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

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@TEricksonSeed

...the Pilbara bioregion......


Erickson et al. (2016), *CSIRO Publishing*
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).

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

Biodiversity Restoration Goal
(no. of species reinstated)

Quality assurance (collection phase)

Storage capacity (seed bank phase)

Restoration-ready seed (seed enhancement phase)

Growing medium (seedling establishment phase)

Step changes in technology development required

Current capacity achieves <10% of desired seed use

Barriers to effective seed use
...improving restoration by using the chain-of-seed-use....

Kildisheva et al. (2018), *Plant Biology*, in press
...improving restoration by using the chain-of-seed-use....

**Chain-of-seed-use**

- Seed collection cleaning & quality
- Seed germination & dormancy
- Seed enhancement technologies
- Seed storage (short- and long-term)

**Plant recruitment**

- Established seedling
  - Juvenile
- Emerged seedling
  - Germinated seed
- Seed bank
  - Topsoil / Growth Medium

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

**Chain-of-seed-use**

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- Seed bank
- Established seedling
- Emerged seedling
- Germinated seed
- Adult
- Juvenile

**Sources**

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’

Technical Article

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

Andrew L. Guzzoni¹, Todd E. Erickson³, King Y. Ling¹, Kingsley W. Dixon², David J. Merritt²,⁴

Restoration Ecology

Western Australia Innovator of the Year

Global Connections Fund

Australian Government National Innovation & Science Agenda
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
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

Winterfat (*Krascheninnikovia lanata*)
- volume reduction after flash flaming -
The innovation shows promise in the USA.
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....

Seed collection cleaning & quality

Seed germination & dormancy

Seed enhancement technologies

Seed storage (short- and long-term)

Seed bank

Topsoil / Growth Medium

Plant recruitment

Established seedling

Juvenile

Emerged seedling

Adult

Germinated seed

Merritt and Dixon (2011), Science, Vol 332


Perring et al. (2015), Ecosphere, Vol 6

Erickson et al. (2016), Restoration Ecology, Vol 24

Erickson et al. (2016), Aust. J of Botany, Vol 64


Guzzomi et al. (2016), Restoration Ecology, Vol 24

Erickson et al. (2017), Aust. J of Botany, Vol 65

Kildisheva et al. (2018), Plant Biology, in press

Muñoz-Rojas et al. (2016), Restoration Ecology, Vol 24

Muñoz-Rojas et al. (2016), SOIL, Vol 2

Muñoz-Rojas et al. (2018), Plant and Soil, Vol 429
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

Seeds sown at 5mm
...improving restoration at scale through seed-based research......

Growing medium (restoration engineering)

Step changes in technology development required

Current capacity achieves <10% of desired seed use

Growing medium (seedling establishment phase)
INNOVATIVE STRATEGIES FOR RESTORING FUNCTIONALITY OF RECONSTRUCTED SOILS IN DRYLANDS

Miriam Muñoz-Rojas\textsuperscript{1,2,3}, Todd E. Erickson\textsuperscript{1,2}, Amber Bateman\textsuperscript{1,2}, Tayla Kneller\textsuperscript{2,3}, Shane R. Turner\textsuperscript{1,2} and David J. Merritt\textsuperscript{1,2}

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

RESTORATION ENGINEERING – A BLENDED SCIENCE-ENGINEERING MODEL

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Wednesday, 11.20am, Session 24, Salon C