Abandoned Croplands in South Africa

Subjects: Environmental Sciences

Contributor: Khuliso Ravhuhali, Bethwell Moyo

There is no standardised definition of agricultural land abandonment; however, a simple definition is the cessation of agricultural activities on a given surface of land. The term agricultural land abandonment is inclusive of land previously used for crops, vegetables, fruit trees, and cultivated and natural pastures. Other agricultural land abandonment studies specifically focus on crops, hence terms such as cropland abandonment, formerly arable lands, and old arable lands or fields are used. Others specify that for the land to qualify as abandoned, it should not be used for any other activity such as urbanisation or afforestation. Therefore, in the context of the rural areas of Africa wherein the cessation of cropping the land is used for grazing, the definition of cropland abandonment suffices. Baxter and Calvert define cropland abandonment as a process of withdrawing cropland from active agricultural production without a plan for crop cultivation in the immediate future. The cessation is usually due to a decline in economic viability even after changes in farming practices. Cessation results in natural succession wherein grasses, shrubs, and trees colonise former cropping lands; it can also result in land degradation. In the former homeland communal areas of South Africa, where the main agricultural activity involves cropping and livestock production, by default if the land is not used for cropping it turns into a grazing area. The same trend of abandoned cropping lands being used for grazing was also reported in Botswana. Therefore, the definition of abandoned cropping land is land mainly used for grazing. The areas are sometimes also called old fields, fallow, or idle fields. Some have turned to be secondary grasslands.

Keywords: succession stage ; species diversity ; croplands ; plant invaders ; restoration

1. Causes of Cropland Abandonment

Different factors drive cropland abandonment to varying extents across the globe and they range from socio-economic, edaphic, and climatic drivers [1][2]. These factors interact at various spatial and temporal scales [3] resulting in unviable land use practices [4]. Cropland abandonment happens when cropping becomes uneconomic [5] due to several factors such as a decline in soil fertility which necessitates higher fertiliser inputs. In addition, a move to the efficient and expensive mechanised agriculture due to family labour shortages [6] increases farming costs making it unprofitable. Unreliable rainfall [6][7], a phenomenon recently associated with climate change, leads to crop failures and thus discourages cropping. Individual household head attributes such as old age, increase in female-headed households, and off-site employment increase cropping abandonment [8].

The most decisive drivers of cropland abandonment in South Africa are drought, rainfall variability, and lack of interest in farming by youths [9] coupled with the decreased ability of old people to continue cropping the lands [10] (**Figure 1**). The long distance between fields and homesteads discourages cultivation by old people since access to the fields is mainly through walking. Old people will find it difficult to walk long distances and, on their arrival, will be engaged in the physical work in the fields. Furthermore, the high possibilities of unmanaged livestock destroying crops in poorly fenced fields deter cropping in communal areas [6]. Furthermore, investment in farming equipment and inputs versus returns is considered unfavourable hence the cessation of cropping [6]. The migration of males to mines for employment purposes also contributed to a decline in cropping [11]. The negative relationship between poor financial revenue and cessation of cropping was also observed in the Mediterranean Basin [12].

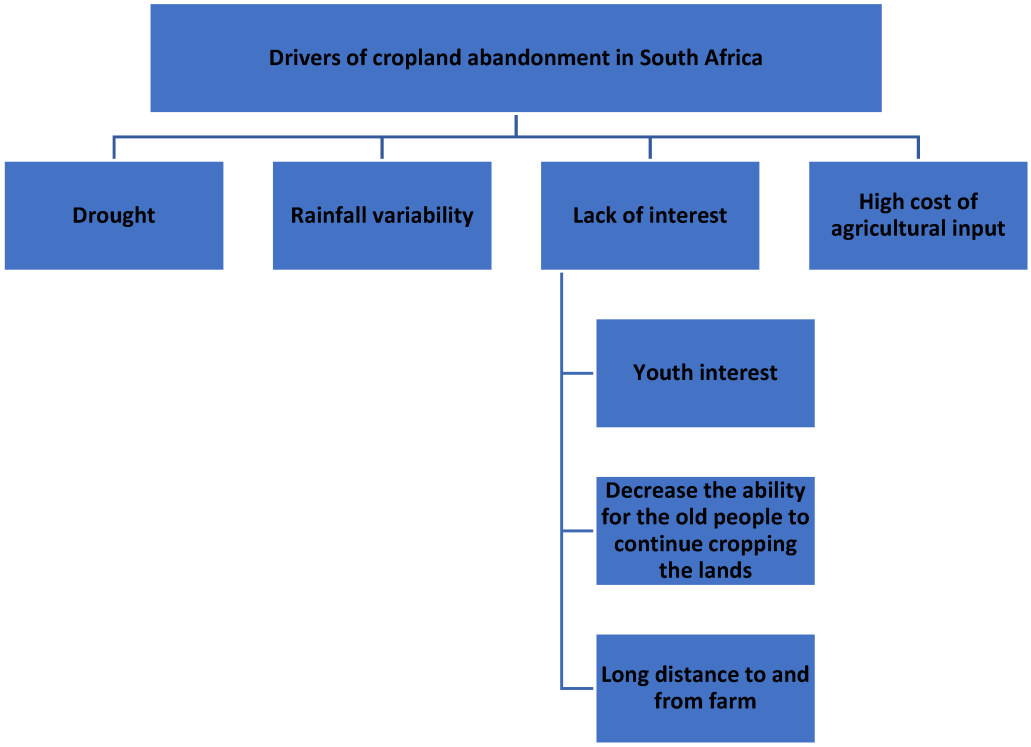

Figure 1. Drivers of cropland abandonment.

The high costs of fertilisers prevent its widescale use in communal areas, particularly in the larger fields which are distant from households. The large fields require large quantities of fertiliser which will be costly for smallholder, poorly-resourced, communal farmers who usually plant the less profitable rainfed maize. Fields closer to homes are sometimes called gardens and farmers usually plant vegetables and high-value cash crops with high returns, making fertilisation economic. Roberts et al. [13] noticed a significantly decreased fertility in soils further afield than those closer to homes; furthermore, Mandiringana et al. [14] attributes the low soil fertility status in smallholder, communal farmer fields to continuous cultivation of land without nutrient replenishment. Kakembo and Rowntree [15] cited reduced soil fertility as one of the reasons for cropping land abandonment in the Eastern Cape Province of South Africa.

2. Economic Impacts Associated with Abandonment of Croplands

Large commercial farms dominate the South African agriculture economy. The high efficiency in production, due to mechanization, adoption of improved technologies, and affordable financing, has disadvantaged small-scale unmechanised farming systems that are characterized by high production costs [10] and low quality and quantity of crops produced per hectare. In addition, poor access to markets by smallholder farmers and intense competition from commercial farmers, which results in unfavourable prices, further push them out of farming. Even though the economy is one of the key drivers of land abandonment [16], the abandonment of cropland affects the agrarian society in South Africa in different ways. This can happen through changes in the ecosystem services and also the negative impact on food security. Similarly, [17] also highlighted that the abandonment of land depresses the economic status of the low-income areas through the destruction of ecosystem services expected from the land. Most of these South African arable lands are known to provide food for most communities [18] and their nonuse will accelerate poverty and food insecurity. Furthermore, cropping cessation will result in a decreased contribution to the gross domestic product, especially if some of these abandoned lands were used for export crops [19]. The failure to meet the local demand for grain has opened the country to international trade with the imported grain being cheaper due to respective countries subsiding their farmers and also being efficient in production. This results in locally-produced grain being expensive and thus the failure to get the market [8] to discourage continued production by smallholder farmers. Though there are several challenges to re-cultivating the abandoned lands, such as environmental and economic costs [20], in a study conducted in Spain on the economic effects of re-cultivating the abandoned land, Corbelle-Rico et al. [19] revealed there can be a higher income generated through re-cultivating the abandoned lands and if attempted in South Africa, with support from the government, it can improve the economic fortunes of the smallholder farmers.

3. Successional Trajectories

Secondary succession is a natural process in abandoned agricultural land that starts with short-life-span annual weeds and biennials, then perennials and grasses to short-life-cycle, fast-growing woody species [21]. It is also called passive

restoration, while human intervention in the succession process through reseeding native grasses [22] and legumes [23][24], improving soil water retention, use of fire, grazing management, and controlling invasive species are considered active restoration. In passive restoration or natural succession, it takes a very long time for the species composition to be like that of natural communities [25]. In extreme cases, it sometimes fails to return to its original state. Multiple factors affect this complex succession process and they include soil fertility, topography, parent material, soil seed bank, soil moisture, and temperature regimes [26] (**Figure 2** and **Figure 3**). Topography and parent material determine soil resource availability. South-facing sunny slopes are characterized by thinly scattered vegetation due to weaker soil development while north-facing shady slopes have thick dense vegetation due to nutrient-rich soils. Less steep slopes are high in species diversity due to a fast rate of secondary succession [27]. Variations in succession rate, species composition, and diversity were also observed in soil derived from different parent material. For example [28], poorer and sandier granite-based soils had higher rates of species recovery compared with more nutrient-rich basalt soils. The chemical and physical soil properties derived from the underlying parent material influence the soil microclimate and fertility. Propagule source and seed dispersal also affect secondary succession and the effect of distance to natural vegetation is critical [29]. Human-induced factors include utilisation and management after abandonment, such as grazing and fire [30].

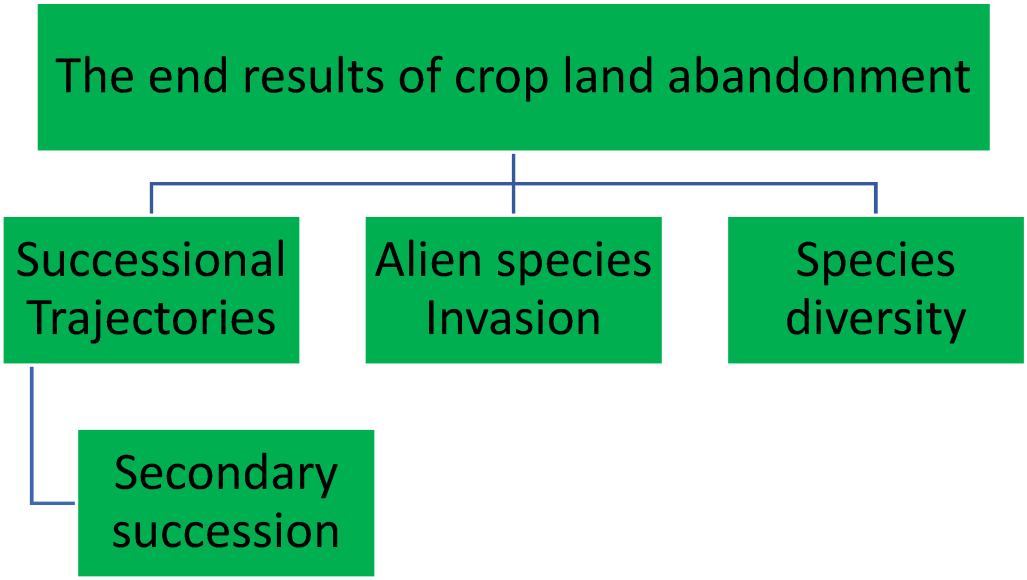

Figure 2. The end results of cropland abandonment.

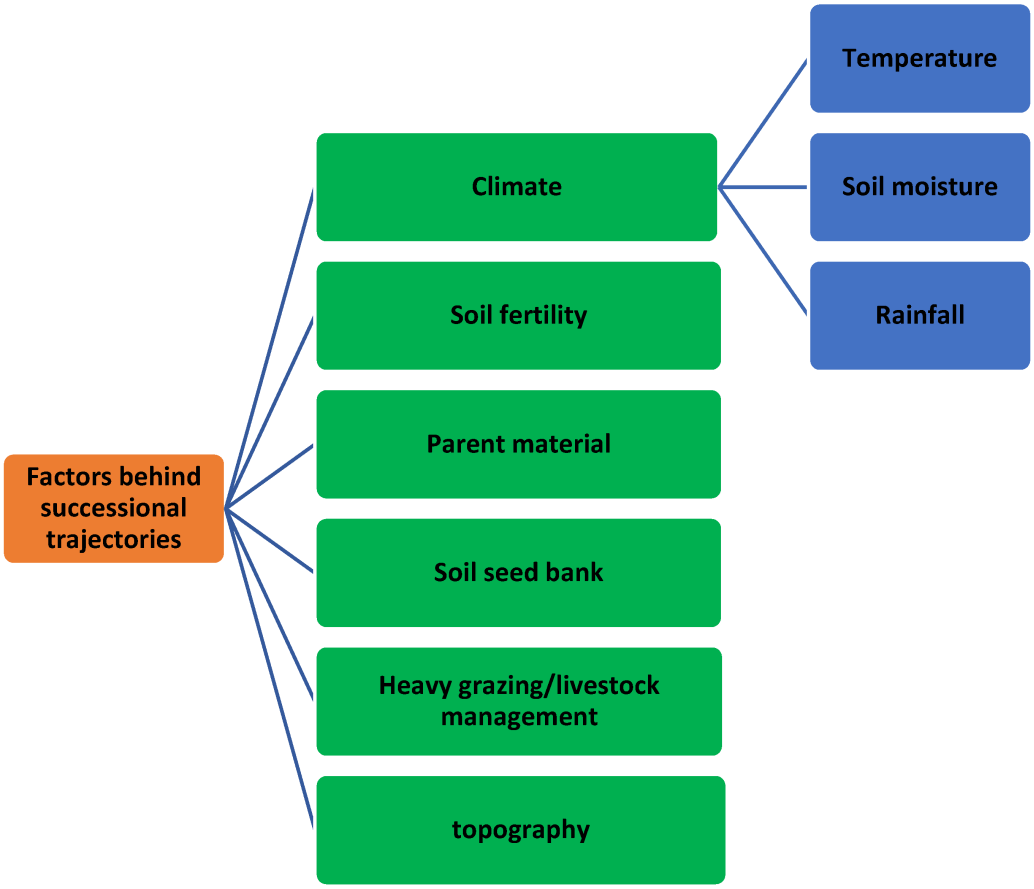

Figure 3. Factors behind successional trajectories.

On a large scale, climate is significant in affecting plant succession. In the tropics, natural succession strongly influences the succession trajectory towards the original state [31] while in semi-arid areas, such as South Africa, active restoration is more effective than natural succession [32]. Soil moisture affects the rate and direction of succession as it differentially affects the germination and growth of different plant species. A slow rate of secondary succession was observed in abandoned arable land in a semi-arid area of Zimbabwe [33]. Soil moisture and available phosphorus content decreased steadily with field age after their abandonment, whereas pools of organic matter, total and available nitrogen, potassium, and total phosphorus, increased with field age. The rate of succession is reported to be limited by water stress and propagule shortage [34]. Chambers et al. [35] observed that in low rainfall years, moisture supplementation in grass-reseeded, abandoned croplands in semi-arid areas increased seeded plant density and biomass. It is therefore vital that abandoned cropland restoration programmes aimed towards a final state of grazing land use should consider the average annual rainfall and the invasive species composition and abundance in the area [36]. The importance of soil moisture levels on the success of restoration initiatives was observed by Porensky et al. [36] who after terminating irrigation of seeded native grasses, saw that their abundance significantly decreased in successive years. Furthermore, Chang et al. [37] highlights that the natural recovery of plant communities in semi-arid areas is slow and therefore, recommends the need for properly managed revegetation initiatives.

Evaluation of the impact of cropland abandonment can be from either an ecological restoration or a degradation lens. In South Africa, cropland abandonment is considered a negative phenomenon as it causes food insecurity and reduces livelihood options [8][29] for rural people whose agriculture is their main source of income. In the long term, if abandoned agricultural land is not managed properly, there are negative effects on the ecosystem due to bush encroachment and alien species invasion.

The trajectory and speed of secondary succession depend on the severity of damage to vegetation and soil properties by previous cultivation practices [29]. Soil nutrients are depleted by inherent cultivation practices engaged by communal farmers and characterised by the lack of fertiliser application. Furthermore, the cultivation of crops reduces the soil seed bank through successive elimination of weeds [38]. Disturbances after abandonment, such as herbivory [39], fire, and fuelwood harvesting [40], will also influence the trajectory of the succession. In addition, on a broader scale, succession will be influenced by biophysical features while the proliferation of invasive species [41][42] also diverts the normal succession process. Soil type has a varied effect on succession depending on the stage of succession. The level of soil nutrients changes with time after abandonment. For example, phosphorus decreases while nitrogen was observed to increase with time [43].

3.1. Alien Species Invasion

Abandoned arable lands provide favourable conditions for invasive alien species [44] due to the poor seed bank of native species. Furthermore, the high seed productivity and dispersal by invasive species make them outcompete native plant species [3] for high nutrients from previous fertiliser applications. Alien invasive plants' increase in an area reduces the native seed bank species' richness, density, and diversity [45]. Invasive species which have colonised abandoned arable lands in the Eastern Cape include *Acacia mearnsii* [46][47], while in the drier areas indigenous shrubs such as *Pteronia incana* [48][49] have dominated. Cropping abandonment and the abandonment of pastoral practices have had some negative consequences, such as the penetration of invasive species. The increase in woody vegetation cover in the Eastern Cape has been attributed to arable land abandonment. Blair et al. [10] reported that woody vegetation has increased of up to 0.16% per annum in South Africa`s former homeland areas. Similarly, Shackleton et al. [50] observed a doubled hectarage of forests and woodlands from 1961 to 2009 in the coastal communal areas of the Eastern Cape. Njwaxu and Shackleton [51] also noted an increase in woody cover in relation to the age of abandonment.

3.2. Species Richness

Early stages of succession are characterised by low species richness because the first colonisers of abandoned lands are annuals and forbs [52]. Plant species that grow vigorously when there is less interspecific competition will quickly dominate in early succession, while late succession plants are drought tolerant and resilient to harsh conditions. Even though it has been widely reported that plant species richness increases with the age of abandonment [37][51][53], it however takes a very long time or fails to reach its original state. Forey and Dutoit [54] found that pristine grasslands had a higher species richness compared to nearby grasslands, which had been abandoned for more than a century. This trend of an increase in species richness with age of abandonment can be altered by environmental factors and human disturbances, such as grazing. Wehn et al. [55] contends that species richness declines with increasing time after abandonment in areas where shrub and tree encroachment dominate the succession. Soil fertility and moisture might favour the growth of woody alien

invasive species, or in semi-arid areas, heavy grazing may infer competitive advantage to woody species and thus, ultimately, alter the increase in the species richness trend. Conversely, Gibson et al. [56] observed that sheep grazing increased species richness in abandoned arable lands in calcicolous grasslands. The climate seems to have some effect on species richness changes in abandoned croplands, with aridity not improving species richness as the period of abandonment increases. This was observed by Sebego [57] in Botswana's semi-arid areas where similar species composition was found between the old fields and undisturbed areas. It is therefore critical to consider these factors when designing targeted management interventions in abandoned arable lands.

4. Conclusions

Rangeland degradation through bush encroachment and an increase in low grazing value annual grass species is an inherent problem in communal rangelands of South Africa. Abandoned croplands are an addition to the grazing area in communal areas; however, failure to manage abandoned croplands has resulted in them being turned to shrublands and hence being of diminished grazing value. Appropriate management of these abandoned croplands, which have been converted to grazing for the benefit of communal livestock farmers, would be critical in increasing the carrying capacity of grazing lands. There is no evidence in the literature that drivers of cropland abandonment in South Africa have been curtailed, and cropping will likely resume soon, therefore strategies to direct the succession towards a mid-late perennial-species-rich grassland with minimum bush density are vital. Implementing proper grazing intensities and establishing active restoration projects are some of the initiatives to be pursued. A policy environment that limits further abandonment and guides targeted active restoration initiatives would assist in preventing a successional shift towards lower grazing capacities and diminished values of ecosystem services. For them to be successful, intervention strategies on abandoned croplands should consider the effects of soil properties, soil moisture, dominant surrounding native woody species, grazing, and fire on succession trajectory.

References

1. Khanal, N.R.; Watanabe, T. Abandonment of Agricultural Land and Its Consequences. Mt. Res. Dev. 2006, 26, 32–40.
2. Bista, R.; Zhang, Q.; Parajuli, R.; Karki, R.; Chhetri, B.B.K.; Song, C. Cropland Abandonment in the Community-Forestry Landscape in the Middle Hills of Nepal. Earth Interact. 2021, 25, 136–150.
3. Hobbs, R.J.; Cramer, V.A. Why old fields? Socioeconomic and ecological causes and consequences of land abandonment. In Old Fields: Dynamics and Restoration of Abandoned Farmland; Cramer, V.A., Hobbs, R.J., Eds.; Island Press: Washington, DC, USA, 2007; pp. 1–14.
4. Keenleyside, C.; Tucker, G. Farmland Abandonment in the EU: An Assessment of Trends and Prospects; Institute for European Environmental Policy: London, UK, 2010.
5. Baxter, R.E.; Calvert, K.E. Estimating available abandoned cropland in the United States: Possibilities for energy crop production. Ann. Assoc. Am. Geogr. 2017, 107, 1162–1178.
6. Zantsi, S.; Bester, B. Farming households'livelihoods strategies in Ndabakazi villages, Eastern Cape: What are the implications to extension services? S. Afr. J. Agric. Ext. 2019, 47, 120–134.
7. Benayas, J.M.R.; Martins, A.; Nicolau, J.M.; Schulz, J.J. Abandonment of agricultural land: An overview of drivers and consequences. CAB Rev. 2007, 2, 57.
8. Mzuyanda, C.; Phiwe, J.; Mdoda, L. Factors Influencing Rain-Fed Agricultural Land Abandonment in Mnquma and Mbashe Municipalities, Eastern Cape. Int. J. Recent Technol. Eng. 2020, 9, 1213–1219.
9. Hull, E. The social dynamics of labour shortage in South African small-scale agriculture. World Dev. 2014, 59, 451–460.
10. Blair, D.; Shackleton, C.M.; Mograbi, P.J. Cropland abandonment in South African smallholder communal lands: Land cover change (1950–2010) and farmer perceptions of contributing factors. Land 2018, 7, 121.
11. Hebinick, P. Post-apartheid land and agrarian reform policy and practices in South Africa: Themes, processes and issues. In The Shadow of Policy—Everyday Practices in South Africa's Land and Agrarian Reform; Hebinck, P., Cousins, B., Eds.; Witwatersrand University Press: Johannesburg, South Africa, 2013; pp. 3–28.
12. Plieninger, T.; Gaertner, M.; Hui, C.; Huntsinger, L. Does land abandonment decrease species richness and abundance of plants and animals in Mediterranean pastures, arable lands and permanent croplands? Environ. Evid. 2013, 2, 3.
13. Roberts, V.G.; Adey, S.; Manson, A.D. An investigation into soil fertility in two resource-poor farming communities in KwaZulu-Natal (South Africa). S. Afr. J. Plant Soil. 2003, 20, 146–151.

14. Mandiringana, O.T.; Mnkeni, P.N.S.; Mkile, Z.; van Averbeke, W.; Van Ranst, E.; Verplancke, H. Mineralogy and fertility status of selected soils of the Eastern Cape Province, South Africa. Commun. Soil Sci. Plant Anal. 2005, 36, 2431–2446.
15. Kakembo, V.; Rowntree, K. The relationship between land use and soil erosion in the communal lands near Peddie Town, Eastern Cape, South Africa. Land Degrad. Dev. 2003, 14, 39–49.
16. Quintas-Soriano, C.; Buerkert, A.; Plieninger, T. Effects of land abandonment on nature contributions to people and good quality of life components in the Mediterranean region: A review. Land Use Policy 2022, 116, 106053.
17. Munroe, D.K.; van Berkel, D.B.; Verburg, P.H.; Olson, J.L. Alternative trajectories of land abandonment: Causes, consequences and research challenges. Curr. Opin. Environ. Sustain. 2013, 5, 471–476.
18. Shackleton, C.M.; Shackleton, S.E.; Cousins, B. The role of land-based strategies in rural livelihoods: The contribution of arable production, animal husbandry and natural resource harvesting in communal areas in South Africa. Dev. S. Afr. 2001, 18, 581–604.
19. Corbelle-Rico, E.; Sánchez-Fernández, P.; López-Iglesias, E.; Lago-Peñas, S.; Da-Rocha, J.M. Putting land to work: An evaluation of the economic effects of recultivating abandoned farmland. Land Use Policy 2022, 112, 105808.
20. Prishchepov, A.V.; Radeloff, V.C.; Baumann, M.; Kuemmerle, T.; Müller, D. Effects of institutional changes on land use: Agricultural land abandonment during the transition from state-command to market-driven economies in post-Soviet Eastern Europe. Environ. Res. Lett. 2012, 7, 024021.
21. Van Rheede van Oudtshoorn, F.P. The Evaluation of Various Reseeding Methods for Restoring Old Croplands in the Highveld Region of South Africa. Master's Thesis, University of South Africa, Pretoria, South Africa, 2007.
22. Albert, Á.J.; Mudrák, O.; Jongepierová, I.; Fajmon, K.; Frei, I.; Ševčíková, M.; Klimešová, J.; Doležal, J. Grassland restoration on ex-arable land by transfer of brush-harvested propagules and green hay. Agric. Ecosyst. Environ. 2019, 272, 74–82.
23. Gulwa, U.; Mgujulwa, N.; Beyene, S.T. Effect of grass-legume intercropping on dry matter yield and nutritive value of pastures in the Eastern Cape Province, South Africa. Univers. J. Agric. Res. 2017, 5, 355–362.
24. Davis, J.K.; Ainslie, A.; Finca, A. Coming to grips with 'abandoned arable' land in efforts to enhance communal grazing systems in the Eastern Cape province, South Africa. Afr. J. Range Forage Sci. 2008, 25, 55–61.
25. Ruprecht, E. Successfully recovered grassland: A promising example from Romanian old-fields. Restor. Ecol. 2006, 14, 473–480.
26. Ruwanza, S. Furrows as centers of restoration in old fields of Renosterveld, South Africa. Restor. Ecol. 2017, 35, 289–291.
27. Robinson, S.J.B.; van den Berg, E.; Meirelles, G.S.; Ostle, N. Factors influencing early secondary succession and ecosystem carbon stocks in Brazilian Atlantic Forest. Biodivers. Conserv. 2015, 24, 2273–2291.
28. Paz, C.P. Patterns of Secondary Forest Recovery in Two Soil Types. Ph.D. Thesis, James Cook University, Townsville, Australia, 2016.
29. Cramer, V.A.; Hobbs, R.J.; Standish, R.J. What's new about old fields? Land abandonment and ecosystem assembly. Trends Ecol. Evol. 2008, 23, 104–112.
30. Teira, A.G.; Peco, B. Modelling old field species richness in a mountain area. Plant Ecol. 2003, 166, 249–261.
31. Crouzeilles, R.; Ferreira, M.S.; Chazdon, R.L.; Lindenmayer, D.B.; Sansevero, J.B.; Monteiro, L.; Iribarrem, A.; Latawiec, A.E.; Strassburg, B.B. Ecological restoration success is higher for natural regeneration than for active restoration in tropical forests. Sci. Adv. 2017, 3, e1701345.
32. Zethof, J.H.T.; Cammeraat, E.L.H.; Nadal-Romero, E. The enhancing effect of afforestation over secondary succession on soil quality under semiarid climate conditions. Sci. Total Environ. 2019, 652, 1090–1101.
33. Gotosa, T.N.; Gotosa, J.; Katsvanga, C.A.T.; Nyakudya, I.W.; Mapaure, I. Woody vegetation diversity and regeneration in an abandoned sugar estate in semi-arid Zimbabwe. J. Anim. Plant Sci. 2013, 23, 1370–1378.
34. Lesschen, J.P.; Cammeraat, L.H.; Kooijman, A.M.; van Wesemael, B. Development of spatial heterogeneity in vegetation and soil properties after land abandonment in a semi-arid ecosystem. J. Arid Environ. 2008, 72, 2082–2092.
35. Chambers, J.C.; Eldredge, E.P.; Snyder, K.A.; Board, D.I.; de Queiroz, T.F.; Hubbard, V. Restoring abandoned agricultural lands in cold desert shrublands: Tradeoffs between water availability and invasive species. Invasive Plant Sci. Manag. 2014, 7, 176–189.
36. Porensky, L.M.; Leger, E.A.; Davison, J.; Miller, W.W.; Goergen, E.M.; Espeland, E.K.; Carroll-Moore, E.M. Arid old-field restoration: Native perennial grasses suppress weeds and erosion, but also suppress native shrubs. Agric. Ecosyst. Environ. 2014, 184, 135–144.

37. Chang, X.; Chai, Q.; Wu, G.; Zhu, Y.; Li, Z.; Yang, Y.; Wang, G. Soil organic carbon accumulation in abandoned croplan ds on the loess plateau. Land Degrad. Dev. 2017, 8, 1519–1527.
38. Riedel, S.M.; Epstein, H.E. Edge effects on vegetation and soils in a Virginia old-field. Plant Soil. 2005, 270, 13–22.
39. Ingram, J.; Kirkpatrick, J.B. Native vertebrate herbivores facilitate native plant dominance in old fields while preventing native tree invasion: Implications for threatened species. Pac. Conserv. Biol. 2013, 19, 331–342.
40. Hajdu, F.; Neves, D.; Granlund, S. Changing Livelihoods in Rural Eastern Cape, South Africa (2002–2016): Diminishing Employment and Expanding Social Protection. J. S. Afr. Stud. 2020, 46, 743–772.
41. Kuebbing, S.E.; Souza, L.; Sanders, N.J. Effects of co-occurring non-native invasive plant species on old-field successi on. Forest Ecol. Manag. 2014, 324, 196–204.
42. Jevon, T.; Shackleton, C.M. Integrating local knowledge and forest surveys to assess Lantana camara impacts on indig enous species recruitment in Mazeppa Bay, South Africa. Hum. Ecol. 2015, 43, 247–254.
43. Walton, B.A. Vegetation and Dynamics of Renosterveld at Agter-Groeneberg Conservancy, Western Cape, South Afric a. Ph.D. Thesis, University of Stellenbosch, Stellenbosch, South Africa, 2006.
44. Meiners, S.J.; Pickett, S.T.A.; Cadenasso, M.L. Exotic plant invasions over 40 Years of old field successions: Communit y patterns and associations. Ecography 2002, 25, 215–223.
45. Gioria, M.; Jarošík, V.; Pyšek, P. Impact of invasions by alien plants on soil seed bank communities: Emerging patterns. Perspect. Plant Ecol. Evol. Syst. 2014, 16, 132–142.
46. Ruwanza, S. Invasion of abandoned agricultural fields by Acacia mearnsii affect soil properties in Eastern Cape, South Africa. Appl. Ecol. Environ. Res. 2017, 15, 127–139.
47. Scorer, C.; Mantel, S.K.; Palmer, A.R. Do abandoned farmlands promote spread of invasive alien plants? Change dete ction analysis of black wattle in montane grasslands of the Eastern Cape. S. Afr. Geogr. J. 2018, 101, 36–50.
48. Kakembo, V. Vegetation patchiness and implications for landscape function: The case of Pteronia incana invader speci es in Ngqushwa Rural Municipality, Eastern Cape, South Africa. Catena 2009, 77, 180–186.
49. Haussmann, N.S.; Delport, C.; Kakembo, V.; Mashiane, K.K.; le Roux, P.C. Restoration Potential of Invaded Abandone d Agricultural Fields: What Does the Seed Bank Tell Us? Restor. Ecol. 2019, 27, 813–820.
50. Shackleton, R.; Shackleton, C.; Shackleton, S.; Gambiza, J. Deagrarianisation and forest revegetation in a biodiversity hotspot on the Wild Coast, South Africa. PLoS ONE 2013, 8, e79939.
51. Njwaxu, A.; Shackleton, C.M. The Availability of Non-Timber Forest Products under Forest Succession on Abandoned F ields along the Wild Coast, South Africa. Forests 2019, 10, 1093.
52. Giourga, H.; Margaris, N.S.; Vokou, D. Effects of Grazing Pressure on Succession Process and Productivity of Old Fiel ds on Mediterranean Islands. Environ. Manag. 1998, 22, 589–596.
53. Zhang, J.T. Succession analysis of plant communities in abandoned croplands in the eastern Loess Plateau of China. J. Arid Environ. 2005, 63, 458–474.
54. Forey, E.; Dutoit, T. Vegetation, soils and seed banks of limestone grasslands are still impacted by former cultivation on e century after abandonment. Community Ecol. 2012, 13, 194–202.
55. Wehn, S.; Taugourdeau, S.; Johansen, L.; Hovstad, K.A. Effects of abandonment on plant diversity in semi-natural gras slands along soil and climate gradients. J. Veg. Sci. 2017, 28, 838–847.
56. Gibson, C.W.D.; Watt, T.A.; Brown, V.K. The use of sheep grazing to recreate species-rich grassland from abandoned a rable land. Biol. Conserv. 1987, 42, 165–183.
57. Sebego, R.J. Field Abandonment and Secondary Succession: Implications on the Quality of Grazing in Kweneng-Nort h, Botswana. Botsw. Notes Rec. 2006, 83, 43–59.