# Making Quality Seed Collections

OPTIONS Workshop 28th – 30th October 2014.

Patrick Muthoka: National Museums of Kenya

# Seed types based on storage behaviour

- **Orthodox seeds – typically small seeds many from dry tropics, their lifespan increases in a predictable and quantifiable way on decreasing moisture content and storage temperature**
- **Can be dried to 3-7 % mc, and stored at minus 20 degree celcius**
- **Have an upper moisture content limit > moisture increase does not result to decline in life span, contrary lifespan increases due to macromolecular repair**
- **Lower moisture content limit - further reduction in moisture content does not increase seed lifespan ,due to presence of strongly bound water not available for biochemical activity**
- **Orthodox seeds can stay alive for hundreds of years** at low temperature

**e.g most crops, vegetables – *Amaranth* / *Cleome*, *Solanum***

# Intermediate seeds

- Relatively big seeds
- Survive drying to moisture content of 7-10%
- Do not benefit significantly from further drying and low temperature storage especially minus twenty degrees
- *Coffee*, *Carica papaya*,

# Recalcitrant seeds

- **Mostly from moist forests, aquatic and temperate eco-systems**
- **Do not withstand drying below 20 to 50% moisture content depending on species**
- **Best conserved as living collections**
- **e.g Mango, coconut, Securidaca e**

# *Making Quality Seed Collections*

- Context of orthodox species:
- 1. Know target species – adequately
- 2.  Assess  the extend of species in the natural range
- 3.Determine readiness to collect
- 4. Preliminarily assess on site seed quality
- 5.Asess seed numbers ?? worth collecting or not
- 6.Fill a detailed passport data sheet and later capture electronically for sharing

# *Making Quality Collections*

## 1. Know target species – adequately

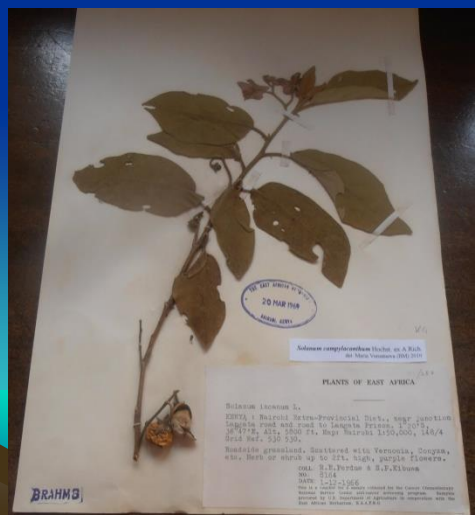
**What species is it?**

**Any similar species on same site? Avoid mixed seeds?**

**Differentiate explicitly which species?**

**If not, collect a voucher and confirm identity in established herbarium;**

**For example *Solanum incanum*, now *S. campylacanthum* so wrong collections or *Carisa edulis*?? *C. spinarum* L.**



# *Making Quality Collections*

- 2. Assess the extend of species in the natural range

Visit site and county number of individuals available and seeding

Are there pest incidences for entire individuals / or part of populations

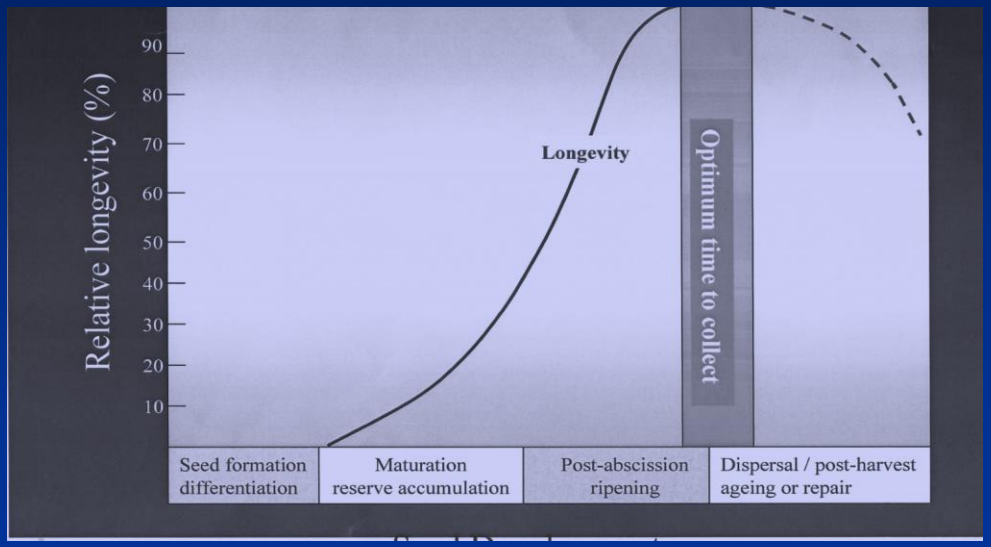
Ascertain the phenology trend of individuals – do individuals have mature seeds, flowers, young seeds, open mature fruits

Enrich this with herbarium historical data as appropriate

Do sub –populations or sub species exist in locality

# *Making Quality Collections*

- 3.Determine readiness to collect.




- Changes in seed fruit colour, seed coat, splitting fruits, best when some seeds have dispersed *in-situ*

# *Making Quality Collections*

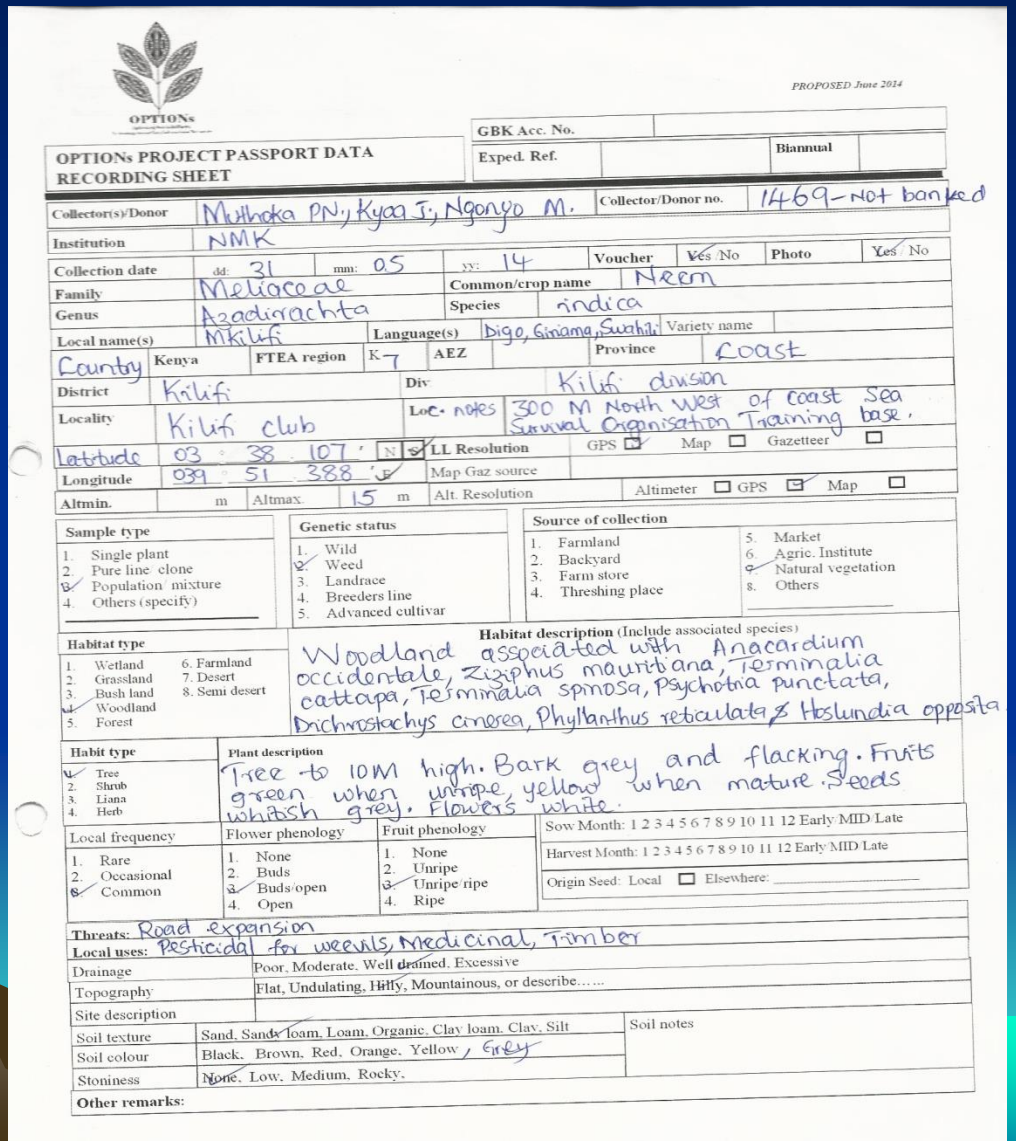
- 4. Preliminarily assess on site seed quality
- KEY TOOL is visual observations and cutting seeds with secateur or sharp blades
- **Inspect seeds or fruits for pest damage**
- **Check for visibly deformed or pest bored seeds**
- **Inspect for empty seeds by cutting tests**
- **(Any photo of infested seeds)**

# *Making Quality Collections*

- 5.Asess seed numbers ?? worth collecting or not
- Normally collect 25% of seeds – leave the rest for other biota and agents along the seed based food chain
- Can population allow collection of 10,000 to 40 ,000 seeds
- Provide for base and active collections
- Germination protocol development / dormancy challenges
- Viability / longevity trials
- Duplication with other institutes
- Dispatch to end users / local users
- Repatriation for on-farm revegetation / rehabilitation

# Quality collections

- 6.Fill a detailed passport data sheet and later capture electronically for sharing.



OPTIONs

PROPOSED June 2014

**OPTIONs PROJECT PASSPORT DATA RECORDING SHEET**

GBK Acc. No.

Exped. Ref. | Biannual

Collector(s)/Donor: Muthoka PN., Kyaa J., Ngonyo M. | Collector/Donor no.: 1469 – Not banked

Institution: NMK

Collection date: dd: 31 mm: 05 yy: 14 | Voucher: Yes / No | Photo: Yes / No

Family: Meliaceae | Common/crop name: Neem

Genus: Azadirachta | Species: indica

Local name(s): Mkilifi | Language(s): Digo, Giriama, Swahili | Variety name:

County: Kenya | FTEA region: K7 | AEZ: | Province: Coast

District: Kilifi | Div: Kilifi division

Locality: Kilifi club | Loc. notes: 300 M North west of coast Sea Survival Organisation Training base,

Latitude: 03 ° 38 ' 107 " N | LL Resolution: GPS ☐ Map ☐ Gazetteer ☐

Longitude: 039 ° 51 ' 388 " E | Map Gaz source:

Altmin. m | Altmax. 15 m | Alt. Resolution: Altimeter ☐ GPS ☑ Map ☐

**Sample type**
1. Single plant
2. Pure line clone
3. ✓ Population mixture
4. Others (specify)

**Genetic status**
1. Wild
2. ✓ Weed
3. Landrace
4. Breeders line
5. Advanced cultivar

**Source of collection**
1. Farmland
2. Backyard
3. Farm store
4. Threshing place
5. Market
6. Agric. Institute
7. ✓ Natural vegetation
8. Others

**Habitat type**
1. Wetland
2. Grassland
3. Bush land
4. ✓ Woodland
5. Forest
6. Farmland
7. Desert
8. Semi desert

**Habitat description** (Include associated species)
Woodland associated with Anacardium occidentale, Ziziphus mauritiana, Terminalia catapa, Terminalia spinosa, Psychotria punctata, Dichrostachys cinerea, Phyllanthus reticulata & Hoslundia opposita

**Habit type**
1. ✓ Tree
2. Shrub
3. Liana
4. Herb

**Plant description**
Tree to 10M high. Bark grey and flacking. Fruits green when unripe, yellow when mature. Seeds whitish grey. Flowers white.

**Local frequency**
1. Rare
2. Occasional
3. ✓ Common

**Flower phenology**
1. None
2. Buds
3. ✓ Buds/open
4. Open

**Fruit phenology**
1. None
2. Unripe
3. ✓ Unripe/ripe
4. Ripe

Sow Month: 1 2 3 4 5 6 7 8 9 10 11 12 Early MID Late

Harvest Month: 1 2 3 4 5 6 7 8 9 10 11 12 Early MID Late

Origin Seed: Local ☐ Elsewhere: _____

**Threats:** Road expansion

**Local uses:** Pesticidal for weevils, Medicinal, Timber

Drainage: Poor, Moderate, Well drained, Excessive

Topography: Flat, Undulating, Hilly, Mountainous, or describe……

Site description

Soil texture: Sand, Sandy loam, Loam, Organic, Clay loam, Clay, Silt

Soil colour: Black, Brown, Red, Orange, Yellow, Grey

Stoniness: None, Low, Medium, Rocky.

Soil notes

**Other remarks:**

| GBK Acc.No. | | Collector, prefix + number | |
|---|---|---|---|

| | |
|---|---|
| Number of plants sampled | 1 2-10 10-100 >100 |
| Number of plants found | 1 2-10 10-50 50-100 >100 |
| Area sampled | <10 $m^2$ 10-100$m^2$ 100-1000$m^2$ >1000$m^2$ |
| % of population seeding | <25% 25-75% >75% |
| Sampling notes | Random |

| | | |
|---|---|---|
| Material collected | Seed Fruit Infrutescence Seed & Fruit Seed & Infrutescence | |
| Coulour of collected Material colour | Seed: | Whitish grey |
| | Fruit: | Yellow |
| | Infrutescence: | |
| Field containers | Paper bag ☐ Cotton bag ☑ Net bag ☐ Gunny bag ☐ Cardboard box ☐ | |
| Method of collection | Handpicking | |
| Field extraction and handling methods | None | |

# *Seed germination techniques – F. Kioko / J.Kyaa*

A CASE STUDY ON THE
SEED GERMINATION TECHNIQUES

for

*Securidaca longipedunculata Fresen*

and

*Azadirachta indica A.Juss*

# (i) *Securidaca longipedunculata* Fresen.

- Multiple seed germplasm collected on 16th June 2014, 10th & 11th July, 2014 & August 22nd August, 2014 in Kwale & Makueni counties.
- Average moisture content *ca* 32.9%.
- Seed processing was done by opening the samara using a scalpel blade and sowing followed immediately.

# The medium used

- Non mist timber propagator was constructed and placed in a glass house.
- Media used  included; coco peat, sand, sawdust, fine and coarse grit, habitat soil, sawdust : coco peat (1:1) &  forest soil: coco peat: sand (2:1:1).

# (a) **Vermiculite**

- Large grained vermiculate used
- 60ml of water was used to moisten 100ml of vermiculite.
- Seeds sown in this media inside buckets Germination OCCURED within fourteen (14) days under glass house conditions.
- During germination period no water was applied.

# (b)Habitat soil

- Soil was collected from underneath the mother tree where the seeds were collected
- Seeds were sown in the soil
- Seeds germinated after 21 days and continued for another 18 days.

# (c) Fine grit

- Coarse grit was sieved to obtain fine grit then washed thoroughly in running water
- The fine grit was spread on polythene paper to drain out excess water to avoid water logging / contamination
- The medium was transferred to the buckets.
- Seeds sown in this media sprouted after 14 days after the date of sowing

# (ii) *Azadirachta indica* A. Juss

- Multiple seed germplasm collection was done on 31st May, 9th July & 10th October 2014 in Kilifi & Tharaka Nithi counties.
- Average moisture content was 18.0 %.
- Propagation medium used was sand which was sieved then washed thoroughly until it was physically clean.
- It was then sun-dried in a plastic sheet to remove excess water, then transferred into plastic troughs, buckets & basins ready for sowing.
- Seeds were sown and germination was recorded after 14 days, transplanted & distributed to farmers in Tharaka County.

# Conclusions.

- Both species both are easy propagate.
- Seeds with higher moisture content failed to germinate due to low maturity(*S.longipedunculata*).
- Correct time of collection – most preferably at the incipient dispersal.
- Truly a recalcitrant seed-needs careful handling.
- Epigeal type of germination hence the need for deeper media to avoid root coiling.

# Cont.

- Understand seed development and acquisition germinability in detail.
- Need to understand media water holding capacity and particle size to air space.
- *Azadirachta indica A.Juss* can not survive in Nairobi as seedlings  hence the need to further investigate  relative humidity conditions

# *Seed handling - principles*

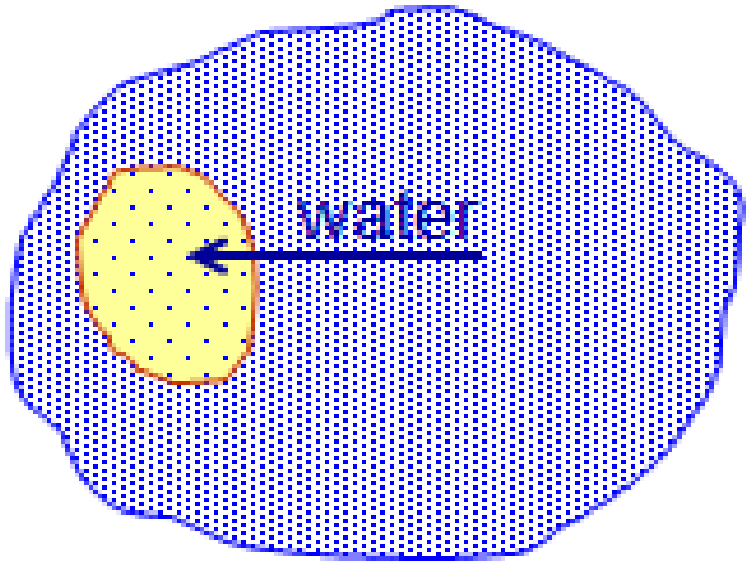
**A range of facts, exist.**

**Underpin the way seeds are handled**

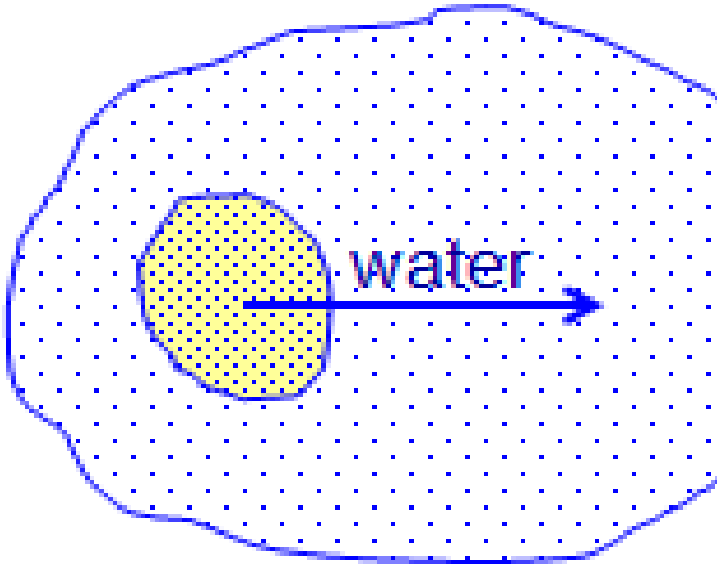
**Must be explicitly understood by seed collectors / handlers**

**Few will be mentioned here – as this is basic seed science**

# Seeds are hygroscopic: desorb or absorb wa from environment to attain equilibrium

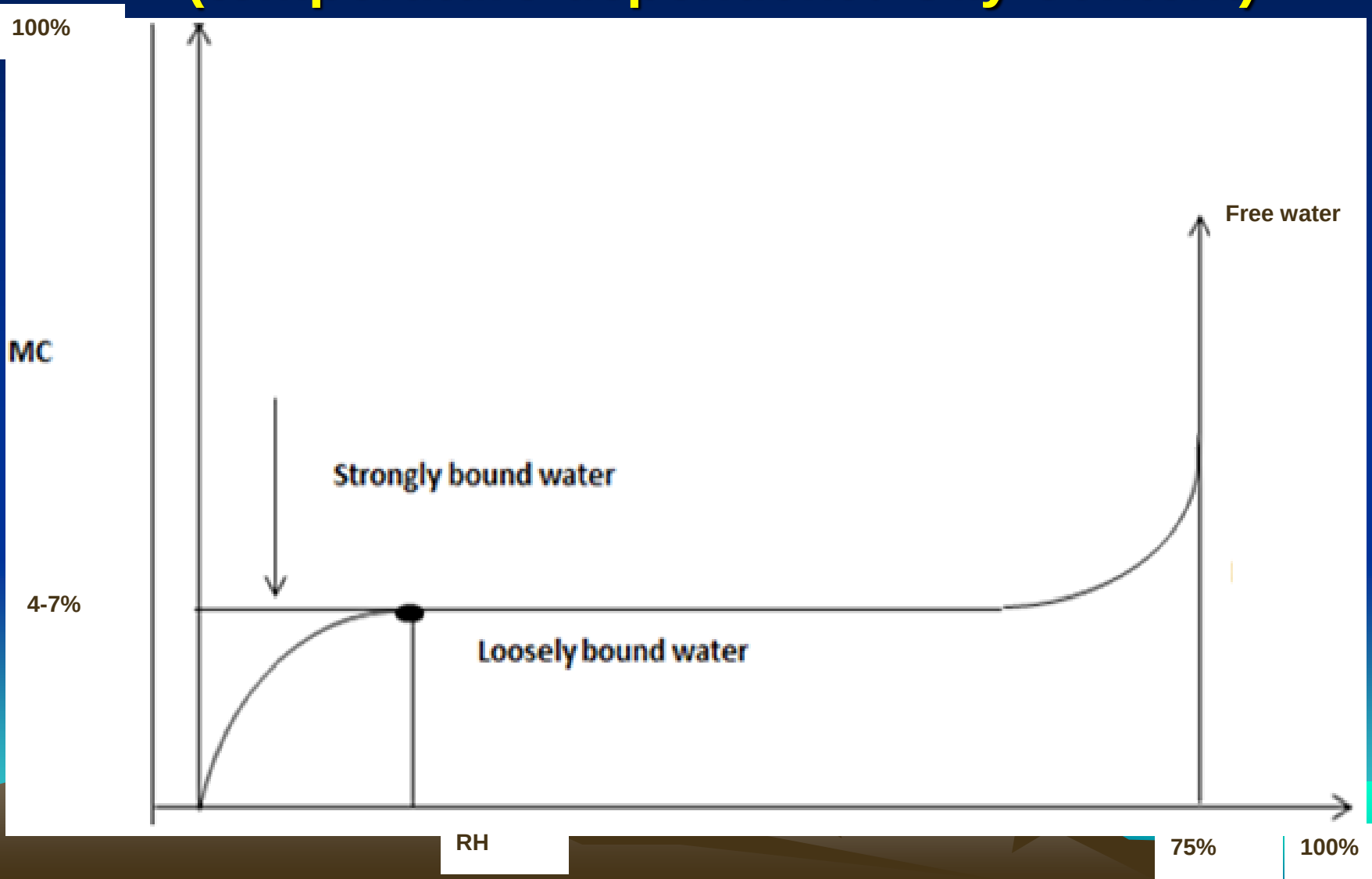



Dry seed in air with high RH

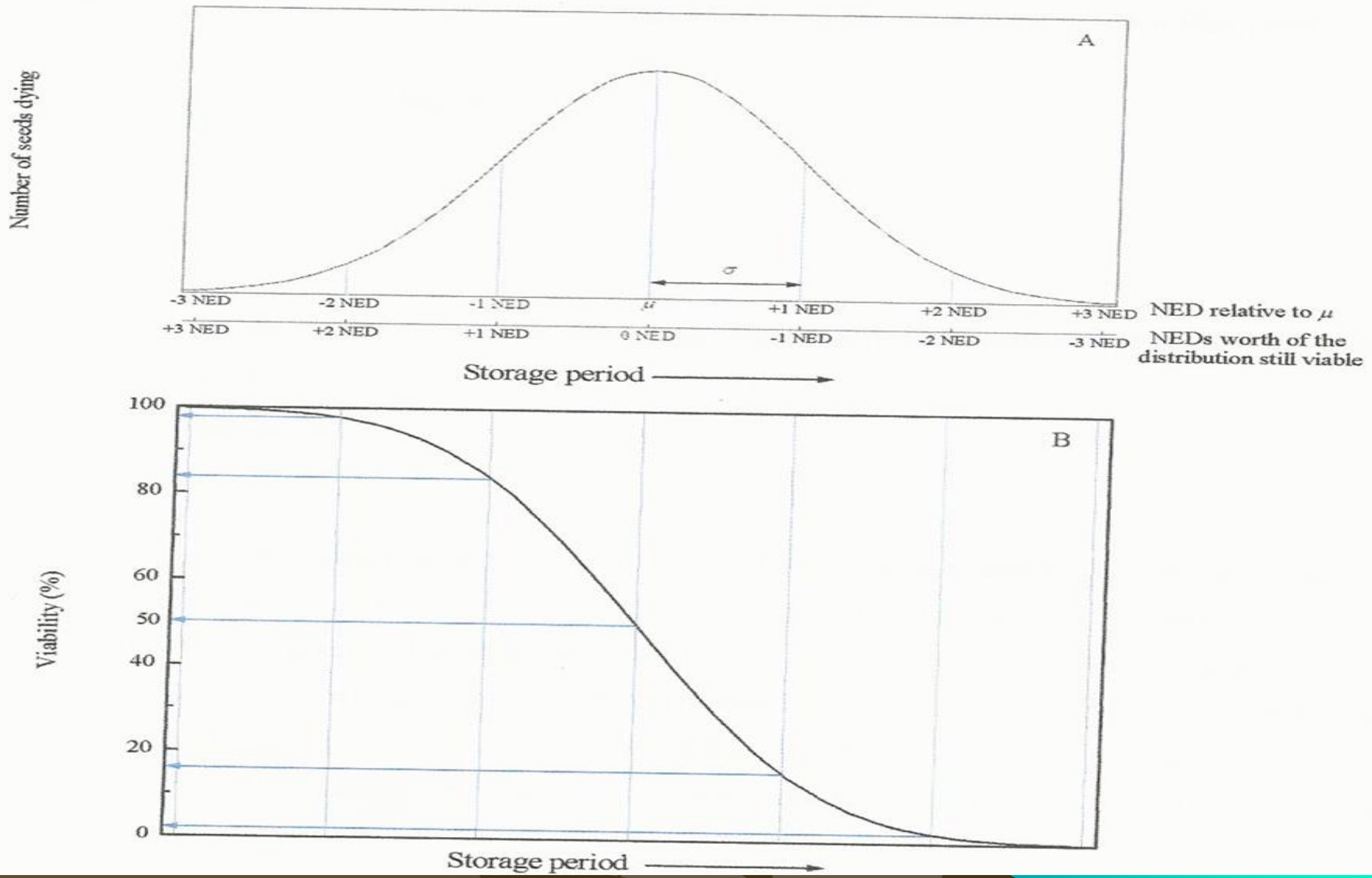



Wet seed in air with lo

# Across seed hydration range, moisture content and relative humidity have reverse sigmoid relationship (temperature dependent / Oily content)



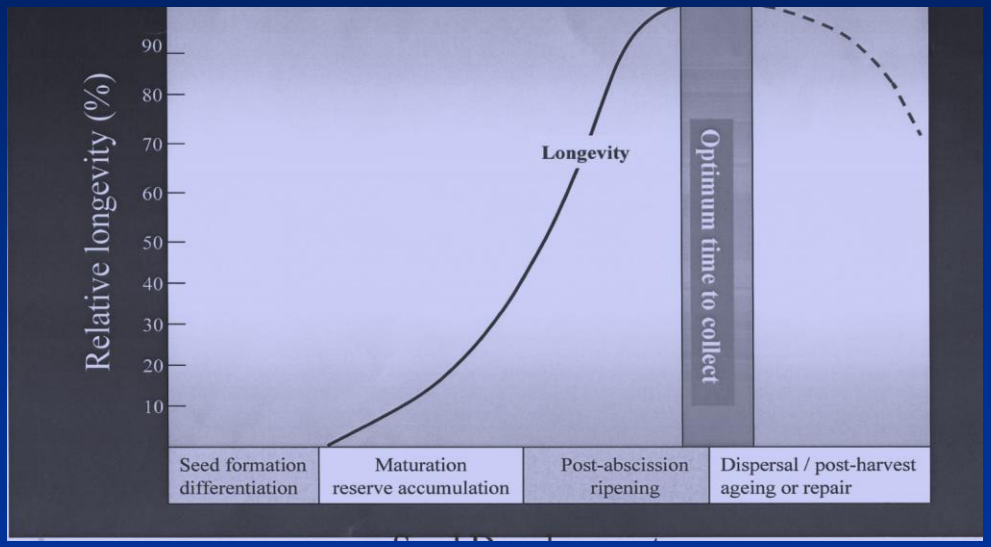
# Seeds have binomial behaviour with common mean and few outliers




Adopted from Muthoka 2009 Thesis

# *Optimum collection time*

- 3.Determine readiness to collect.




- Changes in seed fruit colour, seed coat, splitting fruits, best when some seeds have dispersed *in-situ*

# Seed lifespans well modelled

- Orthodox seeds - desiccation tolerant – Seed science very critical

basic viability equation: $v = K_i - p/\sigma$

–moisture relations: $\log \sigma = K - C_W \log m$

–temperature relations: $\log \sigma = \hat{a} - C_H t - C_Q t^2$

–combining 2 and 3: $\log \sigma = K_E - C_W \log m - C_H t - C_Q t^2$

–combining 1 and 4:

$$v = K_i - \frac{p}{10^{K_E - C_W \log m - C_H t - C_Q t^2}}$$

These enable the prediction of seed longevity under different storage conditions.

# Handling of orthodox seeds e.g most vegetables *on-farm*

- Harvest at point of maximum maturity – when seed/fruit colour changes significantly (browning) : Inspect for pests diseases, cut for maturity



- Spread as a thin layer on absorbent material – fast drying
- Harrington rule, for every one degree loss in Mc, life of seed doubles
- This rule occur between upper and lower limits

# Handling.....

- Well ventilated area – increase loss of moisture, better quality
- Re-spread daily until moisture if about <10% mc
- Pack in appropriate container, absorbent material or hermetic containers
- Avoid gunny bags or open plastics as seeds don't breath well and die



# Avoid the following conditions

- Harvesting seeds / handling when wet : seeds may germinate or become mouldy
- Packing seeds in thick layer – generate too much heat, die
- Avoid plastics – no drying, slowed respiration and seed death occur
- Direct sun drying – death of embryo / cracking of seed coats

# Seed storage

Depend on envisaged STORAGE period (few years or hundreds of years): Conventionally two storage methods

- Base collections – LONG TERM
- Active collections – SHORT /MEDIUM TERM

- Base collections – Long term stored collections
- Dried to 4-7% f.w.b at 15%RH/15$^{o}$C and hermetically stored at minus 20$^{o}$C
- Materials used to store seeds include aluminium foil packets, aluminium bottles
- Not routinely available (research or exchange) except after catastrophes – war, earthquakes, floods
- Checked for viability every ten years, those with less than 84% regenerated
- Examples, most gene banks (Fort Collins (USA), Millennium Seed Bank (UK), Genetic Resources Institute (Kenya)

# Active collections

## Collections stored for short time and medium term (few years – 1 to 15 years

- Dried to 8-12% f.w.b and stored at +5 $^{o}$ C or ambient conditions
- Materials used to store seeds include plastic jerry cans, guards, metal tins, wine bottles etc
- Collections routinely available for research , exchange, donations, or teaching obligations
- Checked for drop in viability as need arises
- Examples, most university collections, major seed banks maintain a cell for active collections to ensure base collections are not exhausted (ICRAF collections)
- Farmers like you keep active collections – dried under ambient conditions and loosely sealed in on-farm containers

## Basic reading

**Ellis, RH, Roberts EH 1990**. Improved equations for the prediction of Seed longevity. *Annals of Botany* 45: 13-30

**Hay FR, Smith RD 2003.** Seed maturity: When to collect seeds from wild plants. Seed Science – Turning Science into Practice pp 97-133 ISBN 1

P**robert RJ. 2003.** Seed viability under ambient conditions. The importance of drying. Seed Science – Turning Science into Practice pp 337-365 ISBN 1

**Muthoka, P. N., Hay, F. R., Dida, M. M. Nyabundi, J. O. and Probert, R. J. 2009:** Moisture content and the longevity of seeds of six Euphorbia species in open storage. *Seed science and technology* 37: 383-397

*Thank you*