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Restoration technologies to improve the grazing capacity of degraded arid-and semi-arid rangelands in South Africa

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Introduction About 80% of the total land area of South Africa is regarded as rangelands of which most are arid-or semi-arid . It is estimated that approximately 66% of the rangelands are moderately to severely degraded (Snyman , 1988) and many have passed the thresholds of self recovery . Once irreversible transitions have occurred , restoration practices have to be implemented to assist the recovery of these degraded ecosystems (SER , 2002) . In most cases , the general aims of restoration is to increase the biodiversity for higher resilience , increase the vegetation cover to combat erosion and to improve the production potential for a higher grazing capacity (Bakker , *et al* . 1996 ; Van den Berg & Kellner , 2005) . Restoration procedures include both active (burning , clearing , re-seeding and cultivation) and passive technologies (withdrawal of livestock/game) (Milton & Dean , 1995) . All these technologies are very complex and the connection between ecological succession and ecosystem goods and services over time have to be addressed . The challenge is to investigate which technologies are most suitable for mitigating the poor environmental conditions , especially low rainfall and anthropogenic impacts that are responsible for the degradation in different livestock production systems .

Materials and methods Depending on the degree of degradation selected restoration technologies were introduced in the three main types of land-use systems found in South Africa , i .e . commercial , communal and game/conservation . In bare , denuded and heavily degraded areas , active technologies were applied , which included one or a combination of certain cultivation methods to increase the water use efficiency , re-seeding with indigenous , ecotype specific species , covering the area by brush (woody twigs) and the application of organic material to improve the soil structure and fertility . Where vegetation cover was still present , passive technologies were applied which means that grazing by livestock was controlled or withheld in exclosures . The success of the restoration experiments were assessed against selected reference or benchmark sites .

Results and discussions Depending on the degree of degradation and the land-use system , vegetation cover and density of especially high palatable , perennial species increased by > 50% in sites that were actively restored and the grazing capacity improved by > 60% , especially in communal managed systems that were formerly highly degraded and subsequently withheld from grazing . The dry matter (DM) production of grass species increased by > 60% and the biodiversity improved by >30% , depending on the condition of the surrounding vegetation and habitat . Monitoring took place over a period of 5 years and compared to the reference/benchmark sites . The soil type and rainfall , before and during the restoration activities , and type of plants species used in re-seeding activities , influenced the success of the restoration activity .

Conclusions The aim of restoration will determine which type of technology to apply in the different land-use types . Proper management of restoration activities will contribute to the success and long-term sustainability of the restored site . The sites and results are used as demonstration plots to make farmers aware of land degradation , desertification and the application of restoration practices and to apply more sustainable rangeland management practices in the long-term .

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