

Diversifying Tanzania's Native Tree Species Portfolio for People and Biodiversity (Project ID: DITanzania/2024/001)



Expert-led webinar on phenology, seed maturity, viability & storage for successful Tanzanian native tree propagation

26 February 2026

Presenters

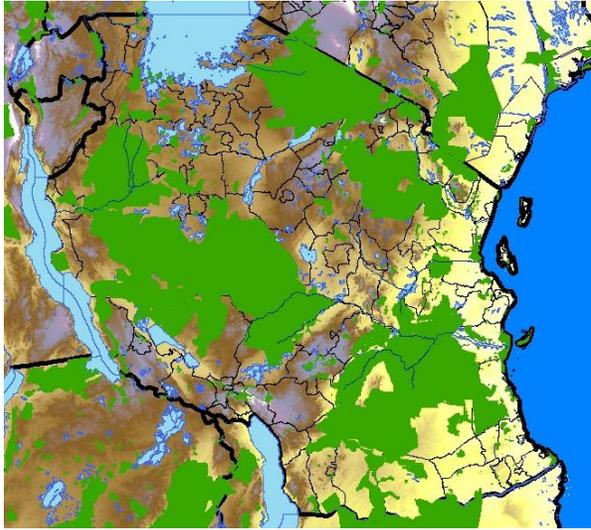
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Webinar Scope & Focus

- Introduction: Tanzania Forest perspectives
- Overview: Why native tree seed matters in Tanzania?
- Overview: Project context
- Phenology as foundation of flowering and fruiting cycles
- Seed collection techniques and maturity indices
- Seed handling, extraction, and storage behaviour
- Seed aging, viability, and nursery implications
- Best practices for successful native tree propagation
- Closing: What the project enables

1: Introduction: Tanzania Forest perspectives



- 48.1 million ha forests (55%)
- Harbours approximately 12,500 vascular plants out of 330,000 globally.
- The highest than all tropical EAC combined



- Climate resilience:
Carbon sink 6.3 billion tonnes of CO₂e per year



- Forests sustain water
- Food
- Biodiversity
- Ecosystem balance
- Ecotourism
- Livelihoods



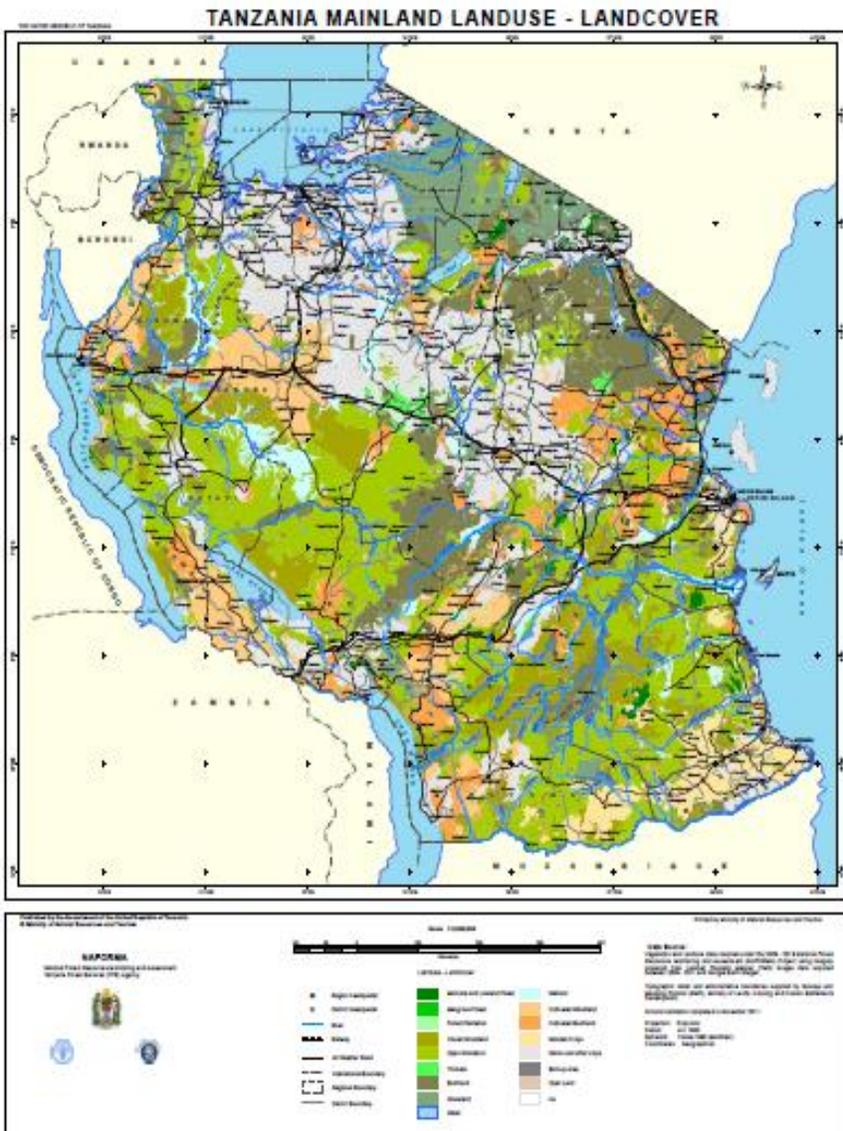
Supporting economy (4% of GDP)

Global: Threats to trees genera



Botanic Gardens Conservation International. (2021). *State of the World's Trees*. Botanic Gardens Conservation International. Richmond, United Kingdom.

1: Introduction: Tanzania Forest perspectives cont...



Diminished predicted potential suitable habitat distribution area for forested plants

Miombo woodlands

- Mountain forests
- Coastal forest
- Mangrove Forests.

2. Overview: Why native tree seed matters in Tanzania?

- Tanzania is among the world's mega-diverse countries, hosting over 1,700 native tree species, with more than 300 endemics.
- Over 350 native tree species are currently classified as Threatened (CR, EN, VU) on the **IUCN Red List**.
- Despite this richness, only a small fraction of species are available in nurseries for restoration and agroforestry.
- Global commitment: AFR100 (5.2 mHa)
- Deforestation 376,000ha/year
- Limited species availability constrains ecosystem restoration, biodiversity conservation, and livelihood benefits.

3. Overview: Project context

- TFS, BGCI Africa, TTGAU, Migombani Botanical Garden and ECHOcommunity and are implementing a Darwin Initiative-funded project in Tanzania.
- **Aim:** Focuses on diversifying Tanzania's Native Tree Species (NTS) portfolio, prioritising species valuable to people and biodiversity.

Key actions include

- i. Selection of useful threatened native species (Seed/Seedling Consultation Group supports a list of ≥ 100 useful & ecologically important NTS)
- ii. Assessment of current NTS portfolio, seedling supply constraint + opportunities/priorities
- iii. Addressing policy and practical barriers
- iv. Strengthening accessibility and restoration readiness

4. Overview: Project context-How priority species were identified

Data sources

- i. IUCN Red List download (distribution, ecology, threats, conservation actions)
- ii. Nursery growers survey (collection, growing, supply constraints)
- iii. Literature review
- iv. Workshop: Dodoma, 24–25 Feb 2025- Criteria agreed + weightings and species scored and ranked

Criteria and weightings

- **Highest weight (2):** IUCN status, Ecological importance, NTFPs value, Seed availability
- **Medium (1.5):** Natural regeneration, ID difficulty, Propagation difficulty
- **Lower (1):** Timber value, Accessibility, Market for seedlings, Presence in nurseries

“Note: The framework prioritizes “threatened + useful + feasible to supply”

2. Overview: Project context-From priority list to actions

	Taxon	IUCN Red List Status
1	<i>Entandrophragma bussei</i>	Not Evaluated
2	<i>Huberantha verdcourtii</i>	Endangered
3	<i>Ficus thonningii</i>	Least Concern
4	<i>Julbernardia magnistipulata</i>	Vulnerable
5	<i>Karomia gigas</i>	Critically Endangered
6	<i>Bussea eggelingii</i>	Endangered
7	<i>Baphia kirkii</i>	Vulnerable
8	<i>Nauclea nyasica</i>	Near Threatened
9	<i>Afrocarpus usambarensis</i>	Endangered
10	<i>Bobgunnia madagascariensis</i>	Least Concern
11	<i>Cephalosphaera usambarensis</i>	Near Threatened
12	<i>Cordyla densiflora</i>	Vulnerable
13	<i>Dalbergia acariaeantha</i>	Endangered
14	<i>Dypsis pembana</i>	Vulnerable
15	<i>Entandrophragma excelsum</i>	Least Concern
16	<i>Guibourtia schliebenii</i>	Vulnerable
17	<i>Hymenaea verrucosa</i>	Not Evaluated
18	<i>Isoberlinia scheffleri</i>	Vulnerable
19	<i>Mkilua fragrans</i>	Vulnerable
20	<i>Premna schliebenii</i>	Vulnerable
21	<i>Vangueria pallidiflora</i>	Vulnerable
22	<i>Vitex zanzibarensis</i>	Vulnerable
23	<i>Warburgia elongata</i>	Critically Endangered
24	<i>Zanthoxylum holtzianum</i>	Vulnerable
25	<i>Ziziphus robertsoniana</i>	Endangered
26	<i>Gigasiphon macrosiphon</i>	Endangered
27	<i>Allanblackia ulugurensis</i>	Vulnerable
28	<i>Prioria msoo</i>	Vulnerable
29	<i>Coffea kimbozensis</i>	Critically Endangered
30	<i>Warburgia stuhlmannii</i>	Vulnerable

Top 100 Species Identified
(Threatened + Useful + Ecological
Importance)

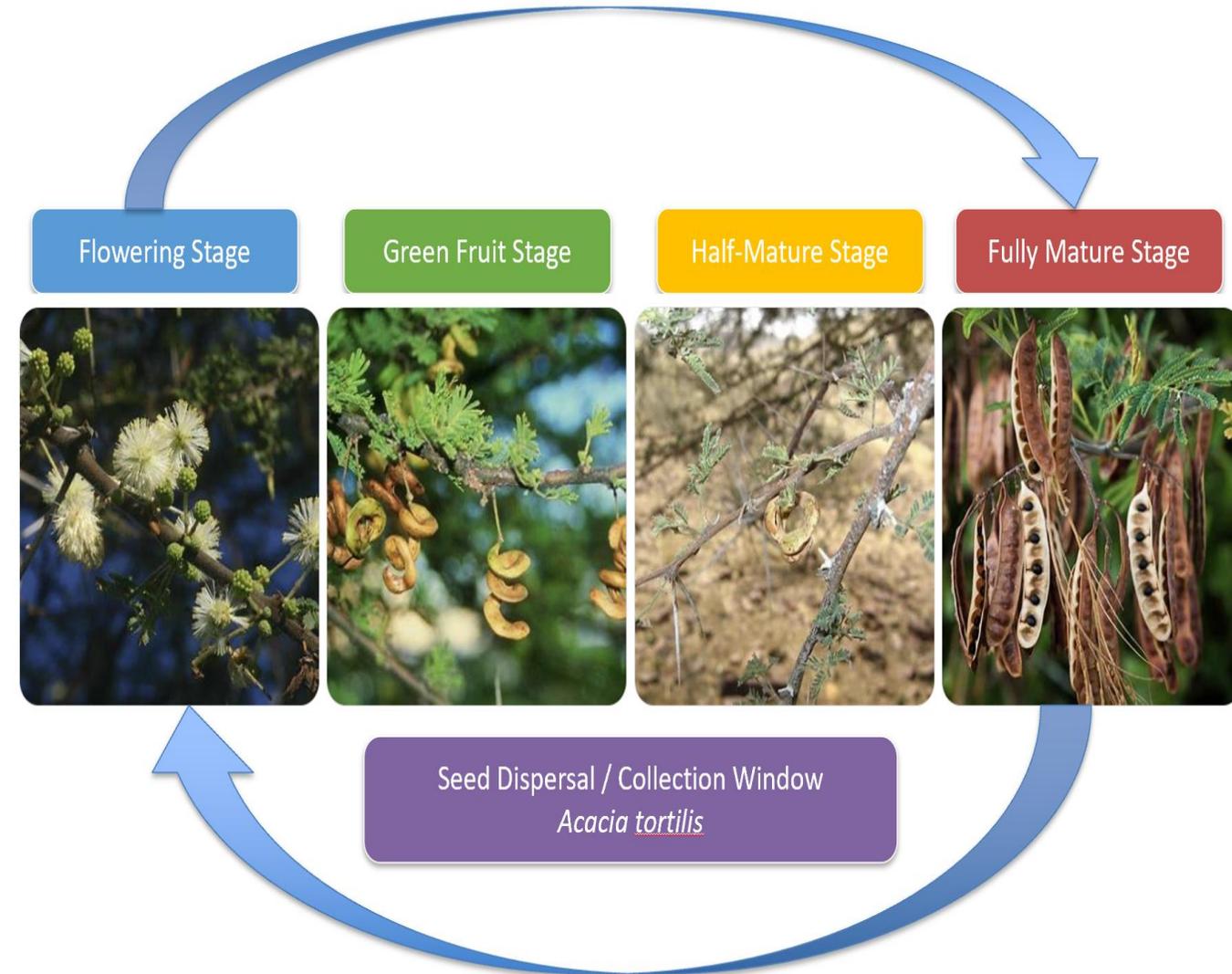
30 Species Selected for Propagation
Protocol Development

Output Products
Freely Available Protocols + Improved
nursery readiness

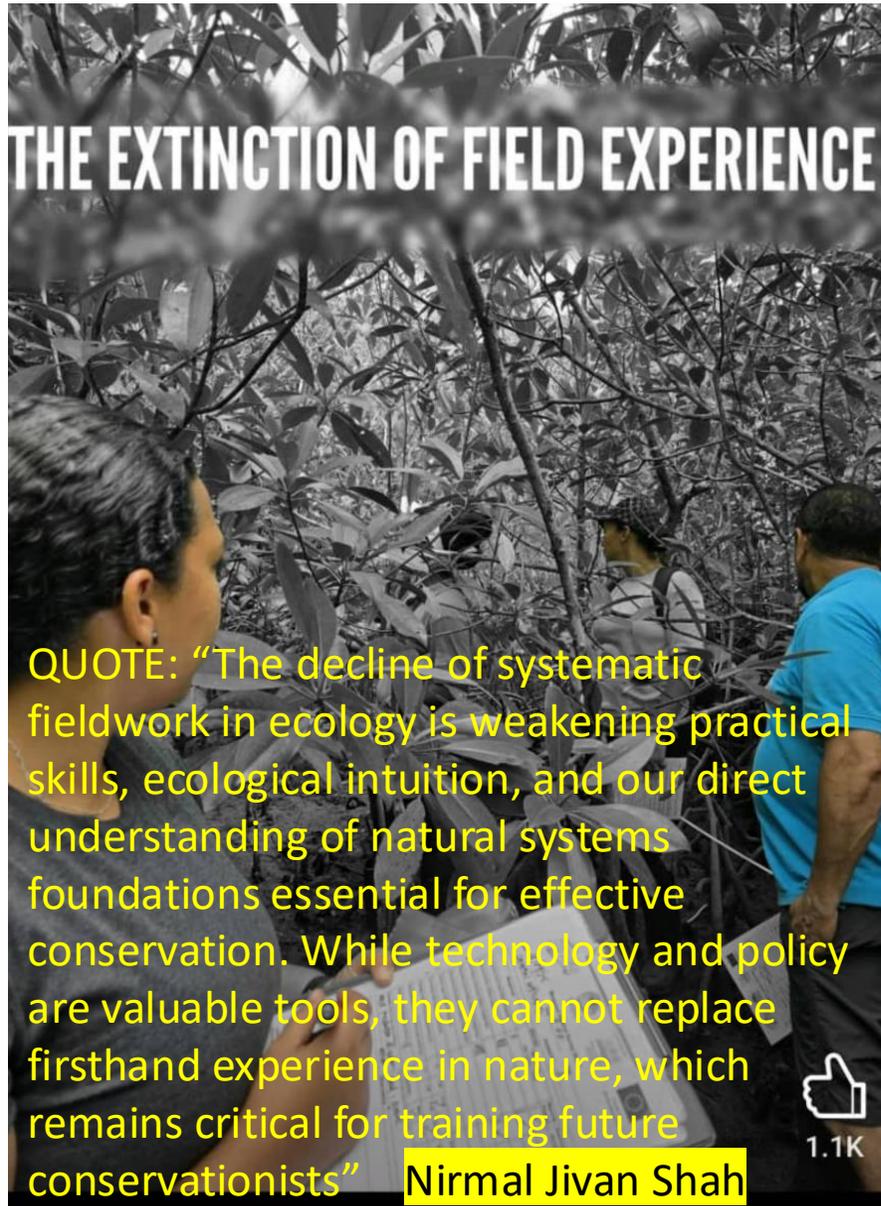
3. Phenology as foundation of flowering and fruiting cycles

What is Phenology?

- Study of the timing of recurring biological events (“*nature’s calendar*”)
- Includes flowering, leafing, fruiting, seed maturation, and leaf fall
- Controls flowering, fruiting, and seed maturation
- Strongly influenced by rainfall, temperature, and climate variability
- Fundamental for ecological understanding and restoration planning



3. Phenology as foundation of flowering and fruiting cycles



Why it matters

- Supports understanding of ecological and climate-driven changes
- **Direct understanding of natural systems foundations essential for effective conservation**
- Guides decisions (agriculture, forestry, and conservation)
- Critical for botanical expeditions and specimen collection

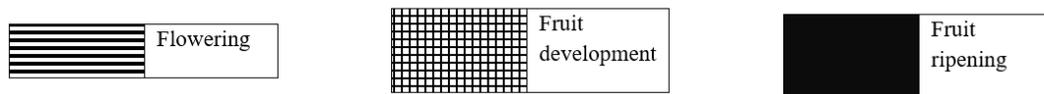
Relevance to seed & restoration work

- Helps anticipate low-production vs mast years
- Enables planning for seed supply stability
- Identifies optimal harvest periods
- Predicts seed crop quantity and quality

3. Phenology as foundation of flowering and fruiting cycles

Phenological observations for *Uapaca kirkiana*, *Sorindeia madagascariensis* and *Bridelia micrantha*. The shaded areas indicate peak season, whereas the open symbols (□) indicate gradual increase and filled symbols (■) indicate gradual decrease in occurrence of flowers or fruits.

Species	Phenology	Period by months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<i>Uapaca kirkiana</i>	Flowering	□	▨	▨	■								
	Fruit development		□	▩	▩	▩	▩	▩	▩	▩	▩	▩	■
	Fruit ripening	■								□	■	■	■
<i>Sorindeia madagascariensis</i>	Flowering					□	▨	▨	▨	■			
	Fruit development						□	▩	▩	▩	▩	■	
	Fruit ripening								□	■	■	■	■
<i>Bridelia micrantha</i>	Flowering	■								□	▨	▨	▨
	Fruit development	□	▩	▩	■								
	Fruit ripening			□	■	■	■						



Uapaca kirkiana



Sorindeia madagascariensis

- Seed collection calendar helps in tracing phenology for effective seed management also enhance predicting seed crop quantity and quality, identifying optimal harvest periods, and enabling planning for seed supply stability

3. Phenology as foundation of flowering and fruiting cycles

- Many species show predictable seasonal peaks
- Tanzania: main fruiting season commonly June-August
- Exceptions exist
 - *Milicia excelsa*, *Syzygium guineense*: Jan-Feb
 - *Uapaca kirkiana*, *Sorindeia madagascariensis*: Sep–Nov
 - *Dalbergia melanoxylon* (Jun-Aug)
 - *Khaya anthotheca* (May-Jul)
 - *Milicia excelsa* (Jan-Feb)
 - *Bridelia micrantha* (May-Jul)
- Thus, you cannot use “one calendar” for all species
- Climate shifts increasingly altering phenological stability
- Species-specific calendars are essential

3. Phenology as foundation of flowering and fruiting cycles

Table 1. Effect of different fruit maturity stages on germination and vigour of *Gmelina arborea*

Maturity stage	Moisture Content (%)	Germination (%)*	Vigour Index
Green fruits	13.75	70.0	959
Yellow fruits	20.70	93.8	1313
Yellow-Brown fruits	6.75	85.0	1224
Black fruits	6.50	96.3	1416
Bulk (Control)	11.00	76.3	1225

*Transformed Values

Fruits of *G. arborea* should be collected when their color range is in between yellowish green to yellowish brown instead of taking time as a fixed parameter since the time of season may vary from year to year (Naithani, R., Varghese, B., Sahu, K. K., Dulloo, M. E., & Naithani, S. C. (2006). *Post-harvest storage physiology of Gmelina arborea Roxb. seeds*. *Indian Journal of Plant Physiology*, 11(1), 20–27.

- **Phenology supports effective seed management by predicting seed crop quantity and quality, identifying OPTIMAL HARVEST PERIODS, and enabling planning for seed supply stability**

3. 1. Phenology as foundation of Seed maturity, germination outcome, seed physiology storage & aging response

Species	Green / Immature Stage	Half-Mature Stage	Fully Mature Stage
<i>Karomia gigas</i>	High moisture, unstable tissues; extremely rapid deterioration; negligible germination	Partial desiccation tolerance; short-lived viability; aging begins quickly	Physiological maturity improves stability; slower aging; highest viability & germination
<i>Milicia excelsa</i>	Physiologically weak seeds; very fast aging; poor storage survival	Moderate storability; viability decline still significant	Mature seeds show improved longevity; aging rate reduced; best germination response
<i>Allanblackia ulugurensis</i>	Desiccation intolerant; immediate viability loss; no storage potential	Still highly sensitive; aging dominated by moisture stress	Recalcitrant behaviour persists; rapid aging unavoidable; sow immediately after harvest
<i>Ziziphus robertsoniana</i>	Incomplete dormancy & poor storage stability; viability loss likely	Improved storage response; moderate aging tolerance	Mature seeds exhibit stable dormancy & slower aging; better storage performance
<i>Warburgia elongata</i>	Low physiological integrity; accelerated aging; weak germination	Moderate viability; aging still pronounced	Recalcitrant, highest physiological quality; aging slowed; improved germination uniformity
<i>Uapaca kirkiana</i>	Extremely high moisture; immediate deterioration; aging very rapid	Very limited storage life; viability declines sharply	Recalcitrant; rapid aging characteristic; rapid sowing essential
<i>Sorindeia madagascariensis</i>	Immature embryos; fast physiological breakdown; poor germination	Partial reserve formation; moderate aging sensitivity	Mature seeds more stable; aging reduced; good germination if promptly handled
<i>Bridelia micrantha</i>	Immature seeds non-viable; aging irrelevant (already poor quality)	Variable viability; storage losses common	Recalcitrant tendency; aging driven by moisture loss; short storage only

The table highlights that seed maturity stage fundamentally controls viability, aging behaviour, storage potential, and germination success, emphasizing that improper collection timing can irreversibly compromise restoration outcomes.

3. 2. Phenology as foundation of implications for seed extraction and quality)

Maturity Stage	Extraction Characteristics	Seed Quality Implications
Green / Immature Fruits	High moisture; tissues tightly bound; pulp adheres strongly; difficult separation	Seeds often physiologically immature; high damage risk; poor viability & germination
Half-Mature Fruits	Partial softening or drying; incomplete detachment of seed structures; irregular release	Mixed seed quality; variable viability; increased heterogeneity in germination
Fully Mature Fruits	Natural dehiscence or softening achieved; efficient seed release; minimal mechanical force required	Maximum physiological quality; lowest extraction damage; highest viability & uniform germination

- **Seed extraction success is not purely mechanical it is governed by fruit and seed physiological maturity.**

3. 2. Phenology as foundation of implications for seed extraction dynamics

- **Immature seeds** → high moisture, poor viability, rapid aging
- **Half-mature seeds** → variable germination and storage response
- **Fully mature seeds** → highest vigour, longevity, stability
- **Note:** Fruit indicators often more reliable than fixed dates

CONCLUSION: Seed maturity determines seed fate

4. Seed collection principles

- **Objective:** Secure genetically representative, high-quality seed
- Match collection timing with maturity indices
- Select healthy populations and reproductively active trees
- Avoid mechanical damage and physiological stress
- Maturity and fruit quality
 - i. Know the consequences of harvesting at different stages of maturity/ripeness on final quality.
 - ii. Make sure workers involved in harvest, selection are well trained to ID correct maturity/ripeness



4.1 Seed collection principles: Assessing seed maturity



- It is important that seeds are collected when mature.
- Best collection time is at the point of natural dispersal.
- It is possible to tell whether seeds are matured by the external colour. As a guide look for:
 - i. Seeds which detach easily from the parent plant
 - ii. Changes in fruit colour /odour
 - iii. Changes in seed coat colour
 - iv. Fruits splitting or breaking open
 - v. Seeds rattling or are hard and dry and some seeds are already dispersed

NOTE: Be careful that you don't collect seeds from the previous season.

Illustration of maturity indices cont...



8th July

16th July

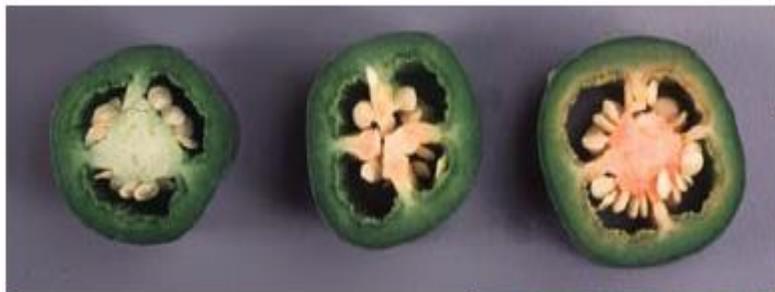
29th July



Illustration of maturity indices



Harvest/maturity Indices
Peppers & chiles



Mango maturity indices
Fullness of shoulders
Internal and external color
Lenticels and hairs on pit
Starch content; specific gravity

4.1 Seed collection principles: Assessing seed maturity

cont...



Collecting team assessing numbers of seeds per dispersal unit in a population



Karomia gigas



Potentially viable seed (upper right) and seed damaged by fungal attack (lower left)

- Further evidence of seed maturity can be through a 'cut-test'
- **Tools:** Secateurs, scissors, nail clippers or similar sharp blades. Tiny seeds can be held on adhesive tape for easier cutting.
- Cut 10–20 seeds, collected from several well-spaced individuals in the population
- Carefully examine using a hand lens (especially for smaller seeds).
- Using the Pre-collection checklist will help you consider the implications after assessing the seed maturity.
- **NOTE:** Immature seeds will have milky or jelly-like contents becoming firmer and generally whiter as the seeds mature.
- Seeds collected before or after this stage may not survive longer in storage facility. **DO NOT COLLECT**, reschedule your collection

4.2. Seed collection principles: Planning for seed collection cont...

- The quantity will depend on demand/objectives.
- Poor seed production may affect planting targets.
- Good crop years results to collecting larger amounts of good-quality seed

Collection Permit

- A collection permit should be obtained in advance from the seed source owner (Including farmers, authorities like Game parks, Forest reserves, Town councils etc.)
- Sometimes you will need to pay royalty if you don't own the seed source.
- The permit should include information about the collection area, collection period, quantity to be collected and number of people to be involved.

4.3. Seed collection principles: Assembling of resources for seed collection

- Have a clear objective for the collection (enough information on the species to be collected; phenology (crop assessment report- many tree species have irregular seed maturation), costs and location of seed sources.
- Select target species in order of priority
- Identify populations to be collected
- Identify target species and collection sites
- Define the requirements for individual tree collections
- Select collection team: Right people with the right skills and experience
- Logistic set up

4.3. Seed collection principles: Assembling of resources for seed collection cont...

Organizing manpower

- Collectors should be organized and be led by the collection leader.
- Labour force depends on
 - i. The quantity of seed to be collected,
 - ii. The number and type of species,
 - iii. Prevailing weather,
 - iv. Terrain and the task of every individual involved in seed collection.

Organizing transport

- Transport must be available where and when needed.
- The overall transport need will be estimated from the size and number of team members, seed source records and the seed demand.
- Vehicles have to be given a thorough check and service.

Select proper motivated team....

.....Gosh...I think I've messed up coming...

..I must prank these guys, I saw a Lion...



Select proper team with right skills....



Plan well your logistic based on field conditions....



4.3. Seed collection principles: Assembling of resources for seed collection cont...

Organizing equipment

- Choice of equipment will vary greatly according to species.
- The equipment includes safety clothing, cotton bags, sisal sacks, plastic sheets, tarpaulins, secateurs, ladders etc.
- Apart from collection equipment, a first aid kit, seed source forms, labels etc. should be provided.
- Budget should be flexible and distributed to periods e.g. months according to expected activities and be revised currently during the year.



- Maximise the quality of the seed collection, making the most of the time and the resources available.



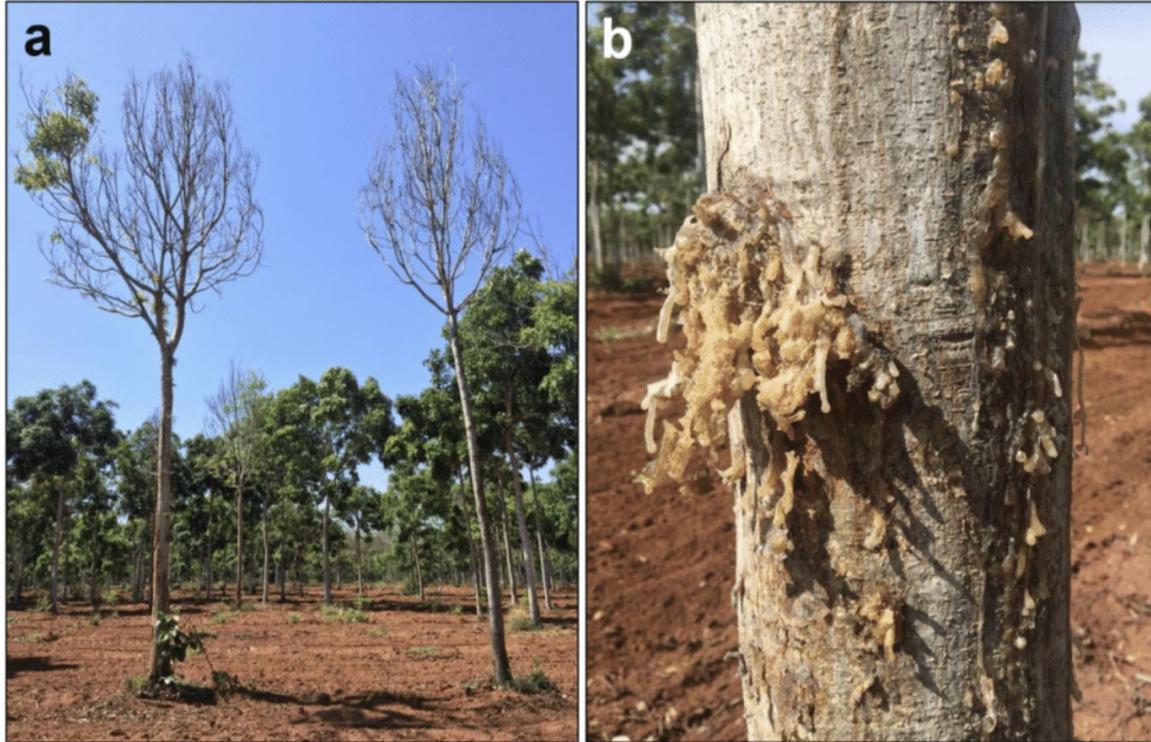
Safety should be your priority to avoid wild animal risks and attacks

4.3. Seed collection principles: Assembling of resources for seed collection cont...

After assessing seed maturity important things to consider

- Good practices collection
- Sampling strategy
- Capturing genetic diversity
- Handling
- Field data
- Herbarium voucher
- Post harvest handling

Good practices collection

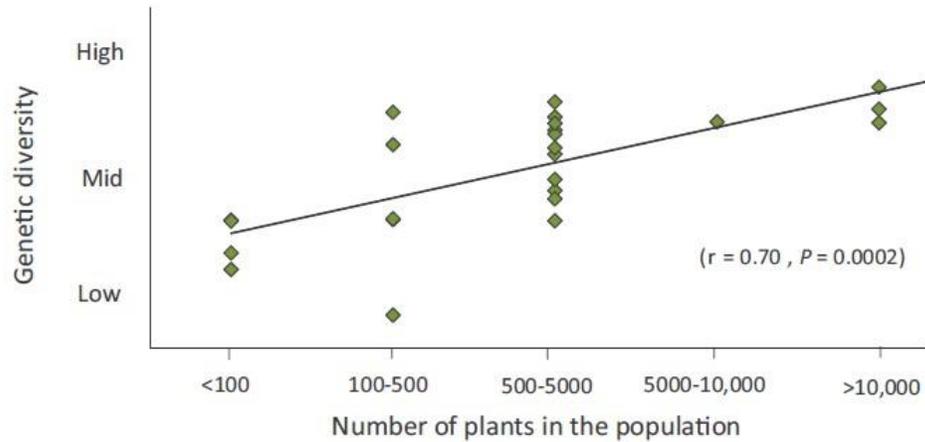


African mahogany, *Khaya senegalensis*, plantation that suffered a serious outbreak of *Euplatypus parallelus* in northwestern Brazil: (a) two mahogany trees with symptoms of dieback wilt syndrome; (b) mahogany trunk with gummosis. Photos by H.L. Rainho

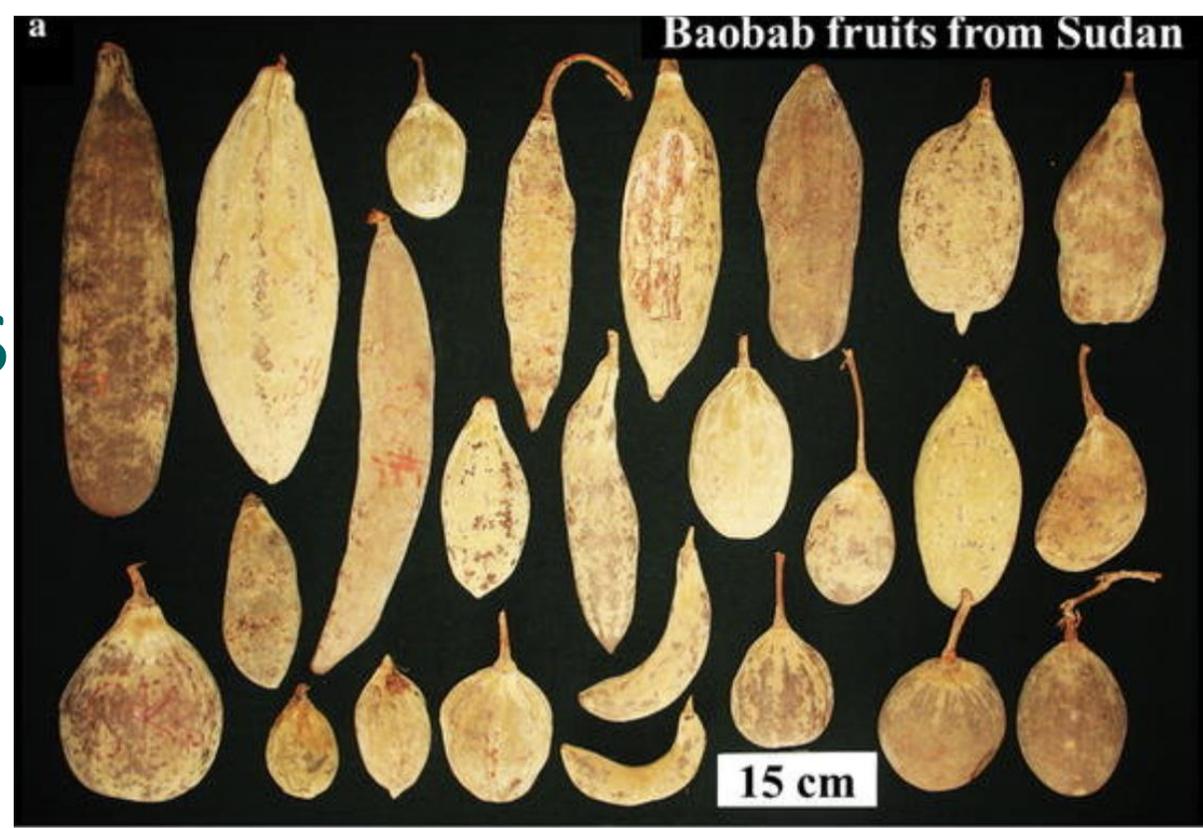
- Collect from multiple mother trees (genetic diversity)
- Avoid diseased, damaged, or infested fruits
- Use ventilated containers and prevent overheating
- Minimize delays between collection and processing

Sampling strategy

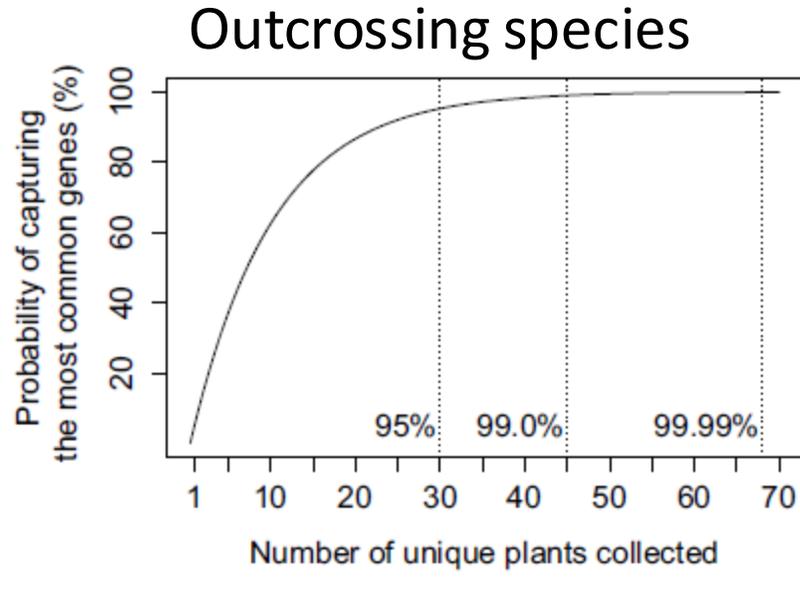
Sample **large** populations



Genetic diversity **increases** with population size



Genetic diversity



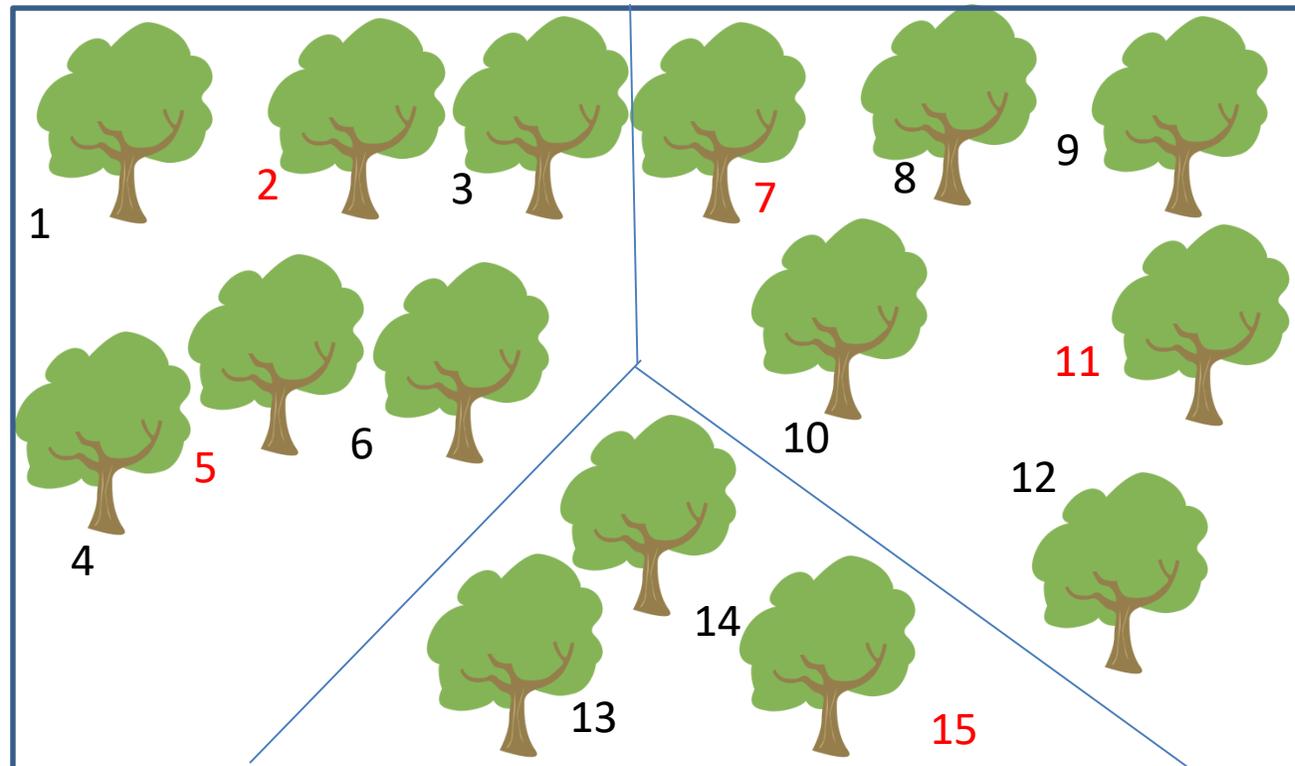
45 individuals are required for 99% of the most common genes

The likelihood of capturing all but the rarest forms of genetic diversity increases with the number of plants collected. Adapted from Basey *et al.* 2015

<http://npj.uwpress.org/content/16/1/37.short>

Sampling Strategy

Collect randomly and evenly in a uniform way across all sectors of the population



What Quantity to collect?

- Seed quantities depend on objectives and demand.

Seed Collection Guidance (Conservation Context)

- For conservation, target **>20,000** healthy seeds per population where feasible.
- Collections should prioritize potentially viable seeds for long-term use.
- Achievability varies with seed availability and species biology.
- Smaller collections remain highly valuable, especially for threatened or rare or restricted species (e.g. *Endemic and IUCN Redlisted* species).

Category	Activity	Seed Required
Conservation	Base collection in case of loss of wild population or need for regeneration of collection	500
Maintenance	Developing a germination protocol	100
Maintenance	Viability monitoring over 200 years	650
Duplication	Seed stored and monitored at a second seed bank for safety reasons	1,150
Distribution	50-seed sample sent to users every second year for 200 years	5,000
Propagation & Restoration	Growing for display in botanic gardens & restoration	10,000

Collection summary

- All collection shall be accompanied by labels at all time (seed collection, processing, drying, testing, storage, distribution) as well as their voucher and DNA specimens.
- **Mixed, absence of labels resulting to valuable collection a garbage regardless its cost**
- From large populations - the more individuals the more genetic diversity present
- Randomly and evenly (you may need to use a system to do this)
- Avoid sampling from isolated plants and ideally collect from many individuals - A minimum of 45 trees at least
- Collect from multiple populations
- In general, it is better to collect fewer seeds from a larger number of trees than a large number of seeds from fewer trees.

5. Seed storage behaviour, extraction and handling

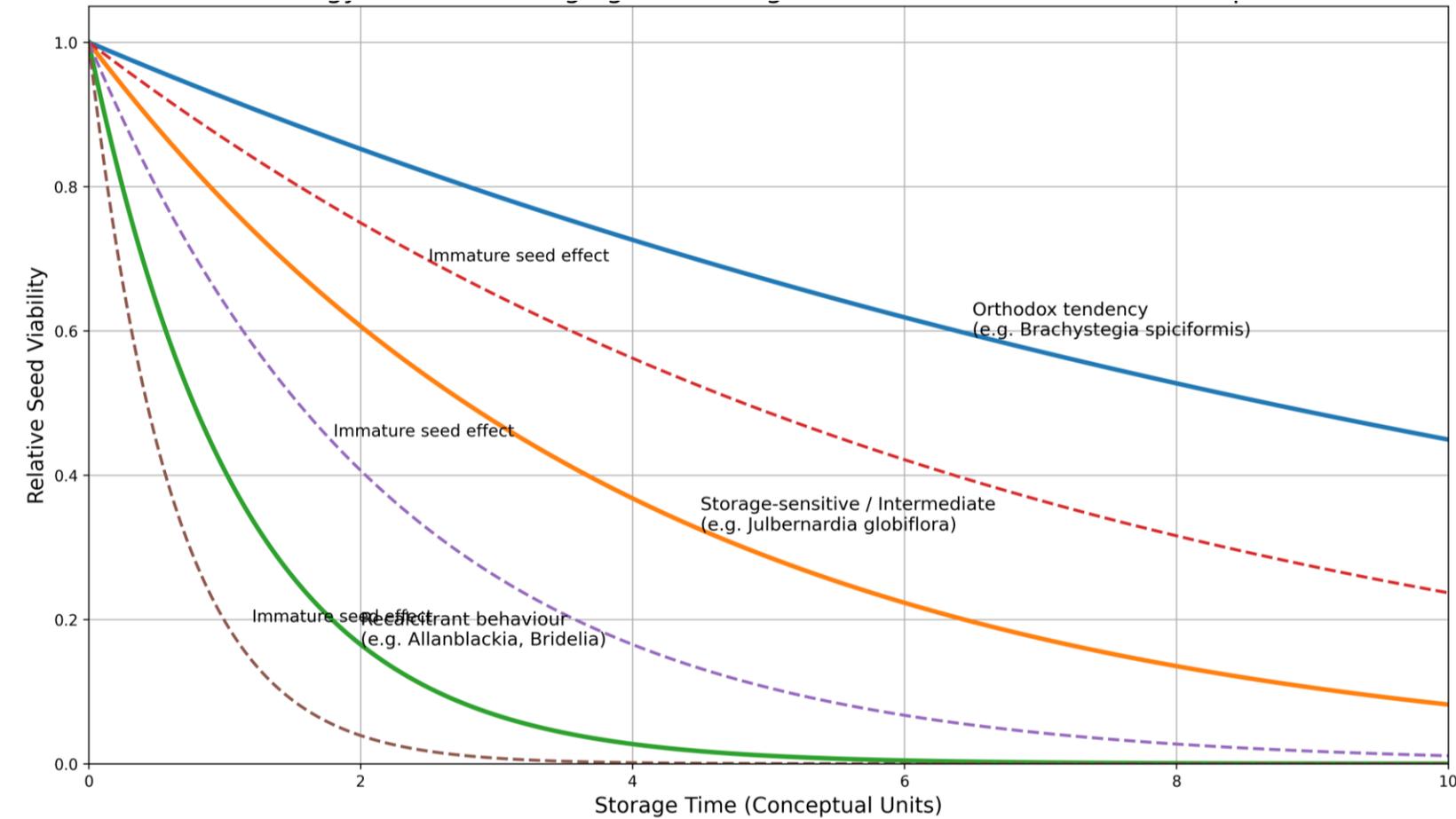


- Seed/fruit biology dictates handling strategies

Defining seed storage behaviour (Roberts, 1973)

- Orthodox / desiccation-tolerant:** water can be removed safely e.g. *Swartzia madascariensis*. (roughly 90 seeds collected in Tanzania are orthodox, can survive drying to 3-7%MC.)
- Intermediate:** some water can be removed (Ellis *et al*, 1990) *Khaya anthotheca*. can tolerate some drying (typically 8–12% MC) but sensitive to freezing temperatures (often -20°C).
- Recalcitrant / desiccation-sensitive:** water removal is lethal e.g. *Uapaca kirkiana* (approximately 5% of tree seeds in main collections)

5. Seed storage behaviour, extraction and handling cont..



These curves illustrate how seed longevity is fundamentally controlled by storage behaviour.

- Orthodox seeds age slowly, storage-sensitive seeds deteriorate faster, and recalcitrant seeds decline rapidly.
- Critically, seeds collected at immature phenological stages shift downward and behave physiologically like short-lived seeds.
- **Thus, phenology directly governs storage success and germination outcomes.**

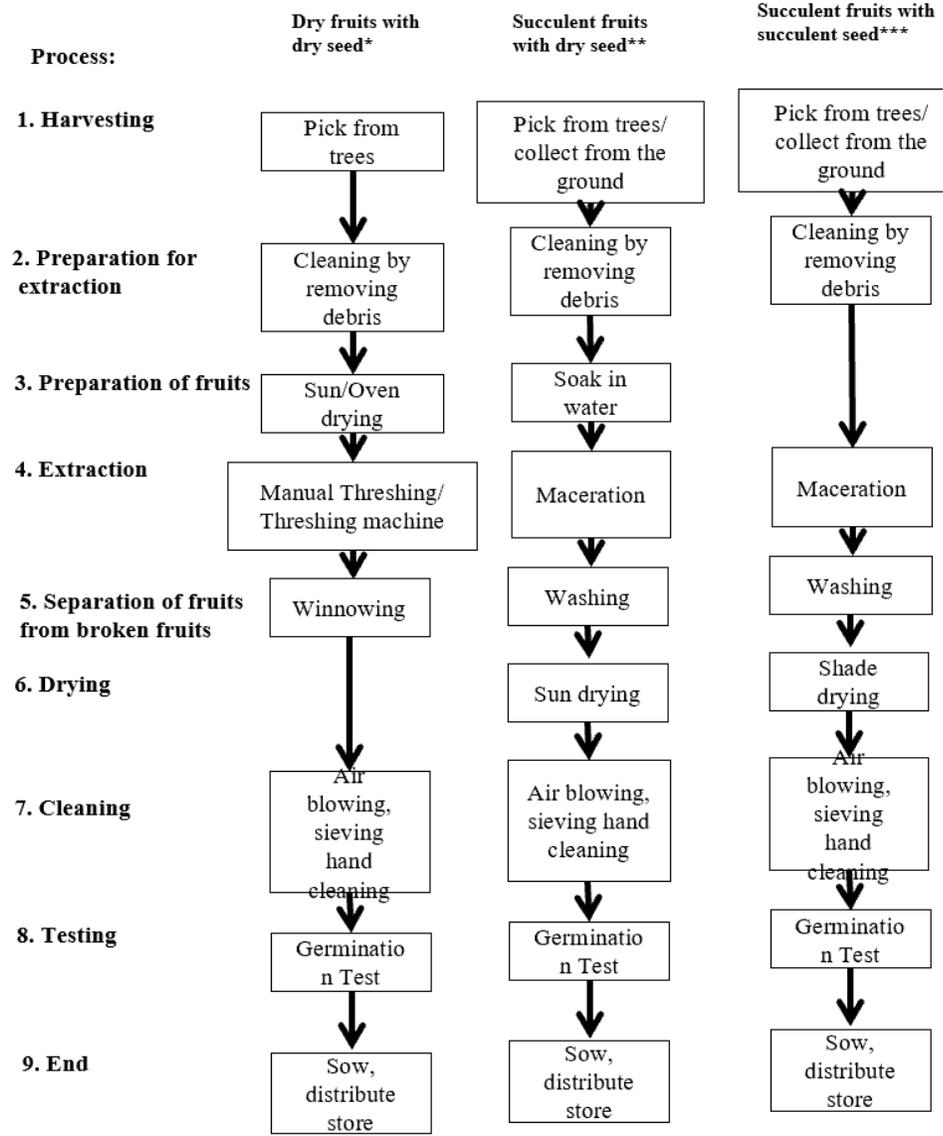
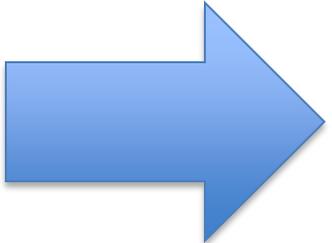
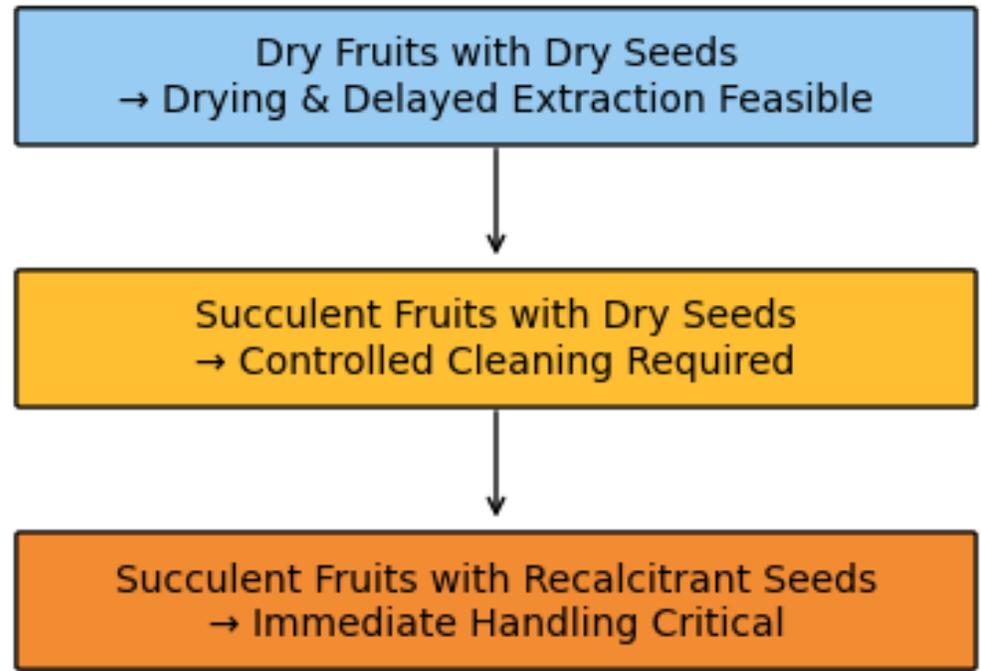
5. Seed **storage behaviour**, extraction and handling cont..

- Orthodox seeds → tolerate drying, long-term storage possible
- Intermediate seeds → moderate moisture constraints
- Recalcitrant seeds → desiccation intolerant, short-lived
- Storage strategy must align with physiology
- How do we know if seeds are orthodox, recalcitrant, or intermediate?
 - i. Taxonomy
 - ii. Literature
 - iii. Laboratory experiments
 - iv. Predicting from seed traits
 - Biochemical traits
 - Ecology
 - Physical attributes

<https://www.kew.org/science/training-and-education/continuing-professional-development/seed-conservation-techniques>

5. Seed storage behaviour, **extraction** and handling

- No universal protocol across all species
- Generally, some recognised standard extraction workflow are shown



Seed extraction standard workflow

5. Seed storage behaviour, extraction and **handling**

CATEGORY 1 – Dry fruits (Orthodox) with dry seeds (Example: *Acacia senegal*)

- **Ripeness indicators**
 - i. **Pods:** Typically transition green → yellow → brown as they mature
 - ii. **Dehiscence:** Fully ripe pods become dry and split open naturally
 - iii. **Seeds:** Colour change whitish/light → brown, indicating physiological maturity
- **Collection:** Harvest at green–yellow stage; avoid brown pods; morning preferred
- **Transport:** Ventilated gunny bags; prevent overheating
- **Drying & Extraction:** Shade-dry then sun exposure; threshing effective
- **Cleaning:** Air-screen cleaner; approx 15 kg pods → 1 kg clean seed; high purity
- **Storage:** Orthodox seeds; 4–7% moisture; longevity up to 3 years in ambient storage or more in dry rooms.
- **Germination:** No strong dormancy; soaking improves speed; high viability
- **Nursery:** Seedbed sowing preferred; manage fungal risks

5. Seed storage behaviour, extraction and **handling**

CATEGORY 2 – Succulent Fruits (Intermediate) with Dry Seeds *Milicia excelsa*

- **Ripeness:** Fruits remain green; maturity indicated by shedding
- **Collection:** Ground collection only; collect daily; predation risk high
- **Transport:** Small ventilated lots; allow juice drainage
- **Extraction:** No drying; soaking or controlled fermentation aids pulp removal
- **Cleaning:** Winnowing effective; gentle shade drying (approx. 8% moisture)
- **Storage:** Storage-sensitive; short-lived; avoid warm storage
- **Germination:** Slow and sporadic; optimisation often required
- **Nursery:** Low-density sowing reduces damping-off spread

5. Seed storage behaviour, extraction and **handling**

CATEGORY 3 – Succulent Fruits (Recalcitrant) with Succulent Seeds

Bridelia micrantha

- **Ripeness:** Fruits purple–black when ripe; green fruits immature
- **Collection:** Tree or ground collection; avoid green fallen fruits
- **Transport:** Same-day handling; maintain ventilation
- **Extraction:** No drying; manual squashing & washing
- **Yield & Cleaning:** Approx 10 kg fruits → 1 kg seed; brief shade drying only
- **Storage:** Recalcitrant seeds; very short-lived; sow rapidly
- **Germination:** No pretreatment; very high when fresh
- **Nursery:** Direct sowing into pots recommended

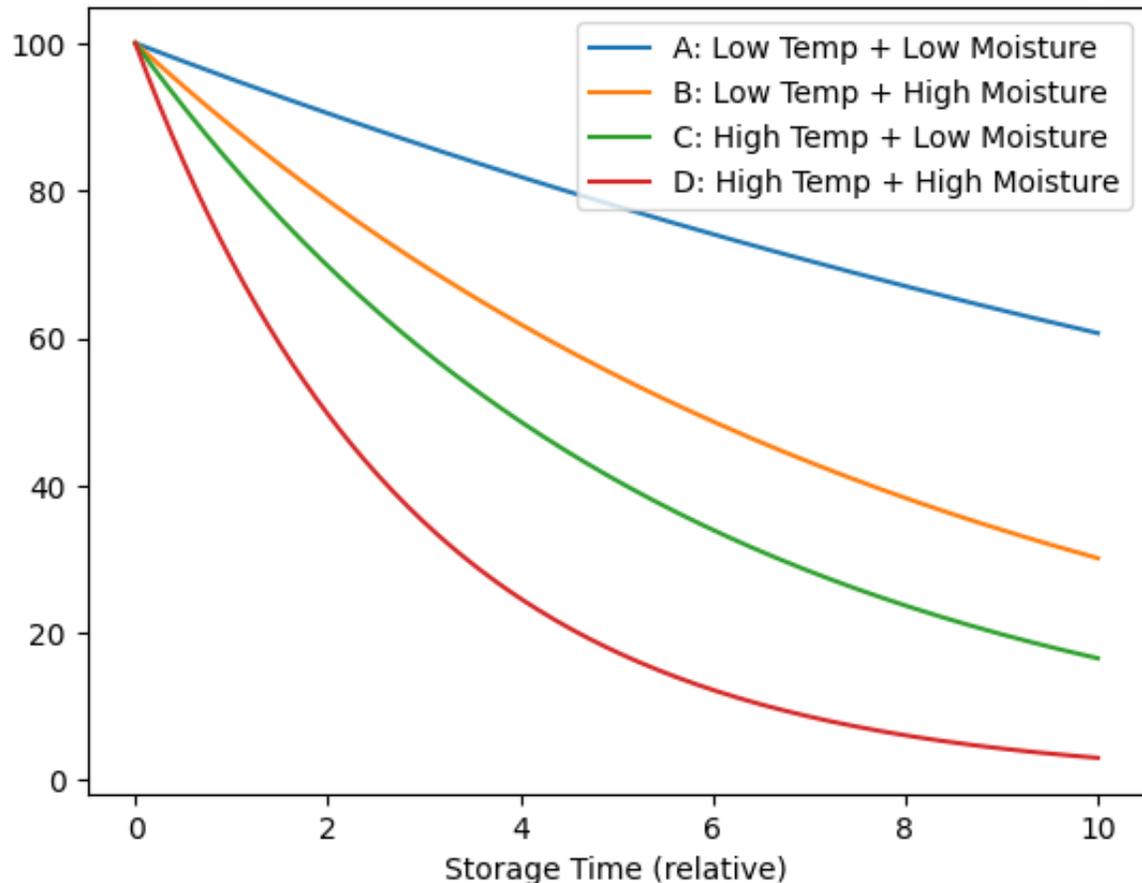
6. Seed aging, viability, and nursery implications

- In storage methods & longevity control moisture content regulation is fundamental
- Seed aging & viability decline
 - i. Temperature and moisture accelerate deterioration
 - ii. Immature seeds behave like short-lived seeds
 - iii. Longevity differences governed by storage class
 - iv. Testing essential for quality assurance
- Low temperature slows aging processes
- Hermetic packaging stabilizes seed environment
- Monitoring viability prevents silent losses

6. Seed aging, viability, and nursery implications

(Seed Aging & Viability Decline)

Conceptual Effects of Temperature & Moisture on Seed Longevity



- **Blue (A)** → Low temperature + Low moisture (slowest aging, longest longevity)
- **Orange (B)** → Low temperature + High moisture
- **Green (C)** → High temperature + Low moisture
- **Red (D)** → High temperature + High moisture (fastest deterioration)
- This visualizes the core seed storage principle that,
- **Viability declines fastest when BOTH moisture and temperature are high. Dry + cold conditions preserve seeds the longest.**

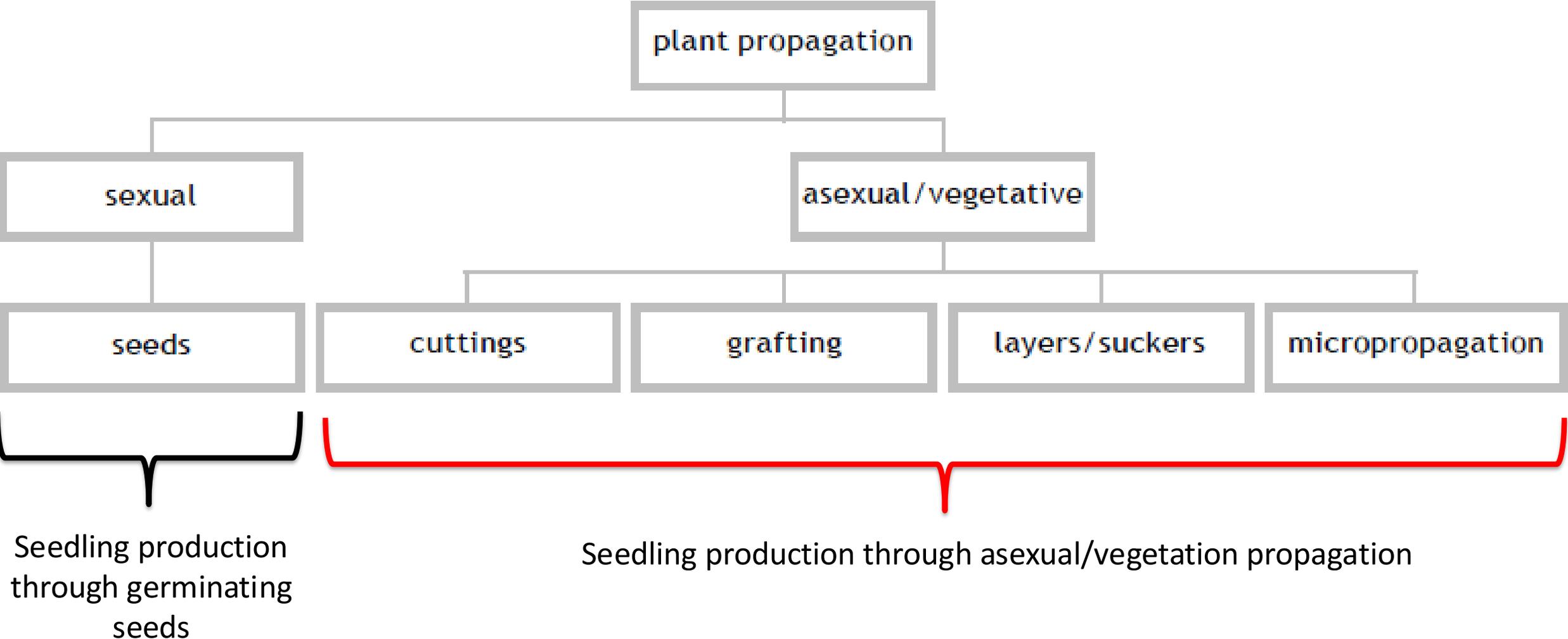
6. Seed aging, viability, and nursery implications

(Seed Aging & Viability Decline) cont...

- Longevity differences also governed by storage class

Storage Class	Longevity in Dry, Cold Conditions	Typical Behaviour
Orthodox	High	Long storage life when dry/cold
Recalcitrant	Very Low	Cannot dry well; short life
Intermediate	Medium	Moderate desiccation tolerance

7. Best practices for successful native tree propagation



7. Best practices for successful native tree propagation

cont...

- Although propagation in a nursery can come from different propagules (clonal methods), seeds still dominate and are recommended.

Justifications

- Seeds maintain genetic diversity → critical for adaptation, resilience, and long-term ecosystem stability
- Enable natural selection under local environmental pressures
- Often produced in large quantities, allowing landscape-scale restoration
- Generally easier and cheaper to collect, handle, store, and transport (except recalcitrant seeds)
- Support both direct seeding and nursery-based production systems
- Lower technological requirements compared to clonal methods
- Facilitate restoration of complex, self-sustaining populations rather than uniform stands
- Well-suited for community-based restoration and large programs

7. Best practices for successful native tree propagation cont...

- **How can seedlings be raised and obtained?**

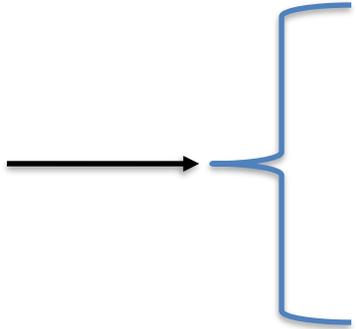
- In an open bed from which seedling plants are lifted and planted with roots bare of soil
- In containerised, either singly or in multi-cavity trays, seedlings planted with a ball or plug of soil around the roots
- Transplanting natural regeneration seedlings often found under mature trees into containers



7. Best practices for successful native tree propagation cont...

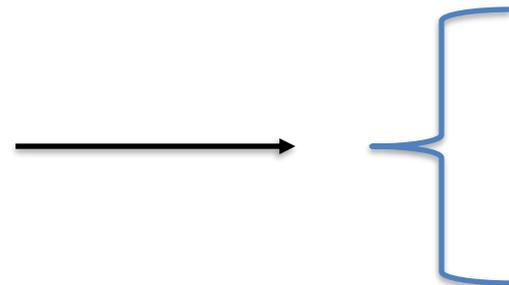
- For some species need to overcome Dormancy

- **Definition:** Failure of viable seeds to germinate under 'favourable' conditions



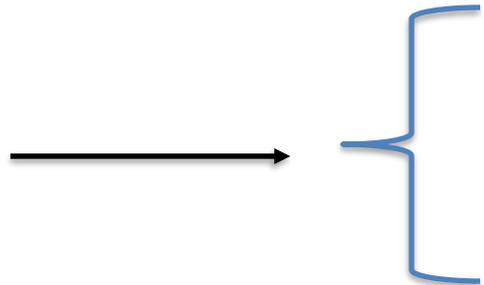
- Water
- Oxygen
- Substrate
- Optimum temperature/light/smoke???!!!

- Endogenous (embryo related)



- Physiological
- Morphological
- Morphophysiological

- Exogenous (seed/fruit coat related)



- Physical
- Chemical
- Combinational

Overcoming dormancy

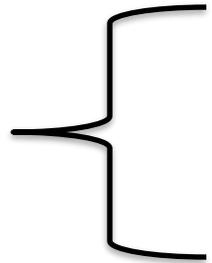
Dormancy factor

- Cold stratification
- Warm stratification
- Dry after-ripening

Environmental cue

- Light
- Alternating temperatures
- Smoke-Karrikinolide / butenolide

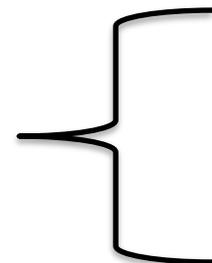
- Endogenous
(embryo related)



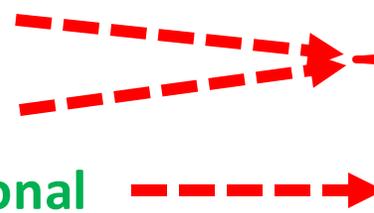
- **Physiological**
- **Morphological**
- **Morphophysiological**

- After ripening/maturity
- Hormone/protocol
- Both of the above

- Exogenous
(seed/fruit coat related)



- **Physical**
- **Chemical**
- **Combinational**



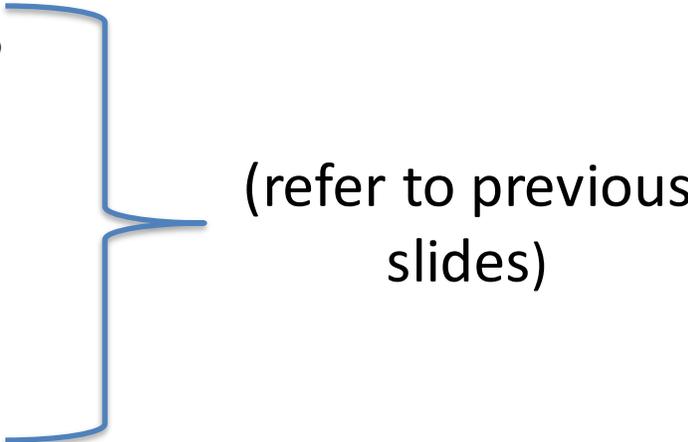
- Soaking (Hot/cold water)
- Breaking seed coats
- Combinational

7. Best practices for successful native tree propagation cont...

Nursery operation and management

- It takes up to 3-6 months tending seedlings
- All seedling beds must be labeled
- All silvicultural activities (watering, weeding, shading, prevention and control of pests and diseases, root and possibly shoot pruning) must be carried out properly and in time
- Proper record keeping & documentation (nursery calendar, daily register, plant development register, nursery production inventory record, sources of nursery supplies, equipment inventory and their statuses)
- Seedlings become uniform and healthy before planting
- Reduces cost

7. Best practices for successful native tree propagation cont...

- Propagation success depends on seed decisions
 - Correct maturity at harvest
 - Appropriate handling and extraction
 - Physiology-aligned storage management
 - Species-specific germination protocols including seed dormancy breaking
 - Use of proper mother tree or handling well the ex-plant and protocols (In macropropagation and micropropagation) respectively
- 
- (refer to previous slides)

7. Best practices for successful native tree propagation cont..

Vegetative propagation options

When

- Where seeds are limited, unreliable, or biologically constrained
- Useful for rapid multiplication of elite, rare, threatened, or slow-reproducing genotypes
- Applicable for species with poor seed viability, dormancy challenges, or irregular fruiting

How (Methods)

- Stem cuttings (softwood, semi-hardwood, hardwood, truncheons)
 - Root suckers / root cuttings (species-dependent responses)
 - Budding & grafting (orchard species; selected forest taxa)
 - Layering, air-layering (marcotting), coppicing systems
- Rooting success influenced by juvenility, season, substrates, humidity, and auxins (IBA/NAA)
 - Clonal material requires careful management to avoid genetic uniformity risks
 - Particularly valuable for conservation, seed orchards, and breeding programs
- Tissue culture (in-vitro propagation). used to grow, multiply, and regenerate entire plants from tiny, isolated plant parts (explants) in a sterile, nutrient-rich, and controlled environment.



Cutting



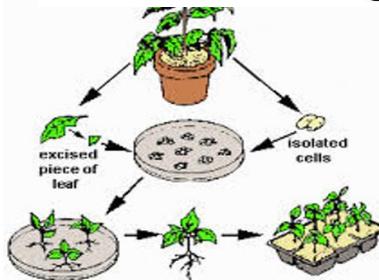
Layering



Budding



Grafting



Cloning (Tissue culture)

8. Closing: What the project enables

- Evidence-based prioritization of useful threatened native tree species
- Transparent criteria → practical and defensible species selection (Top 100)
- Reduced propagation barriers via protocols for priority species
- Strengthened seed-to-nursery-to-field pipeline
- Improved restoration reliability, scalability, and survival outcomes
- Support for agroforestry, enrichment planting, and conservation planting
- Enhanced institutional and technical capacity
- Promotes collaboration across nurseries, researchers, communities, and practitioners
- Aligns conservation objectives with livelihood and landscape restoration goals

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