

Grain Legume Processing Workshop

Value Addition to Bean, Cowpea,
Groundnut and Soybean by Small-Scale
African Farmers



***16 to 18 March 2011 Kleen
Homes and Gardens
Butere, Kenya***

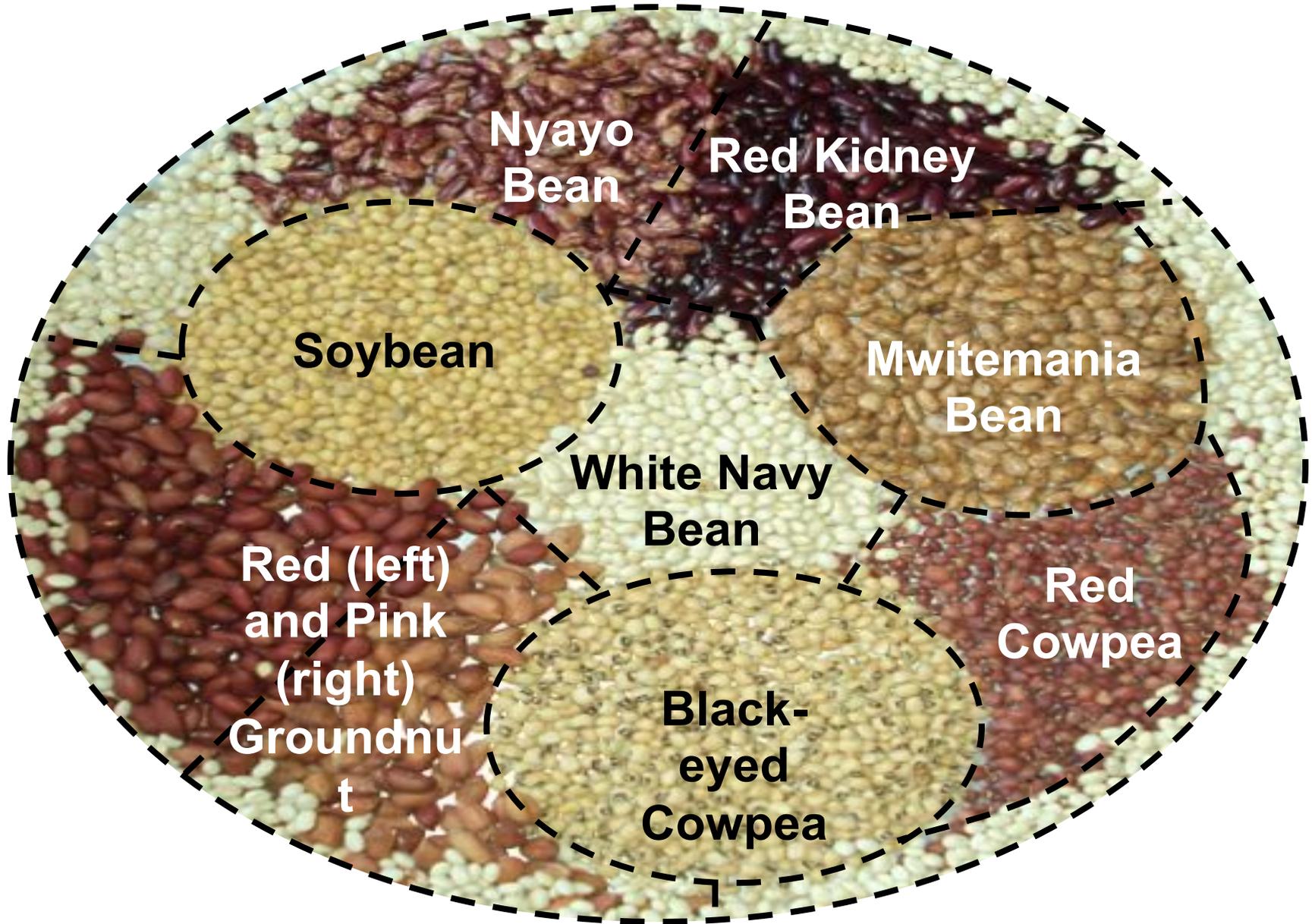
Grain Legume Processing Workshop

- two day training workshop on the processing and preparation of grain legumes
- to provide N2Africa Outreach Team members and others to better understand grain legume utilization
- to empower their respective grassroots groups, communities or businesses to more wisely consume and add value to their legume produce
- combines short presentations with related practicals and demonstrations
- topics covered include the role of grain legumes in household nutrition, protecting grain legume quality and meeting industry standards, and disseminating food processing and preparation technologies

All participants share the following qualifications

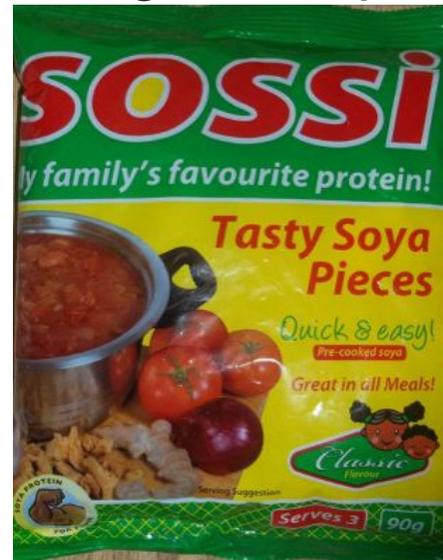
- A basic knowledge of human nutrition
- Fluency in English
- Willingness to create and consume new foods
- Well positioned to liaise with N2Africa, grassroots groups and the private sector in the future

Some popular grain legume varieties in Kenya: each with its own characteristics and advantages





Some grain legume products we will better understand, learn to process and enjoy during workshop legume breaks and meals (clockwise from top left: bean sprouts, cowpea leaves, soy burger, groundnut clusters, textured vegetable protein, tofu)



N2Africa Pilot Grain Legume Processing and Preparation Workshop

Day 1 - 17 May 2011

0900-0930	Course objectives and roundtable introduction	PL Woomer
0930-1000	Grain legumes in Kenyan households	J Ongoma
1000-1030	Nutritional value of grain legumes	A Masinde
1030-1045	Demonstration: Make a quick snack	PL Woomer
1045-1100	<i>Legume break</i>	
1100-1115	<i>Morning Practical:</i> Assign practical teams and workspace	J Ongoma
1115-1200	Pre-cooking grain legumes, volume-weight relations	J Ongoma
1200-1300	Preparing a nutritionally-complete meal	Team
1300-1400	<i>Lunch break: eating a nutritionally-complete meal</i>	
1400-1500	Post-harvest handling and grain quality assurance	PL Woomer
1500-1600	<i>Afternoon Practical:</i> Grain quality assessment	PL Woomer
1600-1615	Demonstration: Make a quick snack	J Ongoma
1615-1630	<i>Legume break</i>	
1630-1730	Preparing a nutritionally-complete meal	Team
1830	<i>Dinner: eating a nutritionally-complete meal</i>	

N2Africa Pilot Grain Legume Processing and Preparation Workshop

Day 2 - 18 May 2011

0830-0915	Flexible planning of household diets	J Ongoma
0915-0945	Principles of complete nutrition	A Masinde
0945-1030	Demonstration: Preparing soy milk	J Ongoma
1030-1045	Demonstration: Make a quick snack	A. Masinde
1045-1100	<i>Legume break</i>	
1100-1130	Disseminating grain legume nutrition knowledge	J Ongoma
1130-1200	Developing work plans for follow up actions	Team
1200-1300	<i>Morning practical: A nutritionally-complete meal</i>	Team
1300-1400	<i>Lunch break: eating a nutritionally-complete meal</i>	
1400-1430	Organizing a grain legume cooking contest	PL Woomer
1430-1600	<i>Afternoon Practical: Creating a winning recipe</i>	Team
1600-1630	Judging, award of certificates and closing	Team

N2Africa Grain Legumes and their Nutritional Value

Alice Masinde, ARDAP



**Grain Legume Processing
Workshop
Day 2 Morning Lecture**

Nutritional value of grain legumes

- Food legumes offer not only excellent sources of protein and starch, but also fat (oil), vitamins and minerals
- Different legumes and plant parts have higher concentrations of each
- These benefits result from the versatility of legumes as sources of edible leaves, green pods, unripe seed, grain and sprouts

Nutrient content of the edible portions of four grain legumes

legume	edible part	protein	fat	carbohydrate
		----- % -----		
common bean	seed	25	2	69
	pod	22	2	70
	leaf	27	3	50
cowpea	seed	26	2	69
	pod	33	5	55
	leaf	36	3	50
groundnut	seed	25	48	8
soybean	seed	39	22	36
	sprout	14	10	43

Vitamins and minerals

- Grain legumes are rich in minerals (calcium and phosphorus) and vitamins A, B (e.g. thiamin) and C
- leaves and green pods having higher concentrations of these essential nutrients
- Legumes also contain significant fiber, sodium, potassium, iron and other members of the vitamin B complex

Mineral and vitamin contents of the edible portions of four grain legumes

legume	edible part	Ca	P	Vitamin A	Vitamin C	Thiamine
		----- mg per 100 g -----				
common bean	seed	137	368	11	2	0.42
	pod	350	300	24559	834	1.36
	leaf	2076	568			
cowpea	seed	124	432	11	1	0.67
	pod	478	522	4027	212	1.24
	leaf	664	964		327	3.18
groundnut	seed	52	438	16	1	0.84
soybean	seed	245	606	11	0	0.73
	sprout	251	580	11	0	0.74

Soybean nutrition

Soybean is of particular importance because of its high protein content, balanced nutritional composition and opportunities for value-added processing

Soybeans are rich in omega fatty acids, iron, magnesium, potassium and contain no cholesterol

Soybeans are particularly important in child nutrition as it prevents stunting due to protein deficiency, supports neurological development, builds stronger bones and strengthens the immune system

Nutritional value of soybean products

preparation	protein	carbohydrate	fat	fibre
	----- % -----			
boiled soybeans	17	5	9	5
pressed oil	0	0	100	0
soy sauce	9	8	0	0
soybean curd	8	0.7	5	1
soy yoghurt	5	4	4	0
textured soy meal	35	28	7	12

Nutritional composition of soy and cow's milk

constituents	soya milk	cow's milk
	----- % -----	
proteins	5.7	3.5
lipids (fat)	2.4	4.0
carbohydrates	1.4	4.2
minerals	0.8	0.7
water	90	88

Soy dairy products are recommended to those with lactose intolerance

Harvesting groundnuts

- Harvesting is done by lifting the whole plants from the soil, allowing them to dry for a few days, threshing to recover the pods then removing the seeds by breaking the pods open
- care must be taken not to split groundnuts, excess broken seeds lower their value
- groundnuts must not be harvested in the rain or placed into heaps that remain damp and encourage mold, including dangerous aflatoxin

Nutritional value of groundnut products

preparation	protein	carbohydrate	fat	fibre
	----- % -----			
peanuts, raw	25	8	48	9
peanuts, roasted	26	10	49	8
peanut butter	24	15	50	6
peanut oil	0	0	100	0

- processing groundnut affects its nutrient content to peanut butter results from passing clean groundnuts twice through cereal mills
- roasting may be done by placing groundnuts in a oven or on a pan or hot sand

Grain legumes as green vegetables

- Fresh or dried leaves of cowpea may be steamed or boiled
- Drying picked leaves greatly reduces their perishability as the leaves readily re-hydrate
- But consumers are biased against wilted leaves in markets
- The immature green pods of many legumes may be cooked and consumed including those of bean and cowpea

Nutritional value of raw and boiled cowpea leaves

preparation	protein	carbohydrate	fat	fibre
	----- % -----			
raw cowpea leaves	36	50	3	4
boiled cowpea leaves	22	46	2	4

Leaves are high in protein
Nutrients lost during boiling
Advantage of steaming or stir frying



Many viable dried grains may be converted into green vegetables by sprouting



- sprouts from bean, soybean and green gram
- wash beans and remove defective grains
- soak 1 cup of seed in water overnight and place into small tubs with drainage
- cover with a clean, moist cloth, keep in the dark
- sprinkle with clean water 3 or 4 times a day
- ready when 3 to 6 cm in length after 4 or 5 days
- wash in clean water to remove seed coats
- eaten in salads or cooked as vegetables

**Make a Quick Snack
Glazed Groundnuts and Soy
Beverage**

PL Woomer

N2Africa Outreach Officer



**Grain Legume Processing
Workshop**

**Day 1 Morning Legume
Break**

Glazed groundnuts

*makes 10 to 12
clusters*

Ingredients

1 cup raw groundnuts or soybean crunchies

½ cup sugar

2 tbsp butter or margarine

Preparation: In a heavy pan, combine nuts, sugar, and butter or margarine. Cook over medium heat, stirring constantly for 7 minutes or until sugar is melted and golden in color and nuts are roasted. Spread nuts on aluminum foil; separate into clusters. Sprinkle lightly with salt and cool.

Talented cooks improvise!

e.g. glazed
groundnuts

substitute soy
crunchies

add sesame

add chocolate



Post-harvest handling and grain quality assurance

PL Woomer

N2Africa Outreach Officer



**Grain Legume Processing
Workshop**

Day 1 Afternoon Lecture

Post-harvest handling of legume grains

Drying grain on the ground collects foreign materials and stones that may damage mills

Field and storage pests often destroy untreated grain

Mixed colored grains considerably lower the market value

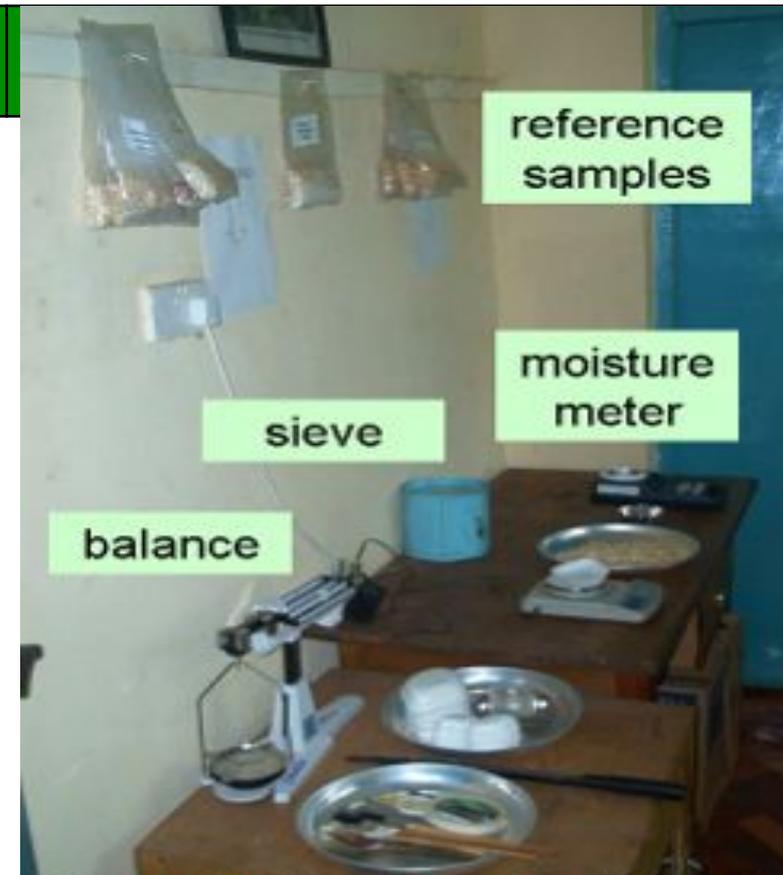
Each bag is expected to meet a specified weight usually 50 or 90 kg, strong local market for 5 kg beans

Winnowing involves slowly pouring seeds from one surface to a lower one, permitting even slight wind to remove lighter foreign materials

Winnowing is time consuming and may be replaced using properly sized sieves

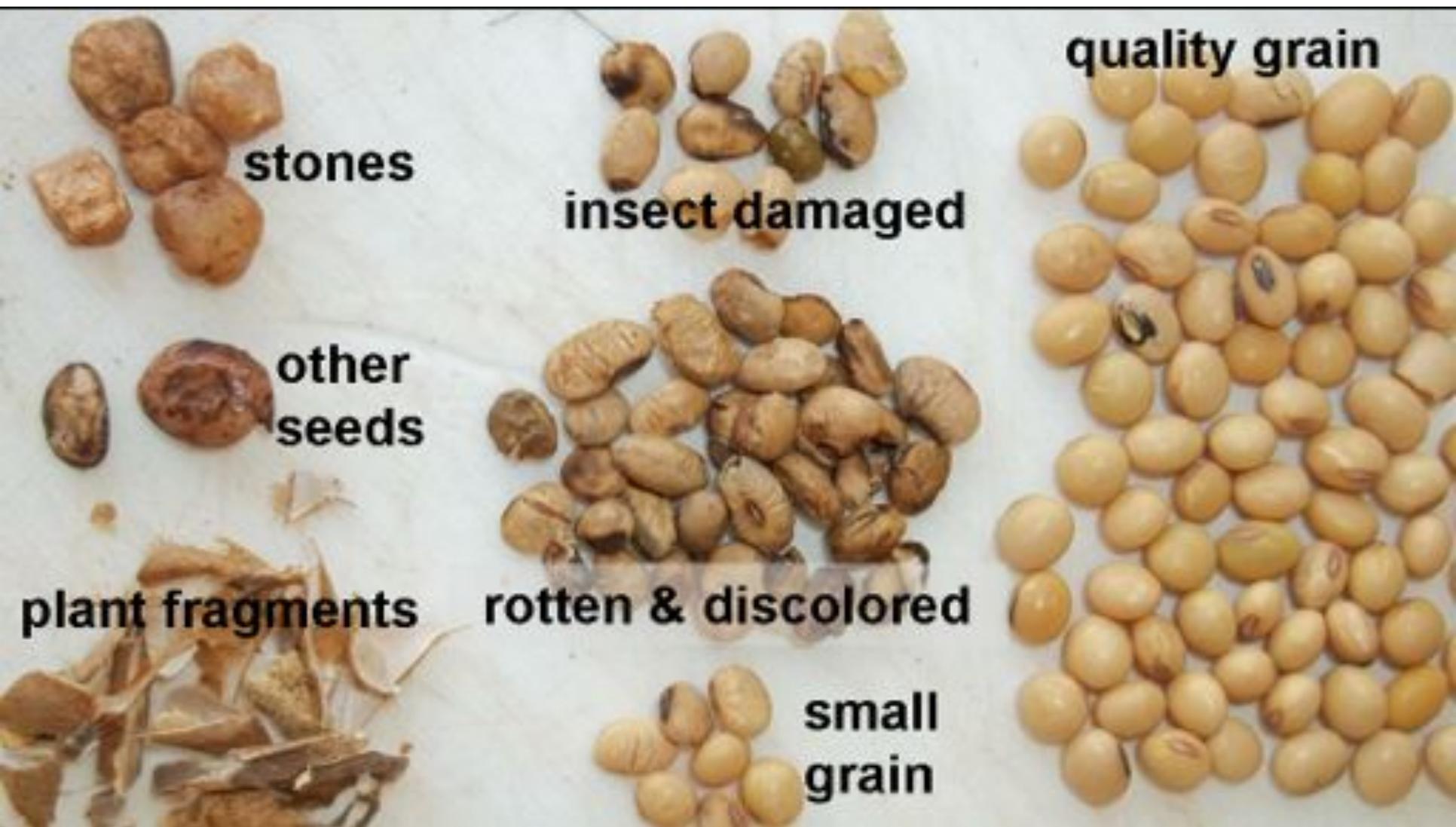
Quality standards of Promasidor for soybeans in Kenya

quality parameter	threshold	target
moisture	< 13.5%	12%
split grain	< 5%	3%
off-color	< 2%	0.5%
shriveled	< 1%	1%
insect damaged	< 3%	1%
foreign matter	< 1%	0.5%
total defective	< 10%	6%



grow varieties with >40 crude protein and < 18% oil

The grains must also be free from objectionable odors and have no live insects



Quality soybeans (right), foreign matter (left) and off-grade grain (center).

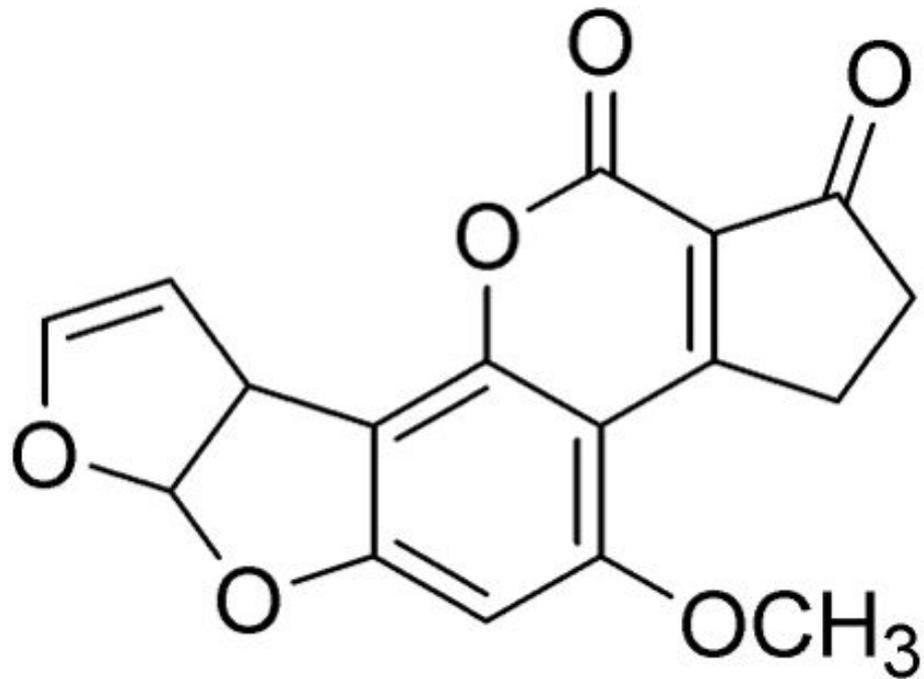
Beware of Aflatoxins!

- Aflatoxins are lethal mycotoxins produced by some fungi.
- They mainly grow on grains and legumes during storage.
- these poisons are heat stable, neither cooking nor freezing destroys the toxin.
- They remain on the food indefinitely, causing liver disease and predisposing humans to cancer.

Some precautionary measures include:

- Storing grain under clean, dry conditions
- Consuming fresh rather than dried groundnuts
- Check for signs of discoloration of grains and seed
- Never swallowing foods with the characteristic bitter taste of aflotoxin

- Aflatoxins are naturally occurring mycotoxins that are produced by many species of *Aspergillus*,
- Aflatoxins are toxic and among the most carcinogenic substances known.
- The native habitat of *Aspergillus* is soil, decaying vegetation, and grains
- 20 ppb limit for all food for human consumption



Post harvest handling of grain legumes

Post-harvest handling assures that grain legumes provide quality food and meet buyers' standards

Excess moisture predisposes to dangerous fungi (mycotoxins)

Tradeoff between field drying and shatter loss during harvesting

Drying on ground collects foreign materials and stones damage mills

Field and storage pests may damage or destroy the crop

Mixed colored grains lower the market value



Post harvest handling tools are essential to meeting legume grain industry standards

Grain Moisture Meters

A method of measuring the moisture content is available through the use of portable grain moisture meters

Most moisture meters are calibrated to different types of grain

Two basic models are available: probes which are inserted directly into grain bags, and those with chambers where grain is removed from containers (right)

samples of about 150 g poured into the device and within a few seconds, the meter provides users with a moisture reading

Grain moisture contents range between 9% and 13%.



LDS Moisture Analyzer

LDS Moisture Analyzer Specifications

Objects: grain and other foods

Moisture range: 3 to 35%

Error: $\pm 0.5\%$

Time: < 10 seconds

Temperature range: 0 to 40°C

Humidity: < 80%



Procedure for collection point quality control

1. Sample about 150 g of grain (volume of LDS top chamber)
2. Place into LDS Moisture Analyzer top chamber slot
3. Turn on LDS, set mode to P2 (soybean) using + or - keys
4. Spring feed lower chamber, wait until moisture content (%) appears
5. Record sample moisture content, flag if >12.5%
6. Press OK, sample weight (g) appears, record weight (W1)
7. Remove sample, separate off-grade grain
8. Return remaining sample to upper chamber, feed to lower chamber
9. Check that moisture measurement is the same
10. Press OK, record new sample weight (W2)
11. Calculate off-grade as $\text{off-grade (\%)} = (1 - (W2/W1)) \times 100$
12. Record off-grade (%), flag if >10%

Grain legumes in Kenyan households

J Ongoma

Kleen Homes and Gardens



**Grain Legume Processing
Workshop
Day 1 Morning Lecture**

Important food legumes: Bean

Description: A bushy or climbing annual with trifoliate, slightly hairy leaves and small, white, yellow or purple flowers bearing long, smooth pods forming large, kidney-shaped seed. Many varieties and land races.

Ecology: Grown from equatorial uplands to temperate regions. Requires moderate rainfall followed by dry ripening interval. Sensitive to extreme soil acidity. Often intercropped. Susceptible to disease.

Propagation: By seed, about 2500 seed per kg. Rapid germination.

Uses: Leaves, young pods, young and mature seeds and sprouts are edible.



Immature pods on bush bean (above) and large diversity of bean seeds (below)



Bean stem maggot

Important food legumes: Cowpea

Description: Erect, prostrate or climbing annual with trifoliolate leaves and white, yellow or violet flowers on short pedicels with long to very long, slender, smooth pods bearing round or cylindrical seeds. Branching roots bear globular nodules.

Ecology: Grown throughout the tropics and subtropics. Tolerates heat, drought and soil acidity but sensitive to waterlogging. Susceptible to many insects. Native to Africa.

Propagation: By seed, about 7000 seed per kg.

Uses: Leaves, young pods, young and mature seeds are edible. Palatable to livestock.



Important food legumes: Groundnut

Description: An erect (bunch) or trailing (runner) annual herb 60 cm in height with pinnate leaves and fleshy stems. Flowers are yellow, forming at lower nodes, fertilized fruit peg into the soil, pod is rounded and dry.

Ecology: Native of S. America, requires about 600 mm of rainfall followed by dry ripening. Best suited to sandy loams, acid tolerant but requires calcium for pegging.

Propagation: Mainly by seed (1200 seeds per kg) but stem cuttings root.

Uses: Nuts are eaten raw or roasted and milled into peanut butter. Seeds are pressed for vegetable oil. Leaves



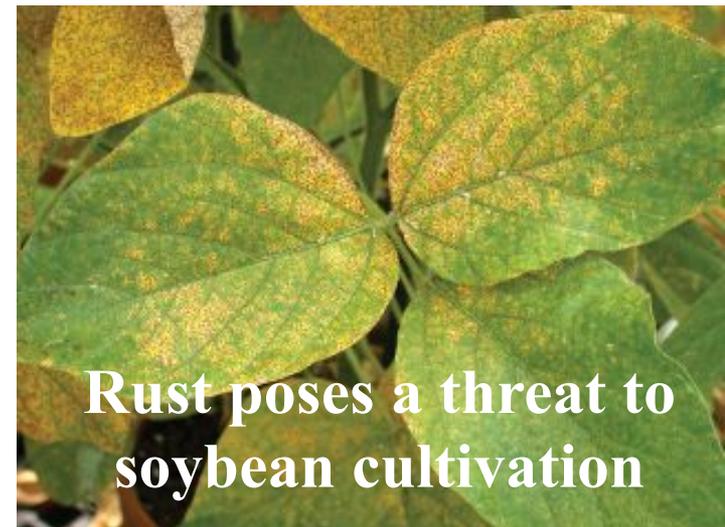
Important food legumes: Soybean

Description: Bush annual (up to 180 cm) with hairy trifoliate leaves and small flowers forming clusters of short, hairy pods. Roots are deep and bear many round nodules.

Ecology: Grown from tropics to temperate regions. Tolerates acid soils and short-term drought. Promiscuously nodulating varieties recently developed.

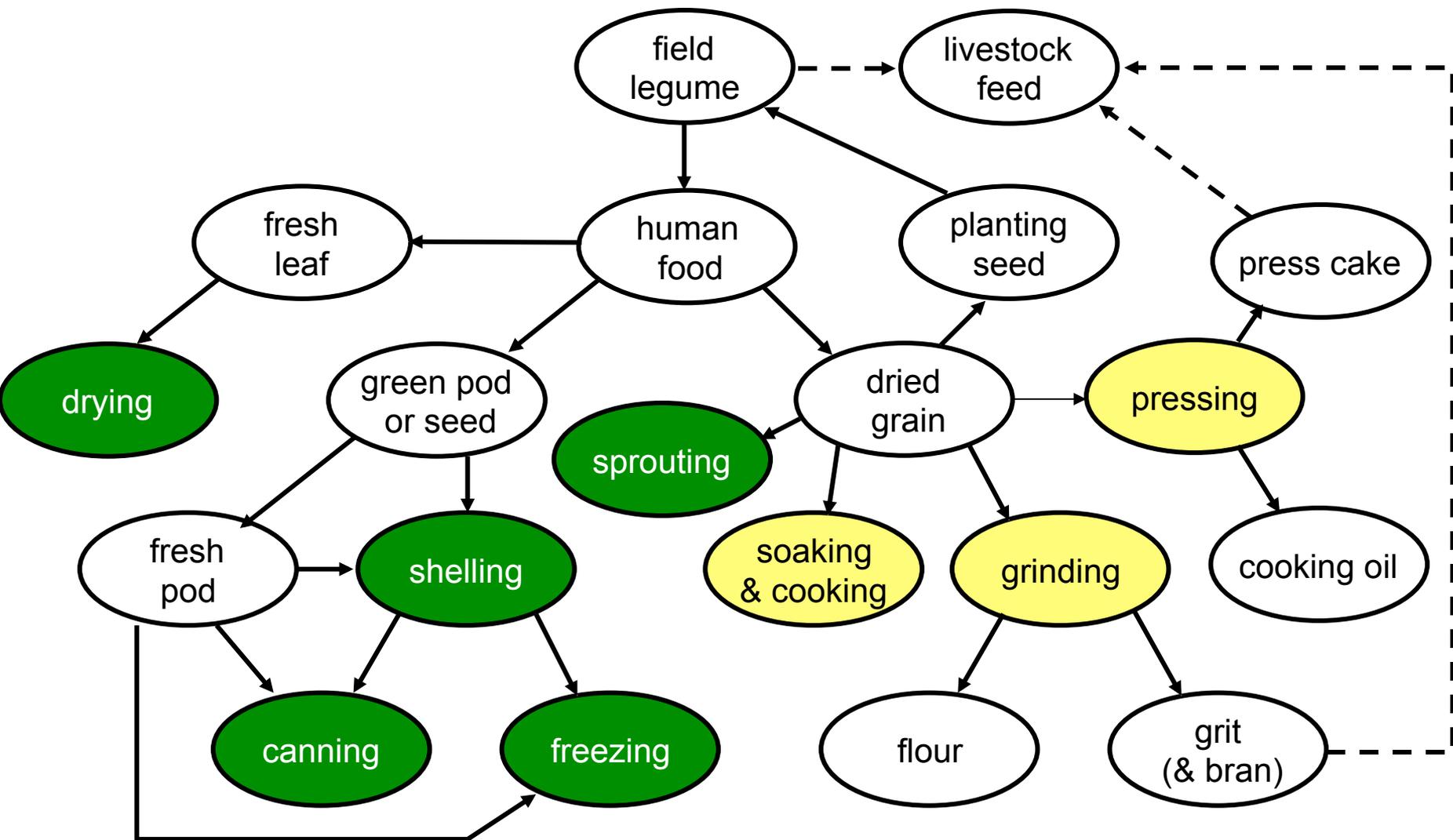
Propagation: By seed, about 7000 seed per kg

Uses: Important source of vegetable oil and protein. Edible green and mature seeds. Fodder and hay.



Rust poses a threat to soybean cultivation

Processing grain legumes



Weights and Measures

pinch = about $\frac{1}{4}$ teaspoon

3 teaspoons (tsp) = 1 tablespoon (tbsp)

1 tablespoon = $\frac{1}{2}$ ounce = 15 ml

2 tablespoons = 1 ounce = 30 ml (liquid)

4 tablespoons = $\frac{1}{4}$ cup

16 tablespoons = 1 cup

1 cup = 8 ounces = 240 ml

2 cups = 1 pint

4 cups = 2 pints = 1 quart

1 quart = 950 ml \approx 1 litre

4 quarts = 1 gallon

Volumetric measurement tools

The traditional cups may easily be translated into the metric system

1 cup = 240 ml

1tbsp = 15 ml

1 tsp = 5 ml



Cooking characteristics of some popular grain legumes

grain legume	dry	soaking	cooking	cooked	cooked
type	weight	uptake	time	weight	volume
	g/cup	ml water	minutes	g/dry cup	cups
Kidney bean	198	225	75	440	2.8
Nyayo bean	191	188	75	390	2.5
Mwitemenia bean	183	182	90	393	2.3
White bean	203	208	75	409	2.5
Black-eye cowpea	211	229	45	480	3.0
Red cowpea	198	234	35	460	3.0
Soybean 19	169	217	90	352	2.3

Assessing grain legume cooking characteristics

1. Measure 1 cup of each grain and weigh on scale, record weight
2. Soak grain overnight in 4 cups water
3. Drain excess water, measure volume and weight
4. Transfer to cooking pan, boil each grain in 3 cups of water
5. Sample cooked grain after $\frac{1}{2}$, $\frac{3}{4}$, 1 and $1\frac{1}{2}$ hours, record impressions
6. Drain excess water, measure volume and weight
7. Summarize results in table format

**Make a Quick Snack
Glazed Groundnuts and Soy
Beverage**

PL Woomer

N2Africa Outreach Officer



**Grain Legume Processing
Workshop**

**Day 1 Morning Legume
Break**

Glazed groundnuts

*makes 10 to 12
clusters*

Ingredients

1 cup raw groundnuts or soybean crunchies

½ cup sugar

2 tbsp butter or margarine

Preparation: In a heavy pan, combine nuts, sugar, and butter or margarine. Cook over medium heat, stirring constantly for 7 minutes or until sugar is melted and golden in color and nuts are roasted. Spread nuts on aluminum foil; separate into clusters. Sprinkle lightly with salt and cool.

Talented cooks improvise!

e.g. glazed
groundnuts

substitute soy
crunchies

add sesame

add chocolate



***Morning Practical: Assign
practical teams and
workspace***
J. Ongoma



**Grain Legume Processing
Workshop
Day 1 Morning Practical**

Organizing a grain legume cooking contest

PL Woomer

N2Africa Outreach Officer



**Grain Legume Processing
Workshop**

Day 2 Afternoon Lecture

Grain Legume Cooking Contest

A great way to stimulate interest in grain legumes, popularize new recipes and acknowledge superior cooking skills within the local community

- Readily incorporated within farmer field days and agricultural shows.
- Participants arranged in advance and submit a recipe for competition.
- Variety of entries selected by organizers
- Rules of the contest are established and explained to the contestants.
- Contestants are expected to produce sufficient dishes for both the judges and members of the public



**Participants of the Grain
Legume Processing Workshop
Kleen Homes and Gardens
17 and 18 May 2011**





Guidelines for the cooking contest rules

1. Entries consist of locally-produced grain legumes and vegetables that are boiled, fried or steamed
2. Prepared start-to-finish within three hours using no more than two cooking vessels.
3. Grain legumes may be pre-soaked but not pre-cooked.
4. Each contestant is provided similar cooking facilities but must supply their own pot, utensils and ingredients
5. Only one entry is allowed per participant in a single contest.
6. Every entry must be accompanied by a list of ingredients and recipe
7. Dishes judged shortly after preparation in the presence of the contestant



Contestants are provided identical facilities and time to prepare a dish conforming to contest rules

Selection of Ingredients

- The following ingredients are strictly forbidden; meat, fish, cheese, canned products, noodles, arrowroot corms and cassava roots (due to the lengthy cooking time necessary to detoxify)
- Cooking fat, butter and margarine may be used at the contestant's discretion
- Use of grain legume products such as soymilk or milled flour is encouraged
- Entries are permitted the use of non-indigenous plants, herbs and spices, but excess reliance upon non-traditional ingredients may be penalized during judging

Judging Criteria

- There are three judges, including a head judge
- Judges evaluate entries on the basis of taste, texture, presentation and any other criteria they deem important
- Contestants may be called upon to sample their own entries before judging, and the judges may ask questions of contestants
- Judging takes place during the periods allocated to the cooking contest while the contestant is present
- The best three dishes are selected based upon taste, presentation, creativity and communication with the judges
- Prizes awarded during a public ceremony.



Judging by top chefs is not necessary, better to aim toward tastes of the local community

N2Africa Grain Legume Processing Workshop

Exercise 2. Quality Assessment of Grain Legumes (Day 1 Afternoon)

This practical provides cooperators with greater appreciation of available grain legume industry standards and how to rapidly test grain for compliance. Grain standards include threshold values of moisture, insect damage, off-color and diseased grains, and foreign matter. The exercise requires about two hours for participants to complete their tasks. The participants are grouped into teams with each team evaluating a set of different grain legumes and the results compiled across teams at the end of the exercise. The exercise results in a useful table that identifies the cooking times, tastes and textures of several grain legumes.

Advance preparation. Obtain at least six samples of grain, taking care to include samples that contain a large proportion of off-grade grain and foreign matter.

Materials. Weighing scale, grain moisture meter (LDS Moisture Analyzer), sieves (1 cm, 5 mm, 1 mm), brush or small spatula

Procedure

1. Smell the sample for objectionable odors, record impression on table below.
2. Sub-sample about 150 g of grain (about the volume of LDS Moisture Analyzer top chamber)
3. Place into LDS top chamber slot
4. Turn on LDS, set mode to P2 (soybean) using + or - keys
5. Spring feed lower chamber, wait until moisture content (%) appears
6. Record sample moisture content, flag if >12.5%
7. Press OK, sample weight (g) appears, record weight (W1). Transfer to weighing scale and reweigh. Compare weights.
8. Remove sample, place on clean, dry surface, separate off-grade grain using a brush or spatula. Separate sample into categories: acceptable grain, insect damaged, off-color and diseased grains, and foreign matter. Weigh each fraction using a scale. Calculate the proportion of each off-grade fraction as *off-grade fraction (%) = (Wfraction/W1) x 100*. Record the proportion of each fraction and enter into the table.
9. Return acceptable grain sample to moisture meter upper chamber, feed to lower chamber
10. Check that moisture measurement is the same
11. Press OK, record new sample weight (W2)
12. Calculate total off-grade as *total off-grade (%) = (1 - (W2/W1)) x 100*
13. Record off-grade (%), flag if >10%

sample	W1	moisture	insect damage	off color	diseased (shriveled)	total off-grade	odor
	g	----- % -----					
1.							
2.							
3.							
4.							
5.							
6.							

Note: flag by underlining values that exceed industry thresholds.