Australian Government

Australian Centre for International Agricultural Research

Final report

project

High quality markets and value chains for small-scale and emerging beef cattle farmers in South Africa

project number	LPS/2005/128
date published	1/06/2019
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approved by	Werner Stur
final report number	Fr2019-736
ISBN	978-1-925747-49-2
published by	ACIAR GPO Box 1571 Canberra ACT 2601 Australia

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1 Acknowledgments

In South Africa, sincere thanks are due to the Agricultural Research Council (ARC), the Department of Agriculture Forestry and Fisheries (DAFF), the National Agricultural Marketing Council (NAMC), the Provincial Departments of Agriculture in Eastern Cape, Gauteng, Limpopo, Mpumalanga, North West and Free State, North West University, Stellenbosch University and the University of Fort Hare for their in-kind and cash contributions to support project staff and some operating costs to undertake project research and to support the project's farmer support teams and collaborating farmers across the six provinces.

In Australia, the University of New England provided generous in-kind support of the project and their staff contributing to the project.

The project's Industry and Scientific Advisory Council comprised experienced practitioners from across South Africa's research and emerging and commercial beef industry sectors. They provided wise advice of great use to the project throughout its life and their contributions are gratefully acknowledged.

The authors gratefully acknowledge the very significant efforts of many other project researchers and technical staff located in South Africa and Australia who were responsible for field, laboratory and abattoir data collection and collation and analysis of project data.

The project is also extremely grateful for the strong contributions, guidance, advice and collaboration it has received from its commercial partners, particularly Woolworths, Cavalier Meats and Stormberg Meats/Cradock Abattoir. Without their ongoing strong support and the incentives they provide to our collaborating farmers, this project simply would not exist.

2 Executive summary

The history of this project has been one of ongoing changes of direction, though none have had major negative impacts on the project. Initially a 2011 proposal aimed to examine the feasibility of developing higher-value beef markets and value chains in South Africa based on pasture-finished cattle from smallholder farms that were slaughtered at older ages than the 80% of South Africa's grain-finished cattle. Due to difficulties with sign-off in South Africa, the project did not formally start until March 2015. During the sign-off period though, the research team had been able to verify that those new market opportunities were available. Hence, the project's focus was changed in 2015 to concentrate on development of new value chains willing to accept cattle from smallholder farmers.

Initial negotiations occurred with three commercial retailers who had expressed interest in the concept. The intent was to develop independent beef value chains focused on the market specifications from each of the retailers. Woolworths was the first retailer to confirm its market specifications and it nominated Cradock Abattoir in the Eastern Cape as the meat processing plant best suited to work with the project. The other retailers did not provide their preferred market specifications, though one retailer nominated Cavalier Meats in Gauteng as a processing plant which would be a suitable project collaborator. Woolworths also supported Cavalier Meats, which at the time of initial discussions was building its processing plant at Cullinan (the plant became commercially operational in March 2017).

Subsequently, only one retailer – Woolworths - collaborated over the entire project, with the other retailers withdrawing for different reasons e.g. difficulty of product supply during droughts and perhaps an inability to identify a market niche to allow value-adding and provision of incentives for farmers supplying to their market. Woolworths has been expanding its free-range beef offerings (and ultimately aims to increase its share from the current 15% of its beef sales to 100%) and has been offering suppliers of free-range beef a significant premium for cattle meeting their specifications. Based on recommendations from the project's mid-term review in September 2016, the project therefore focused on developing just two value chains, one each centred on Cradock Abattoir and Cavalier Meats and both targeting Woolworths' high value free-range beef market specifications, with supply to come from within an approximate 250 km radius of the processing plants (this distance being deemed to be cost-effective for livestock transport and manageable for the project in terms of provision of farmer support).

Once the collaborating meat processing plants and market specifications had been determined, project efforts concentrated on securing collaboration and in-kind contributions from field staff based across the 6 provinces identified as being able to supply cattle to the two meat processing plants. More than 180 field technicians from those provinces have

received specialist training to ensure they are able and confident in providing ongoing support to potential collaborating smallholder farmers located in their regions.

'Proof of concept' that cattle from smallholder herds had the ability to meet high value free-range beef market specifications was based on a relatively small number of cattle slaughtered through Cradock Abattoir in May 2016. Cattle were sourced from commercial, emerging and communal farmer herds and carcasses evaluated for their compliance with market specifications as well as aspects of beef quality. Cattle from all three production systems were shown to be capable of meeting free-range market specifications.

However once the project started to engage with a broader number of farmers across the six provinces, it quickly became clear that most cattle owned by the farmers were not immediately suitable to target free-range specifications. Most male animals had not been castrated, animal and business recording systems were not in place and the farms' nutritional systems required adjustments to stocking rate and/or supplementary feeding practices to ensure cattle growth rates were high enough to allow the animals to reach target carcass weights by 3 years. Many farmers had also sold their cattle at young ages due to prevailing drought conditions, meaning the first animals targeted for free-range markets in many instances would be weaners or newly-born calves. This meant there would be a significant interim period of 2-3 years before they would be ready for slaughter. The project therefore accepted the reality that a strong supply of cattle suitable for free-range markets could not occur until Stage 2 of the project (which had been recommended and agreed by the September 2016 mid-term review). Project efforts then focused on working directly with interested farmers to ensure their cattle were suitable for free-range markets in Stage 2.

As well as forming the beef value chains, the project had initially anticipated a need to form farmer co-operatives based on common approaches to animal production ('primary co-operatives') and marketing ('secondary co-operatives'). However once partnerships had been established with Cradock Abattoir and Cavalier Meats, it became clear that co-operatives would not be an essential component of either value chain, though existing co-operatives (usually primary co-operatives formed as part of earlier land redistribution schemes) were able to participate in the free-range market opportunities.

In addition to developing the two high value free-range beef value chains, the project undertook several areas of novel research to add value to the value chains per sé. The R&D components were:

1. Evaluation of the performance of the project's two value chains relative to each other and relative to other value chains operating in the same provinces, using the Value Addition Information Management System (VAIMS). The questionnaire focuses on production practices and aims to identify the sustainability of production as well as the performance of different actors (farmers, buyers, transporters, processors, retailers) within the different value chains. A baseline survey was completed for Eastern Cape, where the first value chain was initially developed. Baseline data collection and analysis for the remaining five provinces around Cavalier Meats is ongoing and will be completed in Stage 2 of the project due to that plant commencing commercial operations only in early 2017. The VAIMS surveys will be repeated at the end of Stage 2 to identify changes that have occurred since the initial surveys and to determine whether those changes can be attributed to project interventions.
2. Animal nutrition studies designed to identify cost-effective feeding strategies for smallholder cattle farmers targeting pasture-fed beef markets. An animal house study compared a commercial and control diet to diets supplemented with either 10% or 20% dried cactus leaves. All diets contained maize and hay, while the control and cactus diets also contained lucerne. The commercial and cactus diets had different levels of soya oil cake. Animals in the commercial and control groups consumed more feed, gained more weight and produced heavier carcasses than animals in either of the cactus groups. Feed intake in the 20% cactus group was consistently lower than other groups while animals in the 10% cactus group had similar feed intakes to the

commercial and control groups after 4 weeks. Body condition scores improved in all animals over the feeding period and were similar at slaughter. Due to lower weight gains in the cactus groups, cost of gain was higher than in the commercial and control groups. However during drought periods when commercial feed ingredients become expensive, differences among the diets may be negligible. Meat sensory characteristics (tenderness, juiciness, flavour and aroma) were very acceptable for all groups and no differences were found among treatments. This research is now complete, with the focus of the project in Stage 2 on improving pasture and rangeland management specifically on collaborating farms.

3. Development of decision-support tools which will be made available for wider use. They are designed to assist small-scale and emerging farmers to best manage the grazing capacity and stocking rates of their farms and to evaluate different production systems to maximise the profitability and sustainability of their beef businesses.

4. Behaviour change studies aimed at understanding whether particular types of interventions and training approaches work better for different segments of farmers, based on their responses to a project-designed behaviour change survey. The behavioural assessments are correlated with indicators of individual farm business performance to develop farmer psychological profiles which the project hypothesised will enable farmers to be grouped into farmer groups (for example, ‘entrepreneurs’, ‘average farmers’ and ‘traditional or non-commercial farmers’), with training approaches then specifically designed for the different groups to increase the likelihood of farmers adopting proven technologies and improving their farm business performance. Preliminary results show there is a strong potential for farmers to increase the number of cattle they sell, based on their existing resources and technology. There is also a wide variation in the business performance of the farmers, with a good opportunity to target non-performing farmers to enable them to improve and for all farmers to achieve their maximum attainable farm outputs. However a rigorous analysis of the behavioural variables affecting farm business performance is still underway. The behaviour change survey will also be repeated at the end of Stage 2 to determine whether farmers’ profiles and business performance have changed as a result of the project’s interventions.

In addition to much greater farmer engagement and development of the project’s two value chains and repeated VAIMS and behaviour change surveys, Stage 2 of the project will undertake on-farm research to improve the reproductive performance of farmers’ breeding herds. This focus on reproduction is because the key to improving the ability of sale animals to meet free-range market specifications, and improving the reproductive performance of breeding animals, is the same i.e. improved animal nutrition and pasture and rangeland management for the entire herd grazed on each farm.

Other new research components in Stage 2 will address the impact of gender on farm business performance, including access to resources, profitability and compliance with free-range market specifications; and towards the end of Stage 2 the project will undertake a retrospective systems analysis across Stages 1 and 2 of the project’s decision-making processes and key decision points to identify recommendations and guidelines for other industries and commercial sectors wanting to effectively establish new agricultural value chains that reward smallholder farmers for the quality of the products they deliver.

3 Background

Livestock production is one of the most important agricultural industries in South Africa and beef cattle alone make up some 9% of the gross value of agricultural production (DAFF 2010). There are ~13 million head of cattle in South Africa with over 5.5 million located in the poor rural communities. Cattle from poor communities are therefore an important but unproductive asset for South Africa as these herds comprise about 40% of the national herd but contribute only 5% to South Africa's GDP from beef.

The main reason for this discrepancy is that South Africa's commercial beef markets are dominated by grain-fed beef, with feedlots supplying >80% of beef that reaches retail shelves. Although some small-scale and emerging farmers do supply into the feedlot value chain, many have strong social and cultural preferences for keeping older animals, and many of the breed types they manage (especially Nguni) are not suitable for feedlot finishing due to their slower growth rates and lower mature sizes.

While many small-scale and emerging farmers either prefer to, or can only supply, older animals, the South African beef carcass classification system provides a significant disincentive, significantly favouring younger animals which receive premium prices if they are slaughtered at less than 2 years of age and are finished on grain.

This project (LPS-2005-128) built on the outcomes of an earlier ACIAR funded project (LPS-1999-036 known as '*Beef Profit Partnerships'*) which developed the capacity of emerging and communal farmers to improve their cattle production systems and supply feeder cattle to the commercial feedlot sector. It provided those farmers with an alternative avenue for selling cattle other than the limited local markets. The positive outcomes of the earlier project led to the establishment of the national *'Kaonafatso ya Dikgomo'* (KyD – cattle improvement) emerging and communal cattle farmer support system, which was developed by the earlier project. KyD assists farmers to continually improve their cattle production through recording and monitoring productivity and providing advice on production, animal health and marketing. The KyD farmer support system is funded by the Department of Agriculture Forestry and Fisheries (DAFF) and managed by the Agricultural Research Council (ARC). Access to the feedlot market through the earlier ACIAR project increased income from cattle production but also showed that collaborating farmers were able to supply not only feeder cattle but also grow cattle to slaughter weight and sell slaughter-ready animals. Subsequent research (LPS-2008-013 *'Beef palatability'*) demonstrated that meat quality of cattle from emerging and communal farmers had the potential to meet the specifications of high-end markets.

This project was therefore designed to identify, modify and/or develop a wider range of alternative market systems and value chains available for small-scale and emerging beef farmers in South Africa, with a particular emphasis on grass-fed cattle market opportunities. The main aim was to provide examples of profitable small-scale farmers supplying free-range cattle that meet market specifications to supermarkets as 'proof of concept'.

The project was a partnership between the University of New England (UNE, commissioned organisation) and ARC, DAFF and the National Agricultural Marketing Council (NAMC) in South Africa. It commenced on 16/03/2015 and was completed on 31/12/2017.

The project had a difficult history with sign-off in South Africa. It was originally designed to start in 2012 but the contract was not signed in South Africa until February 2015. The long delay required an immediate variation to contract to update the proposal and to formalise considerable changes in personnel and partnerships. The biggest impact of the variation was to remove the focus of the initial contract on desk-top studies that would generate a better understanding of the market opportunities available to smallholder farmers (as those studies were undertaken by the project team in the interim period) and instead to concentrate on development of new value chains willing to accept cattle from smallholder farmers, in conjunction with commercial retailers and meat processors in South Africa.

4 Objectives

The overall goal of the revised project was to identify, modify and/or develop a wider range of alternative market systems and value chains available for small-scale and emerging beef farmers in South Africa, with a particular emphasis on grass-fed cattle market opportunities. The project's broad objectives were to:

1. **Develop, modify and evaluate the value chain and market requirements** needed to ensure South African small-scale and emerging cattle farmers and Australian cattle farmers better understand customer preferences and receive appropriate rewards from meeting the specifications of expanded and diversified beef markets and value chains, such as a high-quality grass or-grain-finished product (20% of project effort).
2. **Develop, modify, trial, implement, and evaluate the supporting production system, institutional and practice change elements** needed to ensure South African small-scale and emerging cattle farmers can meet the specifications of these expanded and diversified beef markets and value chains (40% project effort). This objective had three components, to:
    a. **Develop, modify and evaluate the technology requirements** needed to ensure South African small-scale and emerging cattle farmers can meet the live animal and/or carcass specifications of these expanded and diversified beef markets and value chains.
    b. **Develop, modify and evaluate the innovation systems and processes** required to achieve behavioural change to ensure that South African small-scale and emerging cattle farmers can make more effective decisions about innovations and improvements for their businesses.
    c. **Support and integrate existing and new organisational structures** for information sharing and production and marketing decision making to assist South African small-scale and emerging cattle farmers working within partnerships to meet the logistic and contractual specifications of a wider range of beef markets and value chains.
3. **Develop, evaluate and implement decision-support tools** to recommend the most appropriate and profitable beef production systems for South African small-scale and emerging farmers (15% of project effort). This objective had two components, to:
    a. **Develop, evaluate and implement a decision support tool to correctly estimate grazing capacity and stocking rates** to ensure sustainability of South African beef production systems.
    b. **Develop, evaluate and implement a decision support tool to evaluate alternative production systems** to recommend the most profitable production systems for South African small-scale and emerging farmers.
4. **Measure, monitor and evaluate the ongoing performance of the project and its components** (25% of project effort)**.**

5 Methodology

Objective 1: Develop, modify and evaluate the value chain and market requirements needed to ensure South African small-scale and emerging cattle farmers better understand customer preferences and receive appropriate rewards from meeting the specifications of expanded and diversified grass-fed beef markets and value chains.

As a result of the long delay in achieving contractual sign-off that would have allowed the project to commence in 2012, the 2015 variation included numerous changes to the project's methodology. Rather than undertaking studies designed to better understand the opportunities to form new beef value chains that would accept supply from smallholder farmers in South Africa, the new focus became development of those new value chains.

Hence, the project's early activities involved negotiation with commercial retailers (initially Woolworths, Massmart and Pick 'n Pay) to identify their interests in engaging smallholder beef farmers and to understand their specific market requirements. Thereafter, negotiations occurred to engage the preferred meat processors nominated by the retailers (Cradock Abattoir in Eastern Cape and Cavalier Meats in Gauteng). Initially all retailers expressed interest in contributing to the project, but only Woolworths provided clear beef market specifications. Massmart subsequently chose not to continue with this (and other agricultural) value chains in May 2016 because of their difficulty with sourcing supply during the ongoing drought. Pick 'n Pay discontinued their engagement with the commercial abattoir servicing the slaughter of the project's cattle in mid-2017.

Once the project had identified and engaged the collaborating meat processors, project efforts focused on formation and training of farmer support teams based within ~250 km radius of each of the processors (that distance considered to be a cost-effective distance for transporting animals as well as providing a limit to the extent of farmer training and support that would need to be provided by the project). Formation of the two value chains (see map below) then enabled farmer identification and engagement, as well as determining the locations of associated research activities to be undertaken by the project.

A parallel area of R&D was pursued in Objective 1 using the Value Addition Information Management System (VAIMS) survey tool across the regions where the new farmer partnerships and value chains were implemented.

Objective 2: Develop, modify, trial, implement, and evaluate the supporting production system, institutional and practice change elements needed to ensure South African small-scale and emerging cattle farmers can meet the specifications of these expanded and diversified grass-fed beef markets and value chains.

The first component of this objective was to develop, modify and evaluate the technology requirements needed to ensure the farmers could meet the specifications of these new markets and value chains. A start-up workshop was held to review the results and outcomes of earlier projects, as well as developments in South Africa's livestock industry policy and the activities in the region of ILRI and other agencies during the interim period (whilst the contract was signed) and to agree the project's cost-effective technology requirements and the processes need to develop Standard Operating Procedures which would be used to train collaborating farmers. A 'gaps analysis' was undertaken to determine the deficiencies in the production systems used by smallholder farmers relative to the new market specifications. The major deficiency identified was a general lack of cost-effective animal nutrition, pasture and rangeland management systems that would enable cattle from smallholder farmer herds to grow at the rates required (minimum of 0.4 to 0.6 kg per head per day through to a maximum age of 3 years) to achieve free-range market specifications. A set of animal nutrition experiments was therefore conducted in Eastern Cape to assess different mixes of pasture *vs.* supplementary feeding. The site was selected because the meat processing plant in Gauteng only became commercially operational in 2017 and hence initial project efforts focused around Cradock Abattoir.

The second component of this objective was to develop, modify and evaluate the innovation systems and processes required to achieve behavioural change to ensure the smallholder farmers can meet the new market specifications and can make more effective decisions about innovations and improvements for their businesses. Because a critical contributor to this area of research had retired during the period while the contract was being signed, the project's approach changed from that proposed in the contract, based on some early results deriving from a comparable smallholder poultry value chain project in South Africa in early 2015. Rather than developing new tools to support systems thinking and organisational learning as was originally proposed (and which would require the specialist expertise of the retired UNE researcher) the project instead co-opted psychologists and a linguistics expert from UNE to suggest alternative approaches. Hence the main aim of the behaviour change component of the project focused on whether particular types of on-farm interventions and training approaches work better for different segments (or profiles) of farmers, based on the farmers' responses to a behaviour change survey developed specifically for the project.

To develop the behavioural profiles, a questionnaire was developed and administered initially to selected beef and poultry farmers across several provinces by 15 project enumerators who had been trained to administer the survey. Preliminary survey data were used to check the farmers' responses for consistency and clarity. Based on those initial responses, minor changes were made to the questionnaire with the revised questionnaire subsequently administered by a combination of electronic and written data capture. Surveys are now complete from a wide range of farmers across both value chains.

The third component of Objective 2 aimed to support and integrate existing and new organisational structures for information sharing and production and marketing decision making to assist the farmers to meet the logistic and contractual specifications of a wider range of beef markets and value chains. Initially the project anticipated a need to form primary (focused on animal production) and secondary (focused on group marketing of cattle across collaborating farmers) co-operatives. However once the beef value chains had been formed, it became clear that formation of co-operatives was not critical to the success of the value chains and farmers' participation in them.

Objective 3: Develop, evaluate and implement decision-support tools to recommend the most appropriate and profitable beef production systems for South African small-scale and emerging farmers.

Objective 3 used the livestock grazing capacity map of South Africa developed from the annual net primary production from the MODIS satellite programme and the feed requirements of Large Stock Units across different breed sizes and physiological stages to develop, evaluate and implement a simulation program which estimates the optimal carrying capacity for individual farms. A software program was also developed and has been made available to government and beef industry sectors including extension officers, consultants and business plan developers. A second component of this objective compared weaner (feedlot), backgrounding and grass-fed systems as possible alternative production systems to determine the most sustainable and profitable system for use by small-scale and emerging farmers in South Africa. It included the use of aspects of the Australian *BeefSpecs* and FATCHOP software packages to better predict the ability of cattle to meet market specifications in different regions of Eastern Cape.

Objective 4: Measure, monitor and evaluate the ongoing performance of the project and its components.

This objective measured, monitored and evaluated the ongoing performance of the project and all of its components over the life of the project.

6 Achievements against activities and outputs/milestones

Objective 1: To develop, modify and evaluate the value chain and market requirements needed to ensure South African small-scale and emerging cattle farmers better understand customer preferences and receive appropriate rewards from meeting the specifications of these expanded and diversified beef markets and value chains *(20% of project effort).*

No.	Activity	Outputs / milestones	Completion date	Comments
1.1	Review the available markets for cattle and beef in South Africa and how they currently work; the current strategies of the major retail chains; what new market specifications might look like for higher quality grass-fed products; and the constraints the retailers see to developing new markets and value chains.	A formal assessment of existing markets for cattle and beef in South Africa and the institutional and market impediments to the development of new markets and value chains.	31 Dec 2014	This activity demonstrated the potential for beef markets in South Africa to be differentiated and the possibility of establishing new higher-value markets for older cattle (up to 3 years of age).
1.2	Select collaborating commercial retailer(s) in South Africa with an interest in delivering higher-quality beef products derived from small-scale and emerging farmer herds.	Preferred retailers(s) willing to collaborate with the project identified and their high-quality grass-fed market specifications identified	31 Dec 2014	The project's 2016 Annual Report outlining the processes to confirm Woolworths and Pick 'n Pay as the collaborating retailers and Cradock Abattoir/Stormberg Meats and Cavalier Meats as the collaborating processors.
1.3	Test the market specifications provided by the collaborating retailer(s) to determine that non-grain-finished cattle from small-scale and emerging farmers which meet those specifications deliver the quality specifications expected of the retailer(s). Iterate this testing until there is agreement between the retailer(s) and the project on the specifications that will apply in the project's value chain(s)	Market specifications to be targeted by the project's collaborating farmers and cooperatives will be validated as meeting the retailer(s)' expectations of a high quality, non-grain-finished beef products	31 Dec 2016	The project tested a small number of cattle from small-scale and emerging farmers in 2016 and demonstrated that cattle from those herds could meet the retailers' market specifications. However as the project engaged with a broader range of smallholder farmers, it became clear that most farmers did not have cattle that were readily suitable for slaughter, with most male cattle not castrated and most cattle considerably under target market weights. Project efforts in 2017 focused on training potential collaborating farmers, signing them up to Cavalier Meats or Cradock Abattoir and working directly with them to best position their cattle for slaughter as the cattle reached potential market specifications beyond the life of this project.

No.	Activity	Outputs / milestones	Completion date	Comments
1.4	Extend the scale and regional coverage of the project's proof-of-concept high quality, non-grain-finished value chain(s) as part of a broader roll-out of project results to ensure benefits flow to small-scale and emerging farmers more broadly	The new value chains will account for as many characteristics as possible of the best-value supply chains (technical as well as economic) but still considering what is feasible based on supply from small-scale and emerging farmers in South Africa	Due to the constraints identified in Activity 1.3, this activity has now been incorporated into Stage 2 of the project (LPS/2016/276)	As the project developed it became clear that some aspects of the original plan (e.g. development of primary and secondary cooperatives for collaborative production and marketing of cattle) were not required. Hence efforts focused on a broader roll-out of the proof-of-concept to a range of primarily emerging farmers (with some communal farmers also included) located in Eastern Cape (Cradock Abattoir) and the five provinces around Cavalier Meats. As indicated in objective 1.3, those efforts have focused on training farmers in the methods needed for their cattle to achieve market specifications and working with them to castrate and manage their cattle with the aim of having the first groups of cattle slaughtered in Stage 2 of the project.
1.5	As part of a broader roll-out of the project's results, design, trial and establish market reporting and market facilitation functions for new or modified value chain.	A well-designed and tested market reporting system for a pasture-finished value chain using cattle from small-scale and emerging farmers where the right incentives are captured and transmitted up and down the value chain.	Formal (non-project) market reporting was not required, but the project has provided SMS reports to farmers since Feb 2017 and more detailed reports by email since Nov 2017.	Original planning for this objective was that NAMC would initiate a public market reporting system for free-range beef. However the project's two collaborating abattoirs already had a good system whereby prices relative to market specifications were updated on a weekly basis and were freely available to anyone wanting to access them. Hence the project developed a cell-phone circulation list comprising >1,000 farmers from within the abattoirs' target regions. Each week a brief summary of the most up-to-date market prices has been messaged by the project to those farmers on the circulation list. In Nov 2017, the messaging process was extended to include a more comprehensive market report which is sent out by the project each week via email to farmers who request access to the report. This will continue into Stage 2 of the project until the farmers are independently able to access and effectively interpret the information for themselves.

Objective 2: To develop, modify, trial, implement, and evaluate the supporting production system, institutional and practice change elements needed to ensure South African small-scale and emerging cattle farmers can meet the specifications of these expanded and diversified beef markets and value chains *(40% of project effort).*

No.	Activity	Outputs/ milestones	Completion date	Comments
2.1	Undertake a review of the scientific and business literature to identify the factors that are associated with either successful or unsuccessful cooperatives, to develop criteria that will allow selection of the best-performing cooperatives in the geographic region nominated by the partner retailer(s)	A formal assessment of the factors associated with successful and unsuccessful cooperatives, particularly those in the agricultural sector. A set of criteria to assist the project team select the best-performing cooperatives in the location(s) preferred by the collaborating retailer(s) as part of its proof-of-concept studies	20 Sept 2015	Once collaborations had been established with Cavalier Meats and Cradock Abattoir it became clear there was no requirement for the project to establish primary or secondary co-operatives to link smallholder farmers with the project's two value chains. However the project did work directly with several primary co-operatives which had been formed as part of earlier government land reform initiatives.
2.2	After the collaborating retailer(s) and market specifications have been agreed (objective 1.3) and selection criteria for successful cooperatives identified (objective 2.1), identify the farmer cooperatives, farmers and farmer support teams most likely to have the interest and capability of delivering cattle to meet the specifications of the project's collaborating retailer(s) and hence to become collaborators in the proof-of-concept evaluation. Plan and deliver a series of introductory workshops for farmer cooperatives, small-scale and emerging beef cattle farmers and their farmer support teams to ensure they have the necessary knowledge to decide whether or not to participate in the project.	A clear understanding of the aims and expected benefits of the project, of the CI&I methodology, and of the roles and responsibilities of all partners. A commitment to participate by farmer cooperatives, small-scale and emerging farmers and their farmer support teams.	Proof of concept was established in 2016 but based on a very limited number of farmers and cattle because of the lack of suitable cattle in smallholder herds (objective 1.4). This activity is therefore being extended into Stage 2 of the project.	Following the mid-term review of the project in September 2016, the project concentrated efforts just on two collaborating abattoirs (Cradock Abattoir and Cavalier Meats). The original 'Standard Operating Procedures' were completely re-written to become a practical Farmer Training Manual which was used as the basis for farmer training in 2017 and this will continue into Stage 2 of the project.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.3	Each of the project's technical teams (nutrition, reproduction and breeder herd management, other on-farm management practices, animal breeding needed for longer term roll-out, animal health, transport and pre-slaughter management, processing, post-slaughter management of carcasses) to formally evaluate the current production and processing systems available to small-scale and emerging beef cattle farmers in South Africa, to develop 'best-bet' recommendations on management of animals to meet market specifications, customised by region. Develop and test best-practice Standard Operating Procedures (SOPs) and training packages customised by region for farmers in the use of those SOPs to improve the farmers' ability to deliver cattle to market specifications.	A formal assessment of existing production and processing systems for small-scale and emerging cattle farmers in South Africa. A validated set of Standard Operating Procedures, customised for different regions that can be utilised by small-scale and emerging farmers to improve their ability to deliver cattle that meet market specifications. Training materials that can be used to educate collaborating farmers and other farmers in the same regions about how best to manage cattle to meet the specifications of high-quality, non-grain-finished cattle.	A series of Standard Operating Procedures were initially developed over 2015 and the early part of 2016. However those SOPs were subsequently re-written as part of a comprehensive Farmer Training Manual in late 2016 and subsequent training has been based on the Manual.	Following the project's mid-term review, the project's Standard Operating Procedures were revised and re-focused directly on the needs of farmers aiming to meet free-range market specifications. Those procedures were integrated into a comprehensive farmer training manual which was tested with selected farmers to seek their evaluation and feedback on further changes. The training manual has been submitted to AgriSeta for accreditation. Training of both the project's farmer support teams and of farmers using the materials has been based on this manual over most of 2017.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.4	Where the need(s) are identified by the reviews undertaken to develop the Standard Operating Procedures (Objective 2.3), design and undertake experimental research that may be required to address the technology deficiencies that must be overcome if the project is to achieve its objective of delivering cattle that meet the retailer(s) specifications.	Scientific reports describing new knowledge and experimental results that can be integrated into the Standard Operating Procedures customised for each of the project's specific regions	31 Dec 2017	During development of the SOPs it became clear the most urgent intervention was the need to ensure animals grew sufficiently well from birth through to sale to ensure they met the minimum weight and fat depth specifications at an age young enough to satisfy market specifications. A research proposal was therefore developed with the title *'Cost-effective feeding strategies for smallholder cattle producers targeting natural pasture-fed beef markets'.* The research initially identified nutritional supplements feasible for use in Eastern Cape and chemical and digestibility tests of potential supplements were undertaken. An animal experiment was completed in the second half of 2017 using treatments based on lucerne hay, *digitaria eriantha* hay, lucerne + maize grain + molasses and *digitaria eriantha* hay + cactus pear + molasses. Meat quality evaluations were also completed.
2.5	Working with the collaborating retailer(s), test and validate the ability of the Standard Operating Procedures and the cooperatives to deliver cattle that meet beef market specifications agreed with the retailer(s)	Proof of concept that adherence of the small-scale and emerging farmers to the Standard Operating Procedures enables those farmers to deliver cattle that meet the high-quality specifications agreed with the collaborating retailer(s)	Because of the lack of availability of suitable cattle (objective 1.4), this activity will continue into Stage 2 of the project.	Based on a very small number of animals, cattle from smallholder herds have the capacity to meet free-range market specifications, but the production systems need to be changed to enable the cattle to routinely meet specifications. Working with smallholder farmers to change their production systems has been the project's main focus over the past year and this will continue into Stage 2 of the project.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.6	Education and training of small-scale and emerging farmers and their farmer support teams as well as the farmer cooperatives to ensure they are able to effectively deliver cattle that meet the specifications required by the commercial retailer(s)	Training materials focused on a wide range of business, technical, marketing and processing topics and customised for use by farmers, farmer support teams and farmer cooperatives. These materials will be accredited by the South African Qualifications Authority and AgriSETA through the National Training Framework.	Farmer education and training has been a major component of this project and will continue into Stage 2 of the project.	The project's approach to training farmers has changed over the life of the project to now focus specifically on the requirements of meeting free-range beef specifications using the Farmer Trainer Manual. This training will continue into Stage 2 of the project.
2.7	Design, conduct and implement an experiment aimed at differentiating a wide range of factors associated with the successful achievement of beef market specifications by small-scale and emerging farmers (e.g. cultural and psychological attitudes of the farmers, their technical and business abilities, availability of infrastructure and financial resources etc.)	New and improved methods and tools to achieve agricultural practice change. Improved psychological and systems thinking capacities of the target farmers and their farmer support teams. Scientific publication(s) and improved social science capacity of the project's team	Initial analyses of survey data were completed by November 2017. However this activity will continue and be extended into Stage 2 of the project, with the aim of repeating the survey in 2020/2021 to determine whether farmers' profiles have changed as a direct result of project activities.	A psychological profile survey tool was designed and tested across several provinces amongst beef and poultry farmers and modified as required. Fifteen survey enumerators were trained to administer the Behaviour Change baseline survey. About 700 surveys were available across the beef and poultry value chains, with 452 beef surveys used in preliminary analyses of the data to rate each surveyed farmer on the technical efficiency of his/her farm business performance and a composite index of 11 psychological variables. A South African PhD student based at UNE is currently estimating the relationships between farmers' technical efficiency and psychological attributes. This research will continue into Stage 2 of the project, with the aim of developing customised interventions to improve the uptake by farmers of interventions which will improve their farm business performance.

No.	Activity	Outputs/ milestones	Completion date	Comments
2.8	Develop and test best-practice Standard Operating Procedures and training packages for farmer and farmer support Executive Coaching (Positive Psychology)	A validated set of Standard Operating Procedures that can be used to train farmers and farmer support teams to focus on the social and psychological factors which impact on decision making and achieving on-farm practice change	30 June 2016	As reported in the 2016 annual report, this objective was modified to incorporate the Standard Operating Procedure into the psychological profile survey tool.

Objective 3: Develop, evaluate and implement decision-support tools to recommend the most appropriate and profitable beef production systems for South African small-scale and emerging farmers *(15% of project effort).*

No.	Activity	Outputs/ milestones	Completion date	Comments
3.1	Develop regression equations for Large Stock Units in respect of cattle of different frame size and physiological stage	Regression equations for the different frame sizes (small, medium, large), physiological stages (lactating cow, pregnant cow, dry cow, replacement heifer, weaner calf, breeding bull, etc.) and at different body weights	30 June 2017	As reported in the 2016 annual report, regression equations for different frame sizes for lactating cows, bulls, heifers, weaners and steers were developed. Equations could not be calculated for pregnant and dry cows and replacement heifers as Meissner *et al.* (1983) did not develop tables in which LSUs were linked to the weights of females for these physiological stages. Modelling was therefore undertaken to develop new equations and fit them into a computerised decision-support tool.
3.2	Collect baseline information on the different production systems aimed at meeting the specifications of commercial retailers (e.g. long weaners, on-farm supplementary feeding, short-term finishing on grain ration prior to slaughter etc.)	Baseline information on different production systems available for desktop study	30 June 2016	Completed and information incorporated into a computerised decision-support tool.
3.3	Develop mechanism(s) to link carrying capacity with a specific area (farm)	Downscale grazing capacity information to town, district, or local municipality level, by e. g. linking it to the postal code of the nearest post office (or any other feasible solution)	30 Sept 2017	Grazing capacity information was downscaled to specific regions of South Africa and needs to be integrated into the computerised decision-support tool.

No.	Activity	Outputs/ milestones	Completion date	Comments
3.4	Develop a simulation program to estimate grazing capacity and stocking rate	Development of a software program (simulation model) that will be made available to the beef industry, from farmers to extension officers.	31 Dec 2016	Feedback from the project's ISAC meeting in May 2017 suggested there would be value from the inclusion of pre-defined costs of production into the model (in addition to allowing the farmers to enter their own costs). An evaluation to determine the feasibility (and value) of this additional research is underway and if appropriate, pre-defined costs of production will be incorporated into the model. A post-graduate student has been identified to work on this.
3.5	Undertake a desktop study using an existing program provided by the University of the Free State to compare the different production systems	Comparison of economic efficiencies of the different communal and emerging beef cattle production systems.	30 June 2017	The initial desktop study is complete but the program continues to be used to evaluate alternative beef production systems as part of ongoing provision of advice to service providers to communal and emerging farmers.
3.6	Evaluate and implement a simulation program to estimate grazing capacity and stocking rate	Evaluation of the practical usefulness of the program by testing it with different scenarios and applying it in practical situations.	31 Dec 2017	The decision-support tool is now available and needs to be developed so that it can be applied in practical farming situations across South Africa.
3.7	Evaluate the current guidelines for the production of grass-fed beef to confirm the different production systems comply with those guidelines	Guidelines for grass-fed beef based on scientific principles and not on artificial standards adapted from northern hemisphere countries.	30 June 2016	Completed and formally approved by South Africa's Meat Industry Council (SAMIC).
3.8	Use outputs from objectives 3.1 to 3.7 and determine the possibilities of integrating them with the Australian FATCHOP and *BeefSpecs* tools and algorithms to improve compliance with beef market specifications and reproductive performance and calibrate the decision support tools for use across different regions of South Africa	If access can be obtained to the *BeefSpecs* modules and FATCHOP algorithms, test, calibrate and validate them for use in different regions of South Africa	30 June 2017	Aspects of the *BeefSpecs* modules and FATCHOP algorithms were tested, calibrated and validated for use in different regions of the Eastern Cape Province.

Objective 4: To measure, monitor and evaluate the ongoing performance of the project and its components (25% of project effort).

No.	Activity	Outputs/ milestones	Completion date	Comments
4.1	Evaluate the effectiveness of the project's selected value chain(s) for its/their ability to deliver beef of expected quality based on the retailer(s) market specifications. Design, trial and establish a MME strategy with appropriate KPIs.	The project's initial value chain aimed at providing proof-of-concept will be described and evaluated from farmers through to abattoir(s) and retailer(s). A well-designed and tested project reporting system for a high-quality, non-grain-finished value chain based on cattle from small-scale and emerging farmers that can be used by the project team to accurately assess progress and achievements.	Eastern Cape (30 Nov 2016) 5 provinces around Cavalier Meats - work will continue into Stage 2 of this project.	Data analysis of the VAIMS survey data in Eastern Cape was completed and results presented to an international conference in July 2017. A detailed report was also provided to the ISAC in November 2017. Because of the delayed commencement of business of Cavalier Meats (which formally commenced commercial operations in March 2017), VAIMS survey collections did not commence until mid-2017 and is continuing into Stage 2 of the project. The VAIMS surveys in all provinces will be repeated in 2020/2021 to determine whether changes in value chains are evident and can be attributed to the project's direct interventions.
4.2	Undertake an evaluation of the effectiveness of the selected collaborating cooperatives to identify strengths and in particular, areas of improvement	Monthly informal evaluations and an annual formal evaluation of the effectiveness of the selected collaborating cooperatives	This activity was not required but an MSc student is continuing to use project data for an associated study.	There was no requirement for the project to form either primary or secondary co-operatives so this activity was no longer required. However a NAMC MSc student project is investigating whether farmers' membership of formal co-operatives delivers benefits to their farm businesses. This study is due for completion by December 2017 and progress will be monitored through Stage 2 of the project.
4.3	Develop and regularly evaluate a comprehensive feedback system across the retailing and processing sectors, farmer cooperatives, collaborating farmers, farmer support teams and the project teams required to underpin the success of the value chain(s)	A comprehensive and highly effective feedback/communication system that routinely provides information in the format needed by the value chain partner(s) and the project team to ensure inputs are supplied on time and to the standard required by the different sectors of the chain	This activity was not required by the project	This sub-objective was included in the original project design to monitor the effectiveness of linkages across all sectors of the proposed beef value chains based on measures of the effectiveness of communications at, and between, various sectors of the value chains (the thinking being that project support team members would be directly engaged in each of those levels of communication). However as the value chains developed, the meat processors indicated their preference to work directly with the farmers rather than operating through secondary co-operatives. There has also been no need for the project to engage directly with primary cooperatives. As a result of these changed approaches to the value chain design, the project accepted it was not possible to validly assess the effectiveness of communications across all these various sectors as originally anticipated in this objective.

No.	Activity	Outputs/ milestones	Completion date	Comments
4.4	Collate and analyse business performance data collected by the previous BPP project's farmers to evaluate the effectiveness and sustainability of the CI&I process and to identify new learnings that will assist collaborating farmers in the current project to improve their own business performance	Updated analyses of BPP business performance that will help small-scale and emerging farmers to continue to improve their businesses Evidence (or otherwise) of the effectiveness and/or sustainability of the BPP processes in helping small-scale and emerging farmers to continuously improve the business performance of their enterprises	30 June 2016 and updated in Sept 2017	In 2015 an impact assessment was undertaken of the business performance data collected by the previous ACIAR-funded project in South Africa to evaluate the effectiveness of the Continuous Improvement and Innovation (CI&I) component of that project. ACIAR subsequently produced a report that combined adoption results for seven different ACIAR projects, including the earlier project in South Africa. That report indicated the South African project was deficient in achieving adoption for Objectives 2 and 3 but was considered misleading because this project's adoption report focused only on achievements by smallholder farmers (Objective 1) and largely ignored the scientific/technical outcomes (Objectives 2 and 3) of the earlier project. The adoption report was therefore updated to include those technological outputs and where possible, to list those where adoption has occurred.
4.5	Design, trial and establish a MME strategy for the entire value chain with appropriate KPIs.	The project's initial value chain aimed at providing proof-of-concept will be described and evaluated from farmers through to abattoir(s) and retailer(s). A well-designed and tested project reporting system for a high-quality, non-grain-finished value chain based on cattle from small-scale and emerging farmers that can be used by the project team to accurately assess progress and achievements.	30 Sept 2017, with ongoing use in Stage 2 of the project	This objective was developed with the aim of using the CRC Impact Tool to measure and monitor the impact of each of the project's value chains. However that Tool could only be developed for those value chains once the chains had actually been designed and established. Cradock Abattoir's value chain was reasonably well advanced at the time of the 2016 annual report, but Cavalier Meats did not become commercially operational until March 2017. Hence development of the Impact Tool for this project was discussed during the mid-term review in September 2016 and it was agreed there would be little value in completing it for the current project but there would be great value in completing it for the project's extension period (2018-2021). It was subsequently completed by a team of economists from ARC and NAMC and will be used in Stage 2 of the project.

No.	Activity	Outputs/ milestones	Completion date	Comments
4.6	Undertake a mid-term review to evaluate progress towards 'proof of concept' and the changes that might be required to implement a wider roll-out of the 'proof-of-concept' to other commercial retailers in South Africa and across other Southern African countries. Secure additional investment to allow the wider roll-out of the 'proof-of-concept' to occur	Factors associated with the success of the proof-of-concept and areas of improvement documented, with documented plans to overcome the deficiencies that are identified by the review. Significant new investment from government(s) and private sector partners obtained to enable the broader roll-out of project results to occur	30 Sept 2017	The mid-term review was completed, with a recommendation that the project be extended to include Stage 2 (01.01.2018 – 31.12.2021).
4.7	Collate and synthesise outputs from the project, prepare material for final workshop and write final report. All agencies involved.	Presentations for the final project review meeting, final report and material for communication to partners.	30 March 2018	Subject of this report.

7 Key results and discussion

Objective 1: Develop, modify and evaluate the value chain and market requirements needed to ensure South African small-scale and emerging cattle farmers better understand customer preferences and receive appropriate rewards from meeting the specifications of expanded and diversified grass-fed beef markets and value chains.

By the time the contract was signed in early 2015, the project team had been able to complete a study that clearly demonstrated the potential for beef markets in South Africa to be differentiated, particularly between grass- and grain-fed animals, and the possibility of establishing new higher-value markets for older cattle (up to 3 years of age).

Collaborations were initially formed with three supermarket chains (Woolworths, Pick 'n Pay and Massmart) but for different reasons (possibly related to the ability of the retailers to create value for the new beef products as well as the difficulty of securing supply during droughts), the collaborations with Pick 'n Pay and Massmart did not continue for the entire project. Woolworths provided very tight free-range beef market specifications and for the last year of the project have been offering premiums of around 15% above A-grade grain-fed beef to suppliers able to meet market specifications. Woolworths also nominated two meat processing plants, Cradock Abattoir in Eastern Cape and Cavalier Meats in Gauteng. The project has established strong collaborations with both those processors and has formed two free-range beef value chains with smallholder farmers within a 250 km radius of each of the plants, and engaged staff from the six Provincial Departments of Agriculture operating within that radius to support the collaborating farmers.

Proof of concept

In 2016, the project secured a small number of cattle from small-scale and emerging farmers to test the market specifications and demonstrate that cattle from those herds were capable of meeting the specifications provided by the two collaborating retailers.

Cradock Abattoir supplied loin cuts of 5 animals from commercial, communal and emerging farmers in Eastern Cape. Although this was not a large sample, the results were considered the start of a larger database. The carcass specifications of some of the animals were not ideal, i.e. they did not adhere to Woolworths high value free-range market specifications. All cattle from emerging farmers (BEF) were within age and weight specifications, but lean. Animals from commercial farmers (FR) included 2 C-class animals, of which 1 was a bull. The communal animals (COM) included A, B and C class animals and a bull and the animals were mostly very lean.

Table 1. Carcass characteristics of cattle from commercial (FR), emerging (BEF) and communal farmers (COM)

Type	Age Class	Live weight(kg)	Fat (mm)
FR	AB, B, C (1 bull)	272-532	1-2 mm
BEF	B	430-560	2 mm
COM	A, B, C (1 bull)C	395-451	0-2 mm

Loin cuts were aged for 14 days and colour (uncooked steaks) and mechanical tenderness (Warner Bratzler shear force, oven broiled) were tested.

Table 2. Mean values for Warner Bratzler shear force (WBSF, kg), colour lightness and chroma

	FR	BEF	COM
WBSF	3.2	3.0	2.8
Lightness	31.6	30.3	34.2
Chroma	18.2	16.8	15.9

Lower values for WBSF indicate more tender beef. Considering benchmarks for tenderness, any value lower than 3.8 kg is regarded as tender and acceptable to consumers. All samples

were therefore tender with those from communal animals having the lowest resistance (most tender).

Lightness measures the reflection of light on the meat, with higher values indicating paler meat and lower values indicating darker meat. Meat from the communal animals was slightly paler than the other two groups. Chroma measures the vividness of the typical cherry red colour expected of fresh beef. MacDougall (1977) indicates that values for chroma higher than 20 relate to the bright red colour of bloomed meat and S=18, S=14 and S<12, as dull, distinctly brown and brown to grey-greenish brown, respectively. Cuts from all the groups displayed for 5 days on a shelf (display cabinet) exhibited deterioration in colour stability and this could partly be contributed to vacuum-packaged storage over the extended time. Meat from commercial animals would be regarded as dull whilst samples from emerging and communal animals were starting to turn brown. Many more samples need to be tested and there should be more focus on slaughtering and sampling carcasses that adhere to the specifications of the retailers.

These results provided the initial proof of concept that cattle from emerging and communal farmer herds have the capacity to meet the specifications of high-value markets

Formation of two beef value chains targeting high value free-range beef

By May 2017, 20-25 extension officers from each of the six collaborating Provincial Departments of Agriculture (Limpopo, Free State, Gauteng, Mpumalanga, North West and Eastern Cape) and the regionally-based KyD technicians and interns (~180 people in total) had been trained to provide support to the collaborating farmers who would be prepared to target Woolworths' free-range markets specifications.

Thereafter, the project team began training farmers in all 6 provinces using the new Farmer Training Manual developed by the project and which is specifically focused on supplying cattle to meet Woolworths' free-range markets through both Cavalier Meats and Cradock Abattoir value chains.

By early November 2017, 165 farmers had participated in a two-day training workshop based on the Training Manual, with 42 individual farmers and 1 communal group of farmers signing a contract to supply free-range beef. After farmers signed the contract, the farmer support team followed up with each individual farmer (or in the case of communal farmers, each community group) to undertake a detailed farm evaluation (including rangeland condition and the farmer's record-keeping skills) and assessment of the suitability of their cattle to meet free-range market specifications.

This evaluation identified a number of challenges faced by the farmers if their cattle are to comply with the market specifications. Those challenges mainly revolve around castration of male cattle, animal nutrition (and particularly over-stocking of farmers), record keeping, reproduction and the breeding plan act. Training and recruitment is an ongoing exercise to ensure the Stage 2 project's goal of having ~2,000 farmers supplying Woolworths' free-range market across 6 Provinces by 2021 can be achieved. Recruitment is achieved through farmers days and information days conducted by the Departments of Agriculture in various districts in each of the Provinces.

By early November, 570 animals had been committed to target the free-range market specifications, with those cattle varying in age from new-born calves through to around 24 months of age. Only 15 of the contracted farms had had a rangeland assessment completed by that date, but skilled rangeland management specialists in the six Provincial Departments of Agriculture have agreed to be responsible for this ongoing assessment and to train farmers in the use of a simplified rangeland monitoring tool to assist them to evaluate the condition of their own farms on an ongoing basis.

As the value chains developed it became clear that some aspects of the original plan (e.g. development of primary and secondary cooperatives for collaborative production and marketing of cattle) were not required. Hence efforts focused on a broader roll-out of the proof-of-concept to a range of primarily emerging farmers located in Eastern Cape (Cradock

Abattoir) and the five provinces around Cavalier Meats, with the aim of slaughtering cattle to meet free-range market specifications during Stage 2 of the project.

Objective 2: Develop, modify, trial, implement, and evaluate the supporting production system, institutional and practice change elements needed to ensure South African small-scale and emerging cattle farmers can meet the specifications of these expanded and diversified grass-fed beef markets and value chains.

There were three key components included as part of Objective 2:

i) Development of the comprehensive Farmer Training Manual, which as described previously, has been developed to specifically focus on the requirements for farmers wanting to meet the specifications of high value free-range beef markets. The manual has been submitted to AgriSeta for accreditation and once accreditation has been approved, the manual will be made freely available on a project website to be developed as part of the Stage 2 project and also to vocational education institutions across South Africa;

ii) Animal nutrition studies aimed at identifying alternative animal production systems that would allow smallholder farmers to cost-effectively meet the cattle growth rates required to achieve free-range market specifications; and

iii) Behavioural change studies aimed at improving rates of adoption of proven technologies by smallholder farmers and thereby to improve the productivity and profitability of their farm businesses.

Animal nutrition studies

In 2015 the project undertook a gaps analysis to identify the on-farm technology needs required if farmers were to achieve the specifications of high value beef markets. As part of that analysis it became clear the most urgent intervention was the need to ensure animals grew sufficiently well from birth through to sale to ensure they met the minimum weight and fat depth specifications at an age young enough to satisfy market specifications (i.e. by a maximum of 3 years of age). This requires a whole-of-life average daily gain of at least 0.4 to 0.6 kg per head per day. A project internal research proposal was developed with the title *'Cost-effective feeding strategies for smallholder cattle producers targeting natural pasture-fed beef markets'* and it was implemented by a team of researchers from ARC, Stellenbosch University and the University of Fort Hare. It was focused on the Eastern Cape as the province in which the first value chain was developed.

Baseline surveys of farms in a 50 km radius around Cradock Abattoir showed that most small scale and emerging farmers were older (69% >50 years) men (95%). Natural pasture accounted for most of the available grazing land (74%). Most of the available cattle feed was from natural grasses (49%), followed by crop residue (21%), while trees, planted pastures and legumes each contributed 10% or less. Eighty percent of the natural pasture was in a poor condition. The most common planted pastures in the region were lucerne and maize.

Initial research identified a range of nutritional supplements feasible for use on those farms and chemical and digestibility tests of potential supplements were undertaken. Although not currently grown in the Cradock area, spineless cactus (*Opuntia ficus-indica*) was selected for testing because it is a drought resistant plant high in soluble carbohydrates, calcium, potassium and vitamin A. It was considered to have potential to grow in the study area and be utilised as a source of soluble carbohydrates, mineral and vitamins to supplement cattle on natural pastures. Pads (cladodes) of spineless cactus were collected from Waterkloof Farm, 20 km West of Bloemfontein (450 km from Cradock) in the Free State Province and transported to the ARC-Irene campus where a pen feeding trial was conducted. The *Opuntia* cladodes were cut into strips of approximately 25 mm and dried in direct sunlight on an elevated platform covered with shade net for about six-ten days until a dry matter content of about 700 to 850 g DM/kg was achieved. After that, the *Opuntia* cladode strips

were collected and ground in a hammer mill to pass through a 20 mm sieve, bagged and stored in well-ventilated dry shade prior to feeding.

Animals and their management

Thirty two (32) Nguni steers were sourced from the ARC farm at Loskop, Mpumalanga and divided into four groups of eight animals each so the distribution of age across the four groups was equal. Each group was allocated to one of the following diets: 1) commercial; 2) control; 3) 10% cactus; and 4) 20% cactus. The diets were formulated to be iso-energetic and iso-nitrogenous as shown in Table 3.

Table 3. Feed ingredients (kg) required quantities for half (500 kg) mixer for each diet

Feed ingredients	Formulated diets with different cactus inclusion levels			
	Commercial	Control	10% Cactus	20% Cactus
	Half ton (500 kg)			
Grass hay (*Eragrostis c.*)	62.5	35	10	5
Lucerne	0	40	37.5	40
Maize (milled)	387.5	375	342.5	285
Soy OCM (40% CP)	10	0	10	20
Cladodes (prickly pear)	0	0	64.63	129.27
Molatek feedlot concentrate	50	50	50	50

All steers were adapted for 21 days to their respective supplements prior to the 120-day feeding trial. Each steer was fed in a single pen and had access to fresh water and adlib feed. Animals were allowed out of the pens for about two hours per day when pens were cleaned. All steers were dewormed and dipped once at the beginning of the trial. No anabolic implants were used and antibiotics were only used for treatment of sick animals.

Feed intake was calculated as the difference between feed offered and refused. Animals were weighed and scored for body condition score (BCS) every 14 days. Average daily gain was calculated by dividing each animal's body weight gain by days on-test and feed conversion as the amount of feed consumed divided by the total weight gain. BCS was scored by palpating the live animal and using a 5-point scale (1-very thin and 5-too fat).

Carcass and meat quality analyses

Animals were weighed 24 h before slaughter and transported to the ARC Irene abattoir the afternoon before slaughter. They were slaughtered and dressed following standard commercial procedures including high voltage electrical stimulation. After dressing the warm carcasses were assessed for carcass attributes by certified beef classifiers. After splitting the carcasses, *M. longissimus thoracis et lumborum* (LTL) temperature and pH were recorded at 45 min at the 11th rib of the right side. Following the overnight chill (2°C), at approximately 24 h post-mortem, muscle final pH, side weight and temperature measurements were recorded. Rib-eye muscle area was measured by tracing the LTL eye muscle area between the 10th and 11th thoracic vertebrae. The surface area of the eye muscle was determined by video image analysis. The LTL of the left and right side of each animal was sampled from the 11th rib in the direction of the rump and sampled for quality analyses.

Meat samples were analysed using standardised procedures to determine shelf life over 7 days (2, 4, 7 days) and an additional steak was vacuum packed and stored for 14 days. Three meat colour measurements per steak were made with a Minolta colour meter on each of the three days. The three fundamental outputs were L*, a* and b*. L* is lightness on a scale of 0 (all light absorbed) to 100 (all light reflected); a* spans from +60 (red) to -60 (green) and b* spans from +60 (yellow) to -60 (blue). Hue angle, defined as tan-1 (b/a), describes the fundamental colour of a substance and chroma, the square root of a*2+b*2, the vividness.

On the same days the weight of the steaks were recorded to determine drip loss. On day 14 the fourth steak was removed from the vacuum bag, dried and weighed and then exposed to atmospheric oxygen for 60 minutes at chiller temperatures, after which three objective colour measurements were determined as described previously. Drip loss was calculated as the difference between the initial and final weight of the sample, expressed as a percentage of the initial weight.

Proximate analyses, fatty acid profiles and retail stability were also determined using scientifically proven methods.

Four steaks of 30 mm thickness were used for sensory analyses, Warner-Bratzler Shear Force (WBSF) and percentage cooking loss.

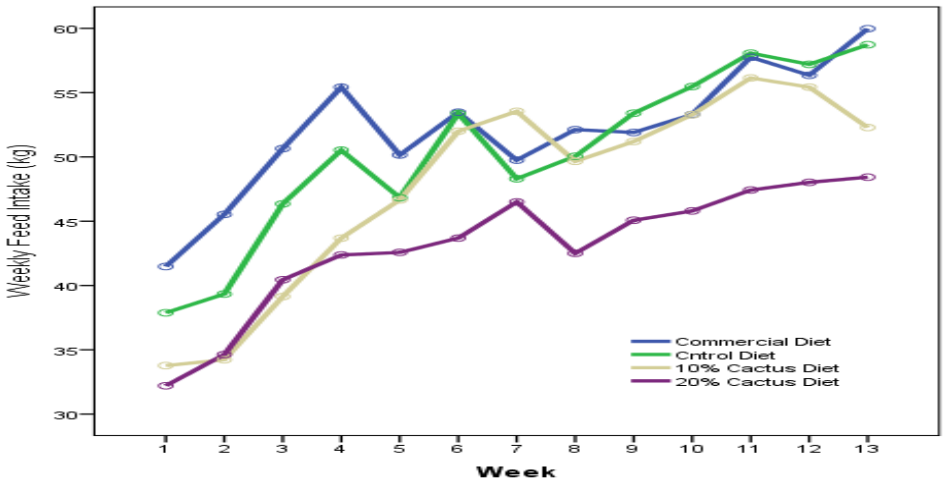
Economic analyses

Gross margin analysis was used to determine the economics of feeding the three test diets. The gross margin was obtained by subtracting the total variable costs associated with each diet from gross income. Total variable costs for each diet were calculated as costs directly related to animal production, including items such as labor, fuel, transport and feed. Gross income for each diet was calculated as the total estimated income earned from selling the carcasses, offals and hides.

Results

There was a significant effect of time (weeks) on feed intake for all diets. Cattle fed commercial, control and 10% cactus diets had higher feed intakes than 20% cactus diet (Figure 1). The difference in weekly intake between the commercial diet and two cactus diet groups was ~10 kg at the start of the trial. After 12 weeks on feed, the 10% cactus group recorded similar intake levels as the commercial and control diet groups (~55 kg/animal/week), while the 20% cactus group consumed ~47 kg/animal/week.

Figure 1. Feed intakes of Nguni cattle fed commercial, control, 10% cactus and 20% cactus diets

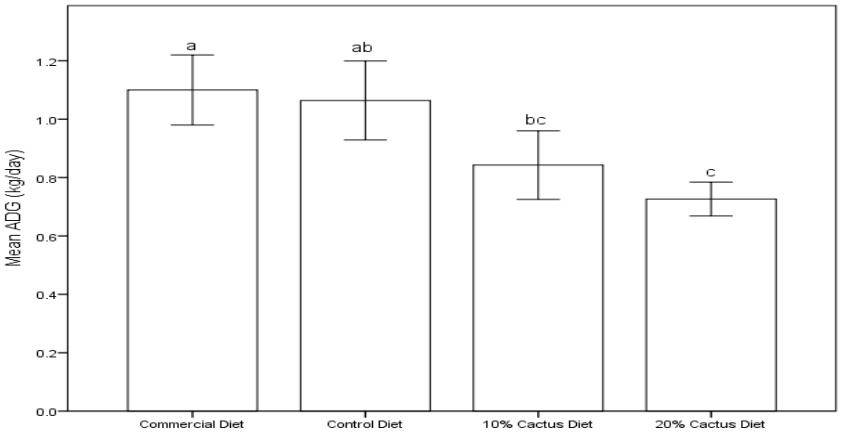


Body condition scores of all animals improved significantly over time (weeks). Despite differences in feed intake and average daily gain between the cactus supplemented groups and the commercial and control diet groups, there were only small differences in BCS among the groups.

Animals fed the commercial diet had significantly higher average daily gain (kg/day) than those on 10% and 20% cactus inclusion diets (Figure 2). There were no significant differences on ADG between 10% and 20% cactus inclusion although the numerical difference between the two groups was ~0.1 kg per day. Despite a similar feed intake among the commercial, control and 10% cactus feed groups towards the end of the trial, the 10% cactus group gained less weight per day *cf.* the other two groups. This was

probably due to the lower feed intake during the first 4-5 weeks, suggesting this group adjusted slowly to the cactus but eventually consumed almost the same amount of food as the commercial and control groups (apart from the last week). The poorer performance of the 20% cactus group was due to lower feed intake for the duration of the growth phase.

Figure 2. Average daily gain of Nguni cattle fed commercial, control, 10% cactus and 20% cactus diets



Animals in the commercial and control diet groups were heavier at slaughter and had heavier carcasses than animals in the cactus groups, reflecting differences in feed intake and ADG among the groups. No significant differences in live and carcass weights were recorded between the two cactus groups.

Table 4. Slaughter and carcass weights.

	10% cactus	20% cactus	Commercial	Control	SEM	P Value
Slaughter weight (kg)	253a	247a	280b	277b	3.56	0.051
Carcass weight (kg)	139a	136a	154b	153b	2.58	0.049

Means with different letters differ significantly

Cost effectiveness

Ration 3 (10% cactus) and 4 (20% cactus) had a higher cost per kg weight gained (Figure 3), than rations 1 and 2 even when the cladodes were costed at 0 Rand. The inclusion of spineless prickly pear cladodes in feeding rations compromised weight gain *cf.* rations with no cladodes (i.e. commercial and control diets).

Weight gain was the same for ration 1 (commercial) and ration 2 (control), but the cost per kg gain was slightly lower for ration 2, indicating that lucerne (ration 2) could be used as an alternative to soy oil cake meal (OCM) in rations for finishing cattle.

When considering the use of cladodes as a drought feed, the prices for other commodities must be considered to calculate economic viability. Commodity prices in the 2015-2016 drought were therefore used to determine the cost-effectiveness of cladodes as a drought feed, with cladodes costs at R 600 per ton. Under that scenario the cost for gain for the 20 % cladode treatment (Ration 4) was the same as for Ration 1 (commercial) even though the cost per kg feed was less (Figure 4). What needs to be further considered is the cost of lucerne as higher lucerne prices will increase the cost of gain for rations 3 and 4.

Figure 3. Feed costs per kg gain for the treatments

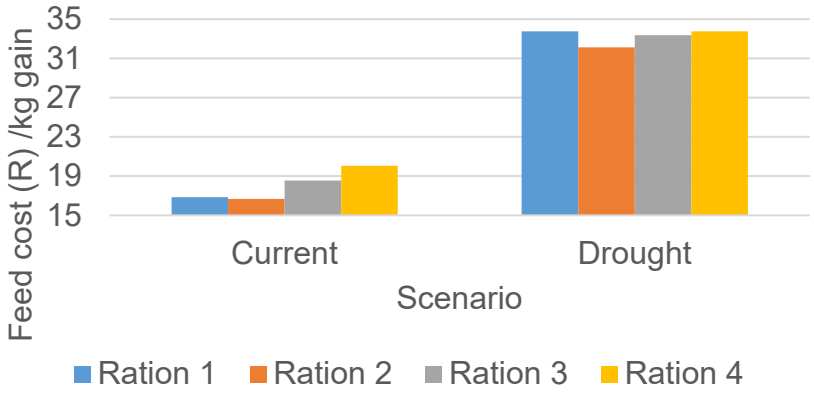
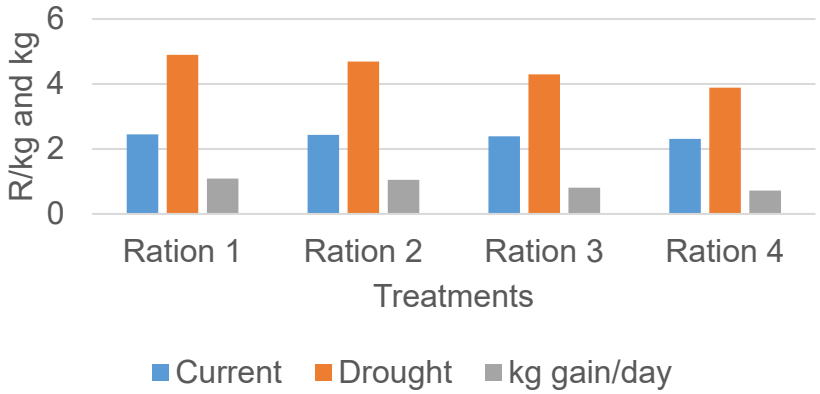


Figure 4. Feed costs per kg and average kg weight gain per day for the treatments



The price of feedstuffs on-farm will greatly influence the cost of weight gain. If the cost of cladodes during drought is close to zero (harvested on-farm), the use of cladodes during times of drought is justified on a cost per kg gain basis. Animals on those diets did gain weight and the use of air dried chopped cladodes should be considered during times of drought or restricted feed availability. Similar weight gains for cattle fed rations 1 and 2 with a lower cost for ration 2 may indicate that Nguni type cattle perform better with higher roughage content in their diets.

Meat sensory characteristics (tenderness, juiciness, flavour and aroma) were very acceptable for all groups with no differences were found among dietary treatments. No off-flavours were recorded by the taste panel for any diet treatment. The shelf life study showed that Ca20 colour deteriorated slightly at 7 days on display but chroma levels above 20 suggested the samples were still acceptable in colour. Discolouration of vacuum aged samples (14 days) were higher in commercial and control samples *cf.* 20% cactus samples, although Chroma values showed that all samples were still acceptable.

Innovation systems and processes required to achieve behaviour change

The aim of the behavioural change component was to understand whether particular types of interventions and training approaches work better for different segments of farmers, based on their responses to a behaviour change survey. The behavioural assessments are correlated with indicators of individual farm business performance to develop farmer psychological profiles which the project hypothesised will enable farmers to be grouped into farmer groups (for example, ‘entrepreneurs’, ‘average farmers’ and ‘traditional or non-commercial farmers’, with training approaches specifically targeted to the different groups e.g. challenge and mentor the ‘entrepreneurs’, group-based learning and peer support for ‘average farmers’ and peer pressure and withdraw support for ‘traditional farmers’).

A psychological profile survey tool was designed and tested across provinces in 2015

amongst beef and poultry farmers and then modified as required to ensure the questions were not misunderstood by the farmers. Fifteen survey enumerators were trained to administer the Behaviour Change baseline survey. By September 2017, about 700 surveys had been completed across the beef and poultry value chains, with 452 beef surveys used in preliminary data analyses to develop different measures of each surveyed farmer, namely: i) the technical efficiency of his/her farm business performance; and ii) a composite index of 11 psychological variables derived from the behaviour change survey.

A South African postgraduate student based at UNE is now estimating the relationships between farmers' technical efficiency and psychological attributes. The research will continue into Stage 2 to develop customised interventions that improve the uptake by farmers of interventions and improve their farm business performance. The behaviour change survey will also be repeated in 2020/2021 to determine whether farmers' profiles and business performance have changed due to the project's interventions.

Results based on the initial 452 beef surveys are presented below.

Farm business performance indicators

Farm-household level surveys were conducted in seven provinces of South Africa to elicit information regarding farm and farming profiles and understand farm business with respect to benefits to farmers, their families and their local communities; any concerns about business and the environment in which it operates; and understand farmers' preferences in order to develop strategies to make it easier for farmers to improve the profitability of their businesses.

This report comprises: i) basic demographic characteristics of selected farmers and identification of issues and areas for improvements in terms of data collection, research design and future analysis; and ii) an analysis of key indicators of performance including productivity and efficiency of cattle production. These key indicators are defined as:

- *Productivity* is measured as partial productivity measures (hereafter, referred to simply as productivity), which provides a similar measure as long as all farmers have access to the same production technologies and there are no scale economies. Examples of productivity indicators are number of calves/year and number of cattle sold/household.
- *Technical efficiency* - a farm is technically efficient when it achieves the maximum possible output for a given set of inputs used in production. A technically inefficient farm can increase output without requiring any more inputs (i.e. the value of the inputs is not being maximised). Technical efficiency shows the capacity of farmers to reach the maximum attainable output.

Data

Data were collected using the ACIAR Behaviour Change Baseline Survey questionnaire, with 452 beef farmer respondents (58 farmers in Eastern Cape; 111 from Limpopo; 18 from Free State; 104 from Mpumalanga; 71 from North West; 52 from Gauteng and; 38 from Northern Cape).

The distribution of respondents according to different categories of farming systems are summarised in Table 5.

Table 5. Distribution of respondents according to main farming system.

Farming system	Number	% of respondents
Crops	8	1.8
Livestock	359	79.4
Mixed	76	16.8
Unspecified	9	2
Total	**452**	**100**

Preliminary results - demographics

The analysis involves the use of descriptive and inferential statistics. An attempt was made to estimate regression-based models to establish and determine some factors affecting the decision of farmers. The succeeding preliminary analyses are based on the sample using the 238 cattle producers only.

Of the 238 cattle producers, 90% were selling their livestock and the rest (10%) were not selling. Most of those who were selling were located in Limpopo (44), Mpumalanga (39), North West (35) and Northern Cape (35).

Of the 215 cattle producers selling their livestock, 74% were males and 26% were females, whereas those who were not selling (23 cattle producers) consisted of 87% males and 13% females. Notably, the respondents as a whole were relatively old, with an average age of 52.08 years (SD=14.808). The results suggest there is an opportunity to increase women's participation in selling cattle. Key output and production indicators are in Table 6.

Table 6. Key output and production indicators of the 238 specialist cattle producers.

Indicators	Don't sell (n=23)		Sell cattle (n = 215)		Total cattle producers (n = 238)	
	Mean	St.Dev	Mean	St.Dev	Mean	St.Dev
No. of cattle owned	14.9	11.77	48.9	77.04	45.7	73.99
No. of calves	2.7	1.89	14.1	25.7	13	24.66
No. of deaths	2.1	2.11	3.6	5.31	3.5	5.11
No. of sales	0	0	10	25.61	8.9	24.47
No. of purchases	0.9	0.29	0.9	0.18	0.9	0.19
Farm size	4.9	2.08	4.1	2.52	4.18	2.49
Labour	1	0.86	1.02	0.65	1.02	0.67
Total costs (ZAR)	1453.91	2166.41	18184.91	45386.18	16568.05	43416.3

On average, the total number of cattle owned is 46 head per farmer. As expected, the herd size is lower for those who do not sell cattle (15 head/farmer). However, there are significant numbers of farmers who kept their stock for consumption and other purposes such as wealth/asset holding, which implies an opportunity to encourage these farmers to be more market-orientated, while those who are already selling should be primarily targeted for business improvement.

Table 7. Number of cattle and farm sizes of all the farmers surveyed

Without own land	Do not sell	Sell	All
Ave. number of cattle owned/farmer	16.40	18.89	18.58
Ave. farm size (in hectare/farmer)	0	0	0
With land			
Ave. number of cattle owned (head/farmer)	14.33	54.68	51.02
Ave. farm size (in hectare/farmer)	694.33	484.12	503.33
All farms			
Ave. number of cattle owned/farmer	14.78	48.86	45.56
Ave. farm size (in hectare)	543.39	404.94	418.38

Table 8. Number of cattle and farm sizes of just the specialist beef farmers surveyed

Without own land	Do not sell	Sell	All
Ave. number of cattle owned per farmer	16.40	18.89	18.58
Ave. farm size (in hectare)	0.00	0.00	0.00
With land			
Ave. number of cattle owned per farmer	14.38	55.20	51.41
Ave. farm size (in hectare)	419.77	418.35	418.49
All farms			
Ave. number of cattle owned per farmer	14.94	47.36	44.12
Ave. farm size (in hectare)	303.17	327.97	325.49

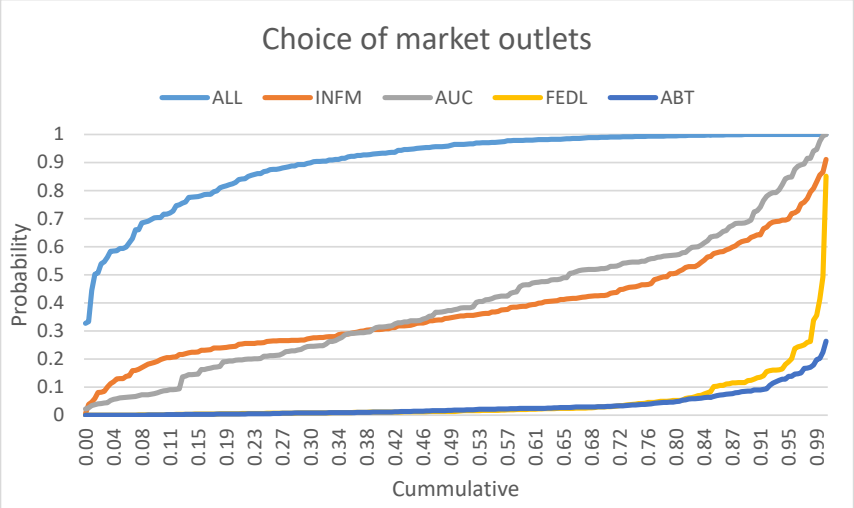
On an annual basis, there is a significant difference in the calving rates between the two groups, but the mortality rate is almost similar. Cattle farmers selling their livestock were investing on average R18 148.91 and this level of investment was higher compared to those who don't sell (1453.91).

Factors affecting the decisions of farmers whether to sell or not to sell cattle are influenced by a number of farm and farmer characteristics. More than 70% of farmers have a very high probability to sell their cattle. Of the farmers selling cattle, the distribution of choices of different market outlets shown in Table 9.

Table 9. Distribution of farmers according to market outlets.

Market outlet	Number of farmers	% of farmers
Informal	74	34.4
Auction	88	40.9
Feedlot	11	5.1
Abattoir	8	3.7
Other	4	1.9
Unspecified	30	14
Total	215	100

Figure 5. Cumulative distribution of probabilities of selling in different market outlets.



As expected, most farmers have a high probability of selling to informal markets and auctions. These market outlets are easily accessible with less requirements compared to feedlots and abattoirs. The results indicate the majority of sampled respondents lack market access to the mainstream value chain of South Africa's beef industry.

Preliminary results – businesses performance indicators

The concept of technical efficiency was used as an indicator of business performance. Technical efficiency indices are calculated by estimating what is called a stochastic frontier production function. A production function expresses farm output as a function of the inputs used to produce that output. The production frontier function used in this study can be considered as an envelope around the relations between all inputs and outputs in beef production after allowing for random events (hence the inclusion of the term, stochastic). We can describe the producers on the production frontier as following best practice in a technical sense.

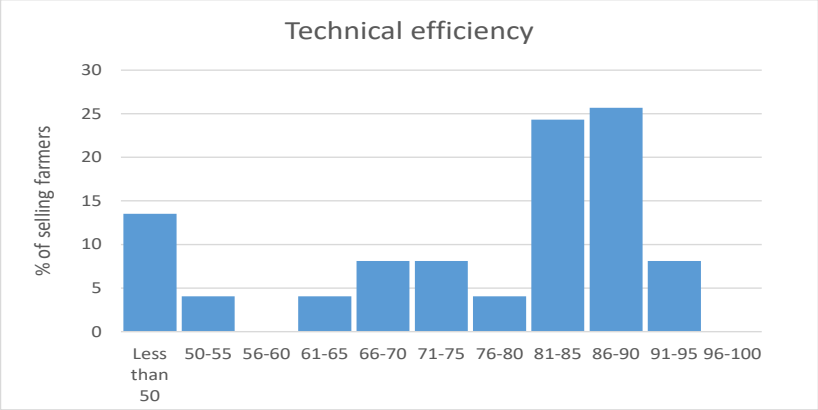
In the technical sense, output is defined as a total output produced per annum per household. Different indicators of output have been used in these analyses: i) total livestock units net of purchases and trading; and ii) total number of cattle sold. For the purpose of this preliminary analysis, the total number of cattle sold per household was used as the output indicator. Inputs in cattle production were aggregated into the following categories: farm size (as an indicator of effective grazing area); labour inputs; stocks measured in LSU (2 year old cattle=1.000 LSU); and total costs (comprising feed and animal health costs). One of the limitations of this definition of variables is the lack of consideration about the quality of the cattle.

For these analyses, it was assumed that all farmers have access to the same set of production technologies (although they do not all make the same use of them). Satisfactory estimates were made of the stochastic frontier production functions of farmers in each benchmarking group, enabling calculation of technical efficiency indices for each individual farm in each year. The model includes variables that also explain inefficiency. In this case, six variables associated with the perceptions of farmers to indicate some behavioural aspects were initially included. These are:

- ‘I complete projects on time by making steady progress’;
- ‘I make lists of things to do’;
- ‘I keep working at difficult uninteresting task if it will get me ahead’;
- ‘I am able to resist temptations when I know there is work to be done’;
- ‘I do things impulsively, making decisions on the spur of the moment’;
- ‘I believe that getting together with friends to party is one of life’s important pleasures’.

Among the main factors of production, labour, LSU and production cost were found to significantly affect the output at 5% level. A 1% increase in LSU is expected to increase the number of cattle sold by 0.90%, while if farmers increase investment on supplementary feeding and animal health this results in an increase of 0.36% in the number of cattle sold. Results showed that technical inefficiency was found to be present among the sampled farmers, with 95% of the variability in the number of cattle sold able to be attributed to the level of inefficiency.

Figure 6. Distribution of estimated technical efficiency scores.



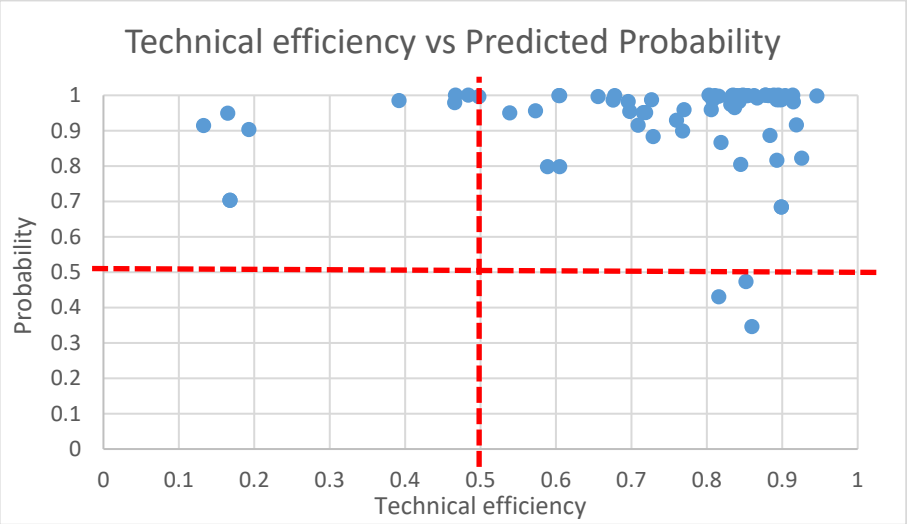
Mean technical efficiency was 0.736 i.e. the technical performance of the average farmers (in terms of their ability to turn inputs into output) was about 74. This implies that farmers can still improve input usage by approximately 26% without reducing the output. The results showed a wide variation of scores, with almost 14% of farmers obtaining a score below 50%, but unfortunately there were no fully efficient farmers in the whole sample.

These results have the following implications:

- there is a strong potential to increase the number of cattle sold with the existing resources and technology;
- there is wide variation in the scores among farmers. There is an opportunity to target and provide intervention to non-performing farmers in order to catch-up and also to all farmers in order to reach the maximum attainable target output;
- all farmers have been assumed to be faced with the same production technology, with no account given to the intervention in production and in marketing in the model; and
- there is still a need to undertake a rigorous analysis of the behavioural variables affecting farm business performances.

Given the high variability of efficiency scores, the correlation between the technical efficiency scores and predicted probability of selling was examined. It should be noted that these were only analysed using the scores for those who actually sell. The correlation between these two indicators are shown in Figure 7. The horizontal axis is the estimated technical efficiency scores (TEs) and the vertical axis shows the probability of selling. The distribution of these scores are divided into four quadrants.

Figure 7. Correlation between technical efficiency scores and probability of selling.



As expected, most farmers were located in the 3rd quadrant (high probability and high TE). No farmers were found in the first quadrant, with low probability and low efficiency scores. In-depth analysis and understanding of the farmers in the 2nd and 4th quadrants is required. Intervention strategies both to encourage farmers to sell and to increase the number of cattle sold is a fundamental approach to improve the overall performance of farmers.

<u>Areas for further analysis and research</u>

- It is important to calibrate the empirical model specification to account for the variation in output among farmers.
- Include variables to account for the categories of farmers according to the type of business characteristics (traditional, entrepreneurial and commercial), psychological profile and other contextual and environmental variables. A more comprehensive analysis of the relationship between farm business performance and behavioural factors will be conducted in Stage 2 of the project. It will include indices to account for farmers' expected benefits, concerns and perceived barriers, farmer'' self-efficacy and ability and farmers' attitudes and beliefs.

- More information is needed to determine factors affecting market choices.
- Only a very basic list of variables was used to account for variability of efficiency scores. However, there are numerous psychological variables that are already available but will require more extensive statistical and data mining activities. One possible approach is the use of principal component analysis. The aim of the principal components analysis of factors influencing technical efficiency in cattle production has been to ascertain why one farm has a higher level of technical efficiency or productivity than another farm.
- Analyse the relative performance of cattle farmers against different enterprises.
- The need to re-visit data collection procedures, completeness of variables and information and consistency of measures among enumerators.

Objective 3: Develop, evaluate and implement decision-support tools to recommend the most appropriate and profitable beef production systems for South African small-scale and emerging farmers.

Objective 3 aimed to develop, evaluate and implement new decision support tools designed to estimate grazing capacity, stocking rates and alternative production systems that maximise the profitability and sustainability of small-scale and emerging farmers in South Africa. The tool is designed to assist small-scale and emerging farmers to best manage grazing capacity and stocking rates and to evaluate different production systems to maximise the profitability and sustainability of their beef businesses. The difference between the grazing capacity of the veld and the stocking rate is that grazing capacity refers to the true number of animals that the vegetation can sustain, whereas stocking rate is the perceived number of animals that the vegetation can sustain.

Development of the decision-support tools required several research steps, all of which were completed and most of which have now been published in the scientific literature and conference proceedings (see list of project publications at the end of this report).

The initial step was to develop regression equations for different frame sizes for lactating cows, bulls, heifers, weaners and steers. Equations could not be calculated for pregnant and dry cows and replacement heifers as the original study (Meissner *et al.*, 1983) did not develop tables in which Large Stock Units (LSUs) were linked to the weights of females for those physiological stages. Modelling was therefore undertaken to develop new equations and fit them into the decision-support tool.

A grazing capacity map based on satellite imagery and net primary production (Meissner *et al*., 2013) was available for southern Africa. Grazing capacity was predicted according to the standard LSU definition (Meissner, 1982), which in dry matter (DM) intake terms equates to about 9 kg/head/day. To calculate the new grazing capacity norms, it was assumed that provision should be made for vegetation material which is available but not consumed because of dietary preferences and other reasons. Therefore the DM intake estimate was escalated to 11.25 kg/head/day. Using standard GIS procedures, grazing capacity maps are available at provincial, district or local municipality level and these were used to develop grazing capacity assessments at the regional level.

The total herd LSU was subsequently linked with the grazing capacity of the rangeland through development of a computerised simulation model which is being made available to the beef industry and extension officers to assist them in estimating the carrying capacity of farms. The practical usefulness of the program continues to be evaluated by testing it under different scenarios and applying it in practical situations such as using it in the development of business plans for land restitution projects.

By way of example, the following section describes an application of the simulation program to estimate grazing capacity and stocking rates based on cattle breeds of different LSUs and to recommend the most profitable production systems. Input values example are summarised in Tables 10 and 11 and are assumed to be the equivalent of best-practice production rather than being representative of either commercial or smallholder beef

production systems in South Africa. Table 12 shows estimated gross annual income of the different breeds under different best practice production systems. Applications of the model can be readily customised for other input values.

Table 10. Input production values

Traits	Afrikaner	Bonsmara	Nguni
Cow weight	460 kg	500 kg	375 kg
Weaning weight	207 kg	220 kg	160 kg
Weaning rate	78%	80%	85%
Weight at 2 years	420 kg	435 kg	340 kg

Table 11. Input price values used for A and C market grades and years (2016 and 2017)

Breed / Price	2016			2017		
Price (ZAR)	Weaner	A2/A3	C2/C3	Weaner	A2/A3	C2/C3
Afrikaner	R18-00	R38-20	R28-50	R28-00	R48-40	R37-50
Bonsmara	R20-00			R33-00		
Nguni	R16-00			R19-00		

Table 12. Estimated annual gross income (ZAR) from different cattle production systems

Breed	Production system	2016	2017
Afrikaner	Weaner	R 360 644	R 535 871
	Ox	R 430 687 (+19.4%)	R 552 829 (+3.2%)
Bonsmara	Weaner	R 402 750	R 628 561
	Ox	R 427 243 (+6.1%)	R 544 796 (-13.3%)
Nguni	Weaner	R 301 060	R 369 288
	Ox	R 381 151 (+26.6%	R 485 653 (+31.5%)

Even though this example is not based on representative production figures for smallholder farmer herds in South Africa, it is interesting to note the considerable advantage over both years for the ox production system (slaughter up to 3 years of age) in the Nguni breed, which is a common breed used by many smallholder farmers. Since input costs are not factored into this comparison, breed comparisons should be avoided.

Objective 4: Measure, monitor and evaluate the ongoing performance of the project and its components.

The summary table in Section 6 of this report records several monitoring and evaluation activities against Objective 4, most of which are adequately summarised in the table. Hence the only detailed report for this objective describes the evaluation of the value chains.

This component of the research aimed to further develop and apply the Value Addition Information Management System (VAIMS). VAIMS is a tool for the quantitative measurement of livestock value chain performance and the identification and analysis of improvement scenarios (Baker *et al.* 2009). The tool was specifically designed to analyse the role of livestock in smallholder farm and food systems. Structured questionnaires were developed specifically for this project to allow trained enumerators to interview project value chain respondents individually. The questionnaire focuses on production practices and aims to identify the sustainability of production as well as the performance within the different value chains.

The initial VAIMS survey collection and data analysis has been completed for the Eastern Cape and results were presented at an international conference in July 2017. However because Cavalier Meats only formally commenced its commercial operations in March 2017, VAIMS survey collections were delayed for the five provinces around Cavalier Meats until mid-2017. Data collection in those provinces will continue into Stage 2 of the project. The survey will be repeated in 2020/2021, to allow an assessment of changes that have been made in value chain performance over the duration of the project and whether they can be attributed to the project's direct interventions.

This report therefore provides an extract of the key results only from the initial survey in Eastern Cape. To evaluate the project's Eastern Cape-based value chain, the first step was to establish a baseline of the initial performance of the emerging cattle farmers in that province in terms of operational and marketing dynamics (i.e. land utilised, type of cattle kept, herd composition, livestock purchases and sales, calving rate, off-take-rate, marketing channels utilised, cost of production, infrastructure available and risks and constraints). This baseline characterises current practices in a representative sample of the informal beef sector and identifies gaps in terms of linking those farmers to mainstream supply chains. The latter will inform adequate interventions for commercialisation of the informal beef sector during Stage 2 of the project.

Eastern Cape Province (EC) is one of the poorest provinces in South Africa with unemployment close to 30% and 63% of the population living in poverty (StatsSA, 2016). Due to its frequent droughts and erratic rainfalls, a large proportion of the EC rural population depends on livestock production for their livelihoods (Musemwa *et al.* 2007; 2008). Although primary agriculture only contributes 1.5% to the province's economy, it provided employment to almost 90,000 people in 2015 (IHS Global Insight, 2017).

Structured questionnaires were used to interview respondents individually. The questionnaire focuses on production practices and aims to identify the sustainability of production as well as the performance within the value chain. Considering the importance of the first step in a value chain analysis process (the mapping of the value chain), this step was prioritised to provide a better understanding of how the product, information and money flows between the different segments of the chain as well as how the inter-linkages between the different segments function. By mapping the chain, the relative importance of the different segments of the chain are identified. This helps identify the starting point for the next step, namely the quantification of the value chain.

The questionnaires used in this study sourced data from producers, traders, processors and retailers and included demographic and general business information and information on livestock operations, purchases, sales and costs of production.

General household information

This section provides an overview of the demographics of the respondents interviewed and provides a broad description of the producer dynamics in Eastern Cape. Most of the respondents' main source of income was from farming activities (90 %), the average age of producers interviewed was 56 years, producers received an average of 8 years of schooling and had been living in their respective regions for an average of 31 years, of which 23 years had been spent actively farming. Most respondents (47 %) indicated they have at least some kind of training in farming activities.

Table 13 provides detail on the portion of income generated from various agricultural practices during the survey production year (2016), the year prior to the survey production year (2015) and five years prior to the survey production year (2012). This was done to determine whether there has been a shift in the major income-generating activities over time and to indicate whether livestock activities have been increasing or decreasing over time. From that table, it is evident that the main contributor towards respondents' income during the past five years has been from livestock operations (81 % in 2016), followed by crop production (11.9 % in 2016). There has been no significant change in the income-generating activities since 2012.

Table 13. Income distribution from various activities for the research area (%)

Activity	2016	2015	2012
Livestock production	81.1	57.5	37.6
Crop production	11.9	10.5	8.0
Off-farm employment	2.5	1.4	1.9
Own business (non-farm)	4.5	3.3	3.1
Other	0.0	27.0	50.6
Total	100	2.9	3.01

To determine whether there were geographical differences within the province, the province was sub-divided into four municipal districts included in the survey area. Those districts comprise Amathole (AH), Chris Hani (CH), Joe Gqabi (JG) and Sarah Baartman (SB) municipalities. Although 81.1 % of income generated in the EC province was from livestock activities during 2016, there were some clear differences in the various districts of the province. From Table 14, all the districts averaged above 70% for income derived from livestock production.

Table 14. Income distribution from various activities for districts of the EC for 2016 (%)

Activity	AH	CH	JG	SB
Number of respondents	45	29	30	23
Livestock production	75.8	93.6	87.3	71.3
Crop production	8.3	28.3	2.5	8.7
Off-farm employment	2.2	0.0	0.0	11.4
Own business (non-farm)	4.7	8.3	0.0	5.3

Table 15 shows the variability in farm size for the EC province as well as regional comparisons in farm sizes. For the EC province as a whole, farm sizes varied between a minimum of 0.5 ha to a maximum of 2,300 ha. For all districts, mostly family owned land and communal land is utilised for animal production. Land ownership is mainly in the form of family owned land as well as communal land.

Table 15. Farm size for the EC province

Eastern Cape	Size (ha)			
Land Available	**Min**	**Ave**	**Max**	**Median**
EC ave	0.5	733	2300	557
AH	0.5	503	2300	372
CH	104	1049	1652	1165
JG	199	999	1900	1080
SB	15	421	930	461
	%			
Land ownership	**AH**	**CH**	**JG**	**SB**
Family owned	**36.4**	**34.5**	**11.5**	**22.7**
Rent in (no payment)	6.8	13.8	0	18.2
Rent out (payment)	3.3	3.4	3.8	9.1
Rent in (payment)	4.5	0	15.4	9.1
Freehold title	11.3	0	15.4	13.6
Communal land	**34.1**	**48.3**	**53.8**	**27.3**
Other	4.5	0	0	0

Employment numbers and monthly remuneration figures for full-time and part-time employees are shown in Table 16. On average, respondents employ 1.3 full-time male and 0.2 full-time female employees at an average monthly cost of R 1 533 and R 1 327 respectively. Part-time employees are usually appointed on a daily or monthly basis and average remuneration is R 964 and R 880 for male and female employees respectively.

Table 16. Employment and remuneration for the EC province

Number	**Min**	**Ave**	**Max**
Full-time employees			
Male	1	1.3	7
Female	0	0.2	4
Part-time employees			
Male	0	1	10
Female	0	0.3	16
Average remuneration R/month			
Full-time employees			
Male	500	1533	5333
Female	400	1327	2600
Part-time employees			
Male	50	964	2500
Female	500	880	1000

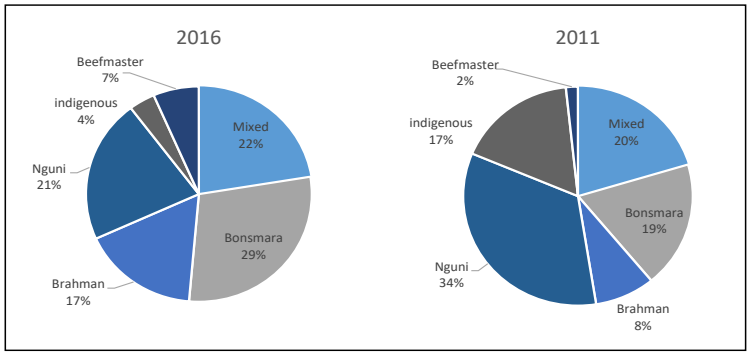
There is little variation in terms of regional employment numbers, compared to the average for the province (Table 17).

Table 17. Average full-time employment and remuneration for EC provincial districts

	AH	**CH**	**JG**	**SB**
Number				
Male	1.4	1.3	0.5	1.3
Female	0.3	0.2	0.03	1.2
Remuneration R/month				
Male	1517	1533	1397	1792
Female	1317	1327	1230	1040

Cattle breeds used by the farmers indicate that in 2016, the Bonsmara (29 %) was the most popular, followed by mixed breed cattle (22 %), the Nguni (21%) and the Brahman (17%). During 2011 the most prevalent breed was the Nguni (34%), mixed breed cattle (20%) and Bonsmara (19%). It is clear that producers in the EC have moved from the indigenous and Nguni cattle to the more popular commercial breeds.

Figure 8. Cattle breeds utilised 2011 and 2016 production seasons



Livestock operations

This section shows the herd dynamics in terms of average animal numbers for the 2016 production season (Table 18). Adult females comprised 48 % of the total cattle herd, while young female animals represented 18 % of the herd. The total representation of breeding females (younger female animals used for breeding purposes and adults) in the cattle herd was 66 %. Calves accounted for only 17 % of the total herd. If the calving rate for the EC is estimated based on the number of adult female animals, the average is 35%. Depending on the source (sources vary due to the lack of reliable or accurate information), the national calving percentage, defined as the number of calves born per active adult female animal, for the commercial sector ranges from 55% to 65%. Some sources indicate levels as low as 45% and as high as 80% in some cases.

Table 18. Herd dynamics for the Eastern Cape (*ratio of young and adult females)

Stock: 2016 production season	Animal numbers (head)	Percentage of total
Adult female	32.8	48
Young female	12.2	18
Young males	5.8	8
Breeding bulls	1.4	2
Calves born in the last 12 months	11.5	17
Castrated males	4.6	7
TOTAL	**69.1**	**100**
Calving percentage	35.1	
Replacement rate* (%)	37.2	

There are also regional variations in the province in terms of production efficiency (expressed as calving percentage). The most productive regions are the CH and SB districts with calving rates of 55.7% and 49.7% and off-take rates of 19% and 22% respectively. The JG district had the poorest calving percentage of 16.5%.

Off-take rate for cattle is a good measure of production efficiency. It is defined as the number of animals marketed as a percentage of the total herd. Jooste (2006) estimated the national off-take rate to be between 23% and 25% while Scholtz and Bester (2009) estimated the South African commercial beef off-take rate at 32%, which is higher than the estimated national average of 25% (RMRDT, 2008). Spies (2011) estimated the commercial off-take rate for the Free State province at 33%. This off-take rate compares well to countries like Australia (28%), New Zealand (37%), the EU (34%), the US (38%) and South America, including Argentina, Brazil, Paraguay, and Uruguay (20%; Scholtz and Bester 2009).

Table 19. Herd dynamics for the different districts in the EC

	Average animal numbers (head)				
Stock 2016 production season	**AH**	**CH**	**JG**	**SB**	**EC ave**
Adult female	38.2	25.9	20.4	39.7	32.8
Young female	14.4	11.2	9.1	12.2	12.2
Young males	6.9	4.7	4.4	6.0	5.8
Breeding bulls	1.6	1.4	0.8	1.9	1.4
Calves born in the last 12 months	10.4	14.4	3.4	19.7	11.5
Castrated males	5.0	5.0	4.0	4.5	4.6
TOTAL	**77.9**	**62.7**	**42.1**	**84.1**	**69.1**
Calving percentage	27.2	55.7	16.5	49.7	35.9
Off-take rate	12	19.1	7.4	22	14.9

Livestock purchases and sales

Table 20 indicates the average cattle purchases, animal sales, home consumption, animal losses as well as purchase and sales prices for the 2016 production season. Animal sales exceeded animal purchases by a large extent. Total cattle purchases averaged 2.7 head (4%) compared to average sales of 10.3 head (14.9%). The largest contributor towards animal sales was adult females (2.9 head) followed by weaner calves (2.6 head) and young males (2.4 head).

Home consumption levels of cattle are relatively low at an average of 0.3 animals per annum. Cattle losses are relatively high (3.1 animals per annum or 4% of the total herd). Main reasons for these losses were identified by the producers as diseases brought about by drought conditions. It should be emphasised that the 2016 production season had below average rainfalls for most of the country.

Table 20. Average animal purchases/sales, home consumption and losses during 2016

Type	Animals purchased (head)	Animals sold (head)	Consumed at home (head)	Animals died (head)
Adult female	1.4	2.9	0.1	1.9
Young female	0.6	0.9	0.1	0.5
Young males	0.1	2.4	0.02	0.1
Breeding bulls	0.2	0.1	0.02	0.03
Calves born in the last 12 months	0.3	2.6	0.04	0.4
Castrated males	0.1	1.5	0.1	0.1
TOTAL	**2.7**	**10.3**	**0.3**	**3.1**

Table 21. Average animal sales during 2016 per district

Animals sold in the past 12 months	AH	CH	JQ	SB	EC
Adult female	4.1	2.3	0.9	3.7	2.9
Young female	0.4	2.4	0.8	0.4	0.9
Young males	1.9	3.3	0.9	3.7	2.4
Breeding bulls	0.1	0.1	0.0	0.1	0.1
Calves born in the last 12 months	1.7	2.0	0.0	8.7	2.6
Castrated males	1.3	1.9	0.5	2.0	1.5
TOTAL	**9.4**	**12.0**	**3.1**	**18.5**	**10.3**

Livestock purchases mainly took place during the middle of the year (June/July) and again in December. Similarly, the most important months for sales were June and December. Purchases were mainly made from other smallholder producers, commercial producers (at farm gate) and at local auctions. All payments were in the form of spot cash payments. Respondents indicated that the main reason for purchases was to increase their herd sizes. The main reason for sales was listed as business income and to cover household expenses. Only 8% and 18% of respondents indicated they make use of a broker or middleman when purchasing and selling animals respectively. Average purchase prices exceeded selling prices in the case of female animals and breeding bulls, implying that when producers purchase animals for breeding purposes, a premium above slaughtering price is paid. This is mainly because producers purchase genetically superior animals at a higher price to improve the genetic ability/base of their own herds.

Table 22. Live cattle purchase and sales prices and average purchase and sales weights

Live animals	Price/animal		Average weight		Price/kg	
	Purchase	Sales	Purchases	Sales	Purchases	Sales
Adult female	7100	5286	413	427	17.19	12.38
Young female	5023	4783	319	305	15.75	15.68
Young males	4500	4688			Nil	Nil
Breeding bulls	23353	8000	518	480	45.08	16.67
Calves born in the last 12 months	3000	4260	251	200	11.95	21.30
Castrated males	4875	6076	349	543	13.97	11.19

Maximum, average, minimum as well as the standard deviation in the various carcass class prices for the 2016 production season are shown in Table 23. The C2/C3 price deviated most from the mean (R 2.16) followed by the B2/B3 (R1.57) and AB2/AB3 (R1.25) price.

Table 23. National carcass and live weaner prices for the 2016 production season

Price	A2/A3	AB2/AB3	B2/B3	C2/C3	Weaners live
	National average carcass price (c/kg; Aginfo, 2017)				
Minimum	3527	3285	2998	2818	1754
Average	3778	3660	3335	3117	1947
Maximum	3915	3837	3679	3538	2183
Standard deviation	99	125	157	216	109

The most important marketing channel for the producers in the EC for all animals is the auction market. Young females are also sold to other emerging producers (17%) while older animals are marketed directly to the abattoir (18%). Respondents were asked to rank the attributes that buyers see as important when buying live animals (1= never, 2= sometimes and 3=always). Table 24 shows the attributes preferred by buyers of animals as perceived by producers on a regional level. The condition of the animal, age, sex and breed are perceived as the most important attributes.

Table 24. Cattle attributes perceived important by producers (%)

Attribute	AH	CH	JG	SB	EC ave
Condition of animal	82	93	96	82	88
Age	90	76	88	78	82
Sex	83	83	88	71	81
Breed	66	62	81	82	72
Weight (measured)	45	67	79	75	64
Weight (apparent)	51	70	63	81	63
Free of disease	50	45	88	63	59
Pelt colour	24	25	59	20	30
Pelt condition	11	13	67	40	29
Specified use of feed or medicine	8	7	57	13	18
Place of delivery	6	30	50	20	18
Time of delivery	6	20	44	25	17
Advance payment	20	7	0	13	12

Production costs

Table 25 represents the average production cost for cattle during the 2015/2016 production season as well as a percentage breakdown of the various production cost components. It is evident that the major contributors towards production cost are feeding expenses,

followed by electricity, water and fuel costs. The average electricity/water costs for the EC were inflated by the Chris Hani district where irrigation is practised.

Table 25. Total average annual production cost

Item	Average cost (R)	% of cost
Feeding expenses	2661	21.4
Animal health	1531	12.3
Labour costs	1821	14.6
Electricity	2070	16.6
Land costs (rental)	204	1.6
Spares	551	4.4
Water cost	1911	15.4
Fuel cost	1671	13.4
Other	15	0.1
Total average cost	**12439**	100

An interesting finding in terms of regional variations towards contributions to production cost for beef is that the feeding cost for cattle in the AH district was a lot less compared to the other districts (Table 26).

Table 26. Total average annual production cost per district

Item	AH	CH	JQ	SB	EC ave
Feeding expenses	856	3003	2426	2750	2661
Animal health	1824	1609	400	2390	1531
Labour costs	1793	3574	480	1439	1821
Electricity	600	7614	167	798	2070
Land costs (rental)	347	9	17	476	204
Spares	456	1672	7	130	551
Water cost	69	8459	0	0	1911
Fuel cost	1602	3743	227	913	1671
Other	29	0	5	22	15
Total average cost	**7576**	**29683**	**3728**	**8918**	**12435**

To enable a comparison of herds, the different classes of animals were converted into Large Stock Units (LSU) by assuming that 1 LSU equals an animal unit of 450 kg live weight. That allowed production costs per district to be expressed in terms of LSU (Table 27). The Chris Hani district had the highest production cost at R572/LSU while the other three districts averaged between R100/LSU and R126/LSU. The average income per LSU was also calculated. Due to the higher production costs, the Chris Hani district showed the least income per LSU (R2355) followed by the Joe Gqaba district (R3728/LSU); the Amathole and Sarah Baartman districts showed the highest income per LSU at R4403.

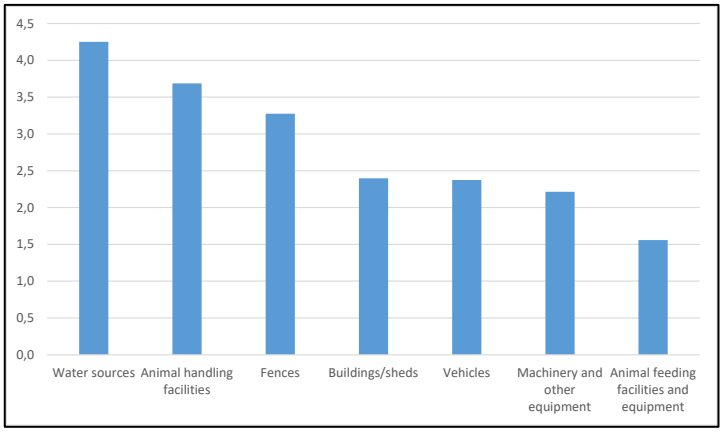
Table 27. Average income per LSU per district

Animals sold in the past 12 months	AH	CH	JQ	SB	EC
Adult female	24468	14108	5214	22497	17223
Young female	1731	11752	3733	2117	4423
Young males	7112	12482	3429	13916	9104
Breeding bulls	1110	574	0	724	699
Calves born in the last 12 months	8201	9750	0	41466	12256
Castrated males	6536	9283	2659	9754	7687
Total Income	49158	57949	15035	90473	51392
Total Production cost	**7576**	**29683**	**3728**	**8918**	**12435**
Total Income	**41582**	**28266**	**11307**	**81555**	**12435**
Income/LSU	4403	2355	3687	4403	3766

Infrastructure

Availability and condition of infrastructure plays an important role in beef production. It is therefore important to analyse the availability and quality of the infrastructure in the emerging sector it the EC province. Respondents were asked to rate their available infrastructure and animal handling facilities (see figure below) on a scale from 1 to 9, with 1 being very poor and 9 being excellent. This allowed potential constraints within the production section of the value chain linked specifically to infrastructure to be identified. From these results the general perception amongst informal producers regarding the quality and availability of infrastructure is very low. The lowest average rating is 1.6 (out of a possible maximum of nine) for animal feeding facilities and equipment. The highest ranking infrastructure was water sources and animal handling facilities (both ranking below 4.5). There was little variation in terms of perceived quality of infrastructure and handling facilities on a district basis.

Figure 9. Perceived quality of infrastructure and handling facilities for the FS



Additional information

To identify trends or changes in farming activities over the five years prior to the survey period, respondents were asked to answer either ‘yes’ or ‘no’ to the questions in Table 28. One notable change was that 75% of respondents indicated the productivity of their animals increased over the previous five years, while 78% of respondents indicated an increase in herd/flock numbers. A disconcerting response was that 82% of respondents indicated no diversification of business activities.

Table 28. Livestock business changes over the previous five years (%)

Activity	Yes	No
More animals in herd/flock	78	23
Higher productivity of animals	75	25
Greater use of technology (breeding, AI, etc.)	23	77
Diversification of herd/flock (raising of other types of animals)	48	52
Diversification of business activities (raising feed, slaughter for business purposes)	18	82
Specialisation of livestock activities (e.g. breeding for larger farmers)	26	74

To test the respondents' perceptions on constraints and risks, they were asked to rank the possible constraints options and risks from 1 (biggest constraint/risk) to 6 (smallest constraint/risk). The results are expressed as a percentage of total responses i.e. in the case of access to markets and access to information it was found that 63% of respondents ranked this as their biggest constraint/concern; access to inputs and variability in prices also received high rankings. In the case of risks, respondents indicated high rankings for climatic conditions as well as for disease.

Table 29. Ranking of constraints expressed in percentage terms

Constraint	1	2	3	4	5	6
Access to markets	63	10	9	5	9	5
Access to information	63	2	5	5	10	15
Access to inputs	53	8	7	9	13	10
Variability in prices	52	14	7	4	6	17
Access to credit	47	2	6	9	13	23
Low productivity levels	41	14	12	11	9	13

Figure 10. Ranking of constraints

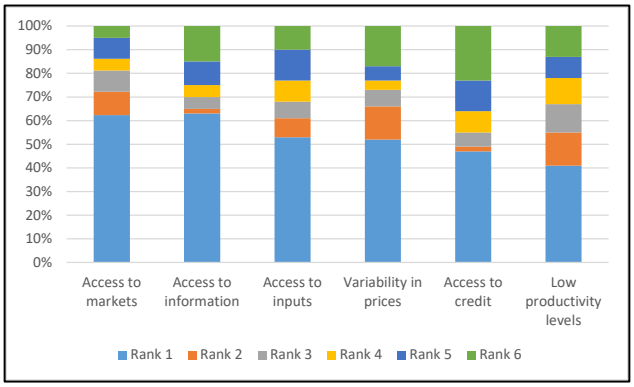
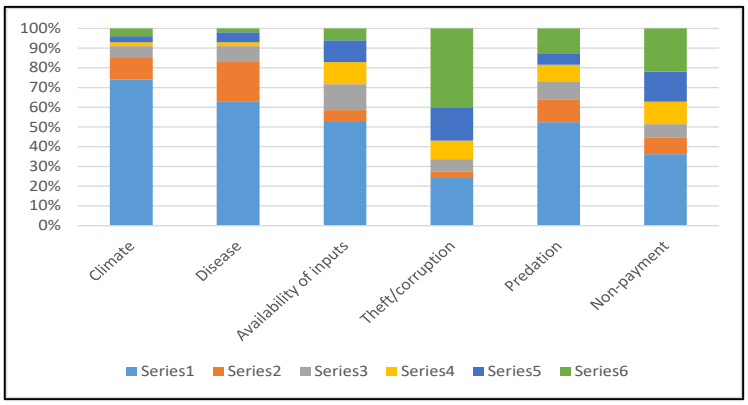


Table 30. Ranking of risks

Risk	1	2	3	4	5	6
Climate	74	11	6	2	3	4
Disease	63	20	8	2	5	2
Availability of inputs	52	6	13	11	11	6
Theft/corruption	23	3	6	9	16	38
Predation	54	12	9	9	6	13
Non-payment	38	9	7	12	16	23

Figure 11. Ranking of risks



Emerging producers, Cradock Abattoir and Woolworths Value Chain

In this section the value chain for the informal sector in the EC province is examined. This is firstly done by means of a SWOT analysis highlighting the possible strengths, weaknesses, opportunities and threats of the value chain. A feasibility analysis will also be conducted in Stage 2 of the project to analyse the feasibility and profitability with various price and logistical scenarios.

Table 31. SWOT analysis

Strengths	**Weaknesses**
• Uniquely produced niche free range product. • Strong market demand. • Market growth opportunities. • Big retailer as stakeholder. • Relatively low production costs compared to an intensive commercial production.	• Seasonality of production. • Inconsistencies in quality of the product due to climatic conditions. • Low volumes of production. • Lack of trust between value chain stakeholders. • Infrastructure challenges at farm level. • Lack of timely, accurate and transparent information flow in the value chain. • Logistical (transportation) challenges
Opportunities	**Threats**
• Marketing possibilities internationally. • Specification as organic, Fair Trade, Free Range or other possibilities. • Incentive for sustainable production practices by marketing older, unproductive animals. • Improve food security and poverty in the poorest province in the country.	• Price movements (margins between the different grades of carcasses) variable and volatile. • The popularity of the weaner production system and feedlots. • Possible feedlots in the region. • No formal agreements between producers and processors. • Non-compliance with product specifications and operating procedures. • Entry barriers to the market is low.

Conclusions

The productivity of cattle production in the province is below national averages in terms of calving rates, especially in the Amathole (27.2%) and the Joe Gqabi (16.5%) municipal districts. The offtake rate in those districts was 12% and 7.4% respectively during the 2015/2016 production season. Animal sales in the province averaged 10.3 head, with the lowest contributor to sales being the Joe Gqabi district with 3.1 head and the main contributor being Sarah Baartman with 18.5 head. Prices received for older female animals was below the national average, while weaner calves traded at national average prices. The lower price for older animals might be due to the condition of the animals given the prevailing

drought situation at the time of the survey and also due to an oversupply of animals in the market, also directly linked to the dry conditions.

Auctions are a trusted trading place as most of the facilities provide a scale to weigh live animals. Producers are often sceptical of buyers in markets where the weight of the animal is not determined, as animals are sold on a R/kg basis. Contrary to popular belief, very few animals are marketed to the informal value chain in the EC, with most of the cattle entering the formal value chain at auctions where they compete directly with commercial producers. In many cases the quality of animals from the informal sector does not compare to those from the commercial sector thereby resulting in price penalties. The reason buyers tend to, in some cases, avoid poor quality animals is that it is too costly to finish them for slaughter. This is true for both weaner calves and older animals.

Variability in prices is one of the main constraints through all linkages in the value chain but can be managed to some extent with proper knowledge of market trends and accurate price information. The success of participation in the Cradock value chain will be determined by the margin between the A2/A3 and B2/B3 carcass prices as this is essentially where the benefit lies for the producer.

The lack of infrastructure still remains one of the main production constraints, especially in the communal farming areas. Establishment of proper animal handling facilities, fences and adequate water supply should be prioritised because the simplest of herd management practises cannot be performed without this infrastructure being in place.

8 Impacts

The project commenced in March 2015 and at that time the project's objective was significantly revised to focus on development of high value beef value chains rather than scoping the opportunity for such development as was planned in 2012. Hence, even though good progress has been made, at this stage of the project the only genuine impacts that have been achieved are capacity impacts. However the project has been able to provide proof of concept that cattle from smallholder farmer herds have the ability to meet high value free-range beef market specifications. As well, considerable enthusiasm has been generated amongst a relatively small number of farmers who have contracted to supply Woolworths' free-range beef market and amongst a large number of researchers and field officers across all six provinces being targeted by the project. Over Stage 2 of the project, it is our expectation this combination of factors and enthusiasm will contribute to significant impacts by the end of Stage 2 (December 2021) and in the years thereafter.

8.1 Scientific impacts – now and in 5 years

The component of the project most likely to yield a significant scientific impact is in the behaviour change area, where a new psychological profiling tool was developed to generate profiles of the project's beef (and linked poultry) farmers and their attitudes to farm business performance. We are hypothesising there may be 3 or 4 farmer profiles including for example 'traditional' (farmers guided more by traditional or cultural approaches rather than being business oriented), 'entrepreneurial' (farmers looking for new ways to improve their farm business performance) and the majority of farmers who are likely to be interested but not pro-active in improving their farm business performance. Assuming the farmers' profiles and their attitudes to farm business performance warrant it, those profiles will be used to specifically design and test interventions customised to their profile type with the aim of significantly increasing adoption of technologies and improving their farm business performance. Proof of this approach will not occur until mid-way through Stage 2 of the project, but if it is successful, this entirely novel method has potential to impact on behaviour change and adoption and scale out in both developed and developing countries.

8.2 Capacity impacts – now and in 5 years

Sixteen KyD technicians, 38 KyD interns and more than 120 extension officers from 6 Provincial Departments of Agriculture received training in the methods needed for cattle from emerging and communal farmer herds to meet the exacting specifications of the virtually unlimited, high-value free-range market specifications. In addition, 165 farmers from the 6 provinces were trained to specifically target free-range beef market specifications, with 42 individual farmers and 1 communal group of farmers signing a contract with Woolworths to supply free-range beef. However very few of those farmers had suitable cattle available for slaughter to actually test their ability to meet those markets and determine the economic feasibility of doing so – that impact will only become evident in Stage 2 of the project.

Through its research components, the project has also provided capacity building to three PhD and one MSc students.

Additionally the specifically designed Farmer Training Manual developed by the project will, once it is accredited by AgriSeta, provide significant capacity impacts for students enrolled through South Africa's vocational training system.

8.3 Community impacts – now and in 5 years

Community impacts will only start to build as collaborating farmers sell their cattle through high value free-range markets in Stage 2 of the project.

8.3.1 Economic impacts

Until many more cattle from the project's collaborating smallholder farmer herds have reached targeted slaughter weights and are evaluated for their compliance with free-range beef markets, the economic impacts cannot be assessed. It is planned that an economic impact assessment will occur at the end of Years 2 and 4 of Stage 2 of the project.

8.3.2 Social impacts

At the end of Stage 1 of the project, there were no genuine social impacts, though there was clear evidence that smallholder farmers contracted to supply free-range beef to Woolworths were starting to form farmer networks to enable them to learn from each other. Over Stage 2 of the project, we expect to see a significant increase in the social infrastructure and a strengthening of the cohesion of production and marketing efforts by small-scale and emerging beef farming communities.

8.3.3 Environmental impacts

At the end of Stage 1 of the project, no genuine environmental impacts had been achieved. However a combination of the widespread use of the decision-support tools developed by the project and a need for cattle in collaborating farmer herds to achieve minimum average daily weight gains to meet free-range beef market specifications has focused strong attention by the farmers and their support teams onto cost-effective pasture and rangeland management. Hence we are expecting clear evidence of environmental spin-off benefits through a reduction in grazing pressure and significant improvements to the resource base early in Stage 2 of the project.

8.4 Communication and dissemination activities

Overwhelmingly, most of the project's communication activities over the first two years were based on face-to-face meetings, workshops and negotiations with potential and confirmed project partners at government, industry and commercial levels, all aimed at achieving buy-in to the project across a range of staff levels from senior management to field workers. Ultimately that translated to face-to-face and extensive training of farmer support team members based across each of the six collaborating provinces and finally in the latter part of the project, negotiating with and training our collaborating farmers.

To maintain awareness of project activities, a quarterly newsletter was distributed to project stakeholders, and a meeting of the Industry and Scientific Advisory Council (ISAC) was held every six months. ISAC membership was available to senior managers of all partner organisations as well as to interested research organisations and others with information that would be of use to the project e.g. ILRI's manager in Southern Africa has chaired the ISAC for the last 18 months of the project.

Social media has been used to keep interested researchers updated on the project's progress. However because of the very small number of farmers contracted to supply the free-range beef market at this stage and because the project's proof of concept was necessarily based on a very small number of animals due to the ready availability of suitable animals, the project has not made a significant effort to promote 'success' to the wider public.

Regardless of these aspects, the project has delivered a wide range of scientific publications, popular press articles and presentations to industry and scientific audiences as documented in the list of publications and communications shown in Section 10.2.

9 Conclusions and recommendations

9.1 Conclusions

This project has established two high value beef value chains based around Cradock Abattoir and Cavalier Meats, both targeting Woolworths' free-range market specifications. It has also provided proof of concept that cattle from smallholder emerging and communal herds can meet those high-value market specifications. But, due to the lack of cattle readily available and suitable for slaughtering to meet those specifications, the project has had to work directly with smallholder farmers who have signed a contract with Woolworths to ensure their cattle will, in future, be suitable for free-range markets. Those cattle will subsequently be slaughtered during Stage 2 of the project, which commenced on 1st January 2018 and will run for four years.

The project has also successfully completed two research R&D components, one to develop cost-effective nutritional supplements for cattle grazed at pasture and the second to develop decision-support tools to assist small-scale and emerging farmers to best manage the grazing capacity and stocking rates of their farms and to evaluate different production systems to maximise the profitability and sustainability of their beef businesses.

Additionally the project has implemented research to evaluate the performance of the project's two beef value chains relative to each other and to other value chains in the same regions of South Africa. A baseline report has been prepared for Eastern Cape (Cradock Abattoir value chain) but because Cavalier Meats only commenced commercial operations in March 2017, baseline data collection and analysis from the five provinces around Cavalier Meats is ongoing. The VAIMS survey will be repeated in all six provinces towards the end of Stage 2 to identify changes in the performance of the two value chains and determine whether those changes can be appropriately attributed to the project's interventions.

Preliminary results from the project's behaviour change survey research show there is a strong potential for farmers to increase the number of cattle they sell, based on their existing resources and technology. There is also a wide variation in the business performance of the farmers, with a good opportunity for the project to target non-performing farmers to enable them to improve and for all farmers to achieve their maximum attainable farm outputs. However a rigorous analysis of the behavioural variables affecting farm business performances is ongoing. The behaviour change survey will also be repeated at the end of Stage 2 to determine whether farmers' profiles and business performance have changed and can be attributed to the project's interventions.

9.2 Recommendations

The research team commends ACIAR's decision to approve Stage 2 of this project, to enable a demonstration of the economic, social and environmental benefits that will accrue to collaborating farmers and their communities through specific targeting of their cattle to high value free-range beef markets. Stage 2 will also provide a significant opportunity to realise the full potential of the VAIMS and behaviour change components of the research as well as deliver outputs and outcomes in the new areas of herd reproductive performance, gender and scaling out.

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10.2 List of publications produced by project

Peer-reviewed Project Publications *(Authors listed in bold are project team members)*

Originating from this project

Gwate O, Mantel S, **Finca A**, Gibson I, Munch Z and **Palmer AR** (2016) Exploring the invasion of rangelands by *Acacia mearnsii* (black wattle): biophysical characteristics and management implications. *African Journal of Range and Forage Science* **33**: 265-273.

Mapiye C, Nengovhela NB *et al.* (2016) Beef traders' and consumers' perceptions on the development of a natural pasture beef brand by smallholder cattle producers in South Africa. *African Journal of Range and Forage Science* http://www.tandfonline.com/action/showCitFormats?doi=10.2989/10220119.2016.1235616

Mapiye C, Nengovhela NB *et al.* (2016) Determinants and opportunities for commercial marketing of beef cattle raised on communally-owned natural pastures in South Africa. *African Journal of Range and Forage Science* http://dx.doi.org/10.2989/10220119.2016.1235617

Marandure Tawanda, **Mapiye Cletos**, Makombe Godswill, **Nengovhela Baldwin, Strydom Phillip,** Muchenje Voster and **Dzama Kennedy** (2017) Beef traders' and consumers' perceptions on the development of a natural pasture-fed beef brand by smallholder cattle producers in South Africa. *African Journal of Range and Forage Science* **33**: 207-214.

Marandure Tawanda, **Mapiye Cletos**, Makombe Godswill, **Nengovhela Baldwin, Strydom Phillip,** Muchenje Voster and **Dzama Kennedy** (2016) Determinants and opportunities for commercial marketing of beef cattle raised on communally owned natural pastures in South Africa. *African Journal of Range and Forage Science* **33**: 199-206.

Marandure Tawanda, **Mapiye Cletos**, Makombe Godswill and **Dzama Kennedy** (2016) Indicator-based sustainability assessment of the smallholder beef cattle production system in South Africa. *Agroecology and Sustainable Food Systems* **41** 3-29.

Mmbengwa Victor, Nengovhela Nkhanedzeni, Ngqangweni Simphiwe, Spies David, Baker Derek, Burrow Heather and Griffith Garry (2016) Developing new value chains for small-scale and emerging cattle farmers in South Africa. *Proceedings in System Dynamics and Innovation in Food Networks 2016* DOI 2016: pfsd.2016.1626, pp. 223-228, available online at http://www.centmapress.org

Mokolobate MC, Scholtz MM, Neser FWC and Buchanan G (2015) Approximation of forage demands for lactating beef cows of different body weights and frame sizes using the Large Stock Unit. *Applied Animal Husbandry & Rural Development* 8: 34 – 38.

Mokolobate MC, Scholtz MM and Calitz FJ (2017) Explaining the principle of large stock units and its implications on grazing capacity. *Applied Animal Husbandry and Rural Development* 10: 17 – 20.

Munch Z, Okoye PI, Gibson LA, Mantel SK and **Palmer AR** (2017) Characterizing degradation gradients through land cover change analysis in rural Eastern Cape, South Africa. *Geosciences* **7**: 7.

Nengovhela NB, Nephawe KA, Mohlapo TD, Sebei J, Mashiloane ML, van der Westhuizen HC, **Burrow H, Strydom PE**, Jordaan F, **Maiwashe A,** Selepe MN, **Mahlathi Y** and Mokholoane TB (2017) Growth potential of Nguni, Bonsmara and Bonsmara cross cattle to meet free range branded beef specifications. *Proceedings 50th Congress of the South African Society of Animal Science*, Port Elizabeth, South Africa, 18-22 September.

Palmer AR, Samuels I, Cupido C, Finca A, Kangombe WR, Yunusa IA, Vetter S and Mapaure I (2015) Above ground biomass production of a semi-arid southern African

savanna: towards a new model. *African Journal of Range and Forage Science* **33:** 43-51.

Palmer AR, Finca A, Mantel S, Gwate O, Munch Z and Gibson L (2017) Determining fPAR and leaf area index of several land cover classes in the Pot River and Tsitsa river catchments, Eastern Cape, South Africa. *African Journal of Range and Forage Science* **34**: 1-7.

Spies DC and Idsardi EF (2017) Performance and marketing options for informal cattle producers in the Eastern Cape province of South Africa. *Proceeding 21st International Farm Management Association Conference*, July 2017, Edinburgh, Scotland (in press).

Relating to the previous project

Burrow, HM (2016) The role of the Afrikaner in developing Belmont Red and Tropical Composite cattle in Australia. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: MM Scholtz, FWC Neser and L Tissier. Chapter 5, 22-29.

Burrow HM (2016) Opportunities and challenges for beef production in tropical and subtropical environments. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: MM Scholtz, FWC Neser and L Tissier. Chapter 15, 74-82.

Griffith GR (2015) *Adoption Study on ACIAR project AS1/1999/036: Developing profitable beef business systems for previously disadvantaged farmers in South Africa*, Final Detailed Report on ACIAR Project C2014/126, University of New England, Armidale, April.

Griffith G, Fleming E, Mounter S, Malcolm B, Umberger W and Baker D (2017) Chain failure and chain goods: re-thinking value chain upgrading in developing countries. *International Journal on Food Systems Dynamics* 8(2): 146-154.

Strydom PE, Frylinck L and Hope-Jones M (2016) The carcass and meat quality of the Afrikaner. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 11, 55-59.

Related publications of project researchers

Burrow HM (2015) Opportunities & challenges to increase productivity in the extensive livestock industries in developed and developing countries. Invited presenter Iowa State University 'Feeding the World' seminar series, Iowa State University 24th September 2015

Burrow HM (2015) Global opportunities for genetic & genomic technologies to improve productivity. Iowa State University post-graduate students 25th September 2015

Burrow HM (2016) Increasing genetic gains in livestock in developing countries. Invited speaker, USAID & Gates Foundation 'Developing Countries Forum', Plant and Animal Genomics Conference, January 2016, San Diego, USA.

Burrow HM, Wolcott ML, **Maiwashe A**, Makgahlela ML, Hayes BJ, Rees JG and Bradfield MJ (2017) Can grazing livestock in developing countries benefit from use of genomic selection? *Proceedings 22nd Association for the Advancement of Animal Breeding and Genetics Conference*, JE Vercoe Memorial Keynote Presentation, 8 pp. available online at http://www.aaabg.org/aaabghome/AllProceedings.php

Dizyee, K, **Baker D**, Rich KM, Fleming E and **Burrow HM** (2016) Applying system dynamics to value chain analysis. *Proceedings 60th Annual Conference of the Australian Agricultural and Resource Economics Society*, 2-5 February 2016, Canberra.

Dizyee K, **Baker D,** Herrero M, **Burrow H,** McMillan L, Sila DN and Rich KM (2017) The promotion of amaranth value chains for livelihoods enhancement in East Africa: a

systems modelling approach. *African Journal of Agricultural and Resource Economics* (submitted December 2017).

Fleming E, **Griffith G**, Mounter S, Malcolm B, Umberger W and **Baker D** (2016) Chain failure and chain goods: re-thinking value chain upgrading in developing countries. *Proceedings 10th International European Forum on System Dynamics and Innovation in Food Networks,* Igls, Austria, 15-19 February.

Griffith GR (2015) Why some technologies will pay and others won't? What can we learn from Australian case studies? Paper presented at an Organized Symposium titled *The beef genome: Mapping the economics* for the AAEA & WAEA Joint Annual Meeting, San Francisco, July 26-28.

Griffith GR (2015) Adoption of genomic information in livestock breeding in South Africa. Paper presented at an Organized Symposium titled *Livestock genomics: ethics, economics and outcomes* for the IAAE 29th International Conference of Agricultural Economists, Milan, Italy, August 8-14, 2015.

Griffith G, Gow H, Umberger W, Fleming E, Mounter S, Malcolm B and **Baker D** (2015) Refocussing on the value chain perspective to analyse food, beverage and fibre markets. *Australasian Agribusiness Perspectives* Paper 104. Available at: https://www.agrifood.info/perspectives/2015/Griffith_et_al.pdf

Jordaan FJ, **Scholtz MM, Mokolobate MC, Neser FWC, Maiwashe A** and King Z (2016) The productivity of the modern Afrikaner. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 10: 49-54.

Khorshidi R, MacNeil MD, Crowley JJ, **Scholtz MM**, Theunissen A and Plastow GS (2017) Evaluating breed complementarity and sexed semen with maternal use of Afrikaner germplasm. *Agricultural Sciences* 8: 507-517.

MacNeil MD, **Mokolobate MC, Scholtz MM**, Jordaan FJ and **Neser FWC** (2017) Alternative approaches to evaluation of cow efficiency. *South African Journal of Animal Science* 47: 118-123.

Makgahlela ML, Mapholi NO, **Burrow HM** and **Maiwashe A** (2017) The genetic architecture of tick resistance. *Proceedings International Tropical Agriculture Conference (TropAg 2017)*, Brisbane.

Mamabolo J and Scholtz MM (2016) Rules and regulations for the export and import of livestock genetic material. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 7, 34-36.

Mapfumo L, Muchenje V, Mupangwa JF and **Scholtz MM** (2017) Changes in biochemical proxy indicators for nutritional stress resilience from Boran and Nguni cows reared in dry arid rangeland. *Tropical animal Health and Production*. DOI 10.1007/s11250-017-1338-0. 0.912

Mokolobate MC, Scholtz MM, Jordaan FJ and **Neser FWC** (2018) A novel breeding objective to improve beef cow efficiency and reduce the environmental impact in extensive systems. *Proceedings 11th World Congress on Genetics Applied to Animal Production*. 11 – 17 February 2018. Auckland, New Zealand.

Motiang DM & Webb EC (2015) Sources of information for small-holder cattle farmers in Dr Ruth Segomotsi Mompati District Municipality in the North West Province, South Africa. *Proceedings of the 48th Conference of the South African Society of Animal Science*, Empangeni, 21-23 September 2015.

Motiang DM and Webb EC (2015) Sources of information for small-holder cattle farmers in Dr Ruth Segomotsi Mompati District Municipality in the North West Province, South Africa. *Appl. Anim. Husb. Rural Develop.* vol 8. pp. 26-33: www.sasas.co.za/aahrd/

Motiang DM and Webb EC (2016) Herd mortality and cattle off-take rates among smallholder producers in the North West Province of South Africa. *African Journal of Agriculture.* vol. 11(11), pp. 930-934.

Motiang DM and Webb EC (2016) The influence of household characteristics on cattle off-take rates in the North West Province of South Africa. *Livestock Research for Rural Development* 28(6), Article #118.

Myeki L, Mmbengwa V, Nengovhela NB, Bhullar N, Burrow H, Coventry W and Griffith G (2016) Efficacy of new smallholder poultry farmers to run profitable enterprises. *Proceedings 49th South African Society of Animal Science Congress.* Contributed paper, Stellenbosch, South Africa.

Neser FWC, Scholtz MM and Pienaar L (2016) Alternative marketing strategies for indigenous beef cattle. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 12, 62-64.

Palmer A (2015) A comparison of the trends in WUE between 2000 and 2013 in a range of land cover classes and land-use systems in South Africa. In: Savanna Network Meeting, Skukuza, March 6-9 2015, SANParks (Poster presentation)

Pienaar L, **Scholtz MM**, Makina SO and **Neser FWC** (2016) Origin and history of Afrikaner cattle. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 2, 6-9.

Pienaar L, **Scholtz MM**, MacNeil MD and **Neser FWC** (2016) Genetic diversity in the Afrikaner breed. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 8, 38-42.

Pienaar L, Grobler PJ, **Scholtz MM**, Swart H, Ehlers K, Marx M, MacNeil MD and **Neser FWC** (2017) Genetic diversity of Afrikaner cattle in southern Africa. *Tropical Animal Health and Production*. https://doi/10.1007/s11250-017-1447-9

Reverter A, Porto-Neto LR, Fortes MRS, Kasarapu P, de Cara MAR, **Burrow HM** and Lehnert SA (2017) Genomic inbreeding depression for climatic adaptation of tropical cattle. *Journal of Animal Science* 95: 3809-3821.

Scholtz MM, Neser FWC and Mamabolo J (2016) The role of the Afrikaner in the development of composite breeds in South Africa. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 4, 18-21.

Scholtz MM, Mokolobate MC, Jordaan FJ, **Neser FWC**, Theunissen A, Hendriks J, MacNeil MD and **Maiwashe A** (2016) Production and breeding strategies to support climate smart beef production in South Africa. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 16, 83-89.

Scholtz MM, Theunissen A, **Mokolobate MC**, Ntwaeagae O and Ferreira M (2017) Factors affecting the pre-weaning performance of Nguni and Angus x Nguni calves in an arid environment of South Africa. Ap*plied Animal Husbandry & Rural Development* 10: 1-8.

Theunissen A, **Scholtz MM, Neser FWC** and MacNeil MD (2016) The Afrikaner in crossbreeding. *In: 'The Afrikaner Breed of Cattle: South Africa's Heritage for Food Security'*, Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 9, 43-48.

Theunissen A, **Mokolobate MC, Scholtz MM and Neser FWC** (2018) Crossbreeding as a potential tool for the South African beef industry's challenge of adaptation and mitigation to global warming. *Proceedings 11th World Congress on Genetics Applied to Animal Production*, 11-17 February 2018. Auckland, New Zealand.

Vermaak L, Bosman DJ, Pienaar L, Fair MD, **Neser FWC** and van der Linde D (2016) The infusion project of the Afrikaner Cattle Breeders' Society. *In: 'The Afrikaner Breed of*

Cattle: South Africa's Heritage for Food Security', Editors: **MM Scholtz, FWC Neser** and L Tissier. Chapter 6, 30-33.

Communication and Dissemination Activities

Originating from this project but not including the numerous presentations and training workshops for managers and staff of a wide range of partner organisations in South Africa, the project's farmer support team members from across six provinces and training workshops and follow-up visits for farmers interested in learning about the free-range beef market opportunity.

Burrow HM (2015) Research outcomes and ongoing opportunities to improve the profitability and sustainability of southern African beef production systems. Institute for Rural Futures Seminar Series, University of New England, 13th October 2015.

Burrow HM (2015) High quality markets & value chains for small-scale & emerging beef farmers in South Africa. Stellenbosch University, South Africa 29th October 2015

Griffith GR (2015) Developing new value chains for small-scale and emerging cattle farmers in South Africa. Paper presented at a seminar in the UNE Business School, University of New England, Armidale, December 4 2015.

Mapholi NO, Maiwashe A, Tjelele J and **Pule G** (2015) Improving the ability of cattle from emerging and small-scale farmer herds to meet the specifications of high quality beef markets. Official launch of the project, Irene, 4th November 2015

Masenya M (2015) Improving reproductive performance of cattle from emerging and small-scale farmer herds. Official launch of the project, Irene, 4th November 2015

Mmbengwa V, Nengovhela N, Ngqangweni S, Spies D, Burrow H and **Griffith G** (2016), Developing new value chains for small-scale and emerging cattle farmers in South Africa. *Proceedings of the 10th International European Forum on System Dynamics and Innovation in Food Networks*, Igls, Austria, 15-19 February.

Motiang D, Griffith GR and **Venter L** (2015) Roles of farmers, farmer cooperatives and beef value chains to improve the profitability of smallholder farmers. Official launch of the project, Irene, 4th November 2015

Nengovhela NB and **Burrow HM** (2015) Incubating beef enterprises by focusing on individuals and linking them to beef value chains. Official launch of the project, Irene, 4th November 2015

Nengovhela NB (2015) Understanding South African livelihood systems and incubating sustainable livelihoods. Oxfam-Australia Vision Indaba 17th November 2015, Durban, KwaZulu-Natal.

Nengovhela NB (2015) Meeting the requirements of the mainstream meat markets in South Africa. NERPO Annual General Meeting, St Georges Hotel; 20- 22 September 2015.

Nengovhela Baldwin, Burrow Heather and **Strydom Phillip** (2016) Free Range Beef: an opportunity to commercialise communal and emerging cattle farmers in South Africa. *Annual Beef Bulletin.*

Nengovhela Baldwin (2017) 'Integrating Animal Science and Psychology to Incubate Smallholder Value Chains' Presentation to UNE Agribusiness Centre, March 2017, https://capture.une.edu.au/ess/echo/presentation/dcb4fcd4-81e8-4caf-8119-acb66d359433?ec=true

Scholtz MM, Mokolobate MC and Hendriks J (2017) A possible explanation for the differences in intake between cattle of the same body weight but different frame sizes.

Proceedings 50th Congress of the South African Society for Animal Science, Port Elizabeth, South Africa, 18 – 21 September, 2017.

Strydom P (2015) Meat science, market specifications and the role of commercial retailers in linking smallholder farmers to high value markets. Official launch of the project, Irene, 4th November 2015

Strydom P (2016) Meat science, market specifications and the role of commercial retailers in the project. Eastern Cape Project Start-up Workshop February 2016.

Strydom PE (2016) Meat science, market specifications and how the project is targeting Woolworths /Cradock requirements. ACIAR review panel Cradock, Eastern Cape, 19 September 2016.

Strydom PE (2016) Market specifications for Cavalier/ Woolworths retail partners. Meeting with participants of AGRiparks initiative, Sedibeng District Municipality. 17 October 2016, Department of Agriculture, Vereniging, Gauteng Province.

Strydom PE (2016) Market specifications for Cavalier/ Woolworths retail partners. Meeting with representatives of Free State Department: Rural Development and Agrarian Reform, National Emergent Red Meat Producers' Organisation (NERPO) and African farmers' association of South Africa Organisation. 17 November 2016, Department of Agriculture, Sasolburg, Free State Province.

Strydom PE (2016) Market specifications for Cavalier/ Woolworths retail partners. ACIAR Stakeholder/Extension Officers' Workshop, 25 January 2017, ARC-FN Bonsma Auditorium, Irene, Gauteng

Strydom PE (2016) High quality markets & value chains for small-scale & emerging beef cattle farmers in South Africa. Training on of regional extension officers on market specifications for Woolworths value chain, ACIAR project. 23 February, Ermelo, Mpumalanga.

Strydom PE (2016) High quality markets & value chains for small-scale & emerging beef cattle farmers in South Africa. Training on of regional extension officers on market specifications for Woolworths value chain, ACIAR project. 28 February, Gauteng.

Strydom PE (2016) High quality markets & value chains for small-scale & emerging beef cattle farmers in South Africa. Training on of regional extension officers on market specifications for Woolworths value chain, ACIAR project. 1 March, Polokwane, Limpopo.

Strydom PE (2016) High quality markets & value chains for small-scale & emerging beef cattle farmers in South Africa. Training on of regional extension officers on market specifications for Woolworths value chain, ACIAR project. 7 March, Glen, Free State.

Relating to the previous project

Burrow HM (2015) Experiences and perspectives on globalisation and development. Globe 302 class, Iowa State University 23rd September 2015.