# RESTORING DEGRADED FARMLAND

## Lessons from the !Khwa ttu restoration pilot project.

Prepared for !Khwa ttu San Culture and Education Centre, January 2023

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**Introduction**

The purpose of the !Khwa ttu restoration pilot was to learn how to restore the historic natural Fynbos ecosystem on degraded farmland on the West Coast of South Africa, during a time of rapid and extreme climate change (IPCC, 2014). Over the last 100,000 years San hunter-gatherers in the Fynbos survived through profound adaptation strategies honed over millennia. Their intimate knowledge of the environment, sophisticated hunting techniques, and utilization of diverse plant species sustained them during periods of climate change (Shakun, 2012) that occurred during this period. Archaeological and ethnographic evidence highlights their resilience and ingenuity in exploiting Fynbos resources, enabling survival in challenging conditions when other areas became uninhabitable (Parkington, 2008). Fynbos, like San hunter-gatherers was resilient to climate change for several reasons. It has a high diversity of species with overlapping functions so if one species is lost due to a change in climate another can take its place. Many species are adapted to fire, with mechanisms such as resprouting from underground organs or seeds germinating after fire. And many of the plants can survive period of drought and water limitation because they have underground root systems and succulent leaves (Cowling et al, 1999).

On the West Coast the climate is becoming hotter and drier, with less precipitation, more frequent and more extreme drought, storms, wind and wildfires (CDM Smith, 2012). The challenge is that over the last 370 years farming and other industry has transformed the landscape, leaving little climate indigenous vegetation behind and what natural habitat remains is fragmented and often infested by invasive species (Rebelo & Holmes, 2019). Fynbos consists of several vegetation (veld) types such as renosterveld and sandveld. Renosterveld vegetation grows in rich soil around granite rocky outcrops in the hills. It was particularly rich in potato like geophytes which are resilient to drought because they have underground tubers. Historically renosterveld supported much of the game but the rich soil it grows on made these areas suited to farming. Estimates are that there is less than 5% of renosterveld left. Sandveld vegetation grows on nutrient poor soils on the coastal plain and provided different types of food, such as berry plants, for animals and people. Estimates are there is less than 10% of sandveld vegetation left (Rebelo & Holmes, 2019) .

The changes in climate are making the landscape increasingly unsuited to crops and viticulture Nel, W., et al. (2020). This is problematic because population on the West Coast is growing and unemployment is rising leaving people vulnerable, with little means to adapt to climate change.

According to Intergovernmental Panels on biodiversity and ecosystem services and climate change, improving biodiversity aids climate change mitigation and adaptation by enhancing ecosystem resilience, carbon sequestration, and regulating climate extremes. Diverse ecosystems, such as Fynbos, sequester carbon, stabilize temperatures, and mitigate extreme weather events.

To address the situation on the West Coast, it is essential that climate resilient natural ecosystems and biodiversity are restored, protected and used sustainably to support livelihoods. This is particularly important in the buffer zone of the West Coast National Park as it reduces or mitigates the negative influences of external activities on the plants and animals protected by the Park and better integrates the park into the surrounding landscape (CDF, 2017).

!Khwa ttu is situated in the hills above the Atlantic Ocean a few kilometres from the coast and would have been a favoured spot for San hunter-gatherers. In 2017 a biophysical analysis found that !Khwa ttu consisted of 497ha of renosterveld vegetation and 355ha of sandveld vegetation. Of this, 4% is critically important biodiversity, 25% is natural area that may harbour important biodiversity, and 5% provides essential ecological support services and enhances landscape connectivity crucial for maintaining gene flow, facilitating species movement, and enhancing resilience to environmental changes (SANBI, 2019; CBD, 2014). Around 66% has been badly degraded by years of farming and holds little biodiversity value.

In 2020, just as COVID-19 hit South Africa, restoration specialist Johann van Biljon who had been visiting for !Khwa ttu for years, raised a red flag about overgrazing in the remnants of renosterveld. It seemed that a period of severe and prolonged drought had impacted grazing in the !Khwa ttu conservation area and was placing pressure on remaining vegetation. The drought conditions also resulted in rapid growth and spread of invasive trees on the sandveld coastal plains. With the support of the international IKI Small Grants Programme, Table Mountain Fund, the Lemonaid and ChariTea Foundation and Swiss Ubuntu Foundation, the !Khwa ttu team initiated a biodiversity restoration pilot project. The aim was to learn how to restore the historic natural ecosystem to support wildlife and sustainable foraging like the land did in the past.

As a San heritage centre, !Khwa ttu chose to turn the 850ha Grootwater Farm into a conservation area because it is possibly the most compatible with San hunter-gatherer heritage. The !Khwa ttu San guides make good use of the landscape to share their heritage with visitors. In support of this primary purpose, the restoration goal is to restore the climate resilient historic natural ecosystem which supported grazing by wildlife and foraging by small family groups of 20-50 hunter-gatherers (Parkington, 2003). The focus is on increasing the carrying capacity for wildlife by increasing palatable perennial shrubs and grasses, and increasing the abundance of edible plants that can be sustainably foraged by the restaurant for its unique “Food from our Ancestors” menu, which has a taste of heritage in every dish.

**Approach**

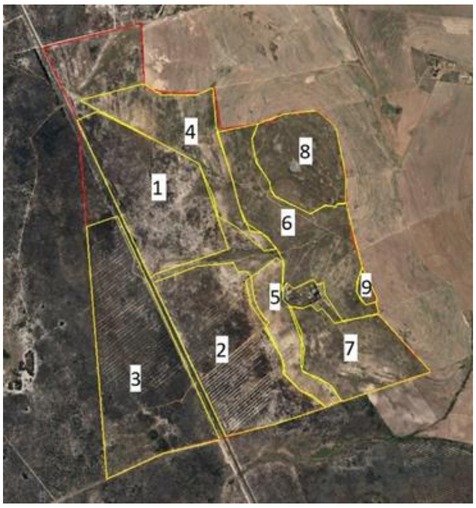
!Khwa ttu’s approach to the restoration pilot aligns with the six principles outlined for ecological restoration (SERA, 2004):

- Set clear, achievable, and measurable goals.
- Use appropriate indigenous species and genetic material.
- Promote genetic diversity and adaptability.
- Restore habitat structure and ecosystem function.
- Implement adaptive management.
- Engage with stakeholders and the broader community.

The pilot focusses on remnants of two endangered vegetation (veld) types, including renosterveld and sandveld. !Khwa ttu uses relatively pristine renosterveld in the neighbouring Rheeboksfontein Farm as a reference site, while a relatively healthy section of sandveld on the property serves as a reference site for more degraded areas. In the short term for the pilot, soil and genetic material to support restoration efforts comes from the reference sites and the conservation area.

Rheeboksfontein Renosterveld reference site (LHS) showing the large fragment of intact Renosterveld. This is how the rolling hills of !Khwa ttu can look in the future. Beautiful, climax Sand Fynbos in the reference site (RHS). Despite the infestation of Port Jackson trees, vegetation has excellent structure and diversity.

Restoration efforts included erecting a game fence around a 50ha renosterveld reserve to exclude large grazers like eland and allow vegetation time to recover from grazing. The intention is to reintroduce eland and forage for the restaurant from this area in the longer-term. Over 300ha of degraded sandveld was cleared of invasive trees. In the sandveld reference site over 90ha of invasive trees were ring-barked and piles of invasive wood that create a risk of hot fires that can damage the soil were cleared. A 1ha patch of invasive kikuyu near the visitor centre (werf), located in and around a low-lying granite outcrop, was cleared and a Mother Garden created to grow the plants to produce the seeds that need to be spread in the landscape in the long-term. A Mother Garden was also begun in the sandveld reference site in and around fynbos cabins where plants can be watered, and the indigenous gardens maintained.




Habitat condition assessments were conducted to inform further activities and ultimately the restoration plan for the whole 850ha area. The assessment indicated that the natural ecosystem had recovered to some degree over the 24 years since the farm was bought for the !Khwa ttu project and is stable. However, it is unlikely that ploughed, contoured renosterveld dominated by pioneering kraalbos, and degraded sandveld dominated by pioneering restios, will recover further without intervention. There were indications that the seedbank was depleted and soil badly compacted and damaged in heavily ploughed areas. Trial plots (20mx20m) were implemented in different habitats in the landscape (sandveld – ploughed strips, sandveld – degraded by invasives, renosterveld – unploughed, renosterveld - ploughed) to pilot soil inoculation, seed reintroduction, as well as animal trampling and ploughing to address soil compaction. Soil inoculation and seed reintroduction also took place in the werf Mother Garden. A baseline survey of trial plots, reference sites and controls conducted in May 2023 when the trial plots were established, supported the findings of the habitat condition assessment.

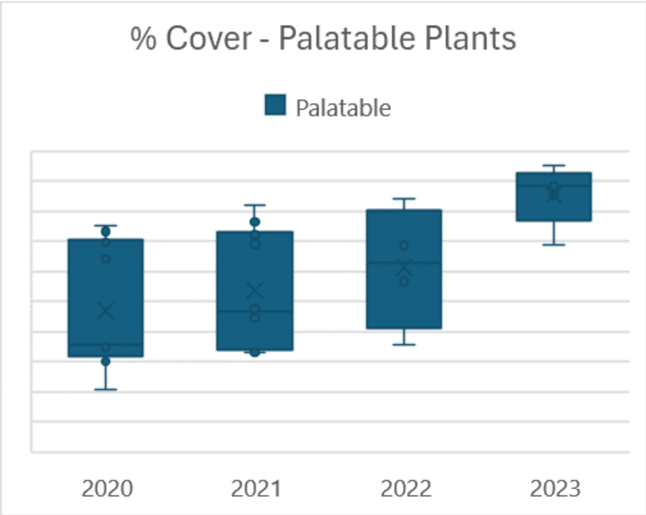
The !Khwa ttu team regularly observed the landscape and identified nearly 300 plant species, including over 20 threatened species, and where they are on the farm.

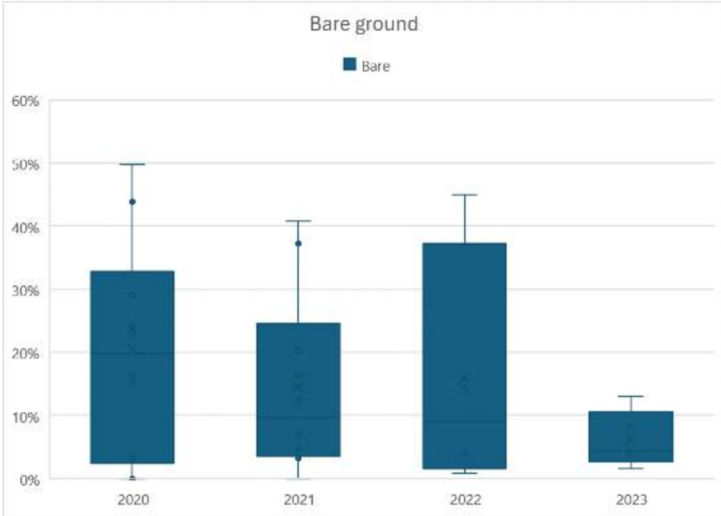
The area also has good diversity of geophtyes and Protea species. Notably rare *Disa cornuta, Geissorhiza exscapa and Babiana tubulosa and Serruria decipiens*.

Drawing on their own local and traditional knowledge, and with the support of archaeobotanist Dr Elzanne Singels, restoration specialist Johann van Biljon and holistic management educator Jozua Lambrechts, the team surveyed the reference sites, identified what was missing and came up with a list of 23 priority plants to be reintroduced to help stimulate natural succession. They also learned how to collect and treat seeds with smoke water, to collect soil and make a soil milkshake with microbes to release nutrients that improve soil health, to set up and monitor plots, conduct vegetation surveys and create a database, and to create and maintain a Mother Garden. The team focussed on seed collection for the trial plots and Mother Garden, while Johann and another specialist Alex Landsdowne propagated missing renosterveld and sandveld plants for the Mother Gardens.

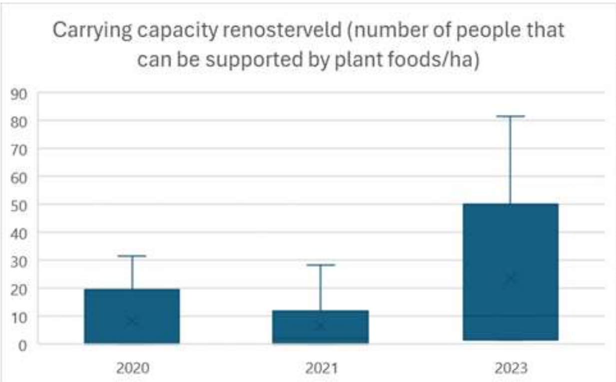
**Monitoring and evaluation**

Regular annual vegetation surveys of the fenced renosterveld reserve (2020-2023) showed that exclusion of large grazers was an effective way to increase the cover of palatable plants to the extent that large grazers could be allowed back in during late summer when there is little grazing left in the landscape.



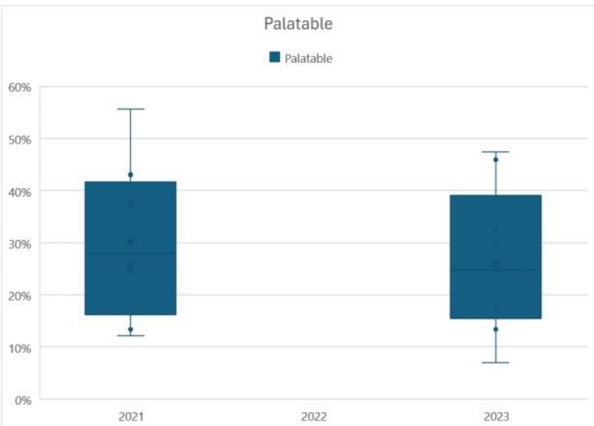

This intervention had the added benefit of decreasing the average percentage cover of bare soil and increasing vegetation cover. This would have reduced carbon emissions from bare soil by on average 14% from 2020 – 2023 in a 50ha area @ 300mg $CO_2$ per square metre per hour (Oertel et al 2016) and increased carbon sequestration by @ 93.7 tons carbon per hectare fynbos (Mills et al 2012).

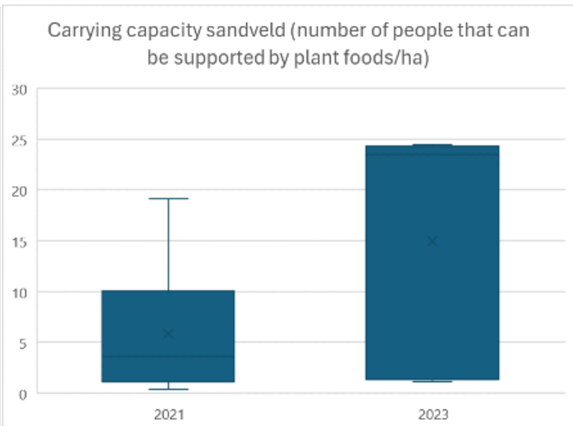



Although there is overlap between the plants animals eat and the plants people eat (De Lange et al. 2008) excluding large grazers did not result in an increase in the abundance of edible plants in the renosterveld reserve. The average abundance increased from 8 – 23 people per hectare from 2020-2023 but variability is high (0-81) and there is no statistical difference. The greatest abundance of edible plants is found in and around unploughed granite rocky outcrops which can support as many as 81 people per day but can drop to <1 person per day in ploughed renosterveld surrounding rocky outcrops.

**Sandveld**

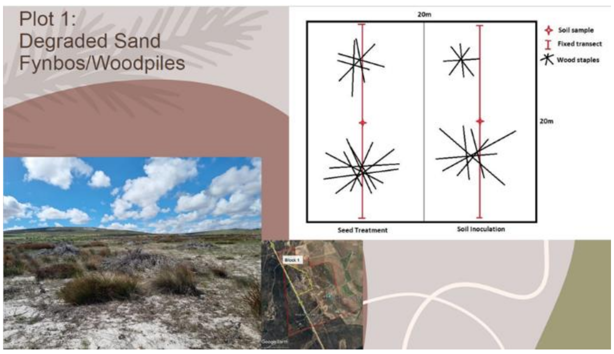
Annual vegetation surveys and habitat condition assessment of sandveld (2021-2023) showed that removal of invasive trees on its own was not enough to improve the cover of palatable plants or any of the other variables that were measured (% cover edible plants, bare soil, vegetation, shrubs, climax species, threatened species). As for renosterveld there was an apparent increase in the abundance of edible food plants from 6 to 15 people per day from 2021-2023 but variability was high (1-24) and this was not statistically different.

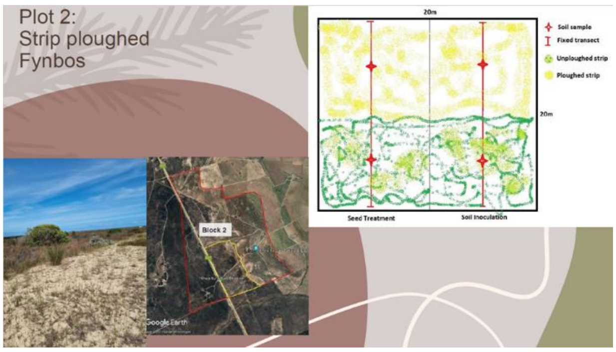


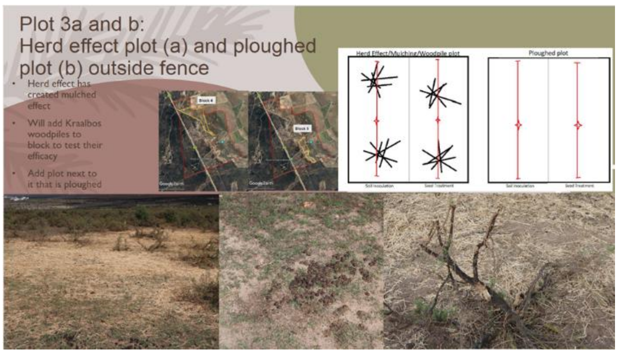



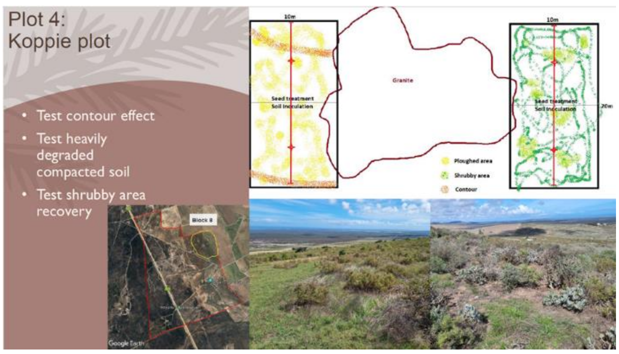
Although plants are mainly being harvested from the werf area and Mother Garden while the landscape is being rehabilitated, the intention is to increase the carrying capacity of the landscape for foraging and this needs to be done sustainably. New seasonal menus were introduced in July and November 2023 and prices adjusted. Assuming visitors spend on average R200 per person in the restaurant and 25% of a visitor's energy intake for the day comes from meat and plants harvested on the farm, the farm supported 2649 people from Jan-Oct'23 or 8-9 people per day which falls within the range of the average carrying capacity of 7-18 people per day. However, the restaurant is becoming increasingly popular and the number of visitors to !Khwa ttu is growing. To increase the carrying capacity for foraging, seeds of edible plants will need to be reintroduced to the landscape. However, introduction of seeds will not help if the soil is not in suitable condition.

Research shows that understanding and working with soil dynamics, community dynamics and the seedbank are important for restoration of renosterveld and sandveld (Rebelo & Holmes, 2019). Understanding soil dynamics is crucial for Renosterveld restoration as soil properties influence plant establishment, growth, and community composition. Knowledge of soil nutrient availability, structure, and moisture retention informs restoration strategies, optimizing habitat conditions for native species and enhancing ecosystem resilience (Rebelo & Holmes, 2019) and similarly for sandveld (Cowling, et al., 1999). Community dynamics informs species selection, habitat management, and ecosystem resilience. Knowledge of species interactions, succession patterns, and community structure guides restoration efforts, ensuring the establishment of diverse and resilient ecosystems (Holmes & Cowling, 2000; Rebelo & Holmes, 2019). Understanding the seedbank is critical for restoration as it informs species reintroduction strategies, aiding in the reestablishment of native plant communities. Knowledge of seed viability, dormancy mechanisms, and germination requirements guides restoration efforts, enhancing ecosystem resilience and promoting long-term success (Krupek et al., 2020; Rebelo & Siegfried, 1992). In alignment with this research, trial plots included soil inoculation with soil from reference sites, spreading selected seeds from reference sites that were treated with smoke water and addressing soil compaction with animal trampling (herd effect) and ploughing in the landscape, and gardening techniques in the Mother Garden.

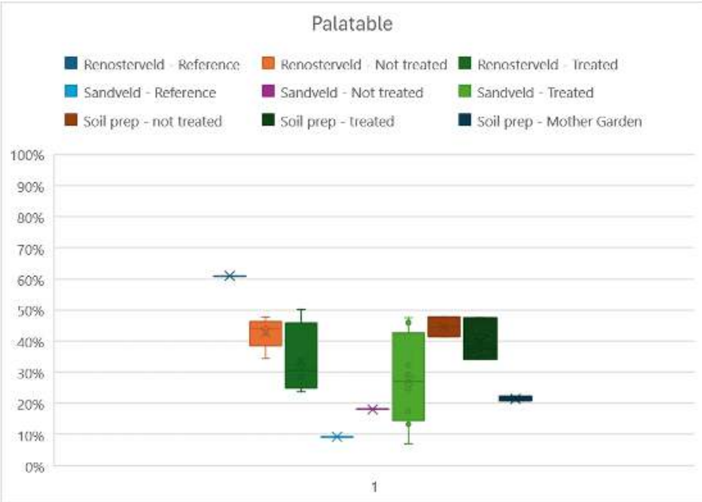


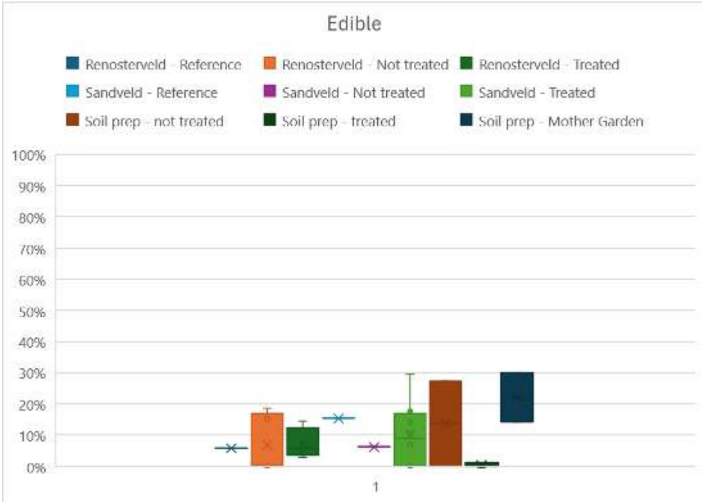




In general, vegetation surveys indicate a high degree of variability in the landscape. There was no marked difference in the range of variation between seed and soil treatment plots and little change from May and November across the range of variables measured. Regular monthly observation of trial plots by the team indicate that some seeds did germinate but analysis shows little difference in vegetation between treated and untreated areas after 6 months. This is not surprising as it takes time for soil to recover and vegetation to respond. Germination is also dependent on climate conditions. The lesson is that it will take time and repeated soil inoculation and reseeding at the onset of the rainy season in May-June for enough seeds to find refuge and grow in the landscape.




What is interesting was the rapid recovery of palatable vegetation in plots where soil compaction was addressed with animal trampling (herd effect) and ploughing treatments. Although there was still a slightly higher percentage of bare ground, in both treatments palatable plants recovered to the level of untreated plots in 6 months. The team observed better germination of seeds in the mother garden where soil was also prepared but in this case by removing kikuyu, raking and composting before soil inoculation, spreading of seeds and mulching. This treatment helped turn a plot of invasive kikuyu grass into a diverse garden of palatable and edible plants. This indicates that preparing the soil before soil inoculation and reseeding is important for facilitating restoration in the landscape. This needs to be done at farm-scale level. Conservation farming techniques and tools like subsoilers( Rebelo & Holmes, 2019). that breakup and aerate the soil without turning it over and disturbing the soil structure, and/or disc harrows (Laverack, 2017). that could increase the carbon content of soil by thinning out pioneers like kraalbos and restios and working them into the soil, will disturb the stability of the natural ecosystem less than ploughing and need to be piloted in one or more habitats in 2024.

Furthermore, the team also found that herbivory was very active. Insects, rodents, small antelope and the occasional springbok all have an impact on the Mother Garden. Owl boxes were erected in the Mother Garden and landscape near trial plots to try and attract owls to control the rodent population. When restoring Fynbos, the optimal method for seed deployment depends on various factors. Surface seeding, where seeds are scattered on the soil surface, can be suitable for some species with specific germination requirements and in areas with favourable conditions. However, in Fynbos ecosystems, where seed predation and competition are common, planting seeds at controlled depths using appropriate equipment may offer better protection and enhance germination rates. Deep planting helps protect seeds from predation and provides better contact with soil moisture, improving establishment success (Krupek et al. 2020). In the next phase it may be more effective to spread seeds using direct planting or seed planters (Lal, 2015) to bury the seeds in the soil to lessen seed predation and improve moisture levels to facilitate germination. However, different seeds have different germination requirements, so this needs to be investigated before seeds are smoke treated, planted or spread on the soil surface.

**Way forward**

Based on these finding the following restoration steps have been identified for different habitats:

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| Fynbos reference site | Remove invasive trees and dead wood especially those choking wetlands. |
| | Source funds for a game fence and introduce eland to prevent overgrowth. |
| | Soil beneath invasive trees and dead wood is very high with alien-friendly microbes. |
| | Inoculate soil for fynbos cabin mother garden with soil from beneath shrubs. |

| | |
|---|---|
| | Direct plant or use a soil planter to bury seeds to lessen predation, improve moisture. |
| Fynbos ploughed strips | Introduce soil from reference site from beneath shrubs. |
| | Use a soil planter to bury seeds to lessen predation and improve moisture. |
| | Increase soil carbon – brush cut and work in restios using discs or subsoiler. |
| | Soil microbes similar to reference site but slightly lower, carbon lower. |
| | Growth forms similar to reference site. |
| | Direct plant or use a soil planter to bury seeds to lessen predation, improve moisture. |
| Fynbos degraded | Introduce soil from reference site from beneath shrubby elements. |
| | Use a soil planter to bury seeds to lessen predation and improve moisture. |
| | Carbon better than ploughed strips. |
| | Soil microbes and carbon similar to soils beneath invasive trees in reference site. |
| | Fewer shrubby elements than reference site, more restios. |
| Renosterveld reference | Little bare soil, no annuals, understory (ferns, moss). |
| | High soil microbes and carbon, low compaction. |
| Renosterveld granite | Understory missing, some annuals, soil carbon high, need soil microbes. |
| | Introduce understory and shrubby soil from reference sites. |
| | Use seed planter to bury seeds to lessen predation and improve moisture. |
| Renosterveld ploughed | Kraalbos, annuals, lots bare ground, different forms to reference site. |
| | High compaction, low carbon, low soil microbes. |
| | Introduce soil and seeds from reference sites – address seedbank. |
| | Use subsoiler to address compaction. |
| | Use seed planter to address herbivory. |
| | Bruch cut and/or use discing to work in cut kraalbos – increase carbon. |

These activities are planned for 2024 and based on the outcomes the restoration plan will be updated and rolled out in the 850ha conservation area.