Improving Restoration Success in the Arid Zone

Arid environments across the world have become increasingly degraded in recent times, prompting the urgent need for restoration works. However, restoration in the arid zone is a difficult task due to extreme environmental factors, which involve, most notably, high temperatures and dry conditions. These difficulties are commonly compounded by limited funding and resources. It is also recognised that restoration practices in arid areas are generally understudied compared to many other environments.

This current work attempted to address this knowledge gap by investigating methods for improving restoration practices in arid areas, with a particular focus on the semi-arid Mallee region. To achieve this aim, both a review of available scientific literature and a survey of arid restoration practitioners, was used to determine the effectiveness of available restoration methods. In addition, the germination biology of four selected Mallee species was studied to determine how such knowledge might be best applied to restoration field work. This study was followed up by field trials investigating how to improve direct seeding in the Mallee region.

Arid Restoration Method Review

Restoration methods which were reported to be effective in both the scientific literature and practitioner survey were (i) grazing control, (ii) weed control (particularly chemical weed control), (iii) pre-seeding seed treatments and (iv) soil ripping. Pre-seeding treatments and soil ripping were also noted to be of relatively low cost and to involve low labour. Although weed control and grazing control come with higher costs and labour requirements, particularly with regard to fencing, the benefits they bring are substantial and it is suggested that they should be incorporated if time and budget allow. On the other hand, soil amendments, including fertilizers, hydrogels, biochars and biosolids, generally have mixed effectiveness and were not widely used despite their relatively lower costs.

When specifically investigating planting methods, direct seeding was found to be significantly cheaper and easier to apply at a large scale when compared to hand-planting. Although, this came with increased mortality rates. Nevertheless, both planting methods were still highly recommended by practitioners with choice of method depending on individual project conditions.

This idea also generally applies to all the restoration methods, with practitioners commonly noting that the choice of method would depend on the particular conditions related to each project.

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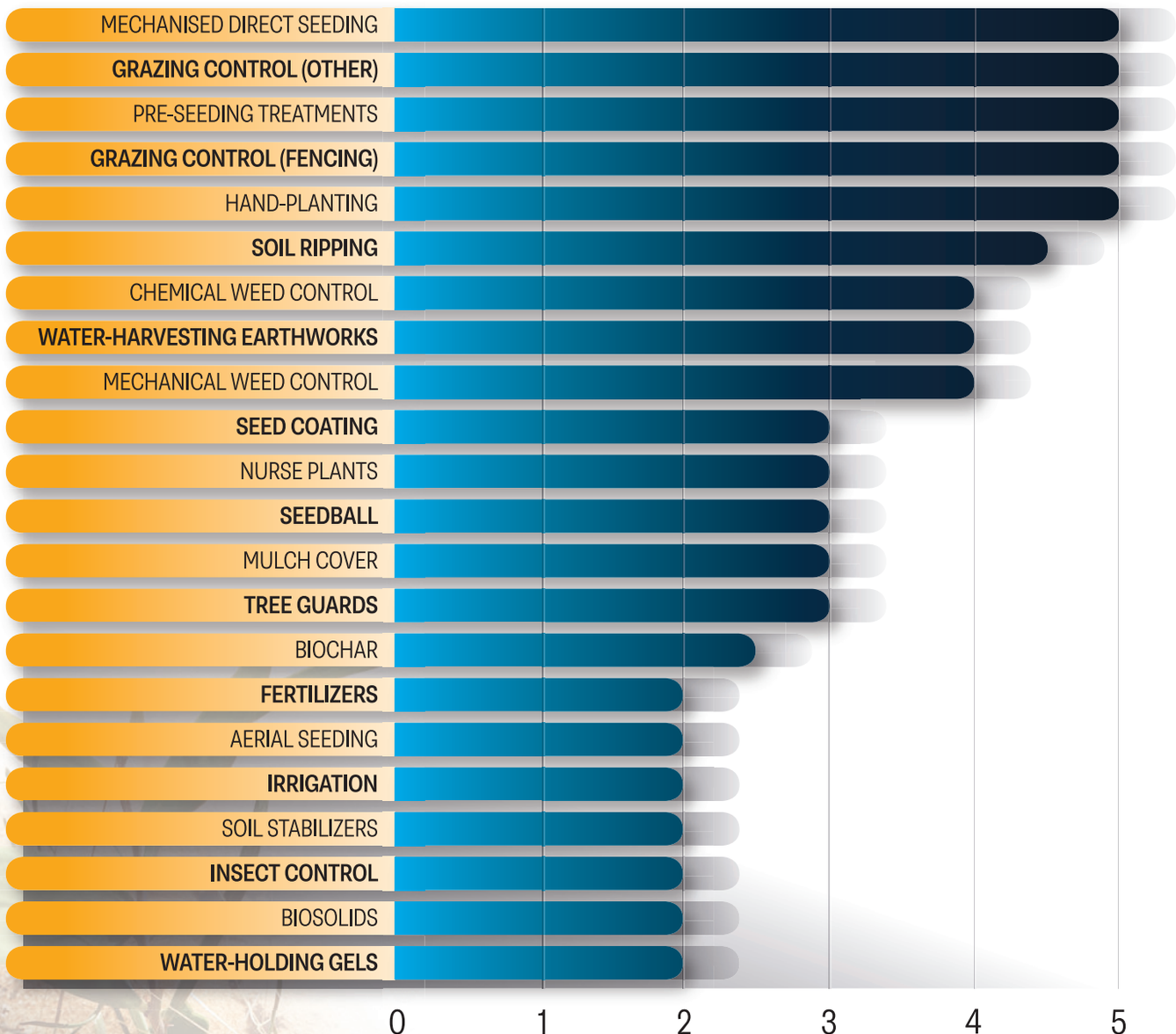
Practitioner responses to question “Which of these techniques would you consider evaluating or using, based on your understanding of their applicability or usefulness? (1 - highly unlikely and 5 - highly likely)”



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Germination Biology

Four woody plant species commonly used in Mallee plantings (Acacia ligulata, Callitris gracilis, Eucalyptus calycogona and Melaleuca lanceolata) were chosen to have their germination biology studied. This was done to determine how germination knowledge could be applied to enhance direct seeding, since this method was generally identified as potentially useful due to its low cost and ability to be applied at large scales.

Using laboratory-based germination trials designed to test different temperature regimes and water potentials, it was discovered that the chosen species had different germination requirements. Acacia ligulata was a generalist able to germinate under a number of temperate regimes and water potentials, whilst E. calycogona and M. lanceolata preferred to germinate rapidly under warm temperatures, and C. gracilis was specialised to germinate under cool wet conditions. Based on the results, mid-autumn was identified as the optimal sowing time for all species based on the Mallee climate. Acacia ligulata was identified as the most suitable species for future restoration work as its generalist ecology would allow it to be applied at different sites under a variety of conditions.

Direct Seeding Trials

Using the four species from the germination trials, a direct seeding experiment was setup where seeds were sown in three different properties around the Mallee region. Along with choice of seeds, there were different combinations of soil amendments (hydrogel, fertilizer, and microbial inoculants) also sown. Soil amendments were chosen as, although findings on them are mixed, they are relatively cheap and can be easily applied alongside direct seeding. The results of the direct seeding trials showed that only A. ligulata and C. gracilis seedlings emerged. This was possibly due to a combination of these larger-seeded species being more compatible with direct seeding and that the previously identified specific germination conditions for C. gracilis were met, with the weather at the time of planting being cool and wet. It was found that soil amendments had no effect on seedling emergence or survival with the seedling location being more important. Sowing on the sand ridges (as opposed to the swales) was found to provide the best mix of emergence and survival, although survival was still low across the whole experiment, this being most likely due to poor spring rains and grazing pressure..

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Overall Recommendations

Grazing control, weed control, pre-seeding seed treatments and soil ripping are indicated to be effective restoration methods;
Soil amendments were generally found to have moderate to low effectiveness;
Direct seeding is likely to be unsuitable for smaller-seeded species in the area, suggesting that a mixture of direct seeding and hand-planting is more appropriate;

Of the species tested, Acacia ligulata was the most suitable for direct seeding work;
When using direct seeding, the location of planting will be an important factor to consider. In the Mallee, sowing on sandy ridges, or in high sand sites, appears to be the best method for maximising success using the species tested.

Example of one of the direct seeding trial sites located on a sand plain near Cramenton, Victoria.

Project Acknowledgements

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