

How studies of seed traits can inform restoration practice



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Seed ecology and seed trait studies to inform restoration

Biotic Factors

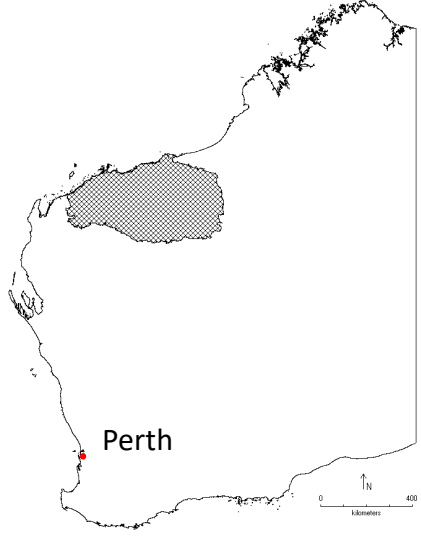
- Dormancy (type, extent, break)
- Germination (temperature, water potential, speed)
- Emergence depth
- Mass
- Persistence

Abiotic Factors

- Soil temperatures (seasonal and diurnal).
- Rainfall and soil moisture.
- Substrate properties.



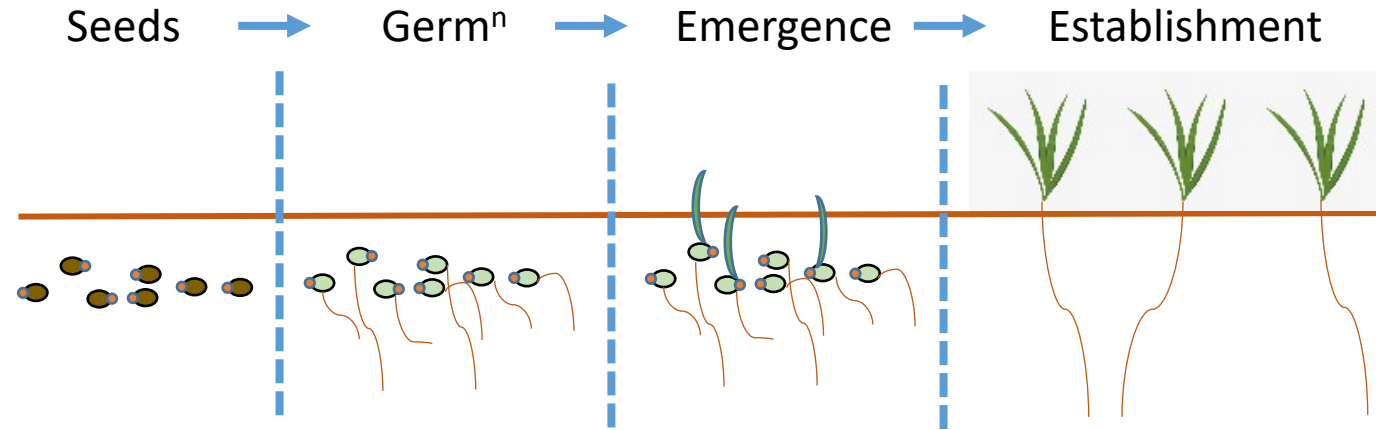
Define the establishment niche and seek to modify that niche to enhance seed regeneration







Demographic Filtering



Study	Probability			Cumulative chance seed establishment
	Germ ⁿ	Emergence	Establishment	
James <i>et al.</i> (2011) <i>J. App. Ecol.</i> <ul style="list-style-type: none"> • 3 grasses • 4 field sites in arid grasslands 	50 - 80%	1 - 5%	20 - 70%	<6%
Larson <i>et al.</i> (2015) <i>J. App. Ecol.</i> <ul style="list-style-type: none"> • 47 arid grasses • 2 watering treatments 	15 - 100%	10 - 80%	60 - 100%	0 - 40%

We set out to:

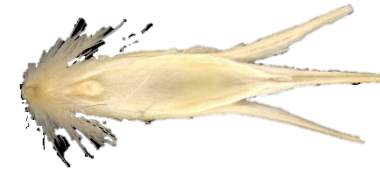
- understand how substrate type and water availability influence seedling recruitment.

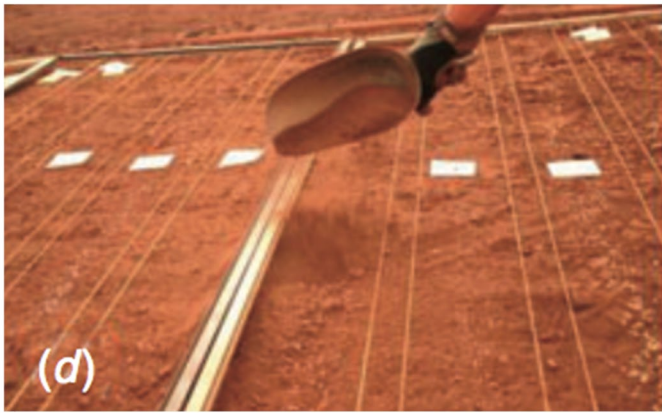
Our aim was to:

- model the probability of seed germination, seedling emergence, and early seedling survival.
- define the early life stage transition(s) constraining seedling recruitment under varying abiotic environmental scenarios.

We selected:

- five species key to successful restoration and representing different plant life-form and seed traits.





Seed

Species

- Acacia inaequilatera*¹
- Acacia hilliana*¹
- Indigofera monophylla*¹
- Triodia wiseana*²
- Triodia pungens*²

Pre-treatments

HW¹ or Removal from florets²

Water

Amount and frequency

280 mm (7 x 40 mm; daily)*
*Non-limiting

160 mm (4 x 40 mm; every 2nd day)

120 mm (4 x 30 mm; every 2nd day)

80 mm (4 x 20 mm; every 2nd day)

Soil

Soil type

- Topsoil (TS)
- MWB Waste
- ER Waste
- TS / MWB blend (50:50)
- TS / ER blend (50:50)

Seed placement

Sown at 3-5mm depth

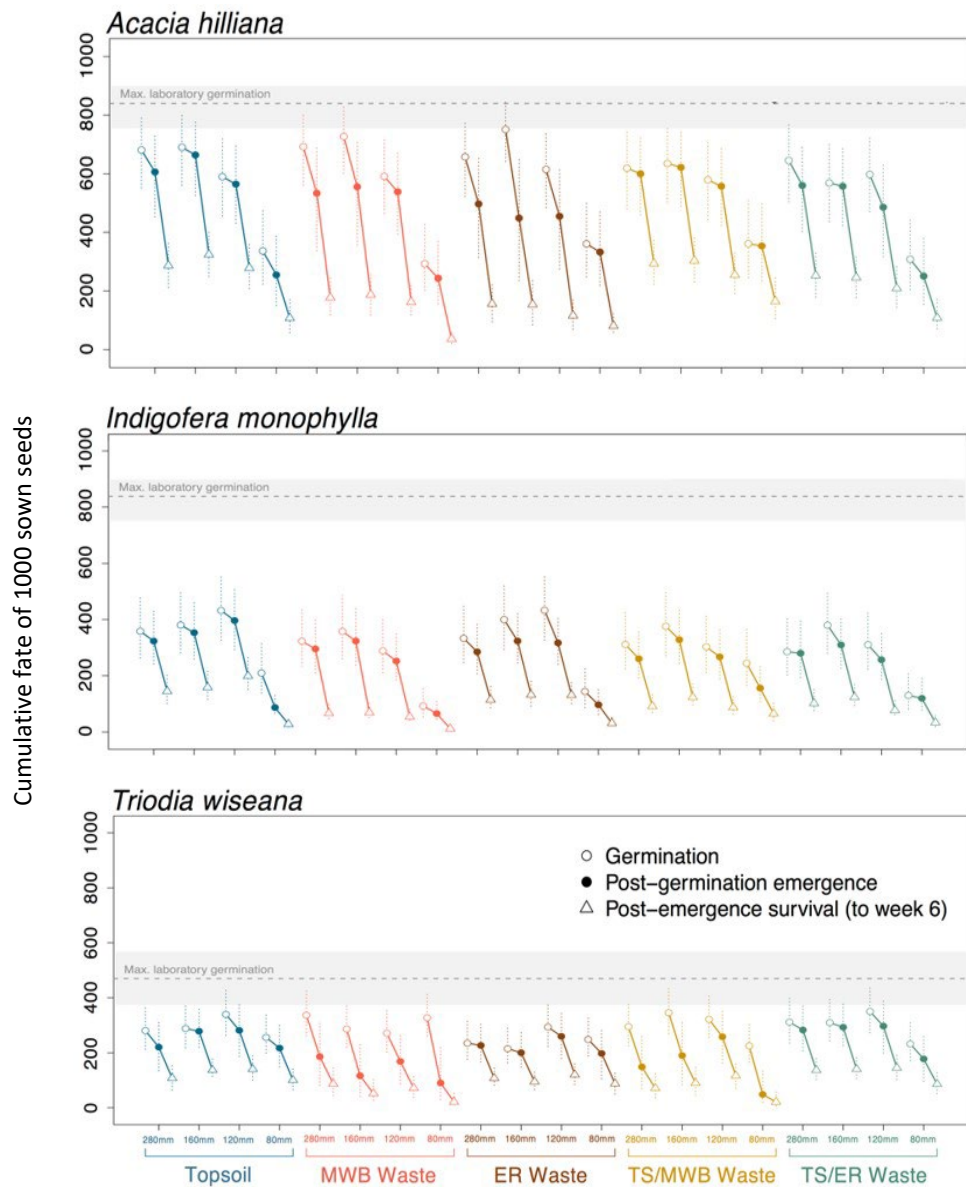
Germination

Emergence

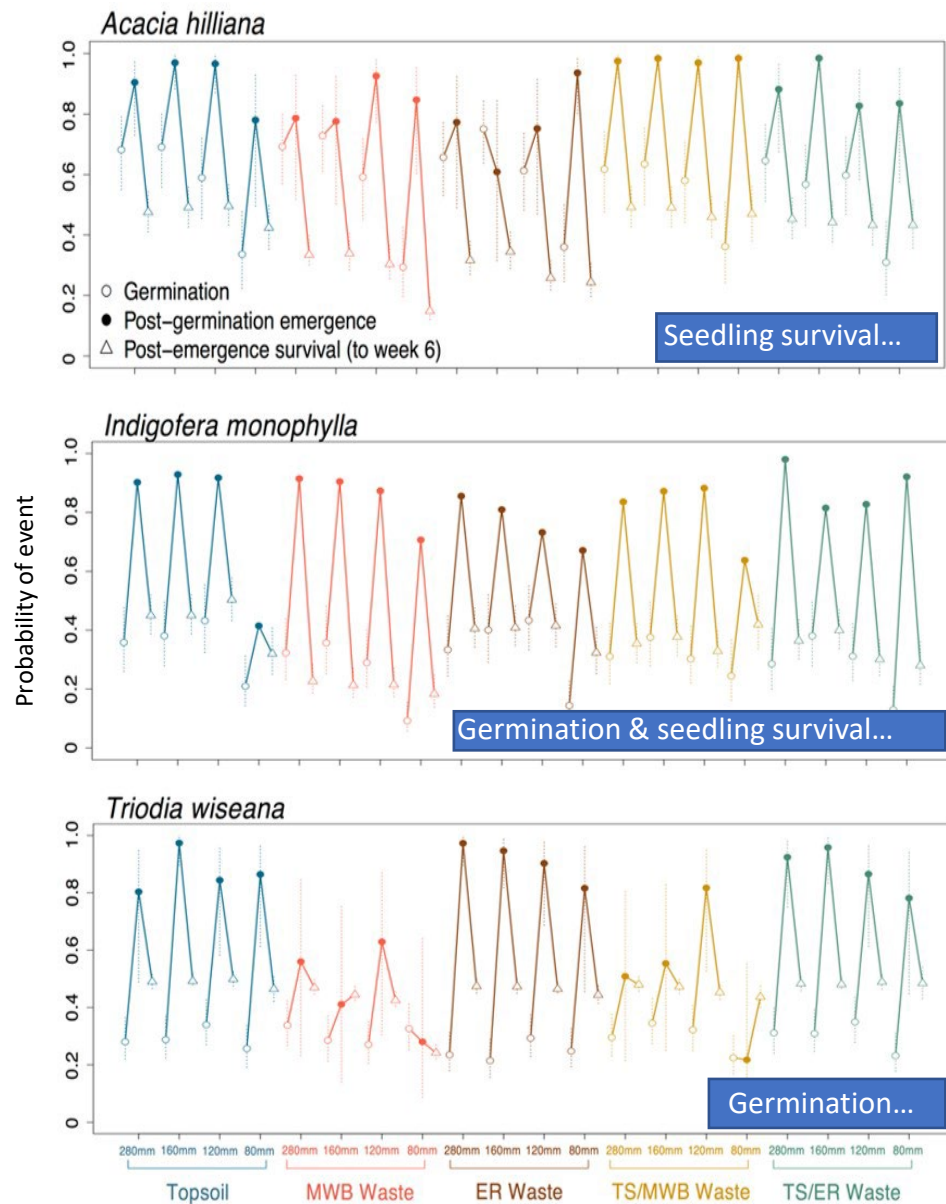
Early survival

Seedling biomass

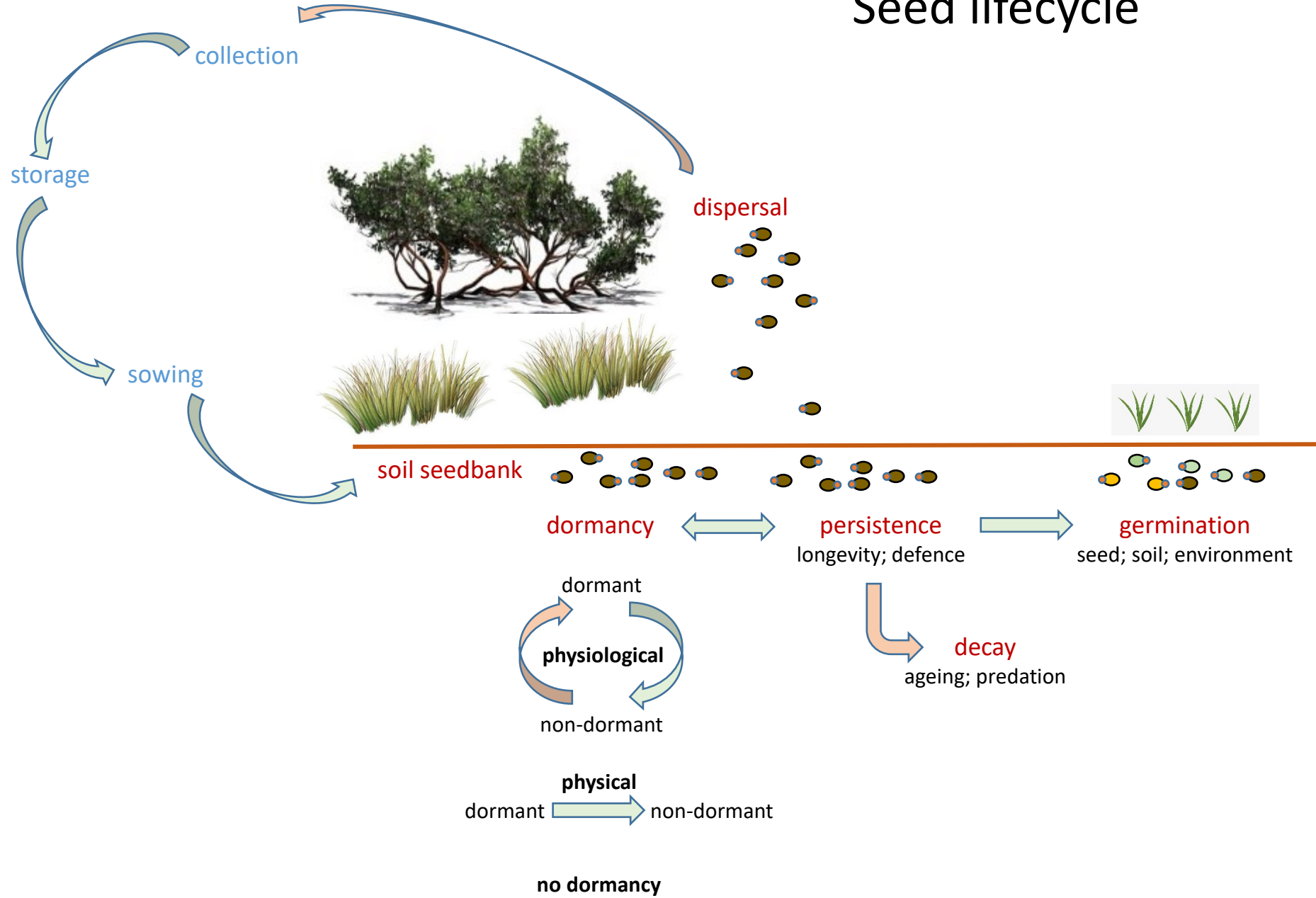
What happened?



Which life stage is most limiting?



Seed lifecycle



Seed dormancy pre-treatments

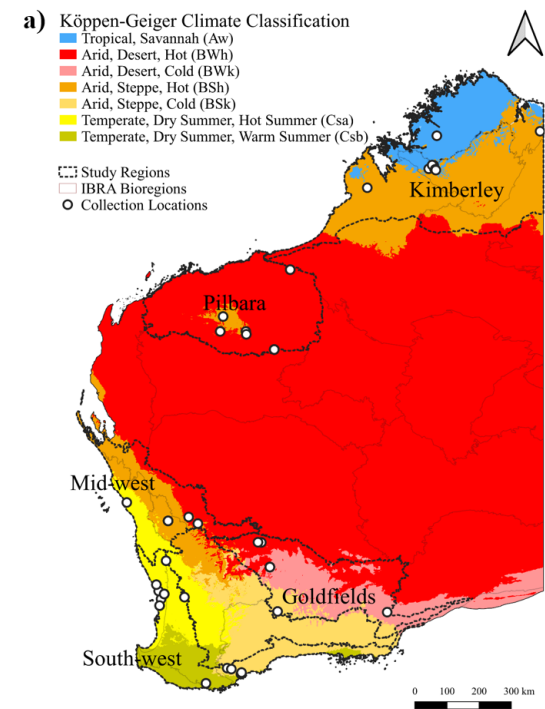
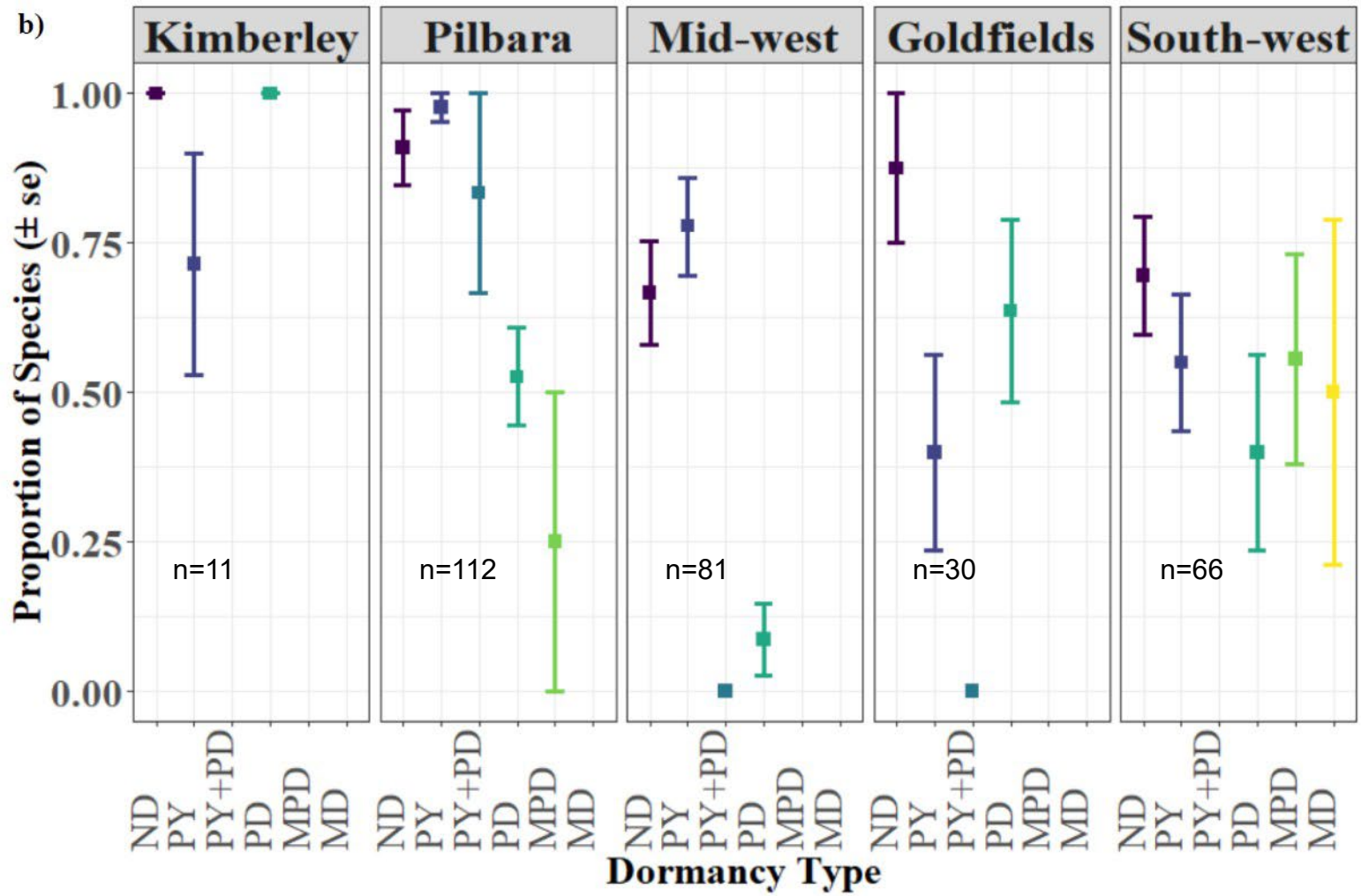
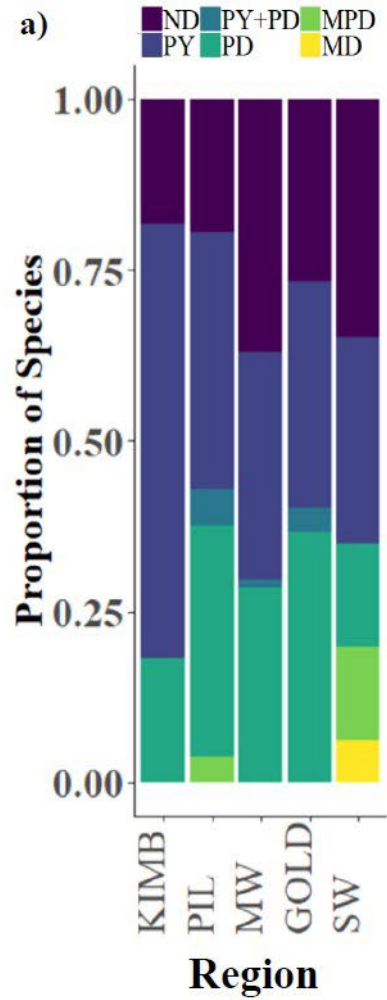
- Reliable and repeatable.
- Applicable to large quantities of seed.

Easy for some.....

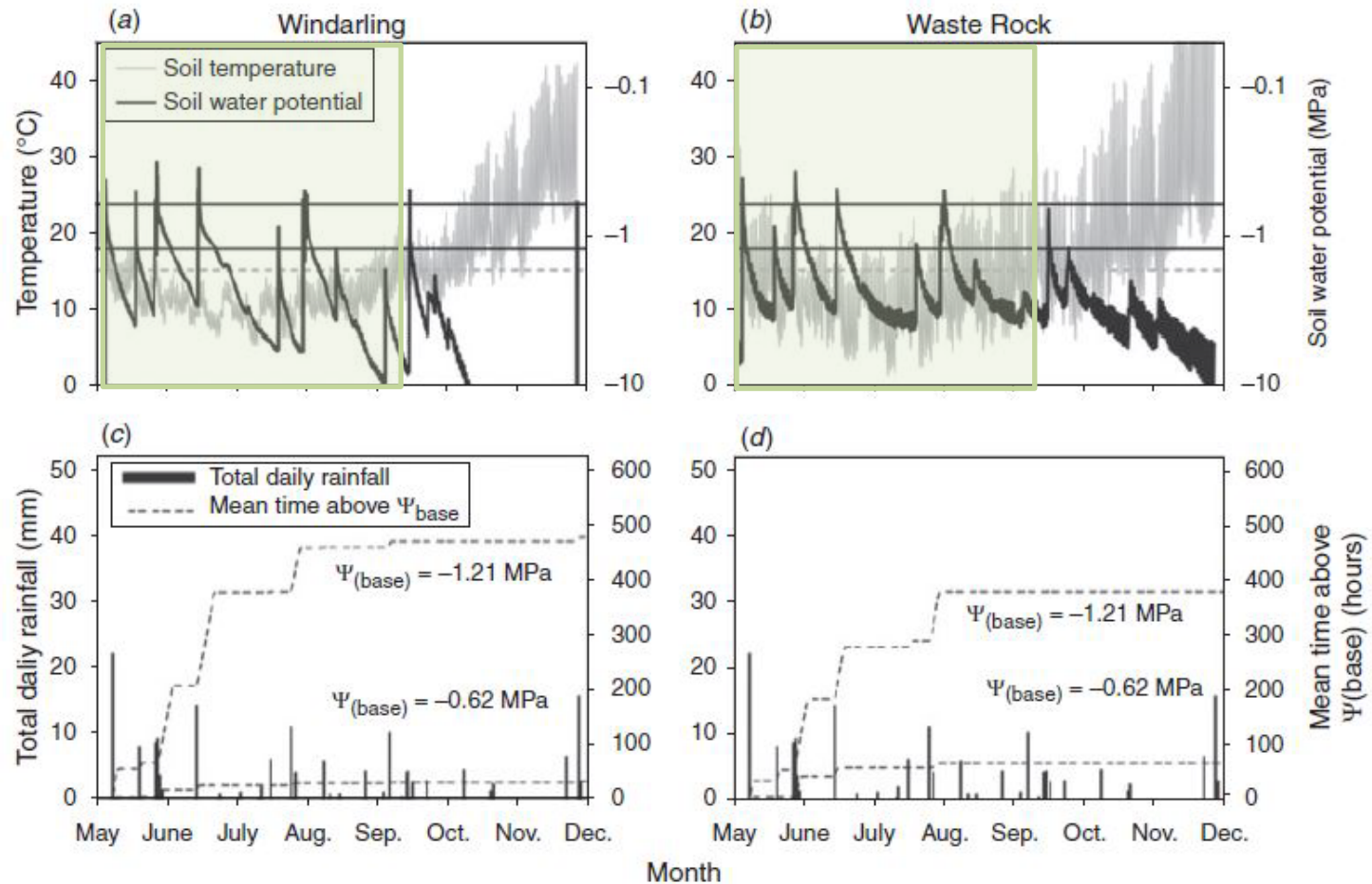


.....not so easy for others.

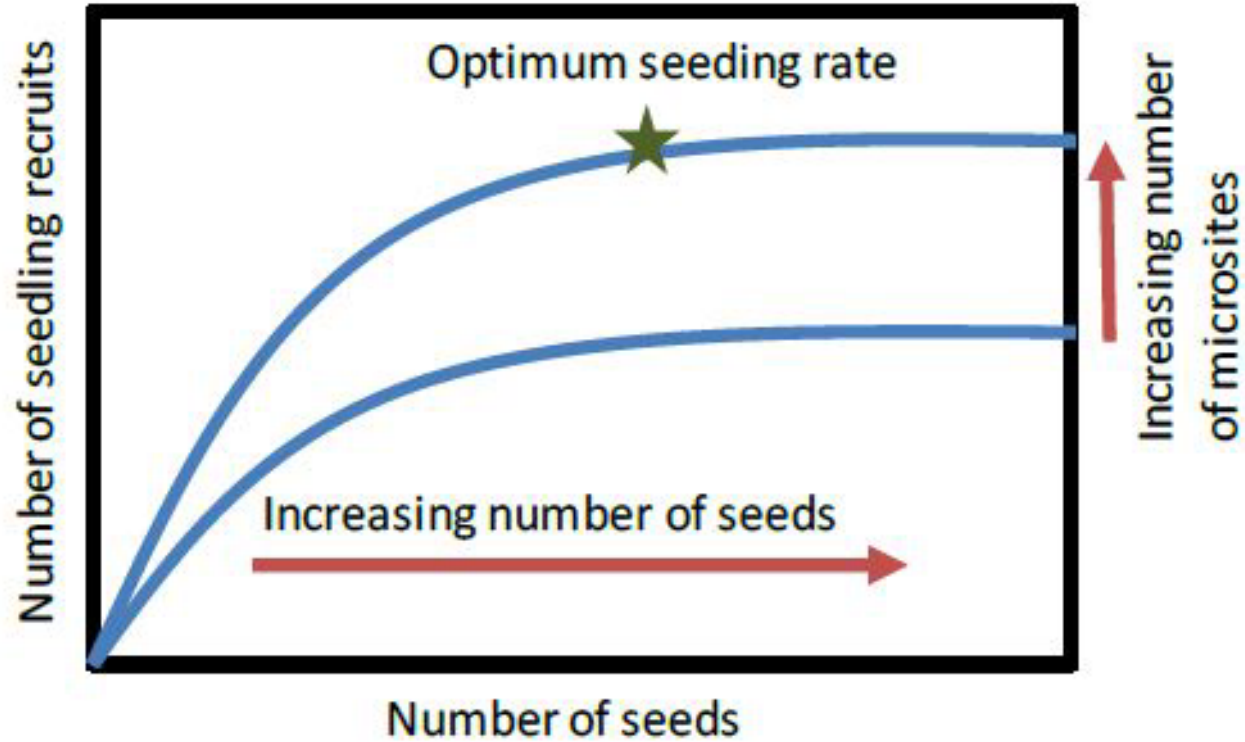




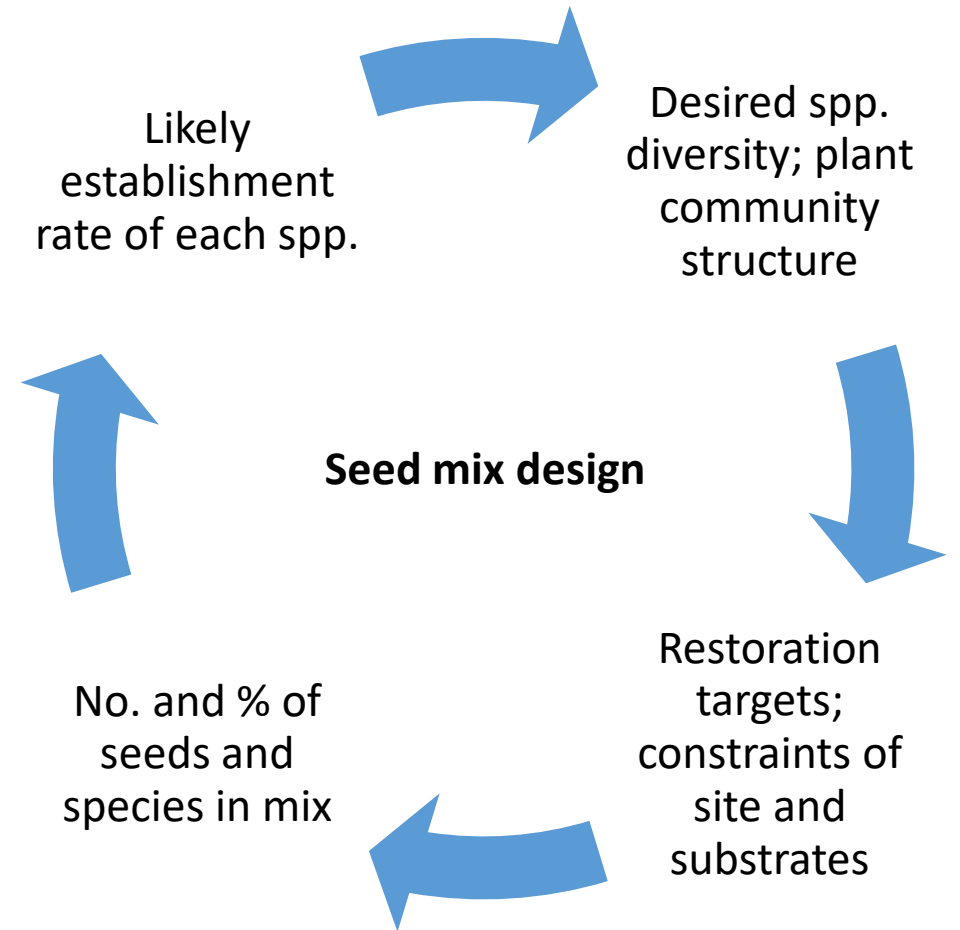
The germination niche



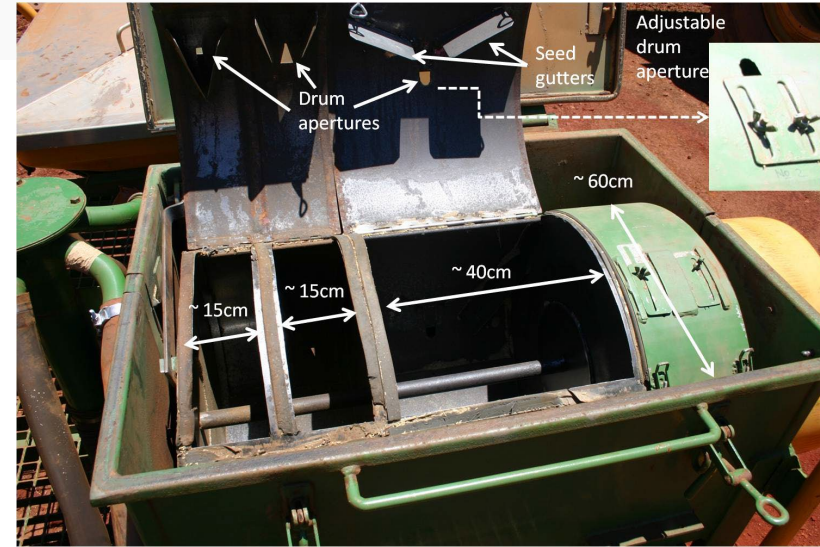
Direct seeding

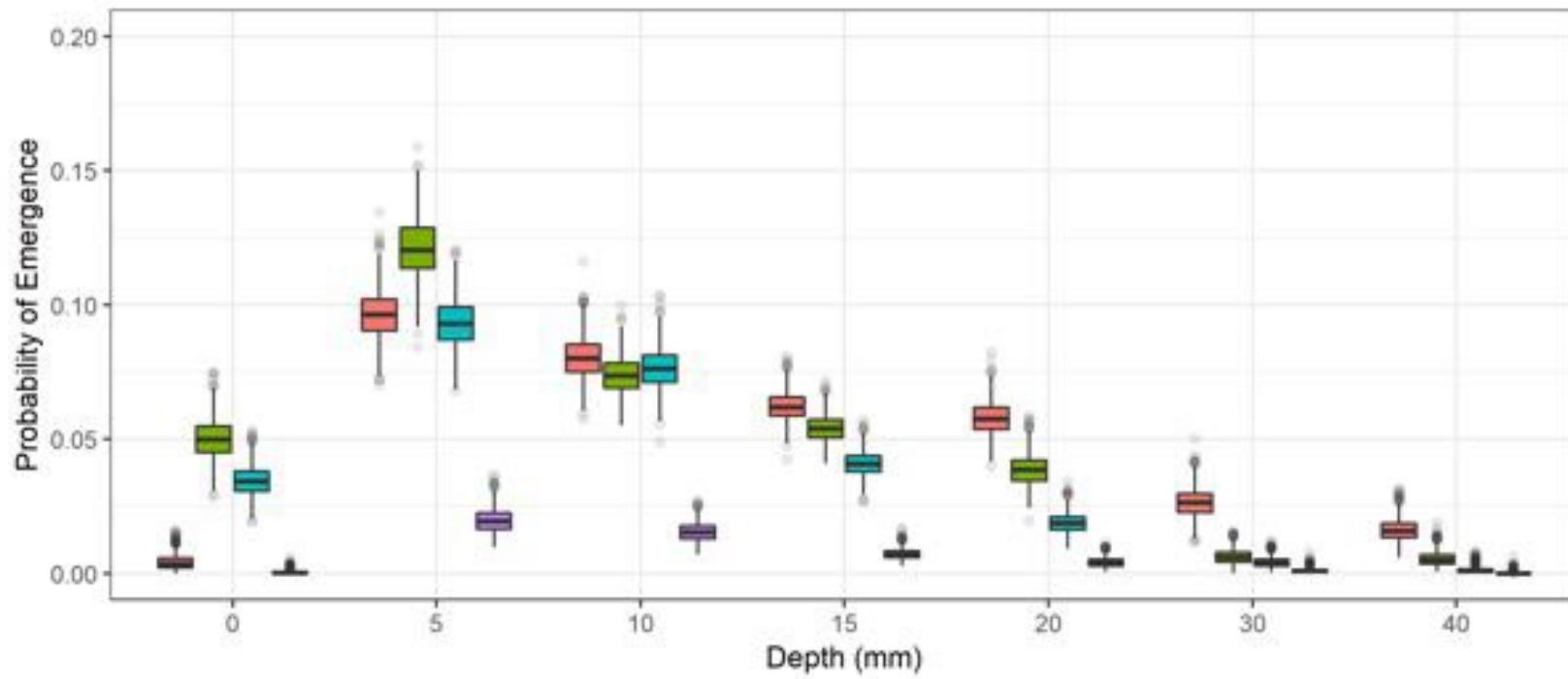


Commander, unpublished, modified from
Duncan *et al.* (2009), *Ecology* **90**: 2129-2138.



Seed traits and direct seeding



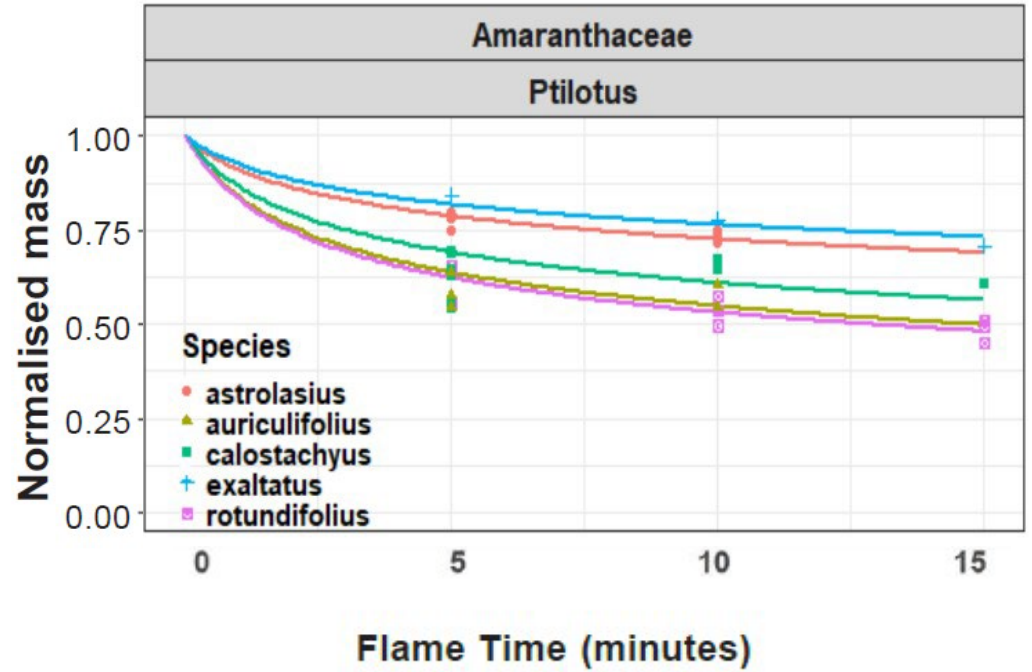
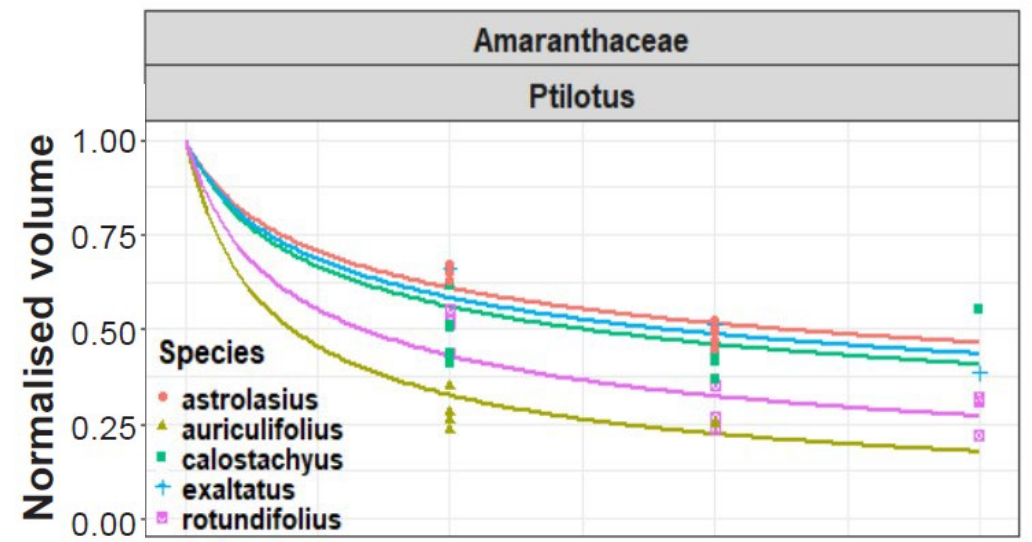
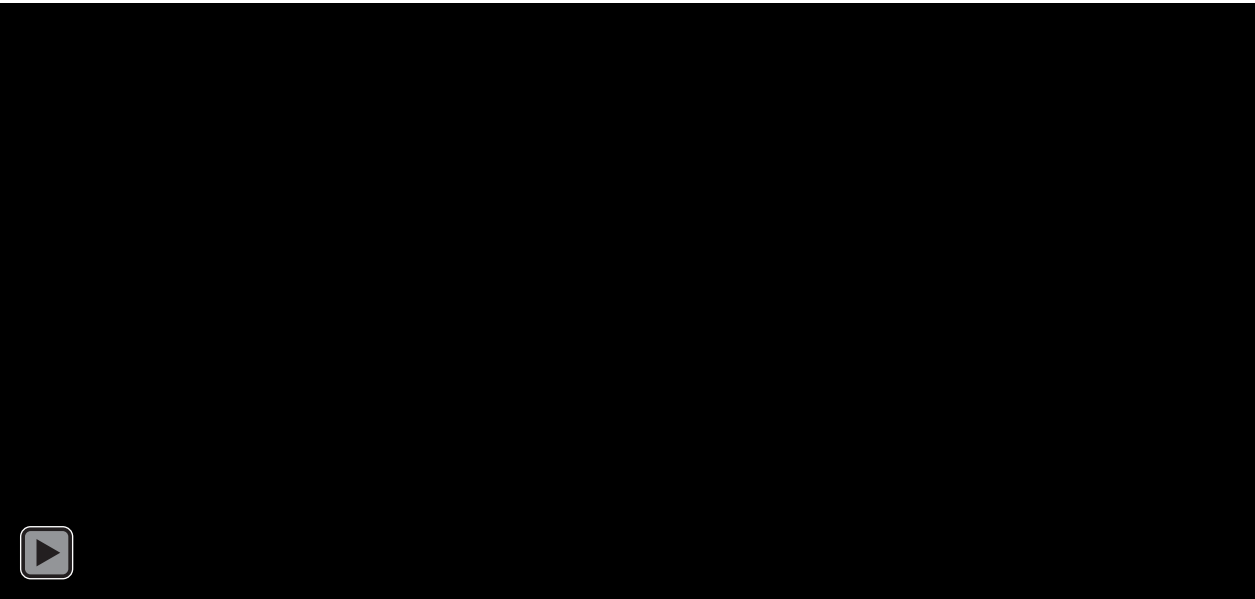


■ S-2mm
 ■ S-25mm
 ■ S-Unsieved
 ■ F-Unsieved
 Increasing rock content
 →

Masarei *et al.* (2020) *Plant and Soil* **450**: 497-509

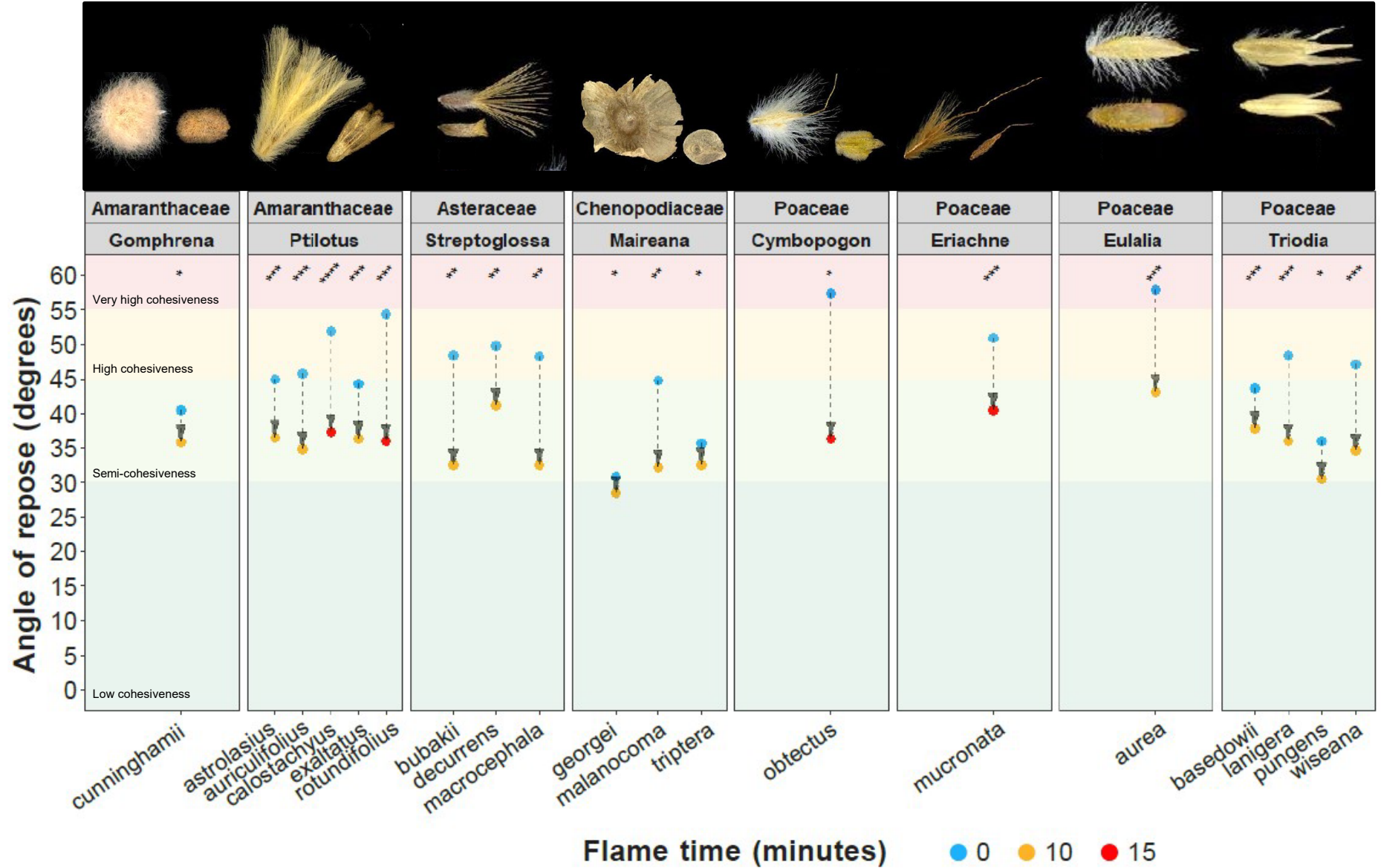
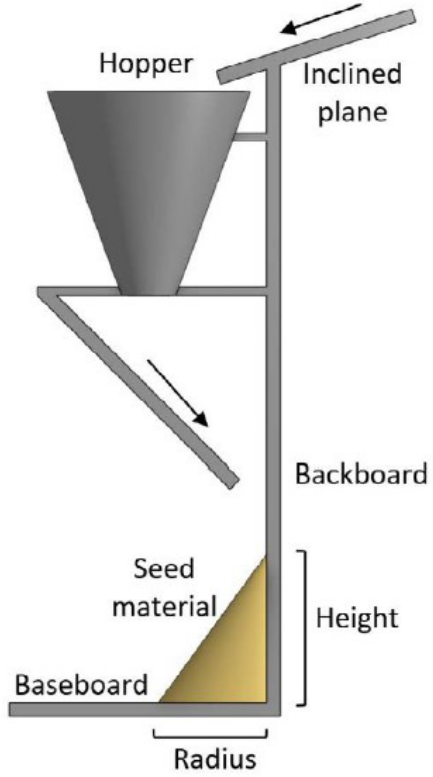


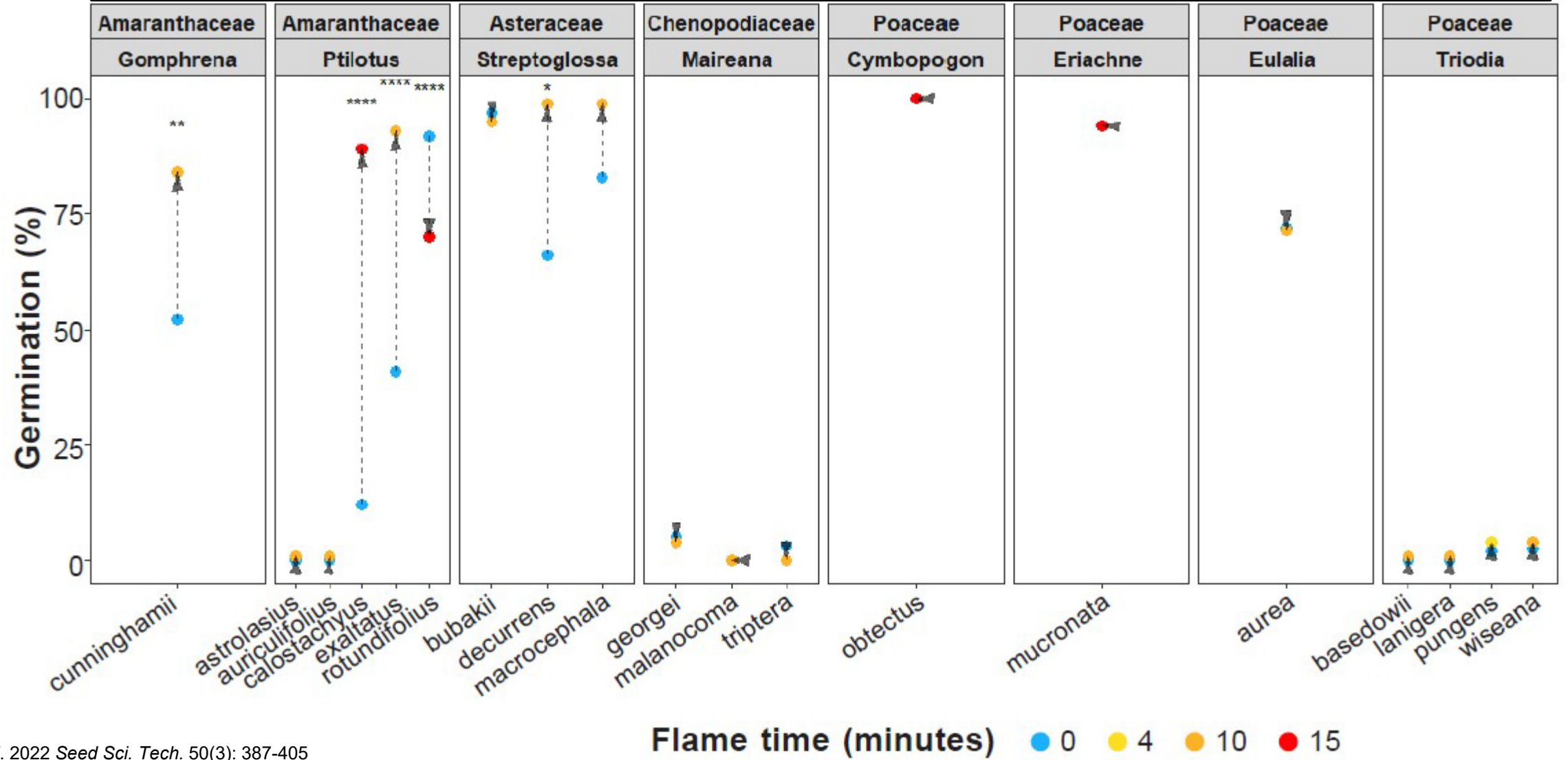
Seed flaming



Quantifying seed flowability

(A)







Seed Material	Seedlings m ⁻²
Untreated florets	5.6



Seed Material	Seedlings m ⁻²
Flamed florets	36.4
Flamed + primed florets	22.0
Cleaned seeds + coat	35.0
Cleaned seeds + prime + coat	31.8

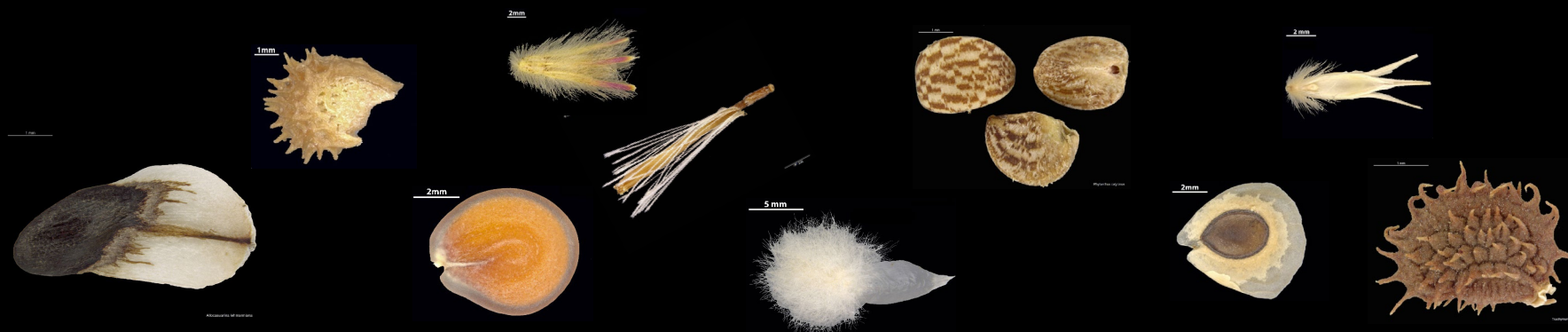
Seeds are complex biological organisms:

- Finely tuned to their surrounding environment.
- Disperse through time and space and recruit only when chances of seedling survival are greatest.
- Possess a suite of functional traits influencing their behaviour (morphological, biochemical, physiological...).
- These traits are under genetic and environmental control – expect variation.



To enhance our use of seeds we need to:

- Identify traits limiting their utility for our rehabilitation purposes.
- Modify, augment, enhance those traits to achieve our goal of biodiverse, restored landscapes.



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