Revegetation of Damaged Terrestrial Ecosystems

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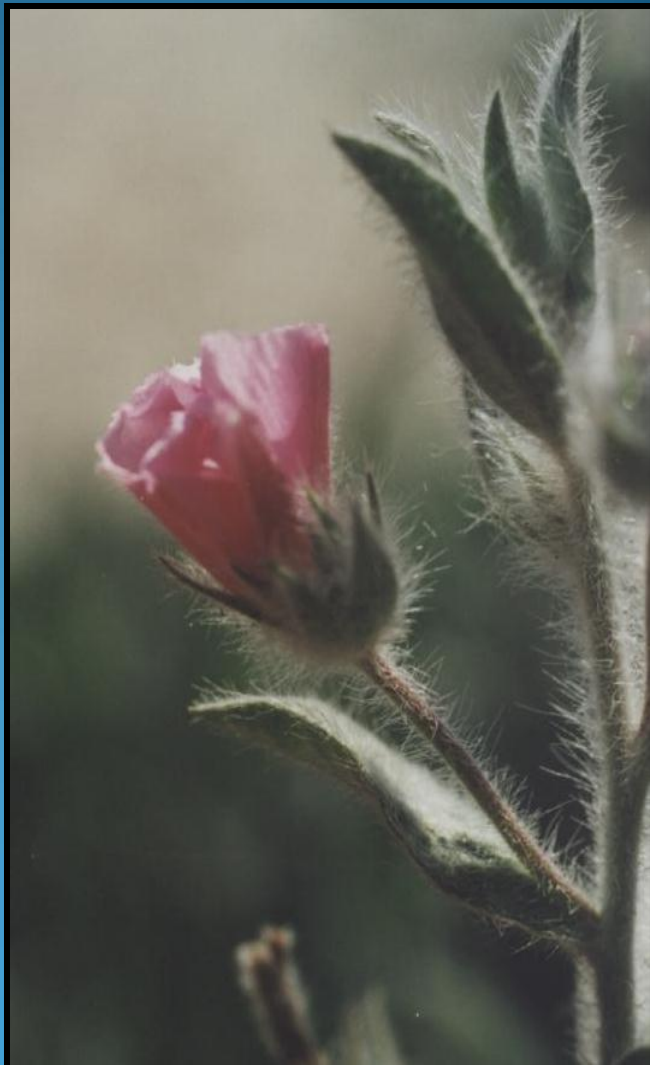
Kuwait's Native Flora

- Represents cultural heritage and an important source of sustainable benefits to Kuwaiti society.
- Provides low-cost feed for livestock grazing
- Source of valuable gene pool and plant material for drought and salt-tolerance research
- Sources of seed and value added products.
- Reduces soil erosion and captures mobile sand.
- Adds Organic matter to the soil.

Revegetation Options

- Rehabilitation
- Restoration



Rehabilitation refers to reclamation of a degraded areas by generating a type of vegetation different from the pre-degradation phase

Restoration is the recovery of an ecosystem, usually to its pre-degradation condition. It is an economically and ecologically sustainable strategy to regenerate deteriorated or damaged ecosystems

Rhanterium epapposum **– once dominant in many parts of Kuwait**

***Haloxylon salicornicum* - Another dominant in many parts of Kuwait**

Completed KISR Projects Related to Revegetation

- Revegetation study – FA010S.
- Revegetation of Damaged Terrestrial Ecosystems (FA009S) – 2003 - 2007.
- HTTD Soil (FA008S).
- Ahmadi Biopark - FA017C
- .Pilot scale Revegetation Study (FA016C).
- Establishment of a Native Plant Nursery – Phase I, Wafra (FA041G), mass production of native plants for multiple purposes, in particular restoration work (2006–2007).
- Production of Native Desert Plants for Multiple Purposes at KISR (FA074K) – 2007- 2008.
- for Native Plants of Kuwait (FA013C) – 2004 – 2006.
- Environmental Rehabilitation Study of the Quarries in the State of Kuwait (EC006C) – 2003 – 2008.

KISR Projects Related to Revegetation

- Sustainable Management of Kuwait's Rangelands (FA009C) –
- Assessment of Rangelands in Kuwait and Improvement for Forage Animal Production and De-Desertification (AG-49) - Completed in 1998.
- Establishment of Selection Criteria and Organization and Management Structure for the Sabah Al-Ahmed Natural Reserve (Formerly known as the National park of Kuwait/ Nature Reserve) - 1982.

Revegetation of Terrestrial Ecosystems – Case Studies

- Revegetation Studies at the Sabah Al-Ahmad Nature Reserve.
- Less intensive revegetation study at Sulaibiya Experiment Station.
- Revegetation of tarcrete damaged areas in Burgan oil field.
- Spirit of the desert
- Revegetation of areas damaged by gravel quarrying.
- Spitit of the desert – Burgan oil fields
- JO- wafra

Conservation and Sustainable Utilization of Native Plants - SES

- ✓ **Strict Enforcement of Protection Measures at SES**
- ✓ **Establishment of Seed Bank for Native Plants at KISR.**
- ✓ **Seed Collection and Long-term storage.**
- ✓ **Establishment of Protocol for Mass Propagation of Native Plants.**
- ✓ **Establishment of Protocol for Short-, Medium- and Long-term Storage of Native Seeds.**

Sabah Al-Ahmad Nature Reserve - Talha

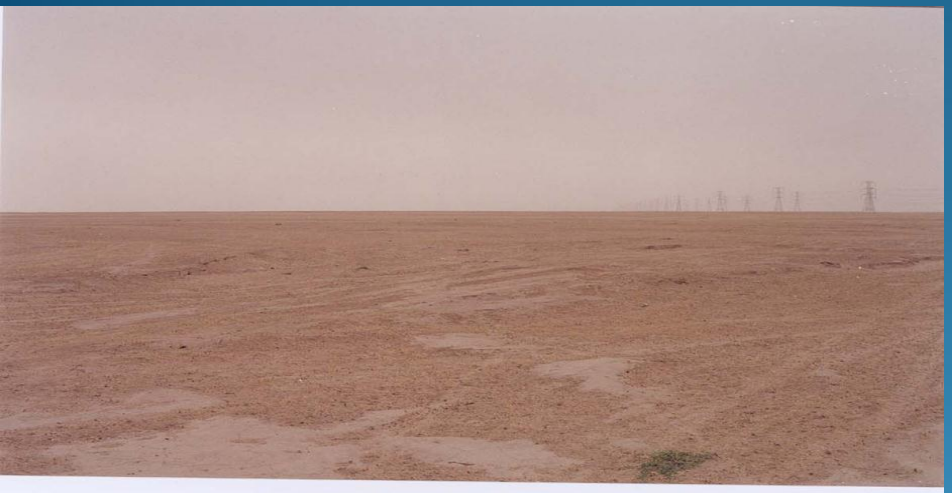
a. Detailed view of a refilled foxhole with gatch.

b. Absence of vegetation on the gatchy area of a foxhole.

Plate 11. A view of foxholes distributed in mapping unit 1 of the At Talhah site.

Restoration of Native Vegetation Cover in Areas Affected by Military Activities

Sabah Al-Ahmad Nature Reserve – Umm Ar. Rimam



a. Refilled depressions in mapping unit 3.

b. Refilled, subsided bunkers in mapping unit 4.

Plate 10. Visual displays of refilled depressions and refilled, subsided bunkers.

Plate 14. Munition disposal at the Umm Ar Rimam site.

Reseeding of desert mixture

Plate 29. Sprouting of annuals inside pits at Umm Ar Rimam site.

Revegetated area

Revegetation of Tarcrete Damaged Areas in the Burgan Oilfield

New KISR-Sulaibiya area in 2004 – immediately after protection

Revegetation Island

Natural vegetation regeneration on sandy soils after two years of protection in 2006

Growth of the dwarf shrub *Farsetia aegyptia* in furrows, 2006, 1.5 years after seeding

Quarry Site Case Study

Greenhouse with native plants being grown by KISR

Native grass field for seed production being carried out by KISR (*Panicum turgidum* & *Pennisetum divisum*)

Restored native vegetation

Some attributes of restored ecosystems

- Increase in perennial vegetation cover of desirable perennial plant species (keystone species)
- Seedlings of keystone plant species are able to become established without outside intervention
- Increase in cover and diversity of typical and more demanding annual plant species of the target community
- Increase in typical fauna
- General improvement of soil structure, in particular increase in soil-organic matter

Integrating science and operations (adaptive management)

1

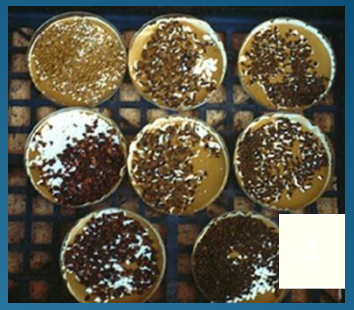
Site selection, determine plant replacement

2

Seed collection

3

Seedstorage



4

Seed pre-treatments

5

Seed germination testing; germination optimisation

6

Greenstock Production

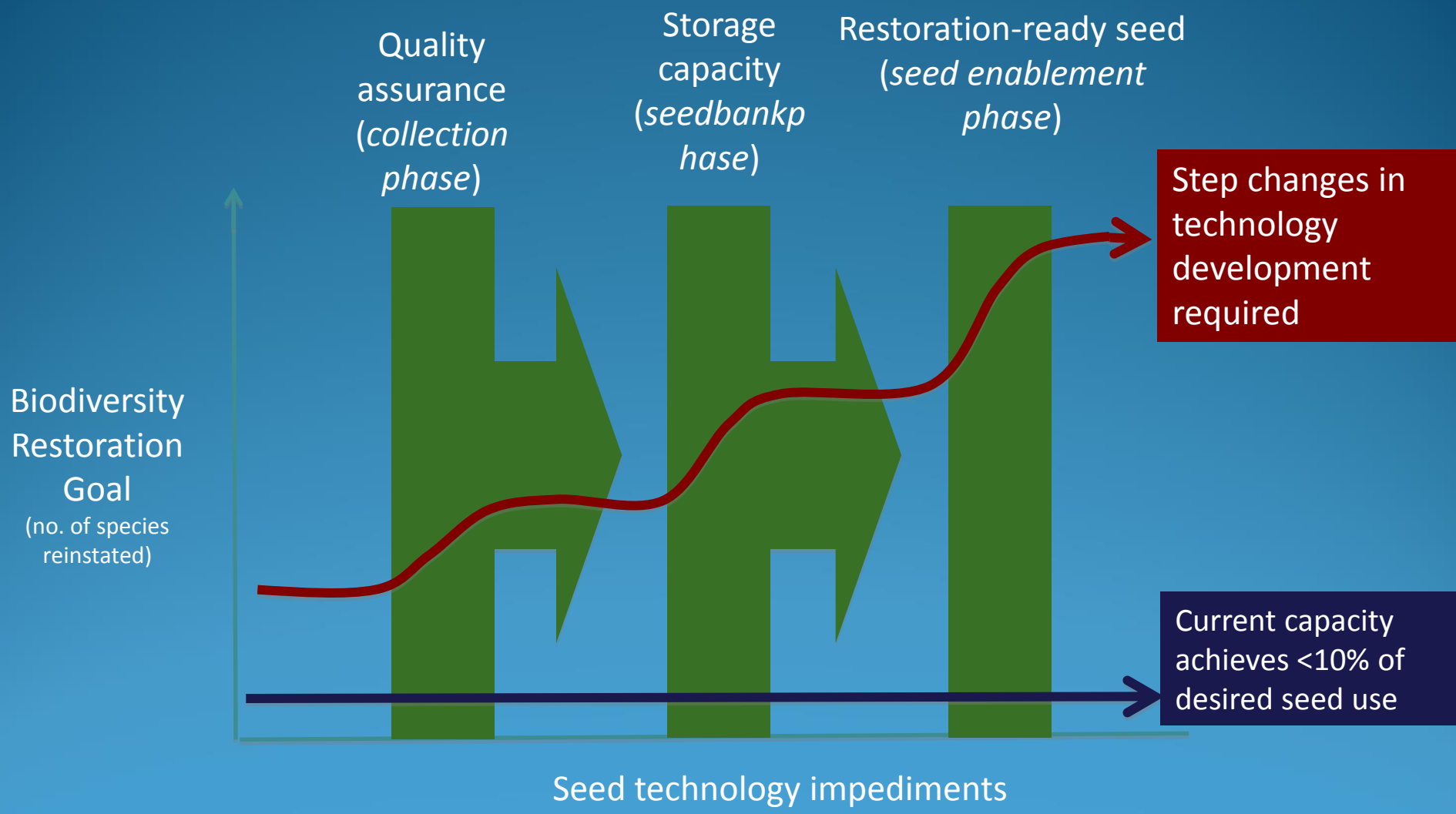
7

Weed management

8

Greenstock planting

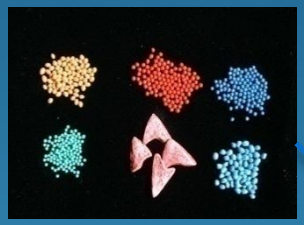
Business as usual VS research-led advances will be critical to scaling-up



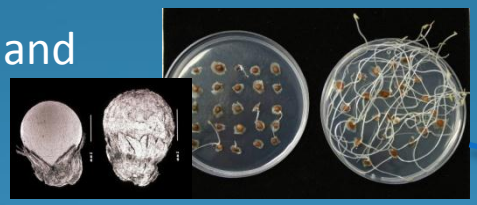
Seed Science and Technology Innovation

'Seed Enablement'

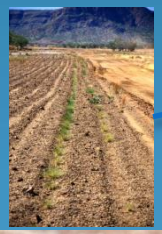
Seed Coatings



Germination on Demand
(Dormancy release)

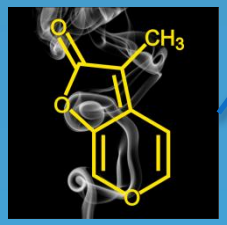


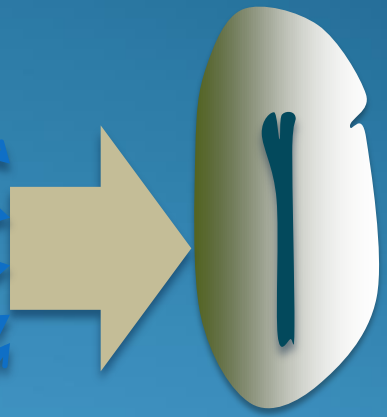
Anti-stress agents



Anti-predation

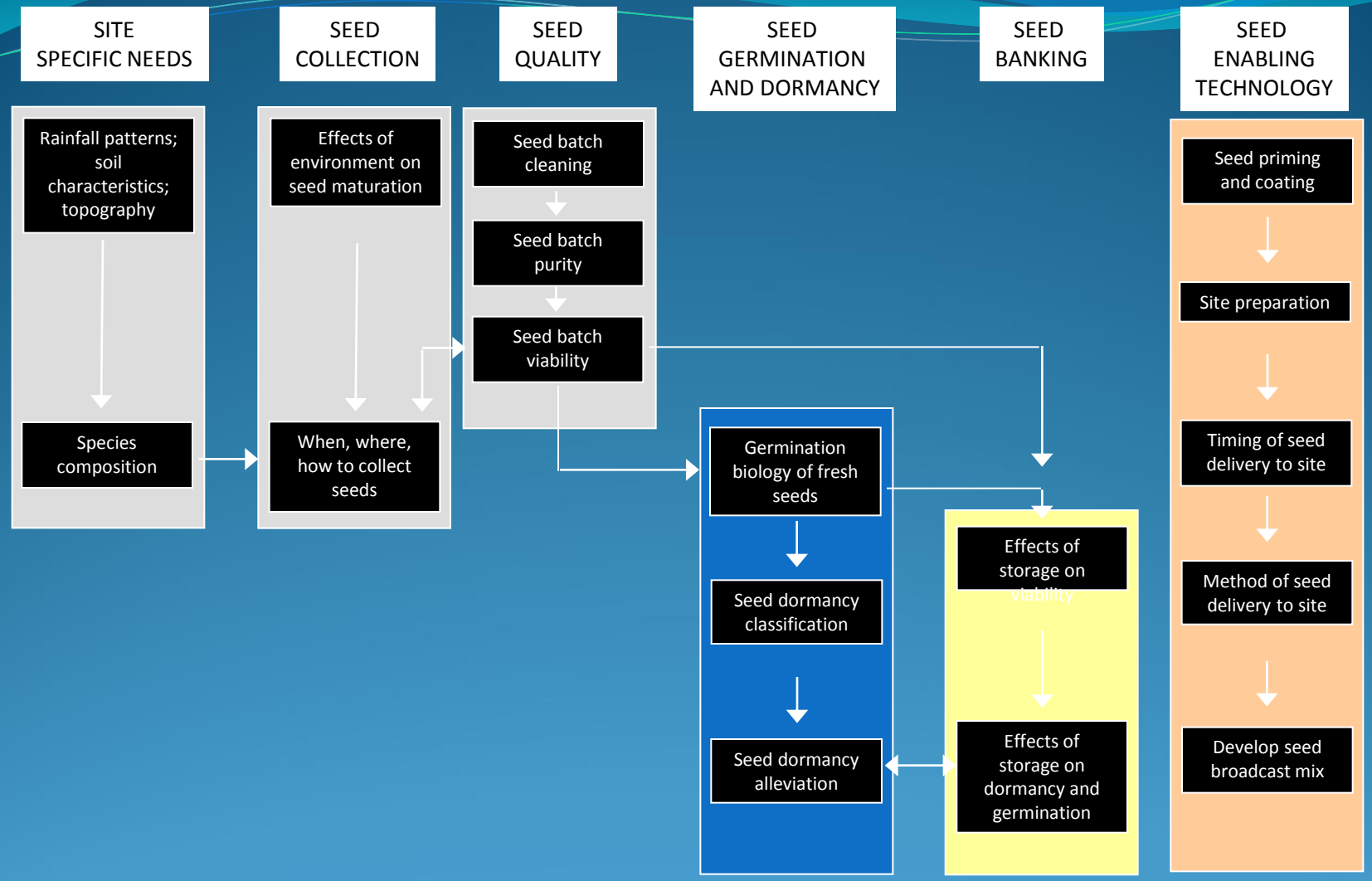
Germination Stimulants





The chemical from smoke can improve germination by 400% (karrikinolide)

Seed-based solutions to restoration will require process



Determine target species

Define seed collection strategy

Optimise quality of collection

Maximise seed germination in lab and nursery

Maximise seed storage life and germination

Enhance seedling establishment

Chain of seed use

Quality

Viability

Germinability

Seed collection → Seed banking → Seed germination → Seed enabling

Environmental effects
Collection timing
Provenance
Supply….

Storage behaviour
Storage conditions
Storage duration
Seed longevity….

Seed viability
Dormancy control
Storage effects….

Dormancy break
Seed priming
Seed coating
Sowing time….

Niche creation
Seedling establishment

Level of effective knowledge

High — Low

Germination on demand – a major challenge to effective seed use for Australian species

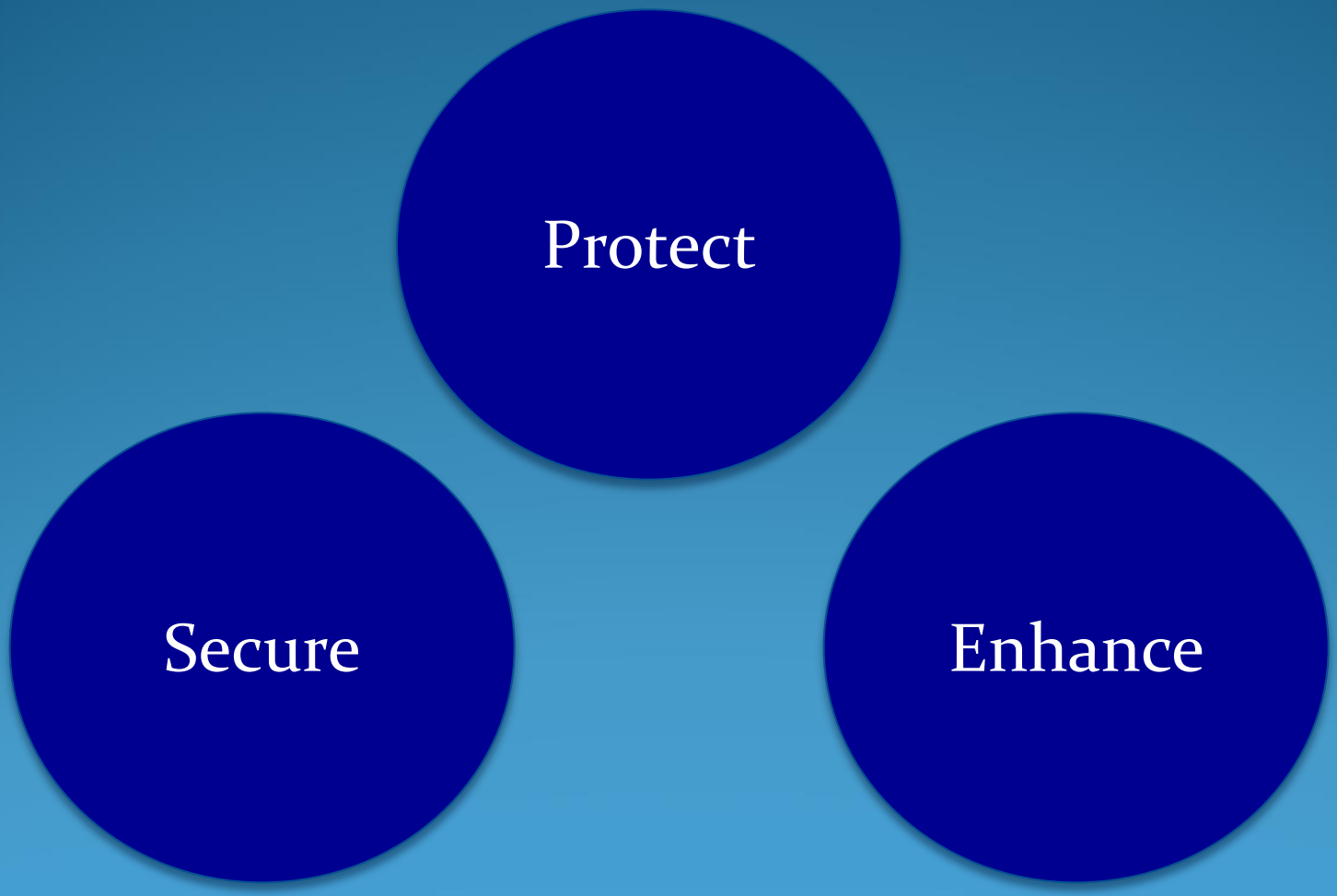
- An inability to germinate seeds inhibits:
  - Propagation of plants for rehabilitation.
  - Effective pre-treatment for seed broadcasting.
  - Accurate determination of seed storage behaviour and longevity.
- Unresolved germination requirements contribute significantly to seed wastage.

Restoration Needs in a Climate Changed Arid Zone

- *Sustainable, achievable, at-scale restoration of indigenous species.*
- *Ensuring no loss of species*

Limited knowledge, science and capability in restoration ecology particularly in the face of climate change

Key Components



Key Components

Protect

Aim: *Protect from loss and extinction rare, endemic, geographically restricted and at-risk species.*

How: Effective, national-scale seed and germplasm banking '*Biobank*' – living collections; seed; tissue banks

Key Components

Secure

Aim: Seedbanking at scale of genetically capable seed for restoration.

How: 1. Establishing national seedbanks '*State Seedbank*' capable of seed storage at the tonne scale.

2. Establish sound, scientifically guided seed farms that produce high quality, at scale seed quantities that are genetically capable.

3. Seed storage physiology understood to ensure long-term storage of high quality seed.

Enhance

Aim: *Ensure restoration-ready seed and greenstock for at-scale restoration*.

How:

- Seed: 1. Dormancy understood and released.

2. Seed of known and high quality stored and made available.
3. Seed enabled (growth stimulants, anti-stress, hydropriming).
4. Delivery-to-site technologies.

- Greenstock: High –health plants produced that are optimised and condition for restoration survival.

Training the Next Generation

Develop active and vibrant post-graduate programs in the restoration sciences.

Just as we want sustainability in landscapes, we must ensure sustainability of the sciences.

KISR Revegetation Strategy

- ✓ **Reduce or eliminate the causes of degradation (off-road traffic, pollution, etc.).**
- ✓ **Initiate soil improving process (reduces soil erosion, improve soil organic matter, nutrient status).**
- ✓ **Undertake measures to improve microsite water availability and nutrient cycling (reduce runoff, improve soil infiltration capacity by pitting, ripping, terracing, establishing microcatchments).**
- ✓ **Reduce detrimental ecosystem interactions while increasing synergies among ecosystem components (establish key species and ameliorate micro-environmental conditions, reducing inter species competition, integrating soil, vegetation and landscape level strategies).**
- ✓ **Train next generation**
- ✓ **Continuously monitor the success of restorations**