



**Feed the Future Innovation Lab**  
for the Reduction of Post-Harvest Loss



**USAID**  
FROM THE AMERICAN PEOPLE

## PHLIL Progress in Ethiopia: 2014-2016



Bhadriraju Subramanyam (Subi)

PHLIL Annual Meeting, May 11-12, 2016

Holiday Inn, Manhattan, KS

# US Team



Dr. Bhadriraju Subramanyam  
PI, KSU  
Stored-product entomologist



Dr. Rizana Mahroof  
Co-PI, SCSU  
Stored-product entomologist



Dr. John Leslie  
KSU-Interim Director  
Mycologist

# US Team



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Dr. Shannon Washburn  
KSU  
Extension/engagement



Dr. Brian Lindshield  
KSU  
Nutritionist



Dr. Sajid Alavi  
KSU  
Drying/grain processing

# In-country collaborators and potential partners

- Mekelle University(host), Bahir Dar University, Hawassa University in Ethiopia
- Regional Agricultural Bureaus (Amhara, Tigray, Oromia, SNNP)
- Ministry of Agriculture
- Ethiopian Institute for Agricultural Research
- Agricultural Transformation Agency, Ethiopia
- Hiwot Agricultural Mechanization, Ethiopia
- Grain Pro, Inc.
- Sesame Business Network, Ethiopia
- International Seed Sector Development, Ethiopia
- ACIDI-VOCA, Ethiopia
- Farmers, farmer cooperatives, small businesses and USAID mission
- Sasakawa Global 2000
- Africa Rising



# Postharvest Loss Estimates

Crop	% Weight loss	Reference
Maize with LGB	2.6	Kidane and Habteyes (1989)
Sorghum, threshed	11.0	Kidane and Habteyes (1989)
	15.4	Kidane and Habteyes (1990)
Wheat	2.1	Kidane and Habteyes (1989)
Barley	2.5	Kidane and Habteyes (1989)
Teff	0.3	Kidane and Habteyes (1989)

Maize 30-100% (Dimisse et al. 2011)

# Underground pit storage



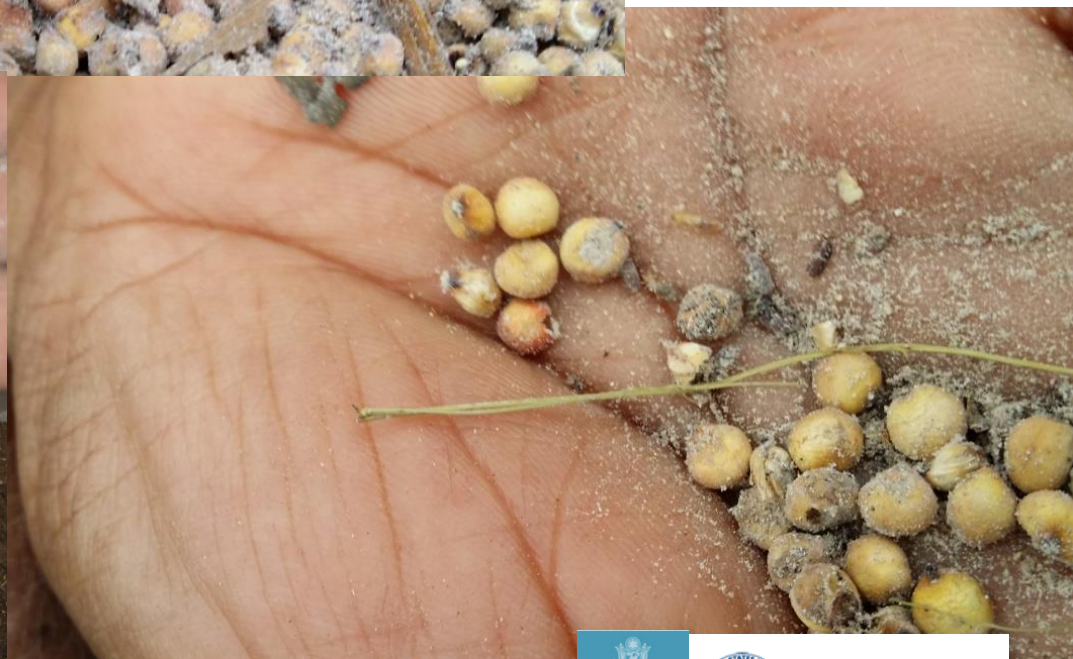


# Site Visits





# Infested sorghum taken from underground pit storage





# Lakota- Storage bags made from goat skin





## Gotera: outdoor grain storage





**Gota: indoor grain storage**





**Fodo: indoor grain storage**





# Storage wastes in wheat warehouses





# Merkab warehouse





**Ethiopian Seed Exchange warehouse**













# 2014 Plans

- Network with university and other stakeholders
- Assess capability of universities for conducting PHLIL projects
- Gather information on farmers' perception of postharvest losses
  - 13 page survey
  - 65 questions



# Postharvest loss assessment survey information

- Crop-specific: Maize, wheat, chickpea, and sesame
- Survey of farmers' perception about PHL
- Information gathered
  - Demography
  - Inputs used in production
  - Causes of grain losses
  - Different postharvest techniques practiced
  - Storage structure and time
  - Methods used to control losses
  - Transportation and marketing
  - Family nutrition
  - Pesticides and environmental safety
  - Role of gender
  - Training and educational needs

# Crop surveys to gauge farmers perceptions of PHLIL









# Number of farmers surveyed by region

Region	Wheat	Maize	Chickpea	Sesame
Tigray	30	51	50	90
Amhara	66	85	60	80
Oromiya	80	70	60	30
SNNPR	15	74	50	----
<b>Total</b>	<b>191</b>	<b>280</b>	<b>220</b>	<b>200</b>

# Cross-cutting issues

## ☐ Gender

- Address role of gender in PHL reduction
- Develop Women Empowerment Agricultural Index and gender dynamics
- Specific training in gender analysis, tools and methods
- Integrate gender-sensitive participatory approaches into all stages of the project cycle

## ☐ Nutrition

- Measure reduction in PHL on nutritional security
- Assess impact of PHL reduction strategies on the nutritional status of families

## ☐ Environment

- Environmental Mitigation and Monitoring Program (EMMP)
- Mitigation measures to be followed by project personnel to minimize potential adverse impacts to humans and environments





# Maize



# Farmer perceptions: Maize survey

## Prevalence and severity of storage insect pests

Description	Farmer's response	No. responding (%)
Prevalence	Prevalent	169 (93.9)
	Not prevalent	11 (6.1)
Severity	Not severe	28 (10.0)
	Moderately severe	70 (25.0)
	Severe	169 (60.4)
	Not able to judge	13 (4.6)

# Farmer perceptions: Maize survey

## Prevalence and severity of molds in storage

Description	Farmer's response	No. responding (%)
Prevalence	Prevalent	197 (70.4)
	Not prevalent	83 (29.6)
Severity	Not severe	62 (22.1)
	Moderately severe	47 (16.8)
	Severe	87 (31.1)
	Not able to judge	84 (30.0)

# Maize: Some key findings

- Only 26% of 280 farmers indicated ever receiving any postharvest loss prevention training
- More than 80% of surveyed farmers expressed a need for training in harvesting, packing, transportation, drying, cleaning, moisture measurement, insect, mold, and vertebrate pest management, proper storage, use and safe handling of pesticides, and marketing of grain
- 82% ( $n = 279$ ) farmers measure moisture mostly by biting with their teeth (91%,  $n = 265$ )
- 20 and 65% of farmers use malathion and pirimiphos-methyl to protect grain in storage from insects ( $n = 275$ )
- Maize is stored in traditional gotera (68% of farmers,  $n = 276$ ), and it is stored for 7-12 months



# Wheat

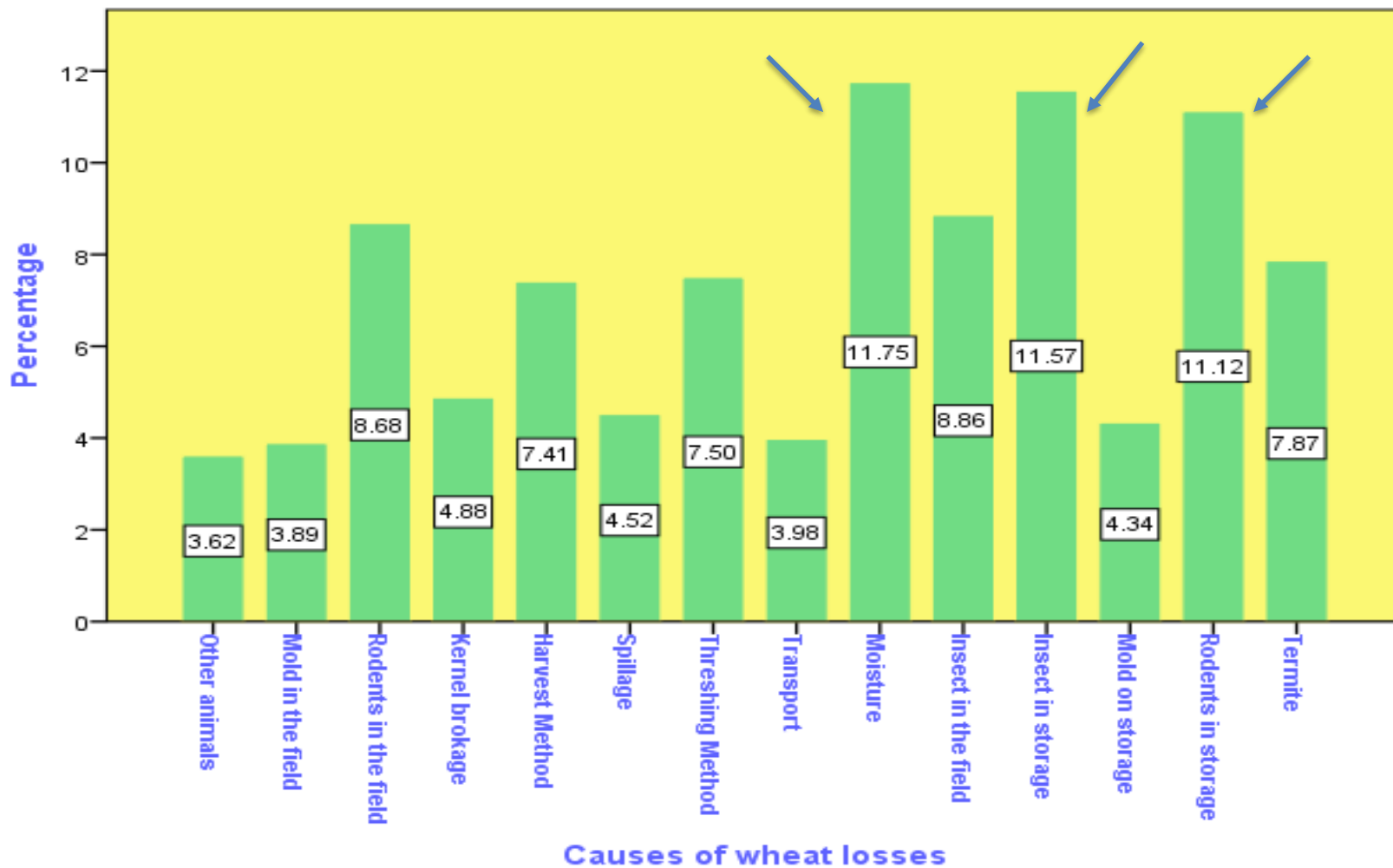
# Wheat survey: Key findings

- Farmers store wheat in traditional storages, fertilizer bags, jute bags, polypropylene bags, and warehouses
- Wheat is stored for 3-12 months
- Farmers inspect grain in storage visually and by smell

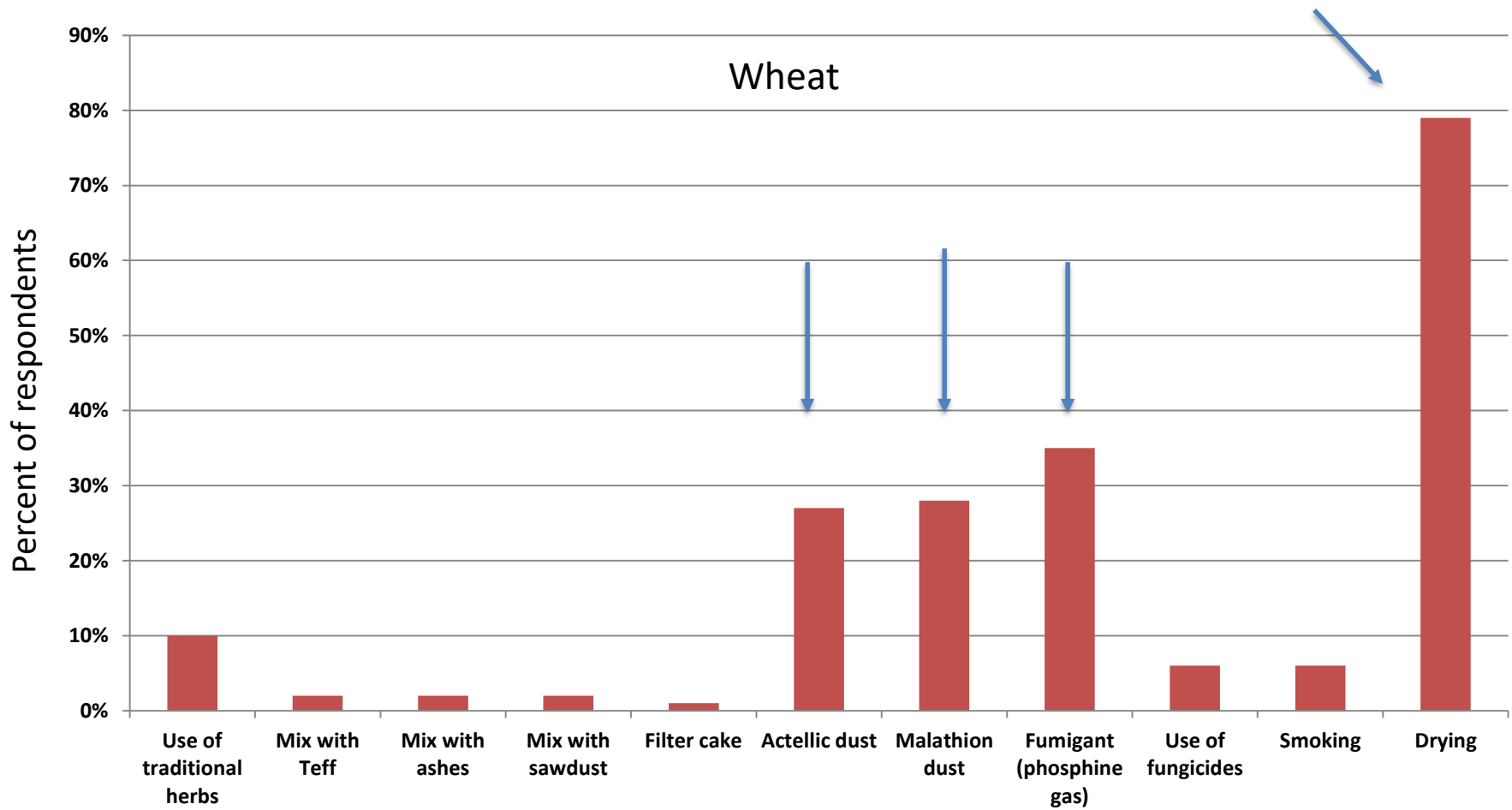


Traditional gotera

# Causes of postharvest losses



# Control methods used in storage



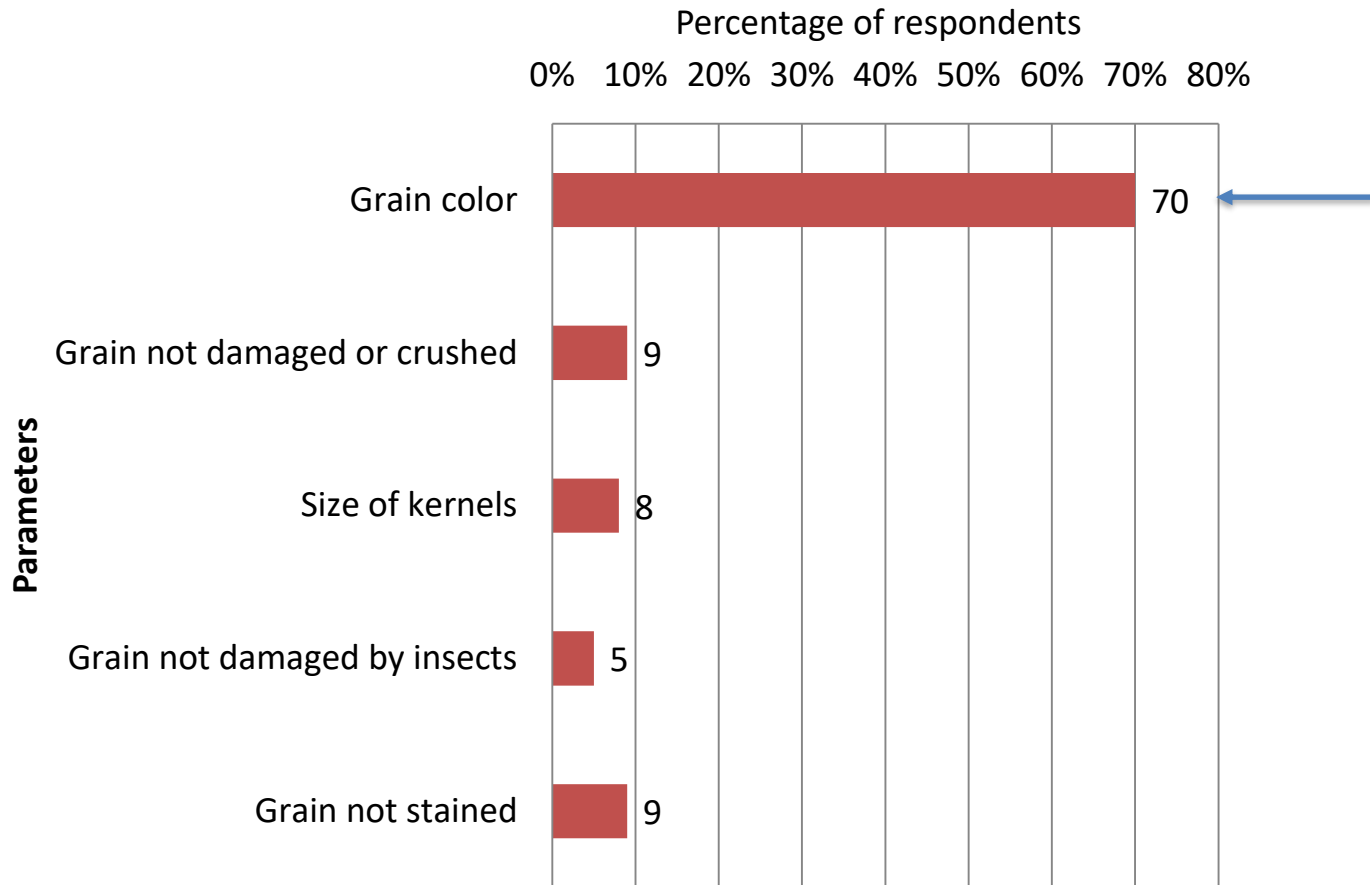


# Estimated postharvest losses in wheat

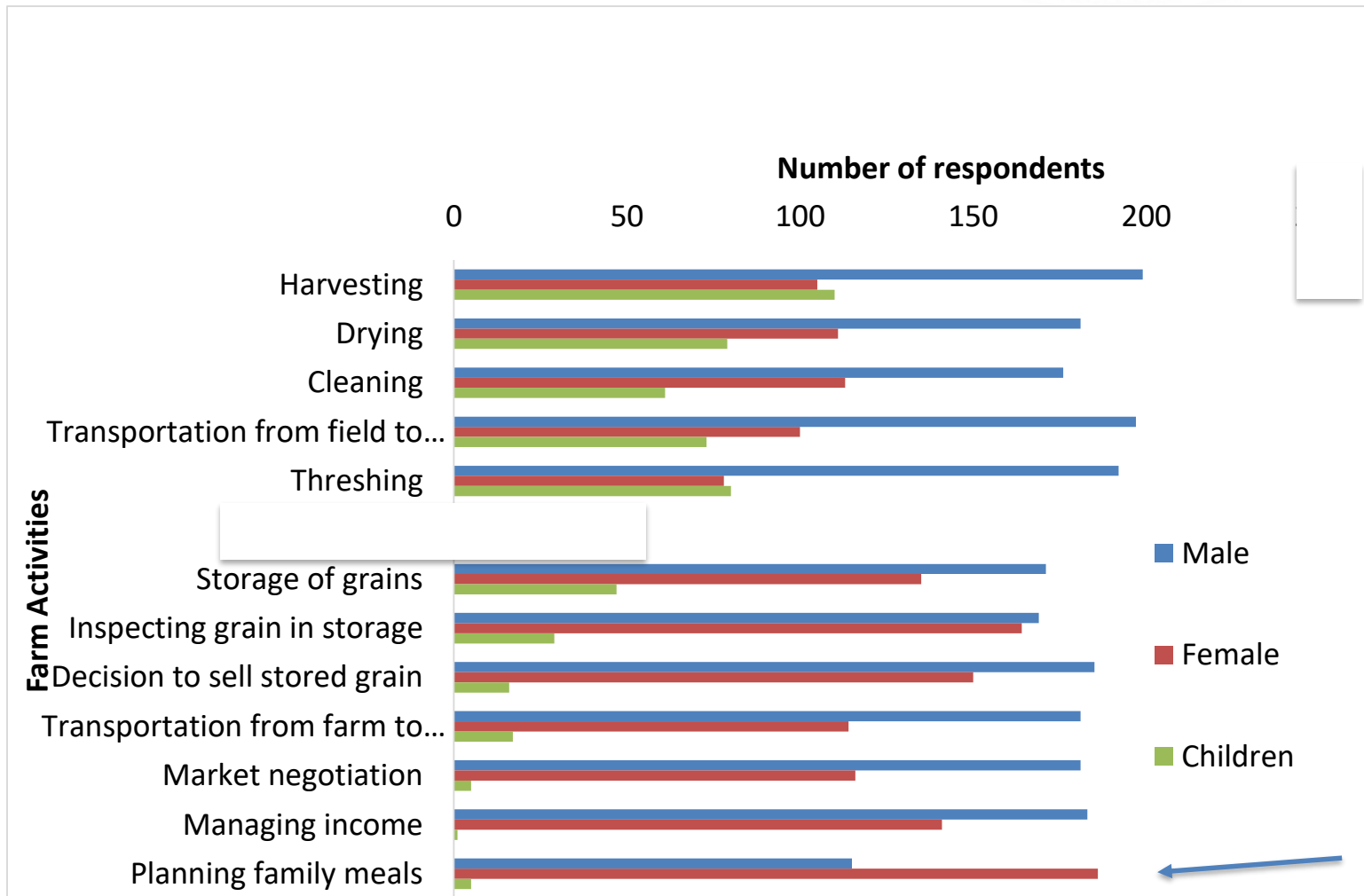
Harvest and postharvest stage	Wheat losses (%)*	<i>n</i>	Calculated estimates under two scenarios**	
			No rain at harvest	Rain at harvest
Harvesting	6.8	183	6.8	16.3
Threshing	3.5	178	3.5	3.5
Cleaning	2.1	175	----	----
Packaging/bagging	0.2	168	----	----
Transportation (farm to storage)	1.1	165	1.2	1.2
Farm Storage	2.7	180	2.7	2.7
Transportation ( storage to market)	0.2	165	1	1
Market storage	0.1	166	2.7	2.7
Milling/Crushing/Grinding	0.4	172	-	-
<b>Total</b>	<b>16.1</b>		<b>17.9</b>	<b>24.6</b>

\*Calculated by SPSS; \*\*Calculated by APHLIS calculator.

# Criteria used to select wheat kernels for consumption



# Roles of gender in farming/marketing



# Sources of information for farmers

- Primary sources:
  - Through large meetings
  - Fellow farmers
  - Radio programs
  - One-on-one delivery
  - Demonstration trials
  - Most of the training was on seed production
  - Farmers interested in training on moisture measurement, harvesting, drying, pest identification and control, safe and proper use of pesticides



# Chickpea



# Chickpea: Harvest and postharvest losses

- Pod-dropping from plants to ground at harvest was cited as the major cause of loss by 75% of the respondents ( $n = 219$ )



# Losses during threshing and cleaning

- Threshing is done by animals (oxen, horses, or donkeys) [75.5% of 174 respondents] or by stick (3.6%)
- Grain loss occurs during threshing (45% of 134 respondents). Some loss due to consumption by trampling animals. Loss is assumed to be 18.6 kg ( $n = 134$ )
- Losses occur during cleaning (winnowing) as reported by 53.2% of 138 respondents. Total loss 14.4 kg



# Losses during transportation

- Losses during transportation were 3.4 kg ( $n = 172$ )
- Storage losses reported by 91 farmers were 29.4 kg
- Only 18.2% of 220 farmers reported receiving any training on postharvest loss issues

# Farmers' training needs

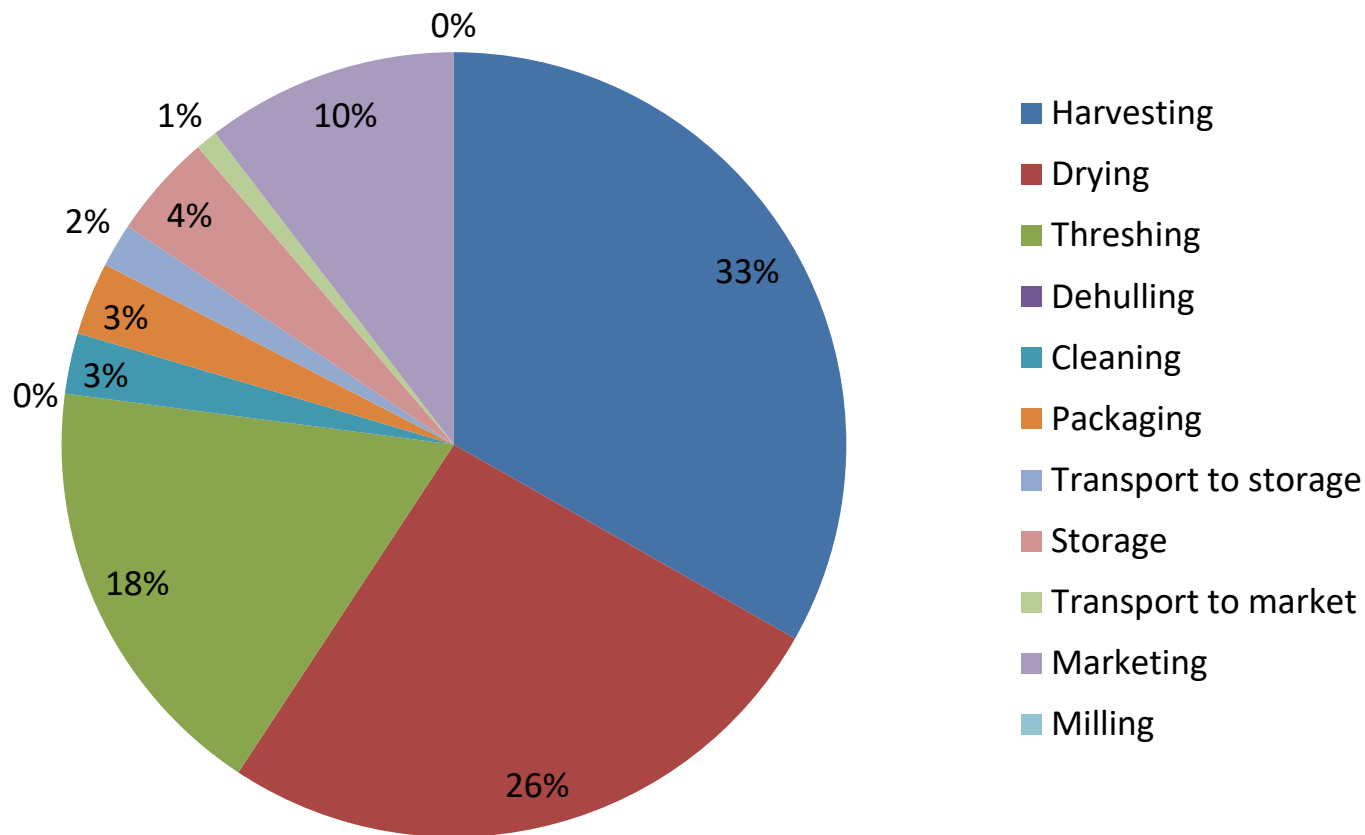
No	Area of training need	Responding farmers	
		Number	Percent
1	Harvesting	148	67.3
2	Threshing	73	33.2
3	Packing	72	32.7
4	Transport	46	20.9
5	Drying	76	34.5
6	Cleaning	107	48.6
7	Insect Identification	179	81.4
8	Mold identification	78	35.5
9	Pesticide usage	197	89.5
10	Pesticide handling	179	81.4
11	Proper storage	148	67.3
12	Rodent and other animal control	111	50.5
13	Bird control	55	25.0
14	Marketing	116	52.7



# Sesame



# Sesame: Losses at and after harvest

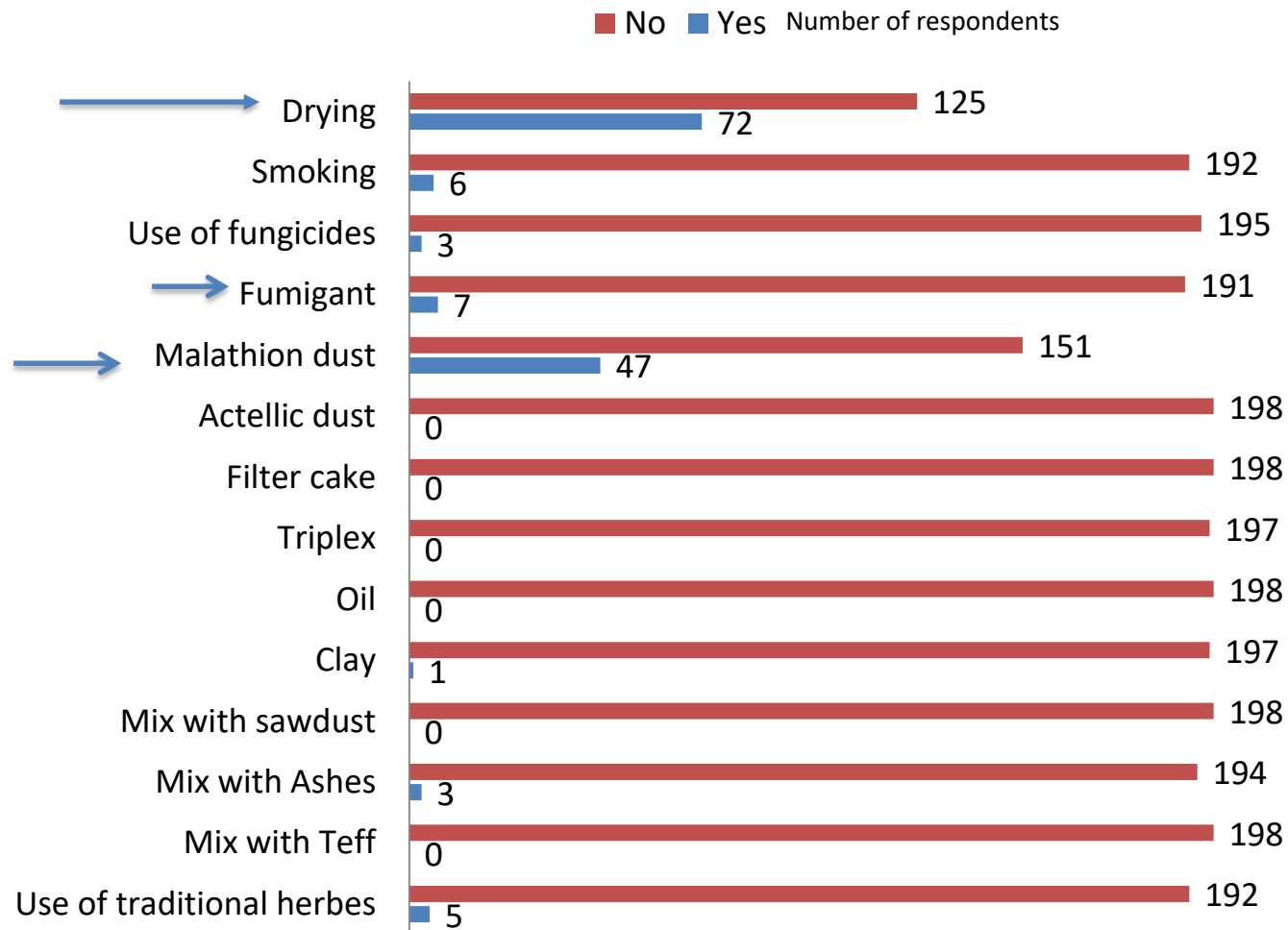




# Shattering

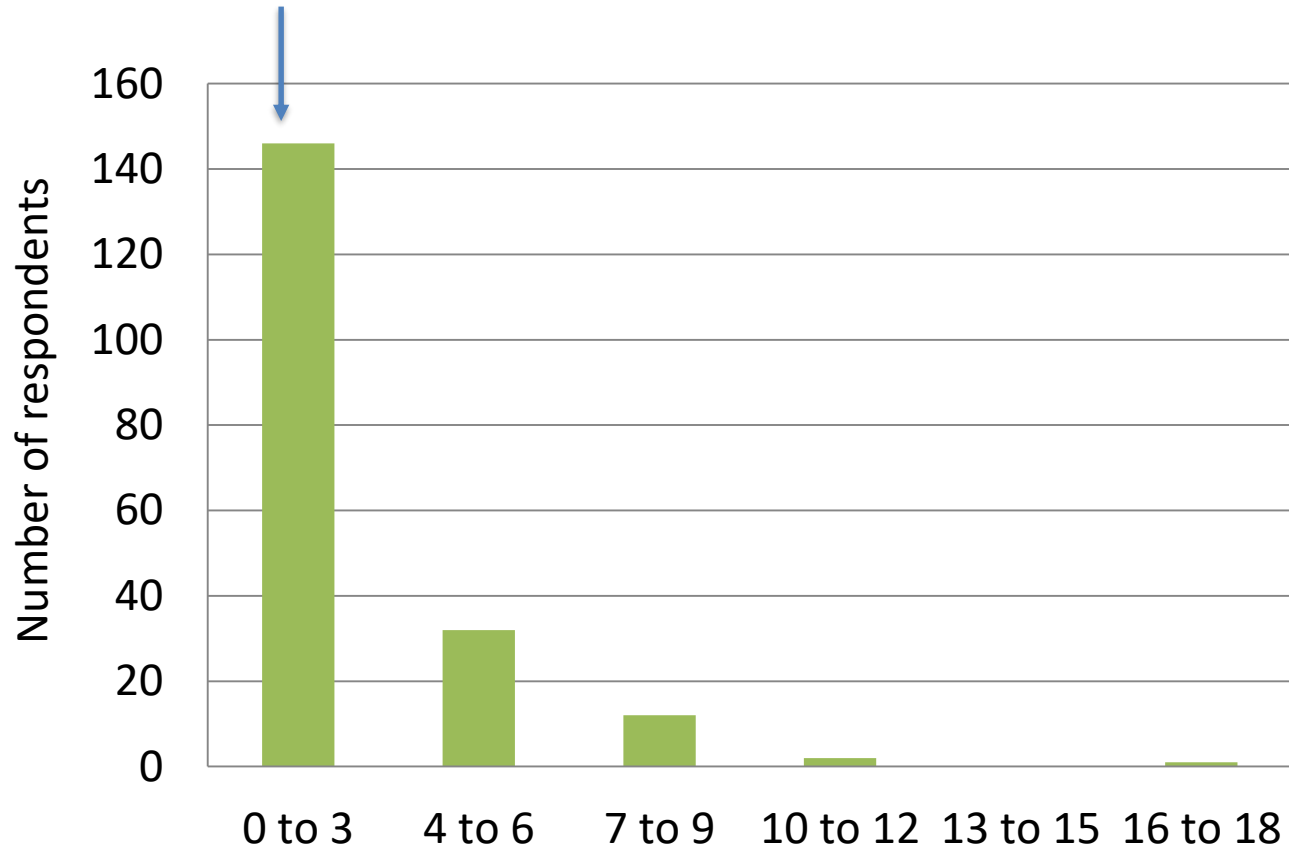


# Sesame storage loss prevention methods



# Duration of sesame storage

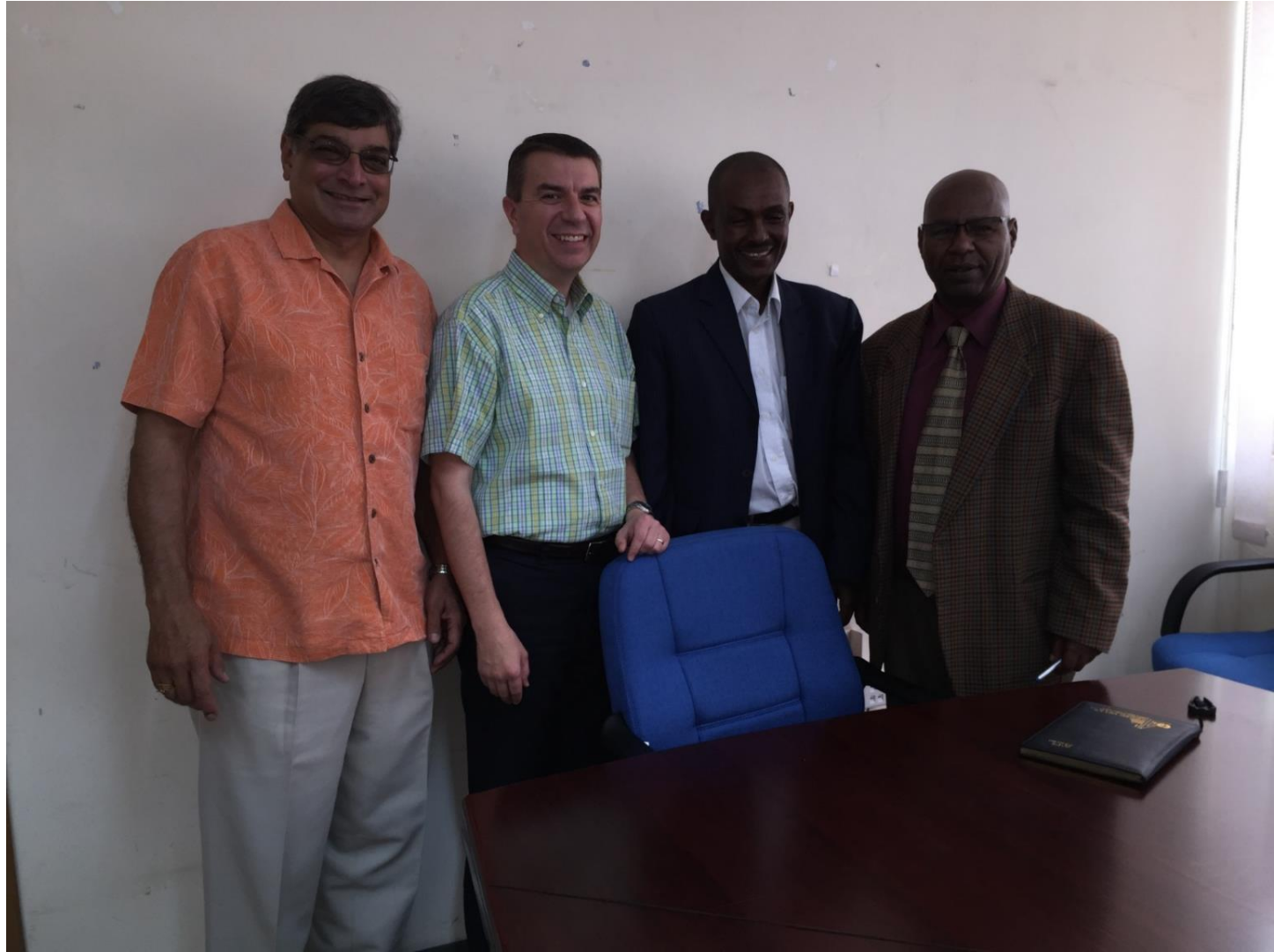
Much shorter than maize, wheat, and chickpea!





# Extension engagement-2015

- Established Extension Advisory Team (EAT)-10-12 members
- First engagement advisory meeting happened in July 2015
- Key concepts identified
  - Harvesting, threshing and shelling are key areas need curriculum and training
  - Drying and mold reduction
  - Storage management
  - Storage insect management
- Target audience: smallholder farmers, development agents, extension personnel
- Secondary audience: storage managers, private sector folks, and input suppliers
- Plans
  - Develop training curriculum
  - Train under leadership of EAT







# Capacity building-2015

- Set up two mycotoxin laboratories
  - ✓ At Mekelle University, Tigray and Bahir Dar University, Amhara
- Provided tools for insect sampling
- Provided probes for grain moisture measurement
- Installed the Grain Pro bubble dryers and cabinet dryers
- Shared books, research articles and literature related to PHL
- Zenzelma campus at Bahir Dar university has a dedicated stored-products research lab
- Recruited three graduate students from each Universities
  - ✓ Start date May 2015
  - ✓ Research is being conducted in Ethiopia



# 2015 Plans

- Review postharvest loss reports (submitted May 2015) for data accuracy (on-going effort)
- Select 30 maize, wheat, chickpea, or sesame farmers to collect samples
  - BDU: Maize and wheat
  - MU: Chickpea and sesame
  - Analyze for insects and mycotoxins
  - Trap insects in grain
- Collect samples from 10 warehouses/traders
  - Analyze for insects and mycotoxins
  - Trap insects in warehouses/traders

Role of gender in PHL mitigation

# Evaluate storage technologies-2015

- With all 4 commodities-10 kg/storage structure
- PICS bags
- GrainPro Supergrain bags
- Polypropylene bags
- Jute bags
- Metal drums
- Plastic drums
- Treat grain in polypropylene/jute bags with
  - Filter cake (1% by wt)
  - Triplex (0.2% by wt)

Evaluate insect control and mycotoxin reduction



# Traps

## Dome traps



*Prostephanus truncatus*  
Larger grain borer



*Rhyzopertha dominica*  
Lesser grain borer



*Tribolium castaneum*  
Red flour beetle



*Trogoderma granarium*  
Khapra beetle

*Tribolium confusum*  
Confused flour beetle

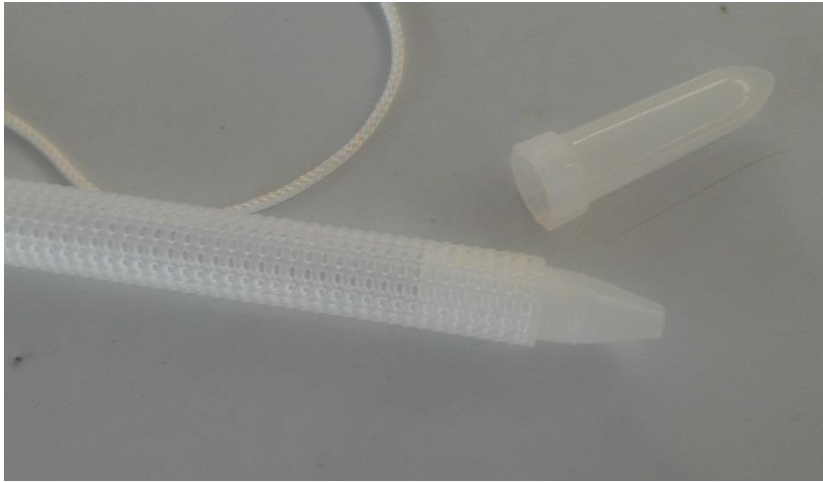


# Sticky traps





# Probe traps



*Sitophilus oryzae*  
Rice weevil



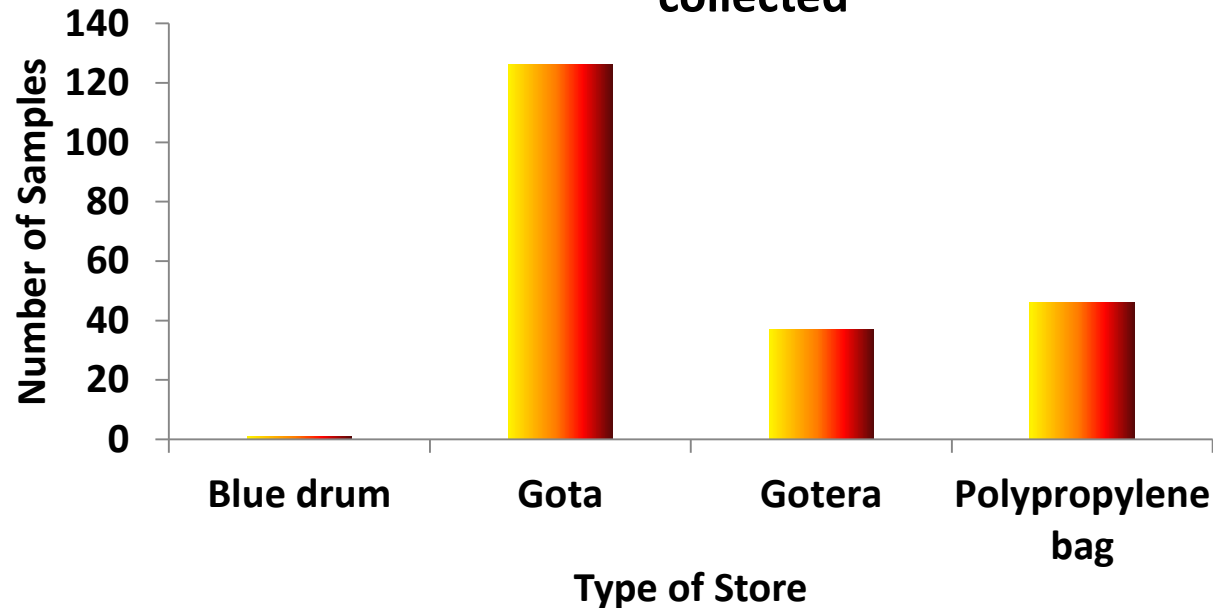
*Sitophilus zeamais*  
Maize weevil





# Insect survey of farmers' grain stores: 2015 research

Types of stores where maize samples were collected

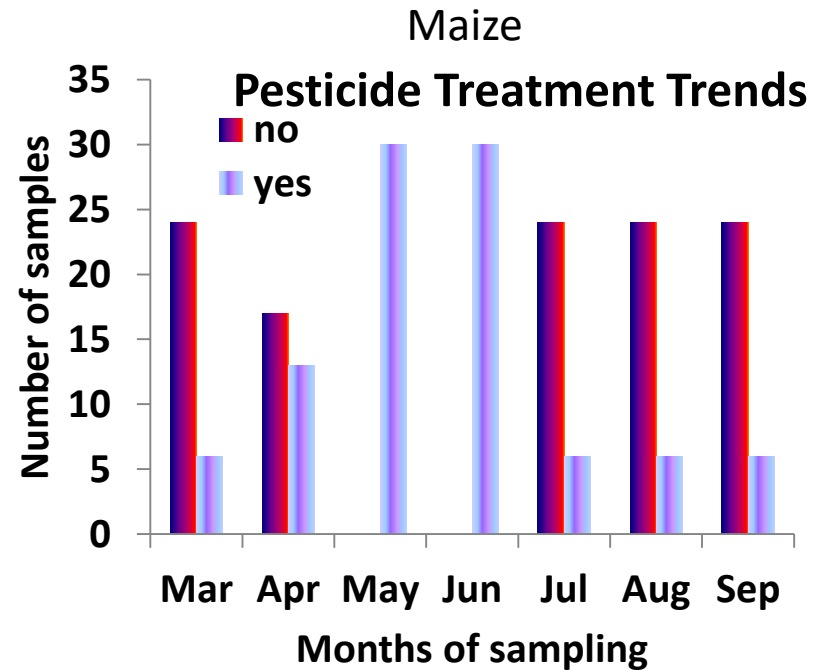


**A majority of maize samples were collected from 'Gota'**

**All of wheat samples were collected from polypropylene bags**

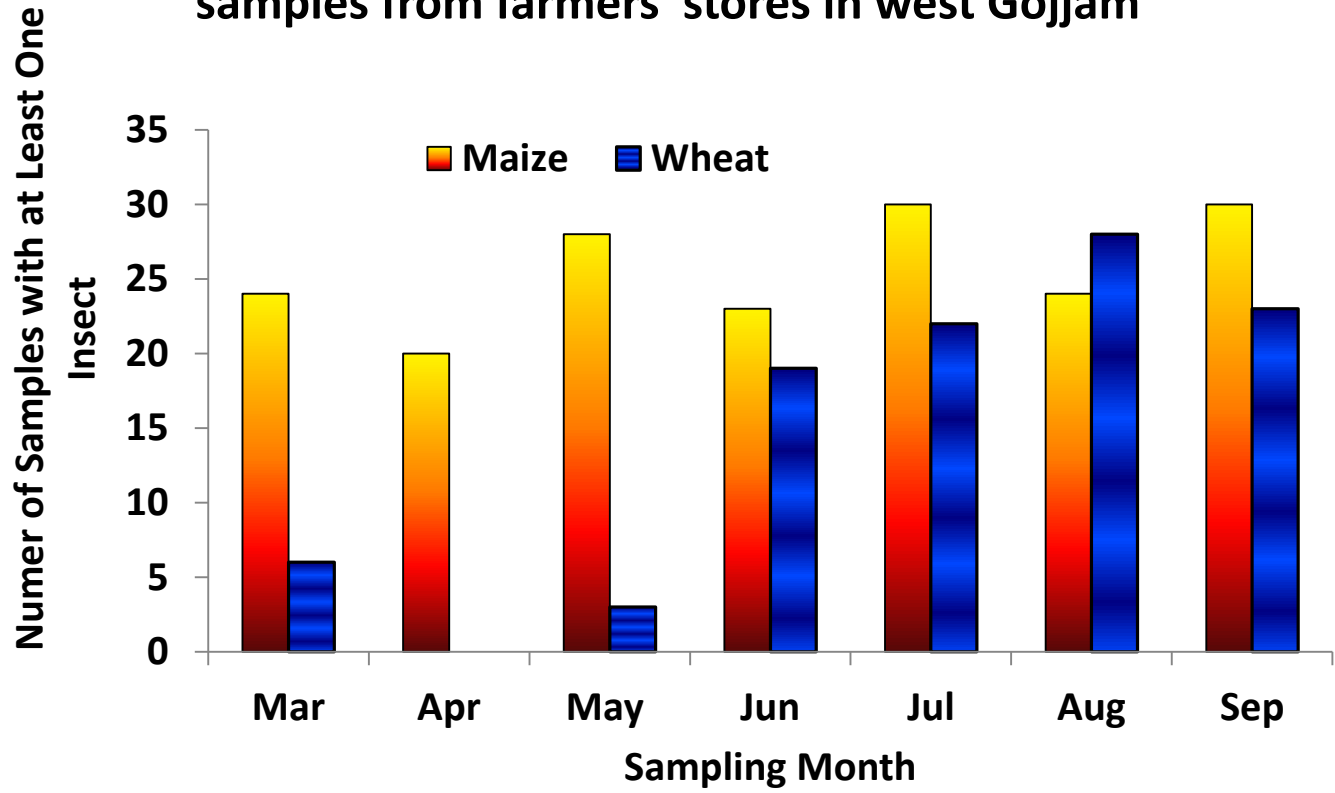
# Insecticide applications made by farmers to their stored grain: 2015 research

Farmers used **Actellic dust**,  
**phosphine fumigant**, **malathion**  
**dust**, and sometimes in  
**combination**



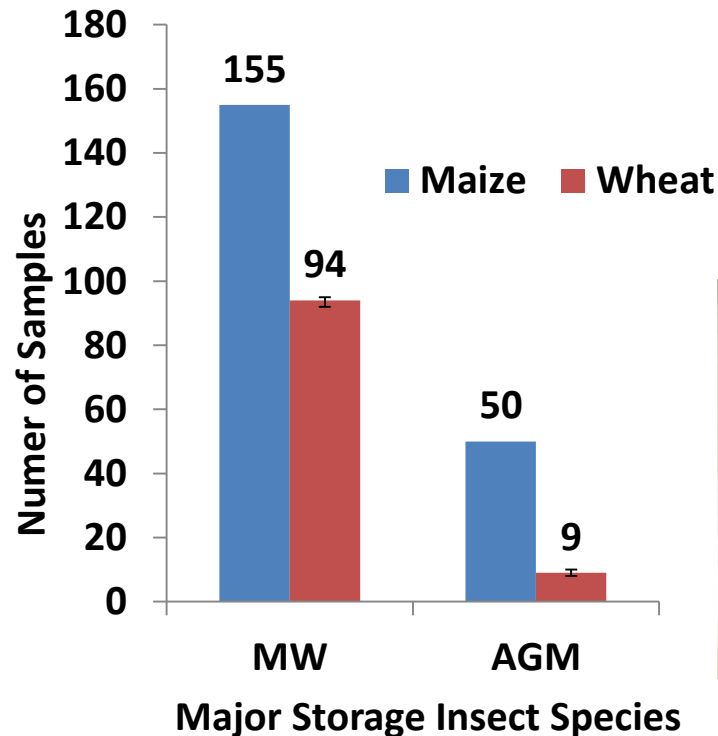
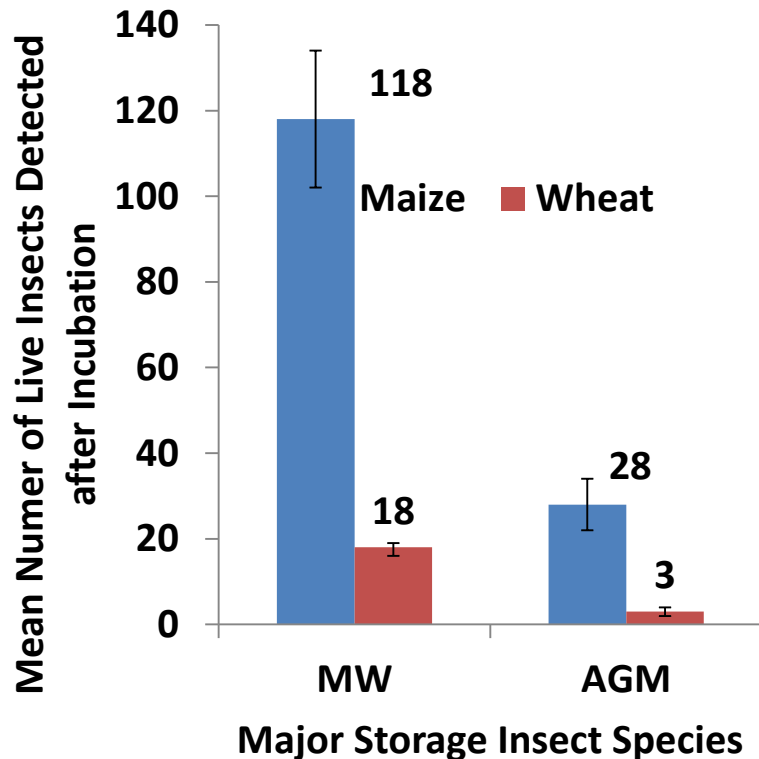
**None of the wheat samples was treated with insecticides**

### Insect prevalence on maize and wheat grain samples from farmers' stores in west Gojjam





## Intensity of maize weevil (*Sitophilus zeamais*) and Angoumois grain moth (*Sitotroga cerealella*) in maize and wheat farmers' stores



# Total aflatoxins: Maize 2015

Month of Sampling	No of samples analyzed	Positive samples (%)	Samples $\geq$ 20 ppb (%)	Observed detection range (ppb)	
				Min	Max
March	30	90	3.3	2.05	29.34
April	30	100	6.6	6.25	22.06
May	30	100	26.7	8.5	26.19
June	30	100	23.3	6.97	23.19
July	30	100	0.0	2.03	7.7
August	30	100	0.0	4.67	12.68
<b>Total</b>	<b>180</b>	<b>98</b>	<b>10.0</b>	<b>2.03</b>	<b>29.34</b>

# Bruchids in farmer's chickpeas





# Evaluation of different storage technologies



**PICS bag**



**GrainPro Super bag**



**Metal Silo**



**Plastic Drum**



**Jute Bag**

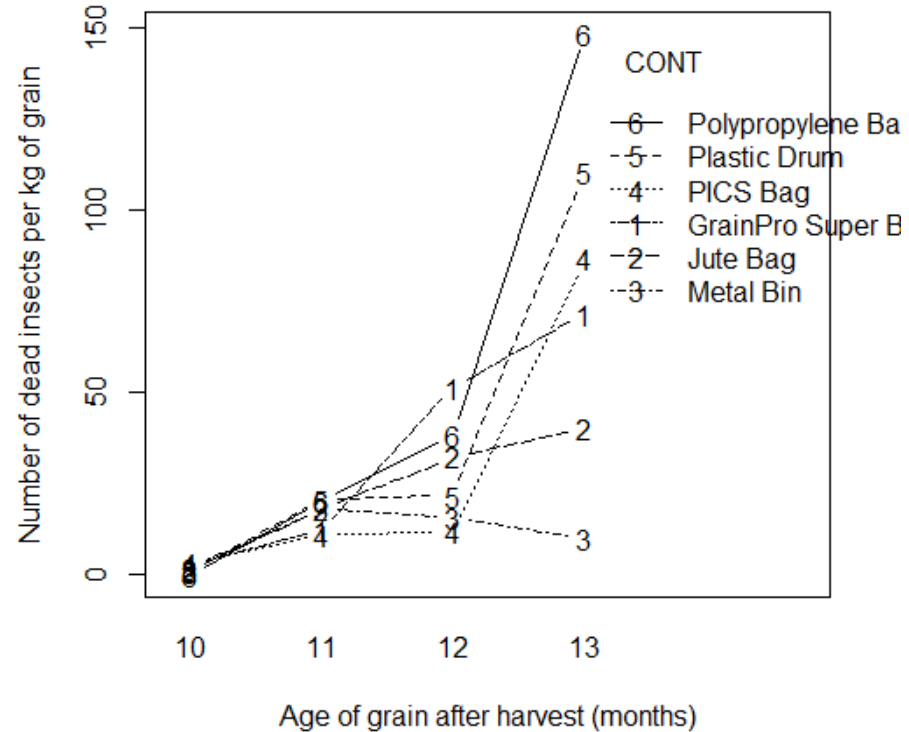
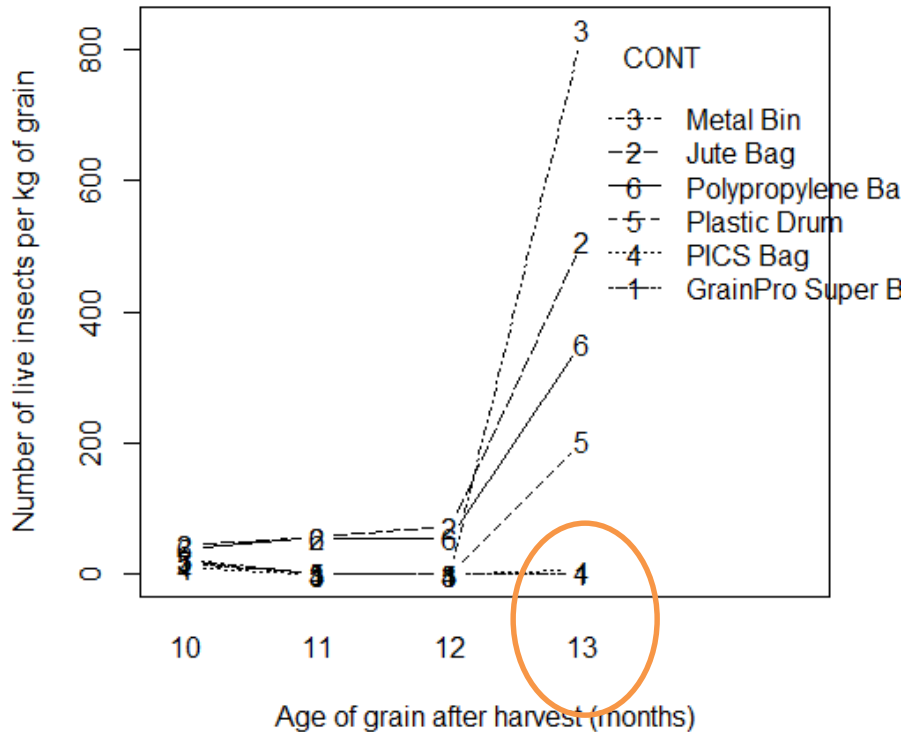
**Polypropylene bag**

# Project managers from KSU visiting the PHL lab at Mekelle University



# Evaluation of different storage technologies

## Number of insects per kg of maize after different periods of storage



**Hermetic bags** suppressed insect population growth, while higher live insect populations were recorded in other containers  
Lower insect mortality in metal bin and jute bag, **ease of access to oxygen**



# Drying research



Solar cabinet dryer



Solar bubble dryer

2 PHL workshops  
April (100)  
& May (2000)  
2016.



Sun drying

# 2016 Plans

- Workshop on reducing postharvest losses in Ethiopia, February 25, 2016, Harmony Hotel, Addis Ababa
- 13 Presentations
  - University researchers: 20
  - EIAR/MOA: 10
  - Private businesses: 7
  - NGOs: 6
  - USAID: 1
  - Males 35; Females 9







# 2016 Plans

- Publish 2015 results
- Repeat 2015 experiments
  - 180 farmers in 4 regions
  - 30 farmers follow up over time
- Storage technologies: 50 kg/storage structure
- Provide PICS and GrainPro Superbags to farmers and evaluate effectiveness in farmer-managed trials
- MOA will support training proposal
- Training of development agents
- Role of gender in PHL mitigation









# Personal observations

- Most universities focus on teaching, with limited research
- Laboratories are ill-equipped to do research
- PHLIL progress the first two years was slower than expected
- In-country researches look at PHLIL support as a project and not as a program
- Momentum is picking up and there is renewed interest in addressing postharvest issues
- Need to bring more awareness about PHLIL projects and their benefits





Thank You

