Recent advancements in restoration-engineering and seed enhancement technologies for use in mine rehabilitation

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@TEricksonSeed

Andrew L Guzzomi, Matthew D Madsen, Mitch Thacker, Olga A. Kildisheva, Shane R. Turner, Jeremy J James, Scott R Abella, Miriam Muñoz-Rojas, David J. Merritt

KINGS PARK & Botanic Garden

GOVERNMENT OF WESTERN AUSTRALIA

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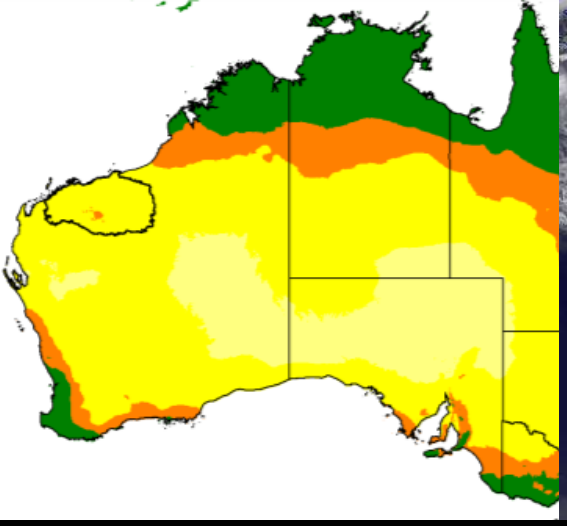
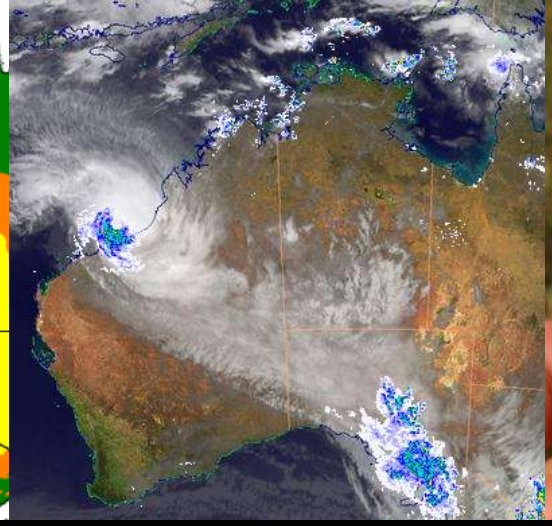
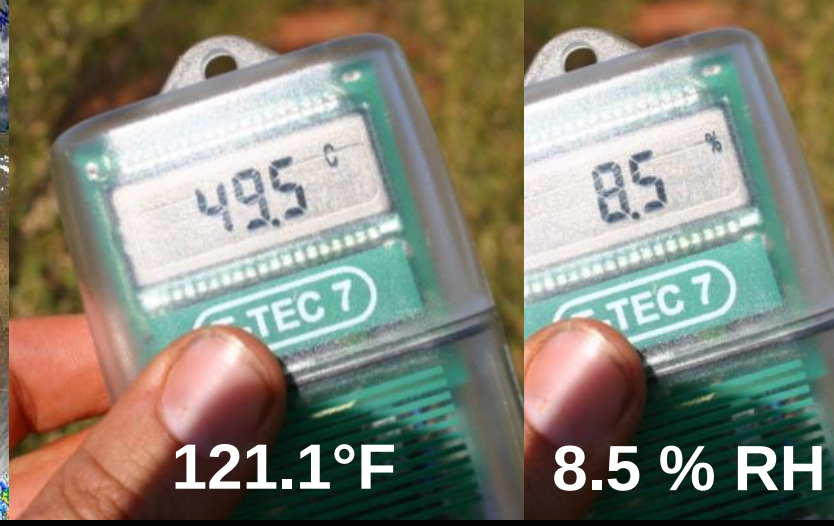
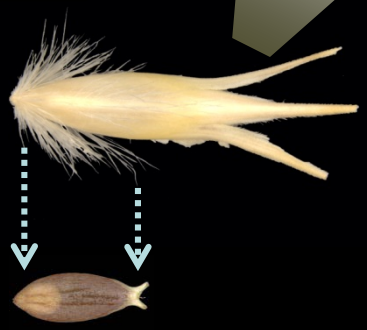






...the Pilbara bioregion.....



Erickson *et al.* (2016),
Australian Journal of Botany, Vol 64

Erickson *et al.* (2016),
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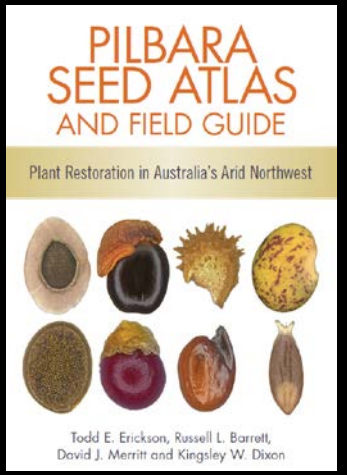
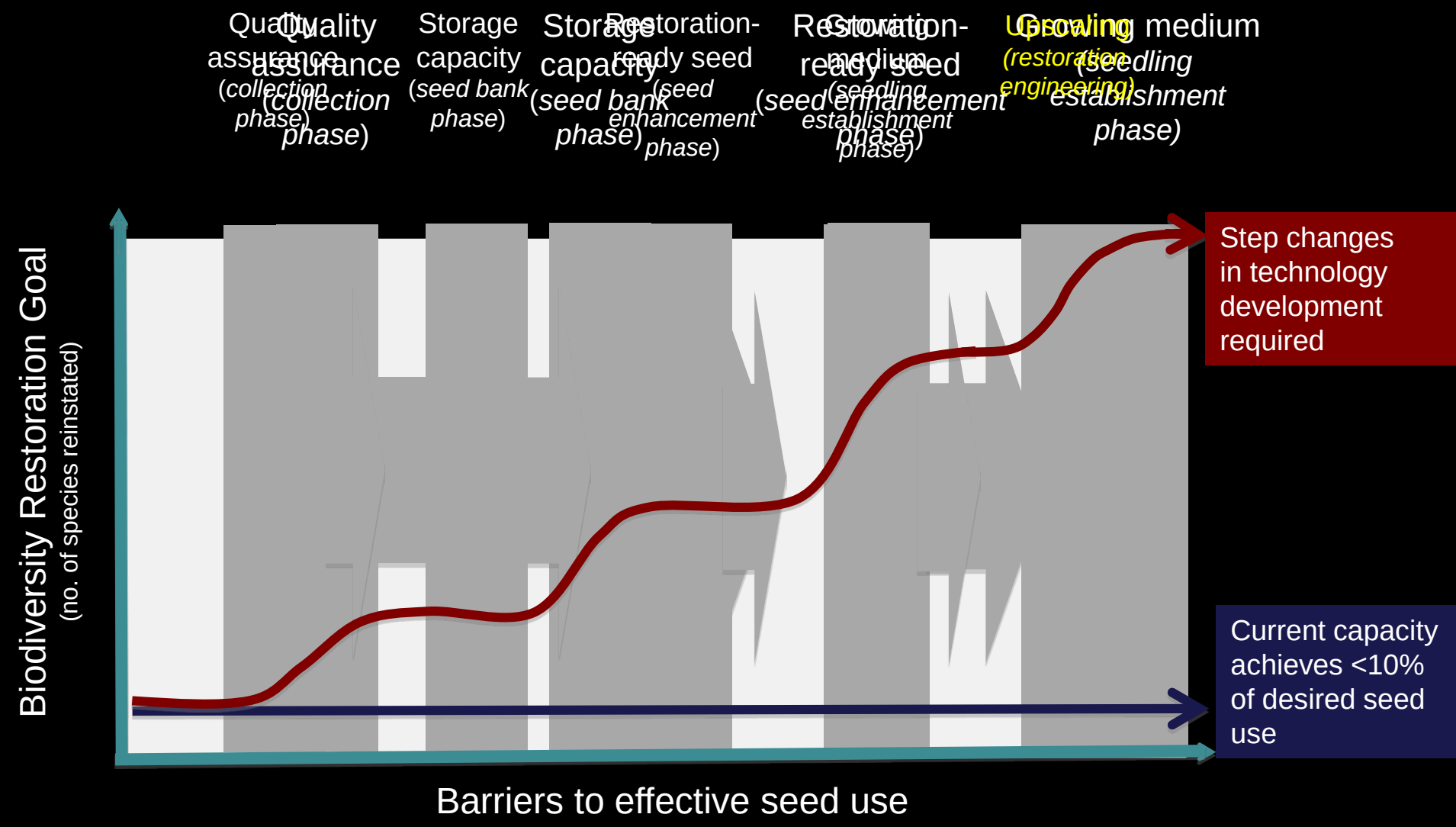


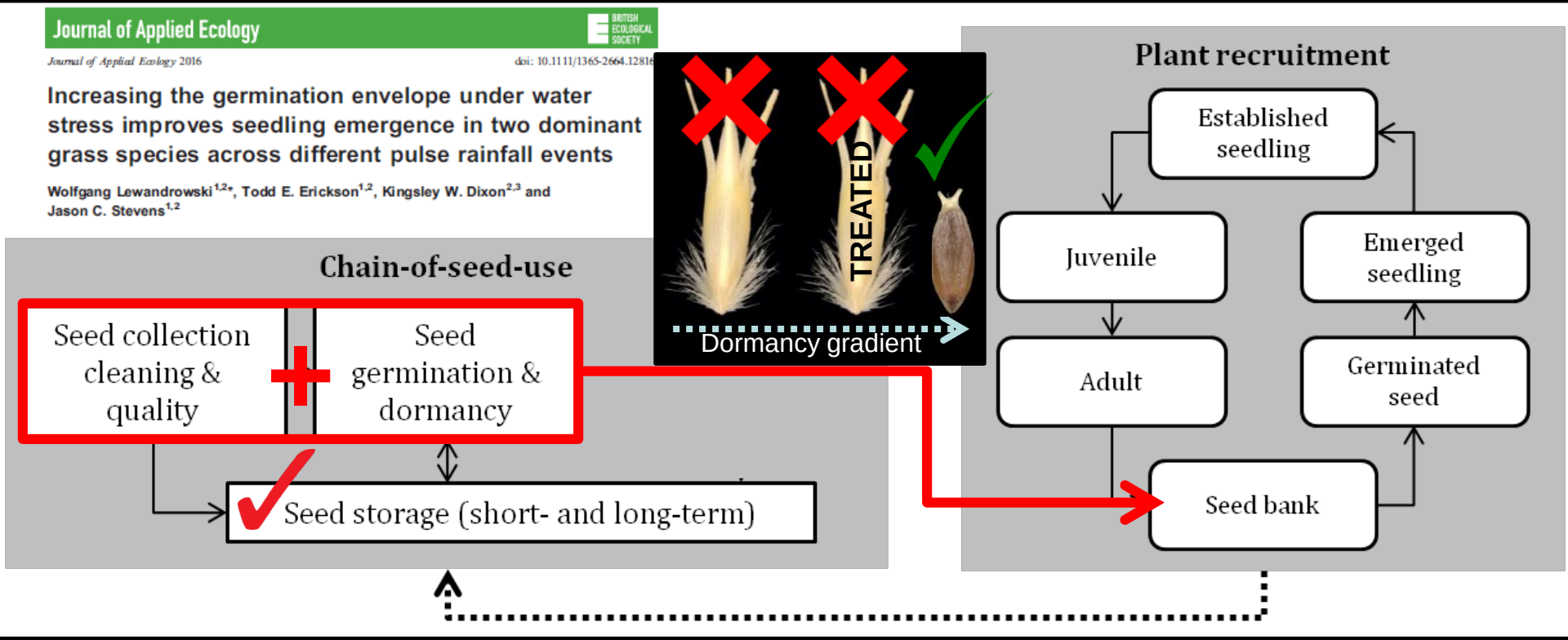
...so what is the challenge.....

- Ministerial requirement to restore vegetation that is comparable to the pre-disturbed landscape (= **high diversity**)
- Large deficit of topsoil = **seed input**
- Dealing with a highly altered growing environment
  - *Natural dormancy cues now absent?*
- The majority of the industry still carry out rehabilitation with non-treated seeds and limited knowledge of seed quality and recruitment capabilities
- *Pilbara Seed Atlas* project initiated to improve seed-use capabilities (2008-2013).
- Research continues with the *Restoration Seedbank Initiative* (2013-2018) and *Global Innovation Linkages Project* (2017→)

...improving restoration at scale through seed-based research.....



...improving restoration by using the chain-of-seed-use....



Merritt and Dixon (2011), *Science*, Vol 332

James *et al.* (2013), *J. of App. Ecol.*, Vol 50

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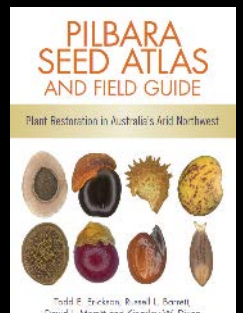

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...improving restoration by using the chain-of-seed-use....

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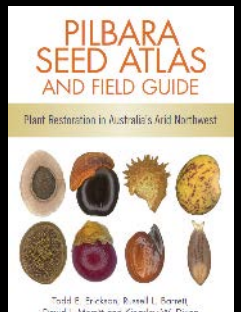

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Seed enhancement technologies include:

- polymer seed coating,
- extruded pelleting,
- priming,
- flash flaming, with
- machine modification / development (i.e. GIL eco-engineering project)

REVIEW ARTICLE

Emerging seed enhancement technologies for overcoming barriers to restoration

Matthew D. Madsen[1,2], Kirk W. Davies[3], Chad S. Boyd[3], Jay D. Kerby[4], Tony J. Svejcar[3]

Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION

TECHNICAL ARTICLE

Flash flaming effectively removes appendages and improves the seed coating potential of grass florets

Andrew L. Guzzomi[1,2], Todd E. Erickson[3,4], King Y. Ling[1], Kingsley W. Dixon[5], David J. Merritt[3,4]

WESTERN AUSTRALIA Innovator of the Year 2016
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GLOBAL CONNECTIONS FUND

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...improving restoration by using the chain-of-seed-use....

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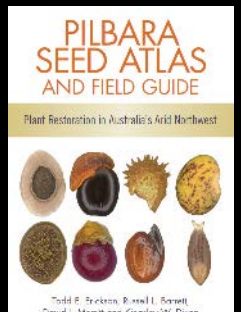

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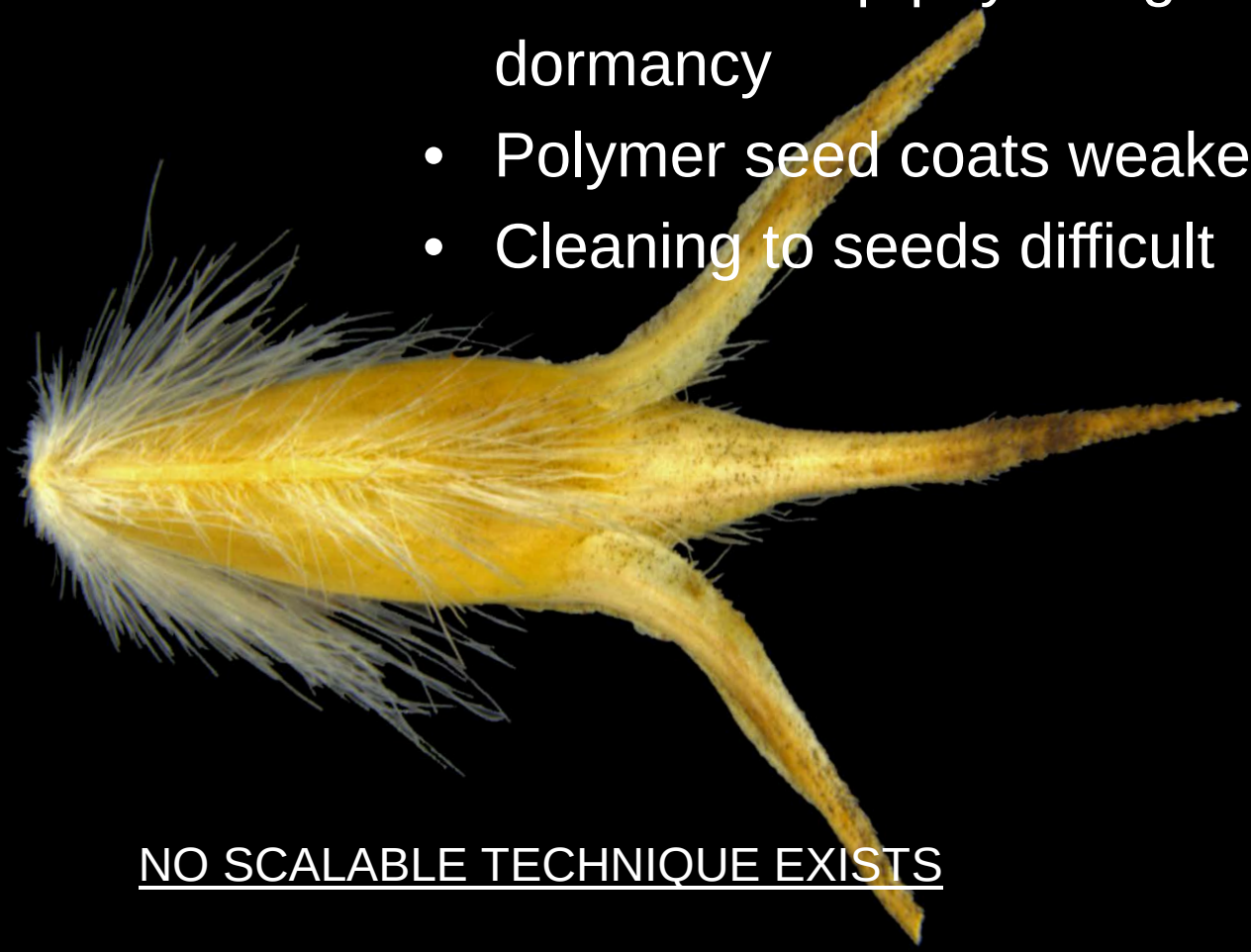
The challenge

- Get tangled, are bulky & difficult to process
- Possess deep physiological seed dormancy
- Polymer seed coats weakened
- Cleaning to seeds difficult



NO SCALABLE TECHNIQUE EXISTS

The innovation: ‘flash flaming’

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Flash flaming effectively removes appendages and improves the seed coating potential of grass florets

Andrew L. Guzzomi[1,2], Todd E. Erickson[3,4], King Y. Ling[1], Kingsley W. Dixon[5], David J. Merritt[3,4]

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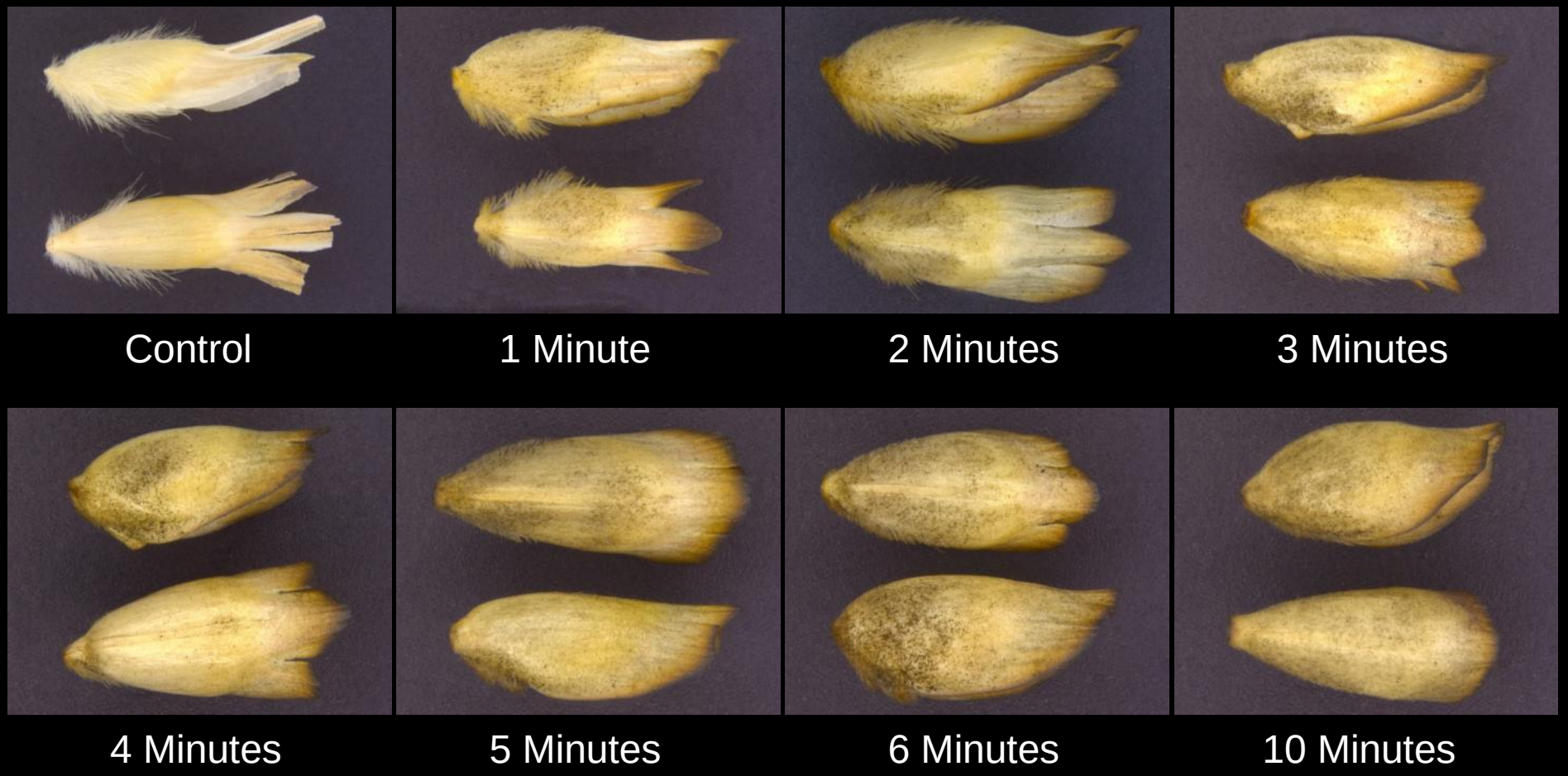
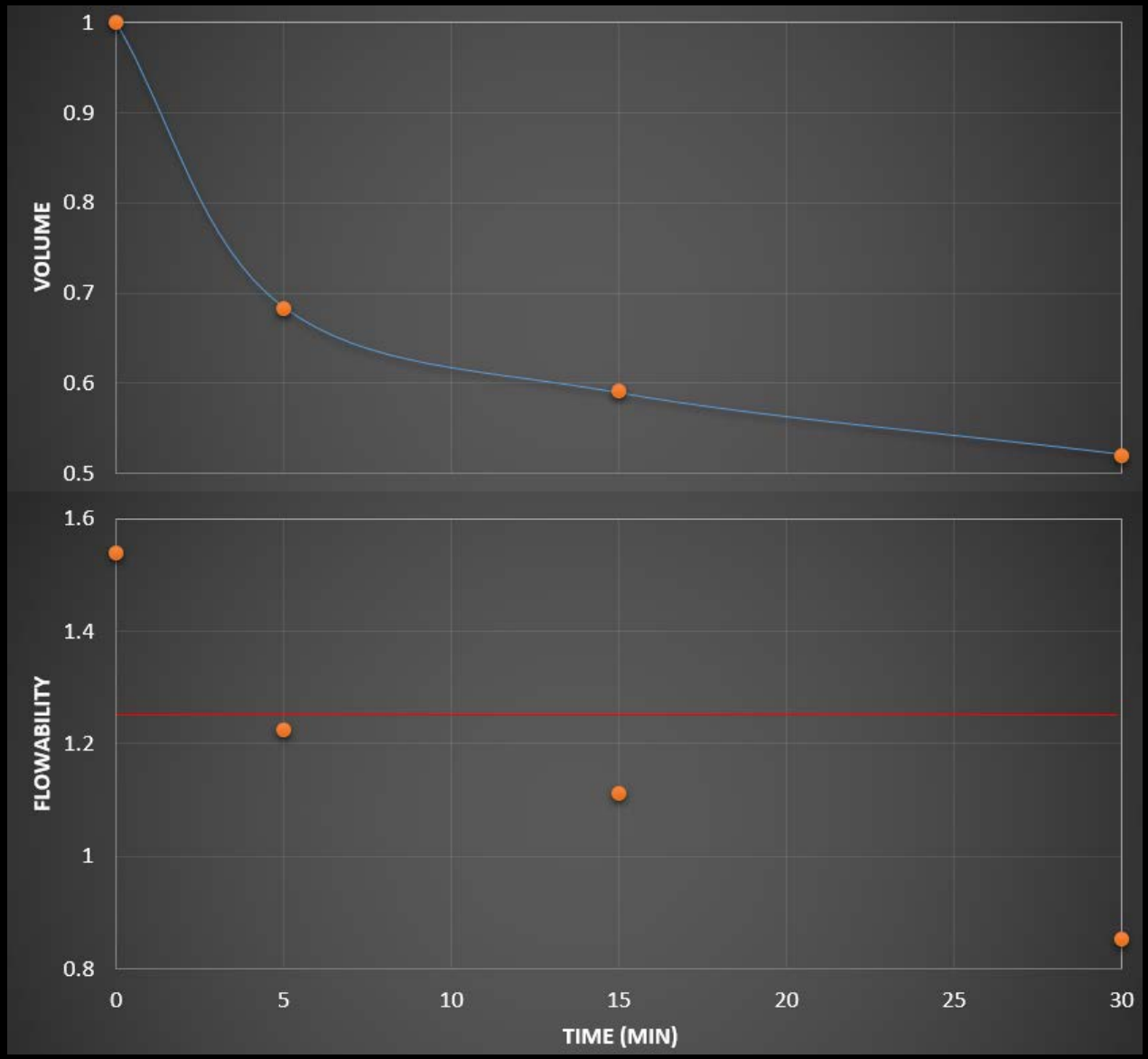
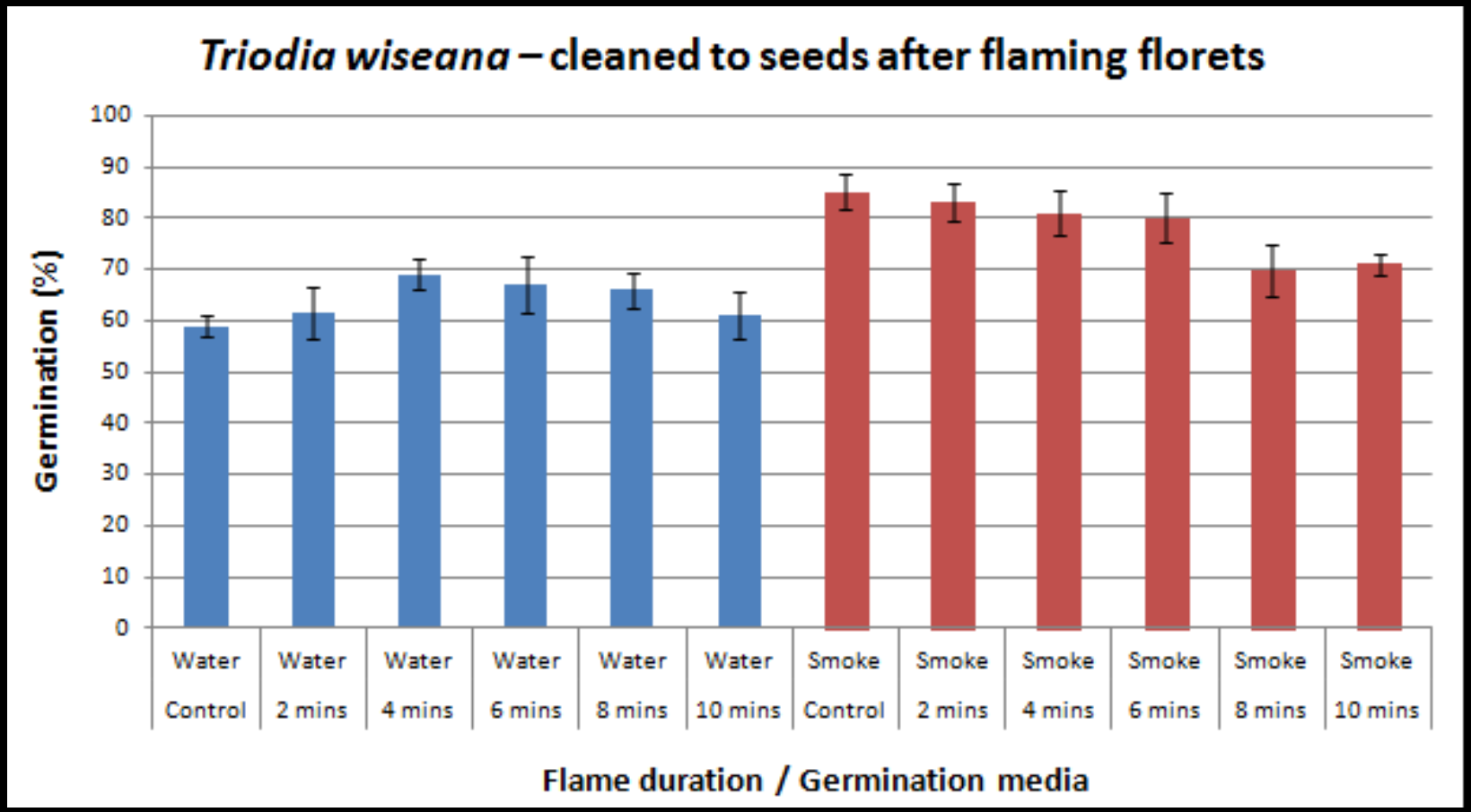
The innovation enables controlled appendage removal



The innovation decreases batch volume & increases flowability



The innovation doesn't impact germination (when delivered correctly)

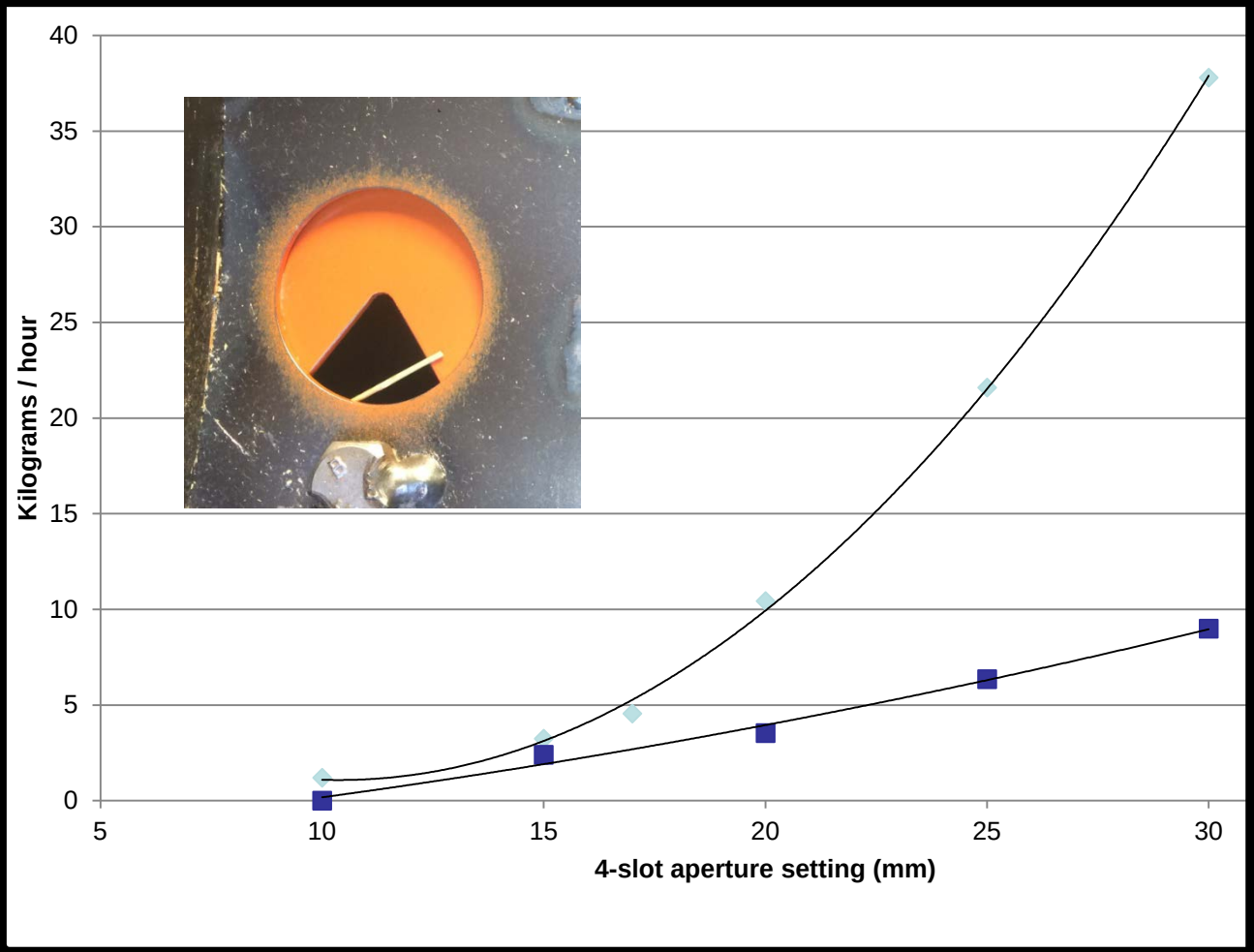


The innovation improves coatability

No-flame

Flamed

The innovation shows promise in Australia



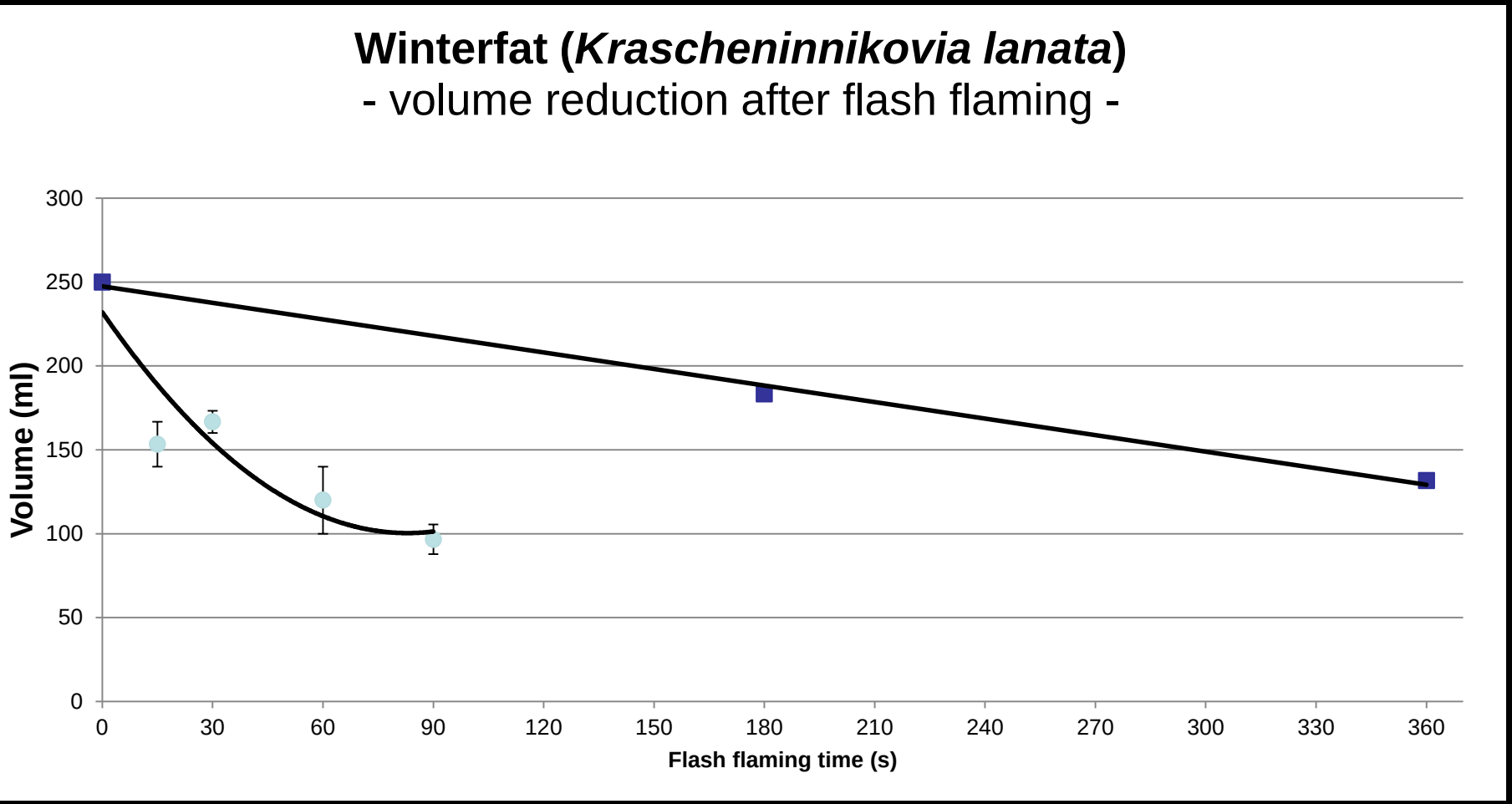
The innovation shows promise in the USA

Winterfat

(*Krascheninnikovia lanata*)

- Valuable protein rich forage for wildlife and livestock
- Seeds are contained in single-seeded fruits enclosed by four silky bracts
- Bracts prevent the seed from flowing from mechanized seeders
- Difficult to apply seed treatments such as seed coating

The innovation shows promise in the USA



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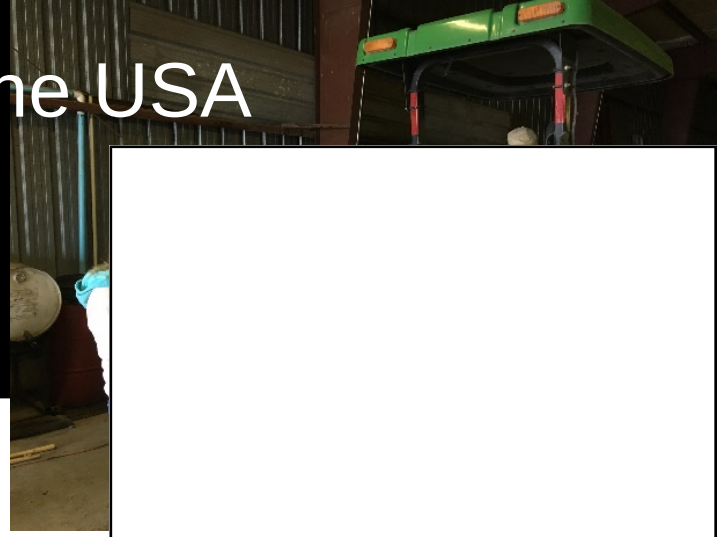

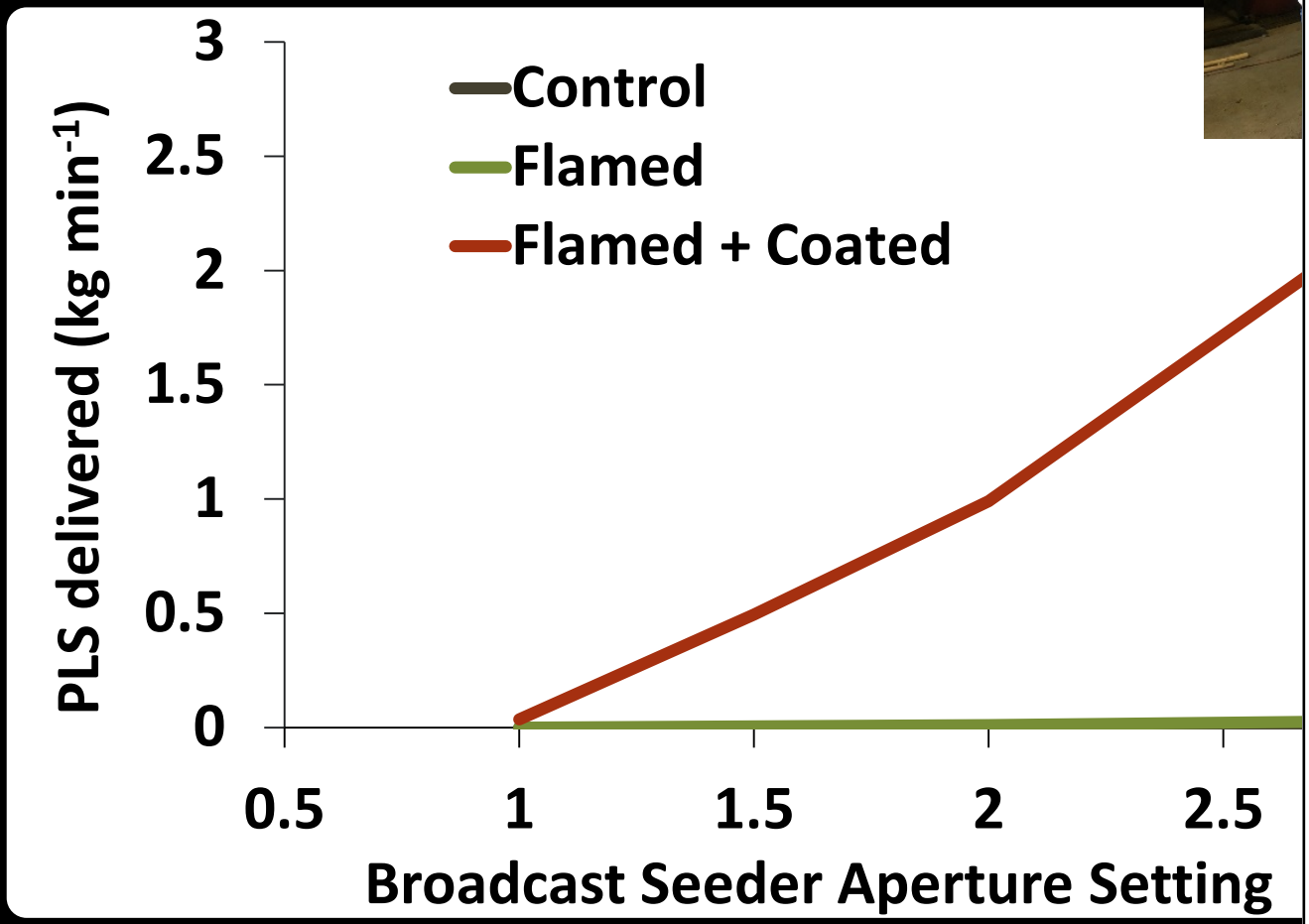

So we believe there is commercial, up-scaling potential...

- it is a simple to apply (patented) solution
- contributes to the step changes required in biodiverse restoration
- seeking support for technology as a service and licensing options
    - on-going discussions with US companies
    - keen to evaluate and implement technology

...improving restoration by using the chain-of-seed-use....

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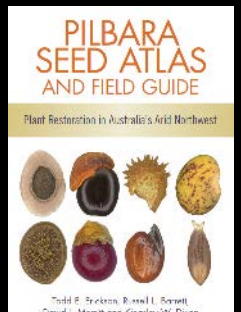

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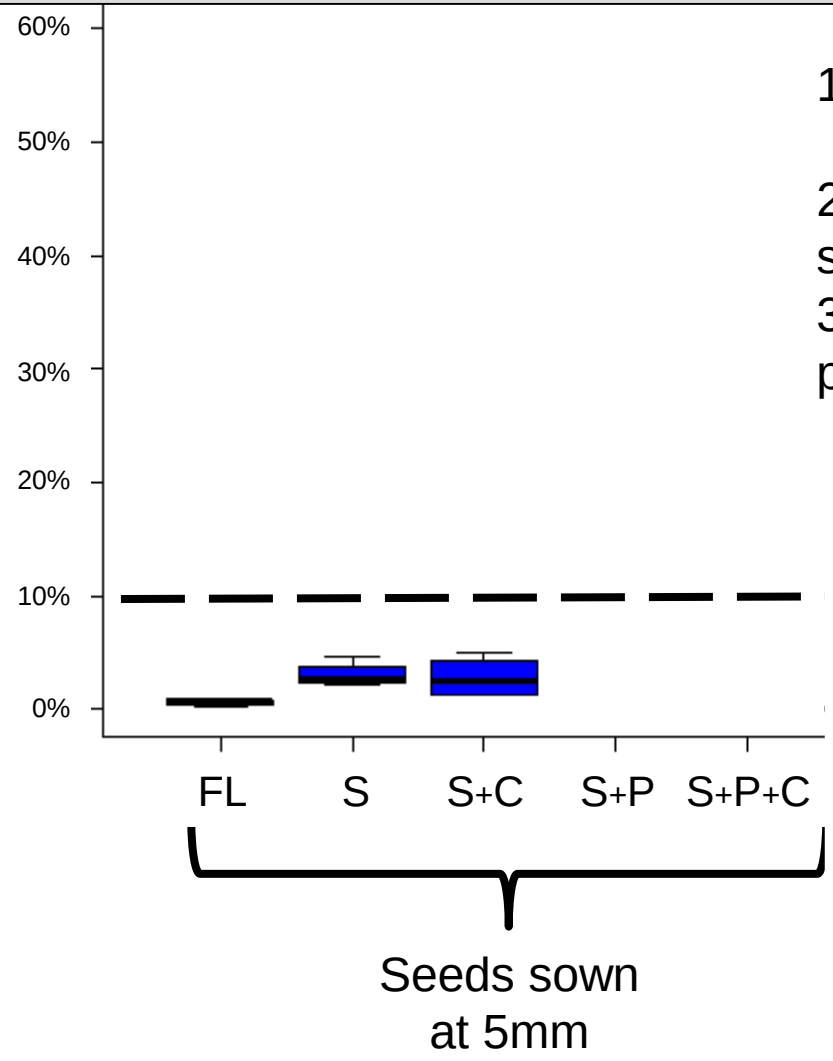
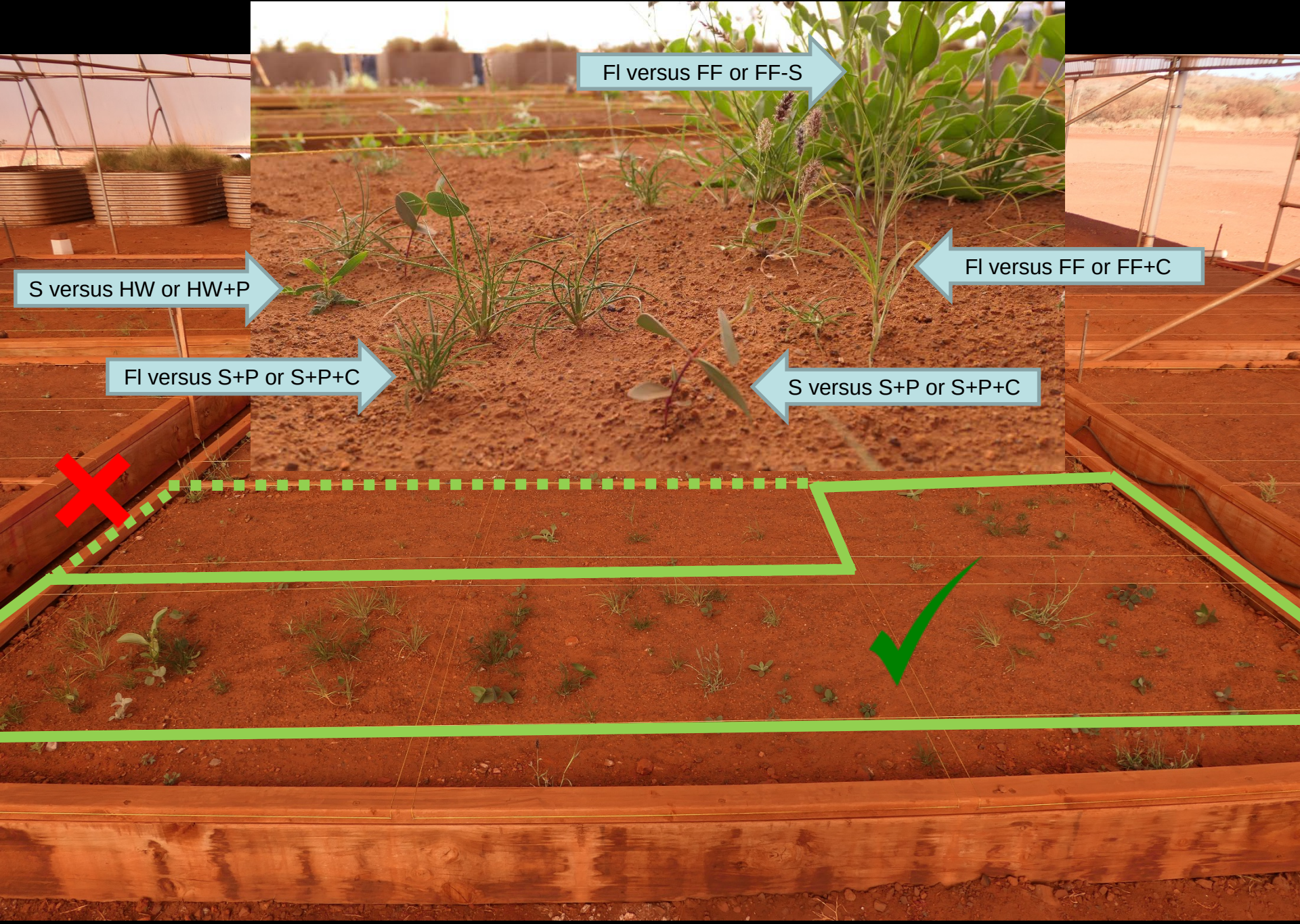
Triodia pungens = Deeply dormant (<1-year old collection)
comparing cleaning, pre-treatments and sowing depth



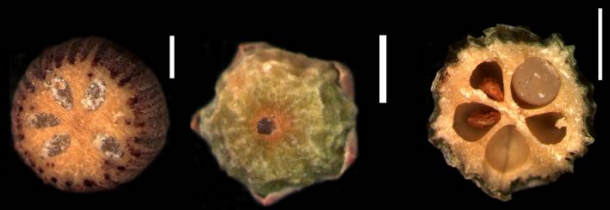
1. Manage recruitment potential of seeds
2. Develop mechanised options for seed processing and treatments
3. Develop mechanised options for precision seeding in rocky soils


Fl versus FF or FF-S
S versus HW or HW+P
Fl versus FF or FF+C
Fl versus S+P or S+P+C
S versus S+P or S+P+C

...improving restoration at scale through seed-based research.....

Growing medium (seedling establishment phase)

Upscaling (restoration engineering)



Wednesday, 2.40pm, Session 28, Salon A&B

INNOVATIVE STRATEGIES FOR RESTORING FUNCTIONALITY OF RECONSTRUCTED SOILS IN DRYLANDS

Miriam Muñoz-Rojas[1,2,3], *Todd E. Erickson*[1,2], *Amber Bateman*[1,2], *Tayla Kneller*[2,3], *Shane R. Turner*[1,2] *and David J. Merritt*[1,2]

[1]University of Western Australia, Crawley, Western Australia, Australia
[2]Kings Park Science, Department of Biodiversity, Conservation and Attractions, Kings Park, Western Australia, Australia
[7]School of Biological, Earth & Environmental Sciences, University of New South Wales, Sydney, New South Wales, Australia

Wednesday, 11.20am, Session 24, Salon C

RESTORATION-ENGINEERING – A BLENDED SCIENCE-ENGINEERING MODEL

Andrew L. Guzzomi[1], *Todd E. Erickson*[2,3], *Monte Masarei*[1], *David J. Merritt*[2,3]

[1]School of Engineering, the University of Western Australia, Crawley, Western Australia, Australia
[2]School of Biological Sciences, the University of Western Australia, Crawley, Western Australia, Australia
[3]Kings Park Science, Department of Biodiversity, Conservation and Attractions, Kings Park, Western Australia, Australia

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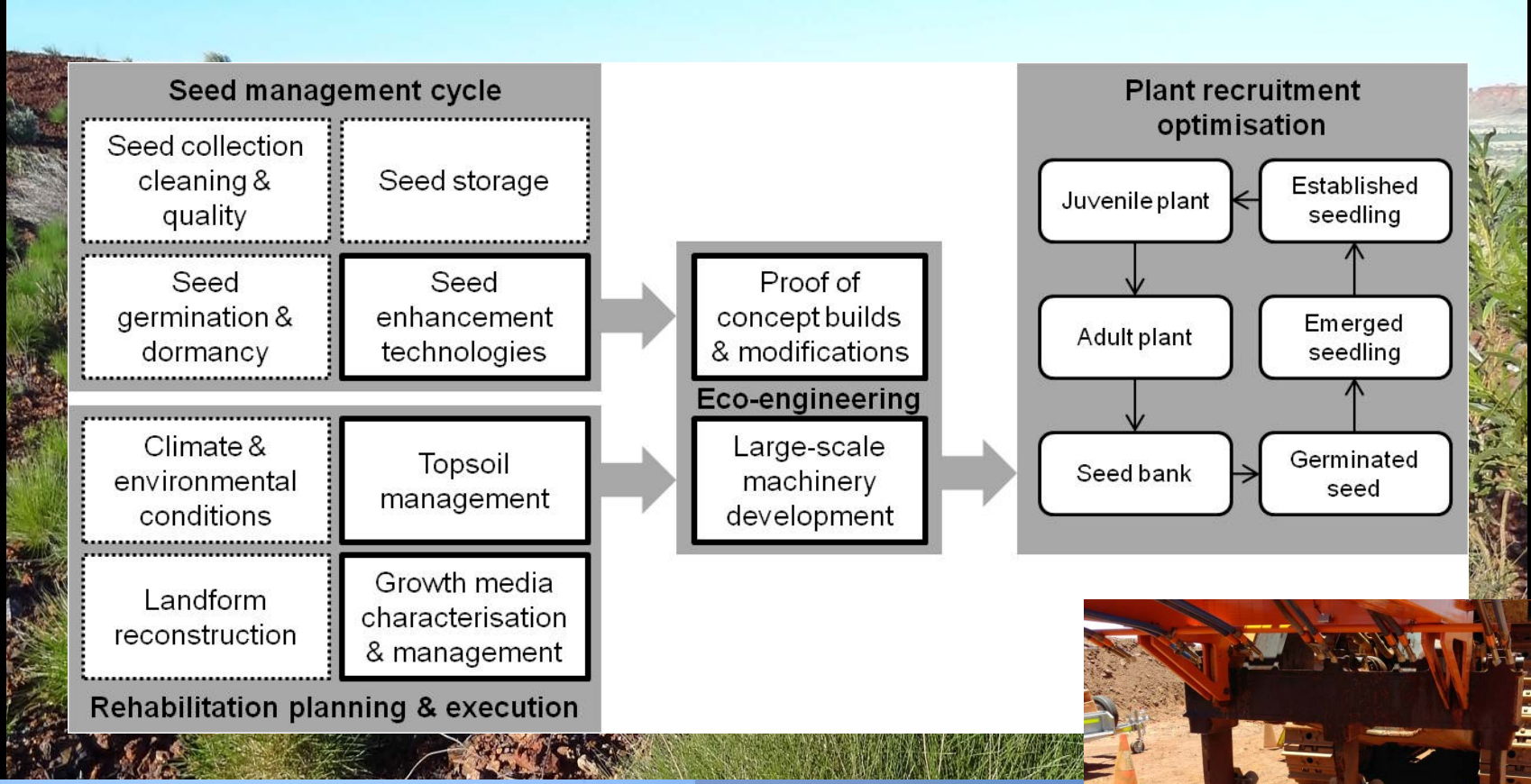
Seed management cycle
Seed collection cleaning & quality
Seed storage
Seed germination & dormancy
Seed enhancement technologies
Climate & environmental conditions
Topsoil management
Landform reconstruction
Growth media characterisation & management
Rehabilitation planning & execution
Proof of concept builds & modifications
Eco-engineering
Large-scale machinery development
Plant recruitment optimisation
Juvenile plant
Established seedling
Adult plant
Emerged seedling
Seed bank
Germinated seed


CAT