Seed Quality Assurance, Management and Control Processes

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Outline:

- Seed; the role of crop/plant breeding
- A typical breeding scheme
- National Performance Trials
- Distinctness, Uniformity and Stability
- Seed certification
- Quality management of seed

In the context of modern agriculture
Crop/plant breeding research is the genesis of seed

Crop/Plant breeding is the genetic improvement of plants for human benefit

Whereas Crop/Plant breeding involves application of specific skill sets to develop cultivars, it helps to reflect that many of the small and big seed companies globally are founded on skillful breeding

Seed is essential to survival of mankind!

Definition; *Seed*

Seed is not just something planted by farmers!

rather

Seed is the carrier of the genetic potential for higher crop production…

Crop breeding seeks to address limiting factors

Biotic

- Diseases (Rusts, Septoria, Fusarium *sp.*)
- Insect pests (Russian Wheat Aphid)
- Weeds

Abiotic

- Drought
- Soil acidity
- Depleted soils
- Pre-harvest sprouting

…A typical breeding scheme: Wheat, KALRO-Njoro

Old cultivars

"Introduced Germplasm"

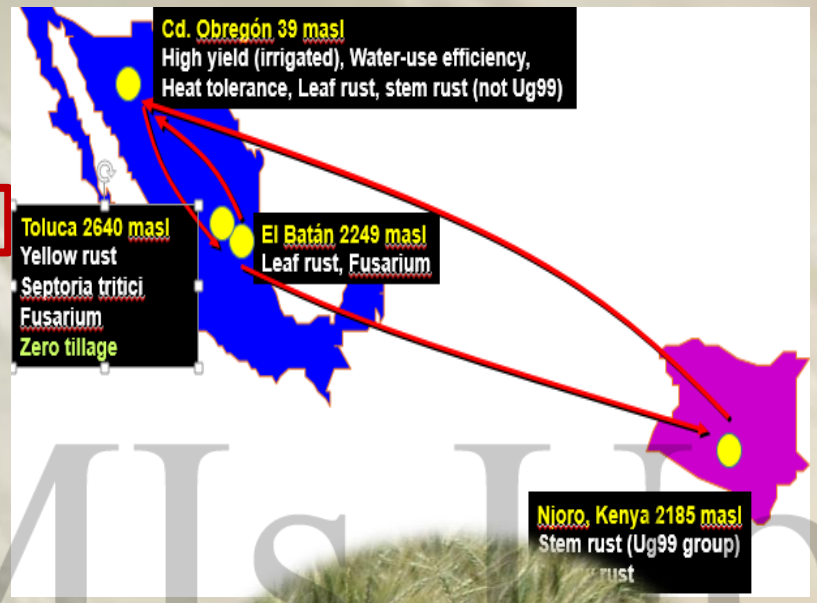
mainly

from CIMMYT

Crossing Block

Early Generations F2…F7

KALRO Njoro-CIMMYT Shuttle



"KSRON" 2 seasons of testing

Preliminary Yield Trial (3 locations, 1 season)

Advanced Yield Trial (7 locations, 2 seasons)

National Performance Trial and DUS (9 locations, 2 seasons)

Variety Release, Breeder Seed bulking, distribution and variety maintenance

...crop breeding research is the genesis of seed

NPT, DUS, Seed Certification

In Kenya…

These activities are legally regulated by KEPHIS

- **Anchored on "Seeds and Varieties Act", laws of Kenya**

Standards for release of variety

National Performance Trial (NPT)

Standards for release of variety

Variety should not be released unless

- **Distinctly superior to existing varieties in one or more characteristics**

Or

- **Is superior in overall performance in areas where adapted**

Standards for release of variety

Yield advantage is often an overarching criterion

- **Experimental lines are tested for yield, quality, survival, disease and insect reaction *etc.* with comparison with standard varieties**

Standards for release of variety

- **NPT provide a platform for comparing promising lines to standard varieties using techniques that assure valid measures of performance**

Standards for release of variety

National Performance Trials (NPT) in Kenya

- ✓ **Breeders submit "best" lines for NPT testing under KEPHIS**

NATIONAL PERFORMANCE TRIALS (NPT)

KENYA PLANT HEALTH INSPECTORATE SERVICE (KEPHIS)
HEADQUARTERS

NPT SUBMISSION – FORM NPT

REQUIREMENTS: PACKAGE YOUR UNTREATED SEEDS FOR EACH PLOT IN LINE WITH THE CROP'S PACKAGING SCHEDULE SHOWN BELOW AND SUBMIT TO KEPHIS HEADQUARTERS, NAIROBI

Important Information

CROP	KIT	NO OF SITES	NO OF REPLICATIONS	NUMBER OF EXPECTED PACKETS	NUMBER / WEIGHT OF SEED PER PACKET UNITS	NUMBER / WEIGHT OF SEED PER PACKET TOTAL
MAIZE	Coast (Low land)	5	3	15	COUNTS	66
	Katumani (Early)	10	3	30	COUNTS	66
	Mugugo (Transitional)	8	3	24	COUNTS	66
	Embu (Medium)	8	3	24	COUNTS	66
	Kakamega (Mid-Late)	7	3	21	COUNTS	66
	Kitale (Late)	11	3	33	COUNTS	66
	Ginga	8	3	24	COUNTS	66

FOR POTATO ENTRIES ONLY

INCLUDE ENTRY IN INTENSIVE TRIALS	YES	
	NO	

OTHER CROPS

CROP	NO OF SITES	NO OF REPLICATIONS	NUMBER OF EXPECTED PACKETS	NUMBER / WEIGHT OF SEED PER PACKET UNITS	NUMBER / WEIGHT OF SEED PER PACKET TOTAL
BUSH BEANS	10	3	30	COUNTS	378
CLIMBING BEANS	7	3	21	COUNTS	225
SOYA BEANS	14	3	42	COUNTS	828
SORGHUM	8	3	24	COUNTS	672
SUNFLOWER	11	3	33	COUNTS	640
WHEAT	11	3	33	gms	60
IRISH POTATO	6	3	18	COUNTS	44
CHICKPEA	7	3	21	COUNTS	765
PIGEON PEA	5	3	15	COUNTS	255
GROUNDNUT	7	3	21	COUNTS	510
FINGER MILLET	8	3	24	gms	
PEARL MILLET	8	3	24	gms	
RICE	8	3	24	gms	75
FRENCH BEAN	5	3	15	COUNTS	558
Oil Seed Rape	4	3	12	gms	5
Cotton	4	3	12	COUNTS	756

KALRO
Kenya Agricultural & Livestock Research Organization

NPT submission Form

1.	CROP	
	ENTRY / VARIETY NAME	
	TYPE (HYBRID OR OPV, TUBERS OR TRUE SEED, COLOUR OF SEED	
2.	KIT / AGRO-ECOLOGY / MATURITY	
	OTHER RELEVANT INFORMATION OF THE ENTRY	
3.	APPLICANT'S NAME AND ADDRESS	

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Kenya Agricultural & Livestock Research Organization

Wheat NPT visit in Rongai

Soy Bean NPT visit in Bahati

Sorghum NPT visit in Rongai

Sorghum NPT visit in Mogotio

Standards for release of variety

Characteristics of (NPT) in Kenya

- **Minimum 2 seasons of testing**
- **Multi-locational *e.g.* > 8 locations for Wheat**
- **Currently USD 1200 per entry per season**

					YIELD(t/ha)					DISEASES								MATURITY		% STAND COUNT		LODGING			
EXP_NAME	SOURCE	TEST STATUS	NPT YRS	DUS YRS	MEAN	% ABOVE BEST CHECK	% ABOVE MEAN OF CHECKS	CONT-TRAST	SWT 1000	GLUME BLOTCH (1-5)	LEAVE BLOTCH (1-5)	BROWN RUST (1-5)	EAR RUST (1-5)	STEM RUST (1-5)	YELLOW RUST (1-5)	SMUT	STREAK	DAYS TO 50% HEADING	DAYS TO 50% MATURITY	GERM.	HARV.	DEGREE (%)	EXTENT (%)	PLANT HEIGHT (CM)	NO OF TILLERS
R1302	KARI NJORO	CANDIDATE	1	0	3.90	4.96	22.29	0.01	89.10	1.30	1.23	1.30	1.08	1.28	1.35	0.57	1.03	62.68	0.00	48.28	4.03	0.60	0.31	86.33	8.11
R1305	KARI NJORO	CANDIDATE	1	0	3.81	2.37	19.27	0.02	92.12	1.31	1.21	1.34	1.13	1.26	1.31	0.57	1.04	63.39	0.00	42.16	4.43	0.67	0.47	96.31	7.83
[redacted]					3.80	2.17	19.04	0.02	80.57	1.23	1.22	1.33	1.09	1.43	1.39	0.57	1.02	63.36	0.00	45.21	3.92	0.60	0.26	96.00	8.36
R1286	KARI NJORO	CANDIDATE	1	0	3.63	-2.29	13.85	0.09	99.36	1.37	1.22	1.51	1.08	1.39	1.38	0.57	1.05	63.74	0.00	50.04	3.87	0.60	0.33	94.97	7.44
R1244	KARI NJORO	CANDIDATE	2	0	3.63	-2.44	13.67	0.09	97.31	1.28	1.26	1.54	1.15	1.52	1.41	0.57	1.03	62.23	0.00	42.96	4.16	0.66	0.33	84.44	7.64
R1271	KARI NJORO	CANDIDATE	2	0	3.54	-4.93	10.77	0.19	187.82	1.25	1.16	1.44	1.16	1.52	1.38	0.57	1.03	66.02	0.00	40.89	4.16	0.66	0.46	87.98	7.47
[redacted]					3.49	-6.23	9.25	0.26	87.29	1.27	1.21	1.52	1.19	1.58	1.37	0.57	1.05	61.33	0.00	43.60	4.19	0.59	0.26	85.52	8.67
[redacted]					3.46	-6.88	8.50	0.34	84.17	1.44	1.19	1.27	1.07	1.14	1.31	0.57	1.04	69.77	0.00	42.16	4.32	0.60	0.33	82.61	8.91
R1238	KARI NJORO	CANDIDATE	2	0	3.32	-10.84	3.88	0.63	98.02	1.32	1.17	1.40	1.12	1.31	1.33	0.57	1.05	64.18	0.00	41.99	4.03	0.59	0.31	87.63	8.17
R1301	KARI NJORO	CANDIDATE	1	0	3.31	-10.97	3.73	0.65	92.22	1.28	1.24	1.36	1.05	1.26	1.34	0.57	1.06	62.36	0.00	49.96	3.96	0.67	0.91	93.70	8.24
R1309	KARI NJORO	CANDIDATE	1	0	3.16	-15.01	-0.97	0.90	96.32	1.30	1.20	1.29	1.09	1.21	1.31	0.57	1.03	61.24	0.00	51.57	4.07	1.46	2.00	94.60	8.04
[redacted]					3.09	-16.99	-3.29	0.69	96.98	1.24	1.26	1.52	1.13	1.34	1.62	0.57	1.07	65.12	0.00	41.05	3.85	0.67	0.74	85.10	8.01
[redacted]					2.88	-22.53	-9.74	0.23	76.79	1.28	1.23	1.50	1.13	1.19	1.50	0.57	1.05	65.52	0.00	46.46	4.15	0.61	0.43	81.50	7.56
[redacted]					2.82	-24.29	-11.78	0.15	76.83	1.52	1.21	1.27	1.08	1.06	1.35	0.57	1.04	67.07	0.00	53.00	4.36	0.59	0.23	80.64	8.82
ROBIN	KARI NJORO	CHECK	2	2	3.72				80.09	1.28	1.21	1.37	1.16	1.37	1.35	0.57	1.04	63.45	0.00	44.12	4.13	1.00	0.97	89.55	7.89
EAGLE 10	KARI NJORO	CHECK	2	2	3.42				89.78	1.23	1.11	1.46	1.12	1.27	1.45	0.57	1.07	60.63	0.00	46.89	3.92	0.67	0.89	83.14	7.79
NJORO BW2	KARI NJORO	CHECK	2	2	3.12				87.48	1.35	1.13	1.70	1.12	1.49	1.60	0.57	1.03	66.73	0.00	45.09	4.41	0.71	0.81	84.69	8.32
KSSIMBA	KENYA SEED Co. LTD	CHECK	2	2	3.04				95.63	1.38	1.30	1.66	1.13	1.45	1.54	0.57	1.03	65.16	0.00	37.72	4.39	0.61	0.36	83.05	6.85
KSMWAMBA	KENYA SEED Co. LTD	CHECK	2	2	2.67				81.00	1.33	1.22	1.65	1.29	1.72	1.51	0.57	1.03	66.07	0.00	45.43	4.08	0.74	0.33	75.30	7.92
ZZ1MEAN	MEAN				2.76				94.15	1.32	1.21	1.45	1.13	1.36	1.41	0.58	1.04	64.30	0.00	45.19	4.13	0.70	0.57	87.00	8.00
ZZ2PV	P-VALUE				0.01				0.47	0.22	0.66	0.05	0.16	0.00	0.05	0.00	0.39	0.00	0.00	0.62	0.66	0.46	0.32	0.00	0.23
ZZ3CV	CV(%)				20.96				43.58	13.94	11.51	20.25	11.83	19.60	14.82	0.00	3.73	3.60	0.00	16.61	6.98	66.07	119.56	5.58	13.75
ZZ4R2	R^2				0.90				0.41	0.83	0.75	0.61	0.71	0.68	0.87	1.00	0.89	0.91	0.00	0.96	0.71	0.67	0.62	0.77	0.88
ZZ5LSD	LSD(5%)				0.66				48.05	0.21	0.16	0.33	0.15	0.30	0.24	0.00	0.04	2.66	0.00	8.79	0.35	0.53	0.79	5.57	1.26

	MEAN ESTIMATES			
		CONFIDENCE INTERVAL		UPPER
	MEAN	LOWER	UPPER	LSD
MEAN OF ALL CHECKS	3.19	1.86	4.53	3.86

Varieties superior to mean checks

Varieties similar to mean checks

Varieties inferior to mean checks

Example of NPT results for wheat

Standards for release of variety

Distinctness, Uniformity, and Stability (DUS)

Standards for release of variety

Distinctness, Uniformity, Stability (DUS)

- **Distinctness**

- **Is a criteria for determining that a newly bred variety differs from existing varieties within the same species**

Standards for release of variety

Distinctness, Uniformity, Stability (DUS)

- **Uniformity**

❖ Is a criteria for determining whether a character used to establish distinctness is expressed uniformly among members of the new variety

Standards for release of variety

Distinctness, Uniformity, Stability (DUS)

- **Stability**

- **Is a criteria for determining whether a character used to establish distinctness does not change over subsequent generations**

Standards for release of variety

Distinctness, Uniformity, Stability (DUS) testing

DUS under KEPHIS is based on Union of Protection of new Varieties (UPOV) guidelines

WHEAT DUS TRIAL

ENTRY / VARIETY DESCRIPTION

NOTE:	DESCRIBE YOUR VARIETY AS PER UPVOS GIUDELINENES WHICH CAN BE DOWNLODEDFROM www.upv.int/publications/tg/rom/tg003/tg-3-11.pdf.
	FOR KEPHIS REQUIREMENT:- PLEASE SUBCRIBE CHARACTERS 9,13 & 15 IN MEASUREMENTS(cm,gms)

CHAR	CHARACTER DESCRIPTION	SCORE	SCORE DESCRIPTION
1	COLEPTILE:ANTHOCYNIN	3	
2	PLANT:GROWTH HABIT	1	
3	FLAG LEAF:ANTHOCYANIN COLORATION OF AURICLES	1	
4	PLANT:FREQUENCY OF PLANTS WITH RECURVED FLAG LEAVES	7	
5	DAYS TO EAR EMERGENCY(FIRST SPIKELET VISIBLE ON 50% OF EARS	5	
6	FLAG LAEF:GLAUCOSITY OF SHEATH	5	
7	EAR:GLAUCOCITY	5	
8	CULM:GLAUCOSITY OF NECK	3	
9	PLANT:LENGTH(STEM,EAR,AWNS AND SCURS) IN CM	5	
10	STRAW :PITH IN CROSS SECTION(HALF WAY BETWEEN BASE OF EAR AND STEM NODE BELOW	5	
11	EAR:SHAPE IN PROFILE	1	
12	EAR:DENSITY	7	
13	EAR:LENGTH(EXCLUDING AWNS AND SCURS)IN CM	5	
14	AWN OR SCURS:PRESENCE	3	
15	AWNS OR SCURS AT OF EAR:LENGTH IN CM	7	
16	EAR:COLOUR	1	
17	APICAL RANCHIS SEGMENT:HAIRNESS OF CONVEX	3	
18	LOWER GLUME:SHOULDER WIDTH(SPIKELET IN MID-THIRD OF EAR)	7	
19	LOWER GLUME:SHOULDER SHAPE(AS FOR 18)	7	
20	LOWER GLUME:BEAK LENGTH (AS FOR 18)	7	
21	LOWER GLUME:BEAK SHAPE (AS FOR 18)	1	
22	LOWER GLUME:EXTENT OF INTERNAL HAIR (AS FOR 18)	3	
23	LOWER LEMINA:BEAK SHAPE (AS FOR 18)	1	
24	GRAIN:COLOUR	2	
25	GRAIN:COLORATION WIDTH	-	
26	SEASONAL TYPE	3	
27	GRAIN LENGTH		

Example of DUS results for wheat

Thank you

Seed Certification

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Definition; *Seed*

- A mature ovule consisting of an embryonic plant, a store of food, and a protective coat

- Parts of agricultural, silvicultural, and horticultural plants used for sowing or planting

Definition of seed quality

Seed Technologist's view of Good seed quality

- **High analytical purity**
  - ✓ *Low content of inert matter*
  - ✓ *Low or absence of seeds of weeds and other crops*
- **High germination percentage**
- **Freedom from seed borne pests and diseases**
- **True to kind or type of variety**
- **Must be of an "improved variety"**

Definition; *Seed Quality*

Latter definition suggests that:

Neither good quality seed of poor varieties nor poor quality seed of superior varieties serves famers well

Ensuring Good Quality Seed

Steps range from crop research to initial seed bulking *etc*

- **In production stage**
  - ✓ *Proper fertilization*
  - ✓ *Adequate water*
  - ✓ *Sufficient isolation between seed multiplication blocks*
  - ✓ *Adequate roguing*
  - ✓ *Timely harvest*
  - ✓ *Care in harvesting and transporting material*
- **During drying**
  - ✓ *Timeliness and correct temperatures*

Ensuring Good Quality Seed

Steps range from crop research to initial seed bulking *etc*

- **During processing**
  - ✓ *Care to increase percentage of pure seed*
  - ✓ *Care to avoid admixtures*
  - ✓ *Care to minimize damage to seed*
  - ✓ *Care to provide proper seed treatment (…if necessary)*
  - ✓ *Care to put seed in satisfactory package*
  - ✓ *Care to only package seed of "safe" moisture level*
- **During storage**
  - ✓ *Proper seed lot identification*
  - ✓ *Suitable conditions to avoid loss of germination*

Ensuring Good Quality Seed

Steps range from crop research to initial seed bulking *etc*

- **During distribution**
  - ✓ *Care in transportation and storage to avoid and prevent:*
    - Excess humidity
    - Excess heat
    - Contamination
  - ✓ *Care in transportation and storage to maintain*
    - Proper identity of seed lot

Ensuring Good Quality Seed

Why seed certification

This is a tool for producing genetically pure, good quality seed of improved varieties

Ensuring Good Quality Seed

What seed certification?

"A legal mechanism established to ensure that a given seed lot conforms to highest standards for genetic purity and quality…"

…usually administered/enforced by a seed certifying authority…"

KEPHIS is the official seed certification authority in Kenya

Ensuring Good Quality Seed

Role of seed certification

- Requires that certain minimum quality criteria in a seed lot are met and made evident for the buyer

- In Kenya, KEPHIS works with seed merchants through certain steps to assure good seed quality

Ensuring Good Quality Seed

Key events in seed certification

1. Determination of eligibility of varieties

- ✓ *Only seed of released/named varieties Should be multiplied. These are verified through the "National variety list under KEPHIS"*

Ensuring Good Quality Seed

Key events in seed certification

2. Verification of seed source

- ✓ *Considers that each generation of certified seed can be traced back to well documented breeder and basic seed*

Ensuring Good Quality Seed

Key events in seed certification

3. Field inspection in growers' fields

Before planting:

- ✓ *Technologists review previous history of land e.g. previous crop in field to minimize contamination (noxious weeds, seed borne diseases, off-type variety)*

Ensuring Good Quality Seed

Key events in seed certification

4. Field inspection in growers' fields

After planting:

- ✓ *Technologists assess off-type plants, other varieties, weeds, other crop plants, diseases present*

…this must be rogued out by grower before harvest or before flowering

Ensuring Good Quality Seed

Key events in seed certification

5. Field inspection in growers' fields

After planting:

- ✓ *Particularly for cross pollinating crops, technologists checks distance to other fields, efficiency of detasseling to avoid unwanted pollen*

Ensuring Good Quality Seed

Key events in seed certification

6. Sampling

Done by KEPHIS following ISTA rules

- ✓ *Seed Testing Laboratory checks for "general cleanliness" of seed, germinability etc*

Ensuring Good Quality Seed

Key events in seed certification

7. Labelling

Done by KEPHIS

- ✓ *Puts certification labels/tags on every container/bag verifying that minimum quality standards for a seed lot have been met*

Ensuring Good Quality Seed

Labelling of certified seed is preceded by Seed testing

7. Seed testing lab conducts 5 major tests:

- **Germinability/Viability**
- **Purity**
- **Vigor**
- **Health**
- **Noxious weed seed**

Ensuring Good Quality Seed

Labelling of certified seed is preceded by Seed testing

7. Seed testing lab conducts 5 major tests:

- **Germinability/Viability**

Percent of normal seedlings produced by pure seed

✓ **Rolled towel test** ✓ **Petri dish test** ✓ **Tetrazolium test**

Ensuring Good Quality Seed

Labelling of certified seed is preceded by Seed testing

7. Seed testing lab conducts 5 major tests:

- **Purity**

Done at two levels- genetic and physical

✓ **Visual** ✓ **Isozyme analysis** ✓ **DNA profiling**

Ensuring Good Quality Seed

Labelling of certified seed is preceded by Seed testing

7. Seed testing lab conducts 5 major tests:

- **Vigor**

Determines capacity of seed to emerge rapidly and uniformly to normal seedlings

✓ **Accelerated aging** ✓ **Electrical conductivity**

Ensuring Good Quality Seed

Labelling of certified seed is preceded by Seed testing

7. Seed testing lab conducts 5 major tests:

- **Health**

Seed samples examined for presence of pathogens

✓ **Visual inspection** ✓ **Incubation** ✓ **Biochemical**

Ensuring Good Quality Seed

Labelling of certified seed is preceded by Seed testing

7. Seed testing lab conducts 5 major tests:

- **Noxious weed seed**

Weed species that sooner or later become aggressive and difficult to control

✓ **Visual inspection**

Ensuring Good Quality Seed

Seed testing is succeeded by labelling/tagging

A label/tag identifies each class of seed

- **White- Breeder seed**
- **Purple-Basic seed**
- **Blue-certified seed**

Ensuring Good Quality Seed

Key events in seed certification

8. Conducting variety control plots

Coordinated by KEPHIS

- ✓ *Plots used to check genetic purity of seed lots previously certified*

- ✓ *Plots used to assess and approve seed for next generation of seed bulking*

Thank you

Quality Management of Breeder, Pre-basic, and Basic seed

Presenters:

1. Godwin Macharia- Review of definitions
2. Bernard Otukho- Seed health testing; wheat
3. Manfred Miheso- Virus indexing; sweet potato
4. Patrick Yegon- Sweet potato seed bulking

Definitions; *Seed Classes*

Breeder seed

- **A class of seed in a seed certification program that is produced under the supervision of the plant breeder, originator, or owner of the variety**

Definitions; *Seed Classes*

Basic seed

❖ **A class of seed in a seed certification program that is the last step in the initial seed multiplications and is intended for production of certified seed**

Definitions; *Seed Classes*

Certified seed

- **A class of seed that has been certified to conform to the standards for genetic purity established or enforced by a seed certifying authority**

Definitions; *Seed Classes*

Commercial seed

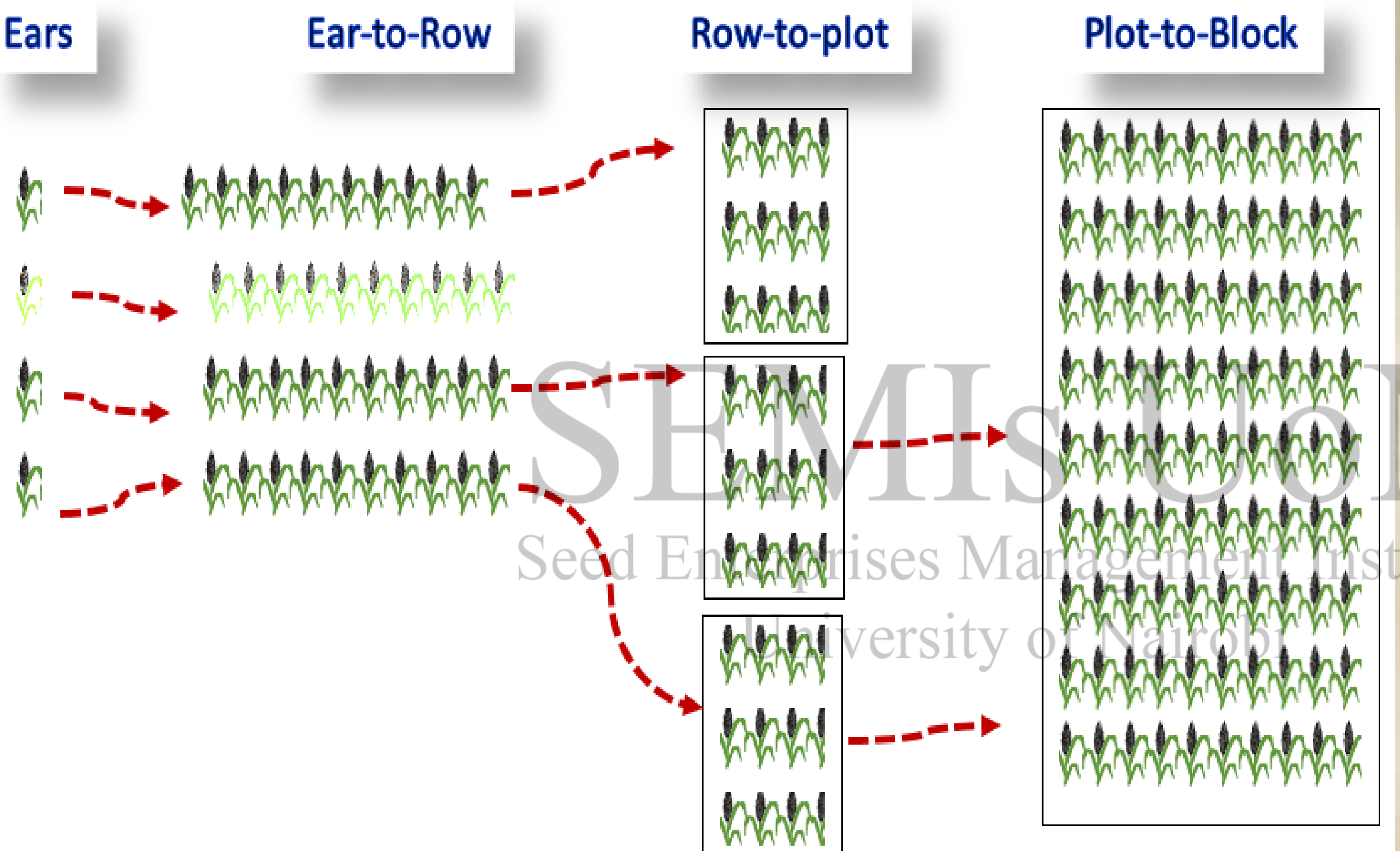
- **Seed intended for crop production.**

Not produced under a seed certification program

Quality management

Best practices

- **Based on OECD rules/schemes depending on species**



Breeder Seed

Breeder Seed

Seed Unit

Seed Company

Prebasic,Basic Seed

Certified Seed (*contracting*)

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KENYA PLANT HEALTH INSPECTORATE SERVICE

REF: 10/13

VARIETY MAINTENANCE PLOTS

CROP SP. Triticum aestivum

MAINTAINER. Kenya Seed Company Research Department

LOCATION. Elgon Downs Farm Endebess Af.

DATE. 1st August 2014

☐ STAGE 1 (☐EAR-ROWS, ☐POD ROWS, ☐INDIVIDUAL PLANTS)

☐ STAGE 2 (SINGLE PLOTS APPROX. $10M^2$)

☑ STAGE 3 (BULK PLOTS 1-20ACRES)
(Tick)

VARIETY	NO. ROWS/PLOTS OBSERVED	NO. APPROVED	REMARKS
NJORO BW II	4 acres.	Pending.	The crop has got offtypes which resembles the Robin variety. The offtypes are significant and the crop is recommended for thorough roughing within 7 days. It is further recommended that the crop or variety remnant seed be replanted again for further observation to ascertain the source of contamination. One kilo of seed to be availed by the breeder KARI NJORO.

OBSERVED BY.

KEPHIS
K.K.
Willyter C. Bii

KARI NJORO
Dr. Godwin Macharia
Gershon Kukurao

Kenya Seed Co.
1. K. WEKULO
2. Hosea Sirma
3. Esther Saj
4. Berry Martha
5. Naomi Chelimo
6. PHILIS MARTIM
7. Alphonce Muthama

Examples of current commercial cultivars

Examples of current commercial cultivars

Examples of current commercial cultivars

Examples of current commercial cultivars

Thank you

...and welcome to KALRO-Njoro