Investigating farm-level exit decisions and exit rates in commercial agriculture in South Africa, an agent-based approach

by

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Declaration

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Abstract

Land supply is an undeniable but neglected component in the agriculture transformation debate, with discussions on and research in the field of structural change in the sector considered overdue. The structural transformation of the agricultural sector rests on the interplay between exogenous and endogenous decisions in the agricultural sector that feed back into the sector's operations, as a collective, and the role players within it as individuals. Ignoring the factors that motivate commercial producers to exit farming has resulted in a substantial gap in the literature regarding this important component of land reform. This study aimed to uncover the reasons that lead to decisions to exit or stay by making use of an analytically rigorous process to bridge the land supply literature gap.

Considering the ex-post review of commercial agriculture over the last 100 years and its learnings, this study explores how an ex-ante modelling analysis approach to the planned and potential effects on producer numbers over the next ten years can enhance land-use planning. A core outcome of this study is the creation of a baseline projection for remaining in or exiting from primary agriculture, and how the exploration of the underlying factors in individuals' strategic decision-making can inform policy and affect structural change.

Three methods are applied in this study. The characteristics of producers planning to exit were identified through clustering. A consequent regression analysis determined the drivers of the ex-ante decision to exit or remain in agriculture, highlighting the interplay between business climate and capital invested. An agent-based model was constructed to create a virtual laboratory in which the output provides insight into how the structure of the sector – demographics, land use, production output, farm size and numbers – will change as the aggregate of the decisions made at the individual farm level drives the structural change at a sector level.

Findings from the cluster analysis show that farm exit decisions are affected by financial problems, access to dependable labour, uncertainty regarding land reform policy and concerns about rural safety. In the subsequent regression analysis that was performed to order the key drivers, age (as a categorical variable), cost of investment and financial constraints feature most prominently in the decision to exit, whilst the presence of production loans and business confidence are significant in countering the decision to exit. From the cluster and regression analyses, two alternative scenarios were constructed in

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which some factors that appear to keep producers locked in were removed. The outcomes thereof were then compared to the baseline exit rate from the extrapolated and upscaled survey data. The baseline and two alternative scenarios in the agent-based model provided exit rates of 22.43%, 25.63% and 34.81%, respectively over ten-year periods, with the structural effects of the different rates discussed at a sub-sector level. Consideration is given to the barriers to exit, which subsequently limit the opportunities and scope for new entrants into commercial agriculture.

This output is a critical element in the continued interaction between demand for and supply of land in the land reform debate.

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Opsomming

Grondvoorsiening is ’n onmiskenbare maar verwaarloosde komponent van die landbou-transformasie debat, met besprekings van en navorsing in die gebied van strukturele verandering in die sektor wat as agterstallig beskou word. Die strukturele transformasie van die landbousektor berus op die samespel tussen eksogene en endogene besluite in die landbousektor wat terugvoer in die sektor se bedrywighede as ’n kollektief, en die rolspelers daarbinne as individue. Deur die faktore wat kommersiële produsente motiveer om uit boerdery te tree, te ignoreer, het gelei tot ’n aansienlike gaping in die literatuur met betrekking tot hierdie belangrike komponent van grondhervorming. Hierdie studie het gepoog om die redes te ontbloot wat lei tot besluite om uit boerdery te tree of daarin te bly deur gebruik te maak van ’n analities streng proses om die gaping in die literatuur oor grondvoorsiening te oorbrug.

Deur die ex-post hersiening van kommersiële landbou oor die afgelope 100 jaar te oorweeg en wat mens daaruit kan leer, verken hierdie studie hoe die benadering van ’n ex-ante modellerings-analise tot die beplande en potensiële effekte op produsentgetalle oor die volgende 10 jaar grondgebruiksbeplanning kan verbeter. ’n Sentrale uitkomste van hierdie studie is die skepping van ’n basislyn projeksie vir die inbly in of uittree uit primêre landbou te skep en hoe ’n verkenning van die onderliggende faktore in individue se strategiese besluitneming beleid kan informeer en strukturele verandering kan affekteer.

Drie metodes is in hierdie studie toegepas. Die kenmerke van produsente wat beplan om uit te tree, is by wyse van trosvorming (*clustering*) geïdentifiseer. ’n Gevolglike regressie-analise het die drywers van die ex-ante besluit om uit landbou te tree of daarin te bly bepaal, wat die samespel tussen sakeklimaat en die kapitaal wat belê is, uitlig. ’n Agentgebaseerde model is gekonstrueer om ’n virtuele laboratorium te skep waarbinne die uitset insig verskaf in hoe die struktuur van die sektor – demografie, grondgebruik, produksie-uitset, plaasgrootte en getalle – sal verander soos die totaal van besluite wat op die individuele plaasvlak gemaak word strukturele verandering op ’n sektorvlak sal dryf.

Die bevindinge van die trosanalise toon dat besluite om uit boerdery te tree beïnvloed word deur finansiële probleme, toegang tot betroubare arbeid, onsekerheid oor grondhervormingsbeleid en kommer oor landelike veiligheid. In die gevolglike regressie-analise wat onderneem is om die belangrikste drywers te orden, is gevind dat ouderdom (as

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’n kategoriese veranderlike), koste van belegging en finansiële stremming prominent na vore gekom het in die besluit om uit te tree, terwyl die teenwoordigheid van produksielenings en sakevertroue prominent was in die besluit om nie uit landbou te tree nie. Vanuit die tros- en regressie-analise is twee alternatiewe scenario’s gekonstrueer waarin sommige van die faktore wat geblyk het om produsente ingesluit te hou, verwyder is. Die uitkomste hiervan is toe met die basislyn uittree-tempo vanaf die geëkstrapoleerde en opgeskaalde opname-data vergelyk. Die basislyn en twee alternatiewe scenario’s in die agentgebaseerde model het uittree-tempo’s van 22.43%, 25.63% en 34.81% onderskeidelik oor tydperke van tien jaar getoon, met die strukturele effekte van die verskillende tempo’s wat op ’n subsektor-vlak bespreek word. Aandag word ook geskenk aan die versperrings vir uittree, wat gevolglik die geleenthede en omvang vir nuwe toetreders tot kommersiële landbou beperk.

Hierdie uitset is ’n kritiese element in die voortgesette interaksie tussen vraag na en aanbod van grond in die grondhervormingsdebat.

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En hij vervolgde: 'Wees sterk en moedig en ga aan het werk. Laat de omvang van deze taak u niet afschrikken, want de Here, mijn God, helpt u, Hij zal u niet in de steek laten. Hij zal ervoor zorgen dat al dit werk op de juiste wijze wordt gedaan.

1 Kronieken 28:20

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Preface

This dissertation is presented as a compilation of five chapters. Each chapter is introduced separately and is written according to the style of the journal to which it was submitted for publication:

Chapter 1	Introduction
Chapter 2	Cloete, K., Greyling, J.C. & Delport, M. 2022. Strategic perspectives on quitting or remaining in commercial agriculture in South Africa and why it matters. *Agrekon.* DOI: 10.1080/03031853.2022.2032222 The chapter is concerned with computing a baseline exit rate and identifying four groups of producers in terms of their perceptions and how these affect their strategic decision-making to continue in primary agriculture or to exit and sell their farms; this was done by making use of a *k*-means cluster analysis. The candidate was responsible for collecting, digitising and cleaning the data used to construct the dataset. The candidate was also co-responsible for the conceptualisation of the analysis. Delport was responsible for analysing the data, with Greyling co-responsible for the conceptualisation and assisting with background research.
Chapter 3	Cloete, K., Mann, S. & Delport, M. 2021. Confident or captured? Commercial producers in South Africa. *International Journal of Social Economics*. DOI:10.1108/IJSE-08-2021-0510 The chapter reports on the drivers in the decision to exit or remain in agriculture and depicts the rather complex interplay between the two main factors that may keep farms in business: a positive business climate and the capital invested. The candidate was responsible for collecting, digitising and cleaning the data used to construct the dataset. The candidate was also responsible for the conceptualisation of the analysis. Delport was responsible for the analysis, with Mann providing inputs on adaptions to the analysis and providing a theoretical framework for the approach.
Chapter 4	Cloete, K., Möhring, A. & Zantsi, S. 2021. *Accelerated exiting of captured commercial producers and the structural impact thereof: An agent-based approach.* Department of Agricultural Economics, Stellenbosch University.

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This chapter illustrates the use of agent-based modelling as a virtual laboratory to test the effect of a certain policy or projection before the implementation or occurrence thereof. The structural effect on the agricultural sector of the baseline exit rate and two alternative scenarios of accelerated exiting were modelled. The candidate was responsible for the conceptualisation, adaptation of the ILUPSA model and execution of the analysis. Möhring and Zantsi were co-creators, together with Cloete and Gabriele Mack, in the construction of the initial ILUPSA model. They also assisted with the model validation.

Chapter 5 Summary and conclusion

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Chapter 1:

Introduction

1.1 Background and context

In recent years, discussions on and research in the field of commercial agricultural land have been approached, almost exclusively, from a land demand perspective (see, for example, Lahiff & Cousins, 2005; Chisasa, 2019; Zantsi *et al*., 2021 on smallholders, and Hall, Kleinbooi & Mvambo, 2001; Moseley, 2006; Lemke & Jansen van Rensburg, 2014). Furthermore, the reality of transformation towards a higher level of racial inclusivity through the land redistribution process in South African agriculture is that of slow progress and few success stories. Symptoms of the slow progress and poor implementation include targets often not met, questionable selection of beneficiaries, and not recognising or considering the heterogeneity of land, industry and people in policy (see Department of Rural Development and Land Reform [DRDLR], 2013; Dlamini, Verschoor & Fraser, 2013; Cousins, 2016; Kirsten *et al*., 2016; Bureau for Food and Agricultural Policy [BFAP], 2018; Sebola, 2018; Zantsi, 2021).

However, in the land redistribution and racial transformation experience and debate in South Africa, the 'other half of the coin', namely land supply, has been neglected. Discussions on and research in the field of structural change in the industry from a land supply perspective are long overdue.

Structural change, or the long-term evolution of farm structure and organisation in response to changes in consumer demand, agricultural policy, climate and technology, etc., is one of the central elements that shape the agricultural sector (Chavas, 2001). Collectively, these factors shape the number of farming units, indicative of producer numbers, cropping mixes and land-use patterns; the extent of mechanisation; labour use; and the structure of value chains. Structural change within South African agriculture has been the topic of various studies that either describe the ex-post long-term structural change observed within the sector (e.g. Troskie, 2001; Liebenberg, 2012), or the effect of agricultural policy on this process (e.g. Kirsten, 2006; Vink, 2012; Greyling, 2019).

One of the key components of structural change within the sector is the exit issue, or changes in the number of farming units and, by implication, farm size. Whilst the long-term trend is known, the key drivers of the decline in the number of farming units and expected

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trajectory going forward are yet to be studied. Therefore, the objective of this study is to transition from an ex-post to an ex-ante analysis of structural change in South African agriculture with an emphasis on exit decisions and, within that, to determine the extent to which transitioning from an ex-post to ex-ante analysis can enhance land-use planning.

To provide the ex-post context, a brief literature review of structural change and transformation and their effects on agriculture is provided. After the provision of this context, the development pathways in South African commercial agriculture and the biggest factors that played a role in the observed structural change are discussed. Of particular interest in this research is the rate at which commercial producers in South Africa exit over time, leading to a review of the main considerations in the decision to contract or expand investment that could have affected the observed change. Whilst such a review contextualises the voluntary considerations in the decision, the review would by incomplete without discussing the involuntary aspects that prevent existing producers from making a contracting investment decision and the implications thereof.

1.1.1. Structural change and transformation and its effect on agriculture

Leontief (1941: 203-204) defines structure as "the interdependence between the quantities of the inputs absorbed, and the amounts of the product or products turned out in a given process". Wherever there is a compilation of elements or an arrangement of parts within a larger order, there is a structure. Wherever there is a structure, the prospect of change exists. This phenomenon is because of the effect that endogenous and/or exogeneous forces can have on the structure. The term 'structural change' is denoted on the sectoral level from output to employment, industry organisation to firm composition, financial systems to political institutions, demography to value systems, distribution of wealth to income, and many more. Structural change, as a concept, is therefore ingrained in the very core of the world we live in and which surrounds us (Matsuyama, 2005). According to Coxhead (2011: 2) "growth inevitably involves change in the product mix of production, demand and trade". It hence causes a structural change in any or all of the sectoral composition of gross domestic product (GDP), the allocation of resources and the distribution of income.

Chenery's (1988: 205) views on structural transformation consider that "these processes include a reciprocal interaction between the increasing income and the change in the proportion of the supply and demand, and they are affected by macroeconomic and

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sector policies". Using this statement by Chenery as a basis, Marjanović (2016: 64) explains that "(t)he essence of structural transformation is the accumulation of physical and human capital, but also the changes in the composition of demand, production, employment and trade". The interrelated processes of iterative structural changes and economic development are consequently called structural transformation. Structural transformation seems to be used to describe the encompassing economic change through both structural change and structural dynamics.

Bonnen and Schweikhardt (1998) argue that the structural transformation of the agricultural sector resulted in a more fragmented sector to a certain extent. At a subsector level, structural change is driven by the economic characteristics, degree of economic stability, and level of vulnerability of such a subsector. As such, observations can be made at an aggregate level, but the conclusions drawn must be contextualised at a more disaggregated level of detail.

1.1.2. Development pathways in South African commercial agriculture

In the case of causal looping within an ever-changing open system – endogenous and exogenous agents acting and constantly reacting – each decision will change oneself and others in the future. When these changes are dramatic enough, they result in a structural change. South African commercial agriculture has experienced at least four such structural shifts in the last century, transforming the sector (see Vink, 1993; Greyling, Vink & Mabaya, 2015) and affecting farm and producer numbers. The ever-changing environment – social, economic, political, climatic, technological – played its role in the increase from 76 149 to 119 556 farms in 1952 and the subsequent decline to 40 122 farms in 2017 (Liebenberg, 2012; Statistics South Africa [StatsSA], 2020). This 65-year period resulted in an annual average decline of 1.81%. This decline is discussed in more detail later.

Since 2007, enterprises registered for value-added tax (VAT) have formed the basis for farm number reporting in the census of commercial agriculture (StatsSA, 2010, 2020). Entities with a turnover below R1 million per annum are excluded from obligatory registration for VAT, which means farm numbers could potentially be underestimated. Kirsten and Sihlobo (2019) estimate that, apart from the VAT registered entities captured in the census, there are an additional 30 000 micro-commercial enterprises. Whereas this may be true in terms of the total number of entities, a counter argument for lower producer numbers (i.e. land owners)

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can be made within the context of these VAT-registered entities. An alternative indication of producer numbers can be derived from the incorporation of plant producer information[1] for the period 2008 to 2017 into the farm number calculation, which leads to an estimation of a total of no more than 36 805 individual VAT-registered producers in 2017 (National Department of Agriculture [NDA], 2008; Department of Agriculture, Forestry and Fisheries [DAFF], 2015, 2020) compared to the 40 122 in the 2017 census. Given the business confidence of producers in the current political and socio-economic climate, some producers with multiple production units opt to register each entity individually as part of their risk mitigation strategy. With acknowledgement of critique of the accuracy of the census data and considerations for alternative figures – both higher and lower than the census data – the census data was considered the primary data source for the purpose of this study.

The four phases – 1910 to WWII, post-WWII to the 1980s, 1980s up to the first democratic elections, and post-1994 to today – are the timeframes during which policy and the business environment in general favoured certain behaviour strongly enough to cause a definitive shift over time, ultimately affecting the pathways of the sector's development and resulting in a structural transformation (Vink, 1993). Parallel to this transformation process, the agriculture sector's share of GDP shrank from 21% to 2.5% over the course of a century (1910 to 2010), while the GDP multiplied 27 times over the same period (measured in 2005 rand value) (Liebenberg, 2012).

During the first phase, in the period from 1910 to the 1940s, there was a political effort to segregate producers regarding their participation in the economy and their land ownership. During this phase, which lasted until after WWII, production was mostly livestock orientated, with little arable land because of the lack of tractors and implements. Very large parcels of land were a challenge to manage, with the subdivision of land (mostly between heirs) resulting in smaller, more manageable farms and an increase in producers. With the

[1] By integrating this data with information on food business operators (FBO), where farms have to be registered as production units to obtain a production unit code (PUC) in order to export plant products or products of plant origin, an alternative estimate of farm owner numbers is presented. From the analysis of 14 084 PUCs, 635 producer names were linked to 2 496 different farm names (often indicated as a company name). This is indicative that individual producers operate multiple land parcels under different company names and, consequently, can lead to overestimating the number of unique producers by considering VAT registrations. Furthermore, another 1 194 producer names were linked to the same farm name, but with multiple PUCs – indicative of the same owner operating different production units under the same company name.

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adoption of more modern implements at that time, employment in agriculture increased, along with the cultivation of crops. Furthermore, the Agricultural Marketing Act of 1937 was passed in this period to stabilise and maintain incomes generated from agriculture (Vink, 1993; Liebenberg, 2012).

During the second phase (post-WWII to 1981), the policy environment favoured an expansion in farm size and subsequent decline in producer numbers. According to Van Zyl, Binswanger and Thirtle (1995), distortionary policy measures, such as tax incentives on depreciation, accelerated the acquisition of machinery at the farm level, affecting employment levels and the productivity ratios of labour to capital and land to capital. Measures, such as the Agricultural Marketing Act (Act 59 of 1968), were introduced and remained prevalent during this phase (Van Rooyen *et al*., 1996).

The third period of structural change lasted until 1993. During this phase of increased liberalisation and deregulation of marketing in the agricultural sector, farm numbers remained relatively constant at an aggregated level. The state assisted producers who had trouble keeping afloat during droughts, which affected dryland field crops more than the horticultural industry. Whilst fruit and vegetable production consistently increased during this phase, production volumes of maize, wheat and sunflower seeds were more volatile, with a contraction in the area under field crops. The opening of international markets for fresh produce promoted intensive agriculture on smaller parcels, and the reductions observed in field crop area contributed to flattening the farm exit curve (Vink, 1993; DAFF, 2013).

In the fourth and final historical phase, from 1994 to the present, the sector has gone through substantial policy reform. Amongst other changes, there was trade liberalisation, agriculture marketing deregulation and drastic subsidy cuts. As a result of the changes in the policy space, land use, economic farm unit size and labour use changed. Firstly, there was a shift towards greater land allocation to livestock and horticultural production at the expense of field crops, as marginal field crop production area was reallocated to livestock and irrigated arable land was reallocated to horticultural use. Although policy changes resulted in a contraction in hectares allocated to grains, production still expanded due to technological advances (Department of Agriculture, Land Reform and Rural Development [DALRRD], 2021).

This shift is observed in the 2007 census and again in the 2017 census. Average farm size also increased as producers attempted to sustain their livelihoods under the new circumstances, with the number of farms shrinking by one third over the course of this period.

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Despite the growth in intensive crop production, such as in the horticulture sub-sector, employment in the sector continued to decline as capital investment in technology improved land productivity and labour productivity per unit of land and capital (Greyling *et al*., 2015).

According to the 2017 census of 40 122 farms, 11.1% of farms earned 76.7% of the income realised in commercial agriculture whilst employing 62.9% of the total agricultural workforce at a ratio of 1:0.82 (one unit of revenue from 0.82 units of labour). Consequently, the 88.9% commercial production units, ranging from micro- to small-sized, employed 37.1% of the labourers whilst collectively earning 23.3% of the total revenue at a ratio of 1:1.59 (StatsSA, 2020). Van Zyl *et al*. (1995) found that the smallest third of farms in their sample were more efficient than larger farms from a total factor productivity perspective and more labour intensive than their larger counterparts. The 2017 census data concurs with Van Zyl *et al*. (1995), who found that micro- to small-sized farms are creating more job opportunities per unit of agricultural output than medium-sized and large farms. Considering the skewed income realisation mentioned previously, it appears that this increase in labour use ultimately coincides with lower relative incomes, but also signals a lack of critical mass to adopt labour-saving technology.

The fact that producers had adapted sufficiently to the post-1994 free market system gave rise to a stouter agricultural sector in South Africa from the 2000s due to increased productivity, limited reliance on subsidies and participation in international trade – assisted in some instances by the ever-weakening rand. Yet challenges remain. Two of these are the lack of business confidence and the limited transformation of the sector towards an inclusive and vibrant rural economy. These factors pose some of the biggest challenges to the sector's long-term sustainability (Greyling *et al*., 2015; Stoddard, 2020).

1.1.3. Main considerations in the decision to contract or expand investment

In his book, *Exit, Voice and Loyalty*, Albert O. Hirschman (1970) proposes exit and voice as two opposing responses to demonstrate an aversion to the status quo – quietly exiting or vocalising dislike. The former only provides a warning sign of decline, whereas the latter, expressing discontent, provides a greater opportunity for information to filter through, reducing exiting. Conversely, when voicing is used without success, it can accelerate departure. This phenomenon sparked the idea that consideration needs to be given to the

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factors resulting in the decision to contract or exit completely, and the alternative of expanding investment.

Based on a review of numerous international literature sources (Gale, 2003; Rural Industries Research and Development Corporation [RIRDC], 2007; Martini & Kimura, 2009; National Farmers Union [NFU], 2011; Katchova & Ahearn, 2014; Antman *et al.*, 2015; Lowder, Skoet & Raney, 2016; European Commission, 2017; Shimizu, 2017; Padmanabhan, 2018; Ramsey, Ghosh & Sonoda, 2019), it became clear that three categories of factors appeared to have the largest effect on the change in producer numbers, whether increasing or decreasing them. Within the context of investment in agriculture, or the withdrawal of investment from agriculture, the factors can be divided into three groups – personal, financial and policy – although with some interrelated occurrences.

Personal considerations, whether mental, social, cultural or emotional, are essential in deciding to invest or divest, especially with respect to farmland. Often, divestment coincides with urbanisation, where higher levels of education and the opportunity to generate income from sources outside of farming reduce the rural population. For some, choosing a different lifestyle leads to a choice to pursue a specific career, whilst for others, the career path unavoidably changes their lifestyle. Regardless of the drivers of change, the result is the same: fewer producers and an increase in the average age of producers (Gale, 2003; Katchova & Ahearn, 2014; European Commission, 2017; Shimizu, 2017).

One example of an exception to the rule of urbanisation leading to divestment in agriculture can be observed in India. Despite rapid urbanisation, average farm size has decreased considerably over the last 50 years. Land parcels are divided between multiple heirs, leading to smaller farms with every new generation. Despite large numbers of rural people moving to the cities for work, this trend continues. The application of fertilisers and other technology as part of the intensification strategy by smaller producers is not enough to sufficiently grow household incomes, thereby increasing the need for greater government funding. The government, however, is already supporting producers with farm subsidies and loan waivers (Lowder *et al*., 2016; Padmanabhan, 2018; World Bank, 2019a, 2019b, 2019c).

Where producers voluntarily or involuntarily supplement on-farm income with off-farm sources, the investment decision is not clear cut. The absence of divestment, and the decision to pursue another career full time, is not a proxy for investment, as these part-time producers are not necessarily using the off-farm income sources to actively invest in production

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operations with the expectation of increasing on-farm income as a result (see RIRDC, 2007; Martini & Kimura, 2009; NFU, 2011; Antman *et al*., 2015; Ramsey *et al*., 2019).

According to conventional wisdom, the idea that "you must spend money to make money" was penned by Titus Maccius Plautus, a Roman playwright who lived in the period 254 to 184 BC (KnowYourQuotes, 2020). The question is whether and to what extent this is true in primary agriculture. Financial considerations in the decision to invest or divest must be viewed in conjunction with the ability to act on the decision – if producers are not in the position to spend money, their own or through the acquisition of a loan, the opportunities to invest are, of course, limited. Some small and medium-sized producers are divesting because farming becomes unsustainable (see Gale, 2003; Gras, 2009; Chen *et al*., 2019). To offset the real decline in income at the primary production level, producers who have the means to invest do so by vertical or horizontal expansion, or both. By investing upstream or downstream in another node in the value chain, producers can expand vertically (Productivity Commission, 2005; Castro-Fontoura, 2016). In terms of horizontal expansion, the investment is serviceable when the denominator in the calculation is characterised by critical mass to warrant the outlay of technology-based productivity improvements in the numerator (MacLeod & Moller, 2006; Pedersen & Møllenberg, 2017).

The direction and intent of public policy shape the environment in which producers operate daily. As such, policy can drive both the expansion and contraction of an investment and, in some cases, the same policy will have a certain set of producers investing, whilst another set may reduce investment. For example, agricultural support through subsidies in Canada resulted in a more dualistic agricultural sector: smaller producers were able to continue operations as a result of the subsidies and their ability to take time to supplement on-farm total income with off-farm sources to sustain their livelihoods, while larger operations were able to grow as a result of land becoming available as the middle-sized producers divested (Chen *et al*., 2019).

A change in policy, such as the retraction of support and interference, including the dismantling of boards and the opening of markets, has resulted in intensification and increased total factor productivity, decreasing the number of producers and growing average farm size in both South Africa and New Zealand. The change ultimately created a climate for certain producers to seek to expand actively and for others to divest and seek other sources

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of income (see Mbongwa, Kirsten & Van Zyl, 2000; Mulet-Marquis & Fairweather, 2008; Liebenberg, 2012; Greyling *et al.*, 2015; Statistics New Zealand, 2018).

Business confidence indices are used to provide an indication of future developments and are based on opinion surveys on developments in various fields of interest related to a specific sector. According to Kershoff (2000), in South Africa, "an increase in business confidence reveals that economic growth and private fixed and inventory investment could pick up in 9 to 12 months' time. The opposite applies if confidence declines". Part of the business confidence score reflects the uncertainty about the macro-environment and, subsequently, the willingness and desire to invest during times of decline in policy uncertainty. Considering that the BER/RMB business confidence index only shows two brief stints of positive business sentiment (index value > 50%) since 2008, the opportunity for South African businesses is rather unattractive (Croucamp & Malan, 2016; Wellman, 2017; Stoddard, 2020).

The Agbiz/IDC Agribusiness Confidence Index is more specific to the agricultural industry and returns an average index value of 51.18% from 2000 to 2020 (AgBiz, 2021). How this score relates back to investment in agriculture can be deduced from analysing the deflated values for capital assets on commercial farms, gross capital formation and total farming debt, published by the DALRRD (2021). While the average annual growth in the real value of capital assets on commercial farms was 2.68% from 2000 to 2020, the same measurement for the same period returned -0.36% growth in gross capital formation. Thus, even though there has been real growth in value, it came at a declining addition rate. Furthermore, the annual growth in total farming debt was 5.11%, on average, from 2000 to 2020, denoting that total farming debt grew in real terms, at a rate of 1.91 times the rate of growth in the real value of capital assets on commercial farms.

Under certain circumstances, this may lead to full divestment in the immediate future, but it can also delay the decision to opt out by adopting a wait-and-see approach. In certain sub-sectors of agriculture, this latter approach has a negative effect on the opportunity to generate income from the investment in the future, e.g. not replacing orchards and vineyards when they reach replacement age (producing at sub-optimal levels), because the risk associated with policy uncertainty does not justify the investment cost. Similarly, investing in new genetic material to improve a livestock stud or herd can improve revenue over time, but uncertainty and a lack of business confidence can halt the process. A third option, which

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seems apparent from the DALRRD (2021) data mentioned above, is for producers to reduce their risk by increasing the foreign capital component when investing in capital assets.

1.1.4. Barriers to exit and the implications thereof

Michel Porter's paper, "Please Note Location of Nearest Exit: Exit Barriers and Planning", was written in response to the economic downturn of the 1970s in the US and consequent exiting or divestment by businesses. At that time, several authors argued that exiting should be a normal response when circumstances are unfavourable, but Porter (1976: 21) noted that "there are a series of barriers to exit working against divestment decisions, in such a way that companies are inclined to hang on to unprofitable businesses". By 1989, the definition was expanded to accommodate the indirect opportunity cost as well, which refers to the costs or loss of potential future profits that an exiting company faces (Gilbert, 1989). In terms of this definition, apart from the direct exit costs such as labour-related exit costs and regulatory exit requirements, indirect opportunity costs, such as sunk cost, penalties on cancellation of long-term contracts and first-mover disadvantage, can be included for companies for which the circumstances render an exit decision. There are also government interventions that can have a range of purposes, depending on the general level of intervention by the government in the market and the firm's role in the economy. This can range from rescue and restructure and subsidies to intervening in mergers and acquisitions (Bascunana-Ambros & Neto, 2019).

Barriers to exit, similar to barriers to entry, have a weakening effect on the competitive process in the marketplace, hence the result is that less-efficient firms remain in the market. Among the adverse effects of such a situation is declining productivity, which restricts innovation and potential innovation, ultimately negatively influencing economic growth (Bascunana-Ambros & Neto, 2019).

Within the context of agriculture and, in particular, the theory of a production unit's life-cycle, Satola, Wojewodzic and Sroka (2018) describe slow economic decline as a method of exiting. One of the main contributors to slowly dying out is the avoidance of making radical decisions, which, in turn, leads to the wasteful application of resources and ultimately – and as a result – decreases the farm's assets and value. The third aspect in Hirschman (1970), namely loyalty, appears to be applicable in this regard. In a cost-benefit analysis, the interplay of loyalty affects whether exit or voice is used when faced with a choice. As loyalty to remain

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excludes the option of exit, voicing discontent whilst ploughing on remains the only alternative.

Rent-seeking, land ownership and the perception that land market prices will grow can be barriers to exit. When the producer a) does not have the investment capacity to plough back into the land continuously, or b) does not necessarily have a profit-maximising goal – scaling down or becoming more lifestyle-oriented, resulting in the underutilisation of productive farmland – this price growth may not realise in the future. The emotional bond to ownership of a specific parcel of land, which often coincides with the land belonging to the same family for several generations, can hinder the producer's decision to exit and sell the land. Because land is sold only once, producers delay the decision, even when it no longer is economically viable to continue on the parcel in question. As a result, and by not making the decision, the land productivity is essentially operating at a suboptimal level (Van Dijk, 2007; Satola *et al*., 2018).

Financial vulnerability due to idiosyncratic risks associated with farming affects short-term finances and often leaves ageing producers unprepared for retirement. When these producers cannot retire, which is a barrier to exit, there is a continuance of operations to meet the family's basic needs by an ageing producer whose cognitive abilities slowly deteriorate (see Gutter & Saleem, 2005; Anstey, 2016). Impoverished by exogenous factors, like droughts, floods, economic downturns or policy changes, or endogenous factors, like poor planning, poor decision-making or shoddy workmanship, the security of a home and the utilisation of a portion of the land owned to remain self-sustainable might not only be a barrier to exit, but also constitute an obstacle to structural transformation under extreme circumstances (Satola *et al*., 2018).

According to Chavas (1994), sunk cost not only relatively increases the cost of divestment, but also has a significant effect on capital's shadow price. As a result, it affects the decision by a firm to enter or exit. Porter (1976) notes that, where the production of a product is unprofitable because of low demand or oversupply, thereby decreasing the price thereof, the market for assets with a high level of specificity for producing that product will also be small. Specialised machinery and equipment, such as mechanical wine grape harvesters, wine tanks and barrels, will have little value outside of the wine industry and increase the sunk cost in the exit decision.

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The transaction cost relating to the sale of resources, be it the preparation or closing of sale transactions, can delay the decision to exit but still result in the discontinuation of production. It appears that divestment without a plan to exit is a likely phase before the final parting between owner and land, as the real and perceived barriers to exit are considered to be too high (Satola *et al*., 2018).

1.2 Research problem

Considering the ex-post review of structural change in commercial agriculture over the last 100 years and the learning therefrom, an ex-ante modelling analysis approach to the planned and potential effects on producer numbers over a ten-year period can assist decision makers and role players in the agricultural sector. By investigating ex-ante farm-level exit decisions and exit rates in commercial agriculture in South Africa through the analysis of the behaviour of individual producers and their inter-producer interactions, it will be possible to determine the commonalities between them and extract the key drivers for producers planning to exit commercial farming. This analysis then forms the basis for understanding potential land-use changes in the future. Incorporating behavioural economics into agricultural structural change can inform future land supply policy proposals and individual farm-level decision-making.

The main research question of this study is: to what extent would transitioning from an ex-post to an ex-ante analysis of structural change in South African agriculture, with an emphasis on exit decisions, enhance land-use planning? This research problem is firmly centred on the land market and the role players in that market, why they would make certain decisions that will affect land use over the outlook period, and what the effect thereof is on the system.

Figure 1.1 provides a simplified schematic of the land market in South Africa. There are different types of land use, with the exclusive interest of this study being commercial agricultural land. Within the commercial agricultural land market, there are supply and demand, with supply dependent on existing producers deciding to sell their property. Current land users can broadly be grouped into producers with an expansion objective, producers with the objective to maintain the current state, and producers who plan to exit.

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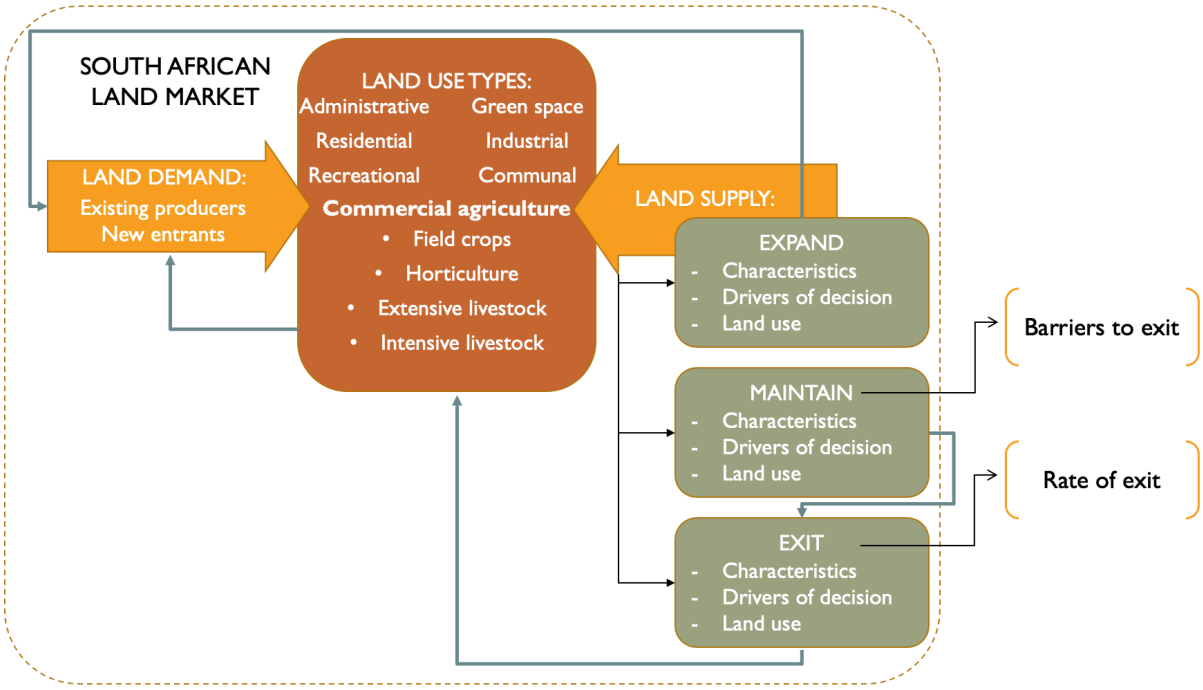

Figure 1.1: Conceptual framework

Each of these groups would potentially have different characteristics, such as age, sub-sector, financial position, rural safety concerns, labour problems and opportunities for off-farm earnings.

Whilst the decision to exit in the future or to remain in agriculture is often a personal one, driven by the unique circumstances of the producer, it is believed that some common themes could be found among the different groups. Many factors are considered to potentially affect the decisions of producers. These include age, years of farming experience, education level, region (province) and financial constraints, rising input and transaction costs, land reform policy and uncertainty, expanding market for leisure agriculture, labour rights legislation, adoption of capital-intensive alternatives to be less reliant on labour, safety and security in rural areas, climate change and erratic weather conditions (e.g. droughts and floods).

From a structural change perspective, the rate of exit and the land use of the different groups will have specific effects on the market for commercial agricultural land. It is believed that there are barriers to exit that potentially could result in producers falling into the 'maintain' group because of factors restricting them from making an exit decision. If these

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barriers can be removed, it could alter the rate of exiting, changing the rate of exit and the land use in the system.

Considering the primary research question and the conceptual framework outlined above, four research themes emerged.

First, to compute an exit rate to create a baseline for the outlook period. Land that will become available in the future is a key ingredient in accelerating transformation and reaching targets. Tied in with the availability of land at an aggregated level are the characteristics of these parcels in terms of size, location and industry.

Second, to uncover the drivers of the decision to exit, the barriers to exit that exist and how this can be used to inform policy. With the slow rate of transformation, the challenges of establishing long-term sustainable and successful projects, and the drive towards more inclusive commercial agriculture, consideration must be given to how the market for land supply works and what can be done to increase the exit rate to fast-track the transformation process. By determining and ordering the key drivers of planning to exit, considering these factors could be included in planning new projects to avoid pitfalls.

Third, to accelerate the exit rate to increase the participation of a broader and more inclusive demographic in commercial agriculture, how can agent-based modelling (ABM) be applied to draw meaningful conclusions on the baseline outlook, as well as the alternative scenario?

In conclusion, it then is possible to derive the fourth part of the research question, viz. what is the scope of opportunity for new entrants?

1.3 Objectives

Answering the research question would require fulfilling the following four objectives:

- Extract the characteristics of the different groups to provide an understanding of the types of commercial producers and their perspectives on land use.
- Determine and order the key drivers of planning to exit or stay, and what policy makers should consider in planning new projects to avoid pitfalls.
- Model the exit decisions and use the information on the characteristics of producers and drivers of decision-making in the different producer groups to construct and model exit rates should some barriers to exit be removed.

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- Under the baseline and alternative scenario conditions, what is the scope of opportunities for new entrants?

1.4 Methods and data

1.4.1. Methodology

From a methodological perspective, three approaches are proposed to achieve the objectives of this study. The three approaches are discussed below.

To extract the characteristics of the different groups to provide a basic understanding of the types of producers in commercial agriculture and their perspectives on land use, a *k*-means cluster analysis is proposed. In a *k*-means cluster analysis, each respondent is randomly assigned to any of the initial clusters' centre locations. For every record, the nearest cluster centre that partitions the dataset is found, after which the location of each cluster centre is updated until a logical outcome is achieved. Through the movement of the cluster centres until convergence or termination, the objective of *k*-means clustering, i.e. to minimise the intra-cluster variance, is achieved. The analysis would be preceded by a principal component analysis (PCA) to reduce the dataset to the appropriate variables by identifying which variables are potentially important in determining the commonalities in the cluster analysis.

To determine and order the key drivers of planning to exit, a binary logistic regression analysis is proposed, as the dependent variable has two possible outcomes – exiting or not. This analysis models the relationship among the explanatory variables and the described categorical response (dependent) variable, expressing the effect of the explanatory variables on the outcome of the dependent variable. The estimated coefficients relate to the log odds of the probability of exiting to provide a more intuitively interpretable solution for which factors have the biggest probability to drive the decision to exit or stay.

To model the exit decisions under the baseline and alternative scenario conditions to determine the scope of opportunities for new entrants, an ABM – virtual laboratory in which individual agents' simultaneous production and investment decisions are simulated – is proposed. Such a model will provide the opportunity to extrapolate the dataset to a representative sample and then to upscale it to national levels based on the 2017 census. By following this approach, a data sample can be used to model the structural change of a sector. A recursively dynamic modelling approach is proposed, with the output of each agent in the

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model becoming the input for the next year, with the application of a quadratic production cost function containing positive mathematical programming terms for both crops and livestock. The ABM will provide the opportunity to discuss the exit rates under baseline and alternative scenario conditions, and to contextualise the effect of the modelled exiting of agents in terms of land use (field crops, horticulture, extensive livestock, intensive livestock).

1.4.2. Data sources

The data for this study was collected over 18 months through a voluntary participation survey, starting at the end of 2017. The questionnaire, distributed via email or by students to commercial producers, was designed to elicit the respondents' background and geographic location, strategic planning and aspirations, employment of skilled and unskilled labour, capital and turnover, production mix, changes in land use, and views on the effect of exogenous factors on their business. The respondents were asked to rank statements on a five-point Likert scale (from one = strong disagreement/not at all to five = strong agreement/most definitely) to indicate the perceived level of constraint or threat to their business of the following factors: social aspects (labour availability and quality, stock theft and farm attacks), policy aspects (land reform, labour laws, environmental laws and market access), natural environmental factors (climate change and predators), and economic aspects (input cost and decreasing commodity prices).

Of approximately 1 370 questionnaires that were distributed, a total of 658 questionnaires were returned, of which 541 were completed in full. Of these, 450 were completed by farm owners and thus formed the sample of interest for this study. Responses were collected from all nine provinces. The Western Cape is overrepresented, as the students who distributed questionnaires had greater access to producers in this province. Based on the provincial agricultural enterprise distribution indications of the 2017 census, KwaZulu-Natal is slightly overrepresented, the Eastern Cape, Limpopo and Mpumalanga are accurately represented, and the Free State, Gauteng, North West and Northern Cape are underrepresented (StatsSA, 2020). (See **Appendix A** for the questionnaire.)

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1.5 Structure of the dissertation and contribution

This dissertation consists of five chapters, of which chapters 2 to 4 have been developed as standalone publishable pieces, although they do follow each other in a structured manner. The outputs from the second chapter are central to the research question of the third chapter, with the pattern repeating with chapters 3 and 4.

Chapter 2 is concerned with computing a baseline exit rate for a ten-year ex-ante period. The data from the 450 respondents was categorised according to the producers' plan to exit[2] to provide a projected exit rate over ten years. Furthermore, a cluster analysis was conducted to identify the commonalities among groups of producers as a first step in understanding the underlying factors of the decision to exit or stay. The purpose of the analysis was to extract the most commonly occurring factors in decisions to exit or stay in the next ten years and where a combination of reasons is prevalent.

Chapter 3 follows the second, in which a framework with four quadrants and two latent variables arose from the cluster output. The two latent variables are business confidence and financial strategy. By examining the relative position of the producers in these four quadrants, and overlapping this information with the cluster analysis output, a good understanding of the types of commercial producers emerged. In addition to those mentioned above, a regression analysis was performed to rank the key drivers. Whereas Chapter 2 proverbially returns an analysis output concerning how wide the extent of exiting is, Chapter 3 delves into the depth thereof – to what extent a certain variable is rooted in the exit decision.

In the final chapter of analysis, the first countrywide ABM for commercial agriculture in South Africa is introduced – a virtual laboratory to run the baseline and alternative scenarios of producer exit rates against the survey data. How the scenarios differ from the baseline is measured in the output of different variables over ten years. Output from this modelling can include variables such as the number of farms, farm size, ownership (occupancy) of the farms, production output and employment. Whilst the modelled baseline is based on producers who indicated that they planned to exit in the next ten years, the scenarios capture accelerated exit rates, removing producers who are categorised as having negative business confidence,

[2] Note that this excludes landowners who indicated that the next generation would take over the farm.

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a contracting financial strategy and/or who experience severe financial constraints to exit in the model. The structural effect of both the baseline and scenarios is discussed.

In addition to a general conclusion that includes a summary, consideration is given in the concluding chapter to the barriers to exit, which consequently limit the opportunity to enter. Lastly, the scope for transformation opportunities is provided, along with recommendations.

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Chapter 2:

Strategic perspectives on quitting or remaining in commercial agriculture in South Africa, and why they matter

2.1 Introduction

From the perspective of the agricultural economist, structural change involves the long-term evolution of farm structure and organisation (Chavas, 2001). This process is evident in changes in farm size and land use, the extent of mechanisation, labour use and the structure of the value chain. Of these, farm size is the most easily comparable international metric, influenced by the amount of farmland available and the number of producers.

Some countries, such as Japan, New Zealand and India, have experienced a decrease in the total amount of farmed land with agricultural zoning. Where farm size has increased, for example in Belgium, Germany, Denmark, Canada, Argentina and South Africa, the increase has been driven mostly by a decrease in the number of producers. Internationally, changes in farm size do not show a universal trend. Between 1960 and 2000, farm sizes increased in Europe, with Belgium (251%), Germany (233%), Denmark (212%), the Netherlands (149%) and France (139%) showing the largest increases; in other developed countries, Canada (88%), Australia (76%) and the USA (46%) showed the largest increases; while the same was found in some developing countries, such as South Africa (125%), Argentina (57%) and Uruguay (47%) (Liebenberg 2012; Lowder *et al*. 2016). However, during the same period, farm sizes decreased in several upper-middle- and lower-middle-income countries, such as India (-51%), Jamaica (-50%), Indonesia (-34%), Chile (-29%) and Venezuela (-26%). By excluding factors associated with rezoning agricultural land, farm size changes are driven by changes in producer numbers. In general, the average farm size decreased in most low-income and lower-middle-income countries, but increased in some upper-middle-income countries and in nearly all high-income countries (Lowder *et al*., 2016).

Several reasons have been suggested for the increase in farm sizes in high-income and upper-middle-income countries. Recurring themes in the literature can broadly be categorised as personal, financial and policy related.

On the personal front, education and alternative opportunities for generating income are highlighted. Examples of personal drivers of farm size include part-time farming (Antman *et*

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al., 2015), supplementing on-farm income with off-farm sources (RIRDC, 2007; Martini & Kimura, 2009; NFU, 2011; Ramsey *et al*., 2019), or the next generation pursuing a non-farm career or lifestyle (Gale, 2003). Part-time farming enables producers to continue to farm on a smaller production unit (Chen *et al*., 2019). Producers who earn off-farm income are less dependent on the returns from primary agriculture, thus these trends can slow down the rate of farm consolidation. The pursuit of a non-farm career by the next generation because of a lifestyle choice or opportunity cost considerations tends to accelerate consolidation because fewer new entrants take up the land which becomes available. These observed trends contribute to the increase in producers' average age (European Commission, 2017; Shimizu, 2017). More ageing producers means more exits in the immediate future, and it also means the exit process will accelerate. Where exiting occurs without concurrent succession or entering, more land is owned by the older, decreasing number of producers (Katchova & Ahearn, 2014; European Commission, 2017). A distinction between 'exiting without succession' and 'exiting with transfer to next of kin' is explored in this analysis.

Regarding finances, increased exiting without new entrants taking up the opportunity is associated with two main factors: viability to continue or opportunity cost. Farm viability, measured in real returns per unit area, will decrease over time if there is a decrease in real output value in conjunction with an increase in real input cost, a phenomenon broadly referred to as the "farm problem" (Babian, 1956: 23-24). The opportunity cost of farming increases when there is an increase in the producer's level of education and an increase in the producer's actual and potential non-farming income.

Babian (1956) investigated the type of increase in efficiency that is required to overcome the farm problem. It is not sufficient to increase production to the extent that the decline in real output prices counters the effort to maintain a specific gross income. This would result in a decrease in net income, possibly combined with a reduction in total production cost. Failure to address these input and output pressures erodes the farm's ability to compensate the owner for the opportunity cost of labour, thereby forcing small and medium producers out of operation (Gale, 2003; Gras, 2009; Chen *et al*., 2019). This can be attributed to several factors, such as the inability to justify the acquisition of expensive, technology-based productivity improvements that are dependent on critical mass to make it worth adopting them and repaying the expense (MacLeod & Moller, 2006; Pedersen & Møllenberg, 2017), or the inability to enact the value chain integration required to offset declining real income at

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the primary production level (Productivity Commission, 2005; Castro-Fontoura, 2016). These factors – production income and cost, and technology adoption – feature in this study and will be extracted through the process of analysis.

Policy, the third theme in the literature, is seen as having an effect, and it can hinder or support growth in producer numbers. Policies that target specific parts of the agricultural industry, such as production quotas or price support measures, can obstruct farm size growth in the industry, with producers boxed in even if they would like to expand their operations (Bokusheva & Kimura, 2016). Direct or indirect transfer payments that artificially increase farm income and revenue can hinder farm consolidation, but they may not be sufficient to keep all small and medium-sized growers in production (Director-General for Agriculture and Rural Development [DG AGRI], 2012; Severini & Tantari, 2015; Brady *et al*., 2017; Volkov *et al*., 2019). The removal of policy distortions, the liberalisation of markets and the dismantling of control boards have compelled producers to run profitable operations in an open market to stay in business, accelerating exiting beyond the rate of replacement by new entrants, which has resulted in fewer producers (Lambie, 2005; Mulet-Marquis & Fairweather, 2008). In the EU, the common agricultural policy (CAP) aims to bolster the sector through income support measures, as well as to enhance the development of rural areas, whilst also aiming to improve agricultural productivity (European Commission, 2018). Countermeasures, such as quotas, have been introduced to support producers without causing an oversupply in the market. These measures inevitably affect production unit size and the total number of producers.

As defined and captured in the 2017 census of commercial agriculture, farm size and producer numbers in commercial agriculture have yet to receive attention in the South African literature, specifically in terms of existing and potential producer decisions. The exception in this regard is the study by Liebenberg (2012), which documents the trend in commercial farm sizes in South Africa. Most studies that touch on the issue refer only to changes in the context of policy reforms (for example, Vink, 1993; Greyling *et al*., 2015; Greyling, Vink & Van der Merwe, 2018). In this chapter, the gap is beginning to be filled by using an unsupervised learning algorithm to investigate the groups that emerge from such an analysis and to understand the characteristics behind the groupings. In addition, information on potential exiters' specific characteristics can be derived by applying data concerning

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potential exiting in the future to the clusters. This information on commercial producers in South Africa can then be compared with that in the international literature.

On the basis of the international literature and observations in South Africa, it was hypothesised that age, sub-sector, financial position, rural safety concerns, labour problems and opportunities for off-farm earnings would feature prominently in the commonalities in the cluster analysis. To test this hypothesis, 450 commercial producers who owned one or more farms were surveyed between 2017 and 2019 in all of the nine provinces of South Africa.

2.2 Data and method

2.2.1. Data collection

The data for this study was collected over an 18-month period through a voluntary participation survey, starting at the end of 2017. The questionnaire, distributed via email or by students, was designed to elicit the respondents' background and geographic location, strategic planning and aspirations, employment of skilled and unskilled labour, capital and turnover, production mix, changes in land use, and view on the influence of exogenous factors on their business. The respondents were asked to rank statements on a five-point Likert scale (from one = strong disagreement/not at all to five = strong agreement/most definitely) to indicate the perceived level of constraint or threat to their business of the following factors: social aspects (labour availability and quality, stock theft and farm attacks), policy aspects (land reform, labour laws, environmental laws and market access), natural environmental aspects (climate change and predators), and economic aspects (input cost and decreasing commodity prices). The results serve as the basis for the cluster analysis described below.

Of the approximately 1 370 questionnaires distributed, 658 were returned, of which 541 were completed in full. Of these, 450 were completed by farm owners and thus form the sample of interest for this study, with the complement completed by farm or production unit managers. The latter's decision to remain within primary agriculture or exiting did not affect producer numbers.

Although the survey sample was not representative of the number of producers by province, many other factors align with the 2017 census.

The respondents' ages ranged from 20 to 90, with an average of 51. Categorically, the age profile is well aligned with the census: 11% under 35 years of age in the survey, compared

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to the 12% of the census. Similarly, 38% of the survey respondents were over 55, comparable to the 40% of the census. With 2% unspecified in the census, that leaves 45% between the ages of 35 and 55, compared to the survey's 51%. Calculating the average age in the census using the midpoint of the different age categories, the average age of producers in the census was also 51 (StatsSA, 2020).

Most respondents had between 16 and 30 years of experience, and 26% had over 30, which should also be comparable considering the age alignment with the census. As expected, respondents were almost all male (95%), although slightly overrepresented in the survey compared to the census (91%). Formal education levels were fairly high: 70% said they had completed an undergraduate tertiary qualification, and 12% said they had completed a postgraduate degree (StatsSA, 2020).

Furthermore, 28% of farms in the census experienced losses because of stock theft, input and produce theft, and violent and other crimes. In the survey, 27% of respondents indicated that theft was a major threat to their operations. Also, natural disasters were considered by 31% of the respondents as most definitely a threat to sustaining their operation, which is comparable to the 29% of producers in the census recording losses as a result of natural disasters (StatsSA, 2020).

2.2.2. Principal component analysis

A total of 37 variables were considered for inclusion in the cluster analysis described below and therefore used in the principal component analysis (PCA) in their standardised form to reduce the influence of units of measurements, for example number of employees and annual turnover (in rand). It was found that 43% of the total variance in the dataset was explained by the first three unrelated variables (PC variables), predominantly featuring constraint, threat and exiting decision variables (see **Appendix B**). The first nine PC variables explained 77% of the variance. By doing the PCA before the cluster analysis, it was possible to determine which variables in the initial setup would not make a meaningful contribution to the analysis. The variables that contributed the least significant variability to the first nine independent variables (see factor loadings in **Appendix B**) were omitted from the subsequent cluster analysis (viz. occupation, education, labour variables, gender and province). It was hypothesised that financial difficulty was associated particularly with one or more of the sub-sectors in agricultural production. It therefore was decided to keep the categorical

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breakdown of the sub-sectors (field crop, livestock, horticulture, forestry and mixed production) in the dataset for the cluster analysis.

The results from the PCA confirmed that the strategic decision at the farm level was affected by producers' perspectives on financial difficulty, intention to retire or rural safety concerns, as well as the constraints and threats to the farming operations, as these factors explained the bulk of the variance in the first three PCA variables.

After doing the PCA, 23 of the initial 37 variables were included in the final clustering analysis and solution. These included the producer's age and experience; decision to exit within the next ten years; type of production; turnover of the farm; and the constraints and threats, or lack thereof, they perceived.

2.2.3. k-*means clustering*

To identify the commonalities in the producers' strategic decisions – whether to expand, exit or contract their farming operations – *k*-means clustering (Sayad, 2020) was used.

A respondent was randomly assigned to any of the initial clusters' centre locations. For every record, the nearest cluster centre that partitioned the dataset was found, after which the location of each cluster centre was updated until a logical outcome was achieved. Through the movement of the cluster centres until convergence or termination, the objective of *k*-means clustering, i.e. to minimise the intra-cluster variance, was achieved, as per objective function *J* in **Equation 2.1**.

Equation 2.1: k-*means clustering – minimising the intra-cluster variance*

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \| x_i^{(j)} - c_j \|^2,$$

where *k* is the number of clusters, *n* is the number of cases and, in the distance function, case *I* is denoted by $x_i^{(j)}$ and the centroid for cluster *j* by c_j. From *J*, it is clear that the Euclidean distance function was applied, where each datapoint was assigned to the closest centroid that is central to that specific cluster.

The reason for choosing *k*-means clustering as the clustering algorithm, rather than an agglomerative hierarchical clustering algorithm, was because of the non-hierarchical nature of the dataset and to prevent mixture modelling because of the non-normal distribution of

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the dataset. In addition, it was also thought that a *k*-means-type solution provided the best fit for the problem statement.

The number of clusters, *k*, for the analysis was informed by the 'within groups sum of squares'. The information of where the 'within-group sum of squares' tapers off or no longer significantly decreases incrementally was used to select the number of clusters to include. In this study, the steep decline in the within-group sum of squares turned into a more gradual decline at four clusters (see **Figure 2.1**). To find a good factor solution, successive steps were performed to identify an interpretable solution with a reasonable number of homogeneous clusters (Suhr, 2018). A well-interpretable solution was found with four homogeneous clusters rather than five or six.

With unsupervised learning, where an algorithm learns patterns from untagged data, it is important to select the correct variables for inclusion in the analysis, and these must be scaled correctly to prevent bias. If data that confuses the algorithm is included, the result could be weak or nonsensical. The selection of variables for inclusion in the cluster analysis was informed by applying the principal component analysis to the initial set of variables.

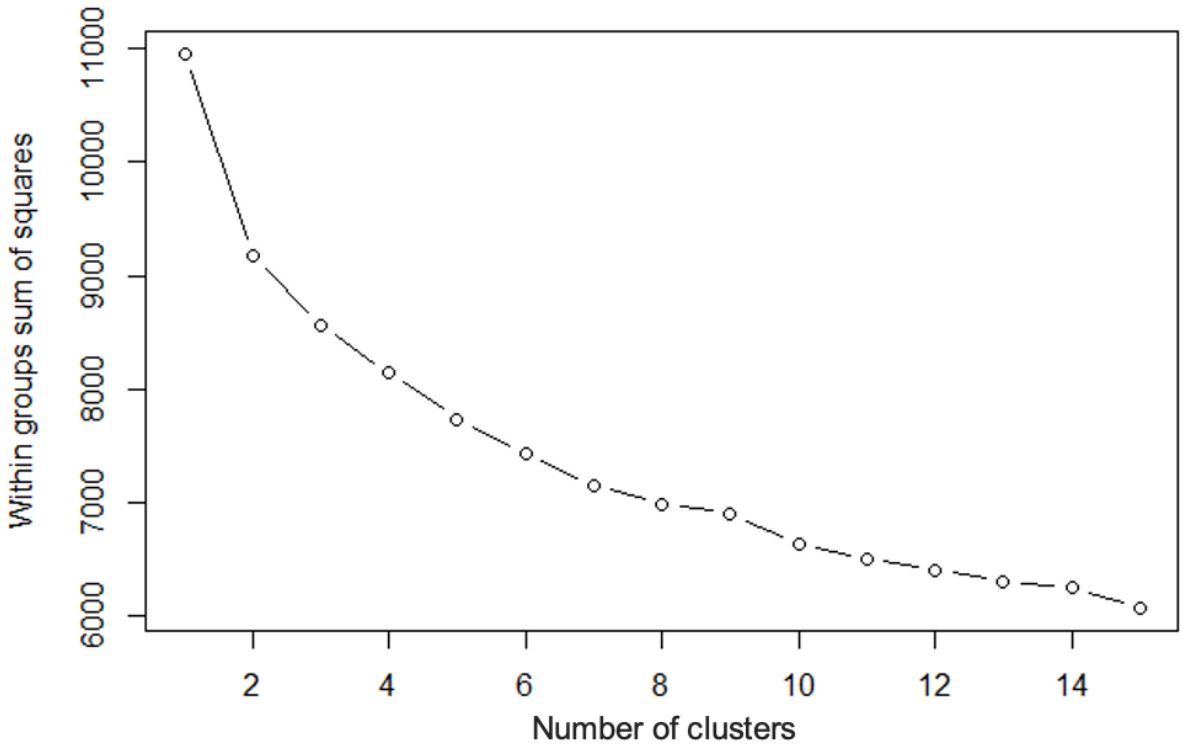

Figure 2.1: Within-group sum of squares for cluster determination

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The *k*-means algorithm converged on the four clusters (**Table 2.1**). Of the total variation in the dataset, 25% was explained by the cluster solution. The analysis aimed to find commonalities in the producers' strategic decisions regarding land and land use – whether to expand, exit or contract their farming operations over a decade. Therefore, even though the groupings explained a small percentage of the variation, the results yielded a cluster that predominantly contained producers who expected to exit. This "exit cluster" enabled us to identify the common factors that can play a role, ex-ante, in the exit decision, whilst the other clusters enabled us to identify the common factors shared by three different groups who had the intention to remain in agriculture.

Table 2.1: Number of observations per cluster

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
No. of responses per cluster	135	119	61	135
Share of respondents per cluster	30%	26%	14%	30%

2.3 Discussion of results

2.3.1. Exploring the clusters

The cluster analysis provided four distinct groups of producers with small within-group variation and large between-group variation. Categorically, the cluster analysis can be discussed in three parts: general themes, the intention of succession or exiting, and perceptions of and attitudes towards challenges and threats. A high-level overview is provided first to define each cluster and easily differentiate between the clusters.

By considering some general themes – experience, turnover, education and age (**Figure 2.2**) – it appears that there were some differences between the different clusters concerning experience (less than or more than 15 years), turnover (below or above R10 million per annum) and age (ranges between 48 and 55 on average), but no notable differences in education levels (graduates vs non-graduates). In cluster 1, the average age was 51, with 60% of respondents having more than 15 years of farming experience and 64% generating turnover of more than R10 million per annum. For clusters 2, 3 and 4, the average age was 55, 51 and 48 respectively, with 90%, 75% and 70% having more than 15 years of experience and 79%, 59% and 70% generating turnover of more than R10 million per annum respectively.

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By cluster, the intention of succession, where own children or family would continue with operations when the current producer exited, or exiting, where the land would be sold once the current producer exited, provided interesting results. Both clusters 1 and 2 revealed that 13% of respondents planned to exit and sell, with 23% of the cluster 1 respondents indicating an intention of succession, compared to the 35% of cluster 2. In clusters 3 and 4, observations revealed that 85% and 4%, respectively, had an intention to exit and sell, with 5% and 31% indicating an intention of succession.

A first glance at the perceptions of and attitudes towards challenges and threats by cluster revealed that the range of responses varied substantially between the clusters on certain variables. In some instances, the variance was much lower. Clusters 3 and 4 showed very consistent trends for the perceptions and attitudes towards challenges and threats to operations, with average concern levels of 74% across the different variables. In comparison, clusters 1 and 2 revealed concern levels of 24% and 52% respectively.

Hence, two groups of fairly similar clusters emerged, with the large between-group variation driven by a small number of variables for which large variances were observed between the groups.

The respondents in cluster 1 collectively appeared to be driven by constant risk mitigation to continue growing their businesses. Hence, the respondents in this cluster are called ‘ambitious’ – optimistic and unwavering in their pursuit. Several traits in cluster 2 coincide with observations from cluster 1. However, they are warier about the impact of challenges and threats to their operations. As such, the respondents in this cluster are deemed ‘persisters’ – continuing firmly despite the difficulty.

The respondents in cluster 3 collectively appeared to be very concerned about the various challenges and threats to operations. Concerning longer term decisions regarding farm ownership, the majority showed an intent to exit, and very few indicated that succession by own children or family was part of future plans. Hence, the respondents in this cluster are called ‘retrievers’ – forced or strategic withdrawal from action. Several traits in cluster 4 coincide with observations from cluster 3; however, they show minimal intent to exit despite perceiving the environment in which they operate as challenging and a threat to their operations. The respondents in this cluster are deemed ‘remainers’ – remain, despite the negativity.

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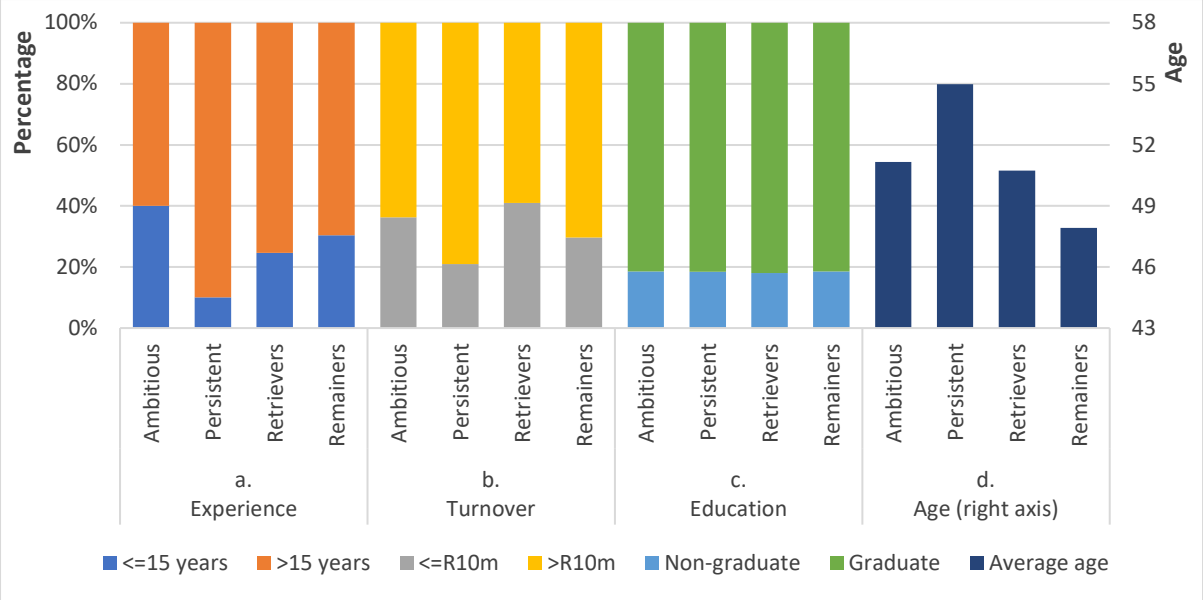

Figure 2.2: Comparing general themes between clusters

The ambitious, and the persisters to a lesser extent, appeared to be able to keep mitigating their risks and adjusting their strategy to continue growing their businesses. A Likert scale, with one equal to 'not at all' and five being 'most definitely', is used to display the level of challenge and threat perceived by producers in the two clusters for several variables in **Figure 2.3**. The ambitious cluster tends to be more resilient than the persistent cluster. Whilst both seem undeterred by the potential of challenges posed by financial constraint (panel a) and servicing loans (panel b), the persisters consistently perceived the exogenous factors to be more threatening to their operations than the ambitious producers (panels c to j). The highest level of threat perceived by the ambitious cluster was from natural disasters (see panel f of **Figure 2.3**), with 47% rating this threat at four or five on the Likert scale. These threats are followed by rising input costs (panel h). The persisters were most concerned about the uncertainty concerning land reform policy (panel e), and were also seriously concerned about rising input costs (panel h) and farm attacks (panel j).

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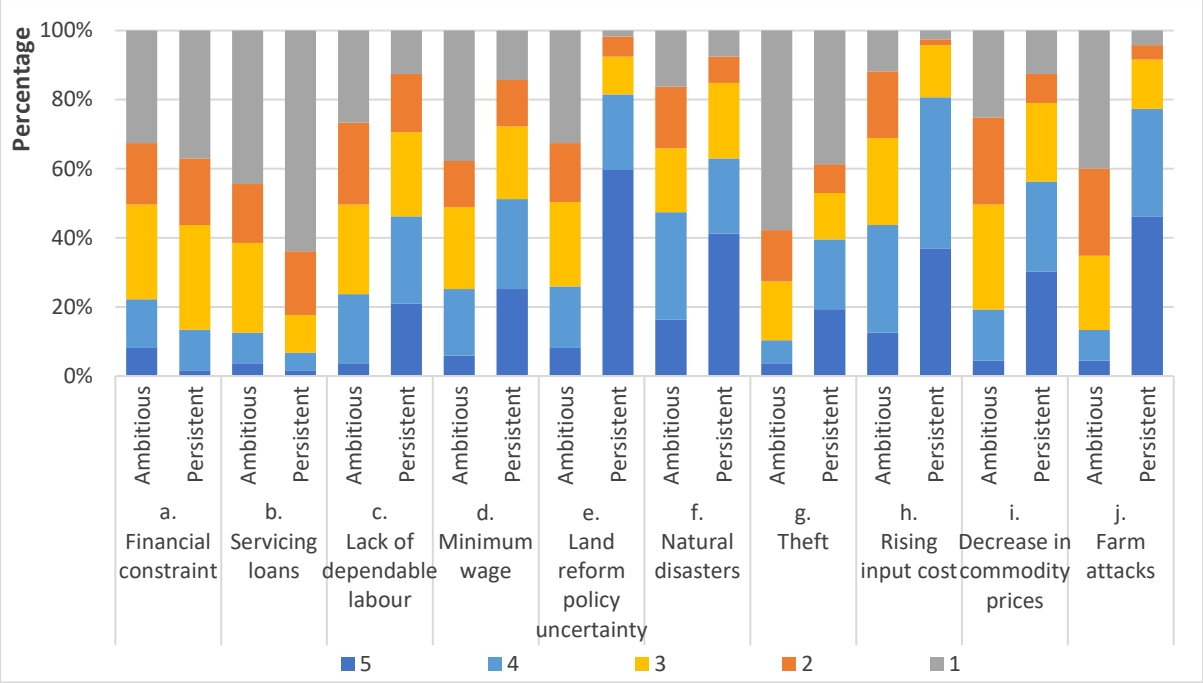

Figure 2.3: Comparing the perceptions of the ambitious and persister clusters

Sixty-seven percent of the total sample of producers with a turnover above R100 million belonged to either the ambitious or persistent clusters. Also, 11% of respondents in these two clusters had a turnover below R1 million per annum. They formed part of these clusters through the commonalities they share with the large-scale producers, such as not being deterred by the constraints and threats of the environment in which they operate.

In contrast to the difference in perception regarding challenges and threats to operations observed between the ambitious and persistent clusters, the retriever and remainer clusters tended to display substantial similarities. However, there was one major difference: 85% of the retrievers also indicated that they planned to exit and sell their farms compared to 4% of the remainers, which makes the substantial similarities in the challenges and threats surprising.

It was found that 75% or more of the retrievers and remainers scored the challenge of financial constraints and the threat of land reform policy uncertainty, natural disasters, rising input cost and farm attacks at four or five on the Likert scale, substantiating the view that they perceived these factors as serious threats to operations (see **Figure 2.4**). The views of both these clusters contrast strikingly with those of the ambitious and persistent clusters. Apart from panels a, e, f, h and j above, a lack of dependable labour, minimum wage and decreasing commodity prices were also concerning for these clusters.

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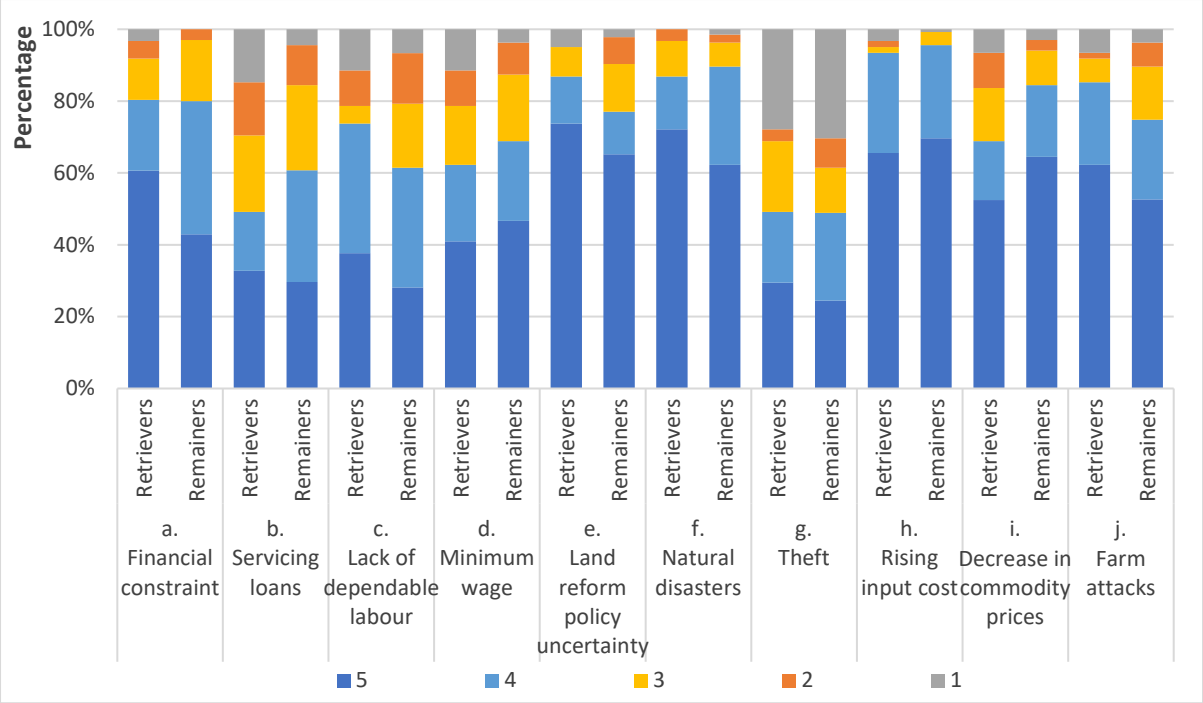

Figure 2.4: Comparing the perceptions of the retriever and remainer clusters

Other differences observed between the retrievers and remainers include that the retrievers were slightly older (51 vs 48 years of age), ran smaller operations in terms of turnover (41% vs 30% generated a turnover of less than R10 million per annum), with a much smaller window for succession by family after exiting (5% vs 31%) and slightly higher postgraduate education levels (15% vs 9%). If the perceptions of challenges and threats are quite negative, succession planning and education (therefore alternative job opportunities) seem to play a large role in the decision to exit or not.

2.3.2. Commercial producers who have a strategic intent to stay in agriculture

Clustering the producers into four groups resulted in most producers with the strategic intent to exit over ten years being bundled into cluster 3, the retriever cluster. This sub-section of the study will focus on the complement – the three clusters primarily concerned with continuing farming. The discussion that follows focuses on these three groups of producers whose strategic intent is to remain operational.

The ambitious producer, on average, is 51 years of age, with 23% having a succession plan and 13% planning to exit. This cluster also features the highest share of postgraduate studies (16% of the cluster). Retirement is the most prevalent reason for planning to exit from

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this cluster and appears only in producers older than 46. For at least 33% of this cluster, it appears that farming is a second career. This was calculated by aligning farming experience with the producer's age. In terms of perceptions and attitudes towards challenges and threats to operations, this cluster averages concern levels of 24% across the different variables – the lowest of all the clusters in the study.

Conclusions drawn from this information is that, firstly, and at least to a certain extent, there has been an influx of new entrants into primary production in the ambitious cluster from other industries. These producers developed skills outside of primary agriculture and are now applying these skills to mitigate the risks they experience in farming. Secondly, whilst collectively appearing to have a strong appetite to grab the bull by the horns, so to speak, some are driven to deal with the challenges as best they can and while they can in order to add value – on the income and balance sheets – but will eventually retire and sell their farms because no other viable solution is available.

The persistent producer, on average, is 55 years old, with 35% of them having a succession plan and 13% planning to exit. Retirement is also the most prevalent reason for planning to exit from this cluster, but with some concern about financial difficulty and physical danger. For only 16% of this cluster, it appears that farming is a second career, hence the highest average years of experience (90% of the cluster had over 15 years), which potentially could also be linked to the highest share of producers with a turnover of more than R10 million per annum (79% of the cluster). In terms of perceptions and attitudes towards challenges and threats to operations, this cluster averages concern levels of 52% across the different variables, the second lowest of all the clusters in the study.

Conclusions drawn from this information are, firstly, that persistent producers, to a large extent, started farming early in their career and have the strongest inclination towards succession. While the determination to continue the family tradition is noticeable, it is also somewhat alarming. The threats most concerning this cluster are uncertainty about land reform policy, natural disasters, rising input costs, decreasing commodity prices, and farm attacks, with which the next generation also will have to deal.

The remainers, on average, are 48 years of age, with 31% having a succession plan and 4% planning to exit. Financial challenges are the most prevalent reason for few producers expecting to exit from this cluster, and appears primarily in producers under the age of 54. In terms of perceptions and attitudes towards challenges and threats to operations, this cluster

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averages concern levels of 74% across the different variables, equalling the threat to operation perception levels of the retriever cluster.

Conclusions drawn from this information on the remainers are, firstly, that retirement as an exit strategy does not feature in this cluster at all. This could be attributed partly to the lowest average age of all the clusters and the questionnaire's ten-year outlook. Secondly, despite perceiving similar levels of constraints and threats to their businesses, the vast majority of this cluster (96%) are planning to remain in primary agriculture. Delving into the specifics of the underlying factors contributing to the high levels of challenges and threats to operations experienced by this cluster, the findings concerning farm-level efficiency – whether these producers can reduce the cost of production more than the decrease in revenue from sales – is not only alarming for their sustainability, but also those family members who have been identified as forming part of the succession plans. In addition, 80% of this cluster experiences financial constraints, and 60% find the servicing of loans challenging, yet only 4% think they might exit because of financial difficulty. Whilst some may interpret this result as a show of character, the existence of barriers to exit could also play a role.

2.3.3. Exiting commercial producers

Most producers who indicated that they were likely to exit within the next ten years formed part of the retriever cluster. Those outside of this cluster were described in the preceding section. For those who formed part of this cluster but did not indicate that they planned to exit, an explanation will be provided for why they are clustered with producers who indicated a strategic exit decision.

To fall into the category of exiters, respondents had to have a high score for one or more of three responses on why they intended to quit farming: to retire, because of safety concerns, or financial difficulty. Whilst retirement was considered the primary reason for planning to exit in the ambitious and persistent clusters, and financial difficulty was prevalent in the remainer cluster, in the retriever cluster not only did 85% of the producers indicate their intention to quit but, in most instances, they gave more than one reason for their intention to exit and sell the farm.

The retrieving producer was, on average, 51 years of age, with 5% having a succession plan and 85% planning to exit. This cluster also featured the second-highest share of

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postgraduate studies (15% of the cluster). Safety concerns were the single most prevalent reason for planning to exit in this cluster. It appeared consistently across different age brackets and featured prominently (46%) as part of a combination of factors driving the exit decision in the future. This was followed by financial difficulty as a reason to exit, and retirement, featuring in combination with each other and/or safety concerns at 44% and 40%, respectively. Whilst financial difficulty is especially pertinent for producers between 35 and 54, retirement was more concentrated among producers older than 55. For 23%, a combination of all three factors was the driving force behind the strategic exit decision. In terms of perceptions and attitudes towards challenges and threats to operations, this cluster averaged concern levels of 74% across the different variables, with perceptions concerning the level of threat posed by uncertainty about land reform policy, natural disasters, rising input cost, and farm attacks to farm operations being especially high.

The non-exiting portion of the retriever cluster, of which 89% was under the age of 54, formed part of this cluster through the commonalities they share with producers who planned to exit. However, they were not at the same level of determination to exit over a decade. Still, the signs are there when considering the levels of threat they perceive from the various factors analysed.

The literature (for example Chen *et al*., 2019; Gale, 2003; Gras, 2009) and the popular press often cite an inability to run a farm profitably as a reason for producers exiting. As profitability cannot be elicited through an anonymous and voluntary survey, farm turnover was used as a proxy to establish whether smaller producers are more likely to plan to exit. From the analysis (and shown in **Figure 2.2**), observations include that the retriever cluster had a higher than average share of respondents with an annual revenue below R10 million (41% compared to 29% for the other clusters). However, by taking a step back, it was possible to delve further into the relationship between turnover and the reasons for planning to exit, testing the hypothesis whether smaller producers were more likely to exit because of financial difficulty.

Figure 2.5 shows the shares of reasons for the intent to exit or stay. Financial difficulty as the sole reason to exit and turnover were not closely correlated, hence the result disproves the hypothesis that it is predominantly the smaller producers who exit because of financial difficulty. When the other reasons, viz. retirement and safety concerns, were included, the split between producers with a turnover below and above R10 million per annum became

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much more equal. However, what is clear is that the sample is much more skewed towards producers with a turnover above R10 million per annum, among whom there is a strategic intent to stay.

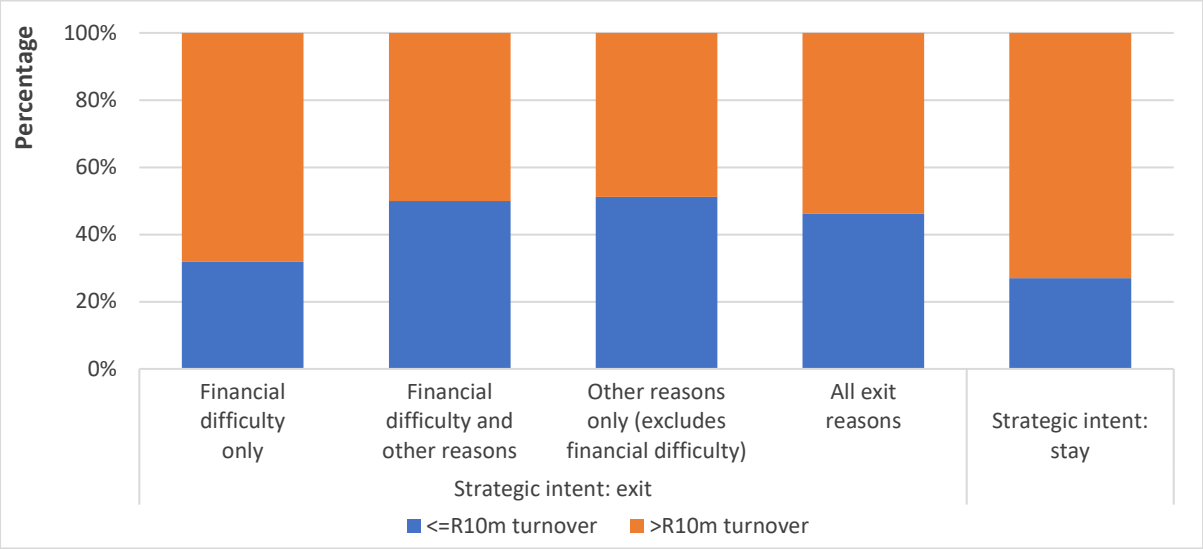

Figure 2.5: Financial difficulty as an exit reason compared to turnover

Conclusions drawn from this information include that it is often a combination of factors, rather than a single factor, that contributes to the intent to exit, with turnover not so much a determining factor in exiting, but rather in the intention to stay.

2.4 Conclusion

Four distinct groups of respondents were identified through the cluster analysis, which included 23 variables. Commonalities and differences between clusters provided valuable insights into the characteristics of the different groups of producers in the study – those who intended to exit farming within the next ten years, excluding producers who said the next generation would take over the farm, and those who intended to stay.

Cluster 1, the ambitious producers, constituted 30% of the sample. Their average age was 51 years, with 60% having more than 15 years of experience. Sixty-five percent had an undergraduate and 16% a postgraduate qualification; 36% had revenue of less than R10 million a year and 64% had revenue of more than R10 million. Thirteen percent said they

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planned to exit within the next ten years, with 23% indicating that a succession plan for their children or other family was applicable.

Cluster 2, the persistent producers, constituted 26% of the sample. Their average age was 55 years, with 90% having more than 15 years of experience. Seventy-three percent had an undergraduate and 8% a postgraduate qualification; 21% had revenue of less than R10 million a year, and 79% had revenue of more than R10 million. Thirteen percent said they planned to exit within the next ten years, with 35% indicating that a succession plan for their children or other family was applicable.

Cluster 3, the retrieving producers, constituted 14% of the sample. Their average age was 51 years, with 75% having more than 15 years of experience. Sixty-seven percent had an undergraduate and 15% a postgraduate qualification; 41% had revenue of less than R10 million a year, while 59% had revenue of more than R10 million. Eighty-five percent said they planned to exit within the next ten years, with 5% indicating that a succession plan for their children or other family was applicable.

Cluster 4, the remainer cluster, constituted 30% of the sample. Their average age was 48 years, with 70% of them having more than 15 years of experience. Seventy-three percent had an undergraduate and 9% a postgraduate qualification; 30% had revenue of less than R10 million a year, and 70% had revenue of more than R10 million. Four percent said they planned to exit within the next ten years, with 31% indicating that a succession plan for their children or other family was applicable.

Collectively, a 20% share of respondents (91 respondents) said they planned to stop farming, excluding producers who said the next generation would take over the farm, as the indication was towards selling their property within the next ten years. If a constant exit rate per year is assumed, using simple arithmetic shows that this potentially could result in an average annual exit rate of 2%. If exiting producers do not sell their farms to new entrants, this will result in a 2% per annum consolidation of ownership, slightly lower than the average annual exit rate of 2.6% for South Africa from 1991 to 2010 (Liebenberg, 2012). In contrast, the average worldwide consolidation of farm ownership increased by 22% (or 1.1% annual average) from 1990 to 2010, somewhat concealing the increasing concentration of land in the hands of a smaller group of larger producers in a mass of 560 million producers worldwide (Lowder *et al*., 2019).

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The retriever cluster warranted further attention, since most of the producers who planned to exit were in this cluster. These producers had two distinguishing features. First, they were relatively small producers, with 41% of them realising an annual revenue of less than R10 million, whereas this was the case for only 29% of respondents in the other clusters. They gave higher ratings to the problems of accessing dependable labour (74% vs 44% in the other three clusters), uncertainty regarding land reform policy (87% vs 61%) and rural safety (85% vs 54%). Second, although only 4% of the producers in the remainer cluster indicated an intent to exit, these producers gave similar ratings to labour, land reform policy and rural safety as those in the retriever cluster, and higher ratings to some other problems. There were higher recorded ratings for the remainers than for the retrievers concerning the effects of minimum wage laws on labour cost (69% vs 62%), servicing loans (61% vs 49%), natural disasters (90% vs 87%), rising input costs (96% vs 93%) and decreasing commodity prices (84% vs 69%).

While all the clusters gave high ratings to the exogenous threats of natural disasters, uncertainty about land reform and rising input costs, the retrievers and remainers gave these factors particularly high ratings. However, the ambitious and persistent clusters were possibly better positioned to absorb, avoid or mitigate these threats, since 67% of the producers in the sample with an annual revenue of more than R100 million a year were in these clusters, which is a clear concentration of mega-producers.

These findings support the hypothesis that farm exit decisions in commercial agriculture in South Africa are affected by retirement without succession, financial problems, access to dependable labour, uncertainty regarding land reform policy and concerns about rural safety. To a lesser extent, the producer's level of education may also play a role, even though it was not significant in the PCA. The other factor that was hypothesised to affect the decision to exit, namely the type of production, was not substantiated by the analysis. Furthermore, more than one factor, or a combination of factors, played a vital role in quitting farming and selling the property. Although a link between planning to exit and turnover could not be established when splitting the turnover at R10 million per annum, it appears that larger turnover could indeed play a role in the intention to stay.

Among the conclusions drawn from this information is that the biggest share of producers with postgraduate degrees form part of the ambitious or retriever clusters, suggesting that education and off-farm earning potential may play a role in the producer's

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initial occupation before entering primary agriculture and could also play a role in the decision to exit or stay. This could also be true for the next generation, since studies have shown that children typically reach the same or higher levels of education as their parents (Piraino, 2015; Narayan & Van der Weide, 2018). Education levels and the resulting ability to generate an off-farm income might contribute to South Africa's situation, as found in studies in the US, Canada and Europe.

In the ambitious cluster, it appears that producers are building up to bigger revenues after coming into primary agriculture as a second career after working elsewhere first. In contrast, in the retriever cluster, the lack of critical mass – a bigger revenue offering better prospects for profitability – experienced by these respondents has also been responsible for reducing producer numbers in other countries, such as New Zealand, Argentina and Uruguay. This issue could further entrench the dualistic nature of production, with primarily the larger producers being able to continue and the smaller ones deciding to exit, as is the case in Brazil. Lastly, the effect of the perceptions and realities of land reform policy and practices in South African commercial agriculture cannot be excluded, or necessarily quantified accurately. Similarities can be found between the effect of reforms in Chile and Venezuela and South Africa.

From the perspective of land reform policy, this study suggests that a substantial number of producers are planning to exit over the next decade. Further research is required to help structure policy if an increase in the rate of land supply to aid transformation is required. Also, understanding the different producer groups, what they have in common and how they envision their future is pertinent information to write and apply policy effectively to drive sustainable transformation.

One of the recommendations of this study for future research would be to broaden the scope of the survey pool to determine whether factors such as province and climatic conditions might play an important role in the strategic decision-making process of producers, as this has been a limitation of the present study. Further studies should also be conducted to identify and quantify the driving factors of the differences in perceptions of the environment in which producers operate and how these differences affect their decision to exit or continue. This could help inform policy. Perhaps the biggest issue is not the loss of the 20% of producers who, according to this study, will exit over the next ten years, but rather the fact that the ones who should, but do not, have an exit strategy are not exiting. A related

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issue for research is the social and economic costs to the country if struggling producers remain in the business of farming when their farms are no longer productive.

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Chapter 3:

Confident or captured? Commercial producers in South Africa

3.1 Introduction

There is broad consensus that the results of the South African government's attempts to distribute land more justly have been disappointing (Cousins, 2013; Lahiff & Li, 2014; Sikwela, Tshuma & Tshabalala, 2018). As long as the process relies on voluntary exchanges, its success depends on the willingness of smallholders and farm workers to take responsibility, and on the willingness of commercial producers to sell or rent at least part of their land. A lot of attention has been devoted to studying the first group of stakeholders, namely smallholders and farm workers (see, for example, Lahiff & Cousins, 2005; Chisasa, 2019; Zantsi *et al*., 2021 for smallholders, and Hall *et al*., 2001; Moseley, 2006; Lemke & Jansen van Rensburg, 2014 respectively).

However, the same cannot be said for commercial producers, whose socioeconomic situation has largely been overlooked. Contributions to the literature on commercial farming in South Africa in the last decade have focused on marketing channels (Jari, Snowball & Fraser, 2013), production (Brüser *et al*., 2014), risk management (Belle, Collins & Jordaan, 2018) or agricultural development and skills development in the industry (AgriSETA, 2018). Whilst South Africa experienced an average annual decline in farm numbers of 1.81% from 1952 to 2017 (Liebenberg, 2012; Statistics South Africa [StatsSA], 2020), key questions relating to structural change have not been the subject of study recently. Thus, by ignoring the factors that motivate commercial producers to exit farming – whether voluntarily or not – the result has been a substantial gap in the literature, especially with respect to sustainable land reform.

This gap in the literature motivated us to explore the responses of 450 participants in a survey on land-use patterns in commercial agriculture in South Africa to identify the factors that drive their willingness to sell farmland. The survey was executed through a self-administered questionnaire, distributed via email or by students, and completed by commercial producers belonging to various industry bodies and producer organisations, as well as willing landowners and production managers. Of approximately 1 370 questionnaires that were distributed, a total of 658 were returned, of which 541 were completed in full. Of

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these, 450 were completed by farm owners and thus formed the sample of interest for this study.

From interacting with the literature and the data, a four-quadrant framework with two latent variables was constructed, with respondents falling into one of four categories. The one axis considered a respondent's perception of the threats or constraints that the business environment poses to operations, and the other axis considers the strategic decision of the respondent to expand or contract capital expenditure. Within this structure, it is theorised that, by making use of a regression analysis and cluster analysis, the drivers of and commonalities in strategic decisions concerning land use and ownership can be extracted. The outcome of this study makes a threefold contribution to the literature, as it offers perspectives on why some producers plan to exit, why others do not plan to exit and how what we learn from this can be used to shape a more sustainable environment for new entrants.

AgriSETA (2010, 2018) identified a number of factors in qualitative studies they have conducted that affect agricultural development and skills development in the industry. Some of the factors highlighted are the rising of input and transaction costs, land reform policy and uncertainty, expanding market for leisure agriculture, labour rights legislation, adoption of capital-intensive alternatives to be less reliant on labour, safety and security in rural areas, climate change and erratic weather conditions (e.g. droughts and floods). In this study, we tested whether these factors would feature in the output of the regression model. It was also hypothesised that factors such as age, years of farming experience, education levels, region (province) and financial constraints may drive the decision to exit or stay in agriculture.

For this purpose, a theoretical framework was developed that builds on the international literature on structural change in agriculture (section 3.2), along with a methodology to test this framework (section 3.3). This is followed by a regression analysis that explains the decisions from the landowners' perspectives (section 3.4), and an interpretation thereof in conjunction with a cluster analysis (section 3.5). Section 3.6 concludes.

3.2 Applying structural change theory to South Africa's commercial farms

Leontief (1941: 203-204) defines structure as "the interdependence between the quantities of the inputs absorbed, and the amounts of the product or products turned out in

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a given process". Wherever there is a compilation of elements or an arrangement of parts within a larger order, there is a structure. Wherever there is a structure, the prospect of change exists. This phenomenon is because of the effect that endogenous and/or exogeneous forces can have on the structure. The term 'structural change' is denoted on the sectoral level from output to employment, industry organisation to firm composition, financial systems to political institutions, demography to value systems, distribution of wealth to income, and many more.

In primary agriculture globally, policy- and market-driven factors appear to have the largest effect on the change in producer numbers, whether increasing (Lowder *et al*., 2016; Padmanabhan, 2018; World Bank, 2019a, 2019b, 2019c) or decreasing (Gale, 2003; Katchova & Ahearn, 2014; European Commission, 2017; Shimizu, 2017) them. This also applies to part-time farming (see RIRDC, 2007; Martini & Kimura, 2009; NFU, 2011; Antman *et al*., 2015; Ramsey *et al.*, 2019).

Historically in South Africa, changes in policy, such as the removal of direct subsidies through the dismantling of marketing boards, have driven some producers out of the market. The new market opportunities have also resulted in intensification. The removal of marginal land from field crop production led to a substantial increase in productivity and continued growth in yields. Total factor productivity increased, thereby reducing the demand for labour. The ability to adopt productivity-increasing technology required a sufficient operating scale. These changes ultimately created a climate for certain producers to actively seek to expand and for others to divest and seek other sources of income, resulting in a decrease in the number of producers and an increase in the average farm size in South Africa (see Mbongwa *et al*., 2000; Liebenberg, 2012; Greyling *et al*., 2015).

This phenomenon of decreasing producer numbers over time is, in broad terms, the result of four different strategies that producers or potential producers can follow. The structural change in the industry is a result of some producers exiting and selling their farms, some producers actively seeking to expand, some producers remaining – whether by choice or by a lack of alternatives, and a general lack of new entrants.

After numerous international literature sources were consulted (Gale, 2003; RIRDC, 2007; Martini & Kimura, 2009; NFU, 2011; Katchova & Ahearn, 2014; Antman *et al*., 2015; Lowder *et al*., 2016; European Commission, 2017; Shimizu, 2017; Padmanabhan, 2018; Ramsey *et al*., 2019), it became clear that three categories of factors appeared to have the

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largest effect on the change in producer numbers, whether increasing or decreasing. Within the context of investment in agriculture or the withdrawal of investment from agriculture, the factors can be divided into three groups – personal, financial and policy – although with some interrelated occurrences. Of particular interest here are the financial and policy considerations.

Financial considerations in the decision to invest or divest must be viewed in conjunction with the ability to act on the decision. Whilst some small and medium-sized producers are divesting because farming becomes unsustainable (see Gale, 2003; Gras, 2009; Chen *et al*., 2019), others offset the real decline in income at the primary production level through vertical or horizontal expansion, or both (Productivity Commission, 2005; Castro-Fontoura, 2016). Critical mass is however a requirement to warrant the outlay of technology-based productivity improvements (MacLeod & Moller, 2006; Pedersen & Møllenberg, 2017).

The direction and intent of public policy shape the environment in which producers operate daily. As such, policy can drive both the expansion and contraction of an investment. Policy also affects business confidence. According to Kershoff (2000: 3), in South Africa, "an increase in business confidence reveals that economic growth and private fixed and inventory investment could pick up in 9 to 12 months' time. The opposite applies if confidence declines". Uncertainty about the macro-environment is reflected in this business confidence. The theory supports the notion that, during times of policy uncertainty, the willingness and desire to invest decline (Kershoff, 2000; Croucamp & Malan, 2016).

The average value of the agribusiness confidence index from 2000 to 2020 was 51.18% (AgBiz, 2021). An analysis of the deflated values for capital assets on commercial farms, gross capital formation and total farming debt concluded that, although there has been real growth in value, it came at a declining addition rate. In addition, real-term growth of total farming debt occurred at a rate 1.91 times faster than what was observed for the value of capital assets in real terms (DALRRD, 2021).

Due to the long-term nature of certain investments and liabilities in agriculture, producers cannot necessarily easily adjust to short-term changes in policy and market signals. Porter (1976: 21) argues that "there are a series of barriers to exit working against divestment decisions, in such a way that companies are inclined to hang on to unprofitable businesses". This can inhibit the natural process, resulting in an alternative course of structural change. By 1989, the definition was expanded to accommodate the indirect opportunity cost, which

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refers to the costs or loss of potential future profits that an exiting company faces (Gilbert, 1989). By this definition, apart from the direct exit costs such as labour-related exit costs and regulatory exit requirements, indirect opportunity costs, such as sunk cost, penalties on cancellation of long-term contracts and first-mover disadvantage, can be included for companies for which the circumstances render an exit decision (Bascunana-Ambros & Neto, 2019).

As barriers to exit, similar to barriers to entry, have a weakening effect on the competitive process in the marketplace, the result is that less-efficient firms remain in the market. The adverse effects of such a situation include, but are not limited to, declining productivity, which restricts change and the potential for innovation and ultimately has a negative effect on economic growth (Bascunana-Ambros & Neto, 2019).

A lack of existing literature on the barriers to exit that exist in commercial agriculture in South Africa affords us the opportunity to test the existence of barriers to exit. Previous research (Cloete, Greyling & Delport, 2022) has alluded to the presence of such barriers, as a segment of producers were found to be financially constrained and struggling to service existing borrowing commitments, yet a negligible share of producers indicated that they planned to exit because of financial difficulty. This could lead to what Satola *et al*. (2018) describe as slow economic decline as a method of exiting. One of the main contributors to the process of slowly dying out is the avoidance of making radical decisions, which, in turn, leads to the wasteful application of resources, thus ultimately decreasing the farm's assets and, as a result, its value.

Linked to the above is the financial vulnerability as a result of idiosyncratic risks associated with farming that not only affect short-term finances, but often leave ageing producers unprepared for retirement. Unable to retire, which is a barrier to exit, they continue with operations to meet the family's basic demands, all the while being an ageing producer whose cognitive abilities slowly deteriorate (see Gutter & Saleem, 2005; Anstey, 2016). With 40% of producers in South Africa older than 55 years of age (StatsSA, 2020), this phenomenon of becoming impoverished by exogenous and/or endogenous factors. The former includes factors like droughts, floods, economic whether scaling down or more lifestyle orientated, resulting in the underutilisation of downturns and policy changes. The latter includes factors like flawed planning, poor decision-making and shoddy workmanship,

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can become increasingly relevant. Not only can it be a barrier to exit, but it also constitutes an obstacle to structural transformation under extreme circumstances (Satola *et al*., 2018).

There are two more factors to be considered as potential barriers to exit that affect the structural change of the industry: rent-seeking and transaction cost. Rent-seeking, the ownership of land and the perception that land market prices will grow can be barriers to exit. Where the producer a) does not have the investment capacity to continuously plough back into the land, or b) does not necessarily have a profit-maximising goal for productive farmland, this price growth may not realise in the future. The emotional bond of ownership of a specific parcel of land, which often coincides with the land belonging to the same family for several generations, can hinder the producer's decision to exit and sell the land. Because land is only sold once, producers delay the decision, even when it is no longer economically viable for them to continue working said parcel. As a result, and by not making the decision, the productivity of the land is essentially at a suboptimal level (Van Dijk, 2007; Satola *et al*., 2018).

The high transaction cost relating to the sale of resources, be it the preparation or closing of sale transactions, can delay the decision to fully exit, but still result in the discontinuation of production. It appears that divestment without a plan to exit is a likely phase before the final parting between owner and land, as the real and perceived barriers to exit are considered to be too high (Satola *et al*., 2018).

This all leads to the existence of the segment of 'sluggers', indicated in **Figure 3.1**. This figure shows that, for the reasons presented above, a bad business climate does not always lead to abandonment of the farm. Producers in this segment keep on trudging forward against the obstacles in their environment. It also shows that, vice versa, farm owners may decide to give up farming despite an advantageous business climate, as is the case with the 'migrators'. It has been shown that non-monetary work satisfaction strongly affects structural change (Mann, Freyens & Dinh, 2017). Both South Africa's crime rate in the countryside (Wilkinson, 2017) and the political pressure from the government may convince financially successful producers that giving up the farm may be their best option.

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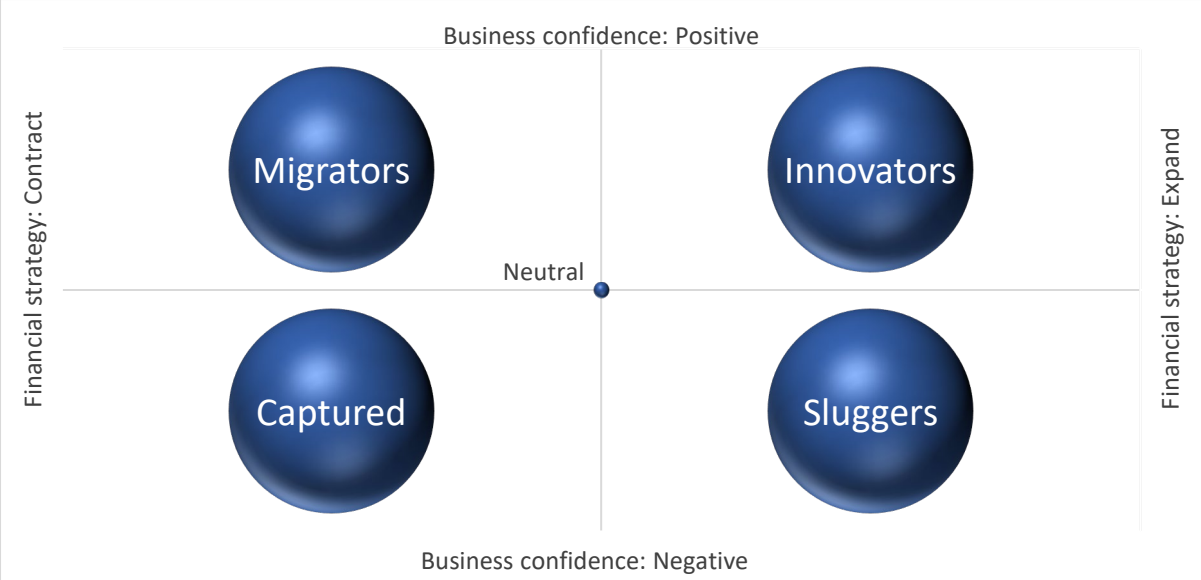

Figure 3.1: Four-quadrant structural framework with two dimensions

On the two opposite sides of the four-quadrant model are the 'innovators' and the 'captured'. The former is a segment of producers who can cope sufficiently with the business environment to not consider it threatening to their livelihood, and who also are strategically inclined to invest further in agriculture. The latter, in contrast, occupy land without a continued investment strategy and are not able have a positive outlook on the business environment.

3.3 Data collection and methodology

3.3.1. Data collection

The data for this study was collected over an 18-month period through a voluntary survey, starting at the end of 2017. The questionnaire was designed to extract information on the participants' background and geographic location, strategic planning (aspirations), employment of skilled and unskilled labour, capital and turnover, production mix, changes in land use, and their view of the effect of exogenous factors on their business.

The age of the survey participants ranged from 20 to 90 years of age, with an average age of 51 years. The majority of respondents had between 16 and 30 years of experience, with 26% indicating that they had more than 30 years of experience. As expected, the vast majority (95%) of respondents were male, and 70% indicated that they had completed an undergraduate tertiary qualification, with an additional 12% indicating that they had also

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completed a postgraduate degree. Within the sample, 20% (91 respondents) indicated that they planned to stop farming and sell their property within the next ten years, hence falling into the exit group (as opposed to the non-exit group, comprised of producers planning to stay).

3.3.2. Four-quadrant model

From the data gathered in the survey, the variables included in the two conceptual axes were selected for their importance in a) shaping the business environment and each respondents' confidence in operating in that environment, and b) determining the level of expansion or contraction of investment in land, production and processing by the respondents. A full list of the variables is available in **Appendix C** (sections (b) and (c)). For the x-axis (investment perspective), the focus was on strategic investment decisions over the next five to ten years and investment decisions of the past two years. The ability to execute on this decision was tested against the level of constraint that the producer was experiencing based on existing financial challenges. Given that three variables (see **Appendix C**, section (d)) were used to identify the exiting producers from the group of variables relating to strategic investment decisions over the next five to ten years, these variables could not be included in the financial latent variable. For the y-axis (perspective on business environment), the variables considered were the perception of the producers regarding social aspects (labour availability and quality, stock theft, and farm attacks), policy aspects (land reform, labour laws, environmental laws, and market access), natural environmental aspects (climate change and predators), and economic aspects (input cost and decreasing commodity prices).

3.3.3. Logistic regression

Apart from the variables included in defining the two axes of the four-quadrant model, another set of explanatory variables was considered in the regression analysis. The latter set was included to account for drivers outside of the business confidence and financial strategy demarcation. Variables such as age, province, education and years of experience, as well as the industry (livestock, field crops, horticulture or mixed) and farm turnover, were incorporated into the regression – the complete list of predictor variables in the first run of the model is available in **Appendix C** (sections (a), (b) and (c)). All of these variables were

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considered as potential drivers of the decision to exit or stay, and therefore included as explanatory variables.

Considering the objective of determining how the abovementioned variables played a role in driving the decision to exit or not, a binary logistic regression was deemed appropriate for this study, as the dependent variable had two possible outcomes – exiting or not. This analysis models the relationship between the explanatory variables and the described categorical response (dependent) variable, expressing the effect of the explanatory variables on the outcome of the dependent variable (see **Equation 3.1**).

Equation 3.1: Probability of exiting – the logistic regression model

$$\theta(\bar{X}) = \frac{e^{\beta_0+\beta_1 X_1+\cdots+\beta_k X_k}}{1+ e^{\beta_0+\beta_1 X_1+\cdots+\beta_k X_k}} = \frac{1}{1+ e^{-\bar{X}\beta}},$$

where $\theta(\bar{X})$ is the probability of exiting (PSU, 2018). The algebraical equivalent of the logistic regression model (**Equation 3.1**) that was estimated is shown in **Equation 3.2** below, and is interpreted as the log odds (also called the logit transformation of the probability), where the odds are the probability divided by the probability of no success (UCLA, 2007).

Equation 3.2: Log odds of exiting

$$\log\left(\frac{\theta}{1-\theta}\right) = \beta_0 + \beta_1 X_1 + \cdots + \beta_k X_k$$

The dataset of 450 observations was split up – randomly – into a model (approximately 80%) and validation set (approximately 20%). Observations were selected randomly from each of the exit group and non-exit group, and the model dataset was used to estimate the regression model, after which the validation dataset was used to validate the model.

After considering 55 explanatory variables from sections (a), (b) and (c) in **Appendix C**, including three categorical/factor variables, all variables that did not contribute significantly to the variation in the binary dependent variable were discarded. The Wald test was conducted to determine whether the categorical explanatory variables of age, experience and province were overall significant in the decision to exit. Age ($\rho = 0.021 < 0.05$) was significant overall in explaining the exit vs non-exit variance, while experience ($\rho = 0.49$) and province ($\rho = 0.77$) were not. By substituting the variables in **Equation 3.2** with the final estimated

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coefficients of the regression analysis that explain the intention to exit farming over the next ten years, the output of the analysis is presented in **Equation 3.3**. See **Appendix C** for more detail on the variable definitions, where the output of the regression analysis is highlighted.

Equation 3.3: Regression analysis output – Log odds of exiting

$$\log\left(\frac{\theta}{1-\theta}\right) = 0.42 - 1.09X_{Production\ Loans} - 1.35X_{Business\ Confidence}$$
$$+0.80X_{Investment\ Cost} + 0.19X_{Financial\ constraint} + 1.08I_{age30-45}$$
$$+0.56I_{age\ 45-65} + 1.50I_{age>65},$$

where I_k is an indicator variable for age, which has a value of 1 if the respondent is in the relevant category, and 0 if not.

3.4 Results of regression analysis

The results of the binary logistic regression results – the estimated coefficients from **Equation 3.3** and odd ratios – are presented in **Table 3.1**, with the age category 'younger than 30 years' being the reference category of the categorical variable.

Table 3.1: Binary logistic regression results

	Estimate	Std. error	*p*-value	Odds ratio	2.5% CI	97.5% CI
(Intercept)	0.42	1.01	0.67	1.53	0.17	10.01
Production loans	-1.09	0.33	< 0.001	0.34	0.17	0.63
Business confidence	-1.35	0.21	< 0.001	0.26	0.17	0.38
Investment cost	0.80	0.30	< 0.01	2.23	1.26	4.05
Financial constraint	0.19	0.11	0.07	1.21	0.99	1.50
Age (30–45 years)	1.08	0.87	0.21	2.95	0.62	21.92
Age (45–65 years)	0.56	0.82	0.49	1.75	0.42	12.06
Age (> 65 years)	1.50	0.90	0.10	4.49	0.89	35.01

The overall performance of the fitted model is measured by the goodness-of-fit test (also called the likelihood ratio test), where the test statistic (difference between residual deviance of the fitted model and the null model) is distributed chi-squared, with degrees of freedom equal to the difference in degrees of freedom of the current and the null model (i.e. number of predictor variables in the model = 7). The chi-square of 76.97 with seven degrees

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of freedom is associated with a p-value < 0.001, indicating that the current model fits significantly better than the empty model (with no explanatory variables).

The validation set was used to evaluate model accuracy (see results summary in **Table 3.2**). Thirty percent of the exiters in the validation set (6/20) were predicted to be exiters by the model, while 70% of the exiters in the validation set (14/20) were predicted to be non-exiters by the model. Five percent of non-exiters in the validation set (4/80) were predicted by the model to be exiters. The model is more likely to falsely identify exiters as non-exiters than the other way round. Even though a 30% success rate is not ideal, it is a satisfactory result, given that factors outside of the financial strategy and business confidence scope of this study, such as personal health or family situation, can play a role in the decision to exit.

Table 3.2: Model validation

		Predicted (from model estimate)		
		Exiters (1)	Non-exiters (0)	Total share (%)
Given	Exiters (1)	6	14	20
	Non-exiters (0)	4	76	80
	Total share (%)	10	90	100

The estimated coefficients relate to the log odds of the probability of exiting and are interpreted more intuitively as odds ratios or probability effects. Three themes emerge from the odds ratios (also given in **Table 3.1**), namely age, business confidence and financial situation.

The odds of producers aged 65 and older exiting is 4.49 times higher than the odds of young producers exiting. Whilst it is logical that producers in the upper age category are more likely to exit than those starting off (younger than 30), one should also consider that this high number indicates the end of an era – if these producers sell at exit, it means that the family is parting with the land and a next generation is not establishing themselves in the rural areas. An interesting observation is the higher odds ratio for exiting by producers aged 30 to 45 (2.95) compared to the age bracket 45 to 65 (1.75). One probable interpretation is that the former is still able to change jobs and start a new career, whereas the latter are in a different life phase – more settled and less able to change jobs and start a new career. Also, their

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slightly lower education levels than the 30- to 45-year-old group could affect their ability to find work in another industry.

In the case of business confidence, the results are not surprising. A unit increase in the business confidence variable (i.e. if the farm owner considers the business climate as good) reduces the odds of exiting by 3.84 times (1/0.26). Producers will be much more likely to continue farming if the business climate is considered promising.

On the financial side, three variables proved to be significant in the analysis: production loans, investment cost and financial constraint. If the producer makes use of production loans (as a form of external capital), his/her odds of exiting are 2.94 times lower (1/0.34). Whilst this may seem counterintuitive at first glance, the result could be interpreted as follows: firstly, if a producer is able to acquire production loans, he/she is in a healthier financial position than a producer who is not able to secure a loan to finance inputs in order to produce. Secondly, it could be indicative of the value chain in which this producer has an off-take agreement for his/her product, as the opportunity to acquire a production loan would increase and such a producer might be less likely to exit.

The positive correlation between exiting and the investment cost and financial constraint variables are indicative of longer term financial pressure. For each unit increase in investment cost, which considers the cost of expansion, the odds of exiting increase 2.23 times. When the investment cost increases, some producers cannot keep up and fall behind as a result. Once behind, they are unable to adjust at a rate consistent with the industry. In terms of the financial constraint variable, i.e. if the producer finds access to foreign capital and/or the servicing of existing loans to be increasingly constraining his/her business, the odds of exiting increase 1.21 times. The tighter the noose, the less likely it is for the producer's situation to improve.

3.5 Contextualisation of output using a cluster analysis

As the regression analysis has shown, business confidence is an important, but by far not the only, predictor of willingness to exit farming. It also is helpful to show typical constellations between these variables by means of a cluster analysis. By making use of an equal weighting between the considered factors, each respondent is plotted in **Figure 3.2** and colour coded according to the original clusters that served as the basis for further

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investigation. Rescaled to a value between 0 and 1, excluding the most extreme points, the figure thus makes use of the second smallest and second largest values to normalise the range.

Previous research (Cloete *et al*., 2022) has demonstrated that two pairs of two clusters each returned relatable results, often distinctly different in only a few major factors. In the first pair, represented by clusters 3 and 4, respondents in each cluster had similar experiences in terms of the level of threat or constraint to their business caused by certain factors, including factors such as a lack of dependable labour, minimum wage laws, rising input costs and decreasing commodity prices. However, despite similar experiences of the business environment in which they operated, the vast majority of cluster 3 (85%) planned to exit farming and sell their land, whereas an almost negligible portion of cluster 4 (4%) had the same intention. In the second pair, represented by clusters 1 and 2, respondents tended to be more investment-positive producers, with the bulk of large-scale producers falling into either of these two clusters. For the most part, the levels of challenges and threats experienced by the respondents in these clusters are notably lower than in the other pair. Of the investment-positive clusters, respondents in cluster 1 seemed, by and large, undeterred by the ever-changing and challenging environment in which they operated, whilst cluster 2 returned similar results to cluster 1 in several instances. The analysis also showed that the latter may be a more vulnerable group from a business sentiment perspective relating to specific challenges and/or threats. These observations lead to the four-quadrant framework with two latent variables, as per **Figure 3.1**.

Each of the 450 respondents were plotted, with 22.0% in the ‘innovator’ quadrant, 32.4% in the ‘slugger’ quadrant, 28.2% in the ‘captured’ quadrant and 17.3% in the ‘migrator’ quadrant. The ‘innovators’ constituted 46.7% of cluster 1, 19.3% of cluster 2, 1.6% of cluster 3 and 8.9% of cluster 4. In contrast, 5.9% of cluster 1, 30.3% of cluster 2, 59.0% of cluster 3 and 34.8% of cluster 4 were plotted as ‘captured’ – with negative business confidence and contracting on investment. Understandably, the ‘migrators’ had the fewest respondents, as few producers experienced the environment as an opportunity and yet had a definitive strategy to contract their agricultural investment. However, the high prevalence of producers from cluster 1 in this quadrant is somewhat alarming – if producers who still have an optimistic outlook are not actively seeking continuous (re)investment in agriculture and agro-processing, this will have a negative effect on the potential of the industry over time.

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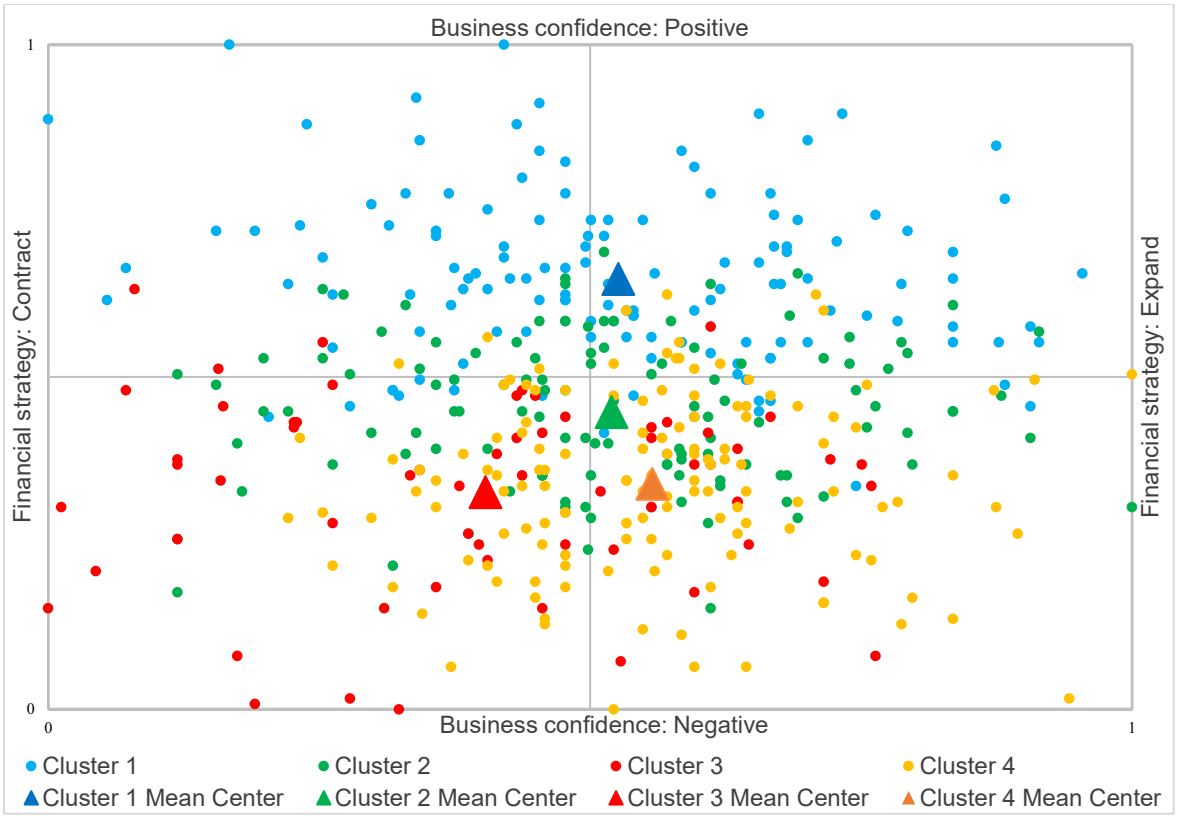

Figure 3.2: Schematic representation of clustered respondents

From these initial observations, it appears that 54% of respondents are represented on the right side of the graph, indicative of the volume of investment-positive respondents. In contrast, 61% are represented in the bottom half and thus have a business sentiment value below 0.5. Considering the mean centre for clusters 1 and 2, which are (0.53, 0.65) and (0.52, 0.45) respectively, it proves that the respondents in these clusters, on average, have very similar financial investment strategies, whilst having opposite perspectives in terms of business confidence. Similarly, the mean centre coordinates for clusters 3 and 4, which are (0.40, 0.33) and (0.56, 0.34) respectively, are negative in terms of business confidence, whilst cluster 3 leans, on average, towards investment contraction, whilst respondents in cluster 4 lean, on average, towards expanding their investment in agriculture, despite their negative perceptions of the business environment. As a result, this quadrant of 'sluggers' amasses a large number of observations from clusters 2 and 4.

In a comparable manner, the data is considered by differentiating between producers planning to exit and sell their property in the next ten years, and those planning for operations to continue, whether by the owner him/herself or by the identified successor(s). Observations include that 59% of the non-exit group have an investment expansion strategy, compared to

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only 37% of the exit group. Considering that some respondents in the exit group are planning to sell their land to retire, it could be to their benefit to continue investing to improve their opportunity for returns when calling it a day. Furthermore, 42% of the non-exit group see the current environment as an opportunity, resulting in 25% of the non-exiting respondents falling into the 'innovator' segment, whilst 43% of the exit group are in the 'captured' segment, reiterating the observations from the cluster analysis concerning financial strategy and the business confidence of exiting and non-exiting respondents.

Additional to the discretionary decision to expand or continually invest vs contracting or retracting on an investment decision is the respondent's current level of financial constraint and ability to service current loans, which could hinder or assist his/her ability to execute a decision. This was tested by analysing the interplay between the financial strategy of the respondents and their current experience of constraint as a result of financial challenges and servicing existing loans. Whilst clusters 1 and 2 were fairly unconstrained, the bulk of clusters 3 and 4 were constrained by current financial commitments. Of concern, however, are the number of producers who are planning to continue with their operations, yet who are constrained by existing financial commitments and not planning to invest in the future. Thus, it can be argued that, to a certain extent, these producers are unable and/or unwilling to utilise the land they own to its full potential, affecting total land productivity in the process.

3.6 Discussion and conclusion

Three core themes emerged from the regression analysis (**Table 3.1**) as being significant in the strategic decision-making process of producers, namely age, financial costs and constraints, and business confidence.

With producers younger than 30 used as the reference category, the odds of other age categories of producers exiting are the highest for those over the age of 65 (odds ratio of 4.49), those aged between 30 and 45 (odds ratio of 2.95) and, lastly, those aged 45 to 65 (odds ratio of 1.75). Firstly, the high odds ratio for producers in the over-65 age category is indicative of severance from land by a family, as selling this land would mean that there is no family succession. Secondly, with producers aged between 30 and 45 having a higher odds ratio that those between 45 and 65, it could be indicative of their ability to re-establish

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themselves elsewhere compared to those who are unable or unwilling to consider selling land and relocating.

In the regression analysis, business confidence emerged as one of two significant variables in reducing the odds of exiting. It is an important indicator and forerunner of private investment. The opposite is also true – when there was a decline in confidence, economic growth and investment, a retraction in investment could be observed over the next nine- to 12-month period (Kershoff, 2000). In addition, the lack of business confidence in producers in clusters 2 and 4 in **Figure 3.2** (78% of them had a business confidence level of below 50%) can be considered as a forerunner of foregoing future investment.

Financial constraint, which refers to the threat to operations experienced by the respondents regarding the servicing of loans and other financial constraints, was also significant in the regression analysis, increasing the odds of exiting by 1.21 for every unit increase, meaning that the threat to operations has an exponential effect on exiting. Financial constraint is a major stumbling block in an operation's ability to expand, to improve productivity through technological and other enhancements, and to act on opportunities (Fernando & Ruggieri, 2015). Whilst only 5% of producers in cluster 2 experienced high (over 50%) levels of financial constraint, this level of constraint is observed in 23% of cluster 1 producers, while a massive 70% and 80% of cluster 3 and 4 producers fell into this category respectively. An expanding or contracting financial strategy is subsequently bound by the business confidence and level of financial constraint experienced over a period of time.

Consequently, the regression analysis depicts the rather intricate relationship between the two main factors that may keep producers in business, of which one is a positive business climate, and the other is strategic financial decision-making. The latter is not represented only by the items describing the financial assets of the farm, but also by the age variable: the older producers are, the more human capital they would have invested in agriculture. While younger producers less frequently plan to exit their business, the very high standard deviation of the age class dummy variables shows this 'locking' element of age as well. The strong significance of the three financial variables and business confidence, however, indicates that both elements – having optimistic prospects and having no other choice than to stay – significantly influence structural change.

The cluster analysis sheds light on the interplay between being optimistic and being locked in farming. The existence of four different clusters in this respect could largely be

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confirmed with respect to ‘innovators’, ‘sluggers’ and ‘captured’ producers. From a land-use and land-productivity perspective, the fact that 69% of the captured quadrant comprises non-exiters is a reason for concern. Few farm owners, however, plan to contract their farms or even to exit, despite perceiving the business climate as promising. Those who do fall within the ‘migrator’ category could be using primary agriculture as a point of departure for other ventures.

In conclusion, the analysis suggests that business confidence and a contracting or expanding financial strategy strongly influence structural change. These factors depict the rather complex interplay between the two main factors that may keep farms in business: a positive business climate and the human and financial capital invested.

Apart from the direct implications, this ranking of the driving factors also provides a first glimpse of the barriers to exit: the presence of production loans increases the odds to stay, indicating some levels of boundedness. Also, producers aged 45 to 65 are more likely to stay than those in the age brackets of 30 to 45 and older than 65 age, indicative of a lack of opportunities to exit voluntarily – either by entering the job market outside of owner-operator primary production, or by selling the farm to retire. Two courses of action can be explored in the policy environment by recognising the drivers for exiting. Knowing what drives the exiting of existing producers, appropriate policy intervention can alter the exit rate. Some hidden factors are brought to the surface, which can be avoided when establishing new entrants.

It is recommended that more work is done in the above regard, with a greater emphasis on identifying and understanding the barriers to exit and the cost thereof to the individual and society. In the broad sense of agricultural land use (or occupancy), the construction of exit strategies is becoming more critical to reduce the squandering of scarce and finite resources. The productivity of South African agriculture could probably be increased if the segment of ‘captured’ producers could make room for entrepreneurs by freeing up the land for new investment. The establishment of comprehensive policy programmes directed at incentivising such a development would accelerate the tempo of establishing new entrants in a more sustainable manner, and therefore should become part of the political discourse on South African land reform.

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Chapter 4:

Accelerated exiting of captured commercial producers and the structural impact thereof: An agent-based approach

4.1 Introduction

One of the many ways of structurally changing the South African agricultural sector is implementing a land reform policy consisting of three elements: land tenure, land restitution, and land redistribution (Department of Land Affairs [DLA], 1997).

The reality of transformation through the land redistribution process of South African agriculture is that of slow progress and few success stories. Symptoms of the slow progress and poor implementation include targets often not met, questionable selection of beneficiaries, and not recognising or considering the heterogeneity of land, industry and people in policy (see Dlamini *et al*., 2013; DRDLR, 2013; Cousins, 2016; Kirsten *et al*., 2016; BFAP, 2018; Sebola, 2018; Zantsi, 2021). Although many studies have focused on the lack and quality of progress, little research has gone into understanding where, when and how commercial land becomes available. How this affects planning for policy and implementation is paramount to improving the success rate of land redistribution. Consequently, these issues were raised by the 2019 Land Reform and Agriculture Advisory Panel, which has then pleaded for more research into these issues (The Advisory Panel on Land Reform and Agriculture [APLRA], 2019).

This chapter aims to establish a method to understand which commercial land will become available over the modelling period to bridge the land supply literature gap.

The first objective of this chapter is to understand the effect of exit decisions on the pathways of development and, ultimately, the sector's structure. A second objective is to describe the characteristics of an accelerated exit rate conceptually.

An agent-based modelling (ABM) approach was applied. This approach uses several data sources, including the results of a self-administered survey. Within the ABM framework, the interactions between multiple agents (producers) are simulated with the individual agents' simultaneous production and investment decisions. This is done to recreate a simulated representation of reality to test the effect of different scenarios in a "laboratory" environment before implementing them in real life.

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The survey was constructed to obtain information on the participants' background and geographic location, strategic planning vision, permanent and seasonal employment, capital and turnover, production mix, changes in land use, and their view on the effect of exogenous factors on their business. In this survey, several producers indicated that they planned to exit and sell their land, including age, financial difficulty, and the danger of farming in South Africa. The baseline exit rate encapsulates these respondents.

To consider situations with an accelerated exit rate that require that agents exit who has not indicated that it is their intention, this study also considers the existence of barriers to exit faced by agents that should, theoretically, exit but hesitate to do so for unknown reasons. Identifying these barriers to exit could aid in accelerating the rate of land reform through the additional availability of land for redistribution (APLRA, 2019). This understanding can serve to counteract more radical approaches to increasing the land supply.

Section 4.2 provides a review of the current literature, and section 4.3 elaborates on the data and method and an understanding of the baseline conditions. Section 4.4 describes the exit scenarios, where the results of the baseline and scenarios of the ABM for South African commercial agriculture are compared comprehensively and then discussed in section 4.5. Section 4.6 concludes.

4.2 Literature review

4.2.1. Structural transformation of South African commercial agriculture

Commercial agriculture has experienced at least four structural shifts in the last century, which have transformed the sector (see Vink, 1993; Greyling *et al*., 2015) and effected change in farm numbers. The ever-changing environment played a role in increasing the number of farms to 119 556 in 1952 and the consequent decline to 40 122 farms in 2017 (see **Figure 4.1**). Policy changes have been very influential – from how tax advantages accelerated technology adoption through tractors and implements, the dismantling of marketing boards, gaining access to international markets, and removing subsidies and protection. There have also been economic considerations, with production units growing to remain economically viable.

Over this 65-year period, the shifts resulted in an annual average decline in farm numbers of 1.81%. Contextually, this figure represents the rate at which producers exit and existing producers become responsible for the uptake of additional land. When a new entrant

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takes ownership of an existing farm when the previous owner exits, it will result in a constant number of production units. Since the 1990s, there has been a shift towards greater livestock and horticulture production, with the area under field crops declining since 1993, affecting farm numbers. This shift can be observed in the 2007 census and again in the 2017 census (Statistics South Africa [StatsSA], 2010, 2020; Liebenberg, 2012).

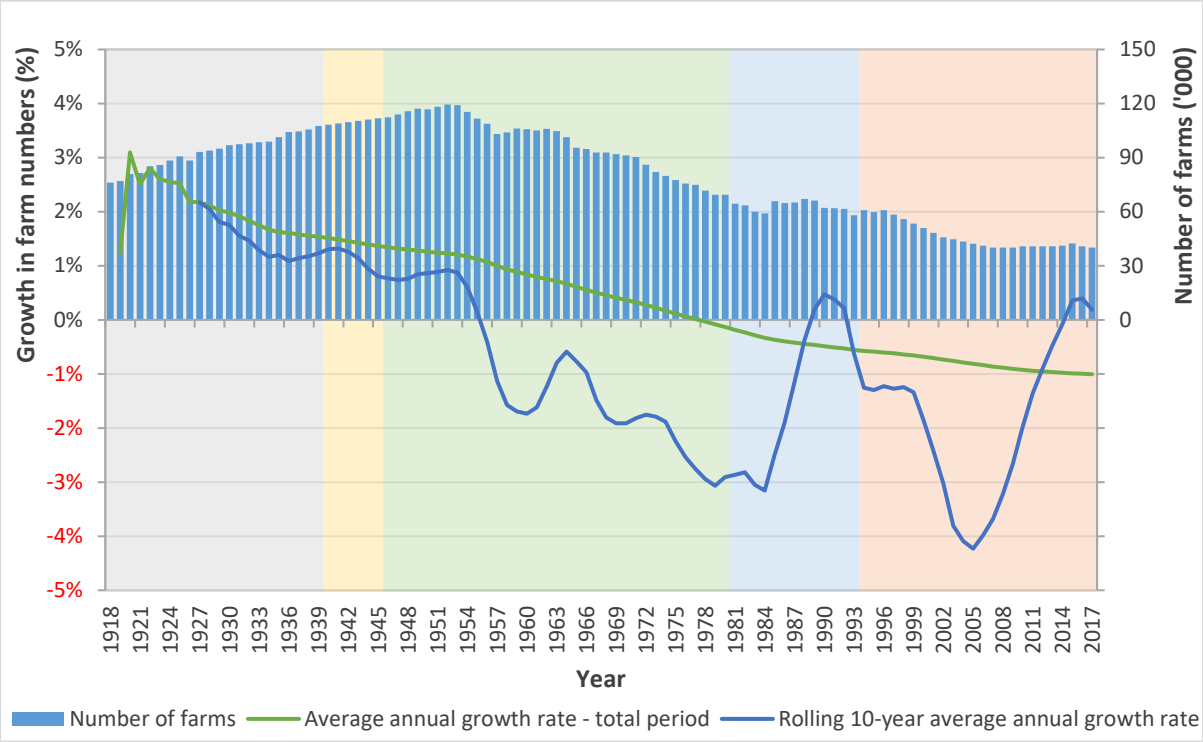

Figure 4.1: A century of commercial farm numbers: 1918–2017

Source: Compilation from Vink (1993), Liebenberg (2012), Greyling *et al*. (2015), Piek and Kirsten (2020), StatsSA (2020)

4.2.2. Main considerations in the decision to contract or expand investment

Globally, three categories of factors appear to have the largest effect on the change in producer numbers. Within the context of investment in agriculture, or the withdrawal of investment from agriculture, the factors can be divided into three groups – personal, financial and policy – although with some interrelated occurrences.

Personal considerations – mentally, socially, culturally or emotionally – are essential in deciding to invest or divest, especially with respect to farmland (see Gale, 2003; Katchova & Ahearn, 2014; European Commission, 2017; Shimizu, 2017).

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Financial considerations in deciding to invest or divest must be viewed in conjunction with the ability to act on the decision – a decision without the means remains a dream. Some small and medium-sized producers are divesting due to unfeasibility (see Gale, 2003; Gras, 2009; Chen *et al*., 2019). Vertical or horizontal expansion, or both, are options to offset the real decline in income per unit at the primary production level. Vertical expansion involves investing upstream or downstream in the value chain (see Productivity Commission, 2005; Castro-Fontoura, 2016). Horizontal expansion is where the investment is serviceable when the denominator in the calculation is characterised by critical mass to warrant the outlay of technology-based productivity improvements in the numerator (see MacLeod & Moller, 2006; Pedersen & Møllenberg, 2017).

The direction and intent of public policy shape the environment in which producers operate daily. As such, policy can drive both the expansion and contraction of investment. In South Africa, policy changes, such as the retraction of support and reducing interference – by dismantling boards and opening markets – have resulted in intensification (increased total factor productivity), decreasing producer numbers, and growing average farm size. The change ultimately created a climate for certain producers to expand and for others to divest and seek other sources of income (see Mbongwa *et al*., 2000; Liebenberg, 2012; Greyling *et al*., 2015).

Essentially, business confidence underpins the interplay between these three pillars – it considers the personal deliberations on financial decisions that have to be made in an environment affected by the policy. According to Kershoff (2000:3), “An increase in business confidence reveals that economic growth and private fixed and inventory investment could pick up in 9 to 12 months’ time. The opposite applies if confidence declines.” The Agbiz/IDC Agribusiness Confidence Index returns an average index value of 51.18% from 2000 to 2020 (AgBiz, 2021). How this score relates back to investment in agriculture can be deduced from analysing the deflated values for capital assets on commercial farms, gross capital formation, and total farming debt published by the Department of Agriculture, Land Reform and Rural Development (2021). While the average annual growth in the real value of capital assets on commercial farms is 2.68% for 2000 to 2020, the same measurement for the same period returned -0.36% growth in the gross capital formation. Thus, even though there has been real growth in value, it did come at a declining addition rate. Furthermore, the annual growth in total farming debt was 5.11%, on average, from 2000 to 2020, denoting that total farming

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debt grew in real terms at a rate of 1.91 times the rate of growth in the real value of capital assets on commercial farms.

Essentially, a producer has three options when lacking business confidence: 1) continue investing as normal, 2) opt-out immediately, or 3) delay decision by adopting a wait-and-see approach. The latter holds a certain risk – for the individual and the industry – as it can diminish the opportunity to generate income from the existing investment in the future. An example hereof is the decision not to replace orchards or vineyards when producing at sub-optimal levels because the risk associated with policy uncertainty does not render investment. Similarly, investment in new genetic material to improve a livestock stud or herd can improve revenue over time, but uncertainty and a lack of business confidence can halt the process.

4.2.3. Barriers to exit and the implications thereof

A review of the survey data suggested that many producers who were planning to stay had negative business confidence and a contracting financial strategy. The question that emerges is what barriers to exit prevent them from planning to do so?

Michel Porter (1976: 21) noted that "there are a series of barriers to exit working against divestment decisions, in such a way that companies are inclined to hang on to unprofitable businesses". This definition was expanded to accommodate the indirect opportunity cost as well, which refers to the costs or loss of potential future profits that an exiting company faces (Gilbert, 1989).

Within the context of agriculture and, in particular, the theory of a production unit's life-cycle, Satola *et al*. (2018) describe slow economic decline as a method of exiting. One of the main contributors to slowly dying out is the avoidance of making radical decisions, which, in turn, leads to the wasting of resources and ultimately decreases the farm's assets and value.

The barriers to exit in agriculture can broadly be categorised into financial vulnerability, sunk cost and transaction cost (see Chavas, 1994; Gutter & Saleem, 2005; Van Dijk, 2007; Satola *et al*., 2018). Any single one or combination of these factors can create an exit barrier, resulting in a period of lower reinvestment, effectively hurting land productivity.

The commonalities in the existing barriers to exit will also be addressed in this chapter (see **paragraph 4.5.2**).

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4.2.4. Agent-based modelling

It is impossible to capture the real world with its infinite number of variables, individual objectives, and preferences in a model. Many conventional modelling tools fall short of accommodating enough heterogeneity to provide a holistically realistic output, as they fail to capture the interaction sufficiently. In agriculture specifically, the real-world complexity of farm heterogeneity, together with the action and interaction of and between endogenous and exogenous agents in the system, is too complex to attempt to unpack using conventional modelling tools, especially when one wants to specifically allow and test for causal looping within an ever-changing open system. The inadequacy of these tools is further exposed when adding changes from an ecological and institutional nature to the equation (see Berger, 2001; Happe *et al*., 2008; Macal & North, 2010; Schreinemachers & Berger, 2011).

To overcome these challenges within the context of the research question to be answered, ABM, which, according to Gilbert (2008: 2), is "a computational method that enables a researcher to create, analyse, and experiment with models composed of agents that interact with each other and within an environment", provides the necessary platform. Agent-based modelling contributes to capturing the variability of agents within a system, especially in agricultural economics, when constructed, to research policy analysis and test social science theories and run hypothesis testing and explain land-use patterns and functions (Matthews *et al*., 2007).

In terms of domestic construction and the application of ABMs to real-world situations, examples can be found in the transport, fishery, climate change and food security literature, as well as in the literature on land reform from the perspective of distributing water resources and land (see Bharwani *et al*., 2005; Olubode-Awosola, Van Schalkwyk & Jooste, 2008; Woyessa, Welderufael & Kinyua, 2008; Van der Merwe, 2011; Cooper & Jarre, 2017a, 2017b). Recently, on the international front, Huber *et al*. (2018) reviewed agricultural ABMs that addressed the heterogeneous decision-making processes in the context of European agriculture.

A first countrywide, multi-disciplinary agricultural ABM was constructed for smallholder and commercial agriculture in South Africa, with the focal point being the effect of land-use patterns. This model is based primarily on the principles applied in the very successful SWISSland ABM (StrukturWandel InformationsSystem Schweiz/Information system of structural change in Switzerland) from Agroscope (Möhring *et al*., 2016). The ILUPSA (Impact

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of Land Use Patterns in South Africa) model has the primary goal of providing support in the running of scenarios to test policy outcomes in a controlled environment before rolling them out in practice (Zantsi *et al*., 2021). Against this background, the adapted model for this research is presented as a virtual laboratory to test two alternative scenarios of producer exit rates against a baseline of planned exiting from the survey data. How the scenario differs from the baseline is measured in the output over ten years, including variables related to the farm structure, production output, and the scope of opportunity for new entrants.

4.3 Data and method

4.3.1. Data required for an agent-based model

Applying the ABM in this chapter requires combining several datasets to achieve the objective. The first dataset, the survey data, is from a national survey of commercial producers, with 658 responses received. Of the 658, 541 were completed fully, and 450 were completed by landowners (whereas production managers may have completed the other). The survey was done through a self-administered questionnaire, distributed via email or by students, and completed by commercial producers belonging to various industry bodies and producer organisations and willing landowners and production managers. The survey achieved a response rate of 41% over 18 months.

The age of the participants ranged from 20 to 90 years, with an average age of 51 years. Most respondents had between 16 and 30 years of experience farming, with 26% of them having had more than 30 years of experience. As expected, the vast majority (95%) of respondents were male, and 70% indicated that they had completed an undergraduate tertiary qualification, with an additional 12% showing that they had also completed a postgraduate degree. A summary is provided in **Appendix D**.

This data forms the basis of the model in terms of the heterogeneity of agricultural production in terms of socio-economic data (age, education), geographical location, cultivated area and methods (i.e. rain-fed vs irrigated), size and scope of crop and livestock enterprises, and employment of labourers. The survey informs the rate at which land becomes available in the model, effectively defining the land market for the baseline and informing the scenarios.

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A process of extrapolation was followed to recreate a more representative sample in terms of the number of producers by province, resulting in 1 962 agents in the model (for which a summary is provided in **Appendix E**). These agents could then be upscaled to equal the total commercial farms in South Africa (40 112 farms). Although it can be argued that the 2017 census of commercial agriculture underestimates livestock numbers and land use, it is the official dataset that underpins the commercial farm numbers. Although potentially inaccurate (see DAFF, 2019; StatsSA, 2020), it provides a consistent dataset across subsectors and is consequently incorporated into the study to extrapolate upscale the model as the second dataset.

Thirdly, an industry average cost, yield and income per hectare are included by cultivation type for each of the 31 crop types modelled, covering all major field crops, horticultural crops (fruits, nuts, and vegetables), planted pastures and veld (open, uncultivated country or grasslands used as grazing area for livestock where there is a large variance in carrying capacity, depending on the biome and topographical nature of the region). For livestock, an industry average cost per livestock unit, and yield and income per livestock product for nine livestock categories and 18 livestock products, have been included, covering most farmed animals, including poultry, small and large stock.

Lastly, a dataset for land rent was developed. Throughout the model, annual rent is used as an indicator of land cost, even though existing private property rights exist. This approach simplifies the model and would be similar to the repayment of a bond to purchase the land or, where no bond on the asset is applicable, to the opportunity cost for investment elsewhere. Rents are computed from the sale of farms on the open market in South Africa, based on the geographical location, water availability and land-use type. The method of rent derivation from land value was adapted from Middelberg (2014).

The optimisation of the individual farms was modelled in the General Algebraic Modelling System (GAMS), whilst the initialisation of the (individual) exit decision and the delivery of output over the outlook period was executed using JAVA modules. These methods increase the transparency of the model and enable reproducibility.

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4.3.2. Model design for baseline

In **Figure 4.2**, a simplified interpretation of the construction of and interaction in the model is provided. The model considers income maximisation as the objective function, based on the outlined production capacities and preferences (**Equation 4.1**).

Equation 4.1: Commercial agriculture ABM – model design

$$Max\ INCOME_{a,t} = \sum_{c} p_{a,c} * \gamma_{a,c} * LAND_{a,t,c} + \sum_{l} p_{a,l} * \gamma_{a,l}\ ANIMAL_{a,t,l} + \sum_{f} p_{a,f} * \gamma_{a,f} * FEEDSALE_{a,t,f} - COSTFUNCTION_{a,t} \quad (1)$$

subject to

$$\sum_{c} \omega_{a,e}^{ENDOWMENTS} * X_{a,t,e} \leq ENDOWMENTS_{a,t} \quad (2)$$

$$X \geq 0 \quad (3)$$

The time resolution in the model is one year, which corresponds to the annual production planning for an agricultural farm. Per the theory of adaptive expectations, agents (α) make their production decisions based on the price (p) and yield expectations (γ) in a given year (t) for the various crops (c), animals (l) and feed production activities (f). The model is based on a recursively dynamic modelling approach according to which previous production capacities and investments made as a result of production decisions are carried over from one year to the next. The period for the trend calculations covers the years 2017 to 2026. The resources (ω) of a given agent consist of the available area and the number of animal places, labour units and other capacities like feeds that limit the activities (X) of the model. The quadratic production cost function contains the Positive Mathematical Programming (PMP) terms for both crops and livestock.

Once the base year for the individual farms is constructed and optimised, the output feeds into the steps where land availability is identified as a result of existing commercial production, deciding to exit agriculture and voluntarily sell their land during the next decade. Where the decision to exit is triggered in the model, the land becomes available as an opportunity for a new entrant to participate in agriculture (or an existing producer, but this feature is excluded for this study).

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This output is upscaled to national levels to quantify the potential structural effect for the base year. The model loops through this iterative process over the set outlook period, with an equal distribution of exiters over this period. As such, land becomes available each year from *t* + 1 onwards, as year *t* considers all agents to remain in agriculture.

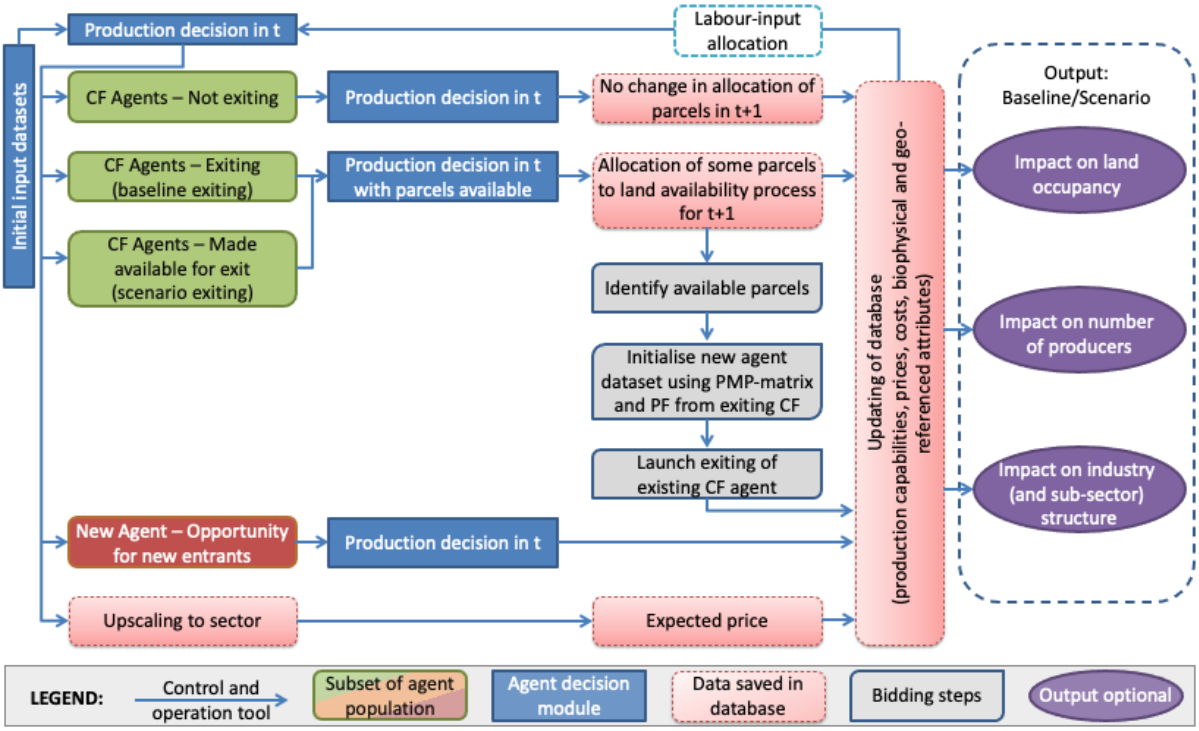

Figure 4.2: Commercial agriculture agent-based model

4.3.3. Model validity

Validation steps were taken. These were based on scientific literature, as suggested by Bruce McCarl (McCarl & Nelson, 1983; McCarl, 1984), and on practical implementation, as suggested by Möhring *et al*. (2016), and considers replicative, predictive and structural validity.

In terms of construct, the model was validated by sample, extrapolation, and calibration. The three steps of model validation and how they are linked to each other are described below. For validation by sample, PMP was used to derive producers' decisions to improve the forecasting performance of the individual farm optimisation models (see Heckelei, Britz & Zhang, 2012), which, in turn, were validated to represent the base year production levels correctly. The population of agents is representative of the population, and the upscaled results accurately depict the current data – validation at the extrapolated level.

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As a result of a lack of one single dataset provided by the government, this step includes but is not limited to secondary data and the consultation of data from Statistics South Africa, BFAP reports, DALRRD, producer and commodity organisations to validate the data by calibration to the most relevant sources.

The PMP followed a continuous modelling approach, which considers continuous improvement at farm levels, typical to what is observed in capital formation. To validate the model, stakeholders from producer and industry organisations were consulted.

4.3.4. Baseline exiting

In the survey, 91 of the 450 respondents indicated that they planned to stop farming and sell their land over the next ten years. For modelling the baseline at an extrapolated level, the land of these agents would become available over the outlook period as these producers voluntarily exited. This approach effectively results in an annual exit rate of 2.82% from *t* to *t* + 9 in the model, which is higher than the average annual decline of 1.81% over the last 65 years and can be skewed by the data sample and/or by the relatively small absolute values.

The model result on the structural effect on land use will be discussed. It will also provide a view of factors considered in the current producers' strategic decision-making process. A conversation on the where, when, and how of land availability for transformation can commence through this undertaking.

4.4 Scenario construction

Consideration is given to three factors in the scenario setup, namely business confidence, financial constraint, and financial strategy.

In Chapter 3, in which a regression analysis was performed to determine the biggest drivers of the decision to exit, the presence of business confidence was considered significant, decreasing the odds of exiting by 0.26 for every unit increase in confidence. Business confidence encompasses the agent's perception of the operational environment – considering social, political, and economic aspects.

Financial constraint, which refers to the threat to operations experienced by the respondents regarding servicing loans and other financial constraints, was also significant in the regression analysis, increasing the odds of exiting by 1.21 for every unit increase. Financial

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constraint is a major stumbling block in an operation's ability to expand, improve productivity through technological and other enhancements, and act on opportunities (Fernando & Ruggieri, 2015).

An expanding or contracting financial strategy is subsequently bound by the business confidence and level of financial constraint experienced. The existence and co-existence of these factors were tested in a Venn diagram format (see **Figure 4.3**), with the data presented for baseline exiters and non-exiters (**Table 4.1**).

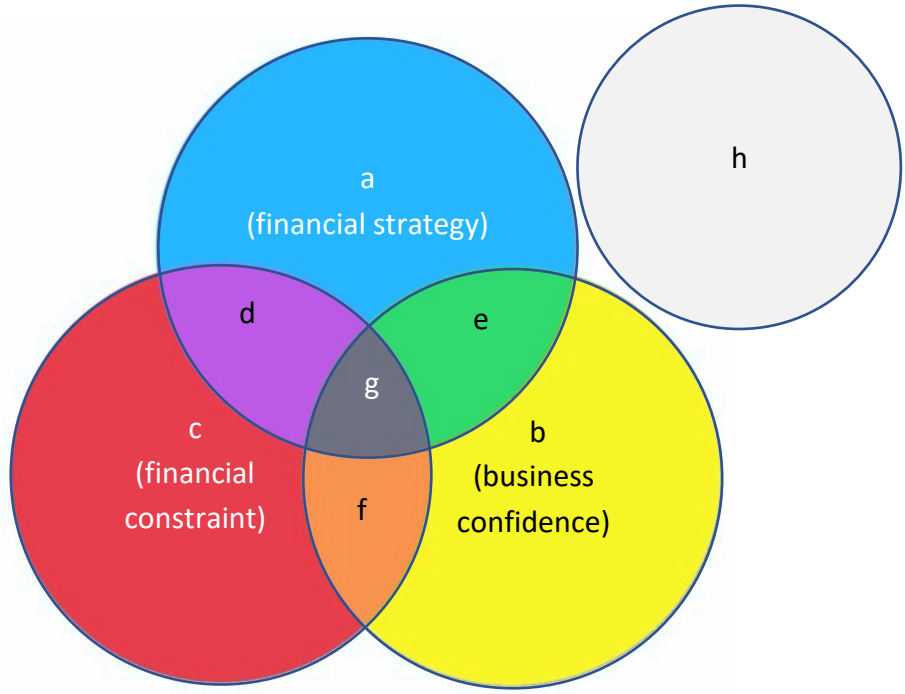

Figure 4.3: Identification of the exiting agents

Table 4.1: Categorisation of baseline exiting and non-exiting

Symbol	Factor	No. of exiters	No. of non-exiters
a	Financial strategy ('FS' < 50%)	54	150
b	Business confidence ('BC' < 50%)	27	183
c	Financial constraint ('FC' > 50%)	72	347
d	'FS' < 50% & 'BC' < 50%	92	170
e	'FS' < 50% & 'FC' > 50%	9	95
f	'BC' < 50% & 'FC' > 50%	8	132
g	'BC' < 50% & 'FC' > 50% & 'FS' < 50%	155	201
h	Unbounded by any of the three criteria	23	244
	Total sample of the model agents	440	1 522

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For the baseline, the consideration to exit by all those agents who indicated that they were planning to exit is honoured. Two subgroups of self-indicated non-exiters were identified and exited in the model to accelerate the exit rate and increase new entrants' scope. These subgroups were determined by the level of financial constraint they experienced, their financial performance within the model, and the combination of business confidence and financial strategy, as indicated by their respective positions in the four-quadrant model. These non-exiters exited in the model were selected from the 'captured' and 'slugger' quadrants (see **Chapter 3**).

For scenario 1 (S1), agents from the non-exit group that fell in category 'g' were added to the list of exiters. However, in the model, the lowest 30% of producers, with the computed farm income as the determinant in category 'g', are exited. For scenario 2 (S2), agents from the non-exit groups in categories 'd', 'e' and 'f' were added to the list of exiters from the baseline and S1. Again, the financial performance of these producers in the model will determine whether they exit or whether they continue. The 70% of 'g' agents who did not exit in S1 are again eligible for selection in the potential exit list of S2, where the agents who exited are selected from the 30% with the lowest farm income. Lastly, the agents in 'h' did not score within the parameters set from 'a' to 'g', and thus for the baseline, only those in 'h' who indicated that they would exit are exited, but no additional exiters were identified in this group for the scenarios. A random distribution was used to exit the agents over the ten years for the baseline. However, the exiting from categories 'd', 'e', 'f' and 'g' were in ascending order, with the worst-performing agents in terms of farm income exiting first and the best-performing agents last.

4.5 Discussion of results

4.5.1. Structural effect of model results

Through the extrapolation process, the decision to exit (for the baseline) and the proposed accelerated exit scenarios using the criteria described above yield a total exit rate of 22.43% over the baseline outlook period in the model, whilst resulting in a 27.47% and 36.65% exit rate for S1 and S2 respectively (see **Table 4.2**).

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Table 4.2: Final agents exiting and staying in the baseline and scenarios

		Model		Upscaled	
Run	Categories	No. of agents	Exit share	No. of agents	Exit share
Baseline	Exit	440	22.43%	8 998	22.43%
	Non-exit	1 522		31 124	
S1	Exit	539	27.47%	10 286	25.63%
	Non-exit	1 423		29 836	
S2	Exit	719	36.65%	13 967	34.81%
	Non-exit	1 243		26 155	

From a structural perspective, the effect of these exit rates can be observed in the change in farm numbers and by industry. On an upscaled, national level according to the 2017 census, the effect of the exit rates described in **Table 4.2** are displayed in **Figure 4.4**, with the change in actual numbers displayed on the left axis and the percentage of exiting agents on the right-hand axis.

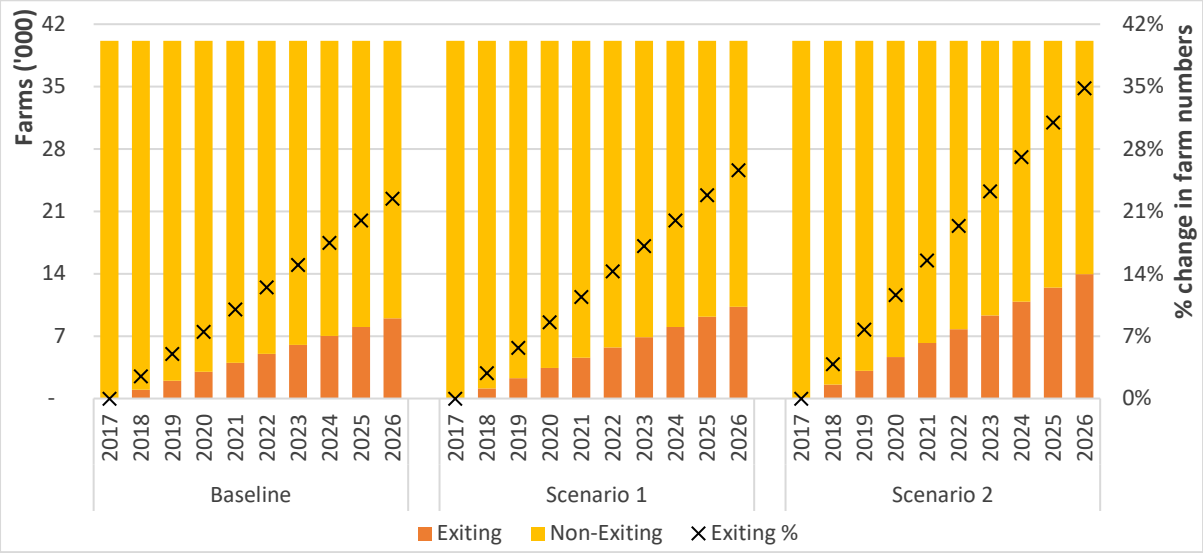

Figure 4.4: Upscaled model results for farm numbers

The nine categories of livestock considered in the model are dairy production cows, cattle for beef production, goats, ostriches, pigs, broiler chickens, laying hens, wool sheep, and sheep primarily for meat production. A two-step process was followed: firstly, the extrapolated livestock numbers were upscaled to the national level by category according to the 2017 census. Secondly, a livestock unit (LSU) equivalent was calculated by considering the

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different LSU ratios of the different livestock to test the effect of exiting on this agricultural subsector.

Figure 4.5 shows the effect on livestock numbers because of exiting producers. With shifts of 14.4%, 15.4% and 16.6% in LSU equivalents over the outlook period of the baseline, S1 and S2, respectively, compared to the total farm exit rates of 22.4%, 25.6% and 34.8%, two possibilities exist: either livestock producers are less likely to exit than the average, or the livestock producers who are exiting are farming with smaller average herds (LSU equivalents). With only 6% of agents in the model farming only with livestock, 21% are farming only with horticultural crops, and 2% only with field crops; this leaves 71% of the agents in the model operating across two or more industries, also commonly known as mixed farming. With total farm income as an additional criterion in the model, exiting by producers with smaller herds may be more likely. Still, there is no definitive distinction between whether the former (less likely to exit) or the latter (exiting by producers with smaller herds) take preference over the other as the primary reason for the lower-than-average change in livestock.

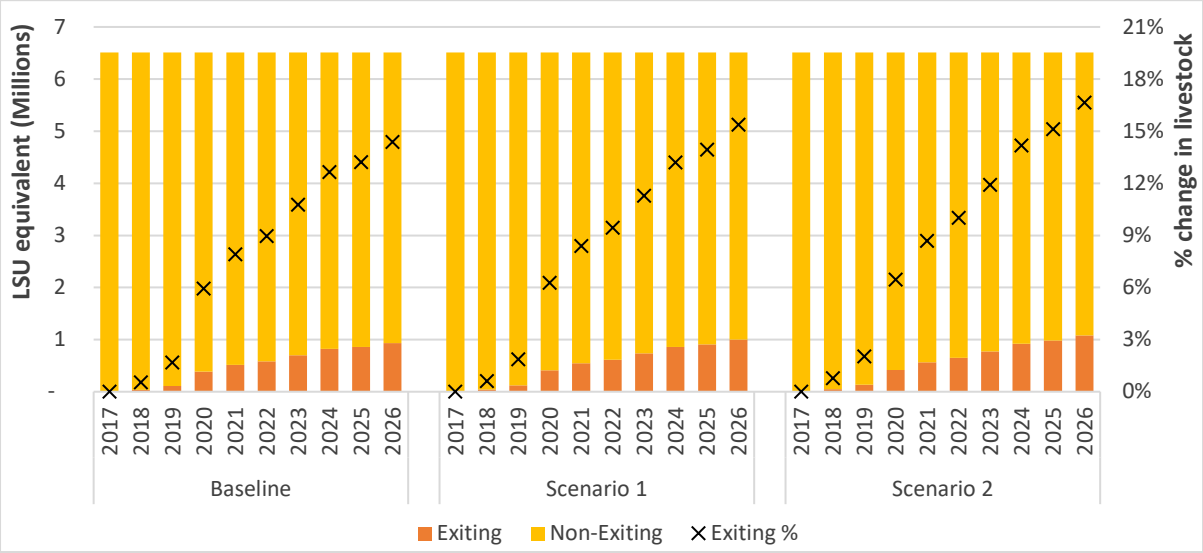

Figure 4.5: Upscaled model results for livestock

Notable, however, is the changes in veld area through the execution of the different exiting strategies, as per **Figure 4.6**. The change in veld area in the baseline is 28.9%, while it is 46.1% in S1 and 61.5% in S2. Comparing these changes to the changes in livestock numbers, it appears that the changes in livestock coincide more with extensive grazing than with

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intensive production systems, as a much larger portion of veld becomes available than the equivalent change in livestock production.

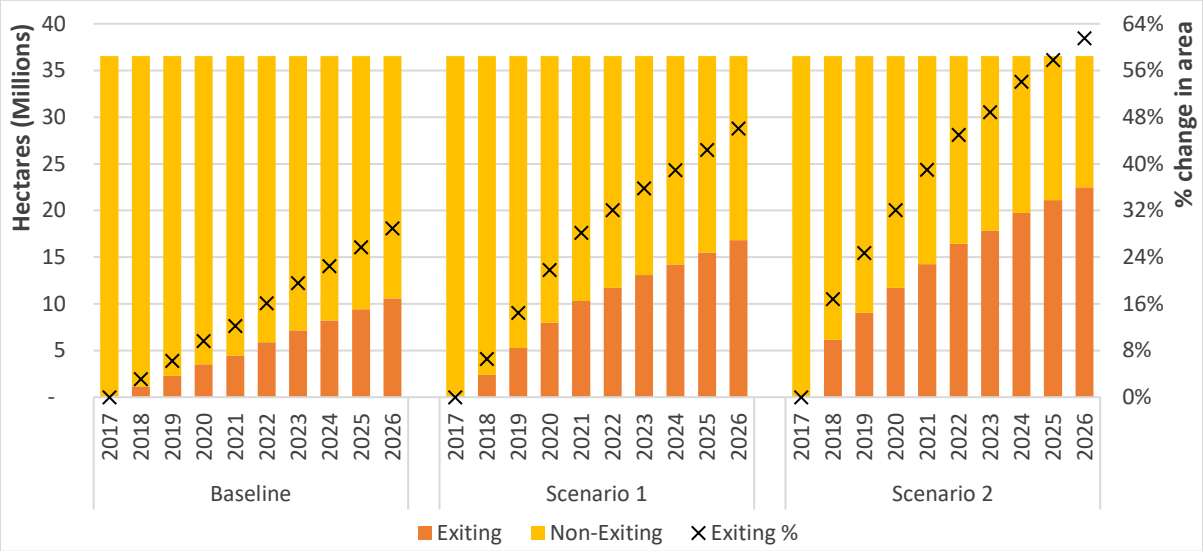

Figure 4.6: Upscaled model results for veld area

The model's main field crop categories are included and upscaled by area. Field crops included are cereals and grains, oil seeds, sugar cane, tea, and planted pastures. In total, these categories of crops returned a total coverage of 4.17 million hectares in the census. An important distinction from the change in field crops, compared to livestock and veld area, is the almost negligible differences between the exit rates observed between the baseline and the two scenarios, as shown in **Figure 4.7**. With a baseline exit rate of 29.3%, a S1 exit rate of 29.8% and a S2 exit rate of 30.3%, although the initial exit decision by respondents strongly reflects in the baseline, the effect of the criterion selected for the scenarios barely affected any change in this subsector.

As mentioned previously, a small portion of operations relies solely on field crop production; thus, the bulk of the field crop production operations coincided with livestock and/or horticulture branches. The higher relative share of field crop area exited compared to the total number of farm exits could be a function of large production units in terms of area and the lower levels of livestock integration in the operations.

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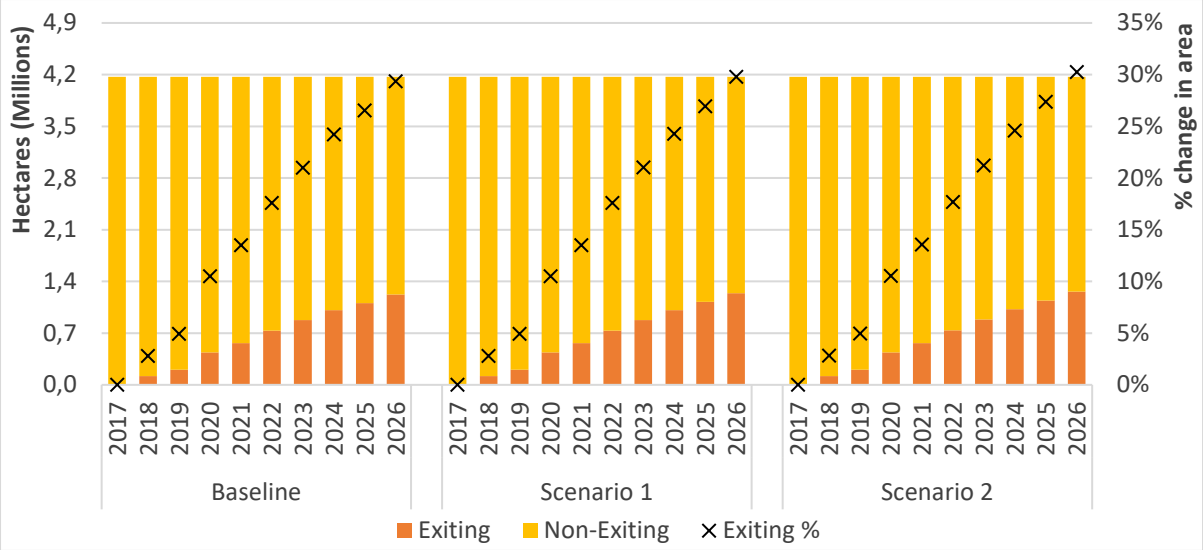

Figure 4.7: Upscaled model results for field crop area

Upscaling the different fruit, nut and vegetable categories in the model resulted in a total area of 484 116 hectares. Although it is the smallest agricultural subsector in terms of area, it contributes around 30% of total agricultural gross production value. From a perennial crop perspective, this includes the area under stone fruit, subtropical fruits, berries, citrus, table grapes, pome fruit and wine grapes, and pecan and macadamia nuts. Fruit and leafy vegetables, like tomatoes and cabbage, and roots and tubers, like carrots and potatoes, are included. The cultivation of fruits, nuts and vegetables is generally done under irrigation. However, rain-fed production is possible in some instances if the crop and the area's climatic conditions allow it.

The upscaled output from the extrapolated agents in the model returned a 15.8% exit rate in terms of horticultural production area over the modelled 10-year period (see **Figure 4.8**). When incorporating the scenario criteria with the farm income derived from the model, the exit percentage rises to 18.0% in S1 and 24.6% in S2. Given the small change from the baseline to S1, it appears that a small portion of the horticultural area is cultivated by producers who have a financial contracting strategy and negative business confidence and experience high levels of financial constraint combined with low farm incomes.

However, when expanding the eligibility criteria for exiting to include combinations of the factors described previously, the exit rate increases considerably, albeit still below the average exit rate in terms of farm numbers. Smaller production units due to the intensive nature of some of these crops can play a role in this phenomenon.

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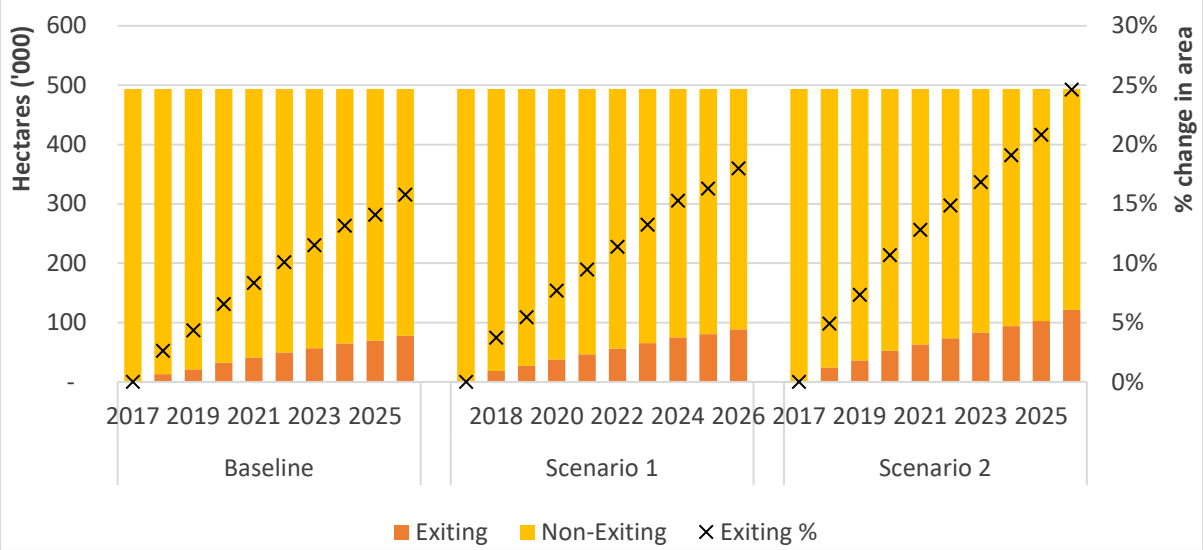

Figure 4.8: Upscaled model results for horticulture area

4.5.2. Observations on the barriers to exit and the potential for growth

By feeding the observations from the ABM back into the original dataset, the objective is to extract the commonalities between the different agents that form part of the potential exit groups of S1 and S2. **Appendices D** and **E** provide the underlying descriptive statistics, with a 'typical' producer described below.

The beyond-the-baseline 'typical' producer in S1 is a third-generation, 54-year-old male who did a diploma programme at a technikon or college and has 26 years of farming experience. He combines different enterprises in his operation, with the importance of his livestock herd dependent on the terrain of his farm. It could be his primary source of income or play a smaller role with the key focus on field crop and/or horticultural production. Given that he is a third-generation producer on the same parcel of land, it is possible that his grandfather would have started there sometime after WWII. Considering that farm numbers decreased by two thirds, this farm was the homestead for his family over a long period, with human capital investment by different generations over many years.

The producer is repaying a long-term loan on the land whilst also using production loans and other short- to medium-term loans to finance production and the acquisition of implements. Given the financially constraining, leveraged position he finds himself in, together with a lack of business confidence, his financial strategy is to contract rather than expand.

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Managing multiple loans whilst planning for retirement remains a challenge. Depending on the leverage situation of the specific producer, selling the farm, clearing the book at the bank, and paying the capital gains tax that accumulated may not enable a sustainable retirement for the producer and, as such, he continues with his daily activities on the farm with no plan to stop anytime soon.

The situation of the 'typical' producer in S2 is not quite as dire, or perhaps not yet as dire as in the case of the S1 producer described above, as these producers are only constrained by two of the three binding constraints observed for S1 producers. However, there is potential for a positive turnaround for both. The S1 and S2 producers are willing be mentors of land reform projects in the future, mentoring new entrants by drawing on the accumulated human capital investment and institutional knowledge acquired over many years. They are busy rethinking the business model on that farm – redefining the structures, including those of ownership, roles and responsibilities, whilst also opening opportunities for new investment – to increase productivity that can result in long-term substantiality and inclusive growth.

4.6 Concluding remarks

Although the agent-based approach is a simplification of reality, it gives some indication of the practical application of such a tool to answer real-life questions. It also provides a platform for further discussion and understanding of the complex nature of decision-making in agriculture. From a structural perspective, the utilisation of qualitative and quantitative data provides a view of the potential changes observed in agriculture in South Africa over the next number of years. By first constructing a baseline of expected exits and then constructing these alternative scenarios, the objective was to reach two specific outcomes. The first outcome was to understand the commonalities these producers share that prevent them from deciding to exit, as the producers in the exiting group have done. Secondly, it was to create a basis to discuss different factors that can be deliberated on in the transformation process – what is required from a supply perspective if an accelerated exit rate is necessitated.

In summary, the baseline conditions, where the respondents indicated whether they were planning to exit and sell their land over ten years, resulted in 8 998 of the 40 122 parcels becoming available, leaving ample scope for expansion by either existing producers or

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entrance by new producers. By subsector, the result of this study shows that veld (28.9%), arable land for field crops (29.3%) and horticultural (15.8%) production, as well as 14.4% of livestock herds, could be put up for sale over the modelled period.

In the first scenario of accelerated exiting, the agents who planned to exit in the baseline conditions are also exiting, as well as the 30% of the worst-performing agents in terms of farm income in the ABM, given that they are also experiencing negative business confidence, a contracting financial strategy, and financial constraints in their current operations, as per the feedback from the qualitative survey. In this scenario, the exit rate increases from the baseline (22.4%) to 25.6% in the scenario, resulting in 10 286 production units becoming available in the market. Here, exiting among livestock producers increases from 14.4% to 15.4%; this increases the grazing land transferred, from 28.9% to 46.1%, which suggests that most exiting producers use extensive grazing.

For field crops, little change is observed from baseline, at 29.3%, to 29.8% in scenario 1, whilst the exit rate for horticultural production increases from 15.8% in the baseline to 18.0% in S1. The increase in the change in farm numbers is driven by veld, which effectively refers to extensive livestock production with a low carrying capacity of the veld. This conclusion rests on the relatively small changes in livestock units and arable area, despite the 3.2% change from the baseline farm numbers.

In S2, which assumes exiting by the lowest performing 30% in farm income, where at least two of the three criteria used in the identification process are met, the exit rate increases to 33.2%, with 13 967 of the 40 122 production units becoming available for sale. In terms of livestock and grazing area, the trend observed in S1 compared to the baseline is further extended in S2, with a livestock exit rate of 16.6% compared to the 61.5% of veld area, which reiterates that the potential change in extensive livestock production would be much greater than intensive production.

Furthermore, S2 provides some insights into the potential land availability that can occur because of exiting by producers in the lower farm income bracket who are experiencing at least two of the three signs of struggle: contracting financial strategy, a severe financial constraint on their operations, and/or negative business confidence. Whereas the trend observed in S1 is replicated for S2 concerning the area under field crops (30.3% vs the 29.8% of S1 and 29.3% of the baseline), a significant jump is observed in horticulture. Whereas a small increase in the exiting percentage was observed between the baseline and S1 (15.8% vs

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18.0%), the potential exit rate rose sharply to 24.6% in S2. It appears that the factors driving this change are related to a combination of a lack of business confidence and financial constraint, with 71.5% of the selection included because of the combination of those two factors, compared to selection based on the combinations of contracting financial strategy together with lack of business confidence (26.5%) and financial constraint (2.0%). This result is, to a great extent, unsurprising, as the average upfront investment cost per hectare is very high in perennial horticultural crops, with the opportunity of reaping benefits only years away. Given the period for which these producers must absorb the investment cost of establishing new orchards or vineyards, together with a bleak view of the future, it could very well result in exiting.

In contrast to most horticultural producers included in S2 as potential exiters based on the combination of lack of business confidence and experiencing financial constraint, the spread is much more even for livestock and field crop producers concerning the different combinations of the three factors represented by 'a', 'b' and 'c' in **Table 4.1**. For livestock producers who were included in the output from S2, the combination of lack of business confidence and the existence of financial constraint was prevalent in 41.4% of the cases, whilst 32.3% were included due to financial constraint and a contracting financial strategy, with 26.3% because of a lack of business confidence and a contracting financial strategy. Using the same order of variable combinations, the output for field crop producers differs somewhat, with 19.2%, 51.0% and 29.8%, respectively.

From a theoretical perspective, potential barriers to exit, such as sunk cost, financial vulnerability and transaction cost, were identified as possible factors that could play a role in a producer's decision not to exit. Observations from the analysis of the S1 and S2 producers can be linked to all these factors. Firstly, there are both quantifiable and unquantifiable sunk costs – an investment made in both financial terms and human capital over generations plays an important role. Secondly, the financially constrained, leveraged position that these producers find themselves in results in a financially vulnerable position over the short term and potentially in the long run. Prolonged periods of financial challenges that lead to a decrease in the rate of reinvestment can result in insufficient market-related land prices and, considering the sunk cost of the producer, resulting in an unviable option to sell the farm in its current state. Thirdly, this leads to a situation where the transaction cost involved with a potential sale does not warrant the execution of such a decision. For example, the net cash

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raised from selling the farm could be inadequate for starting anew or retiring after settling outstanding loans and capital gains tax.

To initialise positively inclined, structured discussions on land supply, the first step involves identifying the barriers to exit. Relating the barriers to the effect on society is a second step. Removing the barriers to the benefit of all stakeholders is where progress can ensue, perhaps even at an accelerated tempo.

The scope and opportunity for further research from this analysis are considerable – not only for data additions to improve and/or expand the model, but also to construct different scenarios to analyse. This is also a mere starting point for understanding the land supply market in commercial agriculture in South Africa. Identifying where land will naturally become available in the market and understanding the underlying issues that must be resolved to increase the availability of land in the market are only the first steps. How these factors can be considered in policy would be a next step in the joint effort to take commercial agriculture to the next level, alleviate poverty, and foster inclusive growth. The solution, in all its simplicity, remains rather complex.

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Chapter 5:

Summary, Conclusions and Recommendations

5.1 Summary

The main research question of this study is: to what extent would transitioning from an ex-post to an ex-ante analysis of structural change in South African agriculture, with an emphasis on exit decisions, enhance land-use planning?

5.1.1. Chapter 1: Introduction

Chapter 1 introduces land supply as an undeniable but neglected component in the agriculture transformation debate. This analysis establishes a platform of opportunity to move from an ex-post to an ex-ante analysis in approaching structural change in South African agriculture. Chapter 1 also provides a global overview of changes in land use and farm numbers and contextualises the ex-post structural change and transformation of the South African commercial agricultural industry within the global context, together with the unique factors that affect major change domestically. Literature on the challenges faced by existing producers who experience barriers to exit, and the implications thereof, are provided as a basis to evaluate potential barriers to exit that arise from the analyses.

5.1.2. Chapter 2: Finding commonalities between producers through clustering

The second chapter is concerned with computing a baseline exit rate for the next ten years. The data from the 450 respondents are categorised according to the producers' plan to exit and sell their farms, providing a projected exit rate of 20% over ten years. A cluster analysis was conducted to identify four groups of producers concerning their perceptions of the challenges and threats to operations and how that affects their strategic decision-making to continue in primary agriculture or to exit and sell their farms. The findings support the hypothesis that farm exit decisions in South Africa are affected by retirement without succession, financial problems, access to dependable labour, uncertainty regarding land reform policy and concerns about rural safety. Whilst a correlation between the decision to exit in the future and turnover could not be established, there is a strong relationship

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between producers who plan to stay and have a turnover of more than R10 million per annum.

5.1.3. Chapter 3: Understanding financial strategy in the context of business confidence

The third chapter follows on the results in the second, where the hypothesis arose from the output that a four-quadrant model with two latent variables exists. The two latent variables are business confidence and financial strategy. By establishing and then examining the relative position of the producers in this four-quadrant model and overlapping that with the cluster analysis output, an understanding of the types of commercial producers emerged. In addition to those mentioned above, a regression analysis was performed to order the key drivers. Age, as a categorical variable, cost of investment and financial constraint featured most prominently in the decision to exit. The presence of production loans and business confidence is significant in countering the decision to exit.

5.1.4. Chapter 4: Depicting the structural impact of a baseline and accelerated exit rate

The first countrywide ABM for commercial agriculture in South Africa is introduced here. It aims to provide a virtual laboratory to run the baseline and alternative scenarios of producer exit rates against the extrapolated survey data. How the scenarios differ from each other, and the baseline is measured by comparing the output of different variables over ten years. Whilst the modelled baseline is based on the producers who have indicated that they plan to exit in the next ten years, the scenarios capture accelerated exit rates – removing producers who are categorised as underperforming financially, measured in the model by using farm profit, together with the presence of negative business confidence, a contracting financial strategy and/or those who experiences severe financial constraint. The structural impact of both the baseline and scenarios is discussed at a sub-sector level. Consideration is given to the barriers to exit, which subsequently limits the opportunity to enter, with a scope provided for transformation opportunities.

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5.2 Conclusions

The importance of this research – tangible, broad-based quantitative and qualitative data collection and analyses – is reiterated as a vital part of the ongoing discussions on an improved rate of transformation that is both realistic and sustainable. Incorporating the fields of behavioural economics and institutional economics is vital in solving problems in agricultural economics.

Land supply in the ex-ante analysis, and the structural transformation of the agricultural industry, rest on the interplay between exogenous and endogenous decisions in the agricultural industry that feed back into the industry's operations, as a collective, and the role players within it as individuals. Agent-based modelling is a useful tool for such analyses. Whilst the land market is complex when considering the heterogeneity of land, industry and people, structured, detail-orientated and focused analyses can provide useful insight into the functioning thereof and the constraints hindering equilibrium between demand and supply in the market.

5.2.1. Learnings from the analyses

Transitioning from an ex-post to an ex-ante analysis of structural change in South African agriculture is paramount when considering the country's current socio-economic environment for commercial agriculture. In this environment, demand for commercial agricultural land is fuelled from a socio-political perspective, without appropriately incorporating the land supply portion in the interactions or understanding current producers' socioeconomic challenges.

A four-prong research question was used to demarcate the contribution of this study to theory and practice concerning considerations in ex-ante structural change in the commercial agricultural industry in South Africa. From the perspective of government and researchers, the emphasis and focus are almost exclusively on the demand side of land and how to ensure the successful transformation of the sector. Land supply, and the intricacies thereof, have so far largely been overlooked. Without considering commercial land and land use as a system of both demand and supply, policy and the execution thereof will continue the current slow progress and implementation trajectory that often neglects the heterogeneity of land, industry, and people. In this regard, the findings and conclusions of this research aim to

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provide considerations and interpretations concerning land supply in South African agriculture.

5.2.2. Baseline exit rate

A baseline exit rate – the rate at which land could become available in the open market – has been established. This estimation was done by extrapolating the survey data on producers who plan to exit due to financial challenges and difficulty, retirement without succession, and lack of safety in rural areas to a national baseline using the 2017 census data. The baseline rate in the analysis is 22.43% over a decade. Once farms are in the market, it creates an opportunity for new and existing producers to acquire land, affecting whether farm size remains constant or whether farm size increases.

Herein lies two findings: firstly, land supply is not a major constraining factor in the transformation of the sector and secondly, that the land's new owner will affect the sector's structure. Even under the baseline conditions, 22.43% of farms can become available in ten years. Whether existing producers expand their operations by purchasing the available farms or whether new entrants buy the farms will impact the industry's structure. Where capital – human, financial or natural – are lacking or applied differently than before, production will not continue as before, which will impact the individual on the farm and the ability of the industry to deliver similar or better production outputs before. Thus, the structure of the industry – demographics, land use, production output, farm size and numbers – will change as the aggregate of the decisions made at the individual farm level results in structural change at an industry level.

5.2.3. Commonalities found between producers who plan to exit

Commonalities were established between the producers who plan to exit. This analysis was done by conducting a principal component analysis (PCA) on variables identified as potentially important in determining the commonalities to reduce the dataset to the appropriate variables, followed by a *k*-means cluster analysis. The findings supported the hypothesis that farm exit decisions in South Africa are affected by financial problems, access to dependable labour, uncertainty regarding land reform policy and concerns about rural safety. To a lesser extent, the producer's level of education can also be a factor. A factor hypothesised to affect the decision to exit, namely the type of production, could not be

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proven in this study. Furthermore, more than one factor, or a combination of factors, plays a vital role in quitting farming and selling the property in the future. Multiple generations on a single parcel of land simultaneously have not indemnified producers from financial problems, with the average in the study equal to three generations.

Two findings can be derived from this. Firstly, even with multiple generations of knowledge gained from farming the same land, this is not always enough to ensure sustainable production and ownership of land. Financial literacy and comprehensive risk analysis become increasingly important when introducing new entrants to farming. Secondly, to avoid the pitfalls of having new entrants find themselves exiting again, these common difficulties experienced must be addressed at the various levels of the industry – farm, sub-sector, and government.

5.2.4. Ordered drivers in the decision to exit

While a quantitative method – the cluster analysis – was used to find the commonalities between exiters, it could almost be deemed a qualitative description of the perceived challenges they face as a collective. In addition to the variables found to be meaningful (based on the PCA) in determining the commonalities, a regression analysis was done to determine which underlying factors are driving the decision to stay or to exit.

The estimated coefficients relate to the log-odds of the probability of exiting and are more intuitively interpreted as odds ratios or probability effects. Whilst the three themes that emerged from the odds ratios, namely age, business confidence and financial situation, are rather unsurprising, the more detailed breakdown is quite interesting.

The regression analysis suggests that business confidence and a contracting or expanding financial strategy strongly influence structural change. These factors depict the rather complex interplay between the two main factors that may keep farms in business: a positive business climate and the capital invested.

Apart from the direct implications, this ranking of the driving factors also provides a first glimpse of the barriers to exit: the presence of production loans increases the odds to stay, indicating some levels of boundedness. Also, producers aged 45 to 65 are more likely to stay than those in the age brackets of 30 to 45 and older than 65 age brackets, indicative of a lack of opportunities to exit voluntarily – either by entering the job market outside of owner-operator primary production or by selling the farm to retire. Two courses of action can be

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explored in the policy environment by recognising the drivers in exiting. Knowing what drives the exiting of existing producers, both reducing or increasing the exit rate is possible through appropriate policy interventions. By considering these drivers of exit or stay decisions, better support programmes can by constructed and implemented for the establishment of new entrants.

5.2.5. Changing the rate of exiting

A framework that emerged from the cluster analysis output is a four-quadrant model, with the financial strategy on the one axis and business confidence on the other. In the first pair of clusters, it appeared that respondents in both clusters were expansion orientated but that one cluster was far less affected by the threats of the business environment than the other. In the second pair of clusters, it appeared that respondents in both clusters were sensitive to the business environment. Still, one cluster was expansion orientated whilst the other appeared to have a contracting financial strategy. Overlaying the cluster outputs with the four-quadrant model framework sheds light on the interplay between being optimistic about and being tied down by farming. The majority of producers fell into one of three groups concerning shared perceptions and intentions:

- 'innovators' – positive business confidence with an expansion strategy,
- 'sluggers' – negative business confidence with an expansion strategy, and
- 'captured' – negative business confidence with a contracting strategy.

However, some farm owners plan to contract their investment in agriculture or even to exit, despite perceiving the business climate as promising. Producers who fall within the 'migrator' category could be using primary agriculture in South Africa as a point of departure for other ventures.

This information provides a basis for conducting alternative scenario analysis concerning exit rates. An ABM was constructed to depict the structural effect of the baseline exit rate at a sub-sector level. Constructing and running alternative scenarios allowed one to determine the effect of an accelerated exit rate compared to the baseline constructed from the primary dataset. The opportunity certainly exists to run scenarios of how potential interventions can decrease the exit rate. Such a study will include creating and analysing a socio-economic and political environment that can reduce exiting drivers. However, given the

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pressure to transform the industry, alternative scenarios for accelerated exiting were constructed and modelled.

Two subgroups of self-indicated non-exiters were identified and exited in the model to accelerate the exit rate and increase new entrants' scope. These subgroups were determined by the level of financial constraint they experienced, their financial performance within the model, and the combination of business confidence and financial strategy, as indicated by their respective positions in the four-quadrant model. These non-exiters exited in the model were selected from the 'captured' and 'slugger' quadrants. In the first scenario, in addition to the baseline exiters, the worst-performing 30% of agents in the model who also experience high levels of financial constraint and are situated in the 'captured' quadrant were exited. This scenario resulted in an exit rate of 25.63%, compared to the baseline exit rate of 22.43%, thus increasing the exit rate by 3.2%. In the second scenario, in addition to the baseline exiters and the exiters in the first scenario, the worst-performing 30% of agents in the model who also experience high levels of financial constraint and are situated in the 'slugger' quadrant were exited. This scenario resulted in an exit rate of 34.81%, compared to the baseline exit rate of 22.43% and the first scenario exit rate of 25.63%. The exit rate is 12.38% higher in the second scenario compared to the baseline.

This result showcases the capability of modelling alternative scenarios to the baseline and provides vital feedback regarding the type of land that may become available, ultimately scoping the opportunities for new entrants. Under baseline conditions, the results of this study show that veld (28.9%), arable land for field crops (29.3%) and horticultural (15.8%) production, as well as 14.4% of livestock herd lands, could be up for sale over the modelled period. In Scenario 1, where producers with poor financial performance and financial constraint, negative business confidence and contracting financial strategy are exited, these figures change to 46.1%, 29.8%, 18.0% and 15.4%, respectively.

In the second scenario, where two of the three factors are present – financial constraint, contracting financial strategy and/or lack of business confidence, the trend observed in Scenario 1 compared to the baseline is extended further. It returns a livestock exit rate of 16.6% and a 61.5% exit rate for veld, which reiterates that the land supply for extensive livestock production would be much greater than the availability of land for intensive livestock production. Little additional field cropland becomes available (30.3% vs 29.8% of Scenario 1 and 29.3% of the baseline). A significant jump is observed in horticulture (24.6%

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vs the 18.0% of Scenario 1 and the 15.8% of the baseline). It appears that the factors driving this change in horticulture are related to a combination of a lack of business confidence and financial constraint. Of the model agents exited in the second scenario, 71.5% is included because of combining those two factors.

5.2.6. Generalisation of the findings

From this study, three fundamental considerations are iterated that was repeatedly highlighted in the various analyses and should serve as guiding information in discussions on and propositions in the debate on land supply and demand.

Firstly, land markets are functioning – proven by the intention to exit of producers in the study, hence land supply, in the general sense, is not a constraining factor in transformation. Secondly, whilst the land market is functioning, it is somewhat constrained by barriers to exit, which is a direct entry barrier for new entrants. Thirdly, land supply and demand remain a vast, complex, and multifaceted phenomenon without negating the first two considerations. However, it can be broken down into smaller parts by using this structured analysis to provide useful insight into where some attention needs to be paid to establish an equilibrium between demand and supply in the land market.

5.3 Recommendations

The three chapters, summarised in **paragraphs 5.1.2**, **5.1.3** and **5.1.4**, can each be considered a study in its own right. Chapter 2 suggests that a broader phenomenon can be present, whilst commonalities were found between future exiters. There potentially are four types of producers when considering the financial strategy concerning investing in agriculture or divesting from agriculture, in combination with a positive or negative business confidence outlook. These factors are addressed in Chapter 3, with Chapter 4 showcasing the structural impact of different exit rates through the application of an ABM. Together with the baseline trajectory established, the impact of removing an additional share of producers based on their negative position concerning financial situation, performance and strategy and their business confidence – a forerunner of potential future investment – is also presented. Despite addressing these research questions, there is scope for improvements on and expansion of the study.

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The recommendations from this study can be broadly categorised as conceptual and practical recommendations. Conceptually, the study has proven that there is scope for incorporating research analyses in behavioural economics and institutional economics to solve problems in agricultural economics. It also shows that there are methods to test various alternative policy implications before implementing them. Scope exists for broadening the application of theory from these fields to study further land-use patterns, demand and supply, and structural change.

At a more practical or applied level, two categories of recommendations exist: broader and deeper. It is recommended that such methodology be further applied and tested outside of South Africa – whether as a collective in the South African Development Community (SADC) or in another developing country where similar challenges are experienced.

In terms of a deeper analysis, the opportunities for further research are endless. Firstly, the lack of accurate data regarding primary agriculture, such as area, production types and yields, production cost and other indicators, was tremendously challenging. A rerun of the study with better data should improve the results and the level of detail expressed in the results. Secondly, it is recommended that more work is done, with a greater emphasis on identifying and understanding the barriers to exit and the cost thereof to the individual and society. In the broad sense of agricultural land use (or occupancy), the construction of exit strategies is becoming more critical to reduce the squandering of scarce and finite resources. In addition, the establishment of comprehensive policy programmes directed at removing exit barriers would accelerate the tempo of establishing new entrants sustainably. It is believed that this research can play an important role in establishing such a policy framework for the continued interaction between demand for and supply of land in the land reform debate.

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Appendices

Appendix A: Producer questionnaire

Producer background

*** 1. The survey team guarantee protection of your identity in this study.**
(Please select the option below)

- ○ I hereby consent that information provided in this survey may be anonymously entered into the group of data for the intended purpose of this study, as per the accompanied letter.

2. What is your gender?
(Select one option by clicking it)

- ○ Male
- ○ Female

*** 3. What year were you born in?**
(19xx)

4. Please indicate the language spoken most often at home.
(Please select from list)

- ○ Afrikaans
- ○ English
- ○ Ndebele
- ○ Northern Sotho
- ○ Sotho
- ○ Swazi
- ○ Tsonga
- ○ Tswana
- ○ Venda
- ○ Xhosa
- ○ Zulu
- ○ Other (please specify)

*** 5. What is the highest level of education you have completed?**
(Please select from list)

- ○ Primary school
- ○ Secondary school (without Matric)
- ○ Passed Matric
- ○ Currently at a tertiary institution
- ○ Technikon / College
- ○ University – Bachelor's
- ○ University – Master's
- ○ University – Doctorate

*** 6. How many years have you been farming?**
(Please select from list)

- ○ < 1
- ○ 1- 5
- ○ 6-15
- ○ 16-30
- ○ > 30

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* **7. How many generations of your family have farmed on this land?**
(Please select from list)

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ N/A

* **8. What is your main occupation?**
(Please select from list)

- ○ Producer (own farm)
- ○ Farm manager (another farm)
- ○ Non-farm business owner
- ○ Public sector employee
- ○ Private sector employee
- ○ Student
- ○ Retired / not working
- ○ Other (please specify)

9. What is your secondary occupation?
(Please select from list)

- ○ None
- ○ Producer (own farm)
- ○ Farm manager (another farm)
- ○ Non-farm business owner
- ○ Other (please specify)
- ○ Public sector employee
- ○ Private sector employee
- ○ Student
- ○ Retired / not working

*** 10. In which province is your operations primarily based?**
(Please select from list)

- ○ Eastern Cape
- ○ Free State
- ○ Gauteng
- ○ KwaZulu Natal
- ○ Limpopo
- ○ Mpumalanga
- ○ North West
- ○ Northern Cape
- ○ Western Cape

*** 11-19. In which municipal district is your operations primarily based?**
(Please select from list)

- ○ (Subsection of full list of municipalities in South Africa provided based on the province selected)

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Land-use aspiration

*** 20. Which of the following describes your long-term goals or strategy? Over the next five years I want to…**

(Select one option for each row by clicking it)

	Increase the…	Decrease the…	Maintain the current	I don't know/Not applicable
...area under field crop production	○	○	○	○
...area under horticultural production	○	○	○	○
...area under planted pastures	○	○	○	○
...area under natural veld	○	○	○	○
...number of intensively kept livestock	○	○	○	○
...number of extensively kept livestock	○	○	○	○
...number of employees	○	○	○	○
...number of enterprises (diversification)	○	○	○	○
...level of water storage capacity of my dam(s)	○	○	○	○
...my capacity to do farm processing or packing	○	○	○	○

*** 21. We would like to hear about your future plans. Please consider the statements below and indicate your choice for each statement. Over the next 10 years, I will...**

(Select one option for each row by clicking it)

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
...expand my primary production farming operations if I could rent or buy additional land	○	○	○	○	○
...expand my processing farming operations if I could rent or buy additional land	○	○	○	○	○
...expand into a new enterprise/ production activity if I could rent or buy additional land	○	○	○	○	○
...consider selling my farm & retire	○	○	○	○	○
...consider to stop farming because it is physically too dangerous	○	○	○	○	○
...consider to stop farming because of financial difficulty	○	○	○	○	○
...continue current production but would like optimise production and reduce costs	○	○	○	○	○
...like to downsize current production, because I am transferring to lifestyle farming	○	○	○	○	○

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...intend to stop farming and hand over my farming business to my children and/or other relatives	○	○	○	○	○
....intend to sell my land and buy land in a different area	○	○	○	○	○
...intend to sell my land but purchase additional land within the area	○	○	○	○	○
...consider the option of subdividing my land to sell in individual parcels	○	○	○	○	○
I am currently thinking of subdividing my land to sell in individual parcels	○	○	○	○	○

22. What is the maximum percentage of your total land you would consider to sell/to rent out?

(Slide cursor to the right or type number in block on right-hand side)

0 - I won't consider selling/ renting out any part of my land

100 - I will consider selling/ renting out all of my land

O

23. I'm interested to sell or rent out land to the following parties:

(Select one option for each row by clicking it)

	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
To other commercial producers	○	○	○	○	○
To employees of my farm	○	○	○	○	○
To the managing staff of my farm	○	○	○	○	○
To newcomers	○	○	○	○	○
To smallholders	○	○	○	○	○
To government	○	○	○	○	○
To neighbours	○	○	○	○	○

24. Please consider each of the following statements regarding BEE (black economic empowerment):

(Select one option for each row by clicking it)

	Yes, free of charge	Yes, at a fee	No
I currently provide mentorship in a land reform project	○	○	○
I am willing to provide mentorship in a land reform project	○	○	○

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Employment

*** 25. How many family members are employed in your farming operations on a full-time basis?**
(Please indicate the number in digits)

*** 26. How many persons (excluding family members) are employed in your farming operations in the following categories?**
(Please indicate the number in digits)

Managerial (excluding team leaders)	
Administration (office work)	
Permanent labourers	
Seasonal labourers	
Processing/Packing	
Other tasks	

27. On average, how many months of the year do you employ seasonal labourers?
(Please select from list)

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ I don't employ any seasonal labourers
- ○ 7
- ○ 8
- ○ 9
- ○ 10
- ○ 11
- ○ 12

28. What is the average daily wage earned by permanent labourers?
(Please select one option by clicking on in it)

- ○ Minimum wage (as per Basic Conditions of Employment Act)
- ○ 1-10% more than minimum wage
- ○ 11-20% more than minimum wage
- ○ 21-30% more than minimum wage
- ○ > 30% more than minimum wage

29. What is the average daily wage earned by seasonal labourers?
(Please select one option by clicking on in it)

- ○ Minimum wage (as per Basic Conditions of Employment Act)
- ○ 1-10% more than minimum wage
- ○ 11-20% more than minimum wage
- ○ 21-30% more than minimum wage
- ○ > 30% more than minimum wage

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Capital and turnover

30. What kind of external capital do you make use of?
(Select all applicable options by clicking it)

- ☐ Production loans (less that 12 months)
- ☐ Loans outside financial institutions (e.g. borrow from family/friends/investors)
- ☐ None
- ☐ Long-term bank loans
- ☐ Short-term finance (e.g. overdraft, vehicle finance, vehicle/equipment rent-to-own)
- ☐ Other (please specify)

31. Please indicate the range in which your farming operation's annual turnover falls (this information will not be shared with any other individuals):
(Please select from list)

- ○ No turnover
- ○ ≤R300,000
- ○ R300,001-R1,000,000
- ○ R1,000,001-R2,500,000
- ○ R2,500,001-R5,000,000
- ○ R5,000,001-R10,000,000
- ○ R10,000,001-R25,000,000
- ○ R25,000,000-R100,000,000
- ○ >R100,000,000
- ○ Prefer not to say

32. In your region:
(Please indicate your answers in whole numbers only)

...how much does arable land without water rights sell for per hectare?	
...how much does arable land with water rights sell for per hectare?	

Field crops

*** 33. How many hectares of field crops do you cultivate?**
(Please type the numerical value - if no values are applicable, please indicate it using the value zero "0")

Irrigated: Cereals and grains	
Irrigated: Oil seeds	
Irrigated: Planted forest	
Irrigated: Sugar cane	
Irrigated: Tea	
Dry land: Cereals and grains	
Dry land: Oil seeds	
Dry land: Planted forest	
Dry land: Sugar cane	
Dry land: Tea	

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Horticulture crops

*** 34. How many hectares of horticulture crops do you cultivate?**

(Please type the numerical value - if no values are applicable, please indicate it using the value zero "0")

Irrigated: Berries	
Irrigated: Citrus	
Irrigated: Nuts	
Irrigated: Pome fruit	
Irrigated: Stone fruit	
Irrigated: Subtropical fruit	
Irrigated: Table grapes	
Irrigated: Vegetables – fruit	
Irrigated: Vegetables – leaf/stem	
Irrigated: Vegetables – root	
Irrigated: Wine grapes	
Dry land: Berries	
Dry land: Citrus	
Dry land: Nuts	
Dry land: Pome fruit	
Dry land: Stone fruit	
Dry land: Subtropical fruit	
Dry land: Table grapes	
Dry land: Vegetables – fruit	
Dry land: Vegetables – leaf/stem	
Dry land: Vegetables – root	
Dry land: Wine grapes	
Irrigated: Berries	
Irrigated: Citrus	
Irrigated: Nuts	

Pastureland

*** 35. How many hectares of planted pastures and grazing do you cultivate?**

(Please type the numerical value - if no values are applicable, please indicate it using the value zero "0")

Irrigated: Planted pastures	
Irrigated: Hay (or similar)	
Dry land: Planted pastures	
Dry land: Hay (or similar)	
Natural veld	
Stubble	

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Yields

36. If you produce any of the following field crops and/or pastures, please provide us with your average yield (tons/ha).

(Please indicate the number in digits only, e.g. Wheat: 2.8)

Black tea	
Canola	
Forest	
Hay	
Lucerne	
Maize	
Rooibos	
Soya	
Sugarcane	
Sunflower	
Wheat	

37. If you produce have any of the following pastures and/or grazing, please provide us with your average carrying capacity (hectare/LSU).

(Please indicate the number in digits only, e.g. Natural veld: 13)

Irrigated: Planted pastures	
Dry land: Planted pastures	
Natural veld	
Stubble	

38. If you produce have any of the following horticulture crops, please provide us with your average yield (tons/ha).

(Please indicate the number in digits only, e.g. Apples: 50)

Apples	
Avocados	
Bananas	
Blueberries	
Cabbage	
Grapefruit	
Macadamias	
Mangoes	
Onions	
Oranges	
Peaches	
Pecans	
Pineapples	
Potatoes	
Pumpkins	

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Table grapes	
Tomatoes	
Wine grapes	

Livestock

*** 39. How many livestock do you farm with? Adult equivalent heads of livestock (12-month basis for pigs, ostriches, poultry, etc.)**

(Please type the numerical value - if no values are applicable, please indicate it using the value zero "0")

Cattle dairy	
Cattle meat	
Goats	
Ostriches	
Pigs	
Poultry broilers	
Poultry eggs	
Sheep primarily meat	
Sheep primarily wool	

40. What percentage of your livestock concentrated feed do you produce yourself? (Assuming that the rest is purchased)?

(Slide cursor to the right or type number in block on right hand side)

Purchase all livestock concentrated feed	50/50	Self-produce all livestock concentrated feed

O

41. What percentage of your livestock roughage feed do you produce yourself? (Assuming that the rest is purchased)?

(Slide cursor to the right or type number in block on right hand side)

Purchase all livestock roughage feed	50/50	Self-produce all livestock roughage feed

O

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Adjustments in land, production and income

*** 42. Have you made adjustments in the following areas in your farming operation over the last two years?**

(Select one option for each row by clicking it)

	Increased	Decreased	Unchanged	Prefer not to say
Size of intensively managed areas	○	○	○	○
Size of extensively managed areas	○	○	○	○
Number of intensively kept livestock	○	○	○	○
Number of extensively kept livestock	○	○	○	○
Number of employees	○	○	○	○
Number of branches (diversification)	○	○	○	○
Water storage capacity (dams)	○	○	○	○
Water from underground sources (boreholes)	○	○	○	○
Water from running sources (rivers, water scheme)	○	○	○	○
Direct costs	○	○	○	○
Investment costs	○	○	○	○
Turnover	○	○	○	○
Interest rate	○	○	○	○

Impact of outside factors

*** 43. To what extent is the following constraining your business, where 1 means "not at all" and 10 means "most definitely":**

(Select one option for each row by clicking it)

	1	2	3	4	5	6	7	8	9	10
Ability to obtain additional water rights	○	○	○	○	○	○	○	○	○	○
Availability of water and water storing facilities	○	○	○	○	○	○	○	○	○	○
Ability to access additional land	○	○	○	○	○	○	○	○	○	○
Financial challenges (e.g. access to foreign capital, market prices)	○	○	○	○	○	○	○	○	○	○
Servicing current borrowing commitments	○	○	○	○	○	○	○	○	○	○
Transport infrastructure	○	○	○	○	○	○	○	○	○	○

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*** 44. To what extent are the following factors a threat to your business, where 1 means "not at all" and 10 means "most definitely":**

(Select one option for each row by clicking it)

	1	2	3	4	5	6	7	8	9	10
Availability of dependable labour	○	○	○	○	○	○	○	○	○	○
Labour laws	○	○	○	○	○	○	○	○	○	○
Tenure laws (ESTA) / Residential rights of farm labourers	○	○	○	○	○	○	○	○	○	○
Minimum wage laws	○	○	○	○	○	○	○	○	○	○
Land reform	○	○	○	○	○	○	○	○	○	○
Predators	○	○	○	○	○	○	○	○	○	○
Predator control legislation	○	○	○	○	○	○	○	○	○	○
Other environmental legislation	○	○	○	○	○	○	○	○	○	○
Drought / Floods	○	○	○	○	○	○	○	○	○	○
Availability of drought relief	○	○	○	○	○	○	○	○	○	○
Stock theft	○	○	○	○	○	○	○	○	○	○
Service from local coop	○	○	○	○	○	○	○	○	○	○
Access to markets	○	○	○	○	○	○	○	○	○	○
Rising input costs	○	○	○	○	○	○	○	○	○	○
Decreasing commodity prices	○	○	○	○	○	○	○	○	○	○
Commodity price fluctuations	○	○	○	○	○	○	○	○	○	○
Foreign exchange rate fluctuations	○	○	○	○	○	○	○	○	○	○
Farm attacks	○	○	○	○	○	○	○	○	○	○
Climate change	○	○	○	○	○	○	○	○	○	○
Unemployment	○	○	○	○	○	○	○	○	○	○

45. If you have additional comments about this questionnaire, please write below.

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Appendix B: Output from the PCA and variables included in the final cluster analysis

Proportion of variance explained	PC1 24%	PC2 10%	PC3 9%	PC4 8%	PC5 7%	PC6 6%	PC7 5%	PC8 5%	PC9 4%	
educ	0%	0%	0%	0%	0%	0%	0%	0%	0%	
occ_code	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Exiting	0%	0%	3%	0%	0%	0%	0%	0%	0%	Included
Exit_Retire	0%	6%	31%	1%	0%	0%	0%	1%	0%	Included
Exit_Danger	1%	6%	21%	2%	0%	1%	1%	1%	0%	Included
Exit_Finance	1%	0%	19%	2%	0%	0%	0%	3%	0%	Included
Prov_EC	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_FS	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_GP	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_KZN	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_LP	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_MP	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_NW	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_NC	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Prov_WC	0%	0%	0%	0%	0%	0%	1%	0%	0%	
Gender_male	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Gender_female	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Industry_mixed	0%	0%	0%	1%	0%	0%	0%	0%	0%	Included
Industry_livestock	0%	0%	0%	0%	0%	0%	0%	0%	0%	Included
Industry_fieldcrops	0%	0%	0%	0%	0%	0%	0%	0%	0%	Included
Industry_horticulture	0%	0%	0%	1%	1%	0%	0%	0%	0%	Included
Industry_forest	0%	0%	0%	0%	0%	0%	0%	0%	0%	Included
born	0%	1%	1%	0%	6%	3%	1%	2%	0%	Included
exp	0%	4%	0%	0%	50%	18%	0%	8%	2%	Included
turnover	0%	0%	3%	1%	4%	6%	29%	15%	32%	Included
Emp_Perm_Num	0%	0%	0%	0%	0%	0%	0%	0%	1%	
Emp_Seas_Num	0%	0%	0%	0%	0%	0%	0%	0%	0%	
const_fin_chal	12%	19%	2%	3%	1%	0%	1%	5%	0%	Included
const_serv_borrow	9%	24%	1%	4%	0%	3%	15%	6%	0%	Included
threat_dep_labour	5%	0%	0%	4%	4%	5%	2%	5%	16%	Included
threat_min_wage	11%	0%	1%	4%	5%	36%	1%	13%	0%	Included
threat_land_ref	11%	14%	1%	5%	7%	2%	0%	27%	4%	Included
threat_drought_flood	7%	0%	0%	0%	0%	9%	24%	2%	15%	Included
threat_ls_theft	6%	9%	14%	63%	0%	0%	0%	2%	0%	Included
threat_input_cost	9%	1%	0%	1%	3%	0%	3%	2%	2%	Included
threat_comm_price_down	13%	1%	0%	3%	18%	14%	2%	7%	11%	Included
threat_farm_att	13%	14%	1%	4%	1%	1%	18%	0%	13%	Included

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Appendix C: Variables considered and included in the analysis

a) Additional variables included in the logistic regression		
Question category	**Question extension**	**Answer type**
In which province are your operations primarily based?	Response	Categorical/Factor
What is your gender? (Male = 1, Female = 0)	Response	Categorical/Dummy
What is your age? (0-30 = 1, 30-44 = 2, 45-64 = 3, >= 65 = 4)	**Response**	**Categorical/Factor**
What is the highest level of education you have completed? (Primary school = 1, Secondary school (without Matric) = 2, Passed Matric = 3, Currently at a tertiary institution = 4, University – Bachelor's = 5, Technikon / College = 6, University – Master's = 7, University – Doctorate = 8)	Response	Categorical - ordered
How many years have you been farming?	Response	Categorical/Factor
How many generations on the same land?	Response	Numeric
What kind of external capital do you make use of? (Yes = 1, No = 0 for **Production loans** | Long-term loans | Short-term loans | Informal | None)	**Response**	**Categorical/Dummy**
Please indicate the range in which your farming operation's annual turnover falls: (range represented by the median turnover in the range)	Response	Numeric
Commodity/industry	Response	Categorical
Latent variables		
What is your perception of the business environment? (1 = least confident, 10 = most confident)	**Business confidence index**	**Calculated (1 – 10)**
Financial constraint: To what extent are the following factors a threat to your business (1 = not at all, 10 = most definitely)	**Financial challenges**	**1 – 10**
	Servicing existing loans	**1 – 10**

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Investment cost: **Have you made adjustments in the following areas in your farming operation over the last two years?** **(Decreased | Unchanged | Increased)**	**Investment cost**	**-1 | 0 | 1**
b) Variables considered for the financial strategy latent variable		
Question category	**Question extension**	
Which of the following describes your long-term goals or strategy? Over the next five years I want to… (Increase the | Maintain the current | Decrease the | Don't know/Not applicable)	...area under field crop production	-1 | 0 | 1 | N/A
	...area under horticultural production	-1 | 0 | 1 | N/A
	...area under planted pastures	-1 | 0 | 1 | N/A
	...area under natural veld	-1 | 0 | 1 | N/A
	...number of intensively kept livestock	-1 | 0 | 1 | N/A
	...number of extensively kept livestock	-1 | 0 | 1 | N/A
	...number of enterprises (diversification)	-1 | 0 | 1 | N/A
	...level of water storage capacity of my dam(s)	-1 | 0 | 1 | N/A
	...my capacity to do farm processing or packing	-1 | 0 | 1 | N/A
We would like to hear about your future plans. Please consider the statements below and indicate your choice for each statement. Over the next 10 years, I will... (Strongly disagree | Disagree | Undecided | Agree | Strongly agree)	...like to downsize current production, because I am transferring to lifestyle farming	-2 | -1 | 0 | 1 | 2
	...consider the option of subdividing my land to sell in individual parcels	-2 | -1 | 0 | 1 | 2
	I am currently thinking of subdividing my land to sell in individual parcels	-2 | -1 | 0 | 1 | 2
Have you made adjustments in the following areas in your farming operation over the last two years? (Decreased | Unchanged | Increased)	Size of intensively managed areas	-1 | 0 | 1
	Size of extensively managed areas	-1 | 0 | 1
	Number of intensively kept livestock	-1 | 0 | 1
	Number of extensively kept livestock	-1 | 0 | 1
	Number of branches (diversification)	-1 | 0 | 1

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	Water storage capacity (dams)	-1 | 0 | 1
	Water from underground sources (bore holes)	-1 | 0 | 1
	Turnover	-1 | 0 | 1
c) Variables considered for the latent variable from a business environment perspective		
Question category	**Question extension**	
To what extent are the following factors a threat to your business (1 = not at all, 10 = most definitely)	Availability of dependable labour	1 – 10
	Labour laws	1 – 10
	Tenure laws (ESTA)/ residential rights of farm labourers	1 – 10
	Minimum wage laws	1 – 10
	Land reform	1 – 10
	Predators	1 – 10
	Predator-control legislation	1 – 10
	Other environmental legislation	1 – 10
	Stock theft	1 – 10
	Access to markets	1 – 10
	Rising input costs	1 – 10
	Decreasing commodity prices	1 – 10
	Farm attacks	1 – 10
	Climate change	1 – 10
d) Variables used in the cluster analysis to identify respondents who would exit		
Question category	**Question extension**	
Which of the following describe your long-term goals or strategy? Over the next ten years I want to… (Strongly disagree | Disagree | Undecided | Agree | Strongly agree)	...consider selling my farm and retire	-2 | -1 | 0 | 1 | 2
	...consider stop farming because it is physically too dangerous	-2 | -1 | 0 | 1 | 2
	...consider stop farming because of financial difficulty	-2 | -1 | 0 | 1 | 2

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Appendix D: General descriptive statistics from the survey for the agents

			Respondents		Baseline exiters		Potential exiters in S1		Potential exiters in S2	
	Variable name	**Units**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Characteristics	Gender	% Male	95%	22%	93%	25%	95%	27%	95%	19%
	Age	Years	51	12	54	13	54	11	54	12
	Education	% Tertiary	82%	39%	81%	39%	88%	34%	88%	42%
	Experience	Years	26	12	27	13	26	12	26	12
	Generations	Number	3	2	2	2	3	1	3	2
Loans	Production loans	% Loans	39%	49%	29%	45%	54%	50%	44%	50%
	Long-term loans	% Loans	60%	49%	54%	50%	78%	41%	63%	48%
	Short/medium-term loans	% Loans	56%	50%	49%	50%	68%	47%	55%	50%
	Informal loans	% Loans	9%	29%	12%	33%	11%	31%	11%	31%
	No loans	% No Loans	13%	33%	16%	37%	3%	16%	11%	31%
Industry	Livestock	% Livestock	15%	35%	15%	36%	15%	49%	15%	49%
	Field crops	% Field crops	1%	10%	3%	18%	1%	49%	1%	49%
	Horticulture	% Horticulture	30%	46%	33%	47%	30%	49%	30%	49%
	Mixed	% Mixed	55%	50%	48%	50%	52%	50%	52%	50%
	Single	% Single	45%	50%	52%	50%	48%	50%	48%	50%
Indices	Business confidence	0 to 1 scale	46%	18%	43%	21%	32%	10%	37%	14%
	Financial constraint	0 to 1 scale	47%	30%	56%	34%	74%	15%	58%	27%
	Financial strategy	0 to 1 scale	52%	19%	40%	20%	39%	9%	53%	16%
Mentor-ship	Currently	0 to 1 scale	26%	44%	27%	45%	22%	41%	29%	45%
	In future	0 to 1 scale	76%	43%	70%	46%	62%	48%	81%	39%

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Appendix E: Production descriptive statistics from the model for the agents

			Model		Baseline exiters		S1 additional exiters		S2 additional exiters	
	Variable name	**Units**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**	**Mean**	**Std. dev.**
Area	Farm size (excl. veld)	Hectares	1 414	4 292	1 542	3 241	185	239	108	98
	Farm size (incl. veld)	Hectares	4 468	11 254	5 482	9 743	16 471	17 367	5 265	18 954
	Field crop & pasture area	Hectares	1 253	4 248	1 456	3 242	135	234	48	79
	Horticulture crop area	Hectares	141	582	79	132	43	105	60	88
	Veld	Hectares	3 055	10 138	3 941	8 654	16 286	17 483	5 157	18 925
LSU	Livestock	LSU number	435	2 925	160	676	121	98	27	56
Labour	Labourers	Number	140	435	70	87	93	69	138	195
	Variable name	**Units**	**n**		**n**		**n**		**n**	
	Total	Number	1 962		440		63		180	
Province	Eastern Cape	Number	212		48		6		7	
	Free State	Number	359		96		-		32	
	Gauteng	Number	66		-		-		-	
	KwaZulu-Natal	Number	202		41		-		15	
	Limpopo	Number	166		33		-		9	
	Mpumalanga	Number	181		22		6		-	
	North West	Number	206		109		26		-	
	Northern Cape	Number	222		27		9		76	
	Western Cape	Number	348		64		16		41	
Industry	Livestock	Number	111		38		-		2	
	Field crops	Number	39		32		-		1	
	Horticulture	Number	414		83		8		68	
	Mixed	Number	1 398		287		55		109	