enhanced food products and to create a sustainable market-led fortified processed**
  - *Screened nutrient dense plant materials for iron, zinc, pro-vitamin A (U Pretoria, Purdue U)*
  - *Biofortified millet varieties evaluated (high Fe and Zn), process to reduce phytate/increase bioaccessibility (U Pretoria)*
  - *Pro-vitamin A stability testing using solar drier developed by K. Ileleji (Purdue U)*
  - *Experiments to maximize micronutrient content and availability (U Pretoria, Purdue U)*
  - *Sensory testing of nutrient fortified instant flours done, towards optimization*
- **Evaluate nutritional composition, micronutrient retention/bioaccessibility and ultimate nutritional impact of the program**
  - *Bioaccessibility of iron, zinc and pro-vitamin A shown to markedly (2x or more) increase with baobob fruit powder (and somewhat with moringa powder) added, in vitro studies nearly completed – has broad implications*
  - *Human nutrition evaluation planned for late 2017/early 2018*
- **Strengthening institutional and human capacities among the actors along the value chains, with emphasis on gender sensitive approaches**
  - *PhD students at Purdue U – E. Ayua, Kenya; C. Ndiaje, Senegal; P. Torres-Aguilar, US; graduate student training in Senegal (2), Kenya (2), and U Pretoria (2)*
  - *Sensory training of 3 scientists (2 Senegal, 1 Kenya) (U Pretoria, R. deKock)*
  - *Training of primarily women entrepreneur processors (Senegal, Kenya)*

University of Pretoria – Year 3 *Summary*

Improving the Essential Mineral Status of At-risk Populations through Natural Fortification and Fermentation of Staple Cereal Foods

- Cereals are fair sources of essential minerals (e.g. Fe, Zn)
- However, their bioavailability is poor because they contain antinutrients (e.g. phytate, polyphenols)
- Mineral absorption can be improved by Promoters e.g. ascorbic acid and Technologies like Lactic acid Fermentation
- Can Natural Fortification of cereals with locally available plant ingredients (Moringa and Baobab) and Souring improve mineral content and bioavailability?



Human Capital Development: Mr John Gwamba- Botswana -BAUN University

MSc with distinction: Pearl millet: Influence of mineral biofortification and simple processing technologies on minerals and antinutrients

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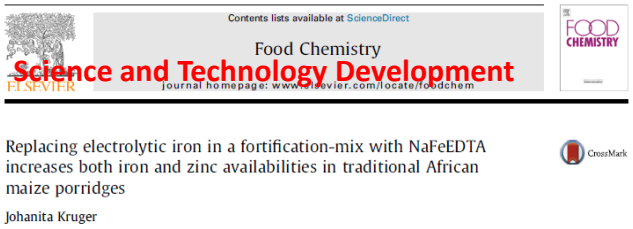
Science and Technology Development

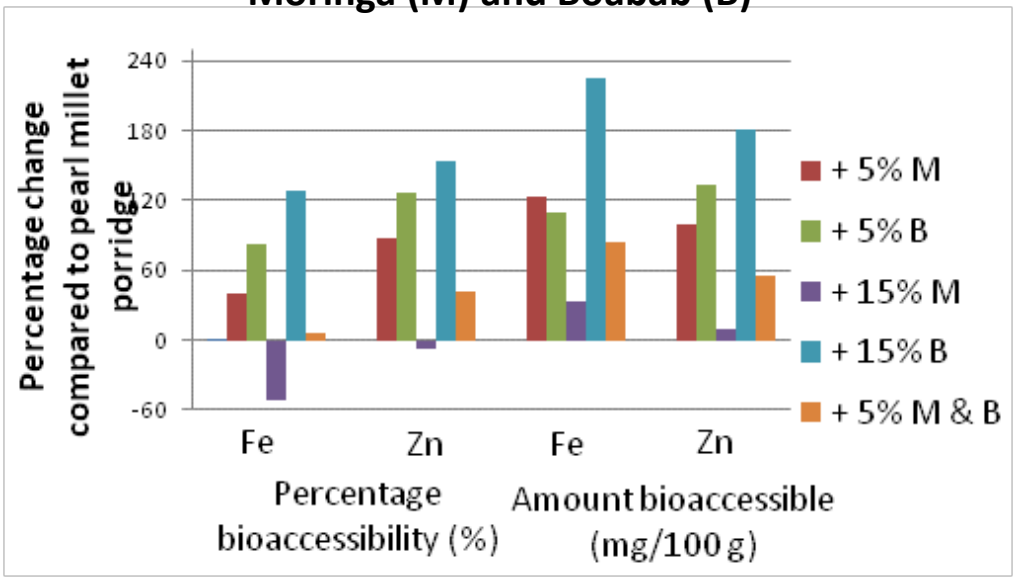

Contents lists available at ScienceDirect
Food Chemistry
journal homepage: www.elsevier.com/locate/foodchem
Replacing electrolytic iron in a fortification-mix with NaFeEDTA increases both iron and zinc availabilities in traditional African maize porridges
Johanita Kruger

FEED THE FUTURE FPL FOOD PROCESSING LAB

University of Pretoria – *Year 3 Summary*

Screening of Micronutrient Bioaccessibility from Model Cereal Porridge products

The change (%) in the percentage (%) and amount (mg/100 g) of bioaccessible iron and zinc, compared to RTE pearl millet-based porridge after the addition of Moringa (M) and Boabab (B)



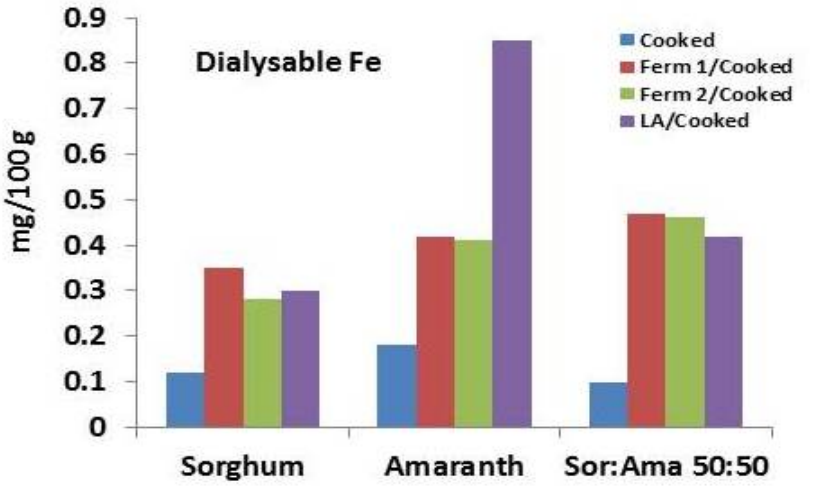
- Moringa rich in iron
- However, Moringa addition to the pearl millet based porridge was the least promising in increasing the iron and zinc bioavailability.
- Baobab, however, resulted in large percentage increases in the percentage and amount of bioaccessible iron (129 & 154%, respectively) and zinc (225 & 181%, respectively).
- Simultaneous addition of Moringa and Baobab, did not result in mineral bioaccessibilites lower than that of the formulations with only 5% moringa or baobab alone. Why?

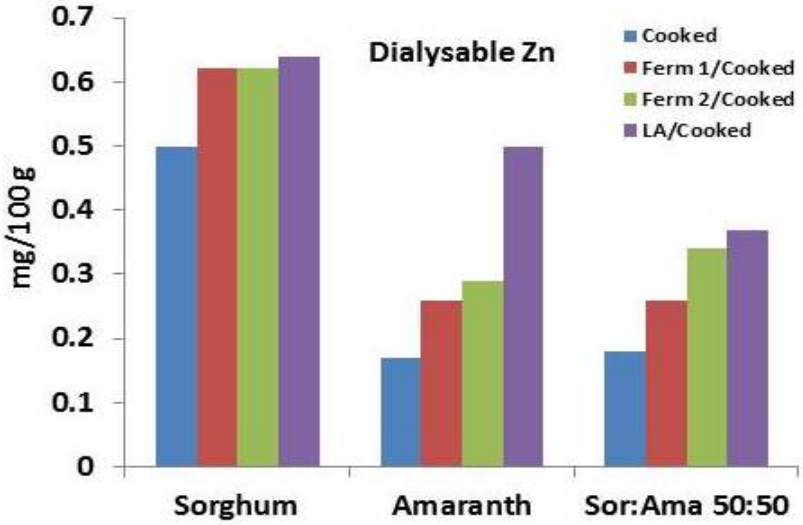
Human Capital Development: International conference attendance Renee van der Merwe (MSc Student) 3rd Hidden Hunger Conference. Stuttgart, Germany. 20-22 March (2017)

University of Pretoria – Year 3 Summary

Soured Sorghum-Amaranth Porridge: Mineral Bioaccessibility

- Souring by three methods, followed by cooking: *Lactobacillus plantarum* (Ferm 1/Cooked), Back-slopped inoculum (Ferm 2/Cooked); or addition of lactic acid (LA/Cooked).
- All three methods of souring enhanced levels of dialysable Fe and Zn.
- **Acidification with lactic acid presents a simple and practical way of enhancing mineral bioaccessibility which can be applied relatively easily.**





USAID FROM THE AMERICAN PEOPLE

University of Pretoria
Year 3 Summary

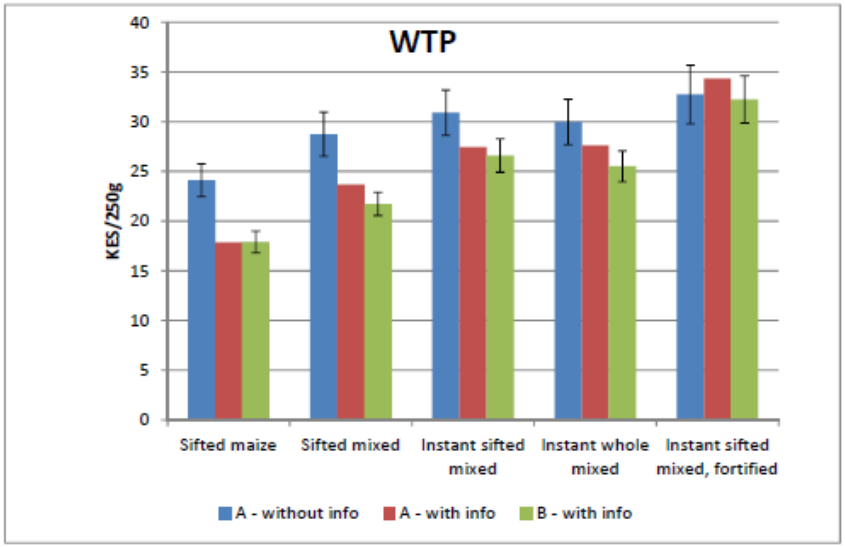
FEED THE FUTURE FPL FOOD PROCESSING LAB

Ensuring Instant Pearl Millet-based Porridge Products have Adequate Shelf-life and are Acceptable to Consumers

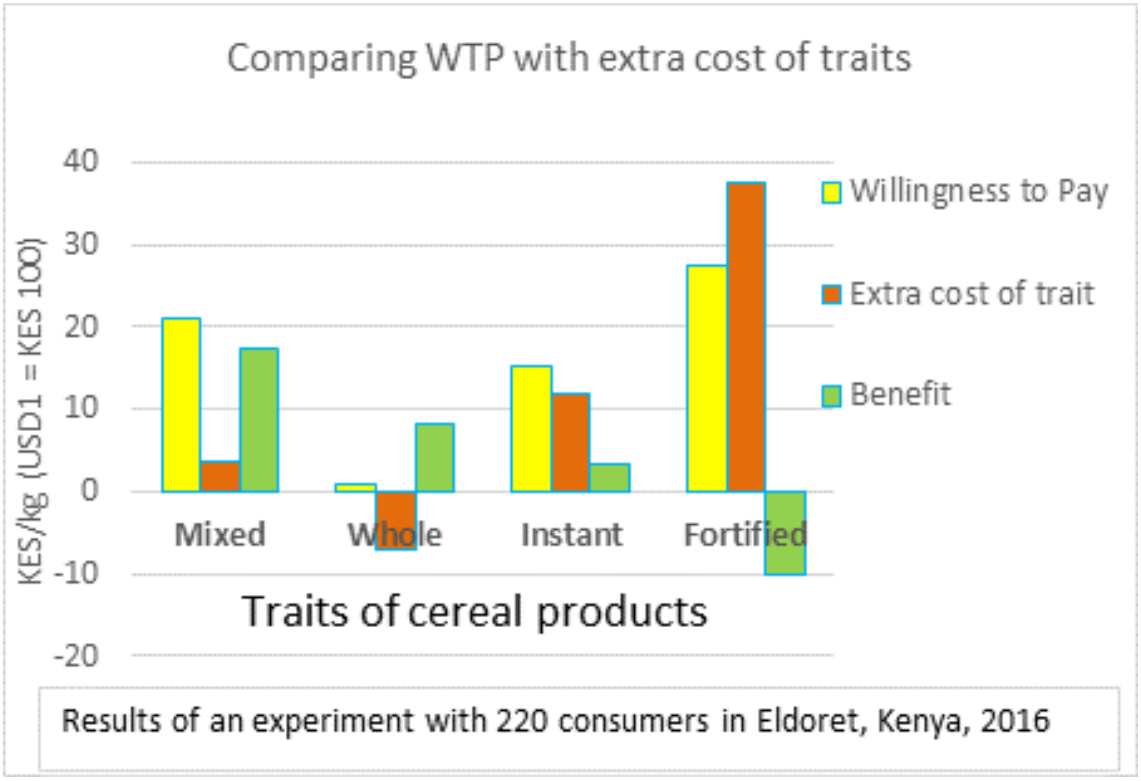
- **Pearl millet flour is particularly prone to rancidity because of its high fat content and unusual C-glycosyl flavone type polyphenols**
- **Extruded and native pearl millet flours stored at 4, 25 – 30, and 50 °C for 6 months (accelerated shelf life study).**
- **Stored flours and porridges made from them used to determine shelf life by descriptive sensory profiling using a trained panel and consumer panel (for acceptance).**
- **Critical sensory descriptors have been identified to describe the sensory profile of pear millet porridges: Painty, Spicy, Branny**
- **Results of the ongoing evaluations based on Survival Analysis Method, will inform choice of adequate packaging material for commercial products, and preferred conditions of distribution, storage, and use.**

CIMMYT : Progress to Date (**Outputs**) – Food processing

- Consumer study Eldoret
  - Data collected and analysed
  - Manuscript ready for submission
  - Conclusion:
    - There is a market for instant, whole, mixed cereals, but for liquid porridge
    - Benefit cost analysis indicates those three traits profitable, but not natural fortification, in the formulation used
    - Need to optimize composition and expand sensory before experiments
- Consumer study Dakar
  - Data collected and entered
  - Preliminary analysis
- Consumer study Touba
  - Paper accepted w/ revisions JSFA



Results Consumer study Eldoret



Results of an experiment with 220 consumers in Eldoret, Kenya, 2016

- WTP> costs for
  - Mixed flours (maize with sorghum)
  - Whole flours
  - Instant flour
- WTP < cost for
  - Natural fortification
- Therefore:
  - Combine with industrial fortification

(CIMMYT) Year 4 Plan

Processing (with U. of Eldoret and ITA):

- Optimize products (content vs. cost) for Kenya and Dakar
- Home use test of optimized products
- Focus group discussion on optimized products
- Pilot marketing

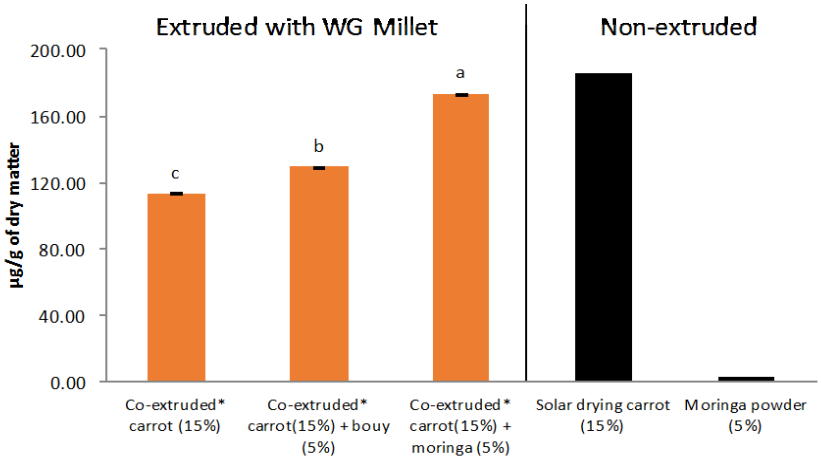
Purdue/NCSU

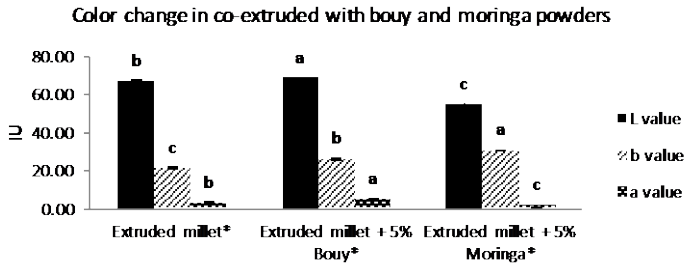
- Year 3 Activity 1: Continued optimization work for millet and sorghum based cereal porridges including formulation and processing
  - Several formulation have been identified based on 15% carrot/mango and 5-10% baobab or moringa for Vit A, iron and Zinc respectively
  - Baobab identified as a critical ingredient in Year 1-3 as a potential potentiator of absorption of iron and vitamin A
  - Connection with DSM established to assess combination of nutritional premix with natural potentiators of absorption identified in year 1-3
- Year 3 Activity 2: Collaborative assessment of solar drying for genration of nutrient dense food powdered ingredients
  - Collaborative trials completed with drying/storage team demonstrating high recovery of provitamin A carotenoid in carrot and mango
- Year 3 Activity 3: Collaborative development of nutritional clinical study plan for Year 4-5

Purdue/NCSU

- Year 3 Activity 4: Determining the impact of extrusion on nutrient recovery and physical properties of blended instant millet products

Inclusion of nutrient dense moringa and boabab improve recovery of β-carotene to extrusion conditions





A subtle but significant change in L (lightness) was observed in co-extruden whole grain millet with inclusion of baobab relative to moringa

High retention of provitamin A carotenoids was observed with solar drying of carrots and mangos

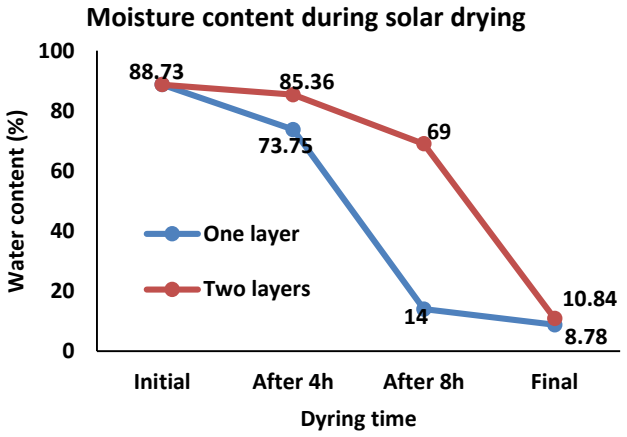
Solar drying of grated carrot yields products with high provitamin A retention

	Raw	Thin Layer	Dehydrated	Solar Dried
TPVA (µg/g dw)	1090.7±17.8	825.2±6.6	955.7±10.0	903.8±10.4
RAE (µg/100g)	7022.0±26.1	4117.7±17.8	4712.0±21.8	4610.4±19.3

~83% recovery of total provitamin A carotenoids through solar drying

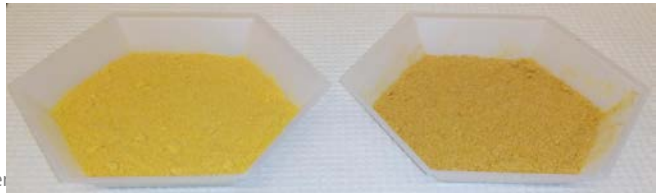
Solar drying of sliced mango (3.25mm): one layer on solar dryer basket vs. two layers

Single layer drying produced highest quality mango powders



Sliced mango solar dried (3.25 mm) using one-layer

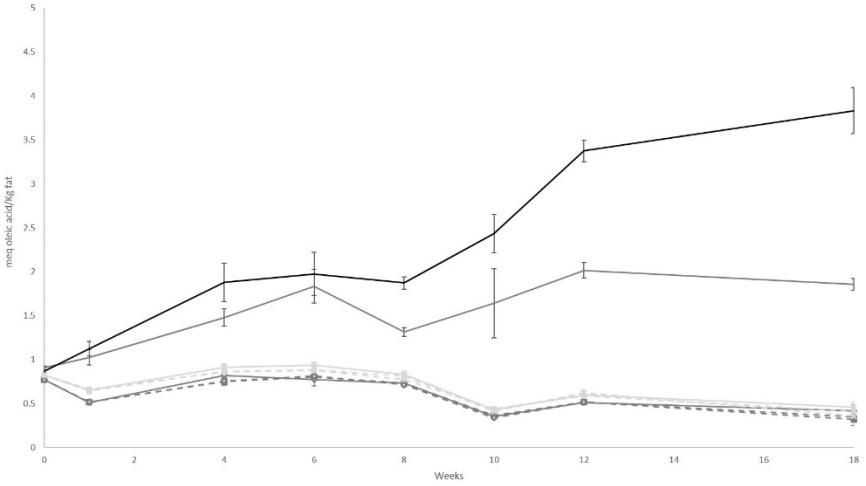
Sliced mango solar dried (3.25 mm) using two layers' rack



Univer
institution.

Extrusion experiment to test stability of flours

- Extruded product stability study
  - Extrusion inactivates enzymes; extruded flours were more stable (no increase in free fatty acids



Purdue/NCSU Year 4 Plan

- Confirmation of nutrient levels in range of scalable formulas (Oct 2017)
- Confirmation of the bioaccessibility of micronutrients from extruded blends. (Dec 2017)
- Finalization of the clinical trial plan and initiation of study to assess the potential of synergies between natural ingredients and micronutrient bioavailability (Sept/Oct 2017)
  - Finalize plan and identification of clinical collaborator in country
  - Complete clinical protocol and IRB submission at all institutions
  - Initiate study in Year 4
- Extrusion optimization and extrusion dietary fiber gut fermentation studies

UNIVERSITY of ELDORET: YEAR 3 REPORT-July/2017_(Outputs)

- Sensitizing consumers and scientists about the natural fortification and developed instant products and getting feedback
- Training of youth in cereal value chain entrepreneurship and different ways of using the fortified instant flours
- Edit and improve the training manual
- Development of linkages
- Home use test of extruded instant flours

- Exhibited, and demonstrated instant products at:
  - UoE Agribusiness Trade Fair (Sept 2016, CRS Exhibition .
  - Conference- "**Technology-based Incubation Centres for Developing Affordable Nutritious Foods**" (Nov 2016);
- Participatory on-station and off station demonstrations carried out (February-May 2017, June 2017).
- Forty eight (48) youth trained: legislative, regulatory and hygiene regimes, entrepreneurship, the cereals and possible fortiifcants (February 2017-May 2017).
- The training manual has been improved; challenges and opportunities, production planning, food safety and sanitation, shelf life.
- Additional linkages developed: Organi Limited , Kabando farmers cooperative;; Compatible Technology International; CIP-SSA; Baobab farmer group; grain amaranth farmer group and sorghum farmer group.
- Home-use –test carried out (May 2017) with a total of 143 participants.

UNIVERSITY of ELDORET: Year 4 Plan

- Further Training
  - Further training on cereal processing products and services; legislative and regulatory requirements; Entrepreneurship; identification of nutrient dense plants; extrusion and use of products. Product development and incubation.
  - Inspection of the FPTIC for approval for use in cereal processing.
- Standardization of chosen composites
  - Favourite instant composites to be standardized, branded; certified by KEBS, and rolled out.
  - Competitions and pitching of ideas for possible start-up funding.
- Competitions between trained young entrepreneurs
  - Selecting entrepreneurship activities along the cereal processing value chain and engaging in them.

Institut de Technologie Alimentaire (ITA)

- **Dakar consumer study**
- "Lakh" and "rouye" instant porridges were developed in the first 3 years
- Consumer study for naturally and synthetically fortified "lakh" was run at ITA, Dakar

- Products were made by Touba Darou Salam (TDS), a partner of the project that received training
- ITA' extruder was out of order and sent to Iowa to be repaired
- Results of the study can be seen in CIMMYT's slides
- Cost analysis is being done with CIMMYT

Institut de Technologie Alimentaire (ITA) Year 4 Plan

- Talks between the FPL team and the Senegalese Government are taking place
- There are strong signs that the Gov. has appropriated the FPL results
- The Gov. wants to buy small extruders for women/ entrepreneurs in the north and the south where malnutrition is high
- The Gov. thru the Bureau de Mise a Niveau has matched the funds for 40% in the remodeling of the processing unit of Touba Darou Salam (TDS)
- CLM has ordered 577 tons of extruded flour for 2017
- This order exceeds TDS's capacity
- WFP also is ready to order and also ready to fund the scaling up
- As a result, TDS will need either several small extruders or a bigger one

Processing/Nutrition Project Overall Plans

- **Identify and develop cost effective, bioaccessible, and commercially relevant fortified millet and maize/sorghum products**
  - *Nearly complete for fortified, instant products – finish cost analysis in Senegal, develop right blends in both countries, whole grain studies*
  - *Complete nutritional study on improved bioavailability of micronutrients (below)*
- **Complete studies to understand drivers of consumer markets**
  - *How nutritional attributes and high quality products can be used to drive markets for local farmers*
  - *Consumer feeling towards whole grain instant foods (which are crucial for complete natural fortification)*
- **Human study on bioavailability of iron, zinc and pro-vitamin A**
  - *Complete in Year 4 (2018)*
- **Senegal**
  - *Have submitted concept note to Senegalese government for expansion/scale-up of rural processing of nutritionally fortified products; workshop and whole grain consumer study (2017); Senegal entrepreneur in Touba, Senegal as a model for disseminating extrusion technology; market study*
- **Kenya**
  - *Improvements for Incubation Center at U Eldoret; workshop in Nairobi and Eldoret; continue training of entrepreneurs and university students; market study*

FPL YEAR 3 ANNUAL MEETING
DRYING AND STORAGE OVERVIEW

Jacob Ricker-Gilbert

OBJECTIVE: HELP SMALLHOLDER FARMERS AND SMALLSCALE TRADERS DRY, STORE, SELL, AND CONSUME BETTER QUALITY MAIZE

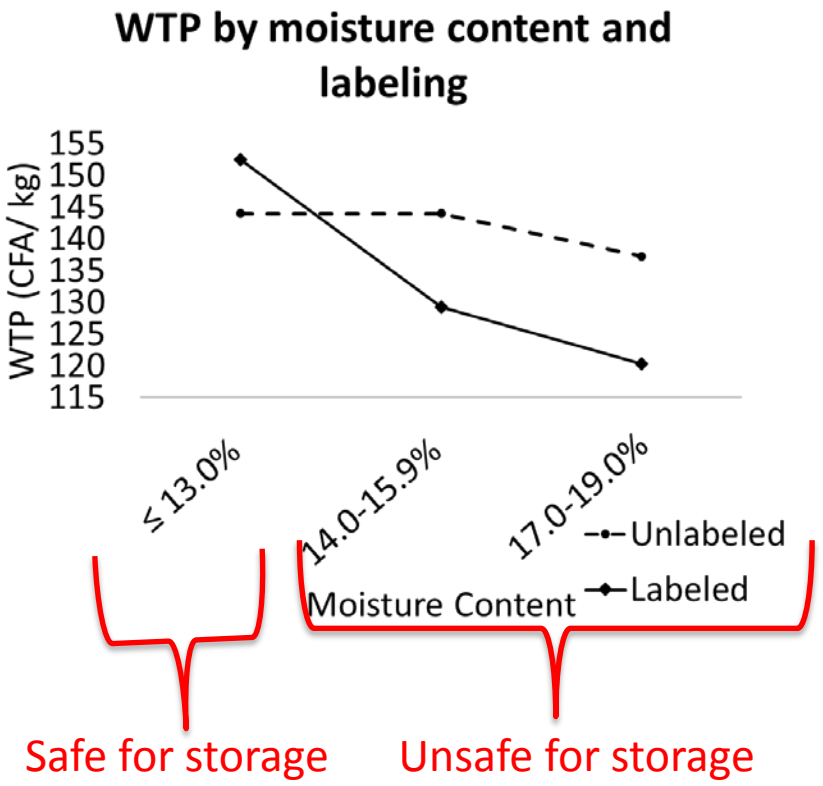
- With lower levels of aflatoxin
- Improve food security
- Overtime help increase income and make market recognize and value quality maize.

Background/baseline work revealed some key problems

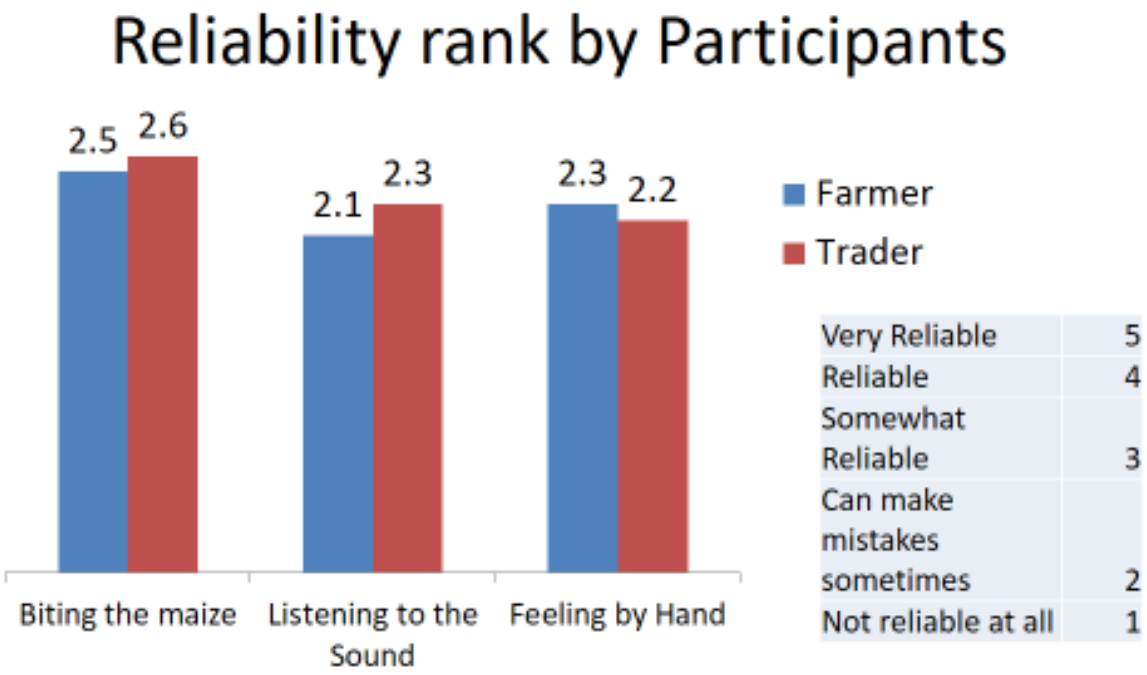
- 26 of 88 maize samples (30%) taken randomly from post-harvest cobs or shelled corn contained aflatoxin in Velingara (Woloshuk, et al. 2016)
- Many people drying maize on the ground (25%)
- Little awareness of aflatoxin (29%).

Photo 1. A practice the project seeks to improve – ground drying increases aflatoxin contamination. *Photo courtesy of Stacy Prieto*

- People have trouble determining maize dryness on their own
- When maize MC is not labelled they can't tell between safe (<13% MC) and unsafe levels.
- But when they are told MC level, they care



Not confident in local methods for MC detection



Suggests that there may be a market for a low cost MC device

Given heterogeneity in target population, range of options developed

- Training in best practices
- Several different drying options promoted
  - From tarps, to solar drying
- Several different MC devices developed and promoted
  - From drycards (hortlab), to hygrometers, to more expensive options

Presentations in this section organized into 4 themes.

- Theme 1: Development of low cost dryers for smallholders
- Theme 2: Development of low cost moisture meters for smallholders and traders
- Theme 3: Testing and awareness building of hermetic bags and links to aflatoxin reduction
- Theme 4: Impact assessment/ monitoring and evaluation

Beginning to show results

- Roughly 2,600 people reached so far
  - Many more in coming years
- Collaborations with other innovation labs
  - HortLab, PHL
- Collaboration with local institutions in SSA
  - ISRA, KALRO
- Collaboration with private sector partners in SSA
  - A to Z textiles, Bell Industries, Global Good (USA)
- > $700,000 in leverage funds from other sources

- Thank you!

Affirmative Action, equal opportunity

OBJECTIVE: DEVELOP LOW COST DRYER FOR SMALLHOLDERS

Two technologies being developed and deployed in Kenya and Senegal are:

1. Multi-purpose solar dryer and drying tray (led by Ileleji)

2. Solar wrap dryer (led by Raman and Stroshine)

Dryers should be affordable and accessible for smallholder population

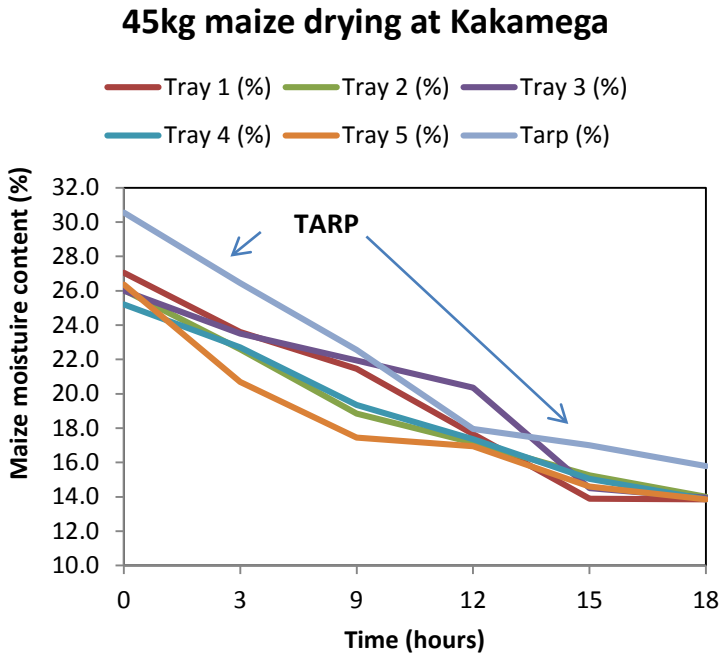
Activities – MP solar dryer & Drying Trays

- Successfully deployed the multipurpose solar dryer in Veligara, Senegal and Kakamega, Kenya.
- Successfully conducted two 2-day train-the-trainer workshop on best post-harvest practices in Kolda, Senegal (21) and Kakamega, Kenya (28), (partnering with ISRA)
- MP-solar dryer presented at the Kakamega agricultural show in June 2017 (partnering with KALRO and CIMMYT).
- Made progress toward commercialization

Solar Dehydrator

Activities: Solar POD Dryer

- Design Modified, tested inside bldg – Feb ’17
- Prototype tested at Kakamega - March 2017 → 0.72 ppts./hr



- Purdue Tests June 2017 → a. 21.1% to13.0% in 11 hrs; 0.8 ppts./hr
  b. 28% to 13.0% in 27 hrs continuous drying

Outcomes: Awards to Date/IP & Trademarking

- Progress towards commercialization of drying trays and MPD via Purdue Foundry Incubated JUA Technologies International (JTI).
- **Leverage:** JTI awarded Elevate Venture Funding ($20,000).
- JTI achieves top 10 innovation award in Nairobi, Kenya.
- **Leverage:** Ileleji & JTI part of USAID Horticulture Lab project on improving the quality of dried apricots in Tajikistan ($300,000).
- **Leverage:** Ileleji & JTI part of USDA-NIFA Small farms project to apply MPD to small growers of specialty crops in Indiana and Georgia ($499,619)
- JTI was semi-finalist in US-China Innovation Alliance.
- JTI filed three US trademarks for MPD, drying tray and power generator.
- Purdue's Office of Technology Assessment is currently considering the possibility of patenting the Solar POD dryer design.

Year 4 Plan: MP solar dryer & Drying tray

- Engagement & Tech Transfer (Year 4 & 5)
  - Finalize MPD (control and thermal collector) and drying tray designs for large-scale manufacturing towards pilot-scale testing in Senegal & Kenya.
  - Pursue key manufacturing partners in Africa and Asia through JTI.
  - Develop pilot testing, work with M&E and pursue funding (DIV & others).
  - Develop MP solar dryer and drying tray training materials
  - Develop business plan and marketing, product logistics, training and scale-up beyond year 5

Year 4 Plan: Solar POD Dryer

- Continue testing and improving Solar POD dryer - summer 2017
  - increasing performance (target 25%)
  - ease of assembly by user
  - Maintaining eventual target market price under $100

- Conduct performance tests in cooperation with KALRO Oct. 17

- Implementing Solar POD drying in Kenya
  - farmer testing
  - Education

- Further market analysis and identify potential business partners

Year 4: Research & Engagement Plan in Kenya

- **Led by KALRO and CIMMYT**
  - Conduct second round of on-field research trials on the multi-purpose solar dryer and drying trays (Aug-Oct 2017) – verify previous results
  - Work with identified SMEs, farmer groups & NGOs in scaling up drying technologies (adoption)
  - Engage county governments and farmer groups on investing in the solar drying technologies (Multi-purpose & POD)- Target Kakamega, Bungoma, Trans-Nzoia & Uasin Gishu (maize growing zones).
  - Collaborate with FPL partners (CIMMYT), A-Z , Bell industries-PICs etc) on drying/storage technology capacity building (workshops for farmers & processors), exhibitions and other scaling up forums

Year 4: Research & Engagement Plan in Senegal

Led by ISRA

- Conduct second round of on-field research trials on the multi-purpose solar dryer and drying trays (Sep-Nov 2017) – verify previous results
- On farm demonstration of grain drying and storage practices
- Work with identified SMEs, farmer groups & NGOs in scaling up drying technologies (toward adoption)

OBJECTIVE: DEVELOP LOW-COST MOISTURE METER

Research from previous years identified $2.00 hygrometer as a low-cost alternative to commercial moisture meters costing > $200.

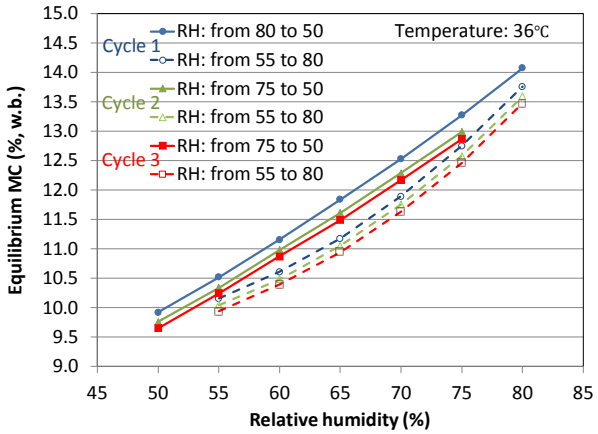
Activities

1. Developed training material in local languages
2. Obtained feedback in-country at training workshops (Kenya, Senegal, Uganda, and Malawi)
3. Investigated willingness-to-pay values (Kenya)
4. Tested market sales (Kenya)
5. Investigated the limits of accuracy
6. Engaged with technology group for future improvements to hygrometer

Package for sale (Kenya)

Training in Senegal

Exhibition in Kakamega



Measurements of accuracy

YEAR 4 PLAN

- Develop educational material for training on the hygrometer moisture meter
- Complete accuracy and durability studies on hygrometer to identify sources of error and needed improvements
- Develop simple color humidity cards to determine when grain is at a safe moisture for storage
- Determine if biocontrol applications reduce aflatoxin accumulation during maize drying process

OBJECTIVE: ASSESS POTENTIALS FOR AFLATOXIN DEVELOPMENT ON MAIZE STORED IN HERMETIC BAGS

- Impact of grain moisture on aflatoxin accumulation in hermetic storage in Senegal and Kenya

Maize with 18% and 13% moisture levels tested with hermetic bags:

- ✓ Maize stored at 18% moisture content lost quality after one month and accumulated aflatoxin in both bags with the highest level in woven bags.
- ✓ Hermetic bags were more efficient for maize stored at 13% moisture content in particular with impregnated A-Z bags against insects in the short term storage (3 months).

Hermetic storage trials in Kenya 2017

- **Objectives:** evaluate the effect of hermetic storage on mould growth and insect loss.
- **Study design:**
  - Three main factors, complete randomized block design with 3 reps
    - infestation with Aspergillus (aflatoxins) and Fusarium (fumonisins) vs. natural
    - grain moisture levels: low (12-13%) and high (14-15%);
    - ten storage technologies,
      - Silos: metal and plastic silos
      - Hermetic bags: PICS, SuperGrainBag, Elite Zero Fly, A to Z
      - Insecticide impregnated bags: A to Z
      - Control: polypropylene bags with and without insecticide
  - All containers artificially infested with weevils and LGB
- **Data collection:**
  - Grain sampling at onset and every 90 days for 270 days.
  - For each sample: mycotoxins, loss from insects, kernel composition.
- **Implementation:** started in June 2017, in Kiboko, Kenya

Year 4 plan

Research

- Senegal: finalize the assessment of potential for aflatoxin development in hermetic bags in the stored maize at 13% after nine months in October 2017
- Kenya:
  - data from trials to be analyzed, write-up March-May 2018
  - Estimation of cost of commercial road-side sun drying in Kenya
  - Economic analysis of different dryers, for maize and alternative uses (especially high value products such as fruits, vegetables, ...)

Extension, in Kenya and Senegal

- Demonstration with PICS bags at community level

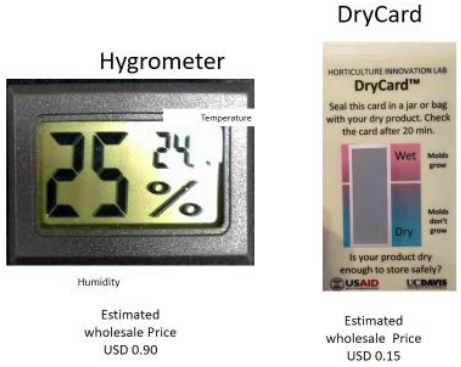
OBJECTIVE: GET APPROPRIATE TECHNOLOGIES AND PRACTICES INTO HANDS OF SMALLHOLDERS

UNDERSTAND MARKET POTENTIAL AND IMPACTS

Activities

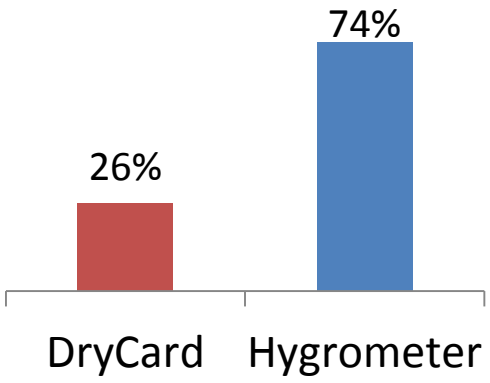
- Nearly 2,000 farmers trained and given technologies in Senegal (collaboration with ISRA)
- Nearly 600 farmers/traders trained on moisture devices and given opportunity to purchase
  - Collaboration with USAID Hort. IL
  - CIMMYT, KALRO, and Bell Industries
  - Leverage from CIMMYT/USAID CRP ($15,000)
  - Leverage from HICKS student research grant ($5,000)

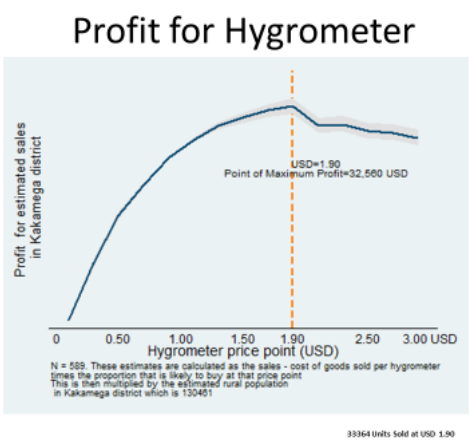
Devices

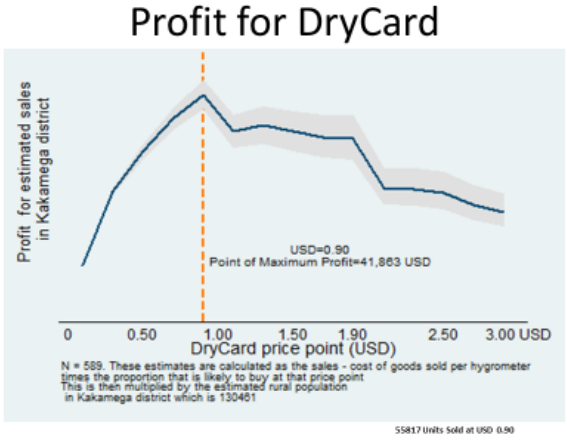


Kenya Intervention Summary: Demand for moisture detection device

Experimental auction in Kakamega where participants paid for devices







- 3/4 prefer hygrometer over DryCard
- But due to lower cost of production for DryCard, profit margin likely higher
- Potential for both products in market place

Senegal Intervention Summary: Aflatoxin results by treatment group

	Number of samples (% of samples within each treatment group)			
	Samples analyzed	0 ppb	≥ 20 ppb	Mean*
1) Control	242	74 (31%)	70 (29%)	**24.72**
2) Training Only	301	116 (39%)	64 (21%)	**16.37**
3) 2 + Hygrometer	295	118 (40%)	70 (24%)	**16.81**
4) 3 + Plastic sheet	371	126 (34%)	95 (26%)	**19.62**
5) 4 + PICS bag	375	151 (40%)	58 (15%)	**11.39**
TOTAL	**1,584**	**585 (37%)**	**357 (23%)**	**17.31**

Statistically different from control and statistically equivalent at 10% level.

Statistically different from all other groups at 5% level.

*The 134 samples that measured > 100 ppb (the test limit) were calculated at 100 ppb.

1. Aflatoxins are a big problem in stored maize in our sample.
   - 23% above US legal limit of 20 ppb (27% above Senegal/EU limit of 10 ppb)
2. Our drying and storage interventions had a significant impact reducing aflatoxin levels.
3. Biggest impact from including PICS bags intervention.
   - Seems to be a link in farmers' minds between good storage technologies and good drying practices.

Impact assessment year 4 plan

Senegal

- **Research:** Continue analyzing data to understand critical point in on farm practices for reducing aflatoxins in stored maize
- **Extension:** work with ISRA to train more households on best practices for drying and storage

Kenya

- **Research:** Continue analyzing moisture device demand data.
- **Extension:** Work with Bell Industries to create awareness and commercialize hygrometer and dryCard.
- **Extension:** Look for resources to provide training and awareness building on moisture detection devices
- **Leverage:** MOU with Global Good to improve the design of the hygrometer and commercialize it.

Gender (Dr. Cheryl O'Brien, SDSU): Past Year (**Outputs**)

- Teams continued collecting gender-disaggregated data and sought Dr. O'Brien's input, as needed.
- Focus Group Discussions Gender Report is under review by Dr. Bugusu based on 2016 FGDs, totaling 8 FGDs / country; 4 sites / country; 2 FGDs / village (1 FGD for men farmers & 1 for women farmers per village).
- From the gender-focused FGDs: Capacity-building for 5 young women (4 students) – namely experience w/ facilitation, translation, transcription; the Kenyan women also helped organize the FGDs in Kenya)]
- Met: project partner & women processors in Touba; & Femmes Africa Solidarité (FAS) on gender & food security, & opportunities for university students

Gender (Teams w/ Dr. O'Brien's support) Year 4 Plan

Our teams need to analyze/assess:

1) gender-disaggregated data (HOHs & spouses; boys/girls; hired laborers; processors; all study participants; group membership and leadership positions; extension/key actors in the value chain).

2) How do local gender norms impact women's empowerment in ag. (WEAI)? Refer back to WEAI domains/indicators (e.g. income; control/spending of income, such as on food; decision-making; ownership of assets; access to knowledge/training; time use & HH division of labor; group membership; speaking & leadership roles; etc.).

3) How do gender inequalities in our study and the gendered impacts of interventions affect outputs for transfer and scale-up? How do they impact men & women's participation & productivity along the value chain? [See O'Brien et al. 2016, NuME project Ethiopia, for e.g.]

4) Integrate gender-sensitive analysis & participatory approaches into all stages of the project cycle.

5) Plan/Publish country & cross-national findings/insights inclusive of gender. Include Dr. O'Brien on gender-relevant analyses & manuscripts. USAID Staff are very interested in gender analysis.

Capacity Building

- Long-term: 22 graduate students
  - 14 male and 8 female
  - 16 Ph.D. and 6 Masters
- Short-term: 4659
  - Train-the-trainers: 59 - extension agents govt. & NGOs
  - 16 scientists and undergraduate students
  - Farmers and processors
- Food Processing Incubation Center in Kenya
  - Equipped with food processing equipment
  - Extrusion technology

Food Processing, Training and Incubation Centre at University of Eldoret, Kenya

Signage for the FPL Centre


Training on extruder operation


Extrusion in progress


Products for taste testing

The researchers during the taste test exercise


Launch of cereal food products manual

Questions, Input?