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WELCOME MESSAGE - SASAS



The 50th Congress of the South African Society for Animal Science (SASAS) will be held in the Eastern Cape. This 50th Congress is a milestone in the history of the Society and I hope to see you all at this important animal science event. A number of international scientists will participate in this Congress. The theme will be “Golden Innovations for Sustainable Animal Agriculture”. These congresses are important events in the calendar of the animal science discipline. Interaction with other animal scientists is the lifeline of animal scientists and this is the ideal opportunity to interact with fellow scientists.

Dr Michiel Scholtz, SASAS President.

INTRODUCTION

On behalf of the organising and scientific committees, I am pleased to present the proceedings of 50th South African Society for Animal Science (SASAS) Congress. This year's congress marks the golden jubilee of this important annual gathering of all members of the association and stakeholders in the field of animal science research and related industries. The 50th congress, themed *Golden Innovations for Sustainable Agriculture*, features a range of highly relevant presentations pertaining to this theme from invited international and local speakers representing the academic, industry and public sectors. Sub themes of the congress include climate change and animal science, ruminant nutrition, animal breeding & genetics, meat science, poultry nutrition and products, wildlife sciences/production, welfare & health, aquaculture, pig production, dairy science, beef production and small stock production.

The presentations at the 50th SASAS congress showcase high quality research in the animal science discipline; aimed towards ensuring the sustainability of agricultural production. Each abstract that was submitted for oral and poster presentation was peer-reviewed by up to 5 independent, anonymous expert reviewers in fields of specialisation related to the theme of the abstract. We extend our gratitude to the reviewers for their professional guidance and valuable input.

We acknowledge and appreciate the SASAS council for approving the hosting of this event by the SASAS Eastern Cape Branch, the Boardwalk Conference Centre for hosting the event, the sponsors, organising and scientific committees; Ms N. Moko, Ms N. Pama and Mr L. Mahachi for logistical support and all congress delegates for contributing to the success of this auspicious event.

Prof. Voster Muchenje - Organising and Scientific Committee member

INVITED SPEAKER ABSTRACTS

Emerging trends in Meat Science

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Performance enhancing technologies in meat animals are often thought to be synonymous with metabolic modifiers. Several examples of metabolic modifiers, such as ractopamine hydrochloride, in beef, pork, and poultry can be cited as improving growth performance and increasing lean meat yield of these animals. However, metabolic modification is not the only means of improving efficiency of food production from livestock species. Historically, performance enhancement in food animal production has been achieved via genetic selection, improved nutrition, and new techniques in animal husbandry. Therefore, metabolic modification is relatively new in terms of application in the livestock and meat industry. The need for development and adoption of performance enhancing technologies continues to grow as our global community works to overcome hunger and malnutrition and improve environmental sustainability. Therefore, new technologies encompassing metabolic modifiers, as well as more traditional forms of performance enhancement like nutrition and management, must be developed and implemented. While producing enough food to feed a growing population is imperative, scientific research to ensure the safety and wholesomeness of the products generated from our meat animal species are equally important. Some reports have noted changes in quality traits such as tenderness or a reduction in marbling (in some cases). It stands to reason most would agree the benefits of increased lean meat yield outweigh the potential reductions in intramuscular lipid or tenderness, especially in the face

of increased global population and potential hunger. Additionally, metabolic modifiers can be considered a tool for sustainable agriculture because they by definition increase output (lean meat yield) relative to required inputs (feed and water). This presentation will focus on the past and future development of performance enhancing technologies of the fish, poultry, small ruminant, beef, and pork industries.

Research developments in pig research

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Conventional protein sources and grains are expensive, limited and out of reach for many farmers as they are also produced for human consumption. The use of locally available feed sources such as potato hash and maize cobs to feed pigs reduces feed cost and also provide alternate energy-rich sources for pigs. Local pigs of Southern Africa serve as an important component of resource based subsistence farming systems and contribute significantly to the livelihoods of many farmers. Their value lie in various attributes such as the ability to utilize fibrous feeds, adaptability and tolerance to endemic diseases. Furthermore, these breeds are adapted to survive under low planes of nutrition and reproduce at low dietary protein levels. Maize cob is an agricultural by-product that remains after removal of kernels from the cob. Potato hash is a by-product of the potato food producing industry. To exploit these agricultural by-products effectively, ways to improve their digestibility and intake are reviewed. This can be achieved through the use exogenous enzymes and ensiling.

Selection for hard-to-measure traits in the national sheep flock: recent progress and the way forward

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Data on growth, wool traits and ewe reproduction are routinely recorded in South Africa. However, the formal scheme does not record data on hard-to-measure trait complexes, such as resistance to pathogens as well as qualitative and quantitative meat traits. A golden innovation such as the recent advance in genomics technology could allow the extension of information from resource flocks under institutional control to industry flocks. To report progress with the assessment of hard-to-measure traits in the South African sheep industry and efforts to extend it to the national flock. Recent reports on genetic parameters of traits belonging to the pathogen resistance and meat trait complexes in resource flocks were

reviewed. The genetic structure of the local sheep resource population was provided along with recommendations for the further development of adapted recording systems for local small stock. Faecal worm egg count (as indicator trait for resistance to gastrointestinal helminths), tick loads, breech strike and associated indicator traits, as well as quantitative and qualitative meat traits were recently studied. Estimates of phenotypic variation and heritability suggested that all traits were variable and heritable and should respond to selection. The genetic structure of the ovine resource population suggested that the effective population size of the mainstream wool breeds (Merino and Dohne Merino) exceeded 200. Hard-to-measure traits will respond to directed genetic selection in the resource flocks. Based on experiences in other countries, the same situation is expected in the national flock. The resource flocks with their extended phenotypes are expected to play an important role as part of a reference population for genomic selection for these traits. However, the effective population sizes of most breeds suggested that breed-specific reference populations of an appreciable size will be needed. At the current cost of genotyping, as well as the availability of funding, it is unlikely that these requirements will be met soon. The possibility of genotype sharing to increase the number of informative individuals should be considered. Access to some resources of Sheep Genetics Australia, with a comparable breed structure and objectives, would be particularly valuable. Most resource flock studies on genetic parameters for hard-to-measure traits were, so far, conducted within flocks. Across-flock studies are urgently needed. Moreover, studies to link South African genotypic data to comparable Australian resources are needed. This should be followed by possible across-country genetic analyses in future.

Development of the Dohne Merino breed in the Eastern Cape - Its current and future
landscape in South Africa and worldwide

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Development of the Dohne Merino breed is generally considered to be a major success of the South African Livestock Industry. The expansion of the breed from its humble beginnings at Dohne Research Station in Stutterheim, to a world-renowned dual-purpose breed is outlined. The Dohne Merino was developed along strict scientific guidelines and the specific applications of animal breeding principles are highlighted. The application of breeding value information on a complete breed basis, is unsurpassed in the South African context. Results of participation in an exploratory genomic project are presented. By using advanced technology, the breed, which may be termed the “Bonsmara of the small stock industry”, still stays at the forefront of animal breeding. The introduction and expansion of the breed into the International arena, is described. The international popularity of the breed stems from the sophisticated scientific approach to provide breeding material suited to optimal commercial woolled sheep farming. It is envisaged that South African Dohne Merinos will continue to, internationally, play a leading role in the global woolled sheep industry.

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Effective communication of information regarding the production of animal-sourced foods with the public (including policy makers) is a complex topic that is critical to the future of the livestock and poultry industries. Animal scientists must take a more active role in engaging the public in discussions regarding the production of animal-sourced foods. Global access to the internet and the increased popularity of social media provide opportunities for distribution of information; however, much of the information available from these sources is inaccurate. Scientists usually try to share their perspectives with the public by using scientific and technical facts to educate the public with the hope that they will view controversial issues from the same perspective as a scientist. On the other hand, the public is often more interested in the social, ethical, and economical aspects of issues related to the production of meat, milk, and eggs. Scientific evidence should be the foundation on which the public makes informed decisions regarding food purchases. Effective communication with the public on issues related to the production of meat, milk, and eggs will require a commitment to building trust, shared values, ethics, and credible expertise. Story-telling and narratives help communicate science to non-experts and may address varying needs by different audiences to understand science. All segments of the food production chain (including researchers, livestock producers, processors, and retailers) must be willing to develop a variety of messages and use multiple platforms to effectively communicate their ability to produce safe,

nutritious, and affordable animal-sourced foods that promote animal well-being without negatively impacting the environment.

The Role of Technologies in Sustainable Livestock Production

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Global demand for animal-sourced foods is increasing in response to population growth and the improving financial status of people in many developing countries. At the same time, the amount of arable land and water available for livestock production is decreasing while extreme weather events and climate variability are increasing. Agricultural innovations and increased efficiencies of animal production will need to be greater during the next 30 years than ever before to ensure the sustainable production of animal-sourced foods. Sustainable food production systems are defined by economic viability, environmental responsibility, and social acceptability. Achieving global sustainability will be a challenge because resources, opportunities, and cultures vary within and between geographical regions. Thus, livestock must be managed in individual production systems that are optimized to suit the region's resources, climate, and people. For more than 60 years, scientists have been developing innovative technologies and management practices to enhance the efficiency of producing meat, milk, and eggs. These technologies include new vaccines or treatments to prevent or control infectious diseases; genetic or genomic selection; and natural or synthetic hormones that are fed to or implanted in animals to increase milk production or enhance growth through accumulation of lean muscle mass with decreased deposition of fat. Use of technologies and innovative management practices in the US has led to significantly more units of animal-sourced foods (e.g., liters of milk, kg of meat, number of eggs) per individual animal

compared to conventional production methods that did not use technologies. With increased production, significantly fewer animals (beef, dairy, swine, and poultry) are needed to generate the same amount or more product, thereby resulting in a significantly smaller environmental footprint, including less water, less land, less manure, and less carbon. However, some consumers do not accept the use of technologies to produce meat, milk, and eggs. These consumers perceive conventional production systems such as pasture-based beef/dairy or cage-free poultry to be better for the environment, better for the animals, and the foods from these systems to be healthier for humans. Yet, results of science-based studies demonstrate that modern food production systems that include technologies are more environmentally responsible and provide more economic viability for farmers and ranchers. All segments of the global livestock industry must play a more active role in educating the public regarding the need for innovative technologies to improve the sustainable production of meat, milk, and eggs to achieve global food security in the future.

Environmentally sensitive animal agriculture and integrated advisory services to ameliorate
the negative effects of climate change on production

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The objective is to understand how Charles Darwin's theory of natural selection "*a grain in the balance will determine which individual shall live and which shall die...*," and how advances in genomics, nutrition, reproduction, as well as in environmental and ecophysiology are pivotal to achieving environmentally sensitive, economically viable, sustainable animal agriculture in changing global climate. Darwin's theory of survival of the fittest implies inherent comparative advantage of survivors over the succumbed in any given environment. An animal's phenotype (P) results from interaction of its genotype (G) and the environment (E), expressed ($P = G \times E$). Human migration distributed livestock breeds across the globe from places of origin to distant agro-ecological zones, where they have little if any inherent comparative production advantage. While *Bos taurus* and *Bos indicus* crosses have higher average performance than the median of either parent populations, this heterotic effect is associated with loss of environmental adaptation compared to parent populations. The loss of adaptive capacity of hybrids requires habitat modifications, if such livestock are to express their fullest genetic potential. On the other hand, indigenous breeds and their ecotypes thrive best in their native environments, *ceteris paribus*. Factors that directly and/or indirectly influence animal productivity in any environment include among others nutrition, genetics, disease, parasites, management practices, climate, rainfall, humidity, heat and cold stressors,

advisory services, and their attendant interactions. This study reviewed literature on how science-driven animal agriculture and integrated advisory services can ameliorate the negative impact of climate change on livestock production. It is concluded that, (a) Darwin's theory of survival of the fittest, (b) conservation of genetic diversity especially for traits that adapt animals to varying thermal environments, (c) advances in genomics, nutrition, reproduction, environmental and ecophysiology, as well as (d) integrated services delivery provide golden innovative solutions to address climate-change in view of nuances of regional and niche-habitat heterogeneity. This will offer practical solutions to challenges facing agriculture and food security in general, while specifically supporting economically viable, socially responsible and environmentally sound sustainable animal agriculture.

Recent developments in the wildlife sector

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To understand the South African wildlife sector, one has to take a look at the history and growth of this very important economic sector over the past century. It is also important to understand the role of each of the four pillars of the South African wildlife sector, namely breeding, hunting, tourism and game products and the effect of increased supply, uncertain market sentiment, economic uncertainty, drought and other factors might have on the sector.

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The research process may be dissected into components: identifying goals, using those goals to specify formal objectives, execution of experiments to test the hypotheses implied by the objectives, analysis of the resulting data, and ultimately publication of the results. Publications are often used in assessing our merit as scientists. An obvious corollary to the use of publications as a metric of success is that without them it is difficult to assess our merit. Thus, the goal of this presentation is to provide some insights, based in personal experiences, into the process of bring our work to fruition through appropriate publication. Setting goals is about preparation: discovery of what is known and recognition of what remains to be learned about a narrowly defined subject. The art of science is in formalizing hypotheses that are aligned with those goals. Once the hypotheses are established designing sufficiently powerful experiments, obtaining resources necessary to carry out those experiments, and faithful conduct of them will give rise to meaningful data. Analysis of the data is most often conditioned on the experimental design. Having properly implemented the preceding steps of the experimental process, publication is the natural outcome. Successful interaction with a journal is a process unto itself; the scientist chooses the journal, but the rules are established by the journal.

Economics of animal production

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South Africa's primary agriculture sector contribution to the country's economy has declined over time from the peak of 8.9% in 1974 to less than 2.5% in 2016. However, its contribution could even be higher if one considers the upstream and the downstream industries in terms of purchasing of inputs and the supply products for manufacturing respectively. The sector plays a critical role as an employer and accounted for approximately 5.7% of formal employment in 2016, of which a significant share is unskilled labour. Labour compensation in the sector rose by 5.6% y/y in 2016 to R28.3 billion. Of the three main sub-sectors (Livestock, Field Crops and Horticulture), livestock accounted for 48% of the total agriculture gross producer value (GPV) at R116.7 billion. It is followed closely by horticulture at R72.6 billion (29%) and field crops at R57.4 billion (23%).

The livestock sector is not only the biggest but also has a direct on the field crops in terms of consumption of grains and oilseeds particularly maize, soybeans, and sunflower. Growth in the livestock sector in the past decade has been driven by rising demand for animal protein due to the increasing middle class and population, increased availability of feed inputs, and technical efficiencies in production systems. The economics of animal production is further depended on consumer tastes and preferences, the meat price, regulatory hurdles, and health challenges for example the recent outbreak of Avian Influenza in the provinces of Mpumalanga and Gauteng of South Africa.

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When a manuscript is submitted for the first time to an academic journal, the Editor-in-Chief or Co-Editors/Associate Editors duly carry-out an initial screening. Only manuscripts that pass this initial evaluation are passed onto expert reviewers. This step is quite necessary in order to reduce the amount of work that reviewers do and ensure that they concentrate on the most promising papers. Regardless of the final outcome of the review process, as an author it is desirable that your submission passes this first test. The comments from expert reviewers are critical for an author's development thus avoiding desk rejection should be the minimum target. Between 50 and 80% of manuscripts submitted for publication in leading journals fail this initial evaluation process for a variety of reasons and are rejected without review. Editors employ several criteria during this initial evaluation step and it is important to note that there is a great deal of variation in the criteria employed across journals. As a rule of thumb, the more 'prestigious' the journal is, the more stringent will be the initial evaluation criteria. In this paper, I discuss some of the reasons why manuscripts get rejected at the first evaluation step. I built these reflections based on 3 years of experience as an Editor of Animal Feed Science and Technology published by Elsevier. Most importantly, I also share several tips that can help prospective authors avoid desk rejection and enjoy the career-nurturing benefits of carefully considered comments from expert reviewers from around the world. It is my

sincere hope that this discussion will help authors look at their manuscript through the eyes of a journal Editor and avoid the cull.

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Meat has been an important component of the human diet for centuries as a rich source of essential nutrients. In addition to nutritional value, meat production and processing provides employment and income generation in both commercial and informal farming sectors. In recent times, the sustainability of meat production, as well as the quality and safety of meat products have come under intense scrutiny; as a result of the negative implications of livestock farming and meat consumption on the environment and human health. These concerns have become increasingly important to consumers and significantly influence consumption trends and the viability of the meat industry. Meat quality, safety and nutritional composition are influenced by the wide range of conditions to which meat-producing animals are exposed from the “farm to fork”. Hence, a complete understanding of meat at all production stages: from prenatal conditions, growth and development of the animal, pre and post – slaughter conditions, carcass dressing and meat processing, distribution, preparation and consumption; is beneficial for the control and enhancement of meat quality. Additionally, adopting a “farm to fork” approach is key to minimizing the negative implications of meat production and consumption on the environment and human health. Current farming conditions are characterised by increasingly variable weather patterns and a diminishing natural resource base. As such, determining the response of different species and genotypes to these conditions is of paramount importance, with the aim of identifying better performing,

environmentally friendly, climate resilient and more sustainable meat producing animals. Pre- to post-slaughter processes tailored to maximise carcass yields, minimise losses and prevent health risks are essential. Furthermore, there is a growing need amongst consumers for transparency and detailed information on nutritional composition of meat. Research linking the dynamics involved in all stages of meat production is necessary in order to conserve and sustain the positive role of meat in the human diet and to maximise the contribution of meat towards the alleviation of food insecurity.

Fertility in dairy cows and ways to improve it

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The fertility of dairy cows affects the genetic improvement and financial sustainability of dairy herds. Fertility is a complex trait being affected by a number of factors. On a genetic level, it is difficult to improve fertility because of low heritability estimates for most fertility traits. At farm level, cows not becoming pregnant, are usually culled from the herd. As management affects fertility in dairy cows, suitable fertility indicators should be used. This may include factors such as the interval from calving to first service (CFS), number of services per conception (SPC) and interval from calving to conception (DO). Earlier work in South Africa included traits such as age at first calving of heifers and calving interval (CI) mainly because of a lack of service records for dairy cows in the national milk recording scheme. This paper presents some results from recent local studies that have been conducted aimed at improving the fertility and reproductive performance of dairy cows. Research results from studies concerning management factors affecting fertility in dairy cows, the estimation of genetic parameters of fertility traits, the effect of crossbreeding on fertility and the effect of diet on the fertility of dairy cows will be discussed. A survey comprising 9046 cows in 14 Holstein herds showed that while lactation number, calving year and calving season affected fertility traits significantly, herds (managers) had the largest effect. Mean \pm sd for interval traits CFS and DO were 77 \pm 30 and 134 \pm 74 days, respectively, while the number of SPC was

2.55±1.79. The proportion of first services occurring within 80 days postpartum and the percentage of cows being confirmed pregnant within 100 and 200 days postpartum were 0.64±0.48, 0.36±0.48 and 0.71±0.45, respectively. Heritability (h^2) estimates were 0.06, 0.08, 0.07 and 0.08 for CFS, DO, SPC and insemination success, respectively. Albeit low, h^2 estimates are consistent with results from the literature. The genetic correlation between CFS and DO was positive (0.56) and negative between CFS and success (-0.29). Crossbreeding, using a dual-purpose breed, showed improved fertility, similar to studies conducted overseas. Increasing the energy content of the total diet of Holstein cows on kikuyu-ryegrass pasture improved fertility as indicated by a higher ($P<0.05$) proportion of cows being confirmed pregnant by 150 days in milk, being 0.52 vs. 0.84 and 0.56 vs. 0.76 for primi- and multiparous cows receiving low and high levels of concentrates, respectively.

Improved reproduction management would prevent management induced infertility in dairy cows. Selection for dairy cow fertility, despite being lowly heritable, is aided by high levels of phenotypic variation. Estimating breeding values for fertility traits for breeding sires would aid in improving fertility in dairy cows. Currently, national milk recording provides information on DO, CI and average lactation number. Information on service records would enable estimation of suitable fertility parameters to allow measurable progress.

An African perspective on livestock production, welfare conditions and product quality: A
Review

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Africa shows great potential for animal agriculture, due to its climatic and agricultural conditions, as well as the ability and resources to accommodate and nurture various indigenous and exotic animal breeds. However, this trend does not seem to reach its full potential and some reasons for this have been identified, but have not been adequately addressed. Animal welfare conditions can be highlighted as one of the major contributing factors to the stunted progress in accessing some markets. Consumers have become increasingly concerned about the conditions animals are reared in, particularly regarding their wellbeing and health. Furthermore, these factors have been flagged and scientifically proven to affect product quality. A well taken care of and healthy animal gives good quality products such as meat, milk, skins and hides, as well as others. The protocols followed to ensure and evaluate farm animal welfare require investigation, innovation and sustainable technologies in order to enhance animal productivity, efficiency and product quality. While there are international animal welfare standards in the developed world, there are inherent factors that hinder adoption of such in most developing regions, such as Africa. These include cultural norms and practices, social ranking, socio-economic status, available resources, information dissemination and monitoring tools. These shortcomings are more often experienced by communal farmers. Therefore, there is need to harmonize what is internationally required and

what is feasible in order to bridge the gap between the developed and developing world. In addition, Investing on animal wellbeing and health, as well as empowering communities with significant knowledge, has a potential to enhance animal productivity, generate income through local and international markets, improve African livelihoods and contribute to food security. Furthermore, with food security being a global challenge, animal products play an important role as nutrient dense food sources in human diets.

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Poultry meat and eggs are the largest source of animal protein in the human diet worldwide. The consumer demand for poultry products is projected to significantly increase by 2050 owing to the predicted increase in world population from 7.2 billion to between 9 and 10 billion. These are the benefits of decades of poultry research investments that were aimed at developing a better understanding of nutrient metabolism and utilization; and the effects of those nutrients on gene expression. A holistic breeding and feed formulation approach in poultry has been towards increasing production efficiency, while reducing the environmental footprint and the financial cost per unit of animal protein product to achieve a sustainable, affordable, and secure animal protein supply. Consequences of animal welfare regulations, food safety, house environment and a number of issues relating to nutrition and feeding are amongst the future challenges to the poultry industry. The projected increases in human population will likely be more pronounced in developing countries, which will put additional pressure on the availability of land, water, and energy needed for animal and crop agriculture. Simultaneously, although the poultry sector has the greatest opportunity to reduce the environmental impact; in many regions, global warming will likely impact animal agriculture in diverse ways, from affecting feed quality and quantity to causing environmental stress in livestock. Thus, support of technology development, its adoption and use should continue by both public and private sectors. The lack of extension to smallholder farmers about how to

utilize the novel technologies for sustainable and improved production as well as to articulate smallholder concerns and needs to the research community remains a key barrier to technological adoption. Moving into the future, of particular importance, keeping the knowledge of nutrient requirements of different genotypes used in meat and egg production current is paramount. Research should continue to identify alternative feed ingredients that may completely or partially replace high-value and unsustainable ingredients, or those that may otherwise compete directly with human consumption.

Kisspeptin as a novel regulator of GH

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Kisspeptin is an important regulator of GnRH and reproduction. However, there is evidence that kisspeptin can also release GH when administered into the lateral ventricle of the sheep brain. The results of fasting studies demonstrated that kisspeptin released GH, but only in fasted sheep. To determine the neural pathway responsible for GH release in response to kisspeptin, a sequence of several studies indicated that neuropeptide Y (NPY) stimulated GH release and kisspeptin increased activation of NPY neurons. Moreover, an NPY antagonist prevented the stimulation of GH by kisspeptin, providing evidence that NPY mediates kisspeptin actions to release GH. Immunohistochemistry studies indicated that growth hormone-releasing hormone and NPY neurons were activated by kisspeptin and somatostatin neurons were inhibited, suggesting a mechanism by which kisspeptin can be linked to GH release.

Scientific publication: an editor's experience

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This talk will open with a discussion of how to select a journal to submit your findings and the merits of impact factors in deciding where to submit a paper. Then we will focus on the editorial process. How reviewers are chosen for a paper and the process for making decisions on a paper. The talk will then examine common reviewer criticisms of papers and will end with a discussion of how to respond to reviewers and the options an author has if a paper is rejected.

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Disease is a catabolic process that can lead to reduced food intake and increased metabolic rate and body mass wasting. We investigated the role of a number of appetite neurotransmitters to determine how the brain regulated food intake in sheep, and to determine how disease altered these neurotransmitters. Moreover, we sought to determine whether there might be pharmacologic means to counter the effects of disease on food intake. Interestingly, activation of the melanocortin-4 receptor (MC4R) causes decreased appetite and increased metabolic rate, thus replicating the effects of disease. We determined that the appetite neurotransmitter, agouti related protein (AgRP) can increase appetite by blocking the MC4R in sheep. Further, AgRP prevents the effects of a disease model (endotoxin) from reducing appetite in sheep. With the production of small molecule MC4R antagonists that cross the blood brain barrier, animal scientists may soon have new tools for increasing food intake and reversing the inhibition of appetite in sick animals.

Recent developments in the pig sector

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Internationally pork production was more than 113 million tons in 2013 compared to 224 000 tons produced in South Africa. During the previous decade pork production in China, the world's largest producer, increased by about 13.5 million tons to 53.7 million tons. The US with 10.5 million tons is the second largest producer. Despite being the largest producer of pork, China is also the world's largest importer of pork (about 2.25 million tons). Despite producing less than 0.2% of world production, participating South African pork producers compared favourably in a global study in terms of profitability with participating producers in Europe, Canada, Brazil, China and Vietnam. This is despite the fact that South African pig carcass weights are mostly lower than that of the other participating countries. Feed prices seem to be similar to European prices while pig carcass prices are somewhat higher in South Africa so that several European farms were outperformed on percentage enterprise profits. While several countries, such as USA, Spain, Hungary, Denmark and Canada had declines in *per capita* pork consumption since 2000 and others a constant consumption, China, Russia and South Africa had increased consumptions albeit that the South African base was low. In fact South African pork consumption almost doubled from 2.6 kg in 2000/01 to 4.8 kg *per caput* in 2015/16. This is in line with the increased income along with increased urbanisation. This increase in production was not accompanied by an increase in sow numbers, but rather

by increased reproduction and higher carcass weights. Further growth will require substantial investment.

Vast strides have recently been made in pig breeding. Pig breeding become of age since it was largely taken over by huge international breeding companies which made it possible to have huge nucleus herds and feedback from member farmers. Biotechnology development led to new technologies such as genomics, genome sequencing and relationship based genomics which made it possible to determine genomic breeding values at accuracies which are reportedly 31% higher than that of pedigree indexes. Gene editing is becoming a reality where DNA is inserted or removed from the DNA of a living organism using engineered nucleases. Embryo transfer can be employed to multiply a specific superior genome to ensure a faster dispersion of desirable genes. Although this technology was developed 50 years ago, it is now modified to be done non-surgically. Real time semen evaluation and morphology became more general practise with the development in CASA technology. Automated semen collection almost doubles the number of collections per employee. New statistical computer programs are available to conduct routine weekly genetic evaluations.

New genotypes obviously also need adapted nutrition. The science of nutritional genomics (Nutrigenomics) is about the effect of diet on gene expression. This will become an important tool in future nutrition science in terms of techniques to evaluate diet formulations. It may even improve pork quality by modulating major meat quality genes. Available amino acids rather than total amino acids will become more important along with gut health promoting agents.

The current carcass classification system is 25 years old and developed for carcasses weighing 65 kg. New lean genotypes slaughtered at higher weights may need a new or revised carcass classification system.

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From Robert Bakewell's "Like begets like" to Jay Lush's "Like does not always begets like", the principles of natural and artificial selection as observed and described by Darwin have been paramount in changing animal populations. Many scholars contributed towards the knowledge base that are currently unified in modern techniques and applications in accelerating accurate genetic selection to obtain breeding objectives in farm animals. Rapid technological advances in computing, laboratory techniques and information dissemination serve as a platform to apply breeding principles more readily. The parallel developments in quantitative and molecular genetics have finally merged with the realisation that both additive and major gene actions are equally important in farm animal breeding.

Charles Henderson eloquently combined information on the hereditary base of trait expression influenced by additive gene action in a set of mixed model equations that forever changed the face of animal breeding. Selection indices, as constructed and defined by Hazel, already encompassed the relationship between genotypic and phenotypic performance for each trait, as well as the correlation between genotypes for different traits. Henderson's brilliance in directly solving the inverse of the Numerator Relationship Matrix (A), accounting for unequal contemporary group sizes and fixed effects and the inclusion of the ratio due to additive variance, led to the BLUP revolution. As these developments also coincided at a time when Moore's Law saw an explosion in computing and data storage

capabilities, complex and more elaborate mixed models became the norm for additive genetic merit predictions.

The quest to include molecular genetic information to increase predictability of genetic merit continued parallel to BLUP model expansions. The major thrust relied on the identification of genes with marked influence on phenotypic expression and the inclusion of such information in BLUP breeding value predictions. Although some breakthroughs were reported, and developments were well on their way in the form of techniques based on Marker Assisted Selection (MAS), the use of single nucleotide polymorphisms (SNP) to highlight genomic differences among animals in populations is the real breakthrough in changing BLUP breeding values from being essentially “family selection” to selection of individuals “within families”, very much like Lush’s prediction in 1951. Initial inclusion of SNP information in BLUP models employed a multiple-step approach, not much unlike a MAS approach of establishing a so-called SNP key, based on a sizable reference population and applying it as a deviation to an expected parent average from BLUP. Currently this is still the method of choice in many countries, for various reasons. An eloquent solution by Legarra, Christensen, Aguilar and Misztal (2014) led to the Single-step method, where the A matrix is adjusted to a genomic relationship matrix, for genotyped animals in a population. Genetic merit predictions now make use of all information, irrespective of the size of the genomic reference population and without a need for a regular update of any SNP solutions (“keys”).

The inclusion of genomic information in genetic merit predictions now, more than ever, necessitates the proper recording of phenotypes. This has led to the phrase by Coffey: “In the era of Genomics, Recording is King”. Elevated accuracy in predicting genetic merit, especially among younger selection candidates, necessitates bigger emphasis on precise breeding objectives and mating plans. While genetic merit predictions will still increase in

accuracy, pushing limits for genetic change through the key equation for ΔG_j , changes in population structures, variance and additive relationships will be key to sustainable genetic progress.

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Almost three decades have passed since the first papers highlighting the potential of hypervariable regions in human DNA were published by Tautz (1989) and others. The completion of the human genome project in 2003 initiated genome mapping of many livestock species. The development of molecular technology was an essential requirement for the execution of genome mapping projects, marker discovery, whole genome sequencing and eventually commercialization of high density SNP chips and high throughput genotyping platforms. The aim of this paper is to provide an overview of genomic technology with reference to the research performed, commercial application and the factors for adoption of genomics towards the advancement of sustainable livestock production.

The process of establishing genomics within the animal genetics domain necessitated basic research for an understanding of DNA markers, followed by discovery of new markers and theoretical simulations to forecast their application. A literature search on publications, across species, over the past five years indicated that the research focus has primarily been on genetic diversity (13%), genomic selection (GS - 23%) and Genome Wide Association Studies (GWAS- 55%), with the remainder covering inbreeding and topics such as Runs of homozygosity (ROH). Within species, dairy and beef cattle have received the most attention (GWAS and GS). South African research papers to date have been reporting on genetic diversity and validation of SNP markers in local indigenous livestock. In South Africa (SA),

genomics for dairy and beef cattle were initiated with state funded programs for the establishment of training populations over 10 years. The first three years have been completed and genomically enhanced breeding values (GEBV's) for the SA Bonsmara was published in June 2017. GEBVs for the Beefmaster breed will follow in August 2017. The Bonsmara and Beefmaster have training populations of approximately 2200 and 800 animals respectively, with genotypes and phenotypes for traits of economic importance. First results from a current PhD study indicate that accuracies, for genotyped animals, have been improved on average between 15 to 30%, depending on the trait, where traditional EBVs accuracies were below 50%. The validation of genotype imputation as a method of inferring high density, in silico, genotypic data to allow genomics-based breed improvement of the SA Drakensberger is currently underway. Inter-chromosomal population-specific parameters that might influence how different chromosomes are treated in the implementation of imputation has been performed and results from this study will benefit all Sanga breeds in terms of setting up cost-efficient reference populations. A number of factors influence the uptake of new technologies and the adoption phase differs among different industries. Adoption of technology will depend on the benefit to the producer weighed against the investment to be made. Scientists have a huge challenge in communicating genomics to both the breeder/farmer and the consumer as the end-user of the product. Genomic technology is expected to contribute to insights into the adaptive mechanisms and disease tolerance observed in indigenous livestock resources. Research and industry will have to make a concerted effort for ensuring the successful outcome of genomic technology for advancement of sustainable livestock production.

A glance at achievements of Animal Scientists over more than 50 years

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With a congress theme, “Golden Innovations for Sustainable Animal Agriculture”, it would be opportune to look not only at innovations with present and future potential, but also to those “Golden Innovations” that have been achieved and established over the last more than 50 years. Many of these innovations still form the basis of many aspects of present-day sustainable animal agriculture in southern Africa. In no small way the South African Society of Animal Production (SASAP) that was established on April 28, 1961 in Pretoria, contributed to the dissemination of the acquired knowledge. The first congress of SASAP was held on 16 and 17 April 1962 at the University of Pretoria with the theme, “Efficiency in Production”, a theme that is still relevant today. Congresses were held annually and for the next nine years proceedings were published annually. In 1971 the South African Journal of Animal Science (SAJAS) replaced the proceedings and now, in 2017, the 47th volume is published. In 1994 the name of the Society was changed to The South African Society of Animal Science (SASAS). At the first congress Dr George Hunter presented an overview of his research on “artificial inovulation”; research that was quoted in the 1968 classic, “The Biological Time Bomb”. At the third congress Prof Jan Bonsma presented his “Functional efficiency in cattle judging”, principles that are focused on adaptability and sustainability. These principles are presently “reinvented” and could be applicable in the breeding of game for the trophy hunting trade. In the 1960’s extensive research was conducted on the feeding

of urea, leading to the now well-established practice of urea-containing rumen-stimulating winter supplementation of ruminants. In a 1983 article in SAJAS it was stated that South Africa is considered a world leader in the field of supplementary feeding practices. South Africa is a country rich in minerals, with cases of rather unique toxicity problems in livestock, such as with copper, bromium and vanadium. Deficiencies in phosphorus, cobalt and selenium in livestock have also being well-documented. In looking back at the research that has been conducted in southern Africa in livestock production over the last 50 plus years, it is evident that there is a large amount of knowledge, applicable to local conditions, which can be drawn upon, or more correctly; should be drawn upon to avoid “reinventing the wheel”.

Aquaculture in South Africa: Food for Thought

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Aquaculture in South Africa is dominated by the production of marine organisms including mussels (1682 tons), abalone (1306 tons) and oysters (266 tons); while the freshwater sector is predominated by the production of trout (1497 tons). There have been attempts at farming species successfully farmed around the world (i.e. tilapia and catfish) for both food security and as commercial ventures however success has been scarce and variable. Reasons such as fluctuating regional temperatures, water scarcity, access to finance and consumer preferences for other protein sources are seen as the main reasons for the slow progress in these sectors. Government's "Operation Phakisa: Unlocking the Ocean's Economy" was launched in 2014 and included Aquaculture as one of its focus areas. While the Department of Agriculture, Forestry and Fisheries (DAFF) has made headway into providing more opportunities through the development of Aquaculture Development Zones (ADZ's), completion of EIA's, streamlining of aquaculture permitting/legislative requirements etc, potential investors have been relatively slow to respond. The presentation aims to explain what drives success and development in South African aquaculture, why certain species work well and others don't. Ideas on possible strategies and future local aquaculture opportunities will be discussed.

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From its inception in 1916, the University Fort Hare had, with the support of the Union South Africa government, offered a course in agriculture to foster existing methods of crop and animal farming. In that critical period, and especially after 1936 when territorial segregation and African reserves' consolidation took shape, Union government sought to push two key aspects concerning sustenance of their productive capacity: ecological reclamation, and augmentation of agriculture. These key strategies became highly emphasised for land set aside for Africans. The government's apprehensive view of African livestock farming methods at this stage had also compelled it to draw expertise arising from the University Fort Hare and other agricultural institutions such as Fort Cox College of Agriculture and Forestry and Tsolo Agriculture and Development Institute. In these schools the training of agriculturalists and extension officers produced personnel attuned with crop and animal husbandry that was aptly required to sustain farming. Crucially during that period of mid-to-late-1940s, rural locations of the Ciskei that encompassed the University Fort Hare and Fort Cox College of Agriculture and Forestry were continually congested, carrying more than 300 000 populations, with more than 100 people per square miles in other districts. In those crowded areas, land was incapable of supporting people and livestock and some arable lands were also deemed unfit for cultivation. Soil rehabilitation then achieved little more than shuffling of people and livestock. From 1948, homeland policy that invoked the corralling of

people and regulation of their livestock into cramped spaces became priority of the then government. Livestock farming a crucial resource in rural economy at that time faced trials. Practices directed at unsettling herd for draught, milk, meat and family exchanges eroded the very basis of existing livelihoods. Whilst the University Fort Hare trained farming officers, and its Agricultural Rural Development Research Institute (ARDRI) continued to offer technical skill for homeland rural economy, this became largely unsustainable. With the change of government in 1994 ARDRI modified its focus to participate affirmatively in the post-apartheid land reform policy. The Faculty of Agriculture has also in recent years introduced the Nguni cattle, poultry and piggery initiatives that also encompass small-scale small holder livestock farming ventures. . How significant is this history in our understanding of the role the University Fort Hare has played in training animal husbandry in the country? How important has been the shifting role of this University regarding the inculcation of the required skills in that vocation, and to what overall benefits for small-scale farmers in the country? This paper offers a historical and contemporary snapshot of Fort Hare's key role in inculcating animal husbandry for South Africa and Eastern Cape's rural economy.

ANIMAL BREEDING AND GENETICS

Computation of the inverse of the genomic relationship matrix

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Background: Best Linear Unbiased Prediction (BLUP) is arguably the most important discovery of the 20th century in animal breeding and genetics. In BLUP, accurate breeding values are only achievable when sufficient performance data is available on either the individual and/or its progeny. The discovery of hundreds of thousands of single nucleotide polymorphisms (SNPs) has presented an opportunity to increase the accuracy of estimated breeding values for selection candidates without own or progeny performance records. However, integration of genomic data into genetic evaluation systems remains a challenge, largely due to general lack of efficient statistical procedures for seamless inclusion of such data in available genetic evaluation software.

Aim: To develop a procedure for inversion of genomic relationship matrix required in the implementation of single step procedure.

Methodologies: Elements of the numerator relationship matrix represent expected (average) relationship between individuals conditional on pedigree data. The main principle behind the numerator relationship is that a parent transmits half of its genes to the offspring hence these relationships do not provide information about the Mendelian sampling, which explains differences in the actual relationships among the same kind of relatives e.g. half-sibs.

Genomic relationships, on the other hand, are actual or realised relationships and therefore similar type of relatives (e.g. half sibs) may have different relationships. Noting that both the pedigree and genomic data provide some measure relationship, the two pieces of information could be brought under the same coherent framework to explicitly show the relationship between the two measures. The actual genomic relationship can be expressed as a sum of pedigree relationship and the absolute difference between genomic and pedigree relationship.

Results: Using the argument above, the actual genomic relationship between a parent (p), assumed to be a base animal, and its offspring (o) can be partitioned into a function of the pedigree ($u_{o,p}$) and the absolute difference between genomic ($g_{o,p}$) and pedigree relationship ($a_{o,p}$) as $g_{o,p} = u_{o,p} + |g_{o,p} - a_{o,p}|$. When the two animals considered are linear descendants separated by at least one generation, the second part of the equation above becomes the sum of the difference between actual genomic and pedigree relationships. The $u_{i,j}$ is equivalent to the $t_{i,j}$ of the lower triangular factor of the genomic relationship matrix (**G**).

Discussion: Similar to the lower triangular factor of the numerator relationship matrix (**A**), the elements corresponding to parents in a row of a particular animal require computational effort while the other non-zero elements are a function of the parental elements. This simplifies computations for obtaining the lower triangular factor of the genomic relationship matrix.

Conclusion and recommendations: The procedure developed in this study allows for efficient computation of the lower triangular factor of the genomic relationship matrix. However, more research is required to compare the performance of this method with existing methods such as the least square procedure for computing the inverse of the triangular factor of **G**.

Identification of selective sweeps in afrikaner, drakensberger and nguni cattle using genome-wide sequence data

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Background: Whole-genome sequencing now provides a suitable platform to examine the entire genome for the identification of selective sweeps. Indigenous South African (SA) breeds including Afrikaner (AFR), Drakensberger (DRA), and Nguni (NGI) are important genetic resources for SA cattle production. These breeds were subjected to strong selection leading to changes in their morphology, physiology and behaviour.

Aim: The aim of this study was to identify selective sweeps that shaped phenotypic diversity among indigenous SA breeds.

Methodologies: Whole genome sequencing of pools of DNA from AFR, DRA, and NGI was performed using an Illumina HiSeq 2000 and 17.6 million variants were discovered across the breeds. To identify the selective sweep regions, SNPs were used to calculate Z-transformations of the pooled heterozygosity (ZHp) in each of the three breeds using a 150 kb

sliding window to compute the ZHp Z-scores in each breed. The results were used to plot the distribution of SNP counts within the windows. The regions of selective sweeps were represented by the lower ZHp Z-scores with the minimum threshold of -4. Animal QTL database was used to determine the gene ontology of the genes identified in selective sweep regions.

Results: In total 688 candidate selective sweeps, with the ZHp Z-score ≤ -4 were identified across the three breeds with 223 putative selective sweeps (ZHp Z-score ≤ -5). About 93 regions had extremely low ZHp Z-scores (ZHp scores ≤ -6). These are the regions subjected to selection segninatures. Using animal QTLdb, several genes were identified, e.g., *ESM1*, *CNOT6*, *ASIC5*, *KIT* and *MITF*, associated with phenotypic variation in livestock species (Zielak-Steciwko et al., 2014; Fallahsharoudi et al., 2016).

Discussion: The ability to detect selective sweep regions provided useful genomic information for these breeds, whereas functional analysis of these regions revealed the presence of genes of biological and economic importance.

Conclusions and recommendations: This study provides a broad insight into the events that happened during recent selection events and artificial selection processes that have shaped the livestock genome. More work is needed to characterise genomic regions and genes identified in this study.

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Background: Small stock numbers in South Africa remained stable over the past decade, with sheep numbers averaging at 25 million and goat numbers at 2.5 million, according to Red Meat Research and Development SA. Approximately 6.3 million sheep and goats were slaughtered annually over the past 5 years. Performance recording of small stock breeds commenced during the 1990s to early 2000s, depending on the breed, allowing the prediction of breeding values and construction of selection indices for enhancement of genetic progress through accurate selection.

Aim: To estimate variance components for application in breeding value prediction for weight, ewe productivity and fertility traits of SA small stock meat breeds.

Methodology: Data and pedigree information for 11 small stock breeds were downloaded from the Logix database of SA Stud Book. Specifications for editing were developed, followed by selection of data for variance component estimation, using VCE6, for weaning (WEA) and post-weaning (POS) weights, number of lambs weaned (NLW), total weight of lamb weaned (TWW), age at first breeding (AFB) and inter-lambing period (ILP). Multi-trait models were fitted for weight traits, including direct, maternal, permanent environmental and herd as random effects for WEA and POS weights. For ewe productivity a multi-trait model was developed for NLW and TWW as traits of the ewe, including parities up to the 10th as

repeated measures. For reproduction AFB and the first two ILPs of the ewe were included in a multi-trait model, also including WEA as anchor trait. PEST2 was implemented for prediction of breeding values.

Results: Direct heritabilities for weight traits ranged from 12% for WEA of the Dormers, to 28% for POS of the Meatmasters, while maternal heritabilities ranged from 5% for WEA of Ile de France to 12% for POS of the Boer Goats. Low heritabilities were estimated for NLW and TWW for all breeds, ranging from 2.0% for NLW of Ile de France to 4.5% for TWW of the Meatmasters. Heritabilities for AFB ranged from 5% for Ile de France to 15% for Dorpers, while estimates for ILP varied between 2.2% for ILP2 of Boer Goats, to 11% for ILP2 of Ile de France. Genetic correlations between weight traits ranged from -38% between POS direct and POS maternal, to 98% between WEA maternal and POS maternal for the Merino Landsheep breed. Genetic correlations between ewe productivity traits varied from 72% for Meatmasters to 87% for Ile de France. For reproduction traits large variation in genetic correlations amongst the breeds for the different traits were observed.

Discussion: Heritabilities and genetic correlations were generally in accordance to literature estimates, with moderate heritabilities for growth and low heritabilities for reproduction traits. Genetic trends indicate variation across breeds with regards to selection aims. Selection indices were developed with inputs of breed societies to be in accordance to the relevant breeds' selection aims.

Conclusion / Recommendations: Variance components were estimated for inclusion in comprehensive genetic evaluations of small stock meat breeds in South Africa. This allowed the development of pro- and reactive genetic reports and top-lists to simplify genetic selection and improve genetic progress in the small-stock industry.

Vulnerability of buck and boar semen to oxidative stress

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Background: Oxidative stress has been implicated as the major cause of infertility in small ruminant production. Direct induction of oxidative stress using an oxidative stress inducing agent, like hydrogen peroxide (H₂O₂), show the higher vulnerability of boar semen motility parameters to oxidative stress as compared to buck semen motility parameters.

Aim (-s): The aim of the study was to determine the vulnerability of boar and buck semen to oxidative stress during liquid preservation.

Methodologies: Semen was collected from three superior experimental Large White boars and South African indigenous unimproved bucks using the gloved-hand technique and an electro-ejaculator, respectively. Semen ejaculates were treated with H₂O₂ in the presence or absence of Dithiothreitol (DTT, an anti-oxidant) for three hours, in liquid preservation media. SYBR-14 and propidium Iodide (PI) Live/ Dead assay kit was used to determine cell viability, and Yo-pro-1 and PI apoptosis kit was used to determine cell death (apoptosis). Semen motility parameters were measured using computer aided sperm class analysis (CASA). Pearson's correlation coefficients were calculated to test the relationship between

the motility rates parameters and treatments. All analyses were performed using SPSS version 17.0 for Windows (SPSS Inc., Chicago, IL). Significance was set at $P < 0.05$.

Results: The raw semen obtained from boars showed 97 ± 2.5 percent viability and no apoptotic sperm with total motility (TM) of 94.07 ± 4.11 percent, progressive motility (PM) of 23.3 ± 4.94 percent whilst rapid motility (RAP) was at 4.0 ± 0.93 percent. In H₂O₂ treated boar semen, (TM) decreased by 25% and (PM) decreased by 20%. In addition, H₂O₂ treatments induced high positive correlations with apoptosis but high negative correlations with viability. In addition, DTT could not restore TM, RAP and viability in boar semen. In bucks, raw semen had 98 ± 1.5 viability and no apoptotic spermatozoa. Buck raw semen TM was 97.0 ± 3.95 , PM was 29.3 ± 1.3 . In treated buck semen, H₂O₂ increased TM by 4-16% in all treatments with only 6% apoptotic sperm cells. PM was increased by 4% and further increased by 16% in the presence of DTT. There were low positive correlations between H₂O₂ treatments and apoptosis plus viability but high positive correlations in the presence of DTT.

Discussion: Results are in agreement with other studies showing decreased motility parameters in boar semen following preservation while buck semen can tolerate oxidative stress.

Conclusion/recommendations: In conclusion, anti-oxidants are required for both buck and boar semen preservation but more so for boar semen preservation. Further studies are envisaged to find out why boar semen is more susceptible to oxidative stress than buck semen.

Effects of breed and gender on ovine slaughter traits

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Background: The major products of the local sheep industry are meat and wool. A lack of stability in the wool sector since 1990 resulted in meat becoming more prominent. The South African Mutton Merino (SAMM) is one of the main dual-purpose breeds used for meat and wool production. In contrast, the Dormer was developed as a terminal crossbreeding sire breed on Merino ewes. The relative performance of these breeds in terms of slaughter traits at yearling age has not yet been studied.

Aim: To determine the effects of breed and gender on slaughter traits of Dormer and SAMM yearlings.

Methodology: Data of 69-132 (depending on breed) yearling ewes and rams from the Elsenburg research farm in the Western Cape born in 2015 and 2016 were used. Traits recorded were slaughter weight, carcass weight, dressing percentage, fat depth at two sites, carcass pH and temperature 45 minutes and 48 hours post-slaughter, cooking loss, drip loss, meat colour and Warner Bratzler shear force. Data were analysed with least squares to allow for uneven subclass sizes.

Results: Only main effects were reported for most traits as there were minimum interactions. Weight-related traits (slaughter weight, carcass weight and dressing percentage) were mostly higher for Dormers in comparison with SAMM yearlings. SAMM yearlings generally had lighter meat with a higher cooking loss compared to Dormers. Dormer and SAMM yearlings born in 2015 had a higher drip loss than lambs born in 2016. Dormers had a thicker rump- and 13th rib-fat cover than SAMM yearlings. Ewe yearlings of both breeds had higher carcass temperatures after 48 hours than rams and a thicker rump- and 13th rib-fat cover. The meat of ewe yearlings was more tender than that of rams.

Discussion: Advantages in growth in Dormers relative to SAMM yearlings probably stems from selection for growth in this breed to fulfil its role as a terminal sire. However, the higher fat depth in the former breed suggests that emphasis was not necessarily on lean growth. As expected, ewes were fatter than rams. The higher fat depth may have had an insulation effect and thus became the reason for higher carcass temperature.

Conclusions and recommendations: This study reported a number of clear breed and gender differences. This can be used in management and mating strategies as well as background knowledge for crossbreeding. With more South African meat research having been focused on crossbred animals, it is important to increase the amount of meat data on purebreds so as to include these into selection criteria for breeding stock selection. This is exceedingly important, as meat traits are among the hard-to-measure traits expected to benefit from genomic prediction.

Relationship between body measurements and semen parameters of kolbroek boars

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Background: Reproductive performance is fundamental for the profitability of pig production. Testicular size of a boar is an essential part of the body that is used to evaluate the performance of pigs in animal breeding.

Aim: The aim of the study was to determine the relationships between body measurements with semen parameters of Kolbroek boars.

Methodologies: Three Kolbroek boars, aged 8 months, were used in the present study. The testicular size was measured using a Vanier calliper. A total of 15 ejaculates were collected using a gloved hand technique method twice weekly from February to March. Semen was filtered through a gauze inside a pre warmed (37oC) insulated thermos flask. Semen samples were then transported to the laboratory within 30 minutes. Upon arrival, the semen samples were evaluated for macroscopic (semen volume, pH and concentration) and microscopic

(sperm motility rates) parameters. Data was analysed using SAS version 9.3. Pearson correlation coefficient was used to determine the relationship between body measurements and semen parameters.

Results: The average bodyweight was 65.9kg. The left testicular length (110.0cm) was significantly higher than the right testicular length (103.3cm). Furthermore, the left testicular width (50.0) was significantly higher than the right testicular width (43.3cm). The average semen volume, pH and concentration was 79.9mL, 7.0 and 5.0×10^9 sperm/mL. Additionally, the average sperm motility was 94.8%. There was a high positive correlation ($P < 0.05$) between bodyweight and semen volume ($r = 0.80$), pH ($r = 0.91$) and sperm concentration ($r = 0.90$). However, a low positive correlation ($P < 0.01$) existed between bodyweight and sperm motility ($r = 0.30$). A highly positive correlation ($P < 0.05$) existed between testicular size and semen volume ($r = 0.90$), pH ($r = 0.66$) and sperm motility ($r = 0.78$). Conversely, a low positive correlation ($P < 0.01$) existed between testicular size and sperm concentration ($r = 0.47$).

Discussion: The results are in agreement with other studies showing that there is a positive relationship between body measurements and semen parameters of boars (Ugwu *et al.*, 2009; Oberlander *et al.*, 2012)

Conclusions/recommendations: Testicular size and bodyweight of Kolbroek boars were positively correlated with semen volume, pH, concentration and sperm motility rates. The results indicate that measurements of testicular size, body weight and semen parameters can accurately guide the

assessment of the reproductive performance of boars. More research is required to understand the relative economic importance of sperm characteristics in the development of breeding objectives.

Comparison of north carolina state university 23, 37 and egf media on maturation rate of
porcine oocytes

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Background: *In vitro* embryo production in pigs has always been a challenge, given the high rates of polyspermy following *in vitro* fertilization. The usefulness of improving efficiency of successful IVM-IVF procedures aid towards implementing modern biotechnologies in farming systems as well as to conserve embryos to be used in future.

Aim (-s): To compare the effects of NCSU-23, NCSU-37 and Epidermal Growth Factor (EGF) media on pig oocyte maturation rate and polar body formations *in vitro*.

Methodologies: Ovaries collected from a local abattoir, preserved in 0.9% NaCl solution at 40°C in a thermos flask were transported to the laboratory within 30min. of slaughtering. Oocytes were aspirated with an 18-gauge needle fixed to a 10 ml disposable syringe. Oocytes surrounded by a uniform complex cumulus mass were selected. A total of 284 oocytes were allocated per treatment and incubated with 5% CO₂ at 39°C for 48 hours. Maturity rates and polar body were then evaluated.

Results: The maturity rates and polar body extrusions were significantly higher ($P<0.05$) for NCSU 37 with 85.9% and 81.9% and there were no significant differences for EGF and NCSU-23 media ($P>0.05$) as 77.1%; 72.5% and 77.1%; 72.7% were obtained respectively.

Discussion: The maturity rates and polar body extrusions in EGF and NCSU-23 media were not significantly different. However, NSCU-37 rendered highest results due to the fact that the composition of the media contained beneficial constituents.

Conclusion/recommendations: Maturation media EGF and NCSU-23 contain constituents which are detriment for maturation, resulting in lower rates of maturation and polar body formations as compared to NCSU-37. NSCU-37 rendered highest results pertaining to the fact that the composition of the media contained beneficial constituents. Further studies should be embarked upon in order to determine further embryonic competency.

Correlation between semen parameters and morphometric characteristics of zulu rams

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Background: Zulu sheep is an adapted breed of South Africa with desirable traits such as thriving harsh environment and tolerated to various diseases. However, this breed is under risk of extinction as the breeding animals are less than a thousand. Therefore, to limit the biodiversity loss there is a need to assess all attributes necessary for fertilizing capacity and correlate them with the semen parameters to develop conservation protocol.

Aim: To evaluate the correlation between morphometric traits and semen parameters of Zulu rams.

Methodologies: The study was conducted at the Agricultural Research Council (ARC). Study procedures were approved by ARC ethics committee, with reference number APIEC16/034. Rams (n=6, age=3 years and average weight=42 kg) were fed standard feed diet with water provided *ad-libitum*. Semen was weekly collected during breeding season (autumn, May, Southern hemisphere) with the aid of artificial vagina filled with warm water (40-42°C), over a four consecutive weeks. A repetitive of two times a week was recognized. Semen was then transported to the laboratory for evaluation within 30 minutes. Semen volume, sperm concentration, motility parameters and viability were evaluated shortly after arrival. Body

measurements were taken in the morning after the fasting period (night) using flexible measuring tape. All reagents used in this study were purchased from Stigma (Sigma-Altrich Chemie GmbH, Steinem, Germany). Pearson correlation coefficient in Minitab 17 was used to analyse the data.

Results: There was a significant correlation ($P < 0.001$) between body weight and live sperm cell ($r = .46$). Rump height was significantly correlated ($P < 0.05$) with live sperm cell, progressive motility (PM), straightness (STR), rapid motility (RM), fast progressive, average path velocity (VAP), curvilinear velocity (VCL) and straight-line velocity (VSL) ($r = 0.33, 0.47, 0.29, 0.45, 0.50, 0.48, 0.48$ and 0.49 , respectively). Noteworthy, moderate significant correlation ($P < 0.05$) between scrotum circumference and live sperm ($r = .28$) was also observed. However, no significant correlation ($P > 0.05$) found between scrotum circumference and semen volume ($r = .06$).

Discussion: When the current study was compared with the previous studies, it contradicted with numerous studies since unexpected none correlation between scrotum circumference and semen volume was observed. Hence suggests no suitability to use SC as a semen volume predictor in Zulu rams. Semen with high velocity parameters (VCL, VAP, VSL and STR) indicates high sperm undergoing vigorous hyper activated pattern and good motility. Moreover, previous studies have been correlating motility parameters with fertilizing capacity. Therefore, based on results obtained in this study, rump height can be used to speculate fertilizing capacity.

Conclusion: These results indicate that, body measurements such as rump height provide reliable CASA (RM, PM, STR, VAP, VCL and VSL) and viability (live sperm) parameters estimates.

Estimation of crossbreeding parameters for pre-weaning growth traits in afrikaner and
simmentaler cattle and their reciprocal crosses

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Background: The use of well-designed crossbreeding system has the potential to improve beef production efficiency. The first step in the crossbreeding effort is generation of genetic information related breed and heterosis contributions to economically important traits.

Aim/Objective: The objective of this study was to estimate additive genetic, heterosis and reciprocal effects on growth traits using data of pure breed Afrikaner (A) and Simmentaler (S) cattle and their reciprocal crosses (i.e. A x S, S x A, A x AS, A x SA, S x AS and S x SA genotypes).

Methodologies: Traits analysed were birth weight (BWT), weaning weight (WWT) and ADG from birth to weaning. Data were collected over a period of 6 years from 1994 to 1999 at the Potchefstroom Livestock Improvement Center. Analysed data was based on 1117 and 490 records for BWT, 924 and 444 records for WWT, 922 and 443 records for ADG from purebred and crossbred calves respectively.

Results: The mean for the genotypes were ranged from 34.3 ± 0.2 kg (A) to 42.7 ± 0.2 kg (S) for BWT, 187.6 ± 1.1 kg (A) to 256.7 ± 4.1 kg (S x SA) for WWT and 751.9 ± 4.9 g (A) to 1049.8 ± 18.8 g (S x SA) for ADG. Additive direct effect of Simmentaler breed estimated as

a deviation from the Afrikaner breed had significant values of 6.6 ± 0.5 kg, 49.0 ± 2.7 kg and 213.6 ± 12.7 g for BWT, WWT and ADG respectively. The maternal genetic effect in favour of Simmentaler breed was only significant for BWT (1.7 ± 0.5 kg). Estimates for the direct heterosis for BWT, WWT, and ADG were 2.0 ± 0.3 kg, 13.8 ± 1.5 kg and 53.8 ± 6.7 g respectively. Maternal heterosis estimates were 1.4 ± 0.5 kg, 23.5 ± 2.4 kg and 105.6 ± 10.9 g for BWT, WWT and ADG respectively. The direct and maternal heterosis estimates were significant. The reciprocal effects were only significant for BWT (1.7 ± 0.5 kg) between F1 calves of A x S vs S x A.

Discussion: These results are in general agreement with estimates reported for other crossbreeding studies in literature.

Conclusion: The improved pre-weaning growth performance indicated that there is an advantage of crossing the Afrikaner and Simmentaler breeds. The pre-weaning growth traits were primarily influenced by the direct genetic effect on the progeny and by both direct and maternal heterosis.

Key words: Beef cattle, direct additives, growth traits, heterosis effects, reciprocal differences

The effect of in vitro maturation medium in cattle oocytes and subsequent embryonic development

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Background: The ability of oocytes to undergo in vitro maturation (IVM) and subsequent embryo development is influenced by the in vitro maturation media and hormonal supplements.

Aim: The aim of this study was to compare IVM media in cattle oocytes and their subsequent embryo development.

Materials and Methods: Ovaries were collected from the local abattoir then, transported to the laboratory in warm (35°C) 0.9% saline. Oocytes were recovered from the ovaries using the aspiration technique. The recovered cumulus oocyte complexes (COCs) were washed in tissue culture media (TCM 199) containing 10% fetal bovine serum (FBS). A total of 800 oocytes were randomly allocated into the four treatment groups of *in vitro* maturation media {(i) epidermal growth factor (EGF); (ii) 0.5 µg/ml of follicle stimulating hormone (FSH), 5 mg/ml of luteinising hormone (LH) and 2 µg/ml of estradiol (E2); (iii) 1 µg/ml of FSH, 6 mg/ml of LH and 2.5 µg/ml of E2 and (iv) 1.5 µg/ml of FSH, 7 mg/ml of LH and 4.5 µg/ml of

E2}. The oocytes were incubated in 5% CO₂ humidified air at 39°C for 24h. Following maturation, frozen semen was thawed and centrifuged for 8 minutes at 1500 rpm in Brackett and Oliphant medium for capacitation. The COCs were fertilized with capacitated sperm and co-incubated in 5% CO₂ humidified air at 39°C for 6h. Thereafter presumptive zygotes were cultured in synthetic oviductal fluid (SOF)-bovine serum albumin (BSA) for 48h at 39°C in a modular chamber containing 5% CO₂, 5% O₂. Following 48h, cleavage rate was assessed and the oocytes were further cultured in SOF-fetus bovine serum (FBS) and further evaluated for embryonic development in day 7. The experiment was replicated 4 times and data was analysed using one-way ANOVA, the means were compared using tukey's test and were considered significant when $p < 0.05$.

Results: The embryonic development of oocytes matured in EGF and 1.5 µg/ml of FSH, 7 mg/ml of LH and 4.5 µg/ml of E2 was significantly higher ($p < 0.05$) compared to the oocytes matured in 0.5 µg/ml of FSH, 5 mg/ml of LH and 2 µg/ml of E2; and 1 µg/ml of FSH, 6 mg/ml of LH and 2.5 µg/ml of E2.

Discussion: The results from this study suggest that *in vitro* maturation is an important and most critical step during *in vitro* embryo production and it influences embryonic development.

Conclusions: In conclusion, EGF and 1.5 µg/ml of FSH, 7 mg/ml of LH and 4.5 µg/ml of E2 are found to be the most suitable IVM media used for subsequent embryonic development.

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Estimation of direct and maternal effects on body weight in merino sheep using random regression models

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Background: In many sheep production enterprises, body weight is regarded as the most important trait for selection of replacement animals. Body weight, especially early body weights, is influenced to a large extent by maternal effects. This could complicate the partitioning of variance and estimation of breeding values. Random regression models have been used recently to model growth rate in cattle and to a lesser extent in sheep.

Aim: The aim of this study was to apply random regression models to estimate direct and maternal effects on body weight in Merino sheep.

Methodologies: The dataset used in this study comprised body weight data recorded from birth until six years of age in the Grootfontein Merino stud from 1968 to 2012. The total number of ram and ewe lambs for which birth weight was recorded, were 7794 and 8317 respectively. These were the progeny of 3814 dams and 359 sires. The number of records available for adult ewes at six years of age was 703. Fixed effects for year-season of birth, sex, rearing status and age of the dam were included in the models. Random regression models fitted included direct genetic, maternal genetic and animal and maternal permanent environmental effects as random effects in various combinations. These models were fitted either with splines separating ages 1, 2, 4, 8, 12, 15, 20, 32, 44, 56 and 68 months, splines

separating ages 1, 4, 15 and 68 months or no splines. The random effects were modelled using cubic spline functions. Polynomials up to the second degree were fitted for the direct genetic and maternal genetic random effects. Residual variances were modelled considering one (assuming homogeneity of variances across all ages) or two age classes divided as follows: 1 to 12 and 15 to 68 months of age. Output values were processed to obtain (co)variances and genetic parameters for the specific body weights at the different ages.

Results: The model with the highest LogL included both the direct and maternal genetic effects fitted as first degree polynomials, 11 spline classes and two age classes. The direct and maternal genetic variance components ranged from 4.0 to 3483.4 and 0.5 to 1005.2 respectively from birth until 68 months of age. Phenotypic variance ranged from 15.2 to 4529.6 and residual variance from 10.7 to 30.3. Direct and maternal heritabilities increased with age and ranged from 0.26 to 0.77 and 0.03 to 0.22 respectively.

Discussion: Direct and maternal genetic and phenotypic variances obtained were much higher than those usually obtained for body weight in sheep. Residual variance was comparable to those obtained with univariate models using the same data set. Furthermore, the large increase in maternal variance with age was also contradictory to most reported literature. The reason for inflated estimates cannot be explained, although similar erratic (co)variance estimates for older ages with fewer data records were reported for this type of modelling.

Conclusions: Further work on model specification need to be done to try and explain the inflated values obtained when fitting random regression models to data sets comprising body weights from birth until adult ages.

The effects of supplementing phosphatidylcholine liposomes on the quality of cryopreserved
bapedi ram semen

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Background: Cryopreservation of ram semen remains a challenge in sheep industry. This method of preserving semen destabilizes the sperm cell membrane composition and organization, resulting into a major loss of phospholipids, which compromise the quality of frozen-thawed semen (Hinkovska-Galcheva *et al.*, 1989; Bergeron and Manjunath, 2006). Phosphatidylcholine (PC) as a major phospholipid of the egg yolk (EY) has been reported to be one of the major protective component of spermatozoa against cold shock (Quinn *et al.*, 1980).

Objective: To determine the effects of supplementing phosphatidylcholine liposomes on sperm motility, membrane integrity and acrosome integrity of Bapedi ram semen in Tris-based extenders with or without egg yolk during cryopreservation.

Methodologies: Semen was collected from four matured Bapedi rams aged 2-4 years using artificial vagina (AV). The semen ejaculates were pooled and randomly divided into eight aliquots. The semen was then diluted with Tris-based extenders (1:2) with or without 10% EY supplemented with four different concentrations of PC liposomes (0, 0.25, 0.5 and 0.75

mg/ml). The experiment was subjected to a 2 x 4 factorial design in Completely Randomized Design (CRD) and replicated 4 times. The extended semen samples were frozen using programmable freezer and plunged into liquid nitrogen (-196 °C). All semen samples were evaluated prior to freezing and post-thawing to determine the sperm motility characteristics using the Computer Assisted Sperm Analysis® (CASA®), membrane integrity using hypo-osmotic swelling test (HOST) and acrosome integrity using the *Pisum sativum* agglutinin fluorescein conjugate (PSA-FITC). Statistical analysis was done using the Statistical Analysis System version 9.4 (SAS, 2013). The data was subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) procedure. Duncan's Multiple Range Test was used to compare means for significant differences ($p < 0.05$).

Results: The supplementation of PC liposomes in Tris-based extenders did not improve total sperm motility (TM), progressive motility (PM), rapid motility (RM) and membrane integrity ($p > 0.05$) regardless of EY or not. Different concentrations of PC liposomes supplemented to Tris-based extenders without EY were significantly different with values 38.43, 47.83 46.35 and 62.5% for 0, 0.25, 0.50 and 0.75 mg/ml, respectively ($p < 0.05$). The acrosome integrity in Tris-based extenders without EY supplemented with 0.75 mg/ml PC liposomes was not significantly different compared to Tris-based extenders with EY that was supplemented with different PC liposomes concentration ($p > 0.05$).

Discussion: The supplementation of PC liposomes in Tris-based extenders with or without EY did not improve the sperm motility characteristics and membrane integrity of cryopreserved Bapedi ram semen. Interestingly, the supplementation of 0.75 mg/ml PC liposomes in Tris-based extenders without EY resulted in higher acrosome integrity similar to extenders with EY.

Conclusion/recommendations: The use of 0.75 mg/ml PC liposomes can substitute EY in Tris-based extenders to maintain acrosome integrity. Future studies should be examine the phospholipid composition of Bapedi ram spermatozoa membrane and their interactions with PC liposomes. The fertilizing ability of frozen-thawed Bapedi ram semen should be evaluated using *in vivo* and *in vitro* fertilization.

Traceability of nguni cattle using illumina bovine snp50 in genome-wide idenentification

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Background: The cost-effective traceability systems to trace animal and their products has been playing an increasingly important role to safe-guard public and animal health. The uses of Single nucleotide polymorphisms (SNPs) provide unique molecular identifiers for tracing and identifying animals and their products to their place of origin.

Aim (-s): The aim of this study is to identify SNPs for traceability in Nguni cattle using BovineSNP50.

Methodology: Purebred Nguni cattle (n=50) sampled across South African provinces were genotyped using Illumina BovineSNP50 chip (Illumina, Inc. San Diego, USA). The data from Bonsmara (n=30), Afrikaner (n=48) and Holstein (n=49) were used for comparison purposes. Only autosomal SNPs were used for analysis. SNPs were filtered to remove those with the call rate of $\leq 95\%$, missing genotypes of $\leq 10\%$ and a deviation from Hardy-Weinberg equilibrium (HWE) of $p < 0.001$. A total of 51985 SNPs were left after filtering. Breeds were differentiated using principal component analysis (PCA). Breed informative markers were determined by Wright's pairwise F_{st} estimation using SVS program. Breed assignment test was carried out using GeneClass2.

Results: About 39% of SNPs with $F_{st} \geq 0.6$ were identified between Afrikaner and Holstein cattle population and 3% were identified in Afrikaner and Nguni cattle population respectively. There were 5346 putative breed specific SNPs identified with $F_{st} \geq 0.6$ across all breeds. The assignment test revealed that in purebreds >98% of animals were assigned to the correct breeds.

Conclusions/ recommendations: This result shows that SNP markers can be successfully used as a part of an effective traceability method for identification of Nguni cattle in the farm.

Genetic diversity and relationships among three southern african nguni cattle populations
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Background: The Nguni is a transboundary indigenous Southern African cattle breed. The breed has distinct populations that are adapted to the different ecological zones of Southern Africa. Recently, South African Nguni ecotypes were genetically characterised using a panel of microsatellite markers for conservation purposes (Sanarana, 2015). No studies have, however, been conducted to characterise Nguni cattle populations across countries. It is important to assess the genetic diversity of Nguni cattle populations across the region to enable the development of appropriate regional breeding programs and conservation strategies.

Aim: To assess the genetic diversity and establish the relationships among SA Nguni, Mozambican Nguni (Landim) and Swazi Nguni cattle populations using a panel of 25 microsatellites markers.

Methodologies: Hair samples were collected from 90 unrelated animals from government research stations and stud herds. These included Nguni cattle populations from three Southern African countries namely, South Africa (SA Nguni n=30), Mozambique (Landim n=30) and Swaziland (Swazi Nguni n=30). Deoxyribonucleic acid (DNA) was isolated by using phenol-chloroform extraction and the DNA extracts were genotyped using a panel of 25 bovine microsatellite markers, recommended by FAO and ISAG for genetic diversity studies. Five South African (SA) beef cattle breeds' DNA profiles were obtained from the ARC-DNA database and used as reference populations. The DNA profiles were analysed using GeneMapper ver. 4.0, followed by computational statistics using software for population genetic analysis (Microsatellite toolkit, GenAlex ver. 6.4.1, Arlequin ver. 3.1, POPTREE2 and STRUCTURE ver. 2.3.4).

Results and Discussion: High gene diversity values were observed among the studied populations. The expected heterozygosity (H_e) varied from 71% (Landim) to 75% (SA Nguni) with a higher mean number of alleles (MNA) in the SA Nguni (7.52 ± 0.42) compared to the Swazi Nguni (6.92 ± 0.40) and Landim (7.16 ± 0.43) populations. Observed heterozygosity (H_o) compared to expected heterozygosity (H_e) was lowest for the Swazi Nguni, confirming a relatively high level of inbreeding ($F_{IS} = 0.158$) in that population. The analysis of molecular variance (AMOVA) revealed moderate genetic differentiation (9.61%) amongst the populations. Short distance (29.9%) was observed between Landim and Swazi Nguni, and SA Nguni (>50%) was the most genetically distant population. The distant relationship between SA Nguni and the other two Nguni cattle populations was further confirmed by neighbour-joining (NJ) tree. The structure of the three Nguni cattle populations clustered independently, despite some evidence of admixture.

Conclusion and recommendation: The information generated in this study indicates a relatively high level of gene diversity and genetically distant relationship between SA Nguni

and Landim and Swazi Nguni cattle populations. This provides the basis for a joint conservation strategy and making decisions for future breeding programs and sustainable utilization of the Nguni cattle breed as animal genetic resource across the Southern African region.

The effects of selenium supplementation and induced stress on semen quality and
reproductive hormones

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Background: Stress is one of the major factors affecting male reproduction. Various antioxidants can be used to reduce the effects of stress particularly, oxidative stress that its production under normal circumstances is controlled by the body of the animal, but beyond control under stressful conditions.

Aim: To determine whether selenium (Se) can protect male Saanen goats against induced stress and preserve the semen quality collected using artificial vagina (AV) or electro-ejaculator (EE) methods.

Methodologies: Forty male Saanen goats were used in this experiment consisting of two main groups of selenium supplementation and control. The groups were further subdivided into induced stress (injected with adrenocorticotrophic hormone -ACTH) and not, and further into semen collection methods, leading to 8 groups (Se x ACTH x AV; Se x ACTH x EE; Se x AV; Se x EE; ACTH x AV; ACTH x EE; AV; EE). The selenium supplemented groups were administered sodium selenite orally, at two months interval, while ACTH was administered at three weeks interval. The experiment was carried out for a period of four months. Semen and blood were collected bi-weekly to determine semen quality and hormonal concentrations. Data collected was analysed using GLM procedures of SAS (2012) and the means were separated by Duncan test.

Results: Supplementation with selenium reduced the effects of induced stress and improved semen quality. Selenium supplementation also reduced the percentages of morphologically abnormal sperm as well as the primary sperm abnormalities. Supplementation with selenium also increased ($P < 0.05$) luteinising hormone, testosterone concentrations as well as blood glutathione peroxidase (GSH-Px) activity and lowered cortisol level.

Discussion: Selenium supplementation in the induced stress group is associated with the improved semen quality of bucks. This observation is supported by the role of selenium as it regulates male reproductive process in male farm animals. Selenium supplementation increased GSH-Px showing that, selenium supplementation reduce the effects of stress and enhance the testicular antioxidant status through increased GSH-Px activity. Therefore, the increased GSH-Px activity can be associated with the improved semen yield and quality of the bucks when selenium was supplemented in this study.

Conclusions and recommendations: Selenium supplementation reduced the effects of induced stress through increase in GSH-Px activity. It also improved semen parameters when using the electro-ejaculator method to be comparable that those of semen collected with the artificial vagina method. Therefore, we concluded that selenium supplementation in male goats is recommended particularly where semen is collected regularly.

Key words: Artificial vagina, Electro-ejaculator, Selenium, Semen quality

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Background: Nanoparticles are used widely for their antimicrobial ability. In livestock production nanoparticles are currently used as medical diagnostic, medical surplus, food safety and biocides, nutrients delivery and wound dressing. However, there is limited knowledge about the toxicity of nanoparticles in semen of livestock and its effects on spermatozoa.

Aim: The aim of this preliminary study was to evaluate the spermatoxicity of silver and diamond nanoparticles on cockerel semen.

Methodology: Semen samples were obtained from healthy cockerels from the Warsaw University of Life Science, Poland. Semen suspensions were diluted with DMEM and randomly divided into 10 groups. Semen suspensions (20µl) were transferred into a micro plate. Five groups of semen suspension were treated with different concentrations of hydrocolloids AG-NPs: group A (0.1 ppm), group B (1ppm), group C (5ppm), group D (10 ppm) & group E control (0 ppm) and the other 5 groups were supplemented with different concentration of hydrocolloids DD-NPs: group F(1ppm), group G (5ppm), group H (10ppm), group I (20ppm) and group J control (0 ppm). Treated semen samples were incubated at 37 oC under CO₂ for 1 hour. Sperm cell viability was assessed using the Presto Blue metabolic

assay. Viability of sperm cells was measured with a spectrophotometer and expressed as the percentage of the control group viability. Morphology of the sperm cells was investigated using a light microscope. Statistical analysis of data was carried out using one-way analysis of variance ($P \leq 0.05$).

Results: After 1 hour of semen incubation with silver and diamond nanoparticles, decreases in sperm cell viability were recorded in a dose dependent manner. Sperm cell viability rate varied from 98 to 70 % for AG- NPs and 84 to 49 % for DD-NPs. As the concentration increased sperm cell viability decreased ($P < 0.05$). More sperm cells had coiled tails after interacting with diamond and silver nanoparticles.

Discussion: Results of AG-NPs are in agreement with other studies showing that sperm cells treated with AG- NPs are viable but immotile and AG-NPs cause decline in spermatogenesis stem cells proliferation. However, it was reported that diamond-coated petri dishes make sperm cells more energetic and longer lasting.

Conclusion: The AG-NPs and DD-NPs exposure in semen decreased sperm cell viability and caused a change in the morphology of the sperm cells. The exposure of cockerels' semen to silver and diamond nanoparticle showed spermatotoxicity as concentration increased. These nanoparticles can therefore not be recommended for its antimicrobial properties in semen diluents.

Does cow size really matter: relationship between dam weight at calving, cow efficiency and pre-weaning growth performance in Nguni cattle

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Background: Cow efficiency (CE) and pre-weaning growth performance are important traits for selection criterion in breeding and measuring production efficiency of the herd. The weight of calf weaned per cow mated is more important than weaning weight *per se*. Relative birth weight (R-BW) is closely associated with dystocia, post-natal mortality or poor post-natal calf performance and reduced cow fertility. The influence of Nguni dam weight on CE and pre-weaning growth traits is yet unknown.

Aim: The objective of this study was to determine the influence of dam weight at calving on CE and subsequent pre-weaning growth performance of Nguni calves.

Methodologies: Data from Nguni cows and their calves (n=826) consisting of calves birth weight, weaning weight and dam weight at calving obtained from nine herds in different agro-ecological zones of Limpopo province were used in this study. All selected herds were kept under extensive grazing system without supplementary feeding or licks. Cows were classified according to their calving weight: high (>385 kg), average (326 – 385 kg) and low (<326 kg) classes. General Linear Model (GLM) procedure of SAS (2014) was used to analyse data whereby agro-ecological zone, season, sex of calf and dam weight at calving

were included as fixed effects, with dam parity and age included as covariates. Least square means were used to compare treatment means.

Results: Dam weight at calving significantly ($P < 0.05$) influenced CE and R-BW, however it did not significantly influence pre-weaning growth performance traits under study. The CE of low (36.95 %) and average (35.79 %) significantly differ with those of high (30.77 %) dam weight class. The R-BW differed between the dam weight classes being 7.99 % for lighter cows, 7.06 % for average dams and 6.23 % for heavier dams.

Discussion: The results are in agreement with other studies showing a higher CE for lighter dams in comparison to heavier dams. Lack of variation in pre-weaning growth performance traits across different dam weight at calving classes depicts that despite calving weights, Nguni dams provide neutral pre-natal and post-natal environment needed for calves' growth. The results are also in agreement with those reported by Rutledge *et al.* (1971) in contrary to several reports who found that heavier dams produced calves with higher pre-weaning growth performance. The R-BW of lighter dams shows increased cow fertility and improved calf vigour leading to exceptional post-natal calf performance.

Conclusion/recommendations: The size of the dam does matter for production efficiency. Therefore breeding with small and average cows can succeed in improving the output and production efficiency of beef cattle enterprise.

Evaluation of growth performance of f2 nguni-angus genotypes under feedlot conditions

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Background: Adequate food production is one of the most basic public concerns. However, the major problem for agriculture and food industries is the sustainability of high-quality foods to satisfy individual well-being, and feed an increasing population, while minimizing complex environmental risks. Livestock production is one of the important industries, which should be improved to meet the demand for food. There is high demand of beef products due to its high protein content for human consumption globally. A particular challenge for farmers in South Africa is that beef herds must remain well-adapted to the environment, while their offspring slaughter percentage must meet the increasingly severe requirements of beef markets and feedlots. Use of indigenous breeds to improve exotic breeds may be one way to increase the production performance of South African beef animals. The performance of these cross breeds needs to be evaluated under feedlot conditions.

Aim: To assess growth and feedlot performance of F2 Nguni-Angus population.

Methodologies: The study was conducted from an ongoing marker detection project at the Agricultural Research Council- Animal Production Campus at Irene. A total of 30 F2 Nguni-Angus cattle of breed three genotypes (NN=1, NA= 2 and AA=3) were randomly selected

from the F2 population. An additional 10 Nguni and 10 Angus cattle were used as reference animals. Animals were placed at the single feeding pens for the periods of 10 weeks. The statistical analysis were performed using the PROC MEANS of SAS 9.4 version and the PROC GLM procedure was used to determine the significance of factors and separation of means was done using the PDIFF STDERR option. The variables analyzed were Average daily feed intake (ADFI), average daily weight gain (ADG) and feed conversion ratio (FCR).

Results: There was a significant effect of genotype on average daily feed intake, average daily gain ($P < 0.05$), while there was no significant effect on feed conversion ratio ($P > 0.05$). There was also correlation between ADG and FCR, while ADG and ADFI or ADFI and FCR were not correlated.

Discussion: The preliminary results show that ADFI and ADG varied significantly ($P < 0.05$) among the three genotypes, while FCR was not significantly differently in the genotypes. F2 Nguni-Angus genotype 2 had better growth and feedlot performance with average ADFI of 7.9 kg/day, ADG of 1.5kg/day and FCR of 5.6. This genotype is therefore ideal for beef production as it will contribute in reduction of feed costs.

Conclusions and recommendations: The F2 animal's feedlot performance shows that the animals are efficient in utilizing feed. There is a need for more research on feed efficiency and improvement of F2 Nguni-Angus population to be done. The outcome of this study could be beneficiary to the livestock industry.

Breed complementarity in productivity traits of dalland, large white and landrace f1 pig
genotypes

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Background: Reduced farm animal productivity of intensive systems is attributed to poor mating strategies, breeding stock and minimum use of performance records. Commercial pig production relies on crossbreeding systems with small-scale farmers struggling to meet pig production standards and having the majority of pigs taking longer periods to reach recommended slaughter weights.

Aim: The study investigated breed complementarity of Dalland (D) with Large White (LW), Landrace (L) and LxLW crosses on traits of economic importance in pig production.

Methodologies: Five mating systems (DxD, DxLW, DxL, DxL/LW, LWxLW) of 1109 sows were used from 2012 to 2015 period. The F1 generation growth parameters (birth weight, weaning weight and average daily gain), and survivability characters (litter size and number weaned) were evaluated. The data was analyzed using the Fixed and Mixed Model Equations following the Best Linear Unbiased Prediction (BLUP) procedure in SAS (Version 9.2)

Results: The sire line of Dalland breed crossed with Landrace breed produced significant higher growth parameters ($p<0.05$). The birth weight, weaning weight and average daily gain between birth and weaning observed were $1.51\pm0.032\text{kg}$, $10.35\pm0.437\text{kg}$ and

0.25±0.012kg/day respectively. DxLW cross had significantly lowest pre-weaning survival rate ($p<0.05$). DxD had the largest litter size of 11.67±0.107 piglets ($p<0.05$). After adjusting for the fixed effects of season of birth, year of birth, dam parity and sex, significant correlations were observed between litter size and birth weight ($r = -0.11$), litter size and number weaned ($r = 0.68$), birth weight and number weaned ($r = 0.74$) and on birth weight and average daily gain ($r = 0.15$).

Discussion: DxL F1 cross excelled significantly on growth characteristics and thus high breed complementarity. DxD and LWxLW pure crosses performed higher on survival traits giving a conclusion that crossbreeding does not necessarily increase performance of lowly heritable traits.

Conclusion/Recommendations: It is recommended to adjust for environmental and animals factors in evaluating productivity performance of complimenting breeds.

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Background: Polled cattle have the advantage of being easier to manage, take up less feeding space in feedlots and the risk of injury, bruising and potential carcass damage is decreased, thereby also decreasing economic losses. Dehorning remains a painful procedure and there is worldwide pressure for humane practises in animal handling activities. However, selection for polledness based on phenotypic records are time consuming and ineffective. Breeding polled animals using DNA technology would be a welfare friendly alternative, as well as a long-term solution to dehorning. The POLL locus has been mapped to BTA1 and at least two different alleles exist at this locus (Celtic (PC) and Friesian (PF) mutations), with one and five candidate mutations identified, respectively, for each mutation. The polled gene is autosomal dominant and if present, will suppress the expression of the horned phenotype. Due to dominance, there cannot be distinguished between the homozygous and heterozygous polled phenotype.

Aim: The aim of this paper is to evaluate the effect of selection for polledness in the SA Bonsmara by estimating the genotypic frequencies of the Celtic mutation (PC) in a selected and unselected herd

Methodologies: Genomic DNA were extracted from 426 bovine hair samples; 216 animals selected for polledness versus 210 unselected animals. Polled, horned and scurred Bonsmara animals were screened for their status for PC at the POLL locus using a microsatellite

marker-based diagnostic test (the CELT primer (Allais-Bonnet *et al.*, 2013)). This screening allowed the identification of carriers of the Celtic mutation, as well as the identification of homozygous and heterozygous polled animals. The PCR products were visualized on a 3% agarose gel with a 100bp size ladder to determine the fragment size of the products; there is a 202bp difference between the Celtic and wildtype allele. Allelic and genotypic frequencies were calculated within and between the Bonsmara herds.

Results: It was possible to distinguish between horned and homozygous versus heterozygous polled animals on a genotypic level. Within the herd selected for polledness, PC were observed at a frequency of 0.759, with the homozygous polled genotype (PP) at 0.148 and the heterozygous polled genotype (Pp) at 0.611. In the unselected herd, PC was only observed at a frequency of 0.048, with no homozygous polled genotypes and Pp occurring at 0.048. The Scurs locus has not been mapped yet, and it was, however, not possible to differentiate between polled and scurred animals on a genotypic level. Scurred animals also show a heterozygous polled (Pp) genotype for PC and of the 61.1% Pp animals observed in the selected group, 31.8% animals had a scurred phenotype.

Discussion: Selection for polledness leads to an increased incidence of homozygous and heterozygous polled animals, suggesting that genetic selection for polledness would assist faster introgression of the polled condition into beef cattle populations. The scurred phenotype, however, poses a problem since it cannot be identified with the Celtic mutation on a genotypic level, and therefore requires further investigation.

Conclusions and recommendations: PC is the causative mutation of polledness in the SA Bonsmara and using DNA technology to identify polled animals allows for improved selection of the polled trait in a much faster and more efficient way.

Testing the utility of imputation from low-density to high-density using Beagle, Impute and Fimpute: Preliminary results

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Background: Genomic selection requires large reference populations that are costly to generate. Genotype imputation provides an opportunity to increase genotype data cost-effectively. Imputation utilises information from animals genotyped on the high-density panels (reference population) to infer unobserved genotypes on study animals genotyped on the low-density panels. Methods of imputation use either family (pedigree-based relationships) or population-wide linkage disequilibrium between markers, or incorporate both.

Aim: The aim of this study was to impute unobserved genotypes on the low-density panel to high-density panels, using three imputation approaches; thereby increasing the size of the reference population for genomic selection cost-effectively.

Methodologies: 493 animals were genotyped based on their genetic contribution in the Braham cattle population. There were 264 young sires and females genotyped using the low-density panel consisting of 7 931 markers (LD), while 161 and 68 herd sires and influential bulls were genotyped on the 150K and high-density (HD) panels with 141 746 and 777 962 markers, respectively. Genotype data were filtered for markers with minor allele frequency < 5%, low call rates < 95% and Hardy-Weinberg equilibrium test ($P < 0.01$).

Filtering retained 6 694, 112 272 and 677 844 markers on the LD, 150K and HD data, respectively. Stepwise imputation using Beagle, Impute and Fimpute was performed from LD to 150K to HD. Efficiency of the imputation method was measured by the speed, computational demands and correlation between actual and imputed genotypes.

Results: Average allelic rate across the programs ranged between 0.5 and 1, which is indicative of imputation accuracy. Higher allelic rates on Fimpute and Beagle compared to Impute showed limitations on Impute, which performs under fixed default settings. Post imputation, the number of animals and markers increased with imputation from LD to 150K resulting in approximately 364 animals and 141 746 markers while imputation from 150K to HD resulted in approximately 187 animals and 777 962 markers.

Discussion: Data structuring especially in the reference population and partitioning of data into chromosomal subsets helps in enhancing imputation accuracy and speeding up the rate of imputation. Imputation from LD to 150K and 150K to HD minimises the time for imputing and computer memory usage. Accuracy between actual and imputed data when imputing with population-based programs indicates that relationships between more distant relatives are well accounted for based on similarities between short haplotype windows. These preliminary results are however reflective of the small data sets, which were used, especially the reference population; thus conclusive statements cannot be drawn until sufficient data have been generated.

Conclusions and recommendations: The preliminary results suggest that programs that make use of both pedigree and population information, such as, Fimpute are more efficient as they are capable of constructing relations over long and short haplotype windows. This also suggests that population-based programs, such as, Beagle and Impute, although efficient,

have limitations. Small datasets also proved to be a limitation, suggesting that a larger reference population can increase imputation accuracies.

Genotype imputation as a genomic strategy for the sa drakensberger breed: preliminary
results

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Introduction: The superior adaptability, and hence competitive advantage, of Sanga cattle breeds such as the SA Drakensberger has sparked interest in the incorporation of genomics-based selection strategies to aid breed improvement. The heterogeneous architecture of Sanga genomes and the difficulty of standardizing between frequently updated genotyping platforms have deemed genomic endeavors daunting. A key limitation impeding large-scale genomic studies has, however, always been the cost of generating sufficient high-density genotypic data to draw meaningful conclusions. There is therefore a need to validate and implement a cost saving strategy to bypass these limitations; genotype imputation presents such an opportunity.

Aim: To preliminarily investigate the accuracy and validity of imputation as a cost saving genotyping strategy for SA Drakensberger cattle using the GeneSeek® Genomic Profiler 150K bovine bead chip.

Methodologies: *FImpute* software was used to perform imputation based on both pedigree- and population-specific linkage disequilibrium (LD) information. A total of 620 SA Drakensberger cattle (174 bulls, 446 cows) were sampled. Post-quality control, 600 animals were subdivided into varying reference (RP)- and target population (TP) sizes. A subset of

SNPs (10%; 12 460 SNPs) was retained in the target population and the rest (90%; 112 138 SNPs) masked and imputed based on the reference sample. Concordance rates, measures of the proportions of correctly imputed alleles (ACR) and genotypes (GCR), as well as Pearson correlations were used to quantify imputation accuracy.

Results: GCR estimates of imputation accuracy were 96.6% and 96.4% for scenario 1 (RP: 426; TP: 174) and 2 (RP: 500; TP: 100), respectively. Imputation accuracy was slightly higher when quantified based on correctly imputed alleles (ACR=98.3% for scenario 1; ACR=98.1% for scenario 2). The Pearson correlation between true- and imputed genotypes was 92.7% and 94.1% (P -value<0.001) for scenario 1 and 2, respectively. Imputation could be performed more accurately for targeted animals with both parents in the reference population (mean GCR: 98.2%, mean ACR: 99.4%) as opposed to none (mean GCR: 96.2%; mean ACR: 98.8%). Imputation was furthermore, on average, more accurate for more densely populated chromosomes with higher inter-SNP LD (eg. BTA14: GCR=96.7%, ACR=98.3%) as apposed to chromosomes displaying lower LD (eg. BTA28: GCR=94.9%, ACR=97.4%).

Discussion: Results presented here indicate that the composition, as apposed to size, of the reference population might be more important for small sample sizes. Inter-chromosomal difference in imputation accuracy can be attributed to differences in population-specific parameters such as MAF and LD and need to be accounted for. Imputation accuracy is furthermore influenced by many other factors, such as the density of the low-density panel, and these factors should be tested to optimize a pipeline for the accurate implementation of imputation for this- and other Sanga breeds.

Conclusions & Recommendations: This study represents a first attempt at investigating imputation as a cost saving genomic strategy for a Sanga breed such as the SA

Drakensberger. Having an admixed genome composed of segments with presumably varying ancestral backgrounds, imputation needs to be optimized for the breed specifically. These results will be transferable to other Sanga breeds.

Estimation of genetic relatedness using snp markers and pedigree in south african brahman cattle

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Background: The recent availability of genome dense SNP markers paved the way to quantifying the actual level of genetic relatedness, based on measures such as genomic relationship matrix and runs of homozygosity, beyond the expected pedigree relatedness. SNP data captures relatedness before the start of pedigree recording.

Aim: The current study aims to determine inbreeding levels estimated using SNP markers, i.e. runs of homozygosity (FROH) and genomic relationship matrix (FGRM) and compare them with pedigree inbreeding coefficients (FPED).

Methodologies: DNA samples extracted from hair and semen were genotyped for SNPs. There were 134, 38 and 17 animals genotyped for 7931 (low-density; LD), 141 716(150K) and 777 962(high density; HD) SNP markers. Quality control led to the exclusion of animals and SNPs with call rates <90%, SNPs with low minor allele frequency (<0.1), and deviation from Hardy-Weinberg-Equilibrium ($p < 0.0001$). The data were further pruned for linkage disequilibrium and SNPs that had a coefficient of determination greater than 0.5 with all other SNPs in a 50-SNP window were removed. The final data contained 6835, 108 140 and

656 463 autosomal SNPs before pruning for linkage disequilibrium; and 4020, 28 685 and 91 645 SNPs after linkage disequilibrium pruning, respectively for the LD, 150K and HD. The ROH were detected using PLINK, at different SNP thresholds from which FROH was calculated. The complete pedigree included 709 852 South African Brahman cattle born between 1946 and 2016, which was used to compute FPED.

Results: In the LD data, there were no ROH detected. The number of ROH called were more in the data that was not pruned for linkage disequilibrium in both 150K and HD panels. Very low levels of relatedness were detected (FROH=0.01, FGRM=0.068) in this study. In the pedigree, 38% of the population were found to be inbred, with the mean and maximum FPED of 4.118 and 54.102, respectively. There was a strong correlation ($r=0.9$) between FPED and FROH ($p<0.005$) estimated from the 150K data that was unpruned for linkage disequilibrium.

Discussion: The overall level of inbreeding detected in the breed is low. The correlation between the two methods was high in 150K data that was not pruned for linkage disequilibrium, probably due to the distance between SNPs, increasing the overall ROH length used to estimate FROH, and pedigree accounts for recent inbreeding, which is associated with long length of the genome that is IBD. SNPs in the HD data might have detected ancient relatedness beyond pedigree records.

Conclusion and recommendations: These preliminary findings show that SNPs in the LD panel are too sparse to detect stretches of homozygosity. FROH and FGRM detected the level of relatedness in all individuals genotyped whereas FPED=0 in most, hence the inbreeding levels were underestimated in the pedigree.

Genetic and phenotypic relationships among yields of milk, fat and protein in south african
guernsey cattle

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Background: A primary goal in dairy cattle breeding is to genetically improve the profitability of milk production. In order to achieve such improvement, all economically important traits should be included in the breeding objective, which requires that they are genetically evaluated on a regular basis. Production traits (milk, butterfat and protein yield) are among the most important traits in dairy cattle. Genetic and phenotypic correlations are a prerequisite to the inclusion of traits in a breeding objective, and are also important parameters in multiple-trait genetic evaluation. Re-estimation of these parameters in a population on a regular basis is important, as they are subject to change over time. The Guernsey is one of the most popular dairy cattle breeds in South Africa. Estimates of genetic and phenotypic correlations for milk production traits of South African Guernsey cattle were last computed over 10 years ago; hence there is a need to update these parameter estimates and the related genetic prediction models.

Aim: The aim of the current study was to estimate the genetic and phenotypic correlations among milk (MY), fat (FY) and protein (PY) yield in the first three lactations of South African Guernsey cattle.

Methodologies: Data comprised 305-day lactation records of 13 404 Guernsey cows, in 639 herds, participating in the National Dairy Animal Recording and Improvement Scheme during the period 1980 to 2013. The pedigree data consisted of 6 260 animals, 368 sires and 4 761 dams. A multi-trait animal model was used to estimate the genetic and phenotypic correlations, by the Restricted Maximum Likelihood (ReML) procedure, using the ASREML software. Environmental factors included in the model were herd-year-season of calving and linear and quadratic effects of age at calving.

Results: Genetic correlations among milk production traits, within each lactation, were all positive and mostly high, ranging from 0.71 ± 0.04 between MY and FY in second parity to 0.90 ± 0.03 for FY and PY in third parity. Phenotypic correlations were also positive and large, and ranged from 0.85 ± 0.006 between MY and FY in the second and third parity to 0.94 ± 0.002 between MY and PY in the first parity. Estimates of genetic correlations among yields of the same trait in different lactations were positive and moderate to high, ranging from 0.41 ± 0.09 for MY in first and third parity to 0.91 ± 0.10 between FY in second and third parity. Corresponding phenotypic correlations ranged from 0.13 ± 0.01 between MY in first and third parity to 0.50 ± 0.01 between MY in first and second parity. Repeatability estimates were 0.42 ± 0.01 , 0.41 ± 0.01 and 0.38 ± 0.02 for MY, PY and FY, respectively.

Discussion: The high genetic correlations among the production traits, within different lactations, indicate that selection for one of the traits is expected to result in a correlated increase in genetic merit for the other traits. Genetic correlations among different parities, for the same trait, were low implying that production in different lactations cannot be considered as the same trait. This fact is supported by the moderate repeatabilities.

Conclusion & recommendations: The high degree of association among milk production traits of SA Guernsey cattle provides a favourable basis for multiple trait genetic evaluation

of these traits and their inclusion in the breeding objective. A lactation repeatability model is not recommended for milk production traits of SA Guernsey cattle.

Key words: SA Guernsey cattle, milk production traits, correlations, repeatability.

Wool production in genetically improved and traditional sheep breeding systems from
selected communal areas of the eastern cape province, south africa

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Background: Communal farmers require a large number of sheep to generate a significant income from wool sales. Sheep reared in communal rangelands produce 2 to 3kg fleece of poor quality compared to commercial sheep which produce 4 to 5kg of high quality. Therefore, one of the aims for genetic improvement in sheep breeding systems is to improve wool production with regards to quality and quantity.

Aim: To evaluate the impact of sheep genetic improvement programs on communal wool production by comparing wool production of genetically improved and traditional sheep breeding systems in communal areas of the Eastern Cape.

Methodology: Two wool producing communal areas were selected (n=15 farmers in each area), whereby both genetically improved and traditional sheep breeding systems were represented. A snowball technique was used to select farmers who were interviewed. Information on socio-economic status, sheep numbers, production experience, management style and production challenges were obtained using personal interviews. In addition, wool statements from the purchasing agent were analysed to compare wool quantity, quality and income.

Results: Farmers were faced with many challenges like uncontrolled breeding, poor breeding stock, theft of rangeland fencing equipment, internal parasites, sheep scab, wool theft and storage which affect both the quantity and quality of wool. Furthermore, when variables such as management style, socio-economic status, sheep numbers and farming experience were evaluated, little or no difference was observed. Likewise, there was no significant ($P>0.05$) difference in quantity of wool, however, there was a significant ($P<0.05$) difference in wool income which relates to wool quality.

Discussion: In both production systems, farmers were faced with a variety of challenges which affect wool production. However, wool from the genetically improved sheep breeding system received higher prices compared to the traditional sheep breeding system and this can in all probability be attributed to the quality of breeding stock which translates to production of quality wool.

Conclusion and Recommendations: Genetically superior sheep produce high-quality wool. Therefore, genetic improvement programs for sheep should be introduced in all sheep rearing communities to improve the livelihoods of farmers.

Estimation of genetic parameters for reproduction traits in a dual purpose sheep flock

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Background: The economic viability of sheep enterprises in South Africa under different environments and production systems is to a large extent dependent on the reproduction rate of the adult ewe flock. Firstly, it is directly linked to the profitability of a sheep enterprise through an increase in the number of slaughter animals. Secondly, an improvement in reproduction rate will influence selection intensity as a result of more animals being available for selection. Selection for increased body weight is used by producers as an indirect selection criterion for reproduction due to the favourable genetic correlations of live weight with reproduction. However, the subsequent increase in mature weight and frame size and hence maintenance requirements stemming from such selection, need to be considered during selection.

Aim: The of this study was to estimate genetic parameters for reproduction in a dual purpose sheep breed and to quantify the relationship among reproduction, body weight and body dimension traits.

Methodologies: Data collected on the Grootfontein Dohne Merino stud from 2001 to 2015 were used for this study. The traits included in this analysis were number of lambs born (LB), number of lambs weaned (LW), total weight of lamb weaned (TWW), body weight, body length, body height, heart girth, testis circumference and testis length. The reproduction traits were recorded from two years of age and the production traits at 14 months of age. The

means and standard deviations for the respective traits were obtained with the PROC MEANS-procedure of SAS and significance levels for the fixed effects were obtained with the PDIFF-option under the PROC GLM-procedure of SAS. The genetic parameters were estimated with univariate and bivariate models using AsReml program.

Results: The most suitable model for analysis of the reproduction traits included only the direct genetic effect. The direct heritabilities for LB, LW and TWW were 0.11 ± 0.06 , 0.09 ± 0.06 and 0.07 ± 0.05 respectively. The genetic correlations among the reproduction traits ranged from 0.22 to 0.80. The genetic correlations between the reproduction traits and body weight ranged from 0.30 to 0.75. TWW and frame size were highly correlated, while the corresponding correlations with LB and LW were approximately zero. The correlations between reproduction and testis size were also low negative or positive.

Discussion: The high favourable correlations between TWW and body weight, as well as frame size suggested that an increase in these traits would have a positive effect on reproduction in this flock. However, it is important to note that according to literature there is a threshold value where a further increase in body weight and frame size will lead to a decrease the reproduction potential. The inclusion of testis size in a selection program as indirect selection criteria in sires for reproduction will not lead to an increase in the reproduction potential of female progeny in this stud.

Conclusions: It can be concluded that despite the possible correlated response in TWW through selection for body weight, it is recommended that selection should rather be based directly on reproduction. Sires must be selected on the reproduction potential of their female ancestry or progeny, rather than using indirect selection criteria. This will ensure that the adult ewe flock will reproduce at optimum levels under a specific environment.

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Background: Successful breeding programs depend on correct parentage as inaccurate pedigrees negatively affect genetic gain. For decades, highly polymorphic short tandem repeat loci (STR) have been used for parentage testing. To date, single nucleotide polymorphisms (SNPs) have superseded the use of STRs as a new DNA technology. The International Society for Animal Genetics (ISAG) officially provides two SNP panels (core and additional list of 100 SNPs) that should be used globally to make results comparable between laboratories for bovine parentage testing. Also, to facilitate the shift to SNP parentage genotyping, the International Committee for Animal Recording (ICAR) and Interbull have standardized sets for parentage SNPs in “GenoEx-PSE”. The database consists of the two ISAG panels and two more SNP panels for conducting parentage discovery analysis (675) and SNP required to impute an animal's microsatellite (STR) profile for the purpose of parentage verification (980). However, SNP markers specific to Sanga cattle breeds are not included, no information is available on the performance of these panels for parentage analysis in Sanga breeds.

Aim: To evaluate the performance of parentage SNP panels at different densities in SA cattle breeds.

Methodologies: Bonsmara (n = 213) and Drakensberger (n = 167) cattle genotypes of known pedigrees were obtained from the database maintained by the Beef Genomics Project (BGP)

of SA. These families were genotyped using GeneSeek® Genomic Profiler (GGP) Bovine 150K consisting of 150, 000 SNPs (Neogen Corporation, 2013) including all the globally recognized USDA parentage markers and hundreds of SNPs to enable the conversion of ISAG microsatellite parentage data. SNP panel quality control was performed using plink software and tested at HWE ($p < 0.001$). Samples with less than 15% missing genotypes were removed. SNPs with less than 95% call rate and less than 0.01 MAF were removed from the analysis. SNPs listed on GenoEx-PSE were grouped accordingly into parentage panel densities for evaluation in SA two beef cattle breeds.

Results: In the two breeds used to evaluate parentage panels, 1420 (79%) of the 1800 parentage SNPs were polymorphic with an average MAF of 0.42. The overall call rate of the panels was 98%, while MAF across the panels ranged from 0.27 to 0.42. The ISAG panels lacked quality control compared to the other larger panels.

Discussion: The results indicate the informativeness of the panels to perform parentage analysis. However, more SNPs are required than what ISAG provides for parentage testing to ensure the usefulness of SNPs.

Conclusion and recommendations: This study has evaluated the GenoEx-PSE listed SNPs and it is encouraging that a set of SNPs informative to SA breeds for parentage were detected. The successful application of the sub-set of SNPs detected from this study should be validated for parent exclusions and likelihood probabilities in SA cattle breed's populations.

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Background: South African sheep breeders aim to breed sheep excelling in production, reproductive efficiency and resistance to internal parasites. Faecal worm egg counts (FWEC), is traditionally used as an indirect measure of parasite resistance. However, it is of paramount interest to know how reproductive traits will be affected if selection for lower FWEC is implemented in mature ewes.

Objectives: To estimate both the heritabilities, genetic and phenotypic correlations of FWEC with reproductive traits in adult Merinos.

Methodology: A dataset consisting of 1581 repeated records of FWEC from 609 ewes was correlated with 1633 (NLB and NLW). The experimental animals belonged to a divergent selection experiment for the ability of ewes to rear multiples and no direct selection for low FWEC in was practiced in either selection line. All animals were naturally challenged with parasites for a period of 6-10 weeks in autumn. FWEC were obtained by using the McMaster technique, with a sensitivity of 100 eggs per gram of wet faeces. (Co)variance components were derived from single- and two-trait analyses in ASREML

Results: Heritability estimates for FWEC after log and cube root transformation were low and not significant at 0.03 ± 0.03 . However, ewe permanent environmental effects contributed 0.06 ± 0.03 to the phenotypic variance, resulting in a repeatability estimate of

0.09 ± 0.03 . Reproductive traits on the other hand were moderately heritable at 0.19 ± 0.03 for NLB and 0.11 ± 0.03 for NLW. Genetic correlations of FWEC with reproductive traits were high and negative at -0.71 ± 0.32 for NBL and -0.78 ± 0.34 for NLW.

Discussion: Low heritability estimates of FWEC in adult ewes suggest that, selection for low parasite resistance cannot be feasible. The season in which faecal samples were collected, amongst other factors could have contributed to low heritability estimates obtained. Reproductive traits were moderately heritable, suggesting that mature ewe reproduction may thus be easy to change by genetic selection. The genetic correlations of FWEC with the reproductive traits were favourable (i.e. negative) and high, suggesting that ewes with a better reproduction rate would also have lower means for FWEC.

Conclusion and recommendations: Heritability estimates for FWEC were low and not different from zero in mature ewes, suggesting that selection for an increased reproduction is unlikely to have a marked adverse on FWEC. Further research is required to establish the effect of season on FWEC in mature ewes.

ANIMAL WELFARE AND HEALTH

Ethnoveterinary medicinal uses of selected cactus species by farmers for treatment of livestock in makhuduthamaga local municipality, limpopo province, south africa

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The aim of the study was to document indigenous knowledge and to investigate the effect of seasonal changes on the quantity and quality of phytochemicals and biological activities in cladodes of three Cacti species, collected from Makhuduthamaga municipality in Limpopo province. The cladodes were extracted using different solvents of varying polarity and phytochemical analyses of the extract were performed using Thin Layer Chromatography (TLC) developed in three solvent systems (EMW, CEF and TEA) and qualitative standards procedures described by Sofowara (1993) were used. Antibacterial activity was evaluated using micro-dilution and bioautography assay using the test organisms; *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. Antioxidant activity was evaluated using micro-dilution and qualitative DPPH scavenging activity was performed on TLC plates. Anti-inflammatory activity was evaluated using the micro-dilution and 15-lipoxygenase (15-LOX) was used as an enzyme. Cytotoxicity was tested using Vero cells, derived from the kidney of an African green monkey (*Cercopithecus aethiops*). Participants of all group age and different gender had knowledge in ethno-veterinary medicine. Dichloromethane was the extractant with a mass of 210 mg followed by methanol of 120 mg. In qualitative screening of phytochemicals all three Cacti species indicated the same results, whereby in summer compounds were strong flavonoids and steroids. In winter flavonoids were moderate and steroids were strong while other compounds were absent. As illustrated Fig 4.3.1 the highest total phenolic content was obtained from *Cereus jamacaru* in winter with a yield of 33 mg GAE/g while *Cactus spiny* obtained similar content throughout the two seasons. As illustrated in Fig 4.3.2 *Spineless Cactus* (c) obtained the highest yield preserving

almost similar yields in summer and winter, in summer the obtained yield was 0.18 mgFlavonoids/g while in winter was 0.16 mgFlavonoids/g. Spiny Cactus (w) was second pre-eminent. In the phytochemical analysis, more compounds were observed

on EMW, followed by CEF and TEA plates. More compounds were observed in summer in EMW and CEF and in TEA mobile phase more compounds were in winter. Antibacterial activity in summer Dichloromethane (DCM) extracts of all three Cacti species inhibited all test organisms, only spineless Cactus (c) methanol (MeOH) inhibited *B.subtilis*. In winter both DCM and MeOH extracts inhibited selected test organisms while Distilled water did not show any activity in all three Cacti species in both seasons. MBC in winter all three Cacti species inhibited *B.subtilis*. Bioautography TEA showed best results inhibiting *E.coli* and *B.subtilis* in summer while in winter inhibiting *S.aureus*. EMW in summer inhibited *P.aeruginosa* and *B.subtilis* while in winter *B.subtilis* was inhibited. The Rf values calculated from bioautography indicated that the Cacti species have different active compounds. Antioxidant activity both methods showed low results. As illustrated in Table 4.4 all three Cacti species extracted with distilled water inhibited the highest activity on 15-LOX in comparison the quercetin in both two seasons. Slight toxicity was observed in *Cereus jamacaru*. Further studies are required to identify the active compounds which showed significant anti-bacterial and antioxidant activities and In vivo investigation.

Keywords: Cacti, indigenous knowledge, phytochemicals, biological activities, cytotoxicity

The comparison of immunological responses of Brahman, Nguni and Angus cattle infested with *Rhipicephalus microplus* and *Rhipicephalus decoloratus*

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Background: Ticks and tick-borne diseases pose major threats to modern South African cattle production. *Rhipicephalus microplus* and *R. decoloratus* are important tick species currently spread throughout most of Southern Africa. Current control methods are not considered sustainable because of various economic, social and environmental concerns. Host resistance to ticks is a characteristic of cattle and is dependent on breed type. An understanding of these resistance mechanisms is necessary if host resistance is to be exploited as an alternative control method. Host reaction to infestation is specific to the tick species. It was hypothesized that tick resistance is a product of co-evolution between host and parasite and a breed will thus show superior resistance to tick species that it has a historical relationship with.

Aim: To investigate cellular and immunological mechanisms of resistance to *R. decoloratus* and *R. microplus* in Nguni, Brahman and Angus cattle.

Methodology: Following the collection of control samples on all animals (n=36), one half (n=6) of breed group (n=12) was artificially infested with roughly 100 unfed larvae of *R. microplus* while the other half was similarly infested with *R. decoloratus*. Approximately 12 hours' post infestation, multiple blood samples were drawn and skin biopsy samples were collected from visible parasitized sites of all animals. The remaining ticks were allowed to

mature and tick counts were performed on day 18 post infestation. The blood samples were used for comprehensive haematology and serum biochemistry profiles while the skin biopsy sites were sectioned for cell counts and histopathological scoring of tissue using H&E staining.

Results: The Brahman breed displayed lower ($p<0.01$) tick counts compared to both the Nguni and Angus breeds. *Rhipicephalus microplus* displayed a higher success rate ($p<0.05$) compared to *R. decoloratus* across all breeds. The Brahman breed displayed a lower ($p<0.05$) level of mean cell volume (40.94 fl). The Nguni breed displayed a lower ($p<0.05$) level of platelets ($311.59 \times 10^9/\text{dl}$). The Angus breed displayed the lower ($p<0.05$) absolute level of circulating neutrophils ($3.65 \times 10^9/\text{l}$) and a higher ($p<0.05$) level of lymphocytes ($9.69 \times 10^9/\text{l}$) compared to the Nguni, but not Brahman breed. The Nguni displayed a higher ($p<0.05$) absolute level of eosinophils ($0.43 \times 10^9/\text{l}$) compared to the Brahman, but not Angus breed. The Brahman breed displayed higher ($p<0.05$) albumin levels (28.85 g/l) compared to both breeds and higher ($p<0.05$) alanine transferase (59.70 U/l) levels compared to the Angus breed. The Angus breed displayed higher ($p<0.05$) levels of blood urea nitrogen (5.21 mmol/l) compared to the Brahman breed. The Brahman breed displayed lower levels of fibrinogen (1.77 g/l) than the Nguni and Angus breeds. Animals infested with *R. microplus* displayed a higher ($p<0.05$) serum globulin level (43.37 g/l) than those

infested with *R. decoloratus*. No differences between breed or tick species groups were observed within the number of cellular infiltrates or histopathology scores.

Discussion: The study highlighted several haematological and biochemical parameters that could likely constitute important factors in parasitic resistance by breeds. It has supported previous findings that susceptible animals might be prone to altered protein metabolism and severe inflammatory responses.

Conclusion: It was concluded that a specific evolutionary relationship is not necessarily the primary contributor to the manifestation of the resistant phenotype and a high level of cross resistance is possible. *R. microplus* has a superior parasitic aggression which will have an influence on its displacement of *R. decoloratus*. Immunological parameters are important when assessing tick-host relationships, but the influence on the host includes a wider range of factors. The 12-hour interval is promising for further investigations, but higher intensities of infestation are recommended to increase the reliability of assessments.

Causes of post-slaughter loss of bovine carcass and offals in the eastern cape province, south
africa

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Background: Infectious and non-infectious diseases often lead to meat condemnation at the abattoir. The continuous post production food loss of this nature undermines the effort to achieve the United Nation sustainable development goal number two- “Zero Hunger.”

Aim: Hence this paper evaluates the causes of carcass and offals condemnation in three abattoirs in the Eastern Cape Province of South Africa to adequately inform designated authority of the implication of such loss to food security.

Methodology: A retrospective study (RS) (n = 51 302) involving the use of abattoir slaughter records from 2010–2012 and a post-mortem meat inspection (PMMI) (n = 1374) was conducted from July to December 2013.

Results: A total of 11346.2 and 927.5 kg of meat was lost during the RS and PMMI respectively. The leading cause of tongue condemnation of the RS was (Abscess: 0.08%, 0.03% and 0.05%), spleen (Splenomegaly: 0.21%, 0.55% and 0.2%), heart (Inflammation: 0.9%, 1.85% and 0.75%) and kidney (Nephritis: 0.94%, 1.01% and 1.18%). The PMMI revealed the main causes of tongue condemnation as gunshot injury (0.9%), spleen (infarct: 3%), heart (haemorrhage: 4.5%), kidney (cyst 5.2%) and carcass (improper evisceration

27%). The direct financial loss due to these condemnations was (RS: 4759.4 USD) and (PMMI: 1996.8 USD).

Discussion: Food losses at the abattoir which is associated with both infectious and non-infectious diseases continue to hamper the effort to attain food security.

Conclusion and recommendation: The result of this study provides baseline information on major causes of loss of ideal protein food source in abattoirs in South Africa. The strict application of good slaughter practices, primary animal health care, and herd health programmes will mitigate these challenges.

Sclerocarya birrea caffra nut meal: dietary effects on circulating metabolic substrates,
haematocrit, and general health profile of dorper lambs

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Background: Marula nut meal (MNM), a by-product of oil extraction, is a promising dietary protein source in feeds. Research interrogating the potential of non-conventional dietary protein (NCDP) sources largely focuses on animal productive performance. Little or no attention is given to the health cost of the NCDP on the animal.

Aim: We evaluated the effect of substituting soyabean meal (SBM) with MNM in grower-fattening diets of male Dorper lambs on PCV, fasting blood glucose and serum cholesterol concentration, serum ALT, ALP and α -amylase activity, serum creatinine, total bilirum (TB), BUN, total protein (TP), globulin and albumin (GloAlb), calcium and phosphorus concentration.

Methodologies: Five diets were formulated: diet 1 through to 5 had the SBM substituted with MNM on a CP basis, at 0, 25, 50, 75 and 100%. Forty 112-day old male Dorper lambs were randomly allocated to the five dietary treatments. Following a 21-day adaptation period the lambs were fed for 63 days, fasted over night and blood collected from the jugular vein. Whole blood was used to determine the haematocrit and blood glucose concentration. Harvested serum was used to determine the health profile of the lambs using a colorimetric-based IDEXX Clinical Veterinary System. Data was analysed using the Genstat statistical

software. A one-way ANOVA was used to analyse data. The LSD was used to compare means.

Results: Dietary MNM did not affect PCV and circulating blood glucose and serum cholesterol concentration. The lambs' serum TP, GloAlb concentration and serum ALT, ALP and α -amylase activities were similar ($P>0.05$). There were no significant differences ($P>0.05$) in the lambs' serum BUN, creatinine and TB concentration. The lambs' serum calcium and phosphorus concentration were similar.

Discussion: Serum TP and GloAlb indicate hepatic synthetic function. ALT and ALP indicate hepatocyte and biliary cell damage, respectively and are used as surrogate markers of liver function. The similarity in TP and GloAlb suggests that MNM did not compromise the liver's synthetic capacity. Similarity in ALT and ALP activity suggests that dietary MNM did not cause hepatocyte and biliary cell damage. Serum α -amylase activity is a marker of exocrine pancreas and or salivary gland pathology. α -amylase is also produced in the bone marrow of growing animals. The similarity in α -amylase activity indicates that MNM did not cause exocrine pancreatic

and salivary glands pathology. Similarities in serum creatinine, BUN and TB concentration suggest that MNM did not compromise the kidneys' excretory function.

Conclusion: MNM could replace SBM in lamb fattening diets without perturbing the homeostasis of circulating metabolic substrates and without risk on liver and kidney function and without causing overt pathology of the salivary glands and exocrine pancreas.

In-vitro validation of *Solanum incanum*'s acaricidal and repellency properties in ethno-veterinary control of goat ticks

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Background: Ticks are vectors of tick borne diseases and are usually controlled using conventional acaricides which are highly costly and not readily available for resource-challenged farmers. As a result resource-challenged farmers have to use alternative remedies in tick population management. However, these alternative remedies have not been validated and therefore becomes a need to validate their use. .

Aim: The objective of the study was to determine the acaricidal and repellency activities of *Solanum incanum* fruit extract used by goat farmers in Bubi district of Matebeleland North Province, Zimbabwe.

Methodologies: *In-vitro* repellency and contact bioassay models were used out to determine the repellency and acaricidal properties of *Solanum incanum* (bitter apple) on nymphal stage of *Rhipicephalus appendiculatus* (brown ear ticks). Five concentrations of *S. incanum* fruit extracts used were, 5, 10, 20, 50 and 100% (weight/volume) compared to Tick buster® (Amitraz 12.5% EC) a positive control and distilled water (negative control) on contact bioassay. Mortality rates at each level of treatment level were noted down after 24, 48, 72 and 96 hours. For repellency bioassay 5, 10, 20, 50 and 100% *S. incanum* fruit extract

concentration were tested against distilled water and 'Peaceful sleep'(*Diethyl-m-toluamide* 250mg) being the positive control at 20, 40, 60, 120 and 180 minutes interval.

Results: A 50% and 100 % *S. incanum* fruit juice concentration recorded the highest acaricidal property ($P < 0.05$) than the other three fruit extracts (5, 10, and 20 %). It gave a mortality of 100 % and others were 46.7%, 71.8% and 95.7% respectively, after *R. appendiculatus* were subjected to acaricidal treatments for two days. The positive control tick buster® had a mortality of 100% while distilled water had 0.0%. With *in -vitro* repellency bioassay 'peaceful sleep' the reference product was repellent for the whole 180 minutes time framed of the experiment. All concentrations of *S. incanum* (5, 10, 20, 50 and 100 %) had no repellency activity after 180 minutes.

Discussion: The acaricidal effects of *S. incanum* could be due to the presence of toxic glycoalkaoids such as solasonine, alkamines such as nitrosamines and carcinogenic glycosides which is supported by other studies. The 20 % treatments of *S. incanum* maintained the tick populations at low levels that may help the goats to build immunity against ticks and the pathogens they transmit.

Conclusion: The study revealed that *S. incanum* has acaricidal effect and no repellency activity. The acaricidal effect was concentrate dependent.

Quantification of the anti-nutritional factors in locally produced grain legumes

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Background: Anti-nutritional factors (ANF's) occur in many seeds, such as legumes, which are destined for human and animal consumption. These seeds are often used as an alternative source of protein in animal feed. Since ANF's affect production negatively, the levels thereof in locally produced seeds should be quantified.

Aim: To quantify the contents of anti-nutritional factors in different grain legumes produced in the Western Cape area of South Africa.

Methodologies: Samples of lupins (*Lupinus albus*, sweet *Lupinus angustifolius*, bitter *Lupinus angustifolius* and *Lupinus luteus*), field peas (*Pisum sativum*), faba beans (*Vicia Faba*) and narbon beans (*Vicia Narbonensis*) were collected in the Western and Southern Cape grain producing areas of South Africa and analysed for alkaloids, non-starch polysaccharides (NSP) and tannins. Two samples of each grain legume were collected, and pooled over a two-year period. The alkaloid content was determined by spectrophotometry. The tannin content was determined by the modified Jerumanis procedure and the NSP content was determined by the Englyst-Cummings procedure.

Results: There were no differences ($P < 0.05$) in the alkaloid levels (measured on dry matter basis) of *L. Luteus* (42.6 ± 589.7 mg/kg) and sweet *L. Angustifolius* (49.1 ± 373 mg/kg) cultivars. The *L. Albus* (1302.2 ± 240.8 mg/kg) cultivars had higher ($P < 0.05$) alkaloid levels

than the *L. Luteus* and sweet *L. Angustifolius* cultivars. Higher ($P<0.05$) alkaloid levels were found in the bitter *L. Angustifolius* (15204.5 ± 589.7 mg/kg) cultivars compared with the *L. Albus* cultivars, the *L. Luteus* and sweet *L. Angustifolius* cultivars. The lupin cultivars, namely *L. Albus* (0.00 ± 0.1 g/kg), sweet *L. Angustifolius* (0.00 ± 0.2 g/kg), bitter *L. Angustifolius* (0.00 ± 0.4 g/kg) and *L. Luteus* (0.00 ± 0.3 g/kg), had lower ($P<0.05$) tannin levels compared with faba beans (4.75 ± 0.4 g/kg), narbon beans (2.55 ± 0.4 g/kg) and peas (3.45 ± 0.3 g/kg). The NSP content of the lupin cultivars (*L. Albus*: 25.8 ± 2.11 g/100g, *L. Angustifolius*: 31.02 ± 2.59 g/100g and *L. Luteus*: 17.77 ± 3.66 g/100g) were higher ($P<0.05$) than that of narbon beans (4.17 ± 5.18 g/100g), faba beans (13.96 ± 5.18 g/100g) and peas (10.48 ± 3.66 g/100g).

Discussion: Alkaloid levels in raw materials are of importance when feeding monogastric animals. Feed rejection has been observed when the alkaloid level of a diet exceeds 0.03%. Tannins are poly-phenolic compounds that inhibit the activity of digestive enzymes including trypsin, amylase and lipase. Plant origin, plant variety, degree of processing and the proportion of NSP-rich hull in the final product are factors that determine the NSP content of vegetable protein sources.

Conclusions and recommendations: As lupins are high in alkaloids, which may lead to a bitter taste in feed, it is important that the levels must be analysed before using in animal feed, due to the possible detrimental effect it may have on the utilization of feed. The lupins contained no tannins when compared to the other grain legumes in this study. The higher tannin content of faba beans may restrict the inclusion rate thereof in diets.

Differential expression of tick-resistance related genes in beef cattle following artificial infestation with rhipicephalus ticks

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Background: The differential expression of candidate genes is associated with the subsequent suppression of cell-mediated inflammatory responses and the activation of antibody induction at the tick bite site. Breeds which may have experienced long periods of evolution in the presence of a particular tick species, and are resistant to that tick species, may have accumulated genes affecting resistance to that tick species. Thus, the Nguni and Brahman breeds are thought to have long term associations and co-evolutionary statuses with the *Rhipicephalus decoloratus* and *R. microplus* tick species, respectively. In contrast, the Angus breed lacks co-evolution or long-term association with either of the two tick species.

Aim: To investigate the gene expression of cytokines, chemokines and their receptors, toll-like receptors and other candidate genes at the host-tick interface on the skin of Angus, Brahman and Nguni cattle artificially infested with *R. microplus* and *R. decoloratus* ticks.

Methodology: Thirty-six cattle from three breeds, Angus (n=12), Brahman (n=12) and Nguni (n=12) and two tick species namely *R. microplus* and *R. decoloratus* ticks, were used. Six animals per breed were artificially infested with *R. microplus* ticks (n~100 ticks per animal) and the remaining six infested with *R. decoloratus* ticks (n~100 ticks per animal). Three full-

skin thickness 5mm diameter skin biopsies were collected from each animal; two from non-parasitized skin pre-infestation and one from the feeding sites of visibly engorging ticks 12-hours post-infestation. RNA was extracted from the skin biopsies and used in real-time PCR analyses to investigate differential gene expression. The fold change value for each gene was calculated using the $\Delta\Delta CT$ method.

Results: There was no breed by tick species interaction, while no differences in gene expression were detected between tick species. Differences were observed in the gene expression between breeds, with the Brahman cattle displaying significantly different ($P < 0.05$) expression levels than the Angus cattle for genes *LUM*, *TBP*, *TRAF6* and *B2M*. *LUM* had expression levels which were significantly higher in the Brahman and Nguni cattle as opposed to the Angus cattle.

Discussion: *R. microplus* and *R. decoloratus* ticks share numerous morphological characteristics which might explain the lack of differences in their feeding signature and, subsequently, host gene expression profiles. Genes *LUM*, *TBP*, *TRAF6* and *B2M* encode products of the extracellular matrix primarily involved in tissue repair. *LUM* presented itself as a potential biomarker for tick resistance in cattle. Breed variations only accounted for approximately 30 percent of the observed variation in gene expression. This suggests that the majority of the differential gene expression profiles produced in cattle post infestation with *Rhipicephalus* (*Boophilus*) ticks was likely due to a complex array of other factors, in addition to variations in breed and tick species.

Conclusion/recommendations: No important tick species \times breed interactions that would suggest differences according to the co-evolutionary history of tick species and cattle breeds were observed. *LUM* needs to be validated as a potential biomarker for tick resistance in cattle.

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ABSTRACT

The incidence of metabolic diseases, conditions or disorders may be seen as a result of the insufficiency of nutritional components such as proteins, minerals, water, disturbance in metabolic developments, extra distribution of mineral to the foetus, increased forfeiture through milk, urine and faeces. Inability to account for the nutritional requirements to maintain development, production and reproduction in livestock still remain a challenge due to the imbalanced feed supply. To develop a physiological of bovine reproductive conditions (downer cow syndrome, dystocia, retained placenta, vaginal prolapse and abortion) in order to establish a reference tool for animal care practitioners. A total of 108 blood samples were collected between 2012 and 2015 from cases of reproductive conditions such as downer cow syndrome (n=13), dystocia (n=14), retained placenta (n=13), vaginal prolapse (n=9), abortion (n=28) and those from cows in the final trimester of pregnancy (n=31) reported to the North-West University teaching hospital. Structured questionnaires were also used to collect data from farmers in the study area. Farmers were interviewed during farm visits and at community outreach programs organized by North-West University Animal Health Department. Data were analysed in SAS (version 20) using the analysis of variance techniques (ANOVA). The results were expressed as means \pm SEM. The different treatments were significant if the associated P-value was less than the alpha level established (i.e. $P < 0.05$). Correlation analysis was performed to see if there is association between reproductive conditions, breed types and blood chemistry between the experimental groups. The data from completed questionnaires were coded, captured and analysed using Statistical

Package for Social Sciences (SPSS) version 21. The results show that most (53.9%) of the cows which encountered downer cow syndrome were in ages between 3-4 years, similarly those which aborted (60%) were mostly in that age group. Greatest of proportion in incidences were found in the Brahman breed cow which aborted (60%) and those that encountered vaginal prolapses (40%). Calcium and magnesium levels in this study were found to be significantly lower than the normal range in all breeds (Afrikander, Bonsmara, Brahman, Nguni, Charolaise, mixed breed and Drakensberger) with values ranging between 0-3.2 mg/dL and 0.32-0.7 mg/dL, respectively.

The prevalence of reproductive conditions was more prominent in the Brahman breed. Younger cows were more susceptible to the conditions as compared to the old ones. Deficiencies of mineral such as calcium and magnesium showed to have an influence on the occurrence of reproductive conditions, which impairs cow fertility. Increased incidences of conditions such as downer cow syndrome, abortion, dystocia, retained placenta and vaginal prolapses in communal areas are a serious concern. Most animals showing reproductive conditions had deficiency of major minerals such as calcium, magnesium and potassium, hence the lack in energy. There is a need for proper herd management and disease control in the rural areas. Strategies such as evaluating nutritional and mineral status of cattle in these areas need to be implemented.

Farmer perceptions on climate change and tick prevalence from cattle reared in sour and sweet rangelands communal in semi-arid environments

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Climate change is expected to have severe adverse effects on communal cattle production. The objective of the current study was to determine farmer perceptions on influence of climate change on prevalence of ticks and tick-borne diseases (TBD) in cattle in semi-arid environments. Perceptions of 174 cattle farmers in the sour and sweet rangelands of the Eastern Cape Province, South Africa were determined using structured questionnaires. Ticks, TBD, feed shortages and extreme weather conditions were highlighted as major constraints ($P < 0.05$) to cattle productivity and caused cattle mortality. Most farmers from the sweet (93 %) and sour (76 %) rangelands were aware of climate change. About 60 and 31 % of farmers in the sweet and sour rangeland, respectively, perceived increased prevalence of parasites, cattle diseases and decreased cattle productivity due to climate change. An escalation of *Otobius megnini* and *Amblyoma hebraeum* due to climate change was reported by 30 % and 58 % of the farmers in the sweet and sour rangeland respectively. Most farmers reported the existence of climate change, but few made significant changes to farming practices in response to perceived change in climate. It was concluded that farmers in both rangeland types perceived that climate change increased tick prevalence in cattle. Objective measurements of the effects of climate change on tick prevalence in communal cattle are recommended.

Prevalence of gastro-intestinal parasites in different agro-ecological zones of Limpopo
Province

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Background: Generally goats are kept for their meat, milk, skins, ceremonial purposes and investment in rural areas. Goat productivity is managed extensively with low weaning rate, high mortality rate and low turnover. Exposure of goats to gastro-intestinal parasites (GIP`s) is one of the factor contributing to low productivity of goats in rural areas. In order to improve goat production in rural areas, geographical distribution and prevalence of GIP`s in different agro – ecological zones (AEZ) and seasons (autumn, winter, spring and summer) should be clearly understood.

Aim (s): To investigate the prevalence and distribution of GIP`s in different AEZ`s of Limpopo province.

Methodologies: Four villages per AEZ under arid, semi-arid, humid and sub-humid were selected. In each AEZ, at least 20 male and 20 female indigenous goats of similar age were

randomly selected and faecal collection was conducted seasonally. Faecal egg count was determined using a modified McMaster technique. Data collected was subjected to Frequency and ANOVA procedures of SAS.

Results: In a total of 340 indigenous goats, 92 (27%) were infected with GIP's namely liver fluke (*fasciola hepatica*), tape worm (*moniezia expansa*), wire worm (*haemonchus contortus*) and roundworm (*naemonchus*). The prevalence of liverfluke, tape worm and roundworm in indigenous goats ranged between 3-9%. Low prevalence could be associated with strong immunity to GIP's acquired by local goats breeds. Wireworm was the most dominant parasites, in humid zone (40%) and in summer season (54%). Tape worm was not prevalent in humid zones and summer season. Liver fluke was not observed in summer season. The faecal egg count of liver fluke, tape worm and roundworm was not influenced by AEZ and season. The effect of both AEZ and season on wire worm faecal egg was significant ($P < 0.05$). The faecal egg count (eggs/gram) mean values observed for liver fluke, tapeworm, wireworm and roundworm were 136, 144, 378 and 163, respectively.

Discussion: The results demonstrated lower prevalence of tape worm, liver fluke and roundworm and were not dependent on AEZ and season. The prevalence of wire worm parasites varied depending on the AEZ and season, with the highest prevalence observed in humid AEZ and in summer season. Variation could be attributed to parasites adaptation to different temperature, humidity ranges and rainfall. The infection intensity of wire worm was high compared to other GIP's.

Conclusion/Recommendation: Result showed that wireworm is the most dominant internal parasite. Its prevalence and intensity may affect the productivity of indigenous goats in the Limpopo Province. The control measures of all GIP's should be implemented in all seasons. More work still need to be conducted on identifying genetically resistance goats to GIP's.

Assessment of behaviour, fecal glucocorticoids and saliva cortisol levels in multiparous
Nguni cows during farm handling

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Background: In cattle handling, blood cortisol has been used as a reliable indicator to determine how animals respond to different degrees of stress. In addition to behaviour observations, the use of minimally invasive techniques has however gained popularity in animal welfare related research.

Aims: To characterise successive handling and parity effect on faecal glucocorticoid metabolites (FGM), avoidance distance score (ADS) and crush score (CS). 2) To determine the effect of subsequent handling on the relationship between blood and saliva cortisol.

Methodologies: Twenty-one Nguni cows were divided into three parity groups; 1 n= 9 (parity 2-3), 2 n=4 (parity 4-5) and 3 n=8 (parity 6-8). Once a week, for five successive weeks, faecal samples were collected to analyse for FGM and behavioural parameters were observed. A hormonal challenge, using a standardised dose (1µg/kg) of ACTH was performed on six cows in week six. From these cows, saliva and corresponding blood samples were collected and analysed for cortisol.

Results: Repetitive handling had an effect ($P<0.05$) on FGM but not on ADS and CS. Inversely, parity did not affect ($P>0.05$) FGM concentrations but affected ADS ($\chi^2 = 13.183$, degrees of freedom =4, $P=0.0104$) and CS ($\chi^2 =20.3769$, degrees of freedom =8, $P= 0.0090$).

Most group 3 cows could not be approached ($P < 0.05$) at a distance of at least 2 m in comparison to other group cows. Group 1 cows were nervous ($P < 0.05$) whilst being handled in the crush. Saliva cortisol concentrations increased then decreased ($P < 0.001$) during the sampling period. Blood cortisol concentrations did not vary. The correlation between saliva and plasma cortisol concentrations was weak ($r = 0.0131$, $P = 0.9310$).

Discussion: Our findings for FGM are similar with other studies, showing that with each subsequent handling encounter, glucocorticoid concentrations decrease. This is an indication that cows can adapt to handling stress. Results are however contrasting to other studies on parity effect. The high avoidance behaviour by cows of parities 6 to 8 could be attributed to fear. Results for blood cortisol were not consistent with findings of other studies. From the time the cows were handled to when they were restrained for blood collection, the aggressive shaking of the crush could have led to insignificant variations in blood cortisol across the sampling time. In addition, pulsatile episodic secretions could have interrupted the anticipated pattern in plasma cortisol, resulting to dissimilar results. The pattern for saliva cortisol was more related to earlier findings of other researchers. Salivary cortisol could have reflected the biologically active fraction of total plasma and blood cortisol the total fraction.

Conclusions/recommendations: Based on our findings, successive handling affects faecal glucocorticoid metabolites concentrations only and classifications of cows by parity affects their avoidance and crush scores. Animal handling prior to characterisation of the relationship between blood and saliva cortisol may lead to a weak relationship between the two parameters.

Seasonal dynamics and species composition of ticks (acari: ixodidae) infesting cattle in
different habitat types in the eastern cape province, south africa

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Background: Ticks are the major economic constraint to successful cattle industry in South Africa. About 80% of the cattle population globally are subjected to tick infestation, resulting in low production and the transmission of tick-borne diseases (TBDs). Various studies reported that tick abundance may vary strongly between different habitat types.

Aim: The study aimed to assess the population dynamics of questing and parasitic ticks in three agro-ecological zones of the Eastern Cape Province

Methodology: Ticks were collected from a total of 360 randomly selected cattle monthly in three agro-ecological zones for a period of 12 months (April 2016-March 2017). At each locality, 10 animals were sampled from Honeydale farm (Nguni), Bathurst (Bonsmara) and Adelaide (Bonsmara) research stations. A half body tick collection was performed and visible ticks were collected by the means of fine-forceps after the animals had been restrained. The ticks from each animal were preserved in separate labelled vials containing 70% ethanol, and subsequently counted and identified to genus and species level using a standard stereomicroscope. At each site, six replicate drags of 100 m, approximately 50 m apart, were

performed. All instars of ticks were identified at University of Fort Hare, Animal Science laboratory and those that could not be identified were confirmed at Dohne Research Institute.

Results: A total number of 31425 ticks belonging to ten species were collected during the survey. *Rhipicephalus decoloratus* (32.50%) was dominant), followed by *R. evertsi evertsi* (18.84%), *R. appendiculatus* (17.26%), *Amblyomma hebraeum* (16.30%) and *R. simus* (7.69%). The other tick species namely *Ixodes pilosus* (3.84%), *Hyalomma rufipes* (3.46%), *R. foliis* (0.08%) and *H. elliptica* (0.04%) together with *Haemaphysalis silacea* (0.02%) were sporadic infestation.

Agro-ecological zones showed significant differences ($P < 0.05$) in tick species and distribution. Significantly more *A. hebraeum* and *R. decoloratus* were collected in Thicket vegetation during summer season compared to all other vegetation types ($P < 0.05$). *R. evertsi evertsi* had higher counts ($P < 0.05$) in Dry grassland during summer season compared to other vegetation types. No *H. rufipes* was collected in Thicket vegetation. Engorged ticks from cattle were significantly higher during the summer season across different farms. Free-living ticks were widely distributed across different seasons but significantly lower during the winter season.

Discussion: These findings concur with other studies showing high prevalence and distribution of adult ticks during the summer season. Warm-humid environment plays a key role for higher tick loads in cattle. However, it is of interest to note the absence of *R. microplus*, whose trend to invade new areas previously colonised by *R. decoloratus* has been demonstrated by various authors.

Conclusion and Recommendation: Agro-ecological differences and seasonal variations had an influence on tick species distribution and abundance. The absence of *R. microplus* in this study highlights the importance of further research as this tick is highly adaptable and invasive in the continent.

Effectiveness of pour-on pesticides when applied at alternative application sites in angora
goats

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Background: Lice infestation has a major impact on the production of mohair in South Africa. Up to 25% less mohair could be produced due to lice infestations. The common practice used by farmers to treat their goats for lice infestation is application of pesticides. When treating goats with pesticides, the problem arises with the residue in the hair after the goats have been shorn. Another cause of concern is the fact that the pesticide washed out of the hair during processing and becomes part of the effluent water that may be pumped back into the environment and cause damage to the environment. It was found that three months after dipping, the amount of residue in mohair still remained above the accepted levels set by the EU Ecolabel and OEKO-TEX® Standard 100.

Aim: The aim of this study was to observe if the effectiveness of two pour-on pesticides in killing lice will be affected when the pesticides are applied at only the ears and tail, compared to the backline of Angora goats with three months' hair growth and Angora goats that were just shorn.

Methodologies: Twenty-four 4-year old Angora goats, which had not received any pesticide treatment for 8 months, were used in this study. The animals were divided into 8 groups in such a way that the pre-treatment lice count did not differ between the application sites (ears and tail or backline) within hair lengths (long and short hair) and pesticides (Pesticide T -

insect growth regulator, and Pesticide W - contact, synthetic pyrethroid). This means that the Pesticide T-ears/tail application-short hair group and the Pesticide T-backline application-short hair group had the same start lice count. The same applied for the other groups. Pesticide T and Pesticide W were applied at the recommended rate of the manufacturers. Live lice were counted weekly at ten predetermined sites over the body for an 11 week period.

Results: With both Pesticide T and Pesticide W lice counts in all groups were reduced within the first seven days. There was no difference in effectiveness of either pesticide whether it was applied along the backline, or only at the ears and tail. Furthermore, lice counts at all the counting sites over the body decreased. For Pesticide T, the long hair animals had significantly more lice than the shorter hair animals, while there was no difference in lice counts between long and short hair animals in the Pesticide W groups.

Discussion: It was found that the effectiveness of both pesticides was not affected when the pesticide was applied at the alternative sites. The contact pesticide was equally effective in long and short hair animals, while it seems that the insect growth regulator was more effective when applied to short hair animals.

Conclusions: Using a contact pesticide, this alternative application method could be used in the mohair industry when farmers are faced with the problem of lice infestation in their goats less than three months prior to shearing. Taking into account a possible loss of 25% in mohair production, combined with a decreased quality, farmers cannot afford to leave lice infestations untreated.

Protocol for selection for resistance / resilience to *haemonchus contortus* under south african conditions

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Background: The issue of resistance of internal parasite species to worm remedies is widespread throughout South Africa and affects all small stock farmers. *Haemonchus contortus* is the most important parasite and causes the most losses among sheep in the summer rainfall regions in South Africa. The farm Wauldby, in the Stutterheim district, has a well-documented history of heavy *Haemonchus contortus* challenge and of *Haemonchus* resistance to all five major anthelmintic groups on the market prior to 2011. Several anthelmintic resistance trials have been done at Wauldby over the years. The severe anthelmintic resistance problem on the farm has inadvertently resulted in selection of sheep over many years with a high degree of resistance / resilience to internal parasites as drenching with anthelmintics has been largely ineffective. At the end of 2011, a project aimed at selection for resistance to *Haemonchus* was implemented at this farm.

Aim: The aim of this study was to develop protocols for selection for resistance / resilience to *Haemonchus contortus* under South African conditions.

Methodologies: Data on faecal egg counts (FEC), Famacha© score (FAM) and body condition score (BCS) recorded from 2011 to 2015 during the parasite resistance trial done on the Wauldby Dohne Merino stud were analysed with various univariate, multivariate and

repeatability animal models using the AsReml programme. The results were used to assist in the development of protocols for selection for resistance / resilience to *Haemonchus contortus* under South African conditions.

Results and Discussion: Two protocols were developed; one for stud breeders and one for commercial producers. In the case of stud animals, recording of individual animals should take place. FEC, FAM and BCS of all lambs could be recorded once before weaning, depending on the rainfall and climatic conditions. All lambs could be drenched after data collection. After weaning, FAM and BCS should be recorded every 14 days until the first week of July when *Haemonchus* challenge has decreased. FEC should be recorded at the beginning (January) and twice during the peak *Haemonchus* season (March and May). Lambs should only be drenched when they have a FAM of 2.5 or more. Any lamb that was drenched should be noted and culled. Replacement rams and ewes should be selected from the animals that did not need dosing on the basis of a selection index incorporating FEC, FAM and BCS and breeding values for FEC. In the case of commercial animals, pooled FEC could be taken before weaning. After weaning only ewe lambs should be recorded. FAM and BCS should be recorded every 14 days until the *Haemonchus* challenge has decreased. FEC should be monitored through monthly pooled FEC samples. Lambs should only be drenched when they have a FAM of 2.5 or more. Any ewe lamb that was drenched should be noted and lambs that needed 2 or more drenchings should be culled.

Conclusions: A protocol for selection for resistance / resilience to *Haemonchus contortus* under South African conditions has been developed and needs to be validated on various farms before implementation on a wider scale.

Molecular characterisation of foodborne pathogens and their antibiotic resistance profiles in ready-to-eat meat sold around Johannesburg Central Business District, Gauteng Province

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Background: The intense use and misuse of antibiotics in animal's farms to prevent diseases are undoubtedly the major forces associated with high numbers of resistant pathogenic and commensal bacteria worldwide.

Aim: The aim of this study was to identify and characterise foodborne pathogens and their antibiotics resistance profiles in ready-to-eat meat sold around Johannesburg Central Business District (CBD), Gauteng Province.

Methodology: A total of 115 samples such as chicken meat (25), chicken gizzard (21), beef intestines (20), beef head meat (24) and wors (25) were collected randomly from the three streets in Johannesburg CBD. Meat samples were analysed for microbial contamination using the conventional biochemical test and molecular methods. The isolated bacteria were evaluated for antibiotic resistance profiles against eight common antibiotics (Ampicillin, Tetracycline, Chloramphenicol, Erythromycin, Ciprofloxacin, Streptomycin and Sulphonamides), using the disc diffusion method.

Results and Discussion: A total number of 13 bacteria spp were detected in the samples namely; *Staphylococcus aureus*, *Lysinibacillus spp*, *Planomicrobium glaciei*, *Bacillus subtilis*, *Bacillus cereus*, *Bacillus spp*, *Bacillus thurigiens*, *Planococcus antarcticus*, *Kurthia spp*, *Planomicrobium glaciei*, *Enterococcus faecalis*, *Citrobacter spp* and *Micrococcus caseolyticus*. The antibiotic resistance test revealed that most isolates had multidrug resistance ability such as *Kurthia spp* was resistant to Ampicillin (18%) and Tetracycline (29%) , *Staphylococcus aureus* (Ampicillin (20%), Tetracycline (50%), Sulphonamides (50%), Streptomycin (100%), Chloramphenicol (50%) and Erythromycin (50%) , *Bacillus cereus* (Ampicillin (29%), Tetracycline (17%), and Erythromycin (25%) among others.

Conclusion and Recommendation: This study reveals a wide diversity of bacteria spp. contaminating the street food; hence consumers of ready-to-eat meat sold around Johannesburg CBD are at risk of food poisoning. The relatively high multi-drug resistance exhibited by these bacteria calls for concern. Hence strict intervention strategies should be put in place by government agencies to prevent the probability of food poisoning in the country.

Prevalence and seasonal changes in the population of gastrointestinal parasites of sheep on three different veld types in communal farming areas of the Eastern, South Africa

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Background: Parasites are a major problem which inhibits animal productivity throughout the world. Gastrointestinal nematodes are ubiquitous parasites of grazing ruminants and causes a decrease in survival, live-weight gain, wool growth and reproductive performance. The prevalence of gastrointestinal helminthes is related to the agro-climatic conditions like quantity and quality of pastures, temperatures, humidity and grazing behavior of the host.

Aim: The aim of the study was to determine the prevalence and seasonal occurrence of gastrointestinal parasites of sheep in humid, semi- humid and arid zones of the Eastern Cape in the Southern Africa.

Methodologies: The study was conducted at Wartburg (humid), Allenwater (semi humid) and commonage areas at Cradock, (Siviwe and Phambili) (arid) in the Eastern Cape Province. At each study site three farmers were selected to contribute 10 Dohne merino female sheep (2-tooth) per kraal. Animals were tagged for identification. Feecal samples were taken monthly from January 2012 until December 2015 in order to determine Gastro Interstinal levels. At the beginning of the trial all sheep was drenched with a broad spectrum (Seponver plus) remedy to standardize the egg count of internal parasites. Sheep per site were only dosed when the feecal internal parasite egg per gram (e.p.g) counts exceeded the levels above 3000 for roundworms and 10000 for coccidia. An epidemiological questionnaire was used to

ascertain from farmers regarding animal health practices, the type of supplementary feeding used and what veld management practices were applied.

Results: A total of 3 374 of faecal samples were collected from sheep on the three different veld types. During winter higher levels of roundworms (2368.12 ± 3565.05) and coccidia (357.35 ± 391.25) levels were found at Wartburg than at Allenwater (roundworms- 1334.15 ± 1797.41), and (coccidia- 103.66 ± 271.69) and Cradock (roundworms- 621.68 ± 722.76) and coccidia (0.00 ± 0.00). During summer higher levels of roundworms (1418.73 ± 2628.32) and lower coccidia (0.00 ± 0.00) levels were found at Warburg than at Allenwater (roundworms- 698.49 ± 1869.99), and (coccidia- 37.12 ± 148.92) and Cradock (roundworms- 493.66 ± 695.54) and coccidia (190.14 ± 638.78).

Discussion: Previous studies reveal that the prevalence and occurrence of sheep internal parasites mostly roundworms is higher in humid areas than semi-humid areas which might be due to high temperature and moisture content. This weather conditions favors the growth and development of larvae on pasture resulting in increased contact between the host and parasites.

Conclusion/recommendations: Keeping in view the above results, some control measures for gastrointestinal parasites can be undertaken to reduce the intensity of the parasitic infection. In this regard, it is suggested that practice of rotational grazing of animals with low stocking rate may be adopted. Furthermore, it is suggested that anthelmimtic treatment on quarterly basis may be implemented to reduce the risk of reinfection. Good management practises is very important and the averages e.p.g counts of the internal parasites should be kept as low as possible to avoid stock losses.

Interaction effects of pen environment and sex on behaviour,
Injury levels and physiology of windsnyer pigs kept in a high stocking density

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Background: Pig production is generally increasing in the sub Saharan Africa as a result of the growing human population. Local genotypes, such as the Windsnyer pigs that are adapted to local conditions and thrive on fibrous feeds can be of much value with regard to feeding the growing population.

Aim: The objective of the study was to determine the interaction effects of pen enrichment and sex on behavioural activities, injury levels and physiology of Windsnyer pigs kept in a high stocking density.

Methodologies: Forty- eight 8 week old growing Windsnyer pigs, with an average initial body weight of 21.6 (\pm 9.01) kg were used. Four pigs were randomly assigned to either enriched or barren pens at a stocking density of 0.45 m² /pig. Enriched pens contained 2 litre bottles filled with stones and suspended at head level on ropes stretching across the pens. In addition, two plastic balls (90 mm in diameter) and 500 ml bottles (235 mm long) were placed on the floor of each enriched pen. Twenty-four animals (12 intact males, 12 females) were housed in physically enriched pens and 24 animals (12 intact males, 12 females) housed in barren pens.

Results: Pigs in barren environments had higher heart rates ($P < 0.001$) than those in enriched pens. There was an interaction of pen environment and sex on rectal temperature ($P < 0.001$). Females in enriched pens had higher rectal temperatures ($P < 0.05$) than females in barren pens. The time spent bullying was influenced ($P < 0.05$) by pen environment and sex. Female pigs in barren environment spent more time on bullying than females in enriched pens. There was an interaction of pen environment and sex on time spent lying down and walking ($P < 0.05$). Female pigs in enriched pens spent more time lying down than females in barren pens. There was an interaction of pen environment and sex on the number of injuries in the head, neck and shoulder region and other parts of the body ($P < 0.05$). Male pigs in barren pens spent more time on behaviours described as others, which were mainly tail biting, rolling and pivoting than females

Discussion: The lower heart rates enriched environments could be a reflection of being calmer and resting more as a result of spending more time on exploratory behaviours. Higher RR in females in barren pens than females in enriched pens could indicate increased stress levels in the female pigs. More time bullying may be a reflection of a dominant pig being more in control of the pen environment. The finding that female pigs in enriched environment spent more time lying down could be because they were trying to cool their bodies from the floor due to excitement as a result of enrichment. The observed interaction of pen environment and sex on skin injuries could be due to difficulty in avoiding an attack by an aggressor at higher stocking densities in the pen.

Conclusion/recommendations: It was concluded that pen enrichment reduced the number of injuries, especially for female pigs in enriched environment. For effective pen enrichment in male

pigs, it is recommended that farmers should provide more enrichment substrates than in female pigs.

Characterisation of Zulu sheep behaviours and distances between ewes and lambs from birth
till natural weaning

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Background: The knowledge on animal behaviour is important for animal welfare implications. Understanding traits such as when the ewe-lamb bond is formed is crucial for lamb survival. This study showed that the behaviour of the lambs is age related and the distance between the ewes and the lambs increased with age.

Aim (-s): In this paper, the behaviours of lambs and distances between ewes (n=10) and lambs (n=11) from birth till natural weaning are presented.

Methodologies: Grazing, suckling, lying, standing and walking behaviours were recorded. The distances between the ewe and their lambs were estimated using fence posts.

Results: During the first week after birth the lying behaviour of lambs was the highest (50%>), followed by the suckling behaviour. The grazing behaviour increased with number of weeks. The lambs stayed closer to their mothers during the first week with an average of 5 m. As the lamb grew the distance between the lamb and the mother increased until it reached a maximum of 20 m. Male lambs tended to be far from the ewe compared to female lambs in most weeks with peak distance of 23.9 m on the 19th week

Discussion: Similar results were obtained in other studies showing increase in grazing behaviour and distance between ewe and lamb after a number of weeks. The Increase of

grazing behaviour could be caused by rumen development and growth while the increase in distance might be caused by the decrease in milk production from the ewe.

Conclusion/recommendations: It was conclude that the behaviour of the lambs is depending on the age of the lambs. The lambs are vulnerable during the early stages of growth if the ewe and lamb bond is disrupted. The weakening of ewe-lamb bond is caused by decrease of maternal role from the ewe. Future studies are contemplated investigating the ewe-lamb bonding even after weaning.

An update on the distribution of the invasive cattle tick, *Rhipicephalus microplus* and the indigenous tick, *Rhipicephalus decoloratus* (Acari: Ixodidae) in South Africa

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Background: Both *Rhipicephalus microplus* and *R. decoloratus* are one-host ticks and major vectors of tick-borne diseases within the family Ixodidae. The *R. microplus* transmits *Babesia bigemina*, *B. bovis* and *Anaplasma marginale*, causing bovine babesiosis and bovine anaplasmosis respectively. Unlike *R. microplus*, *R. decoloratus* only transmits *B. bigemina* and *A. marginale* pathogens. However, *R. microplus* poses a greater potential threat to cattle production than the indigenous cattle tick, *R. decoloratus*, and is responsible for heavy losses in susceptible cattle globally.

Aim: The aim of the study was to address the paucity of information on the geographical distribution of blue ticks in the southern and north-western region of South Africa.

Methodologies: Between October 2013 and March 2015, tick samples were collected from four provinces, namely, Eastern Cape (ECP), Free State (FSP), Northern Cape (NCP) and Western Cape (WCP). Sampling in the ECP specifically focused on the regions west of East London. At each locality, 3 to 6 cattle were examined for ticks. Attention was paid to the predilection sites of blue ticks such as neck including dewlap, abdomen, and peri-anal region

of each animal. The ticks from each animal were preserved in separate labelled vials containing 70% ethanol, and subsequently counted and identified to genus and species level using a standard stereomicroscope. A single sample bottle was used for each animal and a pencil-written label containing information on date, farm, breed, sex and age of the host was inserted in each bottle. The geographic coordinates were used to plot the distribution of the two tick species (*R. microplus* and *R. decoloratus*) in A QGIS v 2.6.1.

Results: A total of 8 408 adult ticks were collected from cattle at 80 localities. *R. microplus* ticks were recorded extensively and for the first time in the NCP. The tick was also widespread in the western part of the ECP. Of these, 6 034 (71.8%) were identified as *R. microplus* and 2 374 (28.2%) as *R. decoloratus*. Overall, the two species were sympatric at 40 (50%) localities, with *R. microplus* present at more localities (80%) than *R. decoloratus* (58.8%). In addition, the abundance of *R. microplus* was higher than that of *R. decoloratus* at most localities where the two tick species were sympatric.

Discussion: Previous studies have shown the distribution of ticks infesting domestic animals in South Africa and at that time *R. microplus* was absent from the NCP, FSP and semi-arid regions of the other South African provinces. The data provided in this study suggests that *R. microplus* is further expanding its geographic range in South Africa. However, *R. decoloratus* is still widespread in South Africa except in areas where it is displaced by *R. microplus*.

Conclusion/recommendations: With the global increase in human movement, and that of their domestic livestock and wildlife, the introduction of new tick species and new hosts have been observed in novel areas, and the invasion of *R. microplus* in South Africa is such an example.

Analysises of herd performance among kyd farmers in three district municipalities of
mpumalanga

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Background: Kaonafatso Ya Dikgomo Scheme was established and designed specifically to enable developing and smallholder beef and dual cattle farmers to improve their livelihood by enhancing livestock productivity and market access. It is a vehicle to monitor and track the performance of their herds against performance standards to enable them to position their enterprises in accordance with market specifications. Challenges of herd fertility, mortality and growth rate receive outmost attention as core business pillars. Engagement of relevant role-players/ stake-holders was also a priority to fast track capacity building for a sound support base structure and resources mobilisation.

Aim: In this study, we evaluated herd performance of KyD participants through calving and mortality rates

Methodologies: Data were collected from three districts of Nkangala, Ehlanzeni and Gert Sibande in Mpumalanga. Calving and mortality rates were compared for the three years from 2014 to 2016.

Results: Results show that herd composition especially the proportion of cows in the herd declined from 55% in 2014 to between 45% and 46% in 2015 and 2016. Calving rates also declined from 55% to 45% over the same period. The bull:cow deteriorated drastically over the past season, declining from 1:25 to 1:10. Herd off-take rates also declined from 17% in 2014 to 9% in 2016.

Discussion: The concern is that herd mortality rates are increasing towards 10% while off-take rates remain unsatisfactory at 9%.

Conclusion & recommendations: The focus for this province should be on improving overall herd profile, addressing herd mortality and improving both calving and off-take rates

Human-animal interactions at an early age: effects on docility and stress responses in juvenile ostriches

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Background: Despite the progress which has been made towards developing the ostrich industry, farming with ostriches is still challenging because of their temperament and relatively wild behaviour. However, some ostriches display willingness to associate with humans. Such behaviour could be used to derive adapted husbandry practices that could assist in resolving these constraints, ultimately benefiting ostrich welfare.

Aim: To examine the effect of extensive human presence and regular gentle handling performed at an early age on stress responses and docility of farmed juvenile ostriches.

Methodologies: 416 day old chicks of mixed sex and genotype hatched at the Oudtshoorn Research Farm were exposed to three husbandry practices for 3 months over two breeding seasons. The husbandry practices were I1 (imprint 1: extensive human presence with audio, visual and touch stimuli, $n=66+70$), I2 (imprint 2: extensive human presence with audio and visual stimuli, $n=68+76$) and S (standard: human presence limited to feed and water supply, $n=66+70$). Birds were managed as a single group during data recording. Short term stress

responses were evaluated at 7.5 months old, by comparing the plasma Heterophil/Lymphocyte ratio (H/L; $n=187$) before and 72 hours after feather harvesting, while long term stress response was evaluated using the enzyme-linked immunosorbent assay ($n=48$) by quantifying corticosterone (CORT) concentration from the floss feathers. At 12 months old social behaviours such as inclination to approach human, allowing touch by human, aggressiveness and sexual behaviours were recorded three times a week for 5 months. Data was analyzed using t-test and generalized linear mixed models procedure of SAS, version 9.3 (Ethical clearance: Ref No.: R13/81).

Results: The H/L ratio was significantly higher 72 hours after feather harvesting than before harvesting (H/L0 vs H/L72: 7.61 ± 0.44 vs 10.80 ± 1.17 ; $P < 0.05$). While I1 birds showed no increase in H/L ratio, I2 and S birds showed increase H/L ratio 72 hours after feather harvesting ($P < 0.05$). Feathers from S birds had higher CORT concentrations compared to I1 birds (15.62 ± 1.04 vs 12.87 ± 0.84 pg/mg; $P < 0.05$, respectively). Husbandry practices did not have a conclusive effect on the willingness of birds to approach the human, allow touch interactions and expression of aggressiveness and sexual behaviours ($P > 0.05$). However, birds were more inclined to approach a familiar human observer than an unfamiliar person ($P < 0.05$).

Discussion: Ostriches exposed to extensive human presence and regular gentle handling at early age revealed no change in H/L ratio and had the lowest CORT concentration suggesting reduced acute and chronic stress sensitivity, while husbandry practices had no effect on aggressiveness and sexual behaviour.

Conclusion/recommendations: Extensive human presence and regular gentle handling at early age reduce stress and improve docility of ostriches when exposed to a familiar handler. Further studies are needed to evaluate the long term effects of these husbandry practices on

reproductive performance of these birds in natural mating and artificial insemination conditions and on welfare implications for this species.

Preliminary evaluation of the production levels and income contribution of livestock to rural households: case of LRAD farms in the Eastern Cape Province

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Background: The importance of livestock in Eastern Cape's economy has long been recognised and livestock is viewed as a source of income and employment for most of the South African rural communities. The majority of black farmers who are poorly resourced are sporadically distributed in the Eastern Cape Province. The socio-economic roles of livestock (financing and insurance) account for more than any other types of enterprises on the farms for rural households.

Aim: The aim of the study was to evaluate the production levels and relative income contribution of livestock in LRAD farms of the Eastern Cape to rural households.

Methodologies: The study was conducted between 2015 and 2016 in four district municipalities (DM) in the Eastern Cape, which are Sarah Bartman, Chris Hani, Alfred Nzo and Joe Gqabi. The DM were selected based on the availability of LRAD farms on each district. Ten LRAD farms from each DM were selected. The selection criteria of these farms was based on their livestock production enterprises (cattle, goats and sheep), farm

infrastructure and level of production. A total of 40 LRAD farms were therefore used as a representative sample of the study.

Results: Most of the farms (37 of 40) were male-headed with an average age of 61 years. All the farmers resided on farms, with 8 of 40 farms belonging to group members. The average number of cattle, sheep and goats per farm in Sarah Bartman were 43.4, 37.3 and 12, respectively. In Alfred Nzo, the average number of cattle, sheep and goats were 119.6, 111 and 58.1, respectively and Chris Hani had 111.7 cattle, 106.8 sheep and 93.4 goats. Joe Gqabi had the highest number of livestock per farm, with an average number of cattle, sheep and goats being 106.6, 239 and 39.2, respectively. Farms in Chris Hani and Joe Gqabi had the highest total annual sales, averaging R180 700 compared to other district municipalities. Ploughing equipment, capital, diseases, drought, nutrition/feeding management and land size were some of the major constraints hindering the growth of the farmers.

Discussion: Not all the LRAD farms had cattle, sheep and goats on these districts. Joe Gqabi DM had the highest average per unit stock compared to the other three district municipalities and this could be due to the bigger farm sizes at Joe Gqabi averaging 810.3ha compared to other farms and the farms at Joe Gqabi are a family corporate with common decision makings.

Conclusion/recommendations: The study is still on going and the data interpreted was not subjected to statistics and only the brief synopsis of four districts is given out of five districts. There is a great potential of growth of the farmers on LRAD farmers with the government support to mitigate on the constraints that are faced by the farmers.

Importance of gastrointestinal parasites on Nguni goats in semi – arid areas facing water shortages

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Background: Goats are largely kept by resource-limited farmers and reared under communal production systems, which are characterised by low management levels and inadequate productivity. Extensive production systems promote parasitism, increases infection and makes it difficult to put control measures in place. Water scarcity and high prevalence of diseases are two major production constraints that communal farmers in semi-arid areas face. Gastrointestinal parasites are ranked as one of the important production constraints in goats.

Aim: The objective of the study was to determine factors influencing gastrointestinal parasite burden in households that face water shortages in communal production systems.

Methodologies: Two hundred and eighty-five households were interviewed as follows: 142 from the area with perennial rivers (not facing water shortages) and 143 from the area with seasonal rivers (facing water shortages). Data were collected on household demographics, the socio-economic status of households, reasons for keeping goats, goat production constraints, severity of water scarcity, disease challenges and prevalence of gastrointestinal parasites.

Results: Mean goat flock sizes were not significantly different ($P > 0.05$) between households in an area with perennial rivers (14.7 ± 1.25) and households in an area with seasonal rivers (13.2 ± 1.23). Goats in households from the area with seasonal rivers were 11.0 times more likely to experience water scarcity than goats in households from the area

with perennial rivers ($P < 0.05$). There was no difference in the prevalence of gastrointestinal parasites throughout the seasons; however, households in the area with seasonal rivers were 1.7 times more likely to experience challenges of gastrointestinal parasites during the rainy and cool-dry seasons than those in the area with perennial rivers.

Discussion: Farmer perceptions demonstrated that diseases and gastrointestinal parasites were the main goat production constraints in both study areas. The findings that water scarcity was high in the area with seasonal rivers could be attributed to that seasonal rivers dry out during dry seasons. Inadequate access to drinking water and feed in communal pastures could have influenced the severity of gastrointestinal parasites in goats from areas with seasonal rivers.

Conclusion/recommendations: It was concluded that roundworms were the most important gastrointestinal parasites in goats from households experiencing water shortages. Water scarcity, diseases and prevalence of gastrointestinal parasites were major challenges experienced by farmers in the study area. Furthermore, it was recommended that farmers should adopt better management practices and preventive measures to reduce gastrointestinal parasite infestations.

Communal farmers' perception of solid waste management and its implications on livestock health in the eastern cape province, south africa

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Abstract

Background: Improper disposal of solid waste often exposes animals to consuming indigestible foreign bodies (IFB), which consequently leads to pathological conditions of both economic and health importance.

Aim: The objective of the study was to evaluate waste management practices among livestock owners and to determine the type of solid wastes suspected of affecting livestock health.

Methodology: A questionnaire survey of 120 livestock owners from July 2015 to December 2015 was conducted using a snowball sampling technique. Four villages in the suburb of Queenstown and eight near East London were randomly selected for the study including MaBright, Ezidulini, Ezola and Indlovukazi for Queenstown and EThuba, EThembeni, ESilimela, Mncotsho, KwaGaxa, Ezikhweba, Kwabathanga and Khwetyana for East London.

Results: The study revealed that 60.67% of communal farmers perceived that plastics, paper, glass, and metals were the likely encountered solid waste materials. Farmers score for proper disposal, minimization, recycling, and treatment of solid waste, were 26.7%, 41.7%, 7.5% and 14.5% respectively. The common mode of waste disposal was burning (60.8%),

composting (7.5%), throw in the backyard (35%) and open land disposal (34.2%). The rumen (71.4%) and reticulum (25.8%) were the main stomach compartment housing the IFB. Pain and swollen stomach (24.2%) and loss of condition (16.2%) were main clinical signs associated with IFB in animals.

Discussion: This study suggests that communal farmers perceived solid waste as a threat to livestock health and productivity.

Conclusion and recommendation: Proper waste management and pollution-free grazing areas will promote livestock production sustainably.

Challenges faced by communal farmers and possible *modus operandi* towards a vibrant and sustainable livestock production sector in the eastern cape province, south africa

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Background: Livestock production in South Africa is a fundamental element of socio-economic development and a significant contributor to food security and food sovereignty. The Eastern Cape Province of South Africa is well-known for livestock production in the country, housing over a third of country's livestock species (cattle, sheep and goats). These livestock are kept for different purposes depending on the available market, resources and the targeted group of consumers. However, there is an increasing demand for livestock products, which is driven by population growth, urbanization and animal-protein products. Poor rural households are continuously involved in a struggle to make ends meet; food security and family livelihood expenses representing some of the major priorities.

Aims: This review highlights the challenges faced by communal farmers and the way forward towards a vibrant and sustainable livestock production.

Discussion: The global problem resulting to food insecurity is the constant population growth with a steady increase in the livestock production and increasing disease outbreaks. This negatively affects the involvement of communal farmers in the livestock value chain. Although communal farmers have existing markets where they sell their produce, the agricultural sector is still faced with minimal involvement of farmers in the established

markets such as auctions, abattoirs and supermarkets. Consequently, local farmers are unable to contribute towards fulfilling the increasing demand for animal-protein products. This is due to several challenges that include poor management of their livestock leading them to have little or no access to the available markets. Furthermore, there are challenges besetting communal farmers such as poor nutrition, poor management practices, inadequate knowledge, and multiple roles of livestock and not keeping abreast with current technology, which affects emerging livestock farmers who are unable to obtain and understand formal market information. Research has focused on food security, climate change, animal welfare issues, meat consumption and others, however, farmers are still suffering especially those who are in the remote rural areas. This is because, the previous information talks to the scholars, industries and governors and there is limited evidence that actually focuses on communal based projects

Conclusions and Recommendations: However, although such is the case, some farmers are unable to get their animals to the markets because they do not meet the current specifications stipulated by each market in the food value chain. With much being said, there is a need to come up with solutions to the challenges associated with poor livestock production and non-existence of local markets where communal farmers can sell their animals and livestock products. The farmers will also be able to contribute to the food value chain either in the growing, processing and or marketing sector depending on their ability.

Duration of slaughter processes and their effects on serum cortisol levels of Bonsmara heifers
and cow culls

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Background: During the pre-slaughter period it is inevitable that animals will be exposed to stressful encounters. Exposure to stress has a significant impact on both animal welfare and the quality of meat produced. Response to stress may be influenced by intensity, duration or individual susceptibility of the animal to the stressor. Hence the use of cortisol as a pre-slaughter stress physiological indicator of the duration of slaughter processes.

Aim (-s): The aim of the study was to determine the duration of slaughter processes and its effects on serum cortisol levels of 40 Bonsmara heifers ($n=13$) and cull cows (27).

Methodologies: This was achieved by identifying a series of activities/points from when the animals left the lairage pens, until slaughter; recording the time (min) duration each animal spent in an activity, before moving to the next. The total duration of time between lairage and slaughter was 1 hour for the whole group. The points of interest were the holding pens, stunning box and at slaughter. Exsanguination blood was collected for the analysis of serum cortisol levels.

Results: The results showed that a longer stay in the holding pens and stunning box led to increased cortisol levels ($P<0.001$). Cow culls had the highest serum cortisol concentration in nmol/l (138.94 ± 12.872 ; 154.98 ± 13.153 ; 174.58 ± 8.868 ; 203.64 ± 8.868), increasing with time

spent after lairaging until exsanguination. Heifers had the lowest cortisol levels which decreased over time (164.38 ± 12.582 ; 108.94 ± 15.890 ; 104.40 ± 12.990 ; 99.23 ± 16.770).

Discussion: These results are in agreement with other studies showing that genotype of the animals had an impact on stress related reactions. This has been shown by cow culls which had the highest blood cortisol as they spent the most time in the holding pens.

Conclusion: Therefore, the duration of slaughter processes was linked to the cortisol levels. Thus, identifying effective strategies to manage stress should be a priority. This may include minimising the time spent in holding pens, stunning box and at slaughter as well as optimisation of animal management practices.

BEEF PRODUCTION

Effect of thermal treatments on fatty acid and mineral compositions of beef and liver from

Bonsmara and non-descript cattle

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Background: Meat and meat products play an important role in maintaining a healthy and balanced diet, because they provides energy, high-quality and readily digestible protein with all essential amino acids, and other absorbable micronutrients which are needed for human growth and development (Mourouti et al., 2015).However, the use of different cooking methods, such as frying, microwaving and grilling, has been reported to induce modification and loss of essential nutrients in meat products (Lopes et al., 2015).In order to minimize the nutrient loss during thermal treatment, many food processors now use sous-vide cooking technique to replace the conventional methods (Roldan et al., 2014).This method allows greater control over degree of doneness compared to other cooking methods (Baldwin, 2012).

Aim: This study examined the effect of thermal treatments on fatty acid and mineral compositions of beef and liver from Bonsmara and non-descript cattle

Methodologies: Meat samples (beef and liver) were collected from 80 cattle (cows), reared on a natural pasture in Eastern Cape Province of South Africa. The age and live weight of cattle before slaughter ranged from 4 to 5 years and 450 to 500 kg, respectively. The meat samples were thermal-processed at 65°C for 120 minutes and 85°C for 60 minutes using sous-vide techniques, and then analyzed for fatty acid and mineral compositions.

Results: The results did not show differences in individual fatty acid composition of meat samples between the breed ($P>0.05$). However, the raw beef sample had higher content of monounsaturated fatty acids (MUFA , $40.22\% \pm 3.79$ ND, $42.53\% \pm 2.39$ BD) and lower content of polyunsaturated fatty acids (PUFA , $11.02\% \pm 5.47$ ND, $10.13\% \pm 6.73$ BD) than liver (MUFA , $20.11\% \pm 4.76$ ND, $21.08\% \pm 2.46$ BD; PUFA , $30.73\% \pm 5.20$ ND, $31.11\% \pm 2.37$ BD) ($P<0.05$). The PUFA /MUFA and $n-6/n-3$ ratios, atherogenicity and desaturase indices were comparable between breeds, but higher in beef than liver. The total percentage of saturated fatty acid, MUFA and PUFA retained after cooking were numerically higher in liver than in beef ($P>0.05$). The results further revealed higher contents of Na, Mg, and Zn in raw beef than liver. However, the content of Na, Mg, and Zn in the beef and liver were not significantly ($P>0.05$) affected after cooking.

Discussion: The findings from this study are in line with previous results reported by Alfaia et al. (2010) for fatty acid profile of liver and beef of cattle raised and finished on pasture while the results of mineral composition are in contrast with those reported by Reykdal et al. (2014); Czerwinka and Szterk (2015) and Lopes et al. (2015) for fresh and cooked beef and liver.

Conclusions/recommendations: This study revealed that breed did not have significant effect on fatty acid and mineral composition of raw beef and liver. It also showed that the liver had higher percentage of PUFA, $n-6$ and $n-3$ than the beef after cooking.

Demand-driven development of cost-effective feeding strategies for small-holder cattle producers: targeting small-holder cattle–fattening systems based on forage-tree-legume – a survey

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Background: The profitability of cattle production in the emerging sector largely depends on the quality and availability of natural pasture feed resources, which vary with seasons. As a result natural pasture-fed indigenous beef cattle sales from the emerging sector are few and erratic. The current challenge is, therefore, to find ways to engage emerging beef producers to optimise the utilisation of the locally available feed resources to improve cattle production.

Aim: The objective of the current study is to identify the locally available feed resources with emphasis on natural pasture-based feed resources for emerging beef cattle production.

Methodologies: A total of 39 structured questionnaires were administered to emerging beef cattle farmers in Cradock, South Africa. The questionnaire included information on farmer demographics, available feed resources, livestock production and rangeland management.

Results: Most of the cattle owners (86%) were adult males and were more involved in herd management than adult females and youths. Cattle herd sizes were higher ($P < 0.05$) in the individual small-scale farms (32 ± 8.4) than in the commonage (11 ± 5.3) small-scale farms and were mainly composed of cows. Small-scale farmers on commonage farms ranked food (meat and milk) and income (31%) as the most important reasons for keeping cattle, whilst those on individual small-scale farms ranked meat (44%). Nguni (67%) and Bonsmara (44%) were the most common breeds in the surveyed areas with Bonsmara (59%) being the most preferred breed. Rangelands (74.4%) were the most common source of cattle feed followed by planted pasture (12.8%), crop residues (12.0%) and other feed sources (7.7%). Beef cattle producers reported that they were faced with feed shortage (82%), bush encroachment (25%) and water shortage (10%) as the main challenges.

Discussion: The finding that rangelands followed by planted pastures and crop residues were the most common locally available feed resources agrees with several surveys conducted in the Eastern Cape Province. The nutritive value of these feed resources, especially browse legumes and shrubs is, however, largely unknown making it difficult to include them in finishing diets for beef cattle. Based on the current results, where necessary, rangelands feed resources can be complemented by crop residues and locally adapted cultivated pastures to increase forage yield, and consequently beef cattle production in the emerging sector.

Conclusion/recommendations: Rangeland feed resources were the most abundant locally available feed resources followed by planted pastures and crop residues in the surveyed areas. It is important to determine chemical composition of the most common rangeland feed resources and develop low-cost feeding strategies for beef cattle in the emerging sector in South Africa.

Hair coat characteristics and thermophysiological stress response of Nguni and Boran cows
raised under natural conditions

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Background: Decreased animal performance under high ambient temperature is a cause of concern in tropical and subtropical areas as this triggers heat stress. Previous studies have shown that high ambient temperatures amplify body heat dissipation, leading to increased respiration rate, body temperature, water consumption and reduced intake of feed, reduced feed conversion and hence a decline in animal growth. Evaluation of the adaptability and thermotolerance of animals is usually determined by thermophysiological parameters such as rectal temperature, body temperature, respiration rate, sweating rate, heart rate and skin temperature. Hair coat characteristics such as coat colour and hair length affect heat transfer from the skin surface to the environment and play a crucial role in maintaining thermal gradients in the tropics.

Aim: The influence of breed, coat colour, monthly changes, and susceptibility to heat stress on weight, body condition score, thermophysiological variables (rectal temperature, skin temperature and hair length) was studied.

Methodologies: Nineteen (19) Nguni and 16 Boran cows were used in the study and data was collected monthly for 7 months. Body weight and body condition scores (BCS) were recorded. Wet and dry temperatures recorded were used to calculate temperature humidity

index (THI). Skin temperatures on the neck, belly and thurl regions were measured using an infrared thermometer. A digital thermometer was used to measure rectal temperature by inserting it into the rectum of each cow for 60 seconds. Fifteen hair strands from each cow were measured and the average hair length (HairL) was recorded.

Results: Breed significantly ($P<0.05$) influenced weight, BCS and neck temperature (NeckTsk). Nguni cows had higher BCS and weight than Boran cows throughout the study. High BCS from March to July, and longest hairs in July were recorded. The THI significantly ($P<0.05$) influenced Tr of the Boran whereas Tsk and HairL for both breeds. Both breeds had the highest Tr in April and February, respectively. Nguni cows had significantly ($P<0.05$) higher NeckTsk and thurl temperatures (ThurlTsk) in June and the lowest in July. Boran cows had the highest significant ($P<0.05$) NeckTsk, BellyTsk and ThurlTsk in August. Red, dun and white-black Boran cows had higher BCS. Red, fawn and white Nguni cows had the highest BCS. Fawn Nguni cows had the highest weight while dun cows recorded the lowest. White-brown Boran cows had the highest weight as compared to white-red cows. White-red Nguni and Boran cows recorded the highest Tr. Thermophysiological measurements for both breeds were significantly ($P<0.05$) correlated.

Discussion: Monthly variations in body weight, BCS, HairL, Tr, NeckTsk, BellyTsk and ThurlTsk indicated that Nguni cows were more adapted to the prevailing bioclimatic changes, although Boran cows have potential of performing well under heat stress conditions over time.

Conclusion: Boran cows have a potential of performing well under heat stress conditions over time. Therefore, there is need for further research to be conducted on adaptability to diseases and parasites such as ticks, and cellular thermotolerance on the Nguni and Boran breeds so that they can be used under communal and commercial enterprises.

Thermotolerance, health profile and cellular expression of
Hsp90ab1 in Nguni and Boran cows raised on natural pastures

Under tropical conditions

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Background: Tropical and arid areas are characterized by environmental conditions typified by intense radiation and high temperatures and humidity that negatively impact on thermoregulation. The Boran and Nguni cattle breeds have small body sizes which allow them to be more adaptable under tropically stressful environmental conditions. Thermotolerance tends to vary with animal species, among and within breeds. However, coat characteristics such as skin thickness and coat colour influence the individual animal's thermotolerance capabilities. Under hot environmental conditions, the expression of heat shock proteins (HSPs) increases, as heat stress response mechanisms. Previous studies have shown that among the HSPs, HSP90 plays a crucial role in cellular thermotolerance.

Aim: The effects of breed, age and coat colour on the concentration of HSP90AB1, physiological parameters and some blood markers of health were investigated.

Methodologies: Boran (n = 15) and Nguni (n = 15) cows used in the study and were separated into different age groups and colour patterns. Wet and dry temperatures recorded were used to calculate temperature humidity index. Rectal and skin temperatures (neck, belly

and thurl) were measured and body thermal gradients were calculated. Blood samples drawn from the jugular vein of each cow were analysed for the concentration of total protein, creatinine, alkaline phosphate, gamma-glutamyl transferase glucose, total cholesterol, urea, aspartate transaminase, alanine transaminase, packed cell volume and neutrophil/lymphocyte and HSP90AB1.

Results: The cows were exposed to summer heat stress and Boran cows had higher significant ($P<0.05$) skin temperature (35.1 ± 0.42 °C) as compared to the Nguni cows (36.0 ± 0.38 °C). Nguni cows had higher body thermal gradients than the Boran cows. Boran cows had thicker skin ($P<0.05$) and longer hairs (24.3 ± 2.26 mm) than their Nguni counterparts (20.2 ± 2.00 mm). The HSP90AB1 concentration was increased in Boran cows, although breed had no significant ($P>0.05$) influence. Significantly ($P<0.05$) high urea and total cholesterol was recorded in Boran cows. Coat colour had a significant ($P<0.05$) effect on the weight and rectal temperature of the study animals. Coat colour and age had no significant effect ($P>0.05$) on the concentration of HSP90AB1, although older cows (≥ 9 years) had higher concentrations (5.4 ± 1.29 ng/ml). Age had a significant ($P<0.05$) effect on packed cell volume, neutrophil/lymphocyte, urea, total protein and gamma-glutamyl transferase whereas cows with ≥ 9 years had more concentrations than young ones. Age significantly ($P<0.05$) influenced hair length, skin temperature and the thermal gradients. Breed was positively correlated ($P<0.001$) to coat colour, age, body condition score, weight and temperature humidity index while negatively correlated to urea and total cholesterol.

Discussion: Nguni cows were more adaptable to hot environments than the Boran cows as the latter were unable to balance thermal load between their bodies and the environment as supported by other studies.

Conclusion/Recommendations: There is need for further research to be done comparing monthly and seasonal variations of concentration of HSP90AB1 and thermotolerance in the Nguni and Boran cows.

Effect of two energy levels in a feedlot diet on growth performance in nguni cattle

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Background: Nguni cattle are well known for their adaptability to South African climatic conditions and well suited to pasture based production systems. In South Africa, approximately 75% of beef is produced in feedlots to meet the demands of a growing population. Although Nguni cattle are not generally grown out in feedlots, research has confirmed high quality beef and therefore of importance to investigate finishing-off Nguni cattle in a cost effective manner in a feedlot system. Low energy diets may hold the key for efficient growth of Nguni in feedlots.

Aim (-s): The aim of this trial was to investigate the effect of a high and low energy diet through the measurement of growth (weight, ADG) and RTU scans (Rib fat, P8 fat, Eye muscle area and Marbling) in Nguni cattle.

Methodology: Twenty Nguni bulls and twenty Bonsmara bulls as a control from the Roodeplaat and Vaalharts Research farms was transported to the ARC Irene Bull testing center. The bulls were randomly divided into two groups with one group receiving the low energy diet (10.9 MJ ME/kg) and the other a high energy diet (12.5 MJ ME/kg). Following the adaptation period, the groups were fed for 120 days, where after they were slaughtered.

The animals were weighed throughout the trial and Real Time Ultrasound (RTU) scanned at the commencement and end of period.

Results: Marbling and carcass weight differed significantly ($p < 0.05$) between the diets for both the Nguni and Bonsmara breed. The Nguni fed the high energy diet had an marbling score of 3.40 and the Nguni fed the low energy diet a score of 2.56. The Bonsmara had a marbling score of 3.27 when fed the high energy diet and a score of 3.34 when fed the low energy diet. The Nguni fed the high energy diet had an average carcass weight of 159.11 kg and fed the low energy diet 153.35 kg. The Bonsmara had a carcass weight of 187.70 kg when fed the high energy diet and a carcass weight of 168.39 when fed the low energy diet. There was no significant difference between diets for the traits: average daily gain, live weight, feed efficiency, rib fat and eye muscle area. A breed difference were clearly observed with significant differences throughout the trail for all traits.

Discussion: The Nguni bulls fed the low energy diet had a higher eye muscle area but a lower marbling score than the bulls fed the high energy diet with a small difference in carcass weights. It seems that the Nguni cattle responded more efficiently on the low energy diet and further investigation on a genetic level for gene-expression is warranted.

Conclusion/Recommendation: The marbling genes will be a focus point in the follow-up study on gene expression analysis for confirmation of possible effects of the low energy diet on marbling.

The effect of bioregions of South Africa on production and reproduction of Nguni cows

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Background: Cow efficiency is key to the success of a beef herd.

Aim: To establish the effect of the different bioregions of South Africa on the production and reproduction of Nguni cattle based on cow fertility and cow and calf weights at weaning.

Methodologies: Data of Nguni cows (n=26681) from Nguni breeders in the savanna and grassland biomes of South Africa was statistically analysed to investigate the hypothesis that bioregions affect production and reproduction of Nguni cows, despite their adaptability. Analyses were done in two different ways: firstly, the effects of non-genetic factors (age of dam, biome and bioregion, season, year category and interactions between the main factors) on cow weight were assessed. Secondly, cow efficiency as affected by non-genetic factors was evaluated using three (3) different equations. Firstly, cow efficiency in the traditional method, using the following equation: $[(\text{calf weaning weight} / \text{cow weight at weaning}) * 100]$. The second equation used was as follows: $[(\text{ICP per cow per year} / \text{Ave ICP as per Nguni average}) * 100]$. Thirdly, cow efficiency was expressed as cow productivity (kg calf weaned/LSU), calculated as $\text{Corrected 205d wt/LSU} * \text{Estimated Calving \%}$. Calf sex was included in the first method but showed no significant effects.

Results: Non-genetic factors significantly ($P < 0.0001$) influenced cow weight at weaning. Cow weight at weaning increased with increase in the age of dam up to 140 months, and then decreased. A reduction in cow reproduction was also noticed after 140 months of dam age. Efficiency of cows in the savanna biome was higher ($P < 0.0001$) than those in the grassland biome. Cow weights ($P < 0.0001$) were higher in Spring than in the other seasons. Cow age categories influenced ($P < 0.0001$) cow weights at weaning. Cow efficiency was best at the beginning of a cow's reproductive life, but decreased with an increase in age of dam. In the savannah biome, cow efficiency was always higher in the Eastern Kalahari Bushveld bioregion irrespective of the equation used, while cows in the grassland biome cow efficiency was higher in the Drakensberg bioregion.

Discussion: Bioregions influence the efficiency of Nguni cows, despite the breed's adaptability. Highest efficiency was observed in spring and summer compared to autumn and winter.

Conclusions and recommendations: The result of this study suggest that even though the Nguni breed is renowned for its adaptability, different bioregions have an effect on the efficiency of its cows. This is aggravated with an increase in dam age.

The effect of temperature on the feed intake and growth of beef cattle from different
genotypes

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Background: Climate change is going to have an impact on livestock production and it is therefore important to understand how livestock will respond to climate stressors such as elevated temperatures. Temperature, humidity and solar radiation are the main direct factors influencing animal performance. The 2015/ 2016 summer was the warmest and driest year ever recorded in South Africa. In the preceding 9 summers there were on average 1.9 heat waves per summer with 6.5 heat wave days. In the 2015/2016 summer, there were 12 heat waves totalling 71 heat wave days.

Aim: This paper investigates the effect of the heat waves in the 2015/2016 summer on the feed intake and growth of young weaner bulls from different genotypes.

Materials and Methods: Young weaner bull calves, from a crossbreeding experiment, were tested at the Irene Bull Testing Station, where individual feed intake and growth was recorded every 14 days. The different bull genotypes were grouped into purebred Bonsmara (n = 8), Sanga breeds (Afrikaner, Nguni and Afrikaner x Nguni) (n = 15), Angus cross Afrikaner, Nguni and Bonsmara cows (n = 8) and similar Simmentaler crosses (n = 16). The dam genotypes were Bonsmara (n= 24), Afrikaner (n= 10) and Nguni (n = 24), Feed intake was measured as daily intake as percentage of body weight at the start of the 14-day period

and growth as average daily gain (ADG). From week 2 – 6 there were 8 heat wave days (29%) and from week 6 -10 there were 14 heat wave days (50%).

Results: Feed intake as percentage of body weight decreased by 13%, 11%, 13% and 11% from week 2 -6 to week 6 -10, in the Bonsmara, Sanga, British (Angus) crosses and European (Simmentaler) crosses, respectively. Likewise, ADG decreased with 6%, 12%, 17% and 17% in the Bonsmara, Sanga, Angus crosses and Simmentaler crosses, respectively. The ADG of the Angus and Simmentaler types decreased by 17%, whereas that of the Sanga and Sanga derived types decreased by 9%. When the information is summarized per dam line, the ADG of bull calves from Bonsmara and Nguni cows decreased by 6% and 7% respectively, whereas that from Afrikaner cows did not change.

Discussion: The results indicate a negative effect of heat wave days on the performance of all genotypes, except those from the Afrikaner dam. It is somewhat surprising that the Sanga (indigenous), British and European breed types were all effected fairly similar by the heat. A possible reason for this is that it was also very dry. If the heat was associated with high humidity, the effect of heat stress may have been more profound.

Conclusion and recommendations: These preliminary results indicate the need for detailed studies on the effect of climate, both temperature and humidity, on the performance and behavior of different genotypes. The ARC is in the process of installing GrowSafe® feed and water intake systems, that will allow real time recording of partial body weight, feed and water intake.

Performance of Nguni cattle in a feedlot environment

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Background: The Nguni breed is an early maturing, small framed indigenous Sanga breed. As feedlots prefer medium- to late maturing breeds, major feedlots are either not accepting Nguni weaner calves or pay significantly less for them.

Aim: To determine the performance of Nguni calves under feedlot conditions.

Methodology: A diverse group of 200 Nguni calves from 5 provinces were obtained by the Nguni Cattle Breeders' Society and placed in a feedlot trial at Sernick feedlot. Calves were on average 10 months old, but ranged between 6 and 14 months of age and weighed between 94 and 242kg at arrival. The average weight of all the calves on arrival was 165 ± 30 kg. Calves were randomly allocated and tested on four rations with different roughage content. They were slaughtered when they reached the same endpoint, i.e. acceptable carcass subcutaneous fat classification (A2). Some animals reached this endpoint after 105 days, a second group after 120 days and all remaining animals were slaughtered after 135 days on test. Calves were back grounded for 32 days after arrival and weighed at arrival, start and end of test as well as at 5 occasions in between. Various carcass traits were also measured.

Results: The heaviest animals at arrival were slaughtered first (105 days), and despite having been on the test for two or four weeks longer, the 120 and 135 day groups never reached the weights of the first slaughter group (105 day group) animals. The 105 day group were significantly heavier (229kg, 195kg and 162kg for 105, 120 and 135 day groups

respectively), but not significantly older than the other groups at the start of the test. The 105 day group gained on average 159kg in 105 days, while the other two groups gained 147kg and 149 kg in 15 and 30 extra days respectively. The ADG (Average Daily Gain) for the groups slaughtered after 105, 120 or 135 days was 1.49, 1.24 and 1.15kg/day respectively, irrespective of the ration that the groups received. Carcass weight (212, 197 and 189kg) and Dressing percentage (56.51, 55.86 and 55.89) were also significantly better ($P < 0.005$) for the 105 day group than for the 120 and 135 day groups respectively. Calves on the commercial ration generally performed the best. Some significant differences in starting weight and age were evident in calves originating from different provinces, but these differences were not significant at the end of the test and with the carcass traits.

Discussion: The effect of ration on the growth of the calves is not as clear cut as the effect of test length (days fed). Arrival weight had a marked influence on test length and margin over feed costs, favouring the heavier calves. Carcass weights of calves with higher arrival weights were heavier and met market requirements.

Conclusion / Recommendations: Given adherence to some basic conditions, Nguni cattle can be fed profitable in feedlots. Results indicate that the precondition for minimum weights to be considered at arrival to be close to 200Kg with an absolute minimum of 180Kg.

RTU measurements as early indicator for carcass characteristics in Nguni cattle

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Background: RTU measurements have the benefit that it can be used to predict carcass traits on the live animal. It is less expensive and more time efficient, compared to other methods such as post slaughter evaluations. It is non-invasive and can also be used on potential breeding animals. In this study a feedlot trail with Nguni cattle was performed where RTU (Real Time Ultrasound) and carcass traits were measured.

Aim: The aim was to determine whether RTU measurements can be a sufficient predictor for carcass traits in Nguni cattle raised in feed lots.

Material and methods: This trail consisted of 60 Nguni bulls finished in a commercial feedlot. The cattle were weighed and RTU measurements recorded. Real time ultrasound measurements consists of marbling (intra muscular fat) fat depth (inter muscular fat), and the eye muscle area (EMA). In this study the rib eye area (REA), eye muscle area (EMA) and rump fat were measured using RTU at 72 and 91 days on test respectively. Animals were slaughtered at 105 days at A2 carcass grade. Statistical analyses were preformed using SAS Enterprise Guide (SAS Institute Inc. 2010). Phenotypic correlations were estimated between the different traits.

Results: Average weight at the start of the trail: 225.3 \pm 2.1. The average for slaughter weight on day 105 were 379kg and average daily gain (ADG) was 1.6 \pm 0.1 kg/day over the entire trail period. The average for slaughter weight on day 105 were 379kg and RTU measurements included the average EMA of 56 cm², \pm 0.5 cm² rump fat of 6mm \pm 0.1mm

and rib eye area of 3,9mm \pm 0.1 mm. The correlation between EMA and slaughter weight was 0.35 and 0.49 at 72 and 91 days on test, respectively. Rump and rib measurements were both weakly correlated to slaughter weight. The rump and rib to slaughter weight had correlations of -0.05 and 0.06 for measurements taken at 72 days. Correlations between rump and rib to slaughter weight were of 0,04 and 0,1 at 91 days. The correlation between ADG and EMA was low when measured at 72 days: 0.1 and when measured at 91 days: 0.17.

Discussion: The average slaughter weight reported in this study is similar when compared with average slaughter weights for Nguni cattle of 220kg to 320kg (Strydom *et al.*, 2001; Mapiye *et al.*, 2007; Strydom, 2008) and 390 kg (Linde *et al.*, 2016) but lower when compared to a composite type such as the Bonsmara with up to 440 kg (Linde *et al.*, 2016) and the Nellore cattle with 413 kg (Pereira *et al.*, 2015). The average ADG of 1.6 kg/day was slightly higher compared to 1.08-1.1 kg/day in Nguni cattle (Strydom *et al.*, 2001; Scholtz & Theunissen, 2010) and comparable to Nguni cattle with: 1.3-1.5 kg/day. The ADG was comparable to Charolais, Simmentaler and crossbreeds of Nguni, Simmentaler and Charolais which ranges from: 1.6 – 1.8 kg/day (Scholtz & Theunissen, 2010); including a composite such as the Bonsmara: 1.28 – 1.7 kg/day (Strydom *et al.*, 2001; Strydom 2008). The average EMA results in this study was 56cm² which is comparable to 55.47 - 56.5 cm² in Nellore cattle (Caetano *et al.*, 2013; Pereira *et al.*, 2015) but, lower compared with Strydom (2008) that reported a range of 75.9cm² to 84.8 cm² in Bonsmara cattle and Nguni cattle in other studies 68.1 - 70.2 cm² (Strydom *et al.*, 2001). RTU was measured twice during the growth period and the EMA measured at 91 days had the highest correlation with slaughter weight and holds the most potential as predictor.

Conclusion and recommendations: Average slaughter weight for Nguni tend to be lower compared to composites generally used in feed lots, but the RTU measurements compared

well to previous studies and could be used to predict slaughter weight of Nguni cattle. The next phase of this study will include the designing of the selection index.

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Efficacy of potassium humate in feedlot rations on bull calve performance and carcass characteristics

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Background: Nutritional management of cattle in feedlots aims to maximise performance and remains a challenge. Various feed additives are available that claim improved performance of feedlot cattle. One group of these additives are humates and different sources vary in composition. Feeding feedlot rations with added humates to cattle have had various levels of success in improving performance and carcass characteristics of feedlot steers.

Aim: To improve performance of weaner bulls during their feedlot period and carcass characteristics with potassium humate added to their rations.

Methodologies: Twenty-two bull-calves, housed in single stanchions (1m x 2m), fed a starter ration regime (first two weeks) and a grower/finisher ration (remaining 14 weeks) with no added potassium humate (T1, n=11) or with added potassium humate (T2, n=11). Calves were weighed and processed on day -1 and weighed on day 0, blocked by weight into two treatments, where after the weighing was done bi-weekly. Animals were fed according to amount of orts observed and had free access to water. Orts were removed weekly and recorded, weight gain and intake were calculated. Potassium humate inclusion were calculated to ensure an intake of 15 gram/animal per day. Fibre content in the starter diet moved from 18% to 4.5% for the grower diet in 4 steps (step 1: 4 days starter diet, Step 2: 4 days 75% starter diet 25% grower, Step 3: 3 days 50/50 and step 4 3 days 25/75). Concentrate

diet included: maize meal (62%), wheaten bran (15%), molasses meal (10%), hay (*Eragrostis c.*) (4.5%), cotton OCM (5%), feed-lime (1.6%), feed grade urea (1.3%), salt (0.5%) and premix (0.1%).

Results: Average daily gain (1.57 vs 1.44 kg/day for T1 and T2 respectively), average daily feed intake (8.93 vs 8.42 kg/day for T1 and T2 respectively) and feed conversion ratio (5.68 vs 5.83 kg/kg for T1 and T2 respectively) were not statistically different. Ration analysis showed lower protein values as compared to initial estimated values. Most carcass parameters measured did not differ statistically. However, shear force was significantly better for T2 than for T1 on day one (6.58 and 5.12 Nm, $p=0.007$, for T1 and T2 respectively) and strongly on day 7 (4.92 and 4.13 Nm, $P=0.07$, for T1 and T2 respectively) after slaughter. In addition, the levels of intra muscular fat was significantly higher for animals in T2 (T1 = 1.66, T2 = 1.97%, $p<0.05$).

Discussion: The Lack of performance during the grower and finisher phase was disappointing and probably due to the lower measured protein levels. The higher intra muscular fat percentage, although still at a low level, of T2 could to some extent, explain the lower shear value of T2.

Conclusion: The lack of performance of this small group of cattle (T1 and T2) during the feeding phase and especially T2 is in contrast with improved adaptation period performance and better tenderness (lower shear force) of T2. These results warrant further studies with larger groups of animals.

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The role of epigenetic mechanisms on livestock production: a review

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Background: The main goal of livestock production is to achieve improved productivity as well as enhancing health and wellbeing of animals. Epigenetics remain an interesting field of animal breeding and genetics that has not yet been well studied in South African livestock.

Aim (-s): The aim of this study is to outline recent advances on the role of epigenetics mechanism on livestock production.

Results: Recent results on the dietary factors on DNA methylation and histone modification revealed that a dietary supplementation with nutrients such as Glutamine, arginine, and conjugated linoleic acid, can regulate gene expression and also maintain metabolic pathways to improve fertility, immune function, survival, feed efficiency and also meat quality. Genomic imprinting also play a role in the variation of complex production traits, such as muscle mass and fat deposition in pigs, as well as meat and milk production in beef and dairy cattle. The current number of confirmed imprinted genes in livestock is about 58 of which 22 are found in pigs and 20 in cattle. Other studies on transgenerational epigenetic effects on milk production indicated that the grand-dam herd test milk volume was positively correlated with increased milk yield in daughter lactation 2 in Jersey cattle, and both lactations in Holstein Friesians with an average of 4.2 litres. The negative correlation was observed in Jersey lactation 1 with daughter milk yield of 213.7 litres. In beef production, recent study of

Snow dragon beef population revealed that DNMT1, DNMT3a and DNMT3b are DNA methylation-related genes and are significantly associated with carcass traits related to beef quality.

Discussion: Selection of livestock that are less susceptible to molecular causes of epigenetics and the resulting phenotypic changes may allow for prevention or treatment of health related issues and enhance production in livestock animals. There is an increasing interest in the role of methylation-related genes such as DNMT1, DNMT3a and DNMT3b as they may play role on economically important traits such as carcass quality and milk production in cattle.

Conclusion/recommendations: There is scope for application of epigenetics in livestock production to assist in answering various questions regarding animal disorders, diseases and for tracing inherited traits that may rise or decline livestock production.

Factors affecting productive herd life in Nguni cows

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Background: Each year beef cow managers are faced with the question of which animals to cull and replace in the herd. A cow is removed from the herd due to her inability to continue as a productive breeding cow or dam. The ability of an animal to remain in the herd and avoid involuntary culling is regarded as the measure of the productive herd life (HL). Several studies indicate a cow's HL to be neither greater, nor significantly different, when heifers first calve at 2 compared to 3 years of age. However heifers calving at 2 years of age produce 0.7 more calves in their lifetime than those calving for the first time at 3 years of age.

Aim: To investigate possible traits that could affect Nguni beef cow productive herd life.

Materials and Methods: Nguni beef cow records (28 138) with pedigree information were edited and analyzed using ASREML software to test different animal models to assess effects and traits to be included in the prediction HL. The final model was:

$$y = X\beta + Za + e$$

Where y = a vector of phenotypic observations for the cow's productive herd life

X = an incidence matrix relating records to the fixed effects β .

β = a vector of fixed effects: number of parities (NP= 1 to 15) and year (Y= 1968 to 2011). Cow's age at first calving in days (AFC) and average inter-calving period in days (ICP) as co-variables.

Z= an incidence matrix relating records to the additive genetic effect

a= a vector of the additive genetic effects

e= a vector of residual effects.

Results: Age at first calving (AFC) minimum and maximum was 512 and 1 099 days, respectively with a mean \pm std of 893.5 \pm 136.4 days. The minimum and maximum inter-calving period (ICP) was 313 and 800 days, respectively with a mean \pm std of 408.4 \pm 59.54. The number of parities (NP) was expressed in categories ranging from the 1st to the 15th parity, mean \pm sd was 7.2 \pm 3.59. All the fixed effects fitted in the model had a significant effect ($P < 0.05$) on productive herd life. The year was also significant ($P < 0.05$).

Discussion: The model with year included and the direct animal effects as random yielded a low heritability estimate. The obtained low heritability estimate for HL is agreement with a number of reports in literature. The standard error observed in this study also falls within the range reported in literature.

Conclusion/recommendations: Further investigations are needed to confirm the initial results of direct genetic effect on productive herd life and the included factors affecting the productive herd life in Nguni cows.

Assessment of the genetic makeup of communal cattle in Limpopo, KwaZulu-Natal and the
Eastern Cape provinces of South Africa

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Background: A characteristic associated with indigenous breeds is the ability to withstand severe climatic conditions, resistance to parasites and to poor quality forages. These unique traits possessed by indigenous breeds are under threat because of unrestrained crossing with exotic commercial breeds and this can lead to the extinction or total loss of a breed. The evaluation of animal genetic resources status is important to design an appropriate management and a point for conservation.

Aim: To evaluate the genetic diversity and population structure of cattle populations in district municipalities in the Limpopo, KwaZulu-Natal and Eastern Cape provinces.

Methodologies: Communal cattle populations from Limpopo (n=150), KwaZulu-Natal (n=101) and the Eastern Cape (n=69) province were genotyped at 25 autosomal microsatellite loci recommended by the ISAG. Seven cattle populations (n=30/population) from the LIDCAT database were included in the analyses as the reference population. Genomic DNA was extracted from hair roots using Proteinase-K digestion followed by the phenol: chloroform: isoamyl alcohol isolation and ethanol precipitation. The size fragments were separated using the Genetic Analyzer ABI 3130XL and allele scoring was done using

GeneMapper v4.0. Descriptive statistical analysis was performed with GenAlEx6.5. STRUCTURE software v2.3.2 was used to cluster individuals to a predefined number of $3 \leq K \leq 9$ clusters.

Results: The percentage of variance indicates that 5.04 % of the genetic variation was due to differences among populations, 16.4 % was due to difference among individuals within populations and 78.6 % of the genetic variations was due to differences within individuals. While, the level of gene diversity were high, indicated by a mean expected heterozygosity across cattle from Eastern Cape (0.92) to (0.94) in Limpopo and KwaZulu-Natal. Structure analysis indicated the levels of admixture in seven clusters ($K=7$).

Discussion: The preliminary results have indicated the genetic diversity between the populations studied. These findings provide insight for conservation of communal cattle in the Limpopo, Eastern Cape and KwaZulu-Natal provinces and will help in the management and prevention of loss of genetic material.

Conclusion: These findings provide insight for conservation of communal cattle in municipal areas of the Limpopo, Eastern Cape and KwaZulu-Natal and will help in the prevention of loss of genetic material.

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Background: *Moringa oleifera* tree leaves and seed have multi-purpose functions in livestock nutrition (proteins and minerals) and in human nutrition as medicinal (organic acids with high antioxidant activity). The tree plays a potential role in reducing stress caused by routine operations such as dehorning, castration and branding, nutritional stress and coronavirus that causes high calf mortalities (> 50%) at pre-weaning and post weaning calves. Vaccination particularly at calf weaning stage is important for passive immunity but effectiveness is reduced by poor vaccine management. *M. oleifera* tree leaves provides protein i.e. 25% crude protein, 85% true protein of high digestibility and some proteins that inhibit pathogenic bacteria in the gut. Organic compounds and antioxidants such as (phenolic and flavonoids); Vitamin E and Selenium reduce the amount of antigens/vaccines and antibiotics needed for protecting immunity at calf weaning. Micro supply of *M.oleifera* powder has reported to improve nutrient utilization efficiency in calves.

Aim: To evaluate the effects of *M. oleifera* proteins and organic acids on health and growth of beef calves in extensive production systems.

Methodologies: Forty-five beef weaners (4-5 months old) of the same breed will be used in the experiment. Initial body weight will be used as covariate. Calves are to be randomly allocated to three groups where each group will be housed in small camps. Calve groups will receive one of three treatment diets that differ by means of *Moringa* powder dosing level,

control (zero dosing), Level 1 (10 g/calf/d) and Level 2 (20 g/calf/d). Hay and water will be available *ad libitum* at all times. Calves will be dosed orally with diluted *Moringa* powder solution (distilled water) 10-days before weaning. Ruminal fluid as well as faecal nutrients and bacteria are to be collected by inserting a rumen tube for vacuum pumping (20 ml/calf) to determine structural and non-structural bacteria and protozoa populations. Blood samples will be taken via jugular venipuncture in sodium heparin vacutainers on day -10, -7, -3 to weaning and on day 5, 10, 14 and 21 post-weaning. Blood plasma will be separated using centrifuge and stored at -80 °C to determine protein and IgE assays. Growth rate will be measured by taking initial and weekly weights up to six weeks post-weaning.

Conclusion and Recommendation: *M. oleifera* tree leaves improves body weight and increase feed conversion ratio (FCR) and dry matter intake (DMI) of cattle. The hematological indices of cattle supplemented *M. oleifera* tree leaves were healthier. *M. oleifera* tree leaves can help farmers overcome shortages of good quality feeds and therefore sustain and improve their cattle productivity. *Moringa* leaves meal (MOLM) also has the potential to decrease glucose level.

A possible explanation for the differences in intake between cattle of the same body weight
but different frame sizes

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Background: Following the need to have suitable animal production “standardization units” Meissner et al. (1983) developed an official definition of Large Stock Units (LSU) for South Africa. Such LSU is the equivalent of an ox with a live weight of 450kg, which gains 500g per day on grass pasture having a mean digestible energy of 55% and to maintain this 75MJ per day is required. It is important to note that, for example a small frame cow with calf weighing 450 kg is 1.32 LSU’s, whereas a large frame cow with calf of the same body weight will be 1.66 LSU’s and their daily feed requirements will be 11.9 kg and 15.0 kg respectively. The reason for this is that there are differences in voluntary feed intake between such animals, although they have the same body weight.

Aim (-s): The aim of this presentation is to offer a possible explanation for the differences in intake between cattle of the same body weight but different frame sizes.

Methodologies: Published and unpublished information was interpreted in order to formulate a possible explanation. The published information is from MacNeil et al. (2013), Hendriks et al. (2014), Mokolobate et al. (2015) and Roux (2017).

Results: The equations for calculating phenotypic Residual Feed Intake (RFI) and Residual Daily Gain (RDG) are quite different for different breeds tested at the ARC’s bull testing

stations where conditions are standardized. One possibility for this is differences in basal metabolism. The results reported by Roux (2017) indicates that the differences in voluntary feed intake between breeds-types of different frames sizes, but with the same body weight, may be related to the basal metabolic rates of the viscera. Basal metabolic rate scales to respiration in the viscera during rest, and since the viscera of larger framed animals will be bigger, the basal metabolic rate will be higher, as demonstrated from the observation that the intercept between body weight and organ weight is scaling quite different (0.20 versus 6.56), whereas the exponent between the two are similar (0.77 versus 0.87). A difference of up to 21% in heat production (HP) exists between low- and high-RFI animals. Visceral organ size is a big contributing factor to HP and energy use, with low-RFI animals having smaller visceral organs. In addition, mitochondrial function is an important factor in RFI and 90% of cellular energy is produced by mitochondria in metabolically active cells like the liver, kidney, muscle and brain cells. If mitochondrial membrane surface areas are scaled with whole body and organ weight, the intercept is very different (2.47 versus 227.1) whereas the exponent is similar (0.61 versus 0.77), emphasizing the importance of organ size.

Discussion: The results discussed above may be important in explaining the causes of observed differences in maintenance requirements (voluntary intake) between animals, as well as reasons for differences in RFI values between animals.

Conclusion/recommendations: This novel interpretation will need more research to unpack the details of the explanation offered here.

Production trends and success rate indices of the Nguni cattle project in the Eastern Cape
Province, South Africa

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Background: The knowledge of the adaptive features of Nguni cattle has resulted to the instigation of programs to introduce the breed to the Eastern Cape Province of South Africa. However, there is a need to assess the effectiveness of the governmental programs.

Aim: The success rate and production differences of (n=80) Nguni cattle project beneficiaries across the six districts in the Eastern Cape Province, South Africa are presented.

Methodology: Data was obtained using a cross-sectional survey done over a period of 10 years in six municipalities of the Eastern Cape Province, where the Nguni Cattle Project has been operating. The data collected contained information on the performance records of 80 Nguni cattle project beneficiaries across the 6 districts. SAS (2010) statistical software was used to analyse the data.

Results: The Amathole district had many beneficiaries (37.5%) followed by Joe Gqabi (21.3%), Chris Hani (17.5%) and Cacadu (12.5%) who participated in Nguni Cattle Project. The Alfred Nzo and O.R Tambo districts had few beneficiaries to the project with (6.2%) and (5%) respectively. The number of beneficiaries across 6 districts had no significant effect ($P>0.05$) between the number of distributed and current animals. The O.R Tambo, Alfred Nzo and Amathole districts had the highest mean score for current cows/heifers with 22.4, 25.6 and 33.2 respectively. The number of distributed animals had no significant effect

($P>0.05$) on the current number of animals across 6 districts. The odd ratios for current bulls 1.084 was found to be higher than cows/heifers and calves which were found to be 0.986 and 0.977 respectively. The highest number of animals (51.25%) under the projects is still running, followed by projects passed the gift (31.25%), projects ready to pass the gift (10%) and terminated projects (7.5%). The Chris Hani, Cacadu and Joe Gqabi districts had some terminated beneficiaries of 50%, 33.33% and 16.67% respectively. The land size was found to have no significant effect ($P>0.05$) on the production and success rate of the project.

Discussion: Many beneficiaries have passed on the gift (returned the loaned animals). The project has few terminations which could be attributed by poor management.

Conclusion and recommendations: The Nguni Cattle Project is positively progressing, thus the current studied governmental program is succeeding. Sufficient monitoring from policy makers is of great importance.

Growth Potential of Nguni, Bonsmara and Bonsmara Crosses Cattle to Meet Free Range
Branded Beef Specifications

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Background: Retailers in South Africa brand beef based on breeds or production systems. Recently, a retailer branded free range beef (FR) that is mainly grass fed. The product is very popular among wealthy South Africans. The success and growth of a branded product depends on many animals meeting the specification. Abattoirs penalise farmers for carcasses that dress to under 180kg and pay very high premium for those that dress at 240kg. The challenge for the farmers interested in supplying this market is to predict the possibilities of reaching these weights on pasture only. The specifications do not fit current animal performance schemes thus there are no readily available records that maps growth in males and females in relation to these specifications.

Aim: The aim of the study is to predict the likelihood for Nguni, Bonsmara and Bonsmara crosses cattle on free range to meet the final slaughter mass as per FR specification.

Methodologies: Three data sets gathered at Mara, Vaalwater and Glen were used that could help predict the likelihood of Nguni, Bonsmara and Bonsmara crosses reaching the slaughter weight for FR specification. The datasets had 507 Nguni and 607 Bonsmara steers on veld tests. This data represented sweet veld savannah vegetation. Another set of data was collected on a private farm at Vaalwater, which is a typical mixed vegetation type. The herd is mainly Bonsmara crosses with Charolais and Beefmaster sires. The last data was collected from 58 Bonsmaras heifers, at Glen which is a typical sweetveld grassland vegetation. The data was analysed using regression model in SAS to predict final slaughter weight within 1080 days.

Results: Nguni cattle under sweet veld condition are likely to reach the FR specifications but only at the entry level. Bonsmara under similar condition are also likely to reach all levels of the slaughter weight. The Bonsmara crosses under mixed veld conditions were likely to reach the three levels. The Bonsmaras under cold sweetveld were likely to reach all levels of the specifications, even though they had negative growth during the winter months but compensated growth in summer.

Discussion: The results show that Nguni at Mara without supplementing with concentrates can grow to meet the FR slaughter weight. FR specification allows concentrates up to 1% of the body weight as long as they were not confined. Ngunis are likely to just make the required weight whereas Bonsmaras under all veld types could easily meet specifications even in situation where they were losing weight during winter. If supplemented with concentrates the Bonsmaras and their crosses could reach the weight at a much younger age.

Conclusion: Nguni, Bonsmara and Bonsmara crosses can easily meet FR specifications under the three veld conditions in South Africa. The cost effectiveness of supplementing 1% concentrates needs to be studied.

Management practices and constraints on beef cattle production in communal areas of
Mpumalanga Province, South Africa

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Background: Beef cattle farming is critical for many of the poor in developing countries, often contributing to multiple livelihood objectives and offering ways out of poverty which is similar in the deep rural communal areas of South Africa (DAFF, 2010). However, despite the dynamism of the contribution of beef cattle farming to the livelihood of communal households, its contribution to households income generation remains unknown especially in Gert Sibande District in Mpumalanga province which has played an important role in the export of beef as it has commanded the highest market shares during the periods 2002, 2004, 2006 and 2008 and 2009 (DAFF, 2012).

Aim (-s): To evaluate the management practiced and their constraints faced by beef cattle production in communal areas of Mpumalanga province.

Methodologies: A total of 200 smallholder farmers were randomly selected, of which, 50 farmers from Elukwatini, 50 Tjakastad, 50 Mooiplaas and 50 Dundonald. Selected participants were based on the beef cattle availability, the willingness to participate and they were interviewed using a structured questionnaire. Data was collected on management practiced and constraints faced by beef cattle farmers which includes; grazing systems and

source of feed used by farmers, provision of supplement and supplementation time, body condition of their cattle, selling time and selling channels of beef cattle. Statistics Package of Social Science (2015) was used to analyse the data.

Results: Results show that management system practiced by farmers on the study area was a communal land, 100% of farmers freely grazed their beef cattle on the mountain. About 93.5% of farmers used veld as a source of feed. However, 82% of farmers supplemented their beef cattle depending on different season. The results on body condition confirm that most farmers supplemented their beef cattle and it was noted that 87.5% of farmers had good body condition of beef cattle in the study area. However, most of the farmers (56.5%) sold their beef on emergency basis and 23% of farmers sold on the non-emergency situation. Private sales were recorded at 39.5% as the quickest selling way. The main challenges were disease (26%) and malnutrition (18%) and ticks (1%) during dry season. However, most of farmers (10%) reported shortage of feeding during winter and in drought season as constraints whereas 9.5% of farmers experienced drought during winter season.

Discussions: Lawlessness in the management of grazing in those communal areas result on people building homes on grazing land, or the land being used as a dumpsite has a negative impact on their grazing camps. The results on constraints were highly expected due to lack of knowledge on health related issues in those communal areas. However, veterinary services from DARDLEA were assisting with vaccination programme, but some farmers were not following the programme due to high input cost needed to buy the vaccines and treatments.

Conclusion/Recommendations: it is therefore recommended that there is a need to develop a collective and comprehensive beef cattle training programme in communal areas of Mpumalanga Province.

Effects of environmental factors on reproductive performance of the Nguni cattle ecotypes in
South Africa

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Background: The most common breed in southern Africa is the Nguni, which belongs to the Sanga group, a result of the *Bos indicus* and *Bos taurus* crossbreeding. The interaction between the environment and the genotype over a period of 1200 years resulted in different Sanga cattle ecotypes, which probably led to different Nguni ecotypes sharing a common genetic background found in South Africa, Mozambique, Swaziland, Namibia and Zimbabwe.

Objective: The objective of this study was to assess the effects of different environmental factors on the reproductive performance of Nguni cattle distributed among 11 farms in four regions of South Africa.

Methodology: Only data of registered Appendix A to Stud Proper Nguni animals, from the Agricultural Research Council of South Africa's database were used. Data were collected from 2 061 dams, between 1990 and 2009 and PROC GLM procedure (SAS, 2003) was used to analyse the age at first calving (AFC) and calving intervals (CI). Breeder (herd of origin), age at first calving (AFC), Year-Season of birth, region and herdbook status were included in the analysis as fixed effects.

Results: Age at first calving (AFC) and calving intervals (CI) averaged 33.79 ± 4.90 months and 400.29 ± 78.70 days, respectively. AFC of females born in different years-seasons

differed ($p < 0.0001$ to $p < 0.05$) within the same seasons and between seasons along the years of study. Dry seasons born heifers had lower AFC than wet seasons born heifers. Both AFC and CI were significantly affected ($p < 0.0001$) by breeder and season of birth/calving, and by the dam's region (origin of the dam) ($p < 0.05$). Calving intervals were significantly ($p < 0.0001$) affected by Year-seasons. Dry seasons 4 and wet seasons 1 had lower CI than seasons 2 and 3. CI was also significantly affected ($p < 0.0001$) by number of parity.

Discussion: Younger age at AFC from females born in Dry year-seasons (3 and 4) than females born in Wet year-seasons (1 and 2) is in agreement with recent studies (Kanuya et al., 2006, Villa-Mancera et al., 2010 and Maciel et al., 2012), but in contradiction with earlier ones (Catalão and Syrstad, 1990 and Carvalheira et al. 1995). In a lag analysis, lower CI of Year-seasons 4 and 1, means that most conceptions take place between December and May, during plain wet seasons and just at the beginning of the dry season (May) when there is plenty of grass available, in quantity and quality, and that those cows conceiving in May still get the remains of grass availability.

Conclusions and Recommendations: For the first time, this study demonstrated that ecological regions of the dam's origin, year-season of birth/calving, breeder's management, parity and herdbook status are influencing reproductive performance of Nguni cattle, confirming the existence of environment-genotype interactions on this indigenous breed of southern Africa. This stimulated a follow up study on the use of geographic information 2 systems (GIS) to specifically identify factors influencing the (re)productive performance of Nguni cattle in southern Africa, using data from the Landim of Mozambique and the Nguni of South Africa ecotypes.

Investigation into the precision feeding of Nguni cattle under feedlot conditions

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Background: The Nguni breed is well-known in South-Africa especially for their low production cost and ability to market a good grade carcass off the veld. Weaners are purchased by the feedlots and are then categorized into early-, medium- or late maturing breeds. The success of feedlots is dependent on the economical deposition of lean meat over an extended feeding period, on high final carcass mass, low fat coverage and conformation at slaughter. The Nguni breed is an early maturing breed. Feedlots discriminate against Nguni cattle and pay less per kilogram live mass than for other breeds.

Aim: To determine the most suitable ration for Nguni calves under feedlot conditions.

Methodologies: Nguni young male calves were sourced from 24 breeders from five provinces. The calves were divided into four groups of 50 animals per group. Each group were fed a different feeding regime. The rations fed was a starter (high roughage), grower (medium roughage), finisher (low roughage) and a feedlot grower commercial (low roughage) ration. These calves were backgrounded in the pre-conditioning phase for 30 days and received *ad lib* *Eragrostis* grass. After 105, 120 and 135 days these calves were slaughtered according to their weight, body condition and visual appearance.

Results: The low roughage group had the lowest average intake per animal per day, while the high and medium roughage groups had the highest average intake per day. Calves on the

commercial ration did significantly better than the calves on the other rations for ADG (average daily gain) at slaughter (1.34 vs 1.24-1.27), total gain at slaughter (159.1 vs 147-150), end weight (7 to 11 kg heavier) and carcass weight of 204 kg vs 196 – 198 kg for the other rations.

Discussion: Although the low roughage and commercial rations were more expensive per ton, the animals fed on them were the most profitable. The heavier the animal is when they arrive at the feedlot, the shorter the feeding period, the better the ADG and the heavier the carcass weight at slaughter. Nguni calves performed the best in the group with the most expensive ration (Low roughage and commercial rations) and also made the biggest profit due to the shorter feeding time and faster growth.

Conclusion and recommendations: Nguni cattle can be fed profitable in the feedlots with a low- and commercial roughage ration.

CLIMATE CHANGE

Enteric methane output from Boran and Nguni cows raised under arid conditions

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Background: Methane (CH₄) is one of the most potent greenhouse gases (GHG) whose levels continue to increase due to various factors and expansion in agriculture production is part of it. Apparently, ruminant livestock farming is one of the agriculture sub-sectors which produce the highest CH₄ levels and it accounts for about a quarter of all global output. Currently, available information on CH₄ output from extensively raised beef cattle under extensive arid African environments varies from limited to non-existent. Such knowledge is crucial to fill the gaps which are required to develop expert recommendations that will inform policy makers.

Aim: To determine the enteric CH₄ estimates through use of a laser methane detector (LMD) on a herd of Boran and Nguni cows raised under arid conditions.

Methodology: A total of 24 cows (12 from each breed) were randomly selected for the study. The animals were identified according to their parities as follows: Parity 1 (*n*=6), Parity 2 (*n*=6), Parity 3 (*n*=6), Parity 4 (*n*=6). An observer used a hand-held LMD to measure the enteric CH₄ emissions plumes during the late afternoon hours when the animals were resting

(either standing or lying down). Point measurements (expressed in ppm/m) were taken for 6 consecutive days and repeated once after every 3 months.

Results: All cows had the lowest estimated dry matter intake (DMI) in the dry season and Nguni cows were collectively consuming the least ($P<0.05$) amount in the same season. The estimated DMI were all approximately 3 % of the live-weights for all the cows from both breeds. There were no significant differences ($P>0.05$) on the adjusted CH₄ output for DMI from all the cows. All cows maintained optimal body condition scores in both seasons. All the animals maintained optimal body condition scores in both seasons.

Discussion: The values for the LMD CH₄ estimates from this study are within the range of reports from other studies. Chagunda *et al.*, (2009) obtained LMD CH₄ estimates of 357g/d for dairy cattle. However, estimates from the current study are higher than those obtained by Du Toit *et al.*, (2013) using the IPCC Tier 2 system for South African commercial beef cattle. High estimates could have emanated from the extreme dry conditions which were prevailing in the southern Africa during the 2015/16 season. Dry conditions are characterised by low quality forage biomass likely resulted in high energy losses by animals when searching for feed to meet their satiety levels. All the animals maintained optimal body condition scores both in dry and wet seasons. Such trend shows that the cows were adjusting and coping to their environments.

Conclusions: From results of the study, it can be concluded that cows from both breeds maintained optimal body condition scores, had different estimated DMI, percentage of DMI to the live weight, CH₄ output per kg of DMI and CH₄ output per kilogram of cows' live weight.

Investigating novelty traits to improve cow-calf efficiency in the South African Afrikaner,
Angus and Charolais for climate smart production systems

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Background: Approximately 84% of South Africa's surface area is available for farming; yet only approximately 14% is arable and the remaining 70% is only suitable for extensive livestock production. South Africa's beef cow-calf production systems are thus mainly extensive and account for 72% of the nutrient requirements from conception to harvest. A measurement is thus required that expresses output per constant (standardized) unit, such as Large Stock Unit (LSU), which may be a useful breeding objective/goal to increase production efficiency. It may also reduce the carbon footprint of extensive cow-calf production systems.

Aim (-s): The aim of this study was to identify novelty traits as possible selection criteria to improve cow-calf efficiency and to describe cow efficiency in extensive systems that will support climate smart beef production.

Methodologies: Traits investigated were calf weaning weight as trait of the dam (K205) and kilogram calf weaned per Large Stock Unit (KgC/LSU); the latter trait being a measure (value) that expresses performance (calf weaning weight) per constant input unit, viz. per LSU. This may be a useful breeding objective/goal to increase production efficiency, which may reduce the carbon footprint of extensive cow-calf production systems. In South Africa, a

LSU is defined as the equivalent of an ox with a weight of 450 kg and a weight gain of 500 g per day on grass pasture with a mean Digestible Energy (DE) concentration of 55%. To maintain this, 75 MJ Metabolizable Energy (ME) is required. The investigation on the novel traits was conducted on three diverse breeds namely the Afrikaner, Angus and Charolais with complete cow-calf records.

Results: The heritabilities for KgC/LSU were 0.52, 0.24 and 0.21 for the Afrikaner, Angus and Charolais respectively and that for K205 0.40, 0.17 and 0.13 respectively. In the case of the Afrikaner, the genetic correlations could not be estimated. There was a major difference in the nature of the relationship between KgC/LSU and K205 between the Angus and the Charolais, the latter indicating a strong negative correlation (-0.75) and the Angus a strong positive correlation (+0.84).

Discussion: The heritability estimate for KgC/LSU is much higher for the Afrikaner (0.52) compared to the Angus (0.24), Charolais (0.21), indicating that it might be possible to drastically increase the cow efficiency in the case of the Afrikaner. However, this will have to be approached through an index based on calf and cows weights to avoid the complexities associated with selection for a ratio.

Conclusion/recommendations: It is becoming more evident that inclusion and combination of traits contributing to cow maintenance in some kind of economic or carbon footprint selection index is the more feasible and most appropriate approach. If cow maintenance requirements can be reduced, the feed energy requirements will be less and this should reduce the input cost of the cow and thus improve cow efficiency. Improving beef cattle productivity/efficiency will have positive sustainability implications as it will reduce resource use and greenhouse gas emissions whilst improving economic viability.

DAIRY SCIENCE

Characterization of emerging and smallholder dairy production systems in South Africa

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Background: Milk production is an important livestock-sector activity globally. An estimated 750 to 900 million people depend on dairy farms or within dairy farming households worldwide (FAO, 2010). The dairy industry is a major provider of food security (milk and meat), employment opportunities (directly as well as indirectly) and supports other enterprises. South Africa has a highly developed, world class, dairy industry. The emerging and smallholder dairy sector in South Africa, however, contributes insignificantly to the mainstream dairy industry. There is limited research and baseline data on this sector and knowledge on its performance is not well documented. Characterization of emerging and smallholder dairy production systems in South Africa is an important prerequisite to understanding the constraints and opportunities that exist within this farming system.

Aim: The aim of the study was to characterize emerging and smallholder dairy production systems in South Africa in terms of cow performance and management practices.

Definitions: Emerging dairy herds (EDH) comprises mainly the beneficiaries of one of government's land reform program, who keep more than 15 milking cows on land larger than 1 hectare and produce more than 100 liters of milk per day. Smallholder dairy herds (SDH)

comprises farmers keeping up to 15 head of milking cows and producing less than 100 liters of milk per day, irrespective of breeds used (Henk et al., 2007)

Methodologies: Cow performance data were obtained from the Integrated Registration and Genetic Information System of South Africa (INTERGIS). It comprised of data on animals participating in the National Dairy Animal Recording and Improvement Scheme between 2004 and 2016. There were 38 549 test-day records of 1 662 cows from 19 emerging dairy herds(EDH) and 2 851 test-day records of 307 cows from 34 smallholder dairy herds (SDH). Data on herd management practices was collected through a survey, using a structured questionnaire on the herd owners during the period August-November 2016 from 27 EDH and 94 SDH in South Africa. Descriptive statistics were calculated to characterize performance and management practices.

Results: Mean daily milk yield (Kg) per cow for EDH was 11.85 ± 0.05 and 5.32 ± 0.1 for SDH. Averages for butterfat and protein percent were, respectively, 3.79 ± 0.01 and 3.21 ± 0.004 for EDH and 4.3 ± 0.04 and 3.54 ± 0.02 for SDH. Somatic cell count (cells/ml) was much lower for EDH (405.339 ± 7.326) compared to SHD (918.934 ± 57.783). Mean age at first calving (AFC) was 30 ± 0.47 months and calving interval was 450 ± 8.5 days for EDH. Corresponding averages for SDH were 28 ± 1.42 months and 459 ± 18.66 days. The most commonly used breed on SDH was crossbred (75%), followed by the Jersey (21%) and Holstein (4%), with an average herd size of 5 cows. On EDH, the most predominant breed was also Holstein (50%), followed by crossbred (38%), Dairy Shorthorn(5%), Jersey (5%) and Ayrshire(2%), and the average herd size was 62 cows. Nearly all SDH (100%) used natural service for breeding, whereas 7.4% of EDH used artificial insemination, 81.5% used natural mating and 11.1% used both. The majority of EDH (63%)

had fixed milking parlours, 25.9% had movable machine and 11.1% used hand milking; however most SDH (92.6%) used hand milking and only 7.4% had movable milking machine. Natural grazing with supplement on communal land was the predominant (58.8%), 30.9% grazing only, 2.9% pasture with supplement and 7.4% on zero grazing feeding system on SDH, while 29.6% of EDH were on zero grazing and 22.3% used pasture with supplement, 7.4% used pasture only, 22.2% used grazing with supplement and 18.5% used grazing only.

Discussion: Individual cow's production performance appears to differ between the two systems. Udder health (somatic cell count) was much better in EDH, which was not according to expectation. Hand-milked cows are generally known to have better udder health. In spite of different management practices observed in the two production systems.

Conclusion and Recommendations: EDH produce more milk with less butterfat and protein content compared to SDH. Breeding strategies that match the predominant environment need to be developed for the two productions systems, and should be underpinned by improved herd management practices.

Rearing dairy bull calves by communal farmers in the Eastern Cape: current strategies,
challenges and opportunities

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Background: Communal farmers purchase and raise for beef, part of more than 200 000 bull calves produced annually in the South African dairy sector. The production practices, challenges and sustainability of these initiatives have not been investigated.

Aim: This snowballing study using 42 calf rearing households in Amathole district municipality investigated the dairy bull calf management practices, rearing challenges, and current rearing costs up to weaning.

Methodologies: A structured questionnaire that contained questions on management practices (feeding, housing, and diseases), identified production challenges and costs of inputs in the pre-weaning period was used. Descriptive statistics were used to analyse the data, and comparisons were done through an ANOVA.

Results: An average of 6 calves were reared per household (range 1 - 19), and many households reared Holstein x Jersey crosses (34.4%), pure Holstein (31.3%) and dairy beef crosses (21.9%). Dairy beef crosses, and pure jersey calves were reported to survive up to weaning in 37% of households for both breeds. Calves were group housed in unbedded kraals, roofed shelter and mud/zinc walled houses in 50, 30 and 20% of households, respectively. Most of the households (56.7%) used milk replacer, with a few foster rearing (23.3%) and feeding calf pellets (20%). Ninety five percent of the households fed 2 litres of

milk replacer per calf twice a day until an average age of 102 days. Solid feeding in the milk-feeding phase started at an average age of 80 days, and the average age at weaning was 200 days. Diarrhoea was reported the most prevalent (40% households) disease, followed by chronic abomasal bloat (16%). Eighty six percent of households experienced an average of 53% calf mortality. A significantly higher ($p < 0.05$) mortality was observed in pure dairy calves that were kraaled and fed milk replacer. Newly purchased and sick calves were not quarantined in 53%, and 62% of the households, respectively. The mean cost of rearing from purchase to weaning was R1969.64 per calf, with a range of R413.00 to R5686.00 among households, reflecting major differences in rearing strategies. Milk replacer was the highest contributor of costs. The main challenge identified by most of the households was high feed costs (31%), and the need to dedicate more time (21%) and care (24%) to the calves. Most of the respondents (85%) lacked sufficient knowledge and skill on calf rearing due to lack of training opportunities.

Discussion: The high mortality rate might be due to the poor management practices that might be associated with poor knowledge of calf rearing. Poor housing and health management practices might have led to some reported diseases.

Conclusions and recommendations: Training on calf rearing, improvement in calf housing and health management; and exploring opportunities of foster rearing would be essential in the development of the communal dairy bull calf production system.

The milk yield and live weight of Holstein cows as affected by selection strategy

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Background: Genetic improvement of a dairy herd depends on the group of bulls selected annually to service cows. Despite careful selection of sires, the production performance of their progeny may be similar, better or worse than the parents. Poor producing first lactation cows should be identified and culled to improve the performance of the current herd while ensuring remaining cows to be better parents for the next generation.

Aim: The study compares the live weight and milk yield of Holstein cows following different selection strategies aimed at identifying and culling poor performing cows during first lactation.

Methodology: Milk recording records of 221 primiparous Holstein cows were used to estimate partial (105-d) milk (MY), fat and protein yields and Component Values (CV) being $[(6 \times \text{fat yield} + 13 \times \text{protein yield})/2]$. Live weight records of cows on milk recording days were used to estimate two production efficiency measures, i.e. (i) an alternative Kleiber Ratio [KR: Net Energy requirement for milk production (NEL) divided by metabolic live weight (LW^{0.75})] and (ii) 4% fat corrected milk yield (FCM) divided by average live weight of dairy cows (Gaines). For each trait, selection threshold values, aimed at identifying the bottom 20% of cows, were estimated as follows: $[\text{mean} - (0.8416 \times \text{standard deviation})]$. Within each selection strategy, cows below the selection threshold were identified. The mean

live weight and 105-d milk, fat and protein yields of the remaining cows within each selection strategy were compared by analysis of variance.

Results and Discussion: For the MY, CV, KR and Gaines selection strategies, 43, 41, 44 and 41 cows, respectively, were identified as being below threshold levels. The level of agreement in comparison to the MY selection strategy was 74, 79 and 72% for the CV, KR and Gaines' methods, respectively. The mean \pm standard deviation milk yield and live weight of remaining cows within each selection strategy did not differ ($P>0.05$) being 2253 \pm 344, 2239 \pm 358, 2246 \pm 358 and 2231 \pm 368 kg milk and 482 \pm 47, 480 \pm 45, 482 \pm 48 and 483 \pm 49 kg LW for the MY, CV, KR and Gaines selection strategies, respectively. Using MY as a reference group, cows identified to be culled produced less ($P<0.01$) milk and had higher ($P<0.01$) live weights than cows selected to remain in the herd, being 1561 \pm 164 vs. 2253 \pm 344 kg milk and 515 \pm 54 vs. 482 \pm 47 kg live weights, respectively.

Conclusion/recommendations: Milk yield may be used as a selection strategy to identify poor performing cows to be culled. For this group of cows using production efficiency measures did not improve selection response. Sire selection should be aimed at improving milk yield while maintaining (not increasing) the live weight or body size of cows.

ABSTRACT

Twenty four calves were blocked on the basis order of birth and sex, used to determine the effects of supplementing *Carica papaya* seed (*Linn*) meal (CPSM) on health and growth performance of calves. In the first study, calves were fed CPSM for only 2 days to determine faecal pathogen population, and the second study; calves were randomly assigned at birth to three treatments and fed until weaning at 42 days, each with six calves. Treatments were; 1) a control group, which did not receive additive; 2) a group that was supplemented 5 g/d of *Carica papaya* seed meal (CPSM) and 3) the last group that was supplemented 5 g/d of a commercial product containing *Lactobacillus acidophilus* (Lact). After receiving colostrum for 3 consecutive days after birth, calves had free to commercial starter pellet and fresh water *ad lib*. Treatments were added to whole milk from day 4 and fed to calves before being allowed to suckle from the mother for 30 min three times a day (8:00h, 12:00h and 17:00h). Calf starter dry mater intake (DMI) was evaluated daily, body weight (BW) and body structural growth were measured weekly. Faecal samples were collected directly from the rectum for two weeks. The DMI (kg), DMI/kg BW, Av BW and BW gain of calves did not differ amongst treatments, and averaged 305.4 kg/d, 7.7 g/kg BW, 39.4 kg, and 32.1 kg, respectively. The initial BW (22.2 kg) did not differ amongst groups, but the weaning BW was higher ($p<0.05$) for CPSM-calves compared to control calves and did not differ between control and Lact-calves. Calves in Lact and CPSM groups had similar average daily gain (ADG) and heart girth (HG), which were higher ($p<0.05$) than control calves. Calves fed CPSM had higher ($p<0.05$) HW and SH than control calves. There were effects of time ($p<0.001$) for starter DMI/kg, ADG and all structural body parameters, and effects ($p<0.05$) of interaction between time and treatments for only starter DMI/kg, ADG and HG. CPSM reduce faecal coliforms and *E. coli* ($p<0.05$) by 93.6% and 96.1%, respectively; and tend to

reduce *Enterobacteriaceae* ($p=0.056$) by 96.4%. The present study revealed that feeding CPSM to calves during the pre-weaning period increased growth performance by improving average daily gain and feed efficiency, and improves health status due to low faecal pathogens count.

Keywords: *Carica papaya* seed, probiotics, faecal pathogen, growth, calves

Joint genetic evaluation of dairy cattle for sub Saharan Africa: a case study on Kenya, South
Africa and Zimbabwe

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Background: Unavailability of breeding programmes is a serious challenge to livestock production in developing countries. Generally, farmers do not have access to high quality, well adapted germplasm, and there are no systems for supporting sound breeding decisions nor appropriate genetic improvement programmes. Genetic evaluation is an important prerequisite to any breeding programme. Few developing countries, however, perform routine genetic evaluations (Chebo and Alemayehu, 2012) and there is sparse availability of data and recording systems among the countries (Wabacha, 2015). In Sub-Saharan Africa, only South Africa has sustainable national animal identification and performance recording schemes, as well as routine genetic evaluation programmes (Banga, 2001). Joint genetic evaluation of animals among countries has several benefits, including sharing of resources and increased genetic gains.

Aim: To assess the feasibility of joint genetic evaluation of dairy cattle for Sub-Saharan African countries.

Methodologies: Performance and pedigree data of Holstein-Friesian cows from Kenya, South Africa and Zimbabwe were used. Selection response was determined for sires performing within Kenya, South Africa, and Zimbabwe and in joint evaluation for 305-day

milk yield and reproduction traits (age at first calving and calving interval) using the breeders' equation. Selection intensities, average reliability of top 5, 10, 25, 50, 75 and 100 bulls and square root of genetic variances were determined for sires within and in joint evaluations.

Results & Discussion: Genetic gains were mostly higher for joint than within country genetic evaluation, for all three countries, for both production and reproduction traits. This indicates that genetic improvement of these traits will be enhanced if a joint evaluation of data from Kenya, South Africa and Zimbabwe is used, as compared to each country relying on its own evaluation. If the top 5 sires for 1st lactation milk yield are selected based on a joint evaluation, genetic gains compared to those for within country evaluations would be 78%, 22% and 7% higher for Zimbabwe, Kenya and South Africa, respectively. This implies that Zimbabwe and Kenya benefit the most from joint evaluations than South Africa. For age at 1st calving, Kenya will benefit 100% from selecting either the top 5 or 50 sires in the joint evaluation. Zimbabwe will gain by improving the genetic merit for age at first calving by 34%. South Africa will, on the other hand, be better off sticking to their within country evaluation. A joint evaluation, however, opens opportunities for South Africa to market their genetic resources to the other participating countries.

Conclusion and Recommendations: A joint genetic evaluation for Kenya, South Africa and Zimbabwe will confer benefits to all countries. Kenya and Zimbabwe will benefit more genetic gains; however there are potential opportunities for South Africa to market their proven genetic resources to other African countries to enhance their genetic improvement.

Effects of compounding dairy feces and vegetation on methane production from anaerobic
batch and continuous cultures

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Background: Poor nutrient utilization by ruminant livestock increases waste nutrient accumulation in soils, water and air pollution by nitrogenous compounds and methane. Anaerobic digesting utilizes the secondary energy stored in animal excreta and crop residues for generation of gaseous energy and chemical compounds such as fertilizers. Dairy cattle dung is a good substrate for anaerobic digestion; however, methane production from pure substrate is low, limiting energy production.

Aim: The aim of the study was to determine the effects of co-digesting of dairy cow fresh feces with vegetable wastes on methane production from anaerobic batch and continuous cultures

Methodologies: Batch and continuous fermentations were managed under mesophilic anaerobic condition (38-39°C) with treatments: (A) control –fresh feces), (B) fresh feces and cabbage, (C) fresh feces and Irish potatoes and (D) fresh feces, cabbage and potatoes. In the batch culture, water was added to substrate at 1:1 in 250 mL bottle and fermented for 120 hr. with 24 hourly measurements of methane release. In the continuous system: water was added at 1:1 at the start of the trial. After 24 hours daily infusion of substrate (5 g) and water (5 g) (39°C) was done for 3 days. The continuous system was flushed with 100% nitrogen for 20 to 30 seconds to retain anaerobic condition after infusion of substrates and water. The methane

content in batch and continuous systems in each bottle were determined using laser methane mini (LMm) ATEX-rated, laser-based remote methane detector at 24, 48, 72, 96 and 120 hours.

Results: Methane production varied between treatments. Treatment A fresh feces yielded the most methane (0.4 ml; $P < 0.01$) during the first 24 hours, exceeding D and C by 40% fresh feces. The B compound of fresh feces and cabbage had the lowest yield (0.18 ml) fresh feces. At 120 hr., D had yielded the most methane (10.35 ml), then C (8.2 ml), and B with 6.8 ml. The control substrate was 50% lower than D. There were differences ($P < 0.001$) between the cultures; the continuous culture yielded three times more methane relative to the batch culture. Continuous culture (36 ml) at 120 hours compared to the batch system (10 ml). Differences were noted at all levels from 48 hours. Peak yield occurred between 48-72 hrs, in the batch culture with insignificant changes in yield thereafter. Methane yield in the continuous culture was linearly ($R^2 = 0.68$; $P < 0.01$) related to time.

Discussion: Co-digesting dairy cattle fresh feces with vegetable waste improved methane synthesis, which indicates that plant sources were providing energy required for growth of anaerobic microbes. Continuous flashing replenishment of substrate increased nutrient supply and modulated pH, which could have improved conditions for anaerobic fermentation.

Conclusion/recommendations: The use of continuous system showed to be the best alternative compared to batch system. When substrate is limiting, the batch system is recommended and should be terminated every 72 hrs. The continuous system is optimum where supply of waste is unlimited. Further studies can be done to compare different mixing ratio of feedstuff with fresh feces.

Productive lifetime and lifetime efficiency in Holstein cows as affected by non-genetic factors

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Background: The lifetime performance of dairy cows affects herd profit margins. Although it is important for cows to have a long lifetime (LT), (from birth to culling date), lifetime efficiency (LTE) is strongly affected by productive life (PL) as indicated by the number of days in milk. Currently in South Africa, the genetic evaluation of cows and sires do not include lifetime performance as a genetic trait.

Aim (-s) In this study the effect of non-genetic factors on the lifetime performance of Holstein cows as indicated by productive live efficiency (PLE) and LTE was determined.

Methodologies: The LTE for each cow was derived by dividing the total lifetime milk, fat and protein yield of cows by their total lifetime as indicated by the interval (number of days) between birth date and age at the end of the last lactation. The PLE for each cow was derived by dividing the total lifetime milk, fat and protein yield of cows by their (PL). Holstein cows born between 1980 and 2008, which calved down at least once, were included in the study. Cows calving down before 18 months of age and herds with fewer than 30 records over the 28 year period were removed. Non-genetic factors investigated included year of birth (25

levels), season of birth (4 levels), month of birth (12 levels), year of calving (20 levels), season of calving (4 levels), month of calving (12 levels), parity (10 levels) and age at first calving (AFC) (20 levels). Analysis of Variance (ANOVA) was performed on each factor separately using SAS statistical software version 9.2 (SAS Institute Inc., Cary, NC, USA).

Results and discussion: As expected, LTE for milk, fat and protein production increased with lactation number. All non-genetic factors affected LTE and PLE significantly. LTE and PLE increased up to the 24th month of age at first calving (AFC), where after it decreased. Cows born in summer had a higher LTE and PLE compared to winter born cows. LTE and PLE increased as number of lactation increased up to 4th lactation after which it stabilized. Cows calved in summer had a higher LTE and PLE compared to cows calved in winter. Longevity is affected by reproduction performance of cows. Improving the fertility of cows would improve lifetime production and LTE.

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Background: A carbon tax policy has been implemented by the National Treasury of the South African (SA) Government and will directly affect the Agriculture, Forestry and Other Land Use (AFOLU) sector by 2020. In support of this, the Department of Environmental Affairs developed a Mitigation, Reporting and Verification strategy in 2016 which provided a baseline for greenhouse gas emissions for the AFOLU sector. The livestock baseline emissions derived from validated data sources from 2011 to 2013 that were based on Intergovernmental Panel on Climate Change (IPCC) Tier 1 and 2 guidelines. This data is most likely out-of-date and represents estimates based on international models. Moving towards a SA carbon tax system it is vital to utilise the most current and accurate emissions data to reflect baseline emissions.

Aim: To compare directly measured enteric methane (CH₄) emissions with the existing SA baseline enteric CH₄ emissions for lactating, pasture-based dairy cows.

Methodologies: Thirty-six multiparous Jersey cows were equally allocated to three treatments that differed by means of dairy concentrate feeding level: 0, 3.6 and 7.2 kg dry matter (DM)/cow/d. Cows grazed perennial ryegrass pasture allocated at ± 12 kg DM/cow/d. Enteric CH₄ emissions were individually measured with the sulphur hexafluoride tracer gas

technique. Animal and feed parameters from this study were used as input data for the Tier 2 equations.

Results: The DM digestibility (DMD) of the grazed pasture and fed concentrate were 87% and 93%, respectively. Measured CH₄ yield across treatments were similar ($P>0.05$): 282, 335 and 281 g CH₄/cow/d for cows fed 0, 3.6 and 7.2 kg DM of concentrate, respectively. Predicted total DM intake were 11.3, 13.4 and 14.5 kg/cow/d and predicted CH₄ emissions were 280, 311 and 326 g CH₄/cow/d for cows fed 0, 3.6 and 7.2 kg DM of concentrate, respectively. The predicted baseline underestimated measured CH₄ emissions by 0.9%, 7.8% and overestimated measured CH₄ emissions by 13.8% for cows fed 0, 3.6 and 7.2 kg DM of concentrate, respectively.

Discussion: The absence of a CH₄ emission response was expected due to the high DM digestibility value of the grazed pasture that was comparable to that of the concentrate fed, hence a zero dilution effect. The actual lower CH₄ emissions of cows fed 7.2 kg DM of concentrate compared with the predicted baseline values, bodes well with the SA commitment of a 34% reduction in emissions by 2020. Therefore, the upcoming carbon tax may perhaps be reassessed.

Conclusions and recommendations: The existing methane emissions baseline for lactating, pasture-based dairy cows is not a true reflection. It is advised that the SA baseline emissions should be updated with results from this study.

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Background: Pasture is the cheapest source of good quality feed in a dairy production system. However, pasture is limited in energy supply and should, therefore, be supplemented with a dairy concentrate. Dairy concentrate level is a delicate matter, because it can result in pasture substitution and may alter the milk response and margin over feed cost. It has been shown that concentrate level is an effective enteric methane mitigation strategy. The impact that concentrate level has on enteric fermentation parameters should not be ignored.

Aim: To determine the effect of dairy concentrate level on enteric fermentation of pasture-based dairy cows.

Methodologies: The study was conducted at the Outeniqua Research Farm during spring. Six rumen-fistulated cows formed part of a replicated 3 x 3 Latin square design with 19-day periods (14 days adaptation and five days data collection). Treatments differed by concentrate level, i.e. 0, 3.6 and 7.2 kg dry matter (DM)/cow/d split evenly between morning (06:30) and afternoon (15:00) milking. Cows strip grazed perennial ryegrass as one group allocated at *ca.* 12 kg DM/cow/d. Ruminal pH (handheld and 72 h indwelling loggers), ammonia nitrogen and volatile fatty acid concentrations, and *in situ* pasture DM degradability at 6, 18 and 30 h incubation (DMd6, DMd18 and DMd30, respectively) were determined.

Results: Cows on the 7.2 kg DM concentrate level had a higher DMd6 than cows on the 0 kg DM concentrate level (42% vs. 35%; $P<0.05$), but similar to that of cows on the 3.6 kg DM concentrate level (38%). Acetic and propionic acid were surprisingly unaffected by treatment, even though numerical difference were visible: 63.6, 59.1 and 56.7 mmol/L ($P=0.16$) and 17.7, 17.2 and 15.6 mmol/L ($P=0.45$) for cows on 0, 3.6 and 7.2 kg DM concentrate, respectively. Butyric acid concentration was higher for cows on 0 vs. 7.2 kg DM concentrate level (13.2 vs. 11.0 mmol/L; $P<0.05$). Handheld pH measurements tended to decrease stepwise with increasing concentrate level (6.26, 6.12 and 6.06; $0.10>P>0.05$). According to the 72 h indwelling pH loggers, pH were lower for cows on 7.2 vs. 0 kg DM concentrate level up to 1 h 30 min after afternoon feeding ($P<0.05$) and only tended to decrease with increasing level of concentrate up to 1 h 30 min after morning feeding ($0.10>P>0.05$).

Discussion: Concentrate feeding level did not have a pronounced effect on most of the fermentation parameters, which was on the contrary of what was expected. Ruminal pH of cows on the high concentrate level decreased directly after feeding concentrate, due to the immediate fermentation of the higher level of readily fermentable carbohydrates (RFC). This also explains the higher DMd after 6 h incubation.

Conclusions and recommendations: A concentrate level up to 7.2 kg DM did not impair the rumen environment to an extent where it is expected that animal production will be impeded. Further studies on different pasture-bases are encouraged.

Effect of potassium content in the diet of dairy cows on alcohol stability of milk

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Background: During the processing of long life milk or UHT milk, milk is subjected to heat treatment. The casein complex in milk must withstand the heat treatment and sustain its integrity. If UHT milk is not stable, protein will precipitate and shelf life of milk is compromised. Consumers find this unacceptable and reject milk resulting in major financial losses. Milk buyers use the Alizarol test as a screening test to estimate the heat stability of milk and may reject milk if it does not pass the 72% alizarol test. Milk has to pass the 76% alizarol test to be suitable for processing as UHT milk. The problem of unstable milk is more pronounced in milk produced by cows on pasture than in milk produced by cows in a TMR system.

Aim: To determine if high levels of potassium in the diet of cows on pasture contribute to alcohol instability of milk.

Methodologies: Sixty Jersey cows of the Outeniqua Research herd between 30 and 150 days in milk (DIM) were randomly allocated to three treatment groups (20 cows/group) in a 3X3 Latin square design replicated 20 times (three periods of 20 days: 14 day adaptation and 7 days measurement period). The three concentrates treatments were low K: 1.05%, medium K: 2.93% and high K: 4.8%. Potassium carbonate was used to increase the K content of the

concentrates. Cows grazed kikuyu pasture and were fed 6kg concentrate per day during milking (3kg per milking). Milk yield was recorded daily and composite morning and afternoon milk samples of each cow were collected on day 1, 3 and 5 of each measurement period. This resulted in 540 milk samples (60 cows X 3 samples X 3 periods). The alcohol stability of milk was determined using the Alizarol test at 72%, 74%, 76%, 78% and 80% alcohol. Milk fat, protein, lactose, milk urea nitrogen (MUN), somatic cell count was determined on all milk samples and the mineral content of milk (Na, K, Ca, P and Mg) was determined on day 3 of each measurement period.

Results: The average percentage Alizarol passed differed significantly ($P < 0.001$) and was 76.6a, 75.3b and 73.5c for milk from cows the low, medium and high K treatment respectively. The milk fat % was 5.79, 5.84 and 5.64, milk protein % was 3.71a, 3.67a and 3.51c, milk lactose % 4.55a, 4.52a and 4.29b, milk urea nitrogen (mg/dl) 15.5a, 14.1b and 12.0c, somatic cell count ($\times 1000/\text{ml}$) 200a, 211a, 187b, milk Na (mg/100g) 46.6, 48.7 and 44.3, milk K (mg/100g) 160a, 156a and 147b, milk Ca (mg/100g) 140a, 142a and 127b, milk P (mg/100g) 89.9a, 87.8a and 80.9b, and milk Mg (mg/100g) was 12.5a, 12.5a and 11.5b for the low K, medium K and high K concentrate treatment respectively.

Discussion: The high level of potassium in the diet of cows significantly reduced the alcohol stability of milk and also reduced protein, lactose and MUN content of milk. The calcium, potassium, phosphorous and magnesium content of milk was lower when cows were fed the high K concentrate compared to the control. It is clear that mineral imbalances contribute to alcohol instability of milk.

Conclusions and recommendations: Reducing the intake of potassium will alleviate the problem of alcohol instability of milk. Farmers should limit application of potassium fertilizer to the minimum required for plant growth, identify paddocks with high potassium

levels and remove the material by making silage. Refrain from using large quantities of chicken manure as fertilizer and determine the mineral status of all paddocks on the farm. Paddocks with a high K status should be avoided especially during warm weather.

Effect of herb antioxidants on blood proteins and milk quality of early lactating dairy cows

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Background: Progressive oxidative stress associated with poor nutrition underlies metabolic problems and poor immune response in dairy cows. Natural plant herbs contains high levels of organic acids, polyphenols, vitamins and complex proteins that confirm anti-oxidative properties and boost immunity and performance of lactating cows.

Aim: To assess the effects of micro-supplementation of herbal antioxidants on dairy milk quality.

Methodologies: Twenty-eight, second lactating (\pm 60 DIM) Jersey cows in 20 zero grazing units were allocated to two treatments: T1: (control no supplementation) and T2: (HERB- 30 g/day/cow). Adaption period was 14 days. Animals were fed 6 kg of commercial lactating concentrate and ad libitum *E. Curvula* hay. Milk yield was recorded daily and composite milk samples were collected once per week for determination of fat, protein, lactose and milk urea nitrogen and the total antioxidant capacity. Blood samples were collected from the coccygeal vein on day 14, 21 and 50 for determination of total antioxidant capacity, total serum protein, albumin, creatinine, urea, total immunoglobulin, and immunoglobulin G. Cows were weighed in 14 interval.

Results: Supplementation with natural herb increased milk fat and total solids (4.0 vs 4.4 %; 13.5 vs 14.9 %) respectively. Milk yield, MUN and protein did not vary (15.5 vs 15.6l/day and 10.43 vs 9.85mg/dl; 3.4 vs 3.6% respectively). Herb supplementation had an effect on

total antioxidant capacity (2423.7 vs 2294.8 mmol TE/g of milk protein; $P<0.0001$) and serum total antioxidant capacity ($P<0.0001$). Differences were also noted in serum proteins, with higher levels in herb supplemented cows (68.6 vs 61.6 g/l; $P=0.0002$), albumin (42.5 vs 36.1 g/l; $P<0.0001$) and IgG ($P<0.0001$) (13.5 vs 10.3 g/l). Supplementation also lowered serum creatinine (87.3 vs 94.7 mmol/dl; $P<0.0001$).

Discussion: High antioxidant capacity in both blood and milk indicate that glutathione peroxidase function was high in herb-supplemented cows. Increased glutathione peroxidase activity in blood plasma is associated with an increased protection from reactive oxygen species that are associated with oxidative stress. Lactating cows experience cyclic negative energy balance and mobilize body fat reserves with resultant increase in release of non-esterified fatty acids (NEFA) into blood. Oxidation of NEFA increase ROS. Dietary regulation and supplementation with herbal antioxidants diminished the effects of ROS as indicated by the high total oxidative capacity of milk and serum.

Concussion: Supplementation with anti-oxidant rich herbs improved immunity of lactating cows and oxidative capacity of milk.

The effect of dried apple pomace as the main energy source for Jersey cows grazing ryegrass
pasture

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Background: Ryegrass pasture is characterised as having high crude protein content (214 – 298 g/kg DM) but low fibre content (390 – 550 g NDF/kg DM). Additional supplementation of energy based concentrates is provided to ensure profitable milk production. The high starch content in these supplements could negatively impact the rumen environment; lowering rumen pH and inhibiting pasture degradability. Dried apple pomace is a possible alternative energy source to maize for dairy cows grazing pasture; however, little information is available on the effectiveness of this high fibre by-product for milk production from pastures.

Aim: To determine the potential use of dried apple pomace as an energy source for Jersey cows grazing ryegrass pasture and the possible rumen health implications.

Methodologies: Seventy six lactating Jersey cows were blocked according to milk yield, days in milk and lactation number. Cows within blocks were randomly allocated to one of four treatments. Treatments were: NDAP – 0% dried apple pomace and 75% maize; LDAP – 25% dried apple pomace and 50% maize; MDAP – 50% dried apple pomace and 25% maize; HDAP – 75% dried apple pomace and 0% maize. Cows received 6 kg as is/day of the allocated concentrate in the milking parlour. Cows of all four treatments strip grazed

perennial ryegrass pasture over an area of 8.6 ha. Additionally, four ruminally cannulated cows were used to monitor treatment effect on rumen activity and health. Each cow was randomly allocated to one of four treatments and subjected to a four period crossover design. Sample collection (diurnal rumen pH, *in situ* degradability study, volatile fatty acid production) commenced after a 14 day adaptation period. Cannulated cows were grazed alongside production cows and subjected to the same experimental procedures.

Results: Treatment had no effect on milk yield ($P=0.095$), but 4% fat corrected milk yield was lower for cows in treatment HDAP (18.6 kg/cow) than for cows in treatments NDAP (20.9 kg/cow) and LDAP (20.5 kg/cow), differences ranging between 1.7 and 2.3 kg/day. Fat yield was lower for cows in treatments MDAP (0.79 kg/cow) and HDAP (0.78 kg/cow) compared to cows in treatments NDAP (0.88 kg/cow) and LDAP (0.88 kg/cow), corresponding to the decrease in milk fat content, $P<0.001$ and $P=0.026$, respectively. The milk protein yield remained unchanged between treatments ($P=0.058$), whereas milk protein content was lowest for cows in treatments NDAP and MDAP, showing a cubic trend ($P=0.005$). No differences in diurnal ruminal pH were recorded and the average pH over a 24 hours period was also not affected. Treatment had no effect on individual volatile fatty acid concentrations or the acetate to propionate ratio. The $\text{NH}_3\text{-N}$ concentration and pasture degradability did not differ between treatments.

Discussion: Replacing maize with dried apple pulp in the concentrate for cows grazing ryegrass pasture resulted in decreased 4% fat corrected milk and total fat yield; however, protein yield remained unchanged. Treatment did not have any effect on the rumen environment, indicating that high levels of dried apple pomace, a high fibre feed source, is not detrimental to rumen health.

Conclusion and recommendations: Replacing maize with dried apple pomace is a viable option for cows grazing ryegrass pasture; however, the decrease in 4% fat corrected milk yield and the potential economic impact should not be overlooked.

Laser methane detector: not a practical measurement tool for pasture-based dairy systems

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Background: Recently, the term climate change has increased the demand to verify greenhouse gas (GHG) inventories and to verify on-farm GHG mitigation strategies. The majority of animal energetics and daily methane (CH₄) production studies utilised respiration chambers. The latter is extremely slow, expensive and influences the animal's normal behaviour. Consequently, the demand to measure enteric CH₄ from individual animals within their natural production environment seemingly increased. This resulted in a variety of short-term emissions measurement methods, such as the Laser Methane Detector (LMD). The sulphur hexafluoride tracer gas (SF₆) technique is still the most reliable enteric CH₄ measurement method in grazing systems and is readily used to evaluate short-term measures.

Aim: To evaluate the LMD as a viable technique to measure enteric CH₄ emissions from cows on pasture against that of the SF₆ technique.

Methodologies: The study was conducted at the Outeniqua Research Farm, George, during spring. Sixteen multiparous, lactating Jersey cows formed part of the study. Cows strip-grazed perennial ryegrass allocated at *ca.* 12 kg dry matter (DM)/cow/d supplemented with 5.4 kg DM dairy concentrate/cow/d. Daily enteric CH₄ emissions were measured both with

the SF6 technique (all 16 cows) and with the LMD (8 cows only, when weather conditions permitted) over five consecutive days. Measurement protocol for the LMD: measurements were taken, standing maximum of 3 m from the nostrils of the cow, every 5 s over a period of 60 s repeated four times in the morning (09:00) and late-afternoon (18:00), resulting in 480 spot samples per animal. Animal position at time of measurement was also recorded (lying vs. standing).

Results: Daily enteric CH₄ emissions were successfully measured from all 16 cows by means of the SF6 technique. In contrast, the daily enteric CH₄ emissions measurement with the LMD was unsuccessful. Only three cows could be measured according to protocol over a maximum period of only three consecutive days. Missing values and skew data from the LMD data set made it impractical to do statistical comparisons.

Discussion: The proposed LMD measurement protocol could not be successfully implemented due to the local weather conditions. As a result, the quantity and quality of spot samples per animal were poor, hence being unreliable. Modifications to the LMD measurement protocol might be necessary to improve the reliability of data obtained under the given experimental conditions.

Conclusions and recommendations: The LMD is not a practical emissions measurement tool for use on grazing animals in the southern Cape. Weather conditions such as direct sunlight, wind, rain, mist and high humidity did not permit the successful use of the LMD outdoors. Animals should be trained and be brought indoors during measurement. Unfortunately, this will affect animal behaviour.

The effect of replacing maize with dried apple pomace on rumen parameters for cows grazing
kikuyu pasture

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Background: Kikuyu pasture, over-sown with perennial ryegrass is a common pasture used for grazing systems in the southern Cape of South Africa. During the summer months the kikuyu component is most prevalent. To ensure maximum milk production additional supplementation is provided, often in the form of a high maize based concentrate. This could lead to a drop in ruminal pH, lowering microbial activity, negatively impacting production. Dried apple pulp is a by-product of the apple juice industry. It has a comparable metabolisable energy and crude protein content to maize, higher fibre content and lower starch content. As such dried apple pulp has the potential to improve the rumen environment for cows grazing kikuyu pasture, while still maintaining milk production.

Aim: To determine whether the replacement of maize with dried apple pulp would be beneficial to rumen health and activity of Jersey cows grazing kikuyu pasture.

Methodologies: Eight ruminally cannulated cows were subjected to a four period crossover design with a 14 day adaptation period between treatments. Treatments were: 0% dried apple pulp inclusion (AP 0), 25% dried apple pulp inclusion (AP 25), 50% dried apple pulp inclusion (AP 50) and 75% dried apple pulp inclusion (AP 75). Cows received 6 kg as is/day of the allocated concentrate in the milking parlour. Cows of all four treatments strip grazed

kikuyu-ryegrass pasture as one group over an area of 8.6 ha. A rising plate meter was used to estimate pasture DM yield pre- and post-grazing and manage the allocation of pasture. Pasture samples and feed samples were collected on a weekly basis, dried at 60°C for 72 hours and pooled every two weeks. Rumen pH, pasture degradability and volatile fatty acid profile were measured.

Results: Body weight and BCS increased through the duration of the trial, however there were no differences between the treatments. Daily pasture allocation of 10.5 kg DM/cow was maintained and pasture was grazed to 11.8 on the rising plate meter. Average rumen pH was lower for cows receiving the AP 75 concentrate (pH 6.03) supplement than cows receiving the AP 0 supplement (pH 6.23) ($P < 0.001$); however, treatment did not affect the volatile fatty acid profile or pasture degradability.

Discussion: Replacing maize with dried apple pomace lowered rumen pH; however, there was no detrimental effect on volatile fatty acid production and pasture degradability.

Conclusion and recommendations: The replacement of maize with dried apple pulp for cows grazing kikuyu pasture does not have any negative effects on rumen health or activity; however, possible production effects should be considered before deciding on complete or partial substitution.

Assessment of available reproductive data for use in genetic analyses of fertility in South
African Holstein cattle

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Background: Fertility is a complex trait affecting profitability of a dairy herd. Recently there has been a decline in female fertility, possibly because of selection for higher yields in dairy cattle. Studies have shown an antagonistic genetic relationship between production traits and fertility. In South African Holstein cattle, genetic evaluations for female fertility are based on calving interval. Calving interval depends on subsequent calving dates, and excludes cows culled for not getting pregnant. These cows are then excluded from genetic evaluations, which could lead to inaccurate estimation of breeding values for female fertility. Even though reproductive data are not recorded routinely under the national milk recording and performance scheme, such data are recorded and kept by farmers for management purposes.

Aims: This study examines the suitability of available service records data from different recording service providers for analyses of genetic parameters of fertility traits, and possible inclusion into the breeding objectives for SA Holstein cattle.

Methodologies: Service records were obtained from a number of large Holstein herds. These herds were using different on-farm dairy herd management programs which include DIMSSA, AFIKIM and ALPRO. Service records from different programmes were assessed

for the level of agreement regarding fertility traits. Data recorded in these programmes included dam identification number, birth date, calving date, lactation number, all service dates and outcome of pregnancy diagnosis (yes/no).

Results: Traits that could be defined from these on-farm recording systems included the interval between calving date and first service date, number of services per conception, interval from calving to conception or days open. Furthermore, information on whether cows were confirmed pregnant within 100-days or 200-days post-partum or inseminated for the first time within 80 days post-partum could be computed. Limitations of the data is inconsistency of some traits, such as calving intervals due to non-recorded subsequent calving dates for some cows which calved more than once as indicated by the number of lactations per cow.

Discussion: Several traits from these recording systems could be defined to provide a basis for genetic evaluations. These traits should contribute in identifying fertility selection criteria other than calving interval and give a sufficient scope towards selection for female fertility. The historic data in other recording systems is sufficient and covers the period 1994 and 2013 while in other recording systems their record range is as short as six months, which will make genetic analyses difficult due to missing performance data.

Conclusions/ recommendations: There is a reasonable overlap among different programmes aimed at capturing data for on-farm reproduction management. These data could be explored further for estimation of genetic parameters for the defined indicators of fertility. For genetic analyses, long-term data recording is required. Recording service providers should therefore expand their herd management programmes to facilitate this possibility.

Comparative performance of cows in smallholder and commercial dairy production systems
in South Africa

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Background: The South African dairy production sector is diverse, ranging from a low-input smallholder system with less than 50 cows per herd to a well-developed high input commercial system having hundreds of cows per herd. Dairy cow performance is an important measure of herd productivity, which is an indicator of the ability of dairy farming to contribute to food security and socio-economic development. Comparing cow performance between these two systems will assist in the development of management strategies for improvement of the productivity of the smallholder sector.

Aim: The aim of this study was to compare the performance of cows in smallholder and commercial dairy production systems in South Africa.

Methodologies: Data for multi-breed dairy cows participating in the national dairy animal recording scheme that calved between 2004 and 2016 were obtained from the Integrated Registration and Genetic Information System (INTERGIS). The data set consisted of 3,723 lactations of 1,609 cows from 59 smallholder herds and 62,917 lactations of 33,686 cows in 121 commercial herds. Two distinct analyses were performed. The General Linear Models (GLM) procedure of the Statistical Analysis System (SAS) was used to compare mean cow performance in the two production systems. Measures of performance used were 305-day lactation yields of milk, fat and protein, udder health (log₁₀ somatic cell count as SCS) and

reproduction (age at first calving and calving interval). First, second and third plus lactation test-day milk yields, fat and protein percentages and somatic cell score (SCS) were used to plot the lactation curves for the two systems using SAS software.

Results: Cows in commercial system produced significantly ($P<0.05$) more milk, fat and protein (kg) and had significantly ($P<0.05$) lower SCS than those in the smallholder herds. Lactation length was significantly ($P<0.05$) longer for cows in the commercial system, than those in the smallholder system. Cows in smallholder had lower and flatter milk yield lactation curves than those in the commercial system. Lactation curves for fat and protein percentages were also lower in the smallholder system. Lactation curve of SCS was elevated for cows in smallholder system than those in the commercial system. With regard to reproductive performance, only age at first calving (AFC) differed significantly ($P<0.05$) between the smallholder (30 ± 0.2 months) and commercial (27 ± 0.5 months) herds.

Discussion: These results have ascertained low production performance and poor udder health of smallholder dairy cows in South Africa, which is a concern. The poor production performance, which is clearly demonstrated by the lactation curves, indicated a poor genetic potential for production, or inadequate nutritional management, or both in the smallholder system. The elevated trend of lactation SCS indicated management challenges in the smallholder system. Previous studies have reported a deteriorating trend in reproductive performance of South African dairy breeds, which are in agreement with the results of the CI in the current study.

Conclusion/recommendation: There is significant room for improving the smallholder dairy production system, particularly in terms of milk production and udder health. Further studies are recommended to determine appropriate management strategies for improvement of the smallholder dairy cows' performance.

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Background: Progressive oxidative stress associated with poor nutrition underlies metabolic problems and poor immune response in dairy cows. Natural plant herbs contains high levels of organic acids, polyphenols, vitamins and complex proteins that confirm anti-oxidative properties and boost immunity and performance of lactating cows.

Aim: To assess the effects of micro-supplementation of herbal antioxidants on dairy milk quality.

Methodologies: Twenty-eight, second lactating (\pm 60 DIM) Jersey cows in 20 zero grazing units were allocated to two treatments: T1: (control no supplementation) and T2: (HERB- 30 g/day/cow). Adaption period was 14 days. Animals were fed 6 kg of commercial lactating concentrate and ad libitum *E. Curvula* hay. Milk yield was recorded daily and composite milk samples were collected once per week for determination of fat, protein, lactose and milk urea nitrogen and the total antioxidant capacity. Blood samples were collected from the coccygeal vein on day 14, 21 and 50 for determination of total antioxidant capacity, total serum protein, albumin, creatinine, urea, total immunoglobulin, and immunoglobulin G. Cows were weighed in 14 interval.

Results: Supplementation with natural herb increased milk fat and total solids (4.0 vs 4.4 %; 13.5 vs 14.9 %) respectively. Milk yield, MUN and protein did not vary (15.5 vs 15.6l/day and 10.43 vs 9.85mg/dl; 3.4 vs 3.6% respectively). Herb supplementation had an effect on

total antioxidant capacity (2423.7 vs 2294.8 mmol TE/g of milk protein; $P<0.0001$) and serum total antioxidant capacity ($P<0.0001$). Differences were also noted in serum proteins, with higher levels in herb supplemented cows (68.6 vs 61.6 g/l; $P=0.0002$), albumin (42.5 vs 36.1 g/l; $P<0.0001$) and IgG ($P<0.0001$) (13.5 vs 10.3 g/l). Supplementation also lowered serum creatinine (87.3 vs 94.7 mmol/dl; $P<0.0001$).

Discussion: High antioxidant capacity in both blood and milk indicate that glutathione peroxidase function was high in herb-supplemented cows. Increased glutathione peroxidase activity in blood plasma is associated with an increased protection from reactive oxygen species that are associated with oxidative stress. Lactating cows experience cyclic negative energy balance and mobilize body fat reserves with resultant increase in release of non-esterified fatty acids (NEFA) into blood. Oxidation of NEFA increase ROS. Dietary regulation and supplementation with herbal antioxidants diminished the effects of ROS as indicated by the high total oxidative capacity of milk and serum.

Concussion: Supplementation with anti-oxidant rich herbs improved immunity of lactating cows and oxidative capacity of milk.

MEAT SCIENCE

Effect of electrical stimulation on carcass and meat quality of different types of Sudanese

Baggara cattle

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Sudanese Baggara cattle subtypes serve as main source of beef for local consumption in Sudan and for beef exports. Most of these cattle originate from nomadic production systems and are often herded to slaughter facilities over long distances. In addition to differences in age and conditioning of such cattle, no technologies are employed at abattoirs to manage beef quality, which contributes to huge variations in carcass and meat quality.

In order to better manage beef quality in Sudan, the effects of electrical stimulation (ES; 110 V) on carcass pH and temperature profiles and meat quality characteristics of two Sudanese Baggara subtypes were evaluated.

A total of 80 Baggara bulls were divided into two equal groups to represent its two main subtypes (Nyalawi and Mesairi). Each subtype was subdivided into 20 bulls each, representative of cattle aged more or less than 4.5 years of age. All animals were finished and slaughtered at the Animal Production Research Centre (KUKU) in Sudan. Feed was withdrawn and offered only water *ad libitum* 12 hours before slaughter. Bulls were slaughtered by the Halal slaughter method. Electrical stimulation (ES) was applied 20 min

postmortem to 50% randomly selected carcasses of both breed types. Meat colour, water holding capacity, cooking loss and tenderness were measured from samples of the left *Longissimus dorsi* muscle.

Results showed that breed type did not affect meat quality attributes. No significant interaction effects were observed between breed, age and ES treatments on meat quality attributes. ES treatment and age groups influenced ($P < 0.01$) carcass and meat quality attributes. ES treatment accelerated the post mortem (pm) pH decline ($P > 0.001$), compared to non-stimulated carcasses up to 24 h pm. ES resulted in higher L^* values ($L^* = 44.61 \pm 1.82$), lower a^* values ($a^* = 13.74 \pm 1.02$), higher hue values (Hue = 46.70 ± 2.39) and more tender meat ($P < 0.001$) than those from non-stimulated carcasses ($L^* = 41.61 \pm 1.46$; $a^* = 14.65 \pm 0.88$; Hue = 44.60 ± 1.72). Meat from younger bulls (< 4.5 years of age) had higher L^* values ($L^* = 43.33 \pm 2.26$; $P < 0.05$), lower a^* values ($a^* = 13.99 \pm 1.21$; $P = 0.05$) and more tender meat ($4.16 \pm 0.59\text{kg}$; $P < 0.001$) than older bulls ($L^* = 42.54 \pm 1.90$; $a^* = 14.40 \pm 0.95$; $4.66 \pm 0.75\text{kg}$) (> 5.5 year old). Meat from older Mesairi type bulls was darker ($P < 0.05$) than other samples. ES also decreased chroma values ($P < 0.05$) and water holding capacity (WHC; $P < 0.01$), but had no effect on cooking loss. WHC of samples from older bulls was lower ($P < 0.01$) than samples from young bulls.

In conclusion, breed type had no effect on meat quality of Baggara cattle. Slaughtering bulls at younger ages may help in achieving more desirable meat quality. ES and meat from younger carcasses improved meat tenderness and colour considerably, and these methods should be exploited by the Sudanese beef industry to improve beef quality.

Grazing system and floor type effects on methane emission, stress and physico-chemical properties of meat from Nguni goats

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Background: Safety, quality of meat, health consciousness, farm to abattoir animal welfare issues and climate change concerns are increasingly driving purchasing decisions made by enlightened meat consumers. Consumers prefer good quality meat from livestock raised under good welfare practices that are cognisant of climatic impact of animals.

Aim: This paper presents the effects of grazing system (tethering vs herding) and floor type (earth vs slatted) on methane (CH₄) emission from goat manure, and physico-chemical properties of the chevon.

Methodologies: Forty eight castrated goats, at 7 months of age, were, randomly selected and allocated to the two grazing systems and two floor types. Static chambers were used to collect gas samples from manure on floors. Gas analysis gas was done using a SRI 8610C gas chromatography machine. Jugular venipuncture was used to sample blood for cortisol concentration analysis. Exsanguination blood was collected for CK analysis. Meat samples

from the *Muscularis longissimus thoracis et Lumborum* (LTL) and *triceps brachii* (TB) were tested for physico-chemical properties.

Results: There were significant interactions between grazing system and floor type on CH₄ emission. The highest CH₄ emission (0.25 ± 0.029 g CH₄ AU-1 d-1) was from manure of herded goats that were accommodated on earth floors (HE). Between the two grazing systems, manure from goats that 30 were herded consistently emitted higher CH₄ (0.13 ± 0.021 g AU-1 d-1). There were also significant interactions between month, grazing system and floor type on cortisol concentration. Activity of CK was high but not affected by grazing system nor floor type. Meat from goats on EF had higher pH₂₄ than those from SF. Meat from tethered goats had higher L* (37.48 ± 0.32), cooking loss (CL %) 34 (25.50 ± 0.53) than herded goats. The TB muscle had higher a* and pH₂₄, but lower WBSF than the 35 LTL.

Discussion: The high CH₄ from manure of HE was attributed to anaerobic, moisture saturated, hoof compacted excreta conditions that promoted methanogenesis. The pH₂₄ and activity of CK was high but similar for grazing management systems and floor types. The loading, transporting, offloading of goats into lairage was their first experience presenting a novel occurrence, that led to anxiety, hyperactivity, high activity of CK and meat pH₂₄. The CL % and L* was higher in tethered than herded goats. The WBSF values were similar between grazing management systems despite differences in CL %. The inconsistent response of WBSF to muscle pH₂₄, CL % varied with literature.

Conclusion/ Recommendation: Herding goats and keeping them on earth floors caused high CH₄ emission. High pH₂₄, activity of CK and cortisol concentration found in tethered and herded goats reflected stress. Slatted floors lowered CH₄ emission, improved welfare of goats and meat pH₂₄.

Consumers perception of offal meat consumption in Amathole District

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Background: In abattoir, slaughtered animal yields quite a number of edible offal meat such as red offal, grey offal and dark offal which are fit for human consumption beside ordinary meat. In this sense, meat products are essential sources of high-quality protein, vitamin, fats, and minerals that enhance effective body functioning and required in human food. Several studies have been conducted on perception of consumers on meat quality, factor associated with perceived beef quality, consumer perception and the role in meat industry, consumer perception of fresh meat quality and perception of consumers on the quality of the mutton but research on consumer perception on offal meat consumption is still scarce.

Aim: The objective of the study was to determine the perceptions of consumers on offal meat consumption and factors influencing its demand in Amathole District.

Materials and Method : A total of 202 consumers from Amathole Districts in Eastern Cape Province from three randomly selected municipalities (Mbhashe, Raymond Mhlaba, and Ngqushwa municipalities) were sampled from a total of six towns in the municipalities. Consumers were randomly selected and interviewed in their shops, schools, butcheries, parks, garages and those that were close to the shopping areas. The key quality indicators which point toward the acceptability of meat offal were included in the interview.

Results: The demographic characteristics of consumers interviewed for their perception on offal meat consumption showed that male (45.5%) and female (53.5%) were involved.

Educational status of the respondent showed that 4.5% had no formal education, 22.3% (grade 1-7), 46% (grade 8-12) and 27.2% (tertiary). Most of the respondents were either unemployed, students, university staff, petty traders or pensioners. 56.4% earn a monthly income range of R 501-R2000, 12.9% earn R2001- R4000, 14.4 % earn less than R500. The most preferred purchase points for meat offal in the current study was butchery. The result showed that 64.4% of liver, heart (42.6%), tongue (40.1%), kidney (37.6%) tripe (59.4%), spleen (34.7%), intestine (59.4%), and lungs (37.6) were purchased at the butchery. The reasons were that meat offal from butchery is fresher (unfrozen), cheaper and readily available compared to supermarkets. However, the study indicated that majority of the consumers prefer sheep offal (41.1%) to cattle offal (16.3%) among the red meat offal.

Discussion: This study revealed that the majority of consumers buy bulk of their offal meat at butcheries. Consumers prefer offal meat from butcheries because they suspect and presume that it is fresher, cheaper and readily available. This is in agreement with Rani et al (2013) that consumers generally preferred meat from sheep. In this regard, offal meat consumption pattern showed that most consumers purchased more of the liver (94.1%), heart (57.9), tripe (79%), tongue (52%) and intestine (65.3%) in the last three month.

Conclusions

In conclusion consumers' perception on offal meat consumption is similar to the indicators that are considered when consumer is about to purchase red meat. However, consumers were concerned and more influenced by the freshness, packaging, price, juiciness and colour of the meat offal.

Physicochemical meat quality attributes of black wildebeest (*Connochaetes gnou*) muscles

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Background: Studies have been conducted on the meat quality of several common South African game species. Black wildebeest (*Connochaetes gnou*) is an endemic Southern African antelope commonly farmed in the game industry; this species therefore has meat production potential. Research on the physicochemical quality of its meat is important for the meat industry and improving consumer perception thereof.

Aim: To study the physicochemical meat quality attributes of male (n = 9) and female (n = 8) black wildebeest muscles.

Methodologies: Seventeen black wildebeest were harvested at Bredasdorp in the Western Cape. The animals were dressed at the abattoir and transported to Stellenbosch University meat laboratory for analysis. Six muscles [*Longissimus thoracis et lumborum* (LTL), *Biceps femoris* (BF), *Infraspinatus* (IS), *Supraspinatus* (SS), *Semimembranosus* (SM) and *Semitendinosus* (ST)] were removed from the hind- and forequarter and stored at 4°C until analysis begun. Standard methods were used to analyse ultimate pH, surface colour, drip loss and cooking loss percentage, Warner-Bratzler shear force and chemical composition of the different muscles.

Results: Gender showed no effect ($p > 0.05$) on the measured physicochemical parameters. pH_u (6.5-6.6), CIE a* and drip loss % did not differ ($p > 0.05$) between muscles. The IS had a

darker ($p \leq 0.05$) red colour with the highest CIE L^* (33.43) and a high b^* value (9.72); whilst the SM had a lighter red colour with the lowest CIE L^* value (27.05). The LTL, BF and SS did not differ significantly from each other in the CIE L^* values nor did the BF, SM and LTL differ significantly from each other in their CIE b^* values. ST had the highest ($p \leq 0.05$) Chroma and hue angle values (15.92, 39.69 respectively); whilst the LTL had the lowest ($p \leq 0.05$) values (13.99, 34.39). Muscle type had an effect ($p = 0.001$) on the cooking loss % and WBSF values; the ST had the highest cooking loss % while the IS had the lowest value, the IS and SS were more tender than other muscles. The chemical composition varied ($p \leq 0.05$) between muscles; SS had the highest moisture content (78.1%) whilst the LTL had the lowest (75.6%). The LTL muscle had the highest protein content (22.6%) whilst the SS had the lowest (19.4%) protein content. LTL muscle had the highest fat content (1.8%) while the ST had the lowest (1.3%). BF muscle had the highest ash content (1.3%) whilst the ST had the lowest value (1.1%).

Discussion: pHu values of the muscles ranged between 6.48-6.59 and are indicative of dark, firm and dry (DFD) meat. DFD is produced due to high ultimate pH (above 6.0) in the muscle from *ante-mortem* stress; this depletes glycogen stores which produce insufficient lactic acid *post mortem* causing the pH to remain high. This species is renowned for its tendency to show running bursts, typically experienced during harvesting which could explain these results. The LTL and SM muscles had an overall lighter red colour than other muscles. The IS and LTL muscles had the lowest cooking loss % which indicates a higher water holding capacity than the ST muscle which had the highest cooking loss %. Arranging the muscles from the least to most tender in terms of WBSF values the result as follows; SM>ST>BF>LTL>SS>IS. The moisture content and protein content of the muscles in the study are higher than those of beef and the fat content is lower than that of beef.

Conclusions and recommendations: According to the physical attributes values the meat can be classified as DFD. The IS and SS are the most tender muscles. According to the chemical attributes, black wildebeest compares well with other game meat. Black wildebeest meat is a healthier red meat alternative due to its higher protein content and low fat content. Future studies on the sensory quality and consumer acceptability of DFD game meat are recommended.

Physicochemical characteristics and oxidative stability of South African beef and pork
droëwors

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Background: Droëwors (traditional South African dried sausages) are commonly stored by consumers in open packets/unpackaged for several days to weeks before consumption. During this time, they are susceptible to oxidative deterioration; which can lead to rancidity, loss of nutritive value and production of toxic compounds. Pork is not commonly used for droëwors production because it is considered to be more prone to rancidity when dried. However, there is no substantive data validating that pork droëwors are indeed more susceptible to oxidation than the commonly used meat sources (beef and game meat).

Aims: The study determined the physico chemical characteristics of droëwors and compared the level of lipid oxidation in similarly produced beef and pork droëwors.

Methodologies: Batches of beef and pork droëwors (6 each) were formulated with similar fat content (18.7 ± 0.33 and 18.3 ± 0.28 g/ 100 g DM respectively), dried (30 °C, 40% relative humidity (RH)) for 2 days to a 50% weight loss and stored 26 days in a controlled environment (25 °C, 50% RH). Physico-chemical properties (proximate, salt content, aw and

pH) were measured on a dry matter (DM) basis at day 0 (before drying) and day 5 (after drying and 3 days of storage); with moisture content, aw, and pH being followed during storage (day 12, 21 and 28).

Results: Day 0 physico chemical characteristics of all droëwors were similar ($P > 0.05$). Moisture content and aw of beef (18.3 g/ 100 g DM, aw 0.72) and pork (23.6 g/100 g DM, aw 0.81) on day 5 were sufficient to inhibit growth of spoilage organisms at ambient temperatures, and continued to decrease ($P \leq 0.05$) during storage. Before drying, TBARS were similar ($P > 0.05$) in beef and pork droëwors. After drying, TBARS were consistently higher ($P \leq 0.05$) in pork droëwors (3.83 mg MDA equivalents/kg DM) than in beef droëwors (0.99 mg MDA equivalents/kg DM) up to day 28.

Discussion: Excessive moisture loss during storage, observed from day 12 onwards, may compromise consumer acceptability and satisfaction. Since the same level of fat was used in both droëwors types, the significantly lower TBARS in beef droëwors compared to pork droëwors is an indication that beef fat may have a more saturated fat profile making it less susceptible to oxidation. The higher level of oxidation in pork is consistent with reports that pork is susceptible to rancidity because of its polyunsaturated fat profile.

Conclusion/recommendations: The physico chemical characteristics of droëwors were determined to be suitable for product stability at ambient temperatures during storage. Protective packaging could be recommended to prevent excessive moisture loss during long storage (> 12 days). Lipid oxidation was significantly higher in pork droëwors than beef droëwors. Further research on the addition of less fat and salt or the use of antioxidants to reduce the extent of oxidative deterioration in pork droëwors is recommended.

Effect of dietary marula nut meal on carcass characteristics and meat quality of male Dorper lambs

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Background: Marula nut meal (MNM), a by-product of oil extraction, can potentially be used as a non-conventional dietary protein source (NCDPS) in livestock feeds. Research evaluating the potential of NCDPS mainly focuses on animal growth performance with little attention on the effects of the NCDPS on product quality.

Aim: To evaluate the potential of MNM to substitute dietary SBM in growing-fattening diets on the carcass and meat quality traits of Dorper lambs.

Methodologies: Forty 112-day old male Dorper lambs (22.51±3.31 kg) were randomly allocated to treatments 1 to 5. The diets were formulated where MNM substituted SBM on a CP basis at 0 (T1), 25 (T2), 50 (T3), 75 (T4) and 100% (T5). After a 21-day adaptation period, lambs were fed for 63 days. They had *ad libitum* access to feed and water. After slaughtering each carcass was eviscerated and electrically stimulated before warm carcass weight, muscle [*M. longissimus lumborum* (*M. ll*)] pH and temperature were measured; and dressing percentage was computed. Carcasses were chilled for 24h at 4°C, cold carcass weight, *M. ll* pH and temperature were measured. The *M. LL* from each carcass was dissected out and sub-sampled for determination of meat colour, drip loss, moisture characteristics and tenderness as well as proximate, mineral and fatty acid composition. Data was subjected to

one-way ANOVA (Genstat 18). Means were separated using Fisher's LSD at 5% level of significance.

Results: Substitution of SBM with MNM on carcass characteristics: warm and cold carcass weight (17.7 to 15.5kg), mean dressing percentage (46.1kg), warm and cold muscle pH (6.1 to 5.6), and temperature (35.2 to 2.5°C) showed no differences ($P>0.05$) across treatments. Mean meat drip loss was below 2%, and mean deoxymyoglobin was 56%. Mean shear force of meat aged for 1 day (5.2kg) and 7 days (3.1kg) did not differ ($P>0.05$) across treatments. Dietary MNM affected ($P<0.05$) the chemical composition of the meat. Meat from lambs in T5 had a lower protein content, but higher lipid (23%), manganese (0.037mg/kg DM), potassium (3.4g/kg DM) and selenium (0.067mg/kg DM) content compared to meat from lambs in T1, T2, T3 and T4. Meat from lambs in T2, T3, T4 and T5 lambs had a higher saturated fatty acids, but a lower polyunsaturated fatty acids concentration compared to meat from lambs in T1. Monounsaturated fatty acids (MUFAs) concentration in meat from lambs in T5 was higher (40.7 %), with oleic acid (38.9%) as the dominant MUFA.

Discussion: The similarities in carcass characteristics and meat physical traits suggest that dietary MNM did not compromise the lambs' carcass traits and the physical quality of the meat. While the 100% substitution of SBM with MNM yielded meat with a higher lipid and a lower protein content; the meat had a high concentration of oleic acid which is known to have health beneficial effects to consumers.

Conclusion/recommendation: MNM can be used to substitute SBM as a dietary protein source in the diets of growing-fattening lambs without compromising carcass and meat quality traits of the lambs.

RTU measurements as early indicator for carcass characteristics in Nguni cattle

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Background: RTU measurements have the benefit that it can be used to predict carcass traits on the live animal. It is less expensive and more time efficient, compared to other methods such as post slaughter evaluations. It is non-invasive and can also be used on potential breeding animals. In this study a feedlot trail with Nguni cattle was performed where RTU (Real Time Ultrasound) and carcass traits were measured.

Aim: The aim was to determine whether RTU measurements can be a sufficient predictor for carcass traits in Nguni cattle raised in feed lots.

Material and methods: This trail consisted of 60 Nguni bulls finished in a commercial feedlot. The cattle were weighed and RTU measurements recorded. Real time ultrasound measurements consists of marbling (intra muscular fat) fat depth (inter muscular fat), and the eye muscle area (EMA). In this study the rib eye area (REA), eye muscle area (EMA) and rump fat were measured using RTU at 72 and 91 days on test respectively. Animals were slaughtered at 105 days at A2 carcass grade. Statistical analyses were preformed using SAS Enterprise Guide (SAS Institute Inc. 2010). Phenotypic correlations were estimated between the different traits.

Results: Average weight at the start of the trail: 225.3 \pm 2.1. The average for slaughter weight on day 105 were 379kg and average daily gain (ADG) was 1.6 \pm 0.1 kg/day over the entire trail period. The average for slaughter weight on day 105 were 379kg and RTU measurements included the average EMA of 56 cm², \pm 0.5 cm² rump fat of 6mm \pm 0.1mm

and rib eye area of 3,9mm \pm 0.1 mm. The correlation between EMA and slaughter weight was 0.35 and 0.49 at 72 and 91 days on test, respectively. Rump and rib measurements were both weakly correlated to slaughter weight. The rump and rib to slaughter weight had correlations of -0.05 and 0.06 for measurements taken at 72 days. Correlations between rump and rib to slaughter weight were of 0,04 and 0,1 at 91 days. The correlation between ADG and EMA was low when measured at 72 days: 0.1 and when measured at 91 days: 0.17.

Discussion: The average slaughter weight reported in this study is similar when compared with average slaughter weights for Nguni cattle of 220kg to 320kg (Strydom *et al.*, 2001; Mapiye *et al.*, 2007; Strydom, 2008) and 390 kg (Linde *et al.*, 2016) but lower when compared to a composite type such as the Bonsmara with up to 440 kg (Linde *et al.*, 2016) and the Nellore cattle with 413 kg (Pereira *et al.*, 2015). The average ADG of 1.6 kg/day was slightly higher compared to 1.08-1.1 kg/day in Nguni cattle (Strydom *et al.*, 2001; Scholtz & Theunissen, 2010) and comparable to Nguni cattle with: 1.3-1.5 kg/day. The ADG was comparable to Charolais, Simmentaler and crossbreeds of Nguni, Simmentaler and Charolais which ranges from: 1.6 – 1.8 kg/day (Scholtz & Theunissen, 2010); including a composite such as the Bonsmara: 1.28 – 1.7 kg/day (Strydom *et al.*, 2001; Strydom 2008). The average EMA results in this study was 56cm² which is comparable to 55.47 - 56.5 cm² in Nellore cattle (Caetano *et al.*, 2013; Pereira *et al.*, 2015) but, lower compared with Strydom (2008) that reported a range of 75.9cm² to 84.8 cm² in Bonsmara cattle and Nguni cattle in other studies 68.1 - 70.2 cm² (Strydom *et al.*, 2001). RTU was measured twice during the growth period and the EMA measured at 91 days had the highest correlation with slaughter weight and holds the most potential as predictor.

Expressing mineral concentrations of livers on a dry or “as is” basis?

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The book “Mineral Levels in Animal Health. Diagnostic data” is widely used by practitioners as reference when evaluating mineral and health status of animals. It is stated that since diagnostic ranges are not absolutely clear-cut, concentrations expressed on a wet (fresh) weight basis are considered sufficiently precise to be used under practical conditions. However, since factors such as health status of an animal can affect the DM content of livers, this statement is debatable.

To obtain the variation in dry matter (DM) contents of livers and evaluate that in terms of reliability in assessing mineral and health status from dry vs fresh liver samples.

Data on the DM contents of livers from different species (sheep, cattle and game animals) analysed in the UP Nutrilab and from experiments conducted by the author were compiled and evaluated.

Mean liver DM of experimental sheep was $28.9 \pm 1.7\%$ ($n = 69$). However, liver DM of sheep suffering from copper toxicity differed drastically from the norm. Ninety-one bovine liver samples contained 29.96% with a SD of $\pm 6.25\%$ DM. Again, ill-health in cattle resulted in drastic deviations from the mean, e.g. eight samples contained between 18% and 25% DM and 19 a DM content of 35% to 50%. Similar deviations were noted in livers from game submitted to UP Nutrilab because of suspected health problems.

Contrary to the premise in “Mineral Levels in Animal Health. Diagnostic data” that, for diagnostic purposes, tissue concentrations on a wet basis are accurate enough, it is suggested

that for diagnostic purposes, analyses based on the DM content of livers should be used. On the other hand, to assess the mineral nutritional status of healthy flocks and herds, their wet livers should contain approximately 30% DM, and mineral status expressed on a wet liver basis would suffice, provided no deficiency or toxicity concentrations are suspected.

It can be concluded that in diseased animals, liver DM levels deviate substantially from the mean of 30% in healthy animals. Considering that the difference between 20% and

30% DM is 33%, mineral concentrations expressed on a wet basis would differ substantially from concentrations expressed on a DM basis, and could lead to misinterpretation of the mineral status of animals.

Consumer perceptions on sensory attributes of chevon from Nguni goats at various boiling times

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Background: The world population is expected to increase to 9 billion by 2050 hence demand for meat will increase and food security in households will be limited. Boiling times used when preparing chevon dishes are quite variable. The extent to which boiling time influences chevon quality remains unclear.

Aim: The objective of the study was to determine the relationship between consumer sensory attributes and boiling time of chevon.

Methodologies: Five clinically healthy castrated Nguni goats aged about 1.5 years, with average body weight of 18 ± 1.32 kg were slaughtered. The Suprasternal notch piercing method was used. The carcasses were chilled for 24 hours. Meat from both right and left thighs were dissected and diced into fragments of about 3 x 3 cm. The meat portions were subjected to boiling for 20, 35, 50, 65 and 80 minutes. The sensory characteristics were evaluated using the hedonic scale of six points, and a panel consisting of 54 untrained participants (Zulu) of different sex and age (≤ 20 , 20-30, 31-60, ≥ 65).

Results: There was a quadratic decrease in tenderness ($P < 0.05$) with boiling time of chevon. Juiciness of the chevon, however, decreased linearly ($P < 0.0001$) with boiling time. The decrease in off-flavour scores ($P < 0.0001$) was similar to that of juiciness. There was a negative quadratic relationship of remainders after chewing ($P < 0.0001$) with boiling time. There was, however, no relationship of aroma and flavour with boiling time ($P > 0.05$).

Discussion: Sensory attributes are boiling time dependent. Boiling time needs to be monitored to prevent overcooking or undercooking of chevon since it is detrimental to the sensory attributes and overall meat quality. This can increase consumer acceptability of chevon, as it is perceived as being of lower quality compared to beef, mutton, pork and chicken.

Conclusion and recommendation: Further studies on exact time of boiling are needed since households use inaccurate qualitative measures.

Variation in ultimate pH, colour, aerobic plate count, *Salmonella* and *Escherichia coli* levels
of selected meat types purchased at different retail outlets

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Background: Meat quality is a critical factor in a highly competitive meat industry. Both physico-chemical and microbial quality of meat depend on various factors, for instance when the ultimate muscle pH is above 6, meat is classified as dark, firm and dry meat (DFD) and is generally it is considered as meat with a lower quality. On the other hand microorganisms grow between pH ranges of 5.4 to 7.0, as they prefer neutral pH. Hence it is difficult to control the overall quality of meat with regards to physico-chemical and microbial quality.

Aim: The objective of the study was to determine the effect of ultimate pH and microbial growth on the physico-chemical quality of selected meat types purchased at different retail outlets.

Methodologies: Sixty four samples of beef, mutton, pork and chicken were collected from the two retail outlets (Middle and Top class) for determination of pH_u, colour (L*, a*, b*) and microbial counts (*Escherichia coli*, *Salmonella* and Aerobic Plate Count (APC)).

Results: Chicken and pork were found to be significantly different on L*, a*, b* and *E.coli*. There was a significant difference pH_u, L*, a* and APC between the two retail outlets. A significant difference (p<0.0001) was observed in a* in all meat types. There was a

significant difference ($p<0.05$) between meat types and class of retail outlets on APC. APC of beef in Middle class was higher (5.79 ± 0.507) in APC than any other meat type at $p<0.05$. There was a significant difference in *E.coli* between meat type and class of retail outlet. *E.coli* of Pork in Top class was higher (2.00 ± 0.313) than other meat types at $p<0.05$. A positive correlation ($p<0.01$) was observed between pHu and *E.coli* CFU/cm² as well as on b* and APC, while L* was negatively correlated with a* and b*.

Discussion: The differences in pHu as observed in this study can be ascribed to sex and breed of the animal and its carcass. High pH meat has L*, a* and b* meat values which are lower than normal meat colour differs between each animal muscle. This can be attributed to different

microbial levels and species resulting from different hygiene practices in these two retail outlets.

Conclusions/ recommendations: Ultimate pH and b* can be perceived to have an influence on microbial growth. It is necessary for further research to be conducted to observe the differences of meat colour and ultimate pH from the slaughter house up to the retail outlet. The purpose should be done to identify what really influences ultimate pH and colour.

Effect of muscle type on mass transfers during salting, physicochemical and textural
properties of South African beef biltong

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Background: Biltong is a popular salted/dry raw meat product, proudly produced in South Africa. It was initially produced by game hunters and farmers in South Africa as the practical technique of preserving meat. It is regarded as healthy snack due to its high protein and low microbial content. Biltong processing involves salting and drying of any muscle from beef or game meat. Muscles used during biltong processing differ from each other and likely to bring variations in the characteristics of the product. Muscles with thick connective tissues and big fibres produce tough and chewy products. They also contain fibrous proteins which may halt the penetration cation ions such salt, sodium as well as water.

Aim: The study was conducted to determine the effect of muscle type on mass transfer during salting, physico-chemical and textural properties of South African beef biltong.

Methodology: Two different muscles (*m. Biceps Femoris* (BF) and *m. Semitendinosus* (ST)) from nine carcasses were used. Visible fat and collagen were trimmed. Each BF and ST muscles (n=9) were then cut into 3 and 2 equal strips (2.5 cm thick × 17 cm long × 6.5 cm wide), respectively. The strips were then salted (commercial spice with 2% salt and 1.72L vinegar) using a vacuum tumbler for 20 minutes and dried at 30°C and 40% relative humidity

for 88 hours. The strips (raw, salted and dried) were analysed for weight loss during drying, salt gain and content, water activity, moisture content and pH. The data was analysed using Statistica 12 (stasoft 2013).

Results: Physico-chemical properties of raw materials were similar in both muscles, except that BF showed lower moisture, water activity and higher ash content ($p<0.05$). The BF muscle had higher ($P<0.05$) salt gain, water and weight loss compared to ST during salting. As a result, it showed higher salt content and lower water activity and moisture content than those of ST muscle both after salting and drying. Dry weight loss between muscles was different ($P<0.05$) within the first 24 hours (higher in BF than ST), however, after 24 hours it was similar for both muscles. Significant differences were also observed in texture properties, particularly hardness and springiness between muscle types. The biltong made from BF muscle showed higher ($P<0.05$) hardness and lower springiness values compared to biltong made in ST muscle.

Discussion: All the physical-chemical and textural properties of biltong were affected by muscle type. The increased salt gain in BF muscle can be associated with fiber organisation between muscles. Higher salt content in BF muscle enhanced water loss. This resulted to lower water activity, moisture content as well as higher hardness values. The results were in accordance with results presented in literature.

Conclusion and recommendations: Therefore, it can be concluded that biltong produced from different muscles differ significantly from each other. Biltong from ST muscle presented high moisture content and water activity as well as lower salt content than those recommended in literature. It can therefore be recommended that ST need more drying and salting time compared to BF muscle.

Physico-chemical characteristics of meat purchased from different purchase points

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Background: Consumer evaluation of eating quality is the key contributing factor in the determination of meat quality. However, it is vital to determine the physico-chemical quality of meat as it also has a bearing on consumer acceptability of meat. Meat consists of chemical and physical components that can determine the final quality of meat. Chemical attributes include pH and physical attributes include tenderness, colour, cooking loss, flavour and juiciness.

Aim: The study was conducted to determine the physico-chemical characteristics of meat purchased from different purchase points.

Methodology: Beef, chicken, mutton and pork samples were bought at three different towns of the Eastern Cape Province (ECP). Meat from retail trays were used to measure pH, colour, drip loss, cooking loss and shear force.

Results: The place of purchase had a significant effect ($P < 0.05$) on the physico-chemical quality of beef, mutton, chicken and pork meat. The L^* (Lightness) values of beef samples from King William's Town (KWT) were lower (28.2) than Queenstown (QNT) samples (39.5). The a^* (redness) values of beef samples from QNT (16.8) were lighter ($P < 0.05$) than samples from Alice (18.6) and KWT (19.9). Chicken samples from Alice had significantly ($P < 0.05$) lower (13.0) cooking loss than chicken from QNT (21.7) and KWT (19.2) samples.

Samples of pork from Alice had significantly ($P < 0.05$) lower WBSF (Warner Bratzler Shear Force value) (18.3) than QNT (29.3) and KWT (25.4).

Discussion: Differences in the colour of meat from different species were expected. The place of purchase has an effect on the meat colour. The type of package used in shops plays the major role in meat quality, as this will affect the amount of oxygen exposure to meat and therefore will influence the colour of meat that appears to consumers.

Conclusion and Recommendations: It was concluded that place of purchase had an effect on physico-chemical properties of meat.

PIG PRODUCTION

Nutrient utilisation of potato hash silage by Windsnyer pigs

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Background: To strengthen sustainability of smallholder pig production, the pigs kept by smallholder farmers should include indigenous pig genotypes. Indigenous pigs such as Windsnyer are adaptable to local environment and are tolerance or resistant to endemic diseases and parasites. Windsnyer pigs do not have reliable feed resources. Farmers tend to feed Windsnyer pigs with cheap fibrous feed resources because they grow slowly and have low financial returns. It is therefore crucial to source for other potential feed resource such as ensiled potato hash silage that are not utilised by humans as an alternative feedstuff for Windsnyer pigs. To effectively exploit potato hash silage as an alternative feedstuff, it is essential to determine the rate of passage and nutrient digestibility in pigs. Reports on nutrient digestibility of potato hash fed to Windsnyer pigs are rare.

Aim: The objective of the study was to determine the nutrient digestibility of potato hash silage fed to Windsnyer pigs.

Methodology: Six Windsnyer pigs were randomly assigned to six diets containing 0, 80, 160, 240, 320 and 400 g/kg of potato hash silage. All diets were blended with chromium oxide. Pigs with initial body weight of 34 ± 4.59 kg (mean \pm standard deviation) were fed diet with potato hash silage for 5 days. Water and feed were offered *ad libitum*. The 5-day faeces for each pig were dried, combined and then a representative sample were analysed according to AOAC (2005).

Results: There was a linear decrease ($P < 0.05$) in the dry matter digestibility (DMD), organic matter digestibility (OMD), crude protein digestibility (CPD), and neutral detergent fibre digestibility (NDFD) as inclusion levels of potato hash silage increased. The linear regression co-efficient for DMD, OMD, CPD and NDFD were -6.12, -9.99, -2.12, -0.60 respectively. The acid detergent fibre digestibility (ADFD) were not affected ($P > 0.05$) by the inclusion levels of potato hash silage.

Discussion: Results obtained from this study are in agreement with similar studies done elsewhere. Reduction in nutrient digestibility by pigs is due to an increase in fibre content, as inclusion levels of potato hash silage increased.

Conclusion / recommendations: It can concluded that as inclusion levels of potato hash silage increased, the nutrients digestibility decreased. Further study is required to determine the effect of locally available inoculants or additives to improve nutrient digestibility of slow-growing pigs fed on increasing levels of potato hash silage.

Comparison of North Carolina State University 23, 37 and egf media on maturation rate of
porcine oocytes

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Background: *In vitro* embryo production in pigs has always been a challenge, given the high rates of polyspermy following *in vitro* fertilization. The usefulness of improving efficiency of successful IVM-IVF procedures aid towards implementing modern biotechnologies in farming systems as well as to conserve embryos to be used in future.

Aim (-s): To compare the effects of NCSU-23, NCSU-37 and Epidermal Growth Factor (EGF) media on pig oocyte maturation rate and polar body formations *in vitro*.

Methodologies: Ovaries collected from a local abattoir, preserved in 0.9% NaCl solution at 40°C in a thermos flask were transported to the laboratory within 30min. of slaughtering. Oocytes were aspirated with an 18-gauge needle fixed to a 10 ml disposable syringe. Oocytes surrounded by a uniform complex cumulus mass were selected. A total of 284 oocytes were allocated per treatment and incubated with 5% CO₂ at 39°C for 48 hours. Maturity rates and polar body were then evaluated.

Results: The maturity rates and polar body extrusions were significantly higher ($P<0.05$) for NCSU 37 with 85.9% and 81.9% and there were no significant differences for EGF and NCSU-23 media ($P>0.05$) as 77.1%; 72.5% and 77.1%; 72.7% were obtained respectively.

Discussion: The maturity rates and polar body extrusions in EGF and NCSU-23 media were not significantly different. However, NSCU-37 rendered highest results due to the fact that the composition of the media contained beneficial constituents.

Conclusion/recommendations: Maturation media EGF and NCSU-23 contain constituents which are detriment for maturation, resulting in lower rates of maturation and polar body formations as compared to NCSU-37. NSCU-37 rendered highest results pertaining to the fact that the composition of the media contained beneficial constituents. Further studies should be embarked upon in order to determine further embryonic competency.

Fibrous diets inoculated with exogenous enzymes on digestibility and growth performance of
grower pigs

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Background: The recent drought conditions have elevated the price of corn and soya, and this presents a greater risk to food security and sustainability of intensive livestock production. There is a need to investigate alternative feed sources that would meet the nutritional requirements of pigs and reduce feed costs.

Aim: To evaluate pig's nutrient digestibility and growth performance, when fed maize cob, maize cob + Potato Hash (PH) silage inoculated with or without exogenous enzyme.

Methodologies: Five diets were formulated to contain 16 % Crude Protein (CP)/kg DM (dry matter) and 14 MJ of digestible energy (DE)/kg DM. The five treatment diets were as follows, control ration (T1), ration with maize cob (T2), ration with maize cob + exogenous enzyme (T3), ration with maize cob and potato hash silage (T4) and ration with maize cob and potato hash silage + exogenous enzyme (T5). Twenty-five Large White X Landrace cross bred pigs (20±5 kg body mass) were randomly allocated to 5 treatment diets in a completely randomized design and fed *ad libitum* for 42 days. Parameters for nutrient digestibility and growth performance were evaluated. Data was analysed using the GLM Procedures of the Statistical Analysis Software Packages (SAS, 1996).

Results: There was no significant difference ($P>0.05$) in digestion of crude protein (T1 0.89, T2 0.84, T3 0.81, T4 0.83, T5 0.86), organic matter (T1 0.92, T2 0.83, T3 0.79, T4 0.81, T5 0.83), fat (T1 0.72, T2 0.71, T3 0.65, T4 0.65, T5 0.60), and gross energy (T1 0.67, T2 0.71, T3 0.68, T4 0.63, T5 0.64) amongst the treatment diets. Pigs fed T2 and T3 diets had the lowest (0.6) average daily gain when compared to the pigs fed T1 diet (0.8). The addition of enzyme did not affect the evaluated parameters.

Discussion: The ability of pigs to digest and utilize fibre is not clearly defined. Maize cob + potato hash silage and T5 treatment diets did not negatively affect growth and nutrient digestion when compared to pigs fed T1 diets.

Conclusion and recommendations: There is a need to investigate the effect of fibrous diets on intestinal health, and the economics of using agricultural by-products in pig diets.

Inclusion levels of α -tocopherol supplementation on Windsnyer boar spermatozoa characteristics

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Background: To promote conservation of Windsnyer pigs which are the indigenous breeds from South Africa, their semen fertility should be improved. The fertility of Windsnyer boars to be improved through nutritional manipulation has however, not received much attention. Antioxidants such as ascorbic acid and α -tocopherol have a protective effect on both metabolic activity and cellular viability of preserved spermatozoa.

Aim: To assess the response of Windsnyer spermatozoa characteristics to α -tocopherol inclusion.

Methodologies: Twenty (n=20) Windsnyer boars with an average weight of 19 kg were penned individually and 5 randomly allocated to four diets; and fed until they reached sexual maturity at 40 kg body weight after 18 months. The diets contained 0, 40, 70 and 90 IU of α -tocopherol. Boar epididymal semen samples were collected from the abattoir following

humane slaughter and semen concentration, volume, pH, motility and morphology were evaluated. Data were analyzed using a polynomial regression (PROC REG) procedure of (SAS, 2008) to determine the relationships between α -tocopherol inclusion and spermatozoa characteristics.

Results: Semen volume and pH were not related to α -tocopherol inclusion levels ($P>0.05$). There was a positive quadratic relationship between spermatozoa concentration and α -tocopherol inclusion. As the α -tocopherol levels increased, the straight-line velocity (VSL) quadratically increased ($P<0.05$). The equation was $y=0.0068x^2 + 0.7679x + 21.983$. There was a quadratic increase ($P<0.05$) in live spermatozoa percentage and the equation was: $y=0.004x^2 + 0.395x + 79.4$. The proportion of spermatozoa with abnormal heads decreased quadratically ($y=0.0011x^2 - 0.1064x + 3.5917$; $P<0.05$) with α -tocopherol inclusion level.

Discussion: The observations of this study indicated that α -tocopherol inclusion was quadratically related to spermatozoa concentration. The inclusion level of α -tocopherol supplementation to Windsnyer boars was effective. There was a positive relationship between VSL and α -tocopherol inclusion levels. The observed quadratic relationship between α -tocopherol and live spermatozoa percentage suggests an increase in α -tocopherol could ensure high percentage of viable spermatozoa and improve quality of spermatozoa. The observed mid-piece and coiled tail spermatozoa were not influenced by α -tocopherol inclusion. This could be explained by the ability of α -tocopherol to scavenge the free radicals from damaging spermatozoa

Conclusion/Recommendation: In conclusion, α -tocopherol inclusion had a positive quadratic response on spermatozoa concentration, VSL, live, dead and head abnormal spermatozoa. Future studies need to be done to assess at a molecular level, an explanation for the influence of α -tocopherol on membranes of sperm cells.

Comparison of growth and feed efficiency of South African windsnyer pigs and large white
fed varying levels of crude protein

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Background: Rural households keep the South African Windsnyer (SAW) pigs for food and income security. However, little effort has been made to improve their productivity. The SAW have small litter sizes, sluggish growth rate and poor feed conversion efficiency. Growth performance is not only influenced by genotype and environment; nutrition, particularly dietary protein and energy intake are critical. Therefore, in order to improve production smallholder pig farmers tend to cross SAW pigs with Large White (LW) pigs, with varying results.

Aim: To assess effects of dietary protein on growth performance of pure SAW pigs and their crosses with LW (SAWLW).

Methodologies: Three hundred and eight weaned boars and gilts were randomly allocated to the treatments within genotypes SAW and SAWLW. Dietary CP levels were 10 g/kg, 14 g/kg or 18 g/kg respectively. Ration energy levels were kept at 13.5 MJ/kg DM. Feed intake, weight gain were recorded on a weekly basis, and ADG, ADFI and FCR were calculated. The effects of diet, genotype, sex and their interactions were analysed using the PROC GLM of the SAS.

Results: SAWLW boars and gilts on 18g/kg CP had the highest ($P<0.001$) ADFI (1.76kg) followed by pigs on 14g/kg CP (1.7 kg) then 10g/kg CP (1.59 kg). The opposite was observed for the SAW boars, which recorded highest ($P<0.001$) ADFI (1.51 kg) at 14g/kg CP, followed by 18g/kg CP (1.41kg) and the lowest for 10g/kg CP. The SAWLW crosses on 18g/kg CP gained the most ($P<0.001$) weight daily (0.59 kg), while 14g/kg CP and 10g/kg CP had lower weight gains (0.51kg and 0.41 kg respectively). Contrary, the SAW boars had their highest ADG (0.46 kg) at 14g/kg CP. FCR for SAW gilts ranged from 1.675 to 1.757, while the SAW boars on 10g/kg CP had the poorest FCR of 1.908 higher than boars on 14g/kg and 18g/kg CP. The 10g/kg CP treatment resulted in poor ($P<0.001$) FCR (2.238 and 2.135) for all SAWLW regardless of gender.

Discussion: The current study showed that even at 10g/kg CP inclusion levels, ADG of 400g/day was recorded for the SAW pigs. In the study SAWLW boars and gilts recorded ADG of 150 g/d, higher than that of SAW boars. However, as the dietary CP levels were reduced to 14 g/kg the SAWLW records higher ($P<0.001$) ADG though the gaps are narrowing to 57g then to 76g at 10g/kg. At 18g/kg CP level the SAWLW cross boars has a higher ADG ranging from 521g to 585g, which is significantly better than of SAW boars, then at 10g/kg CP SAWLW recorded 411g ADG which is not significantly different to SAW boars.

Conclusion/recommendations: Diet that contained 14 g CP/kg was optimal for SAW boars and gilts.

Adaptation of finishing pigs to *Vachellia tortilis* leaf meal inclusion

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Background: The quest for alternative feed integrant for pigs is receiving increasing attention mainly due to the increased worldwide demand for grains for both human and livestock consumption. Leguminous tree forages, such as *Vachellia*, formerly known as *Acacia*, are important in pig feeding since they can be used as protein sources. Changing diets can have severe effects on the finishing periods of pigs hence the use of *V.tortilis* leaf meal diets requires an in-depth knowledge on how pigs adapt to such diets. There is a paucity of information on the adaptation period of pigs fed increasing levels of leaf meal diets.

Aim: The aim of the study was to assess the adaptation period of finishing pigs fed on *Vachellia tortilis* leaf meal diets.

Methodologies: The study was conducted at Ukulinga research farm of University of KwaZulu-Natal. Forty eight clinically healthy castrated (Large White × Landrace) male pigs with a mean (\pm SD) body weight of 63.8 ± 3.28 kg were assigned to 6 dietary treatments; n = 8 per diet. The diets were formulated to contain 0 g/kg DM, 30g/kg DM, 60g/kg DM, 90g/kg DM, 120g/kg and 150g/kg DM *Vachellia tortilis* leaf meal respectively. The pigs had *ad libitum* access to feed and clean drinking water, and were fed for the whole adaptation period which lasted for 19 days. Adaptation period, daily feed intake (DFI), average daily gain (ADG) and gain: feed ratio (G: F) data was computed. The data was analysed using regression analyses of SAS (2008).

Results: A linear increase in the adaptation period was observed ($P < 0.001$) with increasing levels of *Vachellia tortilis* leaf meal inclusion. There was a quadratic decrease in DFI while G: F ratio ($P < 0.001$) increased quadratically. Inclusion level of *V.tortilis* leaf meal increased the ADG linearly ($P < 0.001$). The Variation in feed intake expressed as a coefficient of variation differed significantly across the diets ($P \leq 0.05$). It increased linearly with increasing inclusion levels of *V.tortilis* leaf meal.

Discussion: The linear increase in the adaptation period of grow-finishing pigs fed low to high levels of *V.tortilis* leaf meal diets may be attributed to the fact that increasing inclusion levels of *V.tortilis* leaf meal diets induces the effect of the anti-nutritive factors such as polyphenolic compounds which also increase with the inclusion level of the leaf meal.

Conclusions and recommendations: *Vachellia tortilis* leaf meal inclusion caused a linear increase in the adaptation period of finishing pigs. The higher the level of the leaf meal, the higher the adaptation period. It Is, however, necessary to investigate the extent of the adaptation period and performance even in sows when feeding incremental levels of *V.tortilis* leaf meal so that *V.tortilis* leaf meal diets can also be used in both sows and boar diets.

Effect of *Acacia karroo* leaf meal inclusion on methane emission and productivity of yearling male Boer goats fed an *Avena sativa* hay-based diet

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Background: Goats produce a lot of methane gas which contributes to loss of dietary gross energy and global warming. Loss of energy from these goats limits their productivity. Although there is some evidence that tannin-rich feeds in the diets of the ruminants decrease methane production and emission, not much has been done on *Acacia* (*A.*) *karroo* leaf meal inclusion levels for optimal methane reduction and productivity of growing Boer goats.

Aim: To determine the effect of *A. karroo* leaf meal inclusion on methane emission and productivity of yearling male Boer goats.

Methodology: This study was conducted during spring season of 2016 at the University of Limpopo Experimental farm, Limpopo province. Twelve yearling male Boer goats with an initial mean live weight of 23 ± 2 kg were used in a 21-day experiment. The goats were randomly assigned to four dietary treatments containing *A. karroo* leaf meal inclusion levels at 10, 15, 20 and 30 % with *Avena sativa* hay as based diet. Each goat was housed in well-ventilated individual metabolic pens and replicated three times. The goats were weighed at the start of the experiment, on the first day of data collection and on last day of the experiment. Methane emissions were measured at the start of the experiment and again on the last 5 consecutive days of the experiment together with intake, digestibility and feed conversion ratio. Methane emissions were measured using a hand-held methane detector. The

data collected were subjected to analysis of variance in a completely randomized design. Differences were separated at 5 % level ($P < 0.05$).

Results: No statistical differences ($P > 0.05$) were observed on diet intake and live weight changes across dietary treatments, except for crude protein and fat intake per metabolic weight of the goats. Digestibility of dry matter, organic matter, neutral detergent fibre, acid detergent fibre and energy were affected ($P < 0.05$) by dietary treatments. Feed conversion ratio improved linearly with increased *A. karroo* leaf meal inclusion level. Inclusion of *A. karroo* leaf meal in the diets of Boer goats reduced ($P < 0.05$) methane emission. However, variation in *A. karroo* leaf meal inclusion level had comparable effect ($P > 0.05$) on methane emission of the goats.

Discussion: Results of the present study revealed that tannin content in *A. karroo* leaf meal inclusion levels is lower than the toxic levels reported in many other plants by other authors, and is good enough for its beneficial activity.

Conclusion and recommendations: Experimental goats attained desired live weight gains that remained similar throughout the experiment. Therefore, it can be concluded that all the inclusion levels of *A. karroo* leaf meal in the diet provide adequate nutrients for normal growth of the goats. However, goats on 20 % *A. karroo* leaf meal inclusion level had better digestible nutrients and feed conversion ratio. Therefore, 20 % inclusion level is recommended. Although, *A. karroo* leaf meal reduced methane emission, optimal reduction in methane emission has not been accomplished. Further validation with higher inclusion levels of *A. karroo* leaf meals is required.

Effect of liquid fermented potato hash diet on growth performance of large white × landrace
crossbred pigs

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Background: Potato hash (PH), a by-product derived from the processing of snacks and chips, is produced at ± 50 tons per day in South Africa. The by-product contains a dry matter (DM) of 150 g/kg, and a relatively small amount of yellow maize. One of the limitations for using potato by-products in pig nutrition is their high moisture content. Liquid fermented feed (LFF) have been defined as a mixture of feed with water and stored in a tank for at least 8 hr before feeding to the pigs. The benefits of LFF include increased daily feed intake, live weight gain and reduction of pathogens in the gastrointestinal-tract (GI-tract) of growing pigs compared with dry feeding.

Aim: The study aimed to evaluate growth performance of grower pigs fed liquid fermented potato hash diets.

Methodologies: A back-slopping fermentation approach was employed to prepare liquid fermented diets. Potato hash diets were mixed with water at 1:2 ration and fermented for 8 hours before being fed to pigs. Diets were stored in a closed 100 L drum at 25°C room

temperature. Diets containing either 200 or 400 g/kg fermented liquid potato hash or no fermented potato hash (control) were formulated to provide 14 MJ/kg digestible energy (DE), 180 g crude protein (CP)/kg and 11.6 g lysine /kg. Dietary treatments were control (no LFPH), low liquid fermented potato hash (LLFPH, 200 g/kg LFF), and high liquid fermented potato hash (HLFPH, 400 g/kg LFF). The diets were fed *ad-lib* to 36 Large White x Landrace crossbred grower pigs (25±2.3 kg body mass) that were individually housed. Pigs were allocated in a complete randomized design with six boars and six sows per treatment.

Results: The control and LLFPH had higher ($P<0.001$) final weight (77.1 kg and 76.9 kg respectively) and ADG (0.89 and 0.91 kg respectively) compared to pigs fed diet containing HLFPH. However, the LLFPH had lower ($P<0.001$) ADFI (1.4kg vs control (1.75kg) vs HLFPH (1.85kg) and a better FCR (2.06) compared to pigs fed diets containing control (2.39) and HLFPH (2.48). There were diet x sex interactions for ADG, ADFI and FCR in the growing pigs.

Discussion: Pigs fed LFPH had higher growth performance which differed with other studies, which reported lower growth performance when grower pigs were fed total ensiled mixed ration of potato hash and ensiled potato hash with or without inoculants compared to the control diet.

Conclusions and recommendations: It was concluded that diets containing LLFPH may be an alternative feed source for growing pigs as indicated by higher gain and lower intake compared to control.

Impact of dietary selenium and zinc supplementation on growth performance of finisher
Kolbroek boars

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Background: Body weight (BW) is an important trait in animal production as it forms the basis for not only assessing growth and feed efficiency but in also making economic and management decisions. Selenium (Se) and Zinc (Zn) are essential trace elements for pigs and have many physiological functions, such as immune, antioxidant, growth, and reproduction functions. Growing pigs convert dietary feed at less than 2:1 feed gain while finishing pigs convert feed at over 3:1 feed gain. There is no known research investigating the effect of feed supplements such as selenium and zinc on growth performance of indigenous pigs in a natural environment. However, zinc and selenium are necessary to maintain body functions, optimise growth and reproduction and to stimulate immune response and therefore determine health status.

Aim (-s): To determine the effect of dietary Selenium and Zinc supplementation on growth performance of finisher Kolbroek boars.

Methodologies: A total of 24 Kolbroek (KB) finisher boars aged 3 to 4 months with average live weight of ± 28 kg were used for the study. The KB boars were assigned to five experimental diets with 5 KB boars per treatment. The diets were; control, low-selenium, low-zinc (0,26; 0,34g/kg) (LSeLZn); high-selenium, high-zinc (0,65; 0,74g/kg) (HSeHZn); low-selenium, high-zinc (0,26; 0,74g/kg) (LSeHZn) and high-selenium, low-zinc (0,65 0,35g/kg) (HSeLZn). The KB boars were fed 1.5 kg of feed per day until the end of the experimental period which lasted two months. Average daily feed intake (ADFI) was measured daily by subtracting refusals from feed offered. The pigs were weighed weekly. Feed conversion ratio (FCR) was calculated by dividing the feed intake of each pig by the average daily gain.

Results: Supplementation of Se and Zn had no effect on ADG, ADFI, weight gain (WG) and FCR of the KB ($P>0.05$). The back fat thickness of Kolbroek boars was not affected by interaction of Se and Zn supplementation ($P>0.05$). There were no difference ($P>0.05$) in initial weight and final weight between treatments. Feed intake was not affected by diets in the finisher KB boars ($P>0.05$).

Discussion: The results agree with other studies that showed that different dietary Se products and levels did not influence growth performance in growing-finishing pigs. These results also agree with other studies where there was no influence of dietary Se and Zn treatments on growth performance of finisher pigs.

Conclusion/recommendations: In conclusion, interaction of selenium and zinc supplements did not produce any significant effects on growth performance of finisher KB boars. This could be advantageous for small-scale farmer because LSeLZn diets may be more affordable.

Effects of probiotics on growth performance, blood parameters, and antibody stimulation in
piglets

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The study investigated the effects of probiotic bacteria (*Lactobacillus reuteri* ZJ625, *Lactobacillus reuteri* VB4, *Lactobacillus salivarius* ZJ614, and *Streptococcus salivarius* NBRC13956) administered as direct-fed microorganisms on growth performance and blood parameters of weaned piglets. Forty-five weaned piglets were divided into five treatments: antibiotic (PC), no antibiotic and no probiotic (NC), probiotic (P1), probiotic (P2), and combination of probiotics (P3). Fecal and ileum samples were collected for microbial count analysis. Blood samples were also collected from the animals at the end of the trial for the hematological and biochemical analysis and the ability of the probiotics to stimulate immunoglobulin G (IgG). Supplementation of probiotics had no effect on feed intake (FI). However, daily weight gained (ADG) in the P3 treatment was higher than in other treatments and lowered the value of feed conversion ratio (FCR) of weaned piglets. Microbial count of fecal samples did not differ in all the treatments while ileum samples had lower enteric bacteria in P3 treatment when compared to other treatments. Concentration of albumin, globulin, neutrophils and basophils were higher in the NC treatment when compared to other treatment groups. IgG concentration was highest in P3 compared to other treatments. Results suggested that probiotics have beneficial effects on growth performances, blood parameters, and IgG stimulation of weaned piglets. This advocates that probiotics will offer a significant

benefit in pig farming by reducing the risk of post weaning diarrheal syndromes, and therefore enhance pig industry's economy.

POULTRY NUTRITION

Comparison of growth performance of grower male Venda chickens fed different levels of energy to protein ratio

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Background: Indigenous chickens add a lot to household nutrition and income in rural areas and one of such indigenous breed type is the Venda chickens. The purpose of best dietary energy to protein ratio for maximizing production factors and growth performance of indigenous Venda chickens becomes very important. Hence, a way of accomplishing these factors would be to formulate diets that could be set to a specific energy to protein ratio for feed formulation.

Aim (-s): To determine the effect of energy to protein ratio on indigenous Venda chickens (n=120).

Methodologies: Three treatments were given to grower Venda chickens (n=120) from 8 to 13 weeks of age. Chickens under treatment one received 9 MJ ME/Kg DM energy level, treatment two received 11 MJ ME/Kg DM energy level and treatment three received 13 MJ energy level. Every two weeks the protein level of chicken's feed were changed. First two weeks it was 140 g CP/kg, second two weeks it was changed to 16 g CP/kg, then in the last two weeks it was changed to 180 g CP/kg.

Results: There was a significant different ratio ($P < 0.05$) on feed intake, growth rate and feed conversion, where chickens fed diet 3 were high; 13 MJ ME/Kg to 140, 160, 180 g CP/Kg DM feed compared to chickens received diet 1 and 2. 11 MJ ME/Kg to 160 g CP/Kg DM feed in the diets gave similar ($P > 0.05$) live weights as diets containing 9 MJ/Kg to 140, 11 MJ ME/Kg DM feed to 140 g CP/Kg DM feed and 13 MJ ME/Kg to 140, 160 and 180 g CP/Kg DM feed, but significantly different ($P < 0.05$) from the rest of the diets. Therefore, chicken on the diets containing 9 MJ ME/Kg DM feed to 140g CP/Kg DM feed and 13MJ ME/Kg to 140g CP/Kg DM feed had similar wing length as diets containing 13 MJ ME/Kg to 160g CP/Kg DM feed, but significantly different ($P < 0.05$) from other diets.

Discussion: Similar results were obtained from other studies showing that feed intake, growth rate, body weight gain, feed efficiency and live weight of meat-type broiler chickens change with alterations in dietary energy to protein ratio levels.

Conclusion/recommendations: It is concluded that the level of energy to protein ratio in the diet influenced the feed intake, growth rate, feed conversion ratio, live weight and wing length of the chicken. It is recommended that diet 3 containing; 13 MJ ME/Kg to 140, 160, 180 g CP/Kg DM is suitable to be fed in poultry production.

Effect of humic acid and enzymes on growth performance, protein utilization efficiency and blood parameters of broiler chickens fed canola meal-based diets

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Background: In broiler rations, soybean meal is the most preferable protein source. However, it is becoming rather expensive and unaffordable, provoking a need to explore cheaper sources that include Canola meal. Despite its potential as a protein source (CP = 36-39%), its use can be hampered by high fibre content and considerable amounts of secondary plant metabolites. Nevertheless, utilisation of Canola meal can be improved through the inclusion of feed additives including humic acid and enzymes.

Aim: In this study, the effect of potassium humate and Aextra XAP additives on growth performance, protein utilization efficiency and blood parameters are investigated.

Materials and Methods: A total of 220 broiler chicks (Cobb 500) were allocated to 5 treatments replicated 4 times with each pen holding 11 birds as the experimental unit. Dietary treatments consisted of control (commercial broiler diet), CM (17.5% CM inclusion), CMenz (17.5% CM inclusion + 0.3g/kg Aextra XAP); CMPh (17.5% CM inclusion + 1.5% Potassium Humate, PH), and CMenzPh (17.5% CM inclusion + 1.5% PH + 0.3g/kg Aextra XAP). Feeding trial was conducted over 2 feeding phases: grower phase (15 - 28 d) and finisher phase (29 - 42d). Data on growth, protein utilisation efficiency, blood parameters were obtained and analysed using GLM procedure of SAS (2010) with diet as the only fixed effect. Data on cumulative weight gain was measured on weekly basis and were analysed using mixed model procedure of SAS (2010) consideration the effect of diet and week.

Results: There were no significant ($P > 0.05$) differences on ADFI of all diets for both phases. However, diet significantly ($P < 0.05$) affected ADG for broilers in grower phase and broilers fed CM diet had the highest ADG (71 ± 1.08 g/d) whilst those fed control (63.75 ± 1.08 g/d) had the lowest. On the contrary, control diet had the highest FCR of (1.65) whilst CM diet (1.47) had the lowest. Broilers fed CMEnzPh consistently had the highest values for cumulative weight gain throughout the entire feeding period and also had the highest ($P < 0.05$) final weight (2254.4 g). Diet had no influence on haematology parameters apart from total white blood cell (WBC) and WBC was consistently high in broilers fed CMEnzPh. With regards to serum biochemistry, only aspartate transferase and sodium were affected. The CM (406.86 ± 38.07 IU/L) had the highest levels ($P < 0.05$) of AST followed by CMEnz (389.86 ± 38.07 IU/L) whilst CMEnzPh (254.17 ± 41.11 IU/L) had the lowest levels. Additionally, broilers fed CMPh (150.57 ± 0.69 mmol/l) had the highest ($P < 0.05$) serum sodium content.

Discussion: Results are in agreement with other studies where CM and feed additive inclusion influenced growth performance and protein utilization in broilers. The blood parameters were within normal ranges for healthy broilers and other observations in the study could be attributed by the influence of feed additives included in the diets.

Conclusions/recommendations: Canola meal, in the presence of enzymes and humic acid showed great potential as an alternative for SBM in broiler diets. This can be helpful in designing least cost diet formulations that will improve optimal production in poultry farming systems in future.

Effect of double intra-spiking on the reproductive performance of broiler breeders

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Background: In the last decade, the fertility of broiler breeder flocks has been decreasing gradually, which threatens economic productivity. The main reason of reduced fertility is the intensive selection for body weight, which results in the decline of the reproductive traits. Another reason for the reduction in fertility is generally considered to be due to physical condition of the males with a resultant decline in mating activity. In order to avoid the rapid decline in fertility in the second half of the production cycle, different spiking techniques are used with better results.

Aim (-s): The aim of the study was to determine the effect of double intra-spiking on reproductive performance of broiler breeders and percentage of males to be moved during intra-spiking.

Methodologies: The experiment was conducted as a Randomized Complete Block Design (RCBD) with production cycle as a blocking factor, with the percentage of males (25%, 35% (control) and 45%) moved as the three treatments of interest. There were nine (9) units (production cycles) available, whereby one unit consisted of three houses. Each poultry house accommodates 8200 females and 820 males. The mating ratio commences at 10% and it gradually decreases as the birds' age. Males were moved between the houses twice, viz. at 40 and again at 48 weeks of age (double intra-spiking). A total amount of 4800 hatchable eggs of different sizes produced by broiler breeder hens, aged 36 weeks of age to 55 weeks of age were used to determine the reproductive performance (hatchability of fertile eggs). Data were

analysed using the repeated measures techniques of the Statistical Analysis System (SAS), considering the covariance structure of the observed data.

Results: There was a significant effect attributable to the percentage of male replacement, time (age in weeks) and their interaction. Flocks with 45% males replaced had significantly ($P < 0.05$) higher hatchability (87.50) compared to 35% males replacement (86.63), which also performed better than 25% male replacement (86.09). However significant interactions implied that treatments must be compared taking the age (weeks) into considerations. Hatchability generally decreased towards 40 weeks of age and improved due to first spiking. However spiking at 48 weeks of age did not have a pronounced effect on hatchability.

Discussion: Intra-spiking at 40 weeks of age significantly increased hatchability, however spiking at 48 weeks of age did not influence results. The percentage of males moved influences the reproductive performance of broiler breeders. However, the effect depends on the age implying that different systems of male replacement would be influenced by the time (weeks) when males are moved.

Conclusion/recommendations: Broiler breeders are advised that it may not be necessary to conduct double intra-spiking and that the standard 35% male replacement may not necessarily produce the optimum hatchability. Furthermore, hatchability trend over time (age in weeks) indicates that it might be necessary to conduct intra-spiking at an earlier age than 40 weeks.

Effect of substituting soyabean meal with cold pressed marula (*Sclerocarya birrea*) seed cake in a broiler starter diet on growth, feathering and carcass component weights of broilers

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ABSTRACT

High cost of commercial poultry diets has made it increasingly difficult for small scale broiler farmers in Swaziland to remain in business. This study was inspired by a relatively cheap locally available protein rich byproduct and a desire to formulate a cheaper broiler feed. The 42-day study investigated the effect of substituting soyabean meal with cold pressed marula (*Sclerocarya birrea*) seed cake in a broiler starter diet on growth, feed intake, feed efficiency, feather development, and weight of broiler carcass components. The study employed a completely randomized design with two isonitrogenous diets, two replications, and 120 day old broiler chicks. The broiler starter rations evaluated were a marula experimental starter diet (EXP-diet) (22% CP) in which cold pressed marula (*Sclerocarya birrea*) seed cake completely replaced solvent extracted soyabean meal as the protein source and the control diet (CNT-diet) (22% CP) being the commercial ration. During the first 14 days of the study (starter phase), half of the birds were fed the CNT-diet while the remainder received the EXP-diet, thereafter, all birds in the study were fed a commercial grower diet for 14 days and a commercial finisher diet for the same duration. Feed intake, weight gain, feed efficiency and wing tip feather length were measured weekly. Feed intake, weight gain, feed efficiency, carcass component weights and feather length were significantly ($P < 0.05$) greater in the

CNT-diet than the EXP-diet. The negative effects of the substitution persisted and remained significant ($P<0.05$) up to the end of the 42 day study period. In conclusion, complete substitution of solvent extracted soyabean meal with cold pressed marula seed cake in broiler starter resulted in lower growth, lower carcass component yields and an increase in cases and severity of leg deformities. Further investigation is required to determine the cause of poor performance by birds on the marula based starter diet.

Growth performance, protein utilisation efficiency and blood metabolites in Potchefstroom
koekoek cockerels fed graded levels of canola meal.

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Background: Indigenous chicken production is one of the most important poultry production enterprises in low income communities (Saina, 2005). Currently, there is no certified diet that suits the optimum production of indigenous chickens in South Africa. To supplement appropriately, most farmers presently use expensive commercial feed formulated for exotic breeds, which may exceed the nutrient requirements of the relatively slow-growing indigenous chickens. Provision of high quality protein is, therefore, essential to increase nutrient intake for optimum production. High quality protein, commonly supplied via expensive and competitive soybean meal. One such alternative protein source is canola meal (CM), a cheaper by-product of oil extraction from rapeseed.

Aim: In this study, the effect of graded levels of canola meal on growth performance, protein utilization efficiency and blood metabolites in Potchefstroom koekoek cockerels were determined.

Materials and Methods: 175 Potchefstroom koekoek (PK) cockerels were allocated to dietary treatments replicated 5 times with a pen with 6 birds as the experimental unit. Dietary treatment were formulated with inclusion of canola at 0, 3.75, 6.25, 8.75 and 17.5% in place of soya bean meal in grower diets. Feeding trial lasts for 84 days. Data on growth, protein utilisation efficiency and blood parameters were obtained and analysed using one-way analysis of variance.

Results: Diet significantly affected growth performance parameters, protein utilization efficiency and serum biochemistry of PK cockerels. Diet also affected hematological parameters. All the hematological and serum metabolites values fell within the normal range for health chickens.

Discussion: Results on growth and protein utilization efficiency compared well with findings from previous studies. The blood parameters were all within normal ranges for healthy broiler chickens indicating that inclusion of canola in diets did not negatively affect general health of the chickens.

Conclusions/recommendations: Overall, the results from the study suggest that replacement of SBM with CM in poultry diet up to a level of 17.5% can be effectively used without any adverse effect on PK chicken performance and health.

Effect of production system on the carcass and meat quality characteristics of spent laying
hens

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Background: The utilization of spent laying hen meat is constrained by the limited scientific research on their carcass and meat quality characteristics. Currently there is a well established market for free range broiler chickens, however, there is an entry barrier for the egg producers due to lack of scientific information on the carcass and meat traits of spent laying hens.

Aim: This study evaluated the carcass characteristics and meat quality attributes of spent laying hens under conventional battery cage and free range systems.

Methodology: Thirty free range and thirty conventional battery cage spent laying hens were obtained from a commercial egg producer. All the birds were slaughtered at a commercial abattoir. Carcass, portion, and organ weights plus percentages were determined. Physicochemical analyses were done on both thigh and breast meat.

Results: The caged hens had higher ($P \leq 0.05$) warm carcass, cold carcass, thigh, and wing weights. The percentage of the breast and drum portions was higher ($P \leq 0.05$) for free range hens than caged hens. Production system effect was significant for the gizzard weight and percentage, being higher ($P \leq 0.05$) in the free range hens. Caged hens had higher ($P \leq 0.05$) feet weights. Free range hens had higher ($P \leq 0.05$) breast bone weights and percentage with a lower ($P \leq 0.05$) meat percentage. Free range hens had higher ($P \leq 0.05$) breast thaw and cooking loss percentages, thigh cooking loss percentages, meat redness (a^*), hue angle value,

skin redness (a^*), as well as breast and thigh shear force values(N) compared to caged hens. The caged hens only showed a higher ($P \leq 0.05$) average thigh thaw loss percentage. The free range hens showed higher ($P \leq 0.05$) breast meat moisture content and thigh meat ash content. The breast ash content of the caged hens was also observed to be higher ($P \leq 0.05$) compared to free range.

Discussion: The increased motory activities and uncontrolled environmental conditions under a free range system could have led to the lower carcass, thigh and wing weights, as well as the differences in the thaw and cooking losses of the breast and thigh meat as compared to a caged system. The latter also explains the high percentage of breast and drum for the free range hens. Access to high fiber grasses could have led to the development of gizzard muscles for free range hens so as to grind the food. Free range hens had more bone weight to enable them to support the increased muscle movements. The high skin and breast meat redness, breast and thigh meat shear force, breast and thigh meat moisture and ash could all be ascribed to the increased motory activities enhancing myogenesis more than lipogenesis among free range hens.

Conclusions: Production system significantly influenced the carcass characteristics and meat quality of spent laying hens. Free range production increased the weights of the prime portion (breast) and physical attributes of the meat derived from spent laying hens; however, the breast meat percentage was reduced. Battery cages produce large hen carcasses. Further studies are envisaged to establish the fatty acid profile and sensory characteristics of spent laying hens under free range and caged systems.

The effect of dietary ω -type fatty acids on broiler production performance and fatty acid profile of breasts and thigh meat

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Background: Despite many studies reiterating the potential of dietary lipid sources in altering the fatty acid profile (FAP) of broiler meat, information regarding the deposition efficiency of omega (ω) type fatty acids (FA) in white (breast) and brown (thigh) meat portions are limited.

Aim: To evaluate the use of dietary ω -type (ω -3, ω -6 & ω -9) FAs on broiler performance and fatty acid profile of breast and thigh meat of Ross 308 male broilers.

Methodologies: Four *iso-energetic* (15.15 MJ AME/kg DM) and *isonitrogenous* (223.33 g CP/kg DM) diets were formulated using fish oil (ω -3), sunflower oil (ω -6), high oleic acid (HO) sunflower oil (ω -9) and tallow (SFA) at a 30 g/kg inclusion level. Experimental diets were randomly allocated to 32 floor pens (11.3 birds/m²), each treatment having eight replications. Eight hundred (n=800) day-old vent-sexed broiler males (Ross 308) were randomly divided between the replicate pens (n=25 birds/replicate). Feed and water were provided *ad libitum* and an 18h photoperiod (18L:6D) was used. Feed intake (g) and body weight (g) were recorded weekly, while mortalities were recorded daily. Two birds per replicate pen were randomly selected and slaughtered for the determination of the fatty acid methyl esters (FAME) on D42 of age. Data were statistically analysed using a fully randomized one-way ANOVA design.

Results: Although birds from the ω -9 treatment recorded the highest ($P<0.05$) average daily feed intake (ADFI - 113.75 g/b/d), average daily gain (ADG - 66.37 g/b/d) and performance efficiency factor (PEF - 419), differences observed between the three ω -type FA treatments were random. The FAP of the de-skinned breast and thigh meat portions were successfully altered ($P<0.001$) according to the dietary FAP. The ω -3 treatment resulted in the highest ($P<0.001$) total concentration (Σ) of ω -3 FA in the breast (15.81%) and thigh (11.82%) portions, while the ω -6 treatment resulted in the highest ($P<0.001$) $\Sigma\omega$ -6 concentrations (28.89% & 31.26%) for the respective portions. Additionally, the highest ($P<0.001$) $\Sigma\omega$ -9 concentrations of breast (43.26%) and thigh (46.07%) meat were recorded by the ω -9 treatment.

Discussion: Results are in agreement with other studies showing that dietary ω -type FAs have a limited effect on production performance of broilers. Results further indicate that only approximately 60% of the mean dietary $\Sigma\omega$ -6 FA (37.88%) is deposited in breast (20.97%) and thigh (22.96%) meat. In contrast, the $\Sigma\omega$ -9 concentration of the breast (35.89%) and thigh (38.84%) meat was 7% and 16% higher than that of the diets (33.40%). Dissimilarities in deposition efficiencies of ω -type FA in meat portions illustrate the different metabolic functions and should be considered during the classification of FA enriched meat.

Conclusions/recommendations: The deposition potential of ω -type FA in different tissue should be quantified to ensure optimal utilization efficiencies of dietary FA. The deposition efficiency of ω -9 FA in broiler meat warrants further investigation given its health benefits.

Effect of dietary *Moringa oleifera* seed meal inclusion on performance and carcass quality of female Ross 308 broiler chickens

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Background: Broiler chickens are selected for high feed intake, growth and carcass yield (Richards, 2003). However, improvements in carcass yield have also resulted in excessive carcass fat. High fat content in poultry meat is of great concern for meat consumer's health. Lipid oxidation is a major cause of meat quality deterioration, resulting in rancidity and the formation of undesirable odours and flavours which lower the functional, sensory and nutritive values of meat products (Lawrie, 2006). *Moringa* (M.) *oleifera* seed meal, widely available in many tropical countries, is a good source of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids (Anwar and Rashid, 2007; Makkar and Becker, 1997).

Aim: The aim of this study was to determine the effect of decorticated *Moringa oleifera* seed meal inclusion level on productivity and meat characteristics of female Ross 308 broiler chickens aged 21 to 42 days.

Methodology: A total of 250 female Ross 308 broiler chickens weighing 558 ± 10 g/bird were randomly assigned to 5 dietary treatments with 4 replications, each replicate having 10 chickens. A complete randomized design (SAS, 2008) was used. The experimental diets were isocaloric and isonitrogenous, but with different *M. oleifera* seed meal inclusion levels of 0 (FM0), 5 (FM5), 10 (FM10), 15 (FM15) and 20 (FM20) g/kg DM. Feed intake, growth rate, live weight and FCR were monitored throughout the experimental period. A digestibility trial

was conducted when chickens were aged 35- 42 days. At 42 days of age breast meat samples were analysed for lipids and sensory attributes.

Results: Seed meal inclusion had no effect ($P>0.05$) on intake, growth and live weight but it improved ($P<0.05$) nitrogen retention of the chickens. Similarly, seed meal inclusion had no effect ($P>0.05$) on improved ($P<0.05$) lipid of the meat. The results indicated that meat lipids, energy, polyunsaturated fatty acids, tenderness, juiciness and flavour were optimized at different seed meal inclusion levels of 11.10, 12.96, 12.67, 7.50, 15.50 and 19.50 g/kg DM, respectively.

Discussion: Increasing *M. oleifera* seed meal inclusion levels in the diet of female Ross 308 broiler chickens improved meat sensory attributes. This could be associated with higher PUFA in the breast meat of chickens.

Conclusion: *M. oleifera* seed meal levels of 12.67 g/kg DM optimized PUFA. This has implications on diet formulations for these chickens. More studies are needed to ascertain the findings.

Growth and nutrient utilization of broiler chickens on mash or pelleted diets containing
different levels of whole-sorghum

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Background: The use of sorghum whole grain in broiler diets is limited; furthermore, whole grain inclusion levels for optimum broiler performance is inconsistent. It is still not clear what proportion of whole sorghum grain can be included in broiler diets to optimize performance.

Aim: Therefore, the purpose of this study was to determine the effects of different whole sorghum grain inclusion rates and feed form on the performance and digestibility of broiler chickens.

Methodologies: A 2 (pellet or mash) \times 4 (0, 25, 50 or 75 % inclusion level) factorial array in a completely randomized design having six replicates per treatment, with 9 birds per replicate was used in this study. Body weight (BW) and feed intake (FI) were measured and mortality in each pen was recorded as it occurred, and feed conversion ratio was calculated. On day 25, two birds were randomly selected from each pen, weighed, and humanely killed for measurement of visceral organ and pH. The data were statistically assessed by analyses of variance by a general linear models procedure using an SAS version 10 software program (SAS, 2008).

Results: Whole sorghum inclusion did not improve ($p > 0.05$) the feed intake, body weight and FCR of broiler chickens at 1-35 days. Pelleting increased ($p < 0.05$) feed intake and body weight of broiler chickens aged 1-24 days. The interaction between factors was significant for body weight at 24 ($p < 0.0021$) and 35 ($P < 0.0019$) days. Relative gizzard weight and pH ($p < 0.05$) were lowest in broiler chickens offered mash diets between the hatch and 24 d of age. Feed conversion ratio between the hatch and 35 d increased ($p < 0.035$, quadratic effect) with an increase in whole sorghum and levelled off with higher inclusion rates. Broiler chickens offered mash diets had significantly higher ($p < 0.05$) gross energy and crude protein digestibilities than those on pelleted diets.

Discussion: Chickens offered mash diets had lower feed efficiency compared to those on pellet diets at a similar age. It is unclear why the feed conversion ratio was not improved when feed form was measured over the entire study.

Conclusion: Overall, the results showed that pelleted diets were superior to mash diets. Although higher levels of whole sorghum inclusions enhanced the gizzard development, the performance of birds offered these levels were not affected.

Socio-economic influences on the production of indigenous chickens under varying
ecological zones of the Mpumalanga Province

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Background: The Study was conducted to review available data and study the potential of
village indigenous chicken production management systems in addressing household food
security.

Aim: This study was conducted to determine the socio-economics influences on the
production of indigenous chickens in households under varying ecological zones of the
Mpumalanga province. The ecological zones are Highveld, Lowveld and Midveld.

Methodologies: Data was collected using a semi-structured questionnaire of which a total of
362 households were interviewed. The selection of farmers was done through non probability
sample covering all three ecological zones within the province.

Results: Results from the study indicated that females were the majority (Highveld-52%,
Lowveld-66% and Midveld-63%) farmers of indigenous poultry across the ecological zones.
Most participants (32%, 30% and 32%) were above 60 years when compared with the other
age groups. Majority of participants (98%) were black Africans. In terms of economic status,
majority of the small holder farmers (50% and 61%) were classified as poor whereas there
was no difference between the poor and those below average in the Lowveld (47%). Most
smallholder (77%) had a low level of schooling marked by grade 11 or lower and high

percentage of these farmers kept indigenous chickens for household food requirements. High percentage (70%, 47% and 57%) of households accommodated more than six family members. Majority of the participants (93%) reared indigenous chicken for household consumption. Most farmers (66%, 62% and 65%) feed the chickens with yellow maize, leftovers while they also allow the chickens to scavenge. Disease outbreak, theft and predators are the most common problems faced by most smallholder farmers. Majority of respondents have never received any training on indigenous poultry husbandry training.

Discussions: The present study showed that village chickens can serve as a mean to address food security and contribute to the livelihoods of rural households. The poultry rearing system employed in these ecological zones is a product of indigenous knowledge, household objectives, and financial difficulties accompanied by affordability. Interventions by the Department of Agriculture and other stakeholders will have a marked impact on the attitude towards indigenous poultry farming in the province through development of programmes and creation of awareness so that existing challenges in poultry could be addressed

Conclusion/recommendations: Studies on the impact of stakeholder involvement on uplifting the disadvantaged farmers should be undertaken.

Semen and sperm quality parameters of Potchefstroom koekoek roosters fed dietary moringa
oleifera leaf

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Background: Nutrition is the core of animal production and its ability to reproduce efficiently. The use of non-conventional feed resources is of current interest to animal nutritionist for feed cost reduction. *Moringa oleifera* leaf meal (MOLM) is known for its excellent impact on production, however there's scarcity of information on its effect on animal fertility.

Aim: The aim of the study was to evaluate semen and sperm quality of Potchefstroom Koekoek roosters (43 weeks old) fed *Moringa oleifera* leaf meal (MOLM).

Methodologies: At four weeks of age, the chickens were randomly allotted to two dietary treatments diets consisting of 0 (control) and 7% MOLM. A completely randomised design (CRD) experiment, with 5 birds, replicated 4 times was used for this experiment. Semen was collected three times a week by the dorso-abdominal massage method (Burrows and Quinn, 1937). Semen was used to evaluate ejaculate volume, sperm concentration, live in total sperm, live normal sperm, sperm quality factor and abnormal sperm using a computer-aided sperm analysis (CASA) system.

Results: The 2 way interaction (diet X day) ($P>0.05$) significantly affected semen volume. There was no significant difference ($P<0.05$) between semen volume and sperm concentration with MOLM inclusion. Rosters offered MOLM resulted in improved pH (7.37). Rosters fed MOLM 70 g/kg resulted in higher (57.73) Progressive motility (PM) than control diet (39.38). Control diet had higher Non progressive motility (NPM) and static of

48.59 and 12.57, respectively. *Moringa oleifera* leaf meal diet resulted in higher ($P>0.05$) sperm velocity/rapid (89.06 %) than control diet. Also resulted in higher VCL (106.64 $\mu\text{m/s}$), VAP (66.19 $\mu\text{m/s}$) and VSL (45.54 $\mu\text{m/s}$).

Discussion: Improved pH in the current study is supported by findings by Ashizawa & Wishart (1987) and Ashizawa et al. (1997) who stated that the percentage of motile sperm and sperm velocity were increased at alkaline pH in domestic chickens. The improvement in quality of sperm cells observed in the present study could be attributed to the enrichment of MOLM with fatty acids (45.70%), Vitamin E (113 mg) and Selenium (0.235 dpm).

Conclusion and Recommendations: *Moringa oleifera* leaf meal has proven to be a good supplement that can be used to improve both growth performance and fertility of animals.

Constraints faced by smallholder indigenous chicken farmers in varying agro-ecological zones of the Mpumalanga province

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Aim: This study was conducted to identify the constraints faced by smallholder indigenous chicken farmers in the Mpumalanga Province.

Methodology: A total of 362 farmers were selected and interviewed using a semi-structured questionnaire. The selection of farmers was done through non-probability sample covering all three ecological zones within the province.

Results: Most of the smallholder farmers (84%, 95% 79%) keep their chicken flocks as mixed breeds which could lay eggs up to three times per year. The Highveld (44%) and Midveld experienced acceptable (1-10%) to moderate (11-20%) mortalities respectively. However, the Lowveld (29%) could experience up to 50% mortalities. At post-weaning, most farmers in the Highveld (58%) experienced no losses whereas the Lowveld (58%) and Midveld (58%) had mortalities within acceptable levels (1-5%). The major cause of mortalities was identified as diseases (80%, 80%, and 90%) with Newcastle (85%, 85% and 82%) being the most notable followed by predation. The majority of farmers (93%, 95%, and 96%) do not vaccinate their flocks against diseases. The most common method (44%, 63%, and 75%) of treating sick chickens was through herbs and potassium permanganate. Only few farmers (6%, 2%, and 10%) managed to buy medication for their sick chickens. Record

keeping was only practiced by few (3%) in the Highveld. Only few farmers (9%, 10%, and 9%) are able to sell their chickens occasionally at an estimated local price. The majority of farmers never seek or receive any assistance and advice from Agricultural Advisors regarding indigenous poultry.

Discussions: The challenge of controlling diseases and predators is generally common in most rural households. Inadequate nutrition or lack of nutrition and proper shelter due to economic pressure seem to be responsible for the production loss. Some of these challenges are just a signal of lack of guidance. Enforcing assistance on capacity building from government and can ensure the health, and productivity of these scavenging chickens and also enable farmers to cope with these constraints and access market.

Influence of water salinity on meat quality attributes and sensory characteristics of broilers

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Background: Resource-poor farmers rely poor quality water resources to ensure productivity in livestock. Water play a vital role in metabolic processes in growth of an animal. Drinking water containing high dissolved solids may cause physiological upset and impact negatively on the growth of chickens.

Aim(s): To determine the effects of water salinity on meat quality attributes and sensory characteristics of broilers.

Methodologies: A total of 49 unsexed, day old Ross broiler birds were kept in groups a low cost housing unit with automated ventilation and temperatures, with a floor covered with wood shavings. The birds were fed starter meal from day 0 to day 21, and a finisher from 22 to day 42. Water and feed were provided *ad libitum* through the 49 day experimental period. Post-mortem pH, meat colour and sensory evaluation were determined from the breast muscle of each bird. Meat quality attributes (pH and colour). Texture and taste are the most important sensory property affecting final quality assessment. A total of 60 panellists were recruited to take part in the sensory evaluation of broiler breast meat. Sensory characteristics tested included the taste, texture, and aroma, colour overall acceptability, toughness and saltiness.

Results: Sensory evaluation of meat showed that the appearance, taste, aroma and toughness did not differ significantly among the treatments ($P > 0.05$). Sensory characteristics of meat from broilers were not significant ($P > 0.05$). However, saltiness of meat was more on broilers subjected to increased water salinity levels ($P < 0.05$).

Discussions: Salt levels did not affect meat pH. Slaughtered animal glycogen is broken down into glucose which undergo glycolysis and in the absence of oxygen lactic acid is formed which causes pH to drop in the muscles. f Sensory characteristics of broiler chicken meat that was subjected to varying levels of saline water overall, there was no significant effects on most sensory characteristics that was tasted (taste, texture, aroma colour, overall acceptability, toughness and saltiness) where broiler chicken meat received higher consumer sensory scores in all treatments ($P < 0.05$). Sensory evaluation of chicken meat showed that the appearance, taste, aroma, and toughness did not differ significantly among treatments ($P > 0.05$). There was, though, also no significant ($P > 0.05$) on colour, salt and overall acceptability supporting the observations that the product with highest levels of salts will differ from the other treatments. There is no significant difference between the control and other treatments. Saltiness shows no significant difference among treatments ($P < 0.05$) it means that the consumers did not pick up any salts among the treatments, meaning that the saline water used to raise birds did not penetrate the muscles of the broilers.

Conclusions/recommendations: From the present study it can be concluded that no differences exist in the meat quality (pH, colour and consumer acceptability) in the broiler breast meat that were subjected to varying level of saline water. Saline water up to the level of 3g/L do not affect meat characteristics and sensory evaluation of broilers. The following study should be done to on indigenous birds to see if the saline water would have an effect or not in indigenous chickens.

Effect of solaris tobacco (*Nicotiana tabacum*) oil cake on growth performance, feed conversion ratio (FCR), protein efficiency ratio (PER), European production efficiency factor (EPEF) and slaughter live weights of broiler chickens

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Background: Population numbers are predicted to increase dramatically, especially in developing countries thus increasing the demand for animal protein sources of which poultry is the most consumed. With the increasing consumption of animal protein, the broiler industry is currently faced with the challenge of rising costs of protein sources in order to meet the escalating demand. Therefore, the industry is in search of alternatives to either replace or supplement soybean meal, the current leading crude protein source. Solaris tobacco oil cake meal (TOC) is a by-product of the biofuel industry, is not used for human consumption and is therefore not in competition with food production for humans. The seeds from which the oil cake is produced after processing are obtained from the Solaris plant which is harvested in the same year of plough thus can be supplied sufficiently to the animal feed industry.

Aim: The aim of the study was to investigate the effects on production of broiler birds fed diets supplemented with Solaris tobacco oil cake.

Methodologies: Production parameters: growth performance, feed conversion (FCR) ratio, protein efficiency ratio (PER), European production efficiency factor (EPEF) as well as slaughter live weights of two hundred and forty unsexed Cobb 500 broiler chicks were measured, under commercial rearing standards until a slaughter age of 35 days,

(MUC401SNYE01). Treatment diets were blended in ratios of 100:0 (TOC 0); 75:25 (TOC 25); 50:50 (TOC 50); 25:75 (TOC 75) and 0:100 (TOC 100) following the pattern of dilution diet: summit diet.

Results: The live weights of birds showed no differences ($P > 0.05$) observed across dietary treatments on days 21; 28 and 35. It was observed that supplementing broiler diets with TOC 25 and TOC 75 produced the heaviest birds during the finishing phase (day 35). Moreover, during the finisher stage, TOC 75 had the highest average daily gain (ADG) and that differed ($P \leq 0.05$) from TOC 100 and the control diets.

Discussion: Data obtained from the chemical analysis of Solaris tobacco oil cake meal confirms that it can be classified as a raw material containing middle to high protein content (32.44). Furthermore, the production parameters observed in the study compare favourably to those of birds fed the control and other commercial diets.

Conclusion/Recommendations: Supplementing broiler diets with Solaris tobacco oil cake produced birds of acceptable commercial weight at market age particularly at a summit: dilution rate from TOC

25 (14.4) to TOC 75 (43.2) percent. It would be interesting to evaluate the effect of this protein source on the meat yield and quality aspects thereof.

Molecular characterisation and antibiotic resistance profile of *Enterobacteriaceae* isolated in poultry feed from selected small scale farms in South Africa.

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Background: Poultry feed forms an integral part of the food chain. It is the main input in the production of animal derived food and a reservoir for microbiological hazards contaminating poultry products. Feed contaminated with pathogenic bacteria can lead to diverse infections in poultry and borne diseases in humans. This raises the significance of efforts that must be exerted towards isolation and identification of microbial hazards which may lead to great economic losses and increased public concerns around feed safety.

Aim: The aim of the study was to evaluate and compare the microbial quality and the antibiotic resistance profile of poultry feed used in selected small scale farms with specific reference to *Enterobacteriaceae*.

Methodologies: Eighty-two poultry feed samples were aseptically collected from the feed storage and the feeding trough of each farm using sterile Ziploc plastic bags. The samples were collected from selected small scale poultry farms in Mpumalanga, Gauteng and Limpopo Provinces of South Africa between December 2015 and June 2016. Poultry feed samples were cultured on MacConkey and Xylose lysine deoxycholate (XLD) agar and subjected to morphological examination, a variety of biochemical techniques including Gram's stain, oxidase activity, catalase activity and confirmed with Analytical Profile Index (API 20E). Bacteria were further subjected to genomic DNA extraction using the Zymo

Research Fungal/Bacterial DNA kit. The 16S rDNA nucleotide sequences were determined by PCR using Engine DYAD Peltier thermal cycler (BioRad, USA). An antibiotic susceptibility test was performed on isolated bacteria following the Kirby-Bauer disc diffusion technique and results were interpreted according to the guidelines of the Clinical Laboratory Standards Institute (CLSI).

Results: The overall morphological, biochemical and molecular data indicated that 50 % of poultry feed samples were contaminated with coliform bacteria with *Klebsiella* species being the most ($P < 0.05$) prevalent contaminants of poultry feed (30.5 %). Exactly 100% of the bacterial isolates were found to be resistant to Erythromycin and Ampicillin and 66.7 % antibiotic resistance was observed to Tetracycline. Resistance to Sulphonamides was 53.3 % followed by Ciprofloxacin at 26.7 % and Chloramphenicol at 20 %.

Discussion: The results indicate faecal contamination of poultry feed and the resistance of bacterial isolates to more than one antibiotic. Contamination with multidrug-resistant microorganisms observed is in agreement with various studies. This may be a potential vehicle for spreading food-borne illnesses resulting in reduced poultry consumption.

Conclusion/Recommendations: The observed multidrug resistance might have resulted from the use of antibiotics as growth promoters and/or treatment of bacterial infections in poultry. Such multidrug resistance necessitates the use of alternative means of treating bacterial infections in poultry. Small scale farmers should be given training on the importance of good feeding and storage practices in maintaining hygiene and safety throughout the food chain.

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Background: Mycotoxins are toxic, fungal secondary metabolites produced by a wide range of filamentous fungi that contaminate agricultural commodities in the field, pre-harvest and post-harvest. The presence of fungi-producing mycotoxins in poultry feed can decrease the dry matter, quality of feed and their organoleptic attributes and nutrients value. They present significant hazards in the food chain, which are harmful to animal and human health.

Aim: The aim of this study was to assess fungal contamination and mycotoxin levels of poultry feed in poultry farms in selected areas of South Africa.

Materials: A total of 82 poultry (layer and broilers) feed samples were collected from feeders and storage rooms in 41 small scale poultry farmers in Mpumalanga (20), Gauteng (12) and Limpopo (9) Provinces of South Africa during 2016 summer season. Fungal isolation and identification were done using molecular identification method and the mycotoxins extraction was performed using immune-affinity column. High-performance liquid chromatography (HPLC), thin layer chromatography (TLC) and Enzyme linked Immunosorbent assays (ELISA) were used to determine and quantify mycotoxin.

Results: The results shows high incidence of *Aspergillus* (51.2%) followed by *Fusarium* (46.3%) and *Penicillium* (18.35 %). Samples from Mpumalanga Province had the highest contamination of *Aspergillus* (75.5%). while Limpopo had 55.6% and Gauteng 50%. *Gibberella moniformis* was the most common contaminant at 39% followed by *A. flavus*

(28%) and *A. Niger* (21%). Fumonisin, Aflatoxins Zearalenone and Ochratoxin were the most common mycotoxins detected with the incidence of 100; 89.02; 89.02; and 97.56% ranging between 388.34-8519.35; 15.35–1846.75; 0.36-26.09 and 2.2-40 ppb respectively. No statistical difference ($P \geq 0.005$) was observed for mycotoxin and fungal contamination samples obtained from feeders and storages for all provinces. However significant differences ($P < 0.005$) were observed for aflatoxins between the Mpumalanga, Gauteng and Limpopo provinces.

Discussion

The presence of isolated species and their mycotoxins are in agreement with results obtained by other studies where maize in Limpopo was mostly infected with fusarium and high rate of Fumonisin B2 above the acceptable levels mycotoxins limits in South Africa. The aspergillus incidence in Mpumalanga province was very high which in contradiction to other studies.

Conclusion and recommendations

There is a no need for further study of mycotoxin contamination in comparison with feeders and store room sources. Although, monitoring and awareness of fungi and mycotoxin contamination in farms is recommended to prevent health risks for both animals and consumers.

Key words: poultry feed, fungi, mycotoxins

Effect of replacing maize meal with low tannin white sorghum meal on performance and gut morphology of broiler chickens

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Background: Maize meal constitutes about 50 to 60% of the diets for broiler chickens. There is also high demand for maize meal by humans. Therefore, there is need to replace maize meal with other energy feeds. Sorghum meal is such a possible replacement.

Aim: This study determined the effect of white low tannin sorghum as maize meal replacement on performance and gut morphology of Ross 308 broiler chickens aged one to 21 days.

Methodologies: A total of one hundred and sixty Ross 308 broiler chickens weighing 45 ± 3 g were assigned to 5 dietary treatments replicated 4 times with 8 birds per replicate. Five diets were formulated to contain low tannin white sorghum meal replacement levels of 0% (M100S0), 25% (M75S25), 50% (M50S50), 75% (M25S75) and 100% (M0S100). Data on production parameters and gut morphology were measured. Results were analysed using analysis of variance. A quadratic regression equation was used to determine low tannin white sorghum meal replacement levels for optimal productivity.

Results: Replacing maize meal with sorghum meal in the diet had no effect ($P>0.05$) on diet intake, growth rate, feed conversion ratio, live weight, nitrogen retention, caecum and large intestine digesta pH values, large intestine lengths, crop, gizzard, caecum and large intestine

weights, gut intestinal villi length, crypt depth and length to crypt depth ratio of unsexed Ross 308 broiler chickens. However, chickens on diets having 75 or 100% of maize meal replaced by sorghum meal had higher ($P<0.05$) ME intakes, crop, gizzard and small intestine digesta pH values than those on 100% of maize meal or 25% of maize meal replaced by sorghum meal. Replacing maize meal with sorghum meal at 75 or 100% increased ($P<0.05$) GIT, small intestine and caecum lengths and small intestine weights of the chickens.

Discussion: Results of this study are consistent with other studies indicating that low tannin sorghum meal can replace maize meal in broiler chicken diets without causing any adverse effects on performance and gut development of the chickens aged one to 21 days.

Conclusion/Recommendations: Maize meal can be replaced by a low tannin white sorghum meal without causing any adverse effects on broiler chickens aged one to 21 days.

RUMINANT NUTRITION

Evaluation of the nutritional potential of *Vachellia species* for indigenous farmers application
on goat feeding at port saint johns

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Background: Mortality rate in goat production systems in the Eastern Cape Province represents *ca.* 40% of the total goats produced. Poor goat performance (growth) and mortality, especially in winter, has been associated to insufficient supply of nutrients, specifically proteins. Shrubs and trees are considered as potential feed sources for browsing and grazing ruminants especially in pastures where the quality is poor and quantity limited. Therefore, application of alternative and relatively cost-effective and available sources of supplements such as *Acacia* species can play a major role in goat production systems for farmers in rural communities. However, the community farmers at Port St Johns in the Eastern Cape do not make use of these plants because of their lack of knowledge on its nutritional value.

Aim: The main aim of the study was to determine the nutritional composition of different *Acacia* species located at Port St. Johns as a potential feed supplement for ruminants.

Methodology: Seven different *Acacia* spp. were collected at Port St Johns rangelands: *A. karoo* (AK), *A. nolitica* (ANO), *A. nigrescens* (AN), *A. robusta* (AR), *A. erioloba* (AE), *A. ataxacantha* (AA) and *A. tortilis* (AT). Leaves and mixture of spines and rachis were collected to determine dry matter (DM) content, neutral detergent fiber (NDF), acid detergent fiber (ADF) and crude fiber (CF) content using Ankom fiber analyser technology. Condensed

tannin of *Acacia* species portions were determined using Acid butanol Assay while crude protein (CP) was determined using LecoTruspac nitrogen analyser.

Results: The AN and AT leaves, spines and rachis mixture showed the highest ($P<0.05$) DM content than all other *Acacia* spp. The NDF, ADL, ADF, CF & hemicellulose for leaves were lower ($P<0.05$) than those of the mixture of spines and rachis. Spines and rachis had the lowest ($P<0.05$) CP content than leaves across all *Acacia* spp. Crude protein for both leaves and mixture of spines and rachis varied ($P<0.05$) across all seven *Acacia* spp.. For leaves, AN had the highest CP content, followed by ANO and AK, whereas for mixture of spines and rachis AR had the highest CP content, followed by AA and AE.

Discussion: The lower fiber content of *Acacia* spp. leaves compared to spines and rachis confirmed the nutrient availability for ruminant's consumption of leaves. The difference in CP content of both leaves and spines and rachis is due to their genotypic variation and not location difference as all plants were harvested in the same area. The results obtained complement other author's results that recommend *Acacia* spp., especially the leaves, as a potential feed source for ruminants.

Conclusion/recommendations: Leaves of AN, ANO and AK are highly recommended as ruminant supplementation due to their high CP content. However, *in vitro* and *in vivo* digestibility trials need to be performed to confirm its digestibility and nitrogen availability to small ruminants for proper recommendations on feeding procedure to community farmers at Port St. Johns.

The influence of microbial additives on the ensiling and aerobic stability of avocado (*Persea americana*) pulp

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Shortages of animal feed under smallholder livestock farmers has compelled animal nutritionists to focus on non-conventional feed resources to mitigate this problem. Avocado (*Persea americana*) pulp is one of the available resources that is produced in the oil producing industries of South Africa. This by-product contains 332 g dry matter (DM)/kg, 20 MJ gross energy/kg DM, 119 g ether extract/kg DM and 5.7 pH. Using this by-product as an animal feed in its fresh form has many challenges such as low dry matter and can be easily contaminated. Ensiling is one of the methods that can be employed to preserve high moisture by-products. This method involves the use of additives to improve the fermentation process. To evaluate the influence of silage microbial additives on the ensiling and aerobic stability of avocado pulp using laboratory jars. Avocado pulp (AP) was collected from Westfalia and brought to ARC-Irene for nutrient analyses and silage production. An amount of 800 kg AP was mixed with 150 g grape pomace plus 50 g sugarcane molasses. The mixture was treated with: i) no additive (control), ii) emsilage (microbial inoculant) and Sil-All (microbial inoculant). The treatments were ensiled in 1.5 L anaerobic jars and kept at room temperature for 90 days. After 90 days, three jars per treatment were opened and sampled for fermentation characteristics. Further, silage samples were subjected to an aerobic stability test that lasted for 7 days. The terminal DM and pH were not affected by treatments. However, Sil-All treatment reduced ($P<0.05$) the water-soluble carbohydrates (WCS) content (17.7 g/kg DM)

while increasing ($P<0.05$) the lactic acid content (LA; 47.8 g/kg DM) of the silage compared to other treatments. However, the aerobic stability of silage was reduced ($P<0.05$) with Sil-All treatment as indicated by higher CO₂ production (20.6 g/kg DM) compared to other treatments. The low DM content in avocado pulp necessitates the addition of grape pomace to improve its DM during ensiling. In addition, sugarcane molasses improved the WSC content of the avocado pulp at ensiling. Lactic acid is one of the fermentation acids that preserves the ensiled materials well. Sil-All inoculation increased LA content of silage, consistent with literature. In contrast, the reduced silage aerobic stability with this inoculant worsened the silage quality during the feeding-out phase. This is consistent with literature when a homofermentative lactic acid bacteria (LAB) inoculant was used. High quality silage can be produced from avocado pulp with the aid of additives. This silage should be tested in an animal feeding trial.

Nutrient composition and degradation of climate smart forages high in soluble sugars, starch and true protein

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Background: The increase in global temperatures is evidently contributing to natural pasture loss of palatable forage which affects ruminant productivity. Resilience and sustainability of beef and dairy businesses is dependent on optimum utilization of available feed resources. Climate smart forages (including succulents, grasses and food crops) are adapted to harsh conditions due to physiological mechanisms for water conservation and heat resistance and therefore of paramount importance to ruminant production. South Africa has limited water resources and as a result forages adapted to harsh conditions are critical. Available carbohydrates and proteins drive animal performance.

Aim: The study aimed at assessing the nutrient composition and degradation of climate smart forages high in soluble sugars, true protein and high structural fibre.

Methodologies: *Pennisetum purpureum*, *Digitaria eriantha*, *Lablab purpureus* and *Ipomoea batatas* (high in true protein), and two succulents *Opuntia ficus-indica* varieties (American giant and Zastrom) high in soluble sugars were harvested at maturity. Dry matter, ash, neutral detergent fibre, acid detergent fibre, acid detergent lignin and ether extract were determined. Forage samples were incubated with rumen fluid at 2, 4, 8, 12, 24 and 48 hours and gas recorded using the Ankom *in vitro* gas production technology.

Results: The ash content of American giant (143 g/kg) was higher ($P<0.05$) than other forages. *Digitaria eriantha* had the highest ($P<0.05$) content of neutral detergent, acid

detergent fibre and acid detergent lignin (672 g/kg, 361 g/kg, and 30 g/kg respectively) than other forages. *Ipomoea batatas* and *Lablab purpureus* were higher ($P<0.05$) in ether extracts compared to other forages (Both 22 g/kg). *Pennisetum purpureum* and *Digitaria eriantha* had the lowest ($P<0.05$) gas production at 2, 4, 8, 12, 24 hours averaging; 5, 7, 9, 18, 38 ml/g. Forage type also had an effect on 48-hour degradation, highest degradation occurred with American giant and Zastrom (68 and 75 ml/g respectively) which are rich in soluble sugars.

Discussion: Degradability of *Pennisetum purpureum* and *Digitaria eriantha* is affected by high levels of slowly degradable fibre and also indigestible fibre. The varying properties of climate smart forages are essential in compounding balanced diets. Succulents such as *Opuntia ficus-indica* and *Ipomea batatas* leaves (rich in amino acids) provides nutrients that stimulate non-structural bacteria. The proteins stimulate structural bacterial growth enhancing digestion of mature less palatable grasses and hay.

Conclusion/Recommendations: This is a preliminary study which has demonstrated the limited potential in degradability of climate smart forages. Research is on-going to determine optimum dietary proportions for intensive forage based systems in drier zones where climate smart forages thrive.

Effect of roughage quality on rumen fill, passage and degradability rates, digestibility, and feeding behavior in cattle fed tropical roughage

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Background: Feed intake is a crucial component determining animal performance and with both protein and energy being the key pivot in most ruminant production. Rumen fill is an important indicator for long-term control of roughage intake in ruminant species, thus accurate rumen fill predictions are crucial to enhance livestock productivity. The termination of feed intake by ruminants occurs when the reticulo-rumen is filled, hence feed intake termination by ruminant herbivores occurs mainly as a result of rumen fill. With feed intake being largely regulated by rumen fill, factors such as passage rate, digestibility, degradation rate and feeding behaviour are some of the factors affecting rumen fill thus, feed intake.

Aim: The aim of the study was to determine the effect of roughage quality on rumen fill, passage and degradability rate, digestibility, and feeding behaviour of cows fed tropical roughage.

Materials and methods: Four ruminally cannulated Jersey cows were fed four roughage diets (urea-treated, urea-sprayed, urea-treated + urea-sprayed, and untreated hay) in a 4 x 4 Latin square design. Initially, the cows were adapted 14 days to their allocated roughage diets. After the first period, cows were interchanged and adapted for 7 days to their newly allocated feed. Rumen fill was measured after meal termination in the morning, afternoon, late afternoon and evening using rumen evacuation technique. Passage rates was measured using markers while feeding behaviour were observed using CCTV.

Results and discussion: Our findings showed that feeding behaviour was not affected by roughage quality except for grooming and tongue rolling. However, the time spent on activities was affected ($p < 0.05$) by period of the day except for time spent idling whilst lying and tongue rolling. As expected, cows spent most of their time ruminating, eating, and idling. In agreement with previous studies, our findings indicated that cows spent more time ruminating at night than during the day. Time spent eating was greater during the day (381 min) than at night (109 min). Our findings are in agreement with other studies indicating that cows spend vast of their time eating, ruminating, and idling. In addition, cows spend most of their night time ruminating than eating. Our findings reported that roughage quality had no significant effect on time spent eating. Cows increased their time spent eating from 07h00 AM until reaching their first peak within 10h00 AM. The increased feed intake during the early hours in the morning (07h00-10h00 AM) may be a result of high hunger levels due to extended rumination during dusk lowering rumen fill levels.

Conclusion and recommendations: Improving roughage quality had no effect on time spent and diurnal feeding patterns except for grooming and tongue rolling. Time spent and diurnal patterns on behavioural activities were significantly affected by period of the day. Further research should be done on the effect of feed distribution on feeding behaviour of cows fed tropical roughage.

Knowledge and perception of small holding farmers on feeding sweet potato vines to goats

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Background: Goats in rural communities are often raised in conditions which do not allow them to achieve optimum performance nor express their genetic potential. They are raised on poor quality feeds, with low energy and protein content. For goats to perform to their full potential, it requires high nutritious feed especially in winter or high producing periods. However, commercial supplements such as fresh green feeds, protein blocks or vitamin can assist, but are often expensive. The need for cost-effective, indigenous crop residues, such as groundnut haulms and sweet potato vines, are encouraged.

Aim: This study assesses the knowledge and perception of goat farmers concerning feeding sweet potato vine to goats.

Methodology: A survey was conducted at KwaMthethwa community area, KwaMbonambi local Municipality, KwaZulu-Natal, consisting of seven wards. The survey was administered through a semi-structured questionnaire and 15 households were interviewed per ward, thus n=105 participants. Participants were randomly selected at their willingness to participate. Data was analysed using frequency procedure of SPSS 24 (2016).

Results: Results of this study showed that 56.2% of respondents were males and 43.8% were female, demonstrating male dominion in the farming sector. Results also revealed that 71.4% of households keep goats for socio-cultural purposes e.g. traditional functions and status, whereas 15% and 9% is reared for income generation and consumption, respectively. Farmers (71.4%) were aware and do practice some sort of supplementary feeding. Supplementary

feeds were either bought (34.3%), represented crop residues (26.7%) or represented indigenous trees (9%). Farmers (72.4%) cultivated sweet potatoes for different purposes such as generation of income (53.3%), consumption (27.5%) or both (8%) while 16% were not cultivating. Sweet potato vines were being discarded as waste or burnt, left on the field as manure, conserved as propagation material or fed to livestock by 32.4%, 25.7, 8.6% and 7.6% of the respondents, respectively. However, most of the participants (78.1%) rejected the use of vines as feed. Some farmers (48.4%) use traditional methods as anthelmintic, 30.6% do not treat, 19.4% use drugs and 1.6% use both drugs and traditional medicine.

Discussion: Domination of males in livestock production sector is still high and often reared livestock for socio-economic purposes, which concur with other previous studies. Most farmers seem to know about supplementation but have little understanding concerning the concept of supplementation, since most were giving maize to goats every afternoon for goats to come back for kraaling in the afternoons without herder. Sweet-potato vines are not fed because they assume that it causes fatal diarrhoea to goats which may not be true if they are aware of the right proportion of supplementation. Farmers use traditional plants in supplementation and curing diseases in livestock, which had been reported in several studies.

Conclusion: Apparently, the majority of farmers have heard or do some sort of supplementation, but lack basic knowledge on the importance of indigenous forages. Furthermore, there is a need to educate farmers on supplementary feeding of indigenous forages.

The effects of supplementation with *Brevibacillus laterosporus* and *Bacillus coagulans* on
the digestibility of ruminant diets

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Background: Research on alternative feed additives such as direct- fed microbials (DFM) has increased due to public concern on the use of antibiotics and other growth stimulants in the animal feed industry. Varied responses to feeding bacterial DFM in ruminant production systems emphasize the need for greater understanding of underlying mechanisms affecting diet digestibility. *Bacillus species* offer advantages as DFM because their spores tolerate the harsh environment of the gastrointestinal tract and these species can produce enzymes that enhance feed digestibility, and act as antimicrobial compounds. *Direct fed microbials* are more likely to exert associative or complementary effects on the efficiency of feed utilization when supplemented in combination.

Aim: The aim of this study was to evaluate the effects of supplementation with *B. laterosporus* and *B. coagulans* separately or in combination on *in vitro* rumen digestibility (IVDMD), neutral detergent fibre (NDF) and acid detergent fibre (ADF) degradability.

Methodology: Two separate *in vitro* ruminal batch cultures were performed on different days using the following treatments: Control (Basal diet: CON), Basal diet plus Monensin (positive control: MON), Basal diet plus *B. laterosporus* (1.0×10^9 cfu: LATER), Basal diet plus *B. coagulans* (1.0×10^9 cfu: COAG) and Basal diet plus LATER+COAG. Rumen fluid was collected from a cannulated lactating Holstein cow and mixed with Menke's buffer (3:1) under anaerobic conditions to make the inoculants. Total mixed ration

(TMR) of 0.5 g was added to 100 mL buffered rumen fluid and incubated in triplicate in 250 mL glass serum bottle in a shaking water bath at 39 °C for 24, 48 and 72 h. The pH was measured after each incubation period, and the IVDMD, NDF and ADF degradability were determined.

Results: The pH did not differ amongst treatments at all incubation times. No effect on IVDMD was observed after 24 h. At 48 and 72 h, the IVDMD did not differ amongst all microbial treatments, but it was significantly higher ($p < 0.05$) compared to the control and MON treatment. The MON-treatment had a higher value of IVDMD compared to the control. The degradability of NDF and ADF was not affected by any of the treatments.

Discussion: The improved IVDMD with *B. coagulans* and *B. laterosporus* separately or their combination from 48 h onwards suggests the presence of a lag phase for the ruminal microbial population to adapt to the additives before affecting digestibility of feed nutrients.

Conclusion/recommendations: The results indicate that dietary addition of *B. coagulans* and *B. laterosporus* separately or their combination were effective in increasing in vitro dry matter digestibility of ruminant fed TMR from 48 h of incubation, possibly by altering the rumen fermentation pattern without affecting NDF and ADF degradability.

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Introduction: Smallholder beef production in Malawi is practiced on communal rangelands using Malawi Zebu cattle. There is a strong perception that Malawi Zebu is getting smaller in size over the past years mainly due to reduced protein supply. Development of cost-effective and nutritionally-balanced formulated diets to optimise carcass size is essential for smallholder beef producers. To reduce costs, it would be necessary to complementing expensive protein sources such as legume grains being used by smallholder farmers with less expensive and locally available protein sources. The objective of the study was to evaluate effects of protein sources (soybean meal, baobab seed meal and *Acacia polyacantha* leaf-meal) on morphometric measurements of Malawi Zebu steers.

Materials and methods: Thirty Malawi zebu steers (weighing 182 ± 21 kg; 29 months old), housed individually and in completely randomised design, were allocated to three diets for 120 days. The first diet was made up of baobab seed-meal, maize bran and rangeland hay (24%, 24% and 52%, respectively) and had 157, 416 and 3 g/kg DM of CP, NDF and condensed tannins (CT). The second diet consisted of *Acacia polyacantha* leaf-meal, maize bran and rangeland hay (55%, 28% and 17%, respectively). Acacia diet had 150, 464 and 23 g/kg DM of CP, NDF and CT, respectively. Control diet comprised soybean meal, maize bran, and rangeland hay (22%, 19 % and 59%) and had 158 and 458 g/kg DM of CP and NDF, respectively. Morphometric measurements (MM) were taken on day 0 (D0), 90 (D90) and 120 (D120). Morphometric measurements included body surface area (TBS) and volume (BV) which were computed considering the animal body as a cylinder. The data were analysed using the mixed model with time fitted as a repeated measure.

Results: There were significant diet \times time interactions for rib depth (RD), abdominal width (AW), girth circumference (GC), total body surface area (TBS) and body volume (BV) ($p < 0.05$). The RD did not differ for all steers at D0 ($P > 0.05$). On D90, Baobab-fed steers had greater RD than Soybean and Acacia-fed steers ($P < 0.05$) but Soybean and Acacia steers had similar RD ($P > 0.05$). On D120, Soybean-fed and Baobab-fed steers had higher RD than Acacia-fed steers ($P < 0.05$). The AW was not different among diets on D0 ($P > 0.05$). However, on D90 and 120, Baobab steers had greater AW than Soybean and Acacia-fed steers ($P < 0.05$), but was similar between Soybean and Acacia steers ($P > 0.05$). The initial GC, TBS and BV were similar for all diets ($P > 0.05$). On D90 and D120, Baobab-fed and Soybean-fed steers had higher GC, TBS and BV than Acacia-fed steers ($P < 0.05$). Baobab-fed and Soybean-fed steers had similar GC, TBS and BV ($p > 0.05$).

Discussion: Increase in some MM with time for Baobab-fed and Soybean-fed than Acacia-fed steers may be attributed to higher CP and P profiles of the baobab and soybean diets which increased growth and skeletal size. Although Acacia had better mineral status than soybean diet, performance might be limited by low protein and high condensed tannins content.

Conclusion: Feeding steers with soybean and baobab seed meal improved some MM over time compared to Acacia diets.

Growth and carcass attributes of Malawi zebu steers fed alternative protein sources to
soybean meal

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Introduction: Over 90% of beef produced in Malawi comes from smallholder sector. To improve beef production in the smallholder areas, stall-feeding system was introduced where cattle are confined and finished on grain-based diets. Use of cereals, oilseeds, grain and herbaceous legumes in grain-based diets is limited by scarcity, climatic conditions and high cost of agronomic inputs. Protein supplementation involving indigenous browse legume leaf-meals and oilseeds may be a viable alternative. The objective of this study was to evaluate effects of diets containing soybean meal, baobab seed meal and *Acacia polyacantha* leaf-meal as protein sources on growth and carcass attributes of Malawi Zebu steers.

Materials and Methods: Thirty Malawi zebu steers (weighing 182±21 kg; 28 months of age), housed individually and in CRD, were allocated to three diets for 120 days. The first diet was made up of baobab seed-meal, maize bran and rangeland hay (24%, 24% and 52%, respectively) and had 157, 416 and 3 g/kg DM of CP, NDF and condensed tannins (CT). The second diet consisted of *Acacia polyacantha* leaf-meal, maize bran and rangeland hay (55%, 28% and 17%, respectively). Acacia diet had 150, 464 and 23 g/kg DM of CP, NDF and TEP, respectively. Control diet comprised soybean meal, maize bran, and rangeland hay (22%, 19% and 59%) and had 158 and 458 g/kg DM of CP and NDF, respectively. The measurements recorded were dry matter intake (DMI), average daily gain (ADG), slaughter weights, empty body weight (EBW), non-carcass weight (pluck, viscera, head, feet and hide), hot and cold carcass weights, dressing percentage, carcass pH and temperature, fat thickness and carcass grade. The data were analysed using PROC GLM of SAS.

Results: DMI and ADG were similar in Soybean-fed and Baobab-fed steers ($P>0.05$) but were higher than Acacia-fed steers ($P<0.05$). Soybean-fed steers had the highest slaughter weights followed by Baobab-fed, with Acacia-fed steers having the lowest ($P<0.05$). Baobab-fed and Soybean-fed steers had greater ($P<0.05$) EBW, hot and cold carcass weights and fat thickness than Acacia-fed steers ($P<0.05$). Acacia-fed steers had higher ($P<0.05$) non-carcass weights than Baobab and Soybean-fed steers ($P<0.05$). Soybean-fed steers had the lowest ultimate pH, followed by Baobab and highest in Acacia-fed steers ($P<0.05$). Although, carcasses had six or less incisors, they all graded Standard under the Malawi Grading System primarily because carcasses weighed less 142 kg. Gross margins were the highest in baobab-, followed by acacia and Soybean-fed had the lowest margins.

Discussion: The poor growth and carcass attributes of Acacia-fed steers could be attributed to low CP content and high content of condensed tannins which reduced intake. Condensed tannins at rate of above 20 g/kg DM can reduce intake and digestibility, consequently growth and carcass attributes. Nonetheless, it was profitable to produce on acacia as a protein source than soybean due the low cost of acacia-leaf.

Conclusion: Overall baobab and soybean-fed steers had similar growth and carcass attributes but higher than *Acacia polyacantha*-fed steers. Baobab seed meal has potential to replace soybean-meal as protein source in beef diets. Effects of isonitrogenous diets while improving palatability of acacia leaf-meal must be investigated as acacia improved gross margins more than soybean.

Degradability of amino acids in Velvet bean (*Mucuna pruriens*), Cowpea (*Vigna unguiculata* Walp (L)) and Silverleaf (*Desmodium uncinatum*) forage legumes using the *In vitro* DaisyII Technique

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Background: Forage and browse legumes provide protein, vitamins and mineral elements, which are lacking in mature natural grassland pastures, especially during the dry season (Baloyi et al. 2008). The high protein content of these legumes suggests that they have high potential for use as protein supplements in ruminant feeding. There are significant transformations of nitrogenous feed components that occur in the reticulorumen. Amino acids degradation kinetics is an appropriate evaluation to predict the degradation kinetics of the individual amino acids and consequently, the supply of amino acids to the small intestine (Miranda *et al.*, 2012).

Objectives: This study was designed to determine amino acid profiles and rumen degradability of amino acids in velvet bean (*Mucuna pruriens*), cowpea (*Vigna unguiculata* Walp (L)) and silverleaf (*Desmodium uncinatum*) using the *in vitro* DaisyII technique.

Methodology: Two Friesian cows fitted with 10 cm diameter rumen cannulae on complete dairy feed ration (19% CP dairy meal and maize silage) were used as rumen liquor donors for incubation in both techniques. *In vitro* DaisyII technique was used to evaluate the degradability of the legumes for 2, 4, 8, 12, 18, 24, 48, 72, 96 hours. The degradability characteristics and Effective degradability (ED) of amino acids was calculated using assumed

outflow rates of 0.02, 0.04 and 0.06 per hour were calculated according to the model of Ørskov and McDonald (1979) or McDonald (1981) equations.

Results: There was a considerable variation in amino acid content of the three legumes. Silverleaf desmodium had significantly higher concentration of amino acids compared to cowpea and velvet bean. Aspartic acid showed significantly the highest concentration in all legumes and cysteine showed the lowest concentration in all the studied legumes. Legume forage of Cowpea showed significantly highest level of degradability of amino acid followed by silverleaf desmodium and then velvet bean in both techniques.

Conclusion: The results of the present study confirmed rumen degradability of silverleaf, cowpea and velvet bean forage legumes amino acids. Cowpea is highly degradable compared to silverleaf desmodium and velvet bean. Comparisons of the two techniques show some significant differences in rate of disappearance of amino acids.

Keywords: forages; nutrients; degradability; forage legumes

The performance of steers on kikuyu

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Background: The performance of early maturing beef steers (Hereford and Nguni) on kikuyu pasture was investigated over a 5-year period in two research trials.

Aim: To determine if early maturing beef steers could finish sufficiently off kikuyu pasture, with and without supplementation, by 18 months of age, i.e. before the end of the second summer of their lives.

Methodologies: Two research trials were carried out at Cedara Research Station. Cedara is found in BRG 5, the Moist Midlands Mist Belt. The average rainfall during the months of November to April (when both trials took place) was 577 mm for Trial 1 and 671 mm for Trial 2.

The two treatments in Trial 1 (repeated over 3 years), were 2 kg of molasses (control) and 2 kg of molasses plus 200 g of prilled fat. There were six Herefords and seven Nguni steers per treatment. The average start weight for the Hereford steers was 239 kg and 201 kg for the Nguni steers.

No supplementation was fed in Trial 2 (repeated over 2 years). There were 11 Hereford steers and 14 Nguni steers per year.

Results: in Trial 1, the prilled fat treatment did not cause additional growth in the Hereford steers. The average Hereford end weight was 382 kg (ADG = 0.818 kg/d). However, there was a breed treatment interaction for the Nguni steers. The prilled fat Nguni steers had a significantly greater growth rate than the control by 58 g per day (an ADG of 0.740 versus

0.682 kg/d). The end weight for the Nguni steers was 320 kg for the control and 328 kg for the prilled fat treatment.

In Trial 2, the end weight for the Hereford steers was 378 kg (ADG = 575 kg/d). The end weight for the Nguni steers was 321 kg (ADG = 473 kg/d).

Discussion: Despite the breed treatment interaction observed by the Nguni steers to the supplementation of 200 g prilled fat and 2 kg of molasses meal, both the Hereford and Nguni carcasses were not heavier enough to be deemed a finished carcass. The Hereford steers still needed to gain another 40 to 70 kg; the Nguni steers needed to gain another 60 kg.

Conclusion/recommendations: With or without supplementation, early maturing beef steers were unable to finish sufficiently (reach appropriate slaughter carcass weights) off kikuyu pasture.

Correlation between semen parameters and morphometric characteristics of Zulu rams

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Background: Zulu sheep is an adapted breed of South Africa with desirable traits such as thriving harsh environment and tolerated to various diseases. However, this breed is under risk of extinction as the breeding animals are less than a thousand. Therefore, to limit the biodiversity loss there is a need to assess all attributes necessary for fertilizing capacity and correlate them with the semen parameters to develop conservation protocol.

Aim: To evaluate the correlation between morphometric traits and semen parameters of Zulu rams.

Methodologies: The study was conducted at the Agricultural Research Council (ARC). Study procedures were approved by ARC ethics committee, with reference number APIEC16/034. Rams (n=6, age=3 years and average weight=42 kg) were fed standard feed diet with water provided *ad-libitum*. Semen was weekly collected during breeding season (autumn, May, Southern hemisphere) with the aid of artificial vagina filled with warm water (40-42°C), over a four consecutive weeks. A repetitive of two times a week was recognized. Semen was then transported to the laboratory for evaluation within 30 minutes. Semen volume, sperm concentration, motility parameters and viability were evaluated shortly after arrival. Body measurements were taken in the morning after the fasting period (night) using flexible measuring tape. All reagents used in this study were purchased from Stigma (Sigma-Altrich

Chemie GmbH, Steinem, Germany). Pearson correlation coefficient in Minitab 17 was used to analyse the data.

Results: There was a significant correlation ($P < 0.001$) between body weight and live sperm cell ($r = .46$). Rump height was significantly correlated ($P < 0.05$) with live sperm cell, progressive motility (PM), straightness (STR), rapid motility (RM), fast progressive, average path velocity (VAP), curvilinear velocity (VCL) and straight-line velocity (VSL) ($r = 0.33, 0.47, 0.29, 0.45, 0.50, 0.48, 0.48$ and 0.49 , respectively). Noteworthy, moderate significant correlation ($P < 0.05$) between scrotum circumference and live sperm ($r = .28$) was also observed. However, no significant correlation ($P > 0.05$) found between scrotum circumference and semen volume ($r = .06$).

Discussion: When the current study was compared with the previous studies, it contradicted with numerous studies since unexpected none correlation between scrotum circumference and semen volume was observed. Hence suggests no suitability to use SC as a semen volume predictor in Zulu rams. Semen with high velocity parameters (VCL, VAP, VSL and STR) indicates high sperm undergoing vigorous hyper activated pattern and good motility. Moreover, previous studies have been correlating motility parameters with fertilizing capacity. Therefore, based on results obtained in this study, rump height can be used to speculate fertilizing capacity.

Conclusion: These results indicate that, body measurements such as rump height provide reliable CASA (RM, PM, STR, VAP, VCL and VSL) and viability (live sperm) parameters estimates.

Evaluation of the nutritional potential and moisture content of *Kigelia africana* fruit from
Zululand community

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Background: Major ruminant production losses in both small and commercial farms have been associated to poor diets with low nutritional value. Small ruminants obtain nutrients from grazing or browsing forages. Unavailability and poor quality of forages during winter is a major constrain towards ruminant production systems in the Zululand region, KwaZulu-Natal. It is therefore wise to explore *Kigelia Africana* (sausage) fruit as a potential feed supplement to ruminants during dry periods. This fruit appears to have a high moisture content, which may complement water requirements of animals. Furthermore, the fruit's fibrous pulp may yield enough energy for small ruminants or also contain anthelmintic properties since it has been used for medicinal purposes to treat human intestinal worms in West African countries.

Aim (-s): Therefore the aim of this study was to explore the nutritional value of *K. africana* fruit and its moisture content as potential animal feed supplement.

Methodologies: Sausage fruit was harvested on five different plants from Zululand community and separated into five extract components: Exocarp (Ex), Endocarp (En), Endocarp plus seeds (En+S), Seeds (S) and Whole fruit (Wf). These fruits were weighed and oven dried at 60 °C for dry matter and moisture content determination. The samples were ashed for ash content and organic matter measurement. Condensed tannins (CT) was determined using Acid Butanol Assay of proanthocyanidines while fibre content (crude fibre, neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL),

hemicellulose and cellulose) and crude protein (CP) content of the feed were determined using the ANKOM Fibre Technology and Kjeldahl method, respectively.

Results: Crude Protein content varied ($P<0.05$) across the *K. africana* fruit portions. The S component had the highest CP (12%; $P<0.05$) while NDF and ADF was highest in Ex, 70.7% and 59.2% respectively. Endocarp showed the lowest amount of fibre (NDF 39.0%, ADF 29.3%; $P<0.05$). CT had a significant difference across fruit portions, with highest concentration in Ex followed by Wf, En+S, En and S having lowest concentration ($P<0.05$). All fruit extracts had a high moisture content ($>50\%$), where En+S had the highest value of 79.2% while seeds had a value of 50.4%.

Discussion: Most plants synthesize more anti-nutritional factors like condensed tannins in their Ex to protect themselves against damage by herbivory. This explains why *K. africana* had the highest condensed tannin concentration in Ex. Research shows that plant stem barks are rich in lignin which was not different in this study as observed in the Ex. The fibrous endocarp with low levels of NDF (39.0%) and ADL (29.3%) could suggest that this fruit can be exploited for energy and protein by ruminants. The high moisture content of the En+S component highlights the importance of the sausage fruit towards water contribution in ruminant diets, especially during drought periods.

Conclusion: The results showed that sausage fruit has the potential as an animal feed supplement due to its relatively high protein seed content and low fibre content in the endocarp as well as high moisture content. Seeds were hard to crush, however, once crushed nutrients becomes readily available.

The effect of extrusion on the rumen undegradable protein fraction of lupins

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Background: The protein value of ruminant feeds depends on the digestibility and amount of protein reaching the small intestine. Extrusion has been shown to reduce degradability in the rumen without impairing digestibility in the duodenum thus increasing the rumen undegradable protein fraction.

Aim (-s): To determine the effect of extrusion on the degradability of broad-leaf *Lupinus albus* and narrow-leaf *Lupinus angustifolius*.

Methodologies: Lupin seed of *L. albus* and *L. angustifolius* were extruded at 108-116°C with an Insta Pro 2000RC extruder. The dry matter (DM) and crude protein (CP) degradabilities of broad-leafed and narrow-leafed lupins (control and extruded) were determined by the *in situ* technique (described by Ørskov & McDonald in 1979 and Ørskov *et al.* in 1980) using polyester bags. Five gram samples were milled through a Wiley mill (1mm sieve size) and placed into the bags. The bags were incubated for 2, 4, 12, 36 and 48 h. This procedure was replicated twice for each sample and repeated in three periods as a cross-over design, giving a total of six observations for each variable studied. Eight Merino wethers, fitted with rumen cannulae, were used and had *ad libitum* access to water and a basal diet of wheat straw and lucerne hay (50:50) during the experimental period. The percentage material degraded was fitted to the equation and effective degradability was calculated by the equation proposed by Ørskov and McDonald in 1979. Non-linear parameters were estimated by an iterative, least square procedure using SAS Enterprise Guide® software (2014).

Results: *L. albus* and *L. angustifolius* control samples were highly degradable in the rumen. Extrusion lowered ($P<0.05$) the DM effective degradation of *L. albus* at fractional outflow rates 0.02/h, 0.05/h and 0.08/h (88.1% to 82.8%, 80.5% to 65.0% and 75.9% to 58.5%, respectively). Parameters and differed significantly for DM. The CP effective degradation of *L. albus* was lower ($P<0.05$) at outflow rates 0.05/h (87.1% to 51.4%) and 0.08/h (86.1% to 44.9%) due to extrusion. No differences between extruded and control effective degradation of *L. angustifolius* was found and only CP parameter differed ($P<0.05$). Thus, extrusion lowered rumen degradation of *L. albus*, but did not influence degradation in the rumen of *L. angustifolius* in this study.

Discussion: Lupins are highly degradable in the rumen. Extrusion may be used as a technique to improve the by-pass protein content of lupins. In this study the effect on *L. albus* was positive. Further studies on the *L. angustifolius* are necessary to improve extrusion conditions.

Conclusion and recommendations: Extrusion significantly decreases the protein degradation of broad-leaf *Lupinus albus* in the rumen but did not significantly affect the CP degradability of narrow-leaf *Lupinus angustifolius*. Further studies of the extrusion conditions of lupins to increase the undegradable protein fraction are necessary.

Influence of liquid passage rate on solid digesta passage rates for grazing and browsing
domestic and wild ruminants

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Background: Passage rate of rumen fluid out of the rumen affects passage of solid material, determines the amount of bypass nutrients and the efficiency of synthesis of microbial protein in the rumen, making modelling of passage rate important. Normally, passage rate prediction models have been developed for specific ruminants; buffalo, cattle, sheep and goats.

Aim: This study ascertained the influence of liquid passage rates on prediction of solid digesta passage rates in ruminants.

Methodologies: Artificial neural networks were used to develop models of solid and, solid plus liquid passage rates. Studies that reported fractional passage rates, class and body mass of ruminants were included in the dataset. Animal and feed factors that affect the rate of passage were identified in studies. The database was composed of observations of domestic and wild ruminants of variable body mass (1.5 to 1238 kg) from 74 (solid using predicted liquid passage rate) and 31 (solid using observed liquid passage rate) studies, and 15 ruminant species from different climatic regions. Observations were randomly divided into 2 data subsets: 75% for training and 25% for validation.

Results: Developed models accounted for 76 and 77% of the variation in prediction of solid passage rates using predicted and observed liquid passage rate as inputs, respectively. Simultaneous prediction accounted for 83 and 89% of the variation of solid and liquid

passage rates, respectively. On validation using an independent database, these models attained 45 (solid using predicted liquid), 66 (solid using observed liquid), 50 (solid predicted with liquid) and 69% (liquid predicted with solid) of precision in predicting passage rates. Simultaneous prediction of solid and liquid passage rate yielded better predictions (+7%) compared to independent predictions of solid passage rate.

Discussion: Previously published equations attained modest R² values in predictions of 15-66% for rates of passage of particulate matter not accounting for the influence of liquid passage rates, which are lower than those attained from models in this study. Better predictions of solid and liquid passage rate were obtained when both phases were simultaneously predicted compared to individual predictions of solid and liquid passage rates. This authenticates the importance of fluid passage in influencing particulate digesta movement. **Conclusions and recommendations:** Inclusion of liquid passage rate as an input variable gave better predictions of solid passage rates. Better predictions may be obtained by indexing for ambient temperature.

The effect of fertilisation with bio-digester slurry on fermentation characteristics, chemical composition, and *in vitro* digestibility of napier grass (*Pennisetum purpureum*) silage

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Background: The quality and quantity of nutrients available to grazing animals are extremely variable throughout the year. However, fodder conservation could alleviate the dry season feed shortages. In South Africa, the use of decomposed bio-digester slurry manure in improving fodder for ensiling has not been previously reported. The use of bio-digester slurry as fertilizer for forages facilitates its safe disposal and reduces environmental pollution in an integrated approach to livestock production in rural areas.

Aim: The objective of the study was to determine the effect of fertilisation with bio-digester slurry on the fermentation characteristics, chemical composition, and *in vitro* digestibility of Napier grass silage.

Methodology: Napier grass was planted at the School of Agriculture Experimental Farm, University of Venda in 5 m x 4 m plots replicated three times in a completely randomised design. The grass was irrigated weekly with either bio-digester slurry or tap water (control) for 12 weeks. After 12 weeks, Napier was freshly cut and ensiled for 90 days in 1 ℓ glass jars. Fermentation characteristics (pH and water soluble carbohydrates) and chemical composition (dry matter (DM), crude protein (CP), non-protein nitrogen, ash, neutral detergent fibre, acid detergent fibre and acid detergent lignin) of fresh-cut Napier grass were determined using standard protocols. In addition, ammonia nitrogen and lactic acid were also determined on Napier grass silage. The *in vitro* DM and CP digestibility of rumen un-degradable residue, collected after 12, 24 and 48 h rumen incubation, were determined by sequential digestion in

pepsin (abomasal) and pancreatin (small intestine) solutions. A two-sample *t*-test (Minitab version 17) was used to evaluate treatment effects at a 95% confidence interval.

Results: Fertilisation with bio-digester slurry had no effect ($P>0.05$) on nutrient composition of fresh-cut Napier grass, on the fermentation characteristics and chemical composition of Napier grass silage, on DM and CP degradability at both 12, 24 and 48 h of rumen incubation, and on the *in vitro* DM and CP digestibility of silage residues after 12, 24 and 48 h of rumen incubation.

Discussion: There are currently no comparable studies on the effect of fertilisation with bio-digester slurry on the nutritive value of silages. However, improved crop quality has been reported previously in response to bio-digester slurry application.

Conclusions and recommendations: There were no significant differences among the treatments on all observed parameters. Further research may be necessary to evaluate the long-term effect of bio-digester slurry on the nutritive value of silage.

Comparisons in protein digestion of Nguni and Hereford heifers restricted at 60 percent of
voluntary water intake

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Different beef breeds respond differently to various environmental conditions and natural primers. The Nguni cattle breed tolerates harsh conditions compared to exotic breeds (e.g. Hereford), which might be related to a better nitrogen re-absorption in the Nguni breed compared to the exotic-breeds under environmental stress. To better understand these differences between Nguni and Hereford cattle breeds, various strategies such as feed and water restriction can be followed. One of the strategies is to measure protein digestibility when water supply is limited.

The objective of this study is to determine the differences in protein digestibility between Nguni and Hereford cattle breeds when water is restricted at 60% of their daily voluntary water intake.

A pelleted diet containing 11.5% crude protein (CP) per kilogram dry matter was fed to two breeds of cattle (Nguni and Hereford) consisting of ten heifers per breed. A preliminary study was done with *ad libitum* access to water and feed for two weeks to determine voluntary intake per animal. The heifers were then allowed to drink only 60% of their average daily voluntary water intake with *ad libitum* feed intake recorded for a period of two weeks where the first week was used for adaptation to the water restriction. Daily faeces excreted by each animal were collected from the floor of the individual pens using a shovel and a bucket. For urine collection, urinary catheters were inserted into the bladder of each heifer for ease of

urine collection. After collection, the faecal and urine samples were analysed for nutrient composition. Efficiency of CP digestion was calculated from the data collected.

The digestibility of CP did not differ between the breeds. However, the urinary protein was different ($P < 0.05$) amongst the breeds, where the Nguni cattle excreted more nitrogen (2.9%) in the urine than the Hereford (1.6%).

A previous study indicated that with *ad libitum* access, Hereford cattle tended to drink 6.5% more water than their Nguni counterparts. In this study, water was restricted and the Nguni required less water compared to Hereford breed to digest an equivalent amount of feed. Nguni nitrogen levels in the excretions are expected to be higher and this was observed in the higher urinary nitrogen levels. The results may imply that the Nguni breed may be requiring less protein than the Hereford breed.

It is expected that restricting water intake would generally result in increased concentration of urinary metabolites in cattle but between breed differences shows that genetics play a major role. The tendency to show low protein digestibility in Nguni also further explains the high amount of nitrogen detected in the urine of Nguni cattle. Hereford cattle on the other hand managed to maintain a high digestibility of the experimental diet despite the water restriction, which is also evident in the low urinary nitrogen content. The results may imply that despite the water restriction and the observed differences in protein digestibility, the dietary protein was enough to meet the maintenance requirements of both breeds.

Effect of shredded *Colophospermum mopane* wood inclusion as roughage on the
performance of fattening Nguni cattle

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Background: Beef cattle are nutritionally and economically important in South Africa. However, changes in climate are directly and adversely impacting on beef cattle production in Southern Africa. Thus, pastures are not enough for fattening cattle, particularly during the dry season. This has resulted in farmers using wood shavings as roughage sources for fattening cattle.

Aim: To determine the effect of *Colophospermum (C.) mopane* wood inclusion as roughage on performance of fattening Nguni heifers.

Methodologies: Four diets were used. These diets were isocaloric and isonitrogenous (16 ± 0.8 MJ/Kg DM and 15 ± 0.5 %CP, respectively) but with different shredded *C. mopane* wood inclusion levels of 5, 8.5, 10 and 15% (as fed basis). Twelve yearling heifers were used instead of steers because steers were not available. Animals were given 30 days of acclimatization before commencing with the experiment. The experiment lasted for 90 days. The experimental animals were randomly allocated to four treatments having *C. mopane* inclusion levels of 5, 8.5, 10 and 15%. The diet without *C. mopane* wood as roughage was not used to avoid digestive disorders. Each treatment had three replicates, with one heifer per replicate. The heifers were housed in individual pens and had access to clean water and food *ad libitum*.

Results: Shredded *C. mopane* inclusion level had an effect ($P < 0.05$) on intake and feed conversion ratio (FCR). Shredded *C. mopane* wood inclusion levels of 11.0, 13.7, 8.0, 15.0,

14.0, 14.0 and 15% optimised diet DM, OM, CP, NDF and ADF intakes per metabolic weight and FCR of Nguni heifer. However, shredded *C. mopane* wood inclusion levels used in the study did not affect ($P>0.05$) diet *in vitro* digestibility, carcass weight, dressing percentage, meat pH, meat shear force values and meat colour intensities except for red colour intensity of rump steak.

Discussion: Results agree with other studies showing that wood can be used as roughage without adversely affecting diet intake, FCR, digestibility, live weight and carcass characteristics of beef cattle. The improved diet intake and feed conversion ratio with shredded *C. mopane* wood inclusion level seem to have had no effect on body weight gain, *in vitro* digestibility and carcass characteristics of Nguni heifers.

Conclusion/recommendations: *C. mopane* wood can be included up to 15% level as roughage in diets for feedlot Nguni cattle. It is recommended that further studies be conducted with a large sample size to determine the influence of *C. mopane* inclusion on performance of fattening Nguni cattle.

Effect of drying method on the nutritional composition of pomace from grape varieties grown
in South Africa

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Background: The South Africa wine industry generates large quantities of grape pomace (GP) comprised mainly of seeds and skins. Use of GP in ruminant feeding systems is a potential sustainable option for recycling cellar waste, thus limiting its negative effects on the environment. Grape pomace is highly fermentable and perishable, hence preservation prior to feeding is crucial. Preservation methods have different effects on nutritional quality of GP but supporting literature is scanty, thus warrant further investigation.

Aim: The aim of the current study is to assess the effect of drying methods on nutritional composition of pomace from grape varieties (*Vitis vinifera*) widely produced in South Africa.

Methodologies: Grape pomace cultivars (i.e., Pinotage, Shiraz and Sauvignon Blanc; n= 6) were dried using three different methods: sun-drying for 7 days, freeze-drying for 72 h and oven-drying at 60 °C for 72 h. The dried pomaces were analyzed for proximate composition.

Results: Across varieties and drying methods, oven-dried Pinotage (946.8±0.90 g/kg dry matter (DM)) and Shiraz (945.1±0.90 g/kg DM) had the highest DM (P<0.05). Oven-dried Shiraz (128.2 - 134.7 g/kg DM) had the highest crude protein content (CP) compared to other varieties across drying methods (P<0.05). Oven-dried Shiraz and sun-dried Pinotage had the lowest ash content compared to other varieties across drying methods. Irrespective of drying method, starch content was highest in the Sauvignon Blanc variety (216 - 235.0 g/kg DM) compared to other pomace treatments (P<0.05). Shiraz pomace (101.2- 113.6 g/kg DM) had

the highest ether extract (EE) regardless of the drying method. Sun-dried Shiraz had the highest neutral detergent fiber (NDF, 458.7 ± 1.32 g/kg DM), acid detergent fiber (ADF; 414.4 ± 5.69 g/kg DM) and acid detergent lignin content (ADL; 279.8 ± 1.98 g/kg DM), relative to other varieties across drying methods ($P < 0.05$).

Discussion: The reason for the high DM content observed for oven-dried Pinotage and Shiraz compared to other pomace treatments is not immediately clear. High CP content among the oven-dried varieties, Shiraz in particular, could be due to the presence of tannins which bind to proteins during fermentation in the wine-making process, which prevents their extraction and hence retained in GP. The high starch content in Sauvignon Blanc pomace variety could be because it does not go through the fermentation process during wine production, unlike the red varieties. High EE values reported for sun-dried Shiraz was possibly related to high number of seeds per berry compared to the other varieties. The number of seeds is linearly correlated with oil content, hence higher EE. The high fiber content observed for sun-dried varieties can be attributed to effect of ultra-violet radiation which alters the chemical composition through oxidation of cell soluble components forming Maillard products. These structural changes result in the formation of insoluble polymers resistant to the degradation effects of cell soluble components during fiber analyses.

Conclusion/ recommendations: Based on CP, EE and NDF contents, oven-dried Shiraz has high potential as a feed for ruminants compared to other dried grape pomaces. Further research regarding phenolic compounds and *in vivo* digestibility of GP could be important.

Effect of improved roughage quality on rumen fill

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Background: Rumen fill is an important indicator for long-term control of roughage intake in ruminants. Its measurement and prediction is very crucial to productivity of livestock industry.

Aim: This study determined the effect of roughage quality on digesta load in the rumen (rumen fill).

Methodologies: Veld hay was untreated (PRQ), improved (IRQ) by treating with 4% urea (w/w) or semi-improved by spraying with 2.5% (w/w) urea (SIRQ). Experiment 1 used sheep to measure rumen fill considering the effect of time lapse after feeding while Experiment 2 used goats to measure rumen fill considering the effect of period of day at meal termination. Experiment 1 was divided into three sub-experiments: Experiment 1a, four rumen-fistulated sheep were used to determine *in-sacco* degradability; Experiment 1b, nine sheep (37.6 ± 9.34 kg) were blocked by body weight and randomly allocated to IRQ (n=4) and PRQ (n=5) to determine *in-vivo* digestibility; Experiment 1c, sixteen sheep (36.5 ± 9.46 kg) were blocked by body weight and randomly allocated to IRQ (n=8) and PRQ (n=8) to determine rumen fill at time lapse of 0, 6, 12 and 24 h after feeding (slaughter replicates per IRQ and PRQ treatment per time lapse, n=2). In Experiment 2, eighteen goats (25.4 ± 9.08 kg) were blocked by body weight and randomly allocated to IRQ (n=6), SIRQ (n=6) and PRQ (n=6) to determine *in-vivo* digestibility and rumen fill during morning, afternoon and evening, at meal termination (slaughter replicates per treatment per time lapse, n=2).

Results: Rate of degradation and effective degradability were enhanced by IRQ. Roughage quality had no effect on digestibility [IRQ ($P<0.01$) and SIRQ ($P<0.001$)], but digestibility was higher in goats than sheep. Time lapse after feeding had no effect on rumen fill but period of day at meal termination influenced the rumen load ($P<0.05$). NDF load for goats were above 2.03 kg/100 kg BM for all diet treatments.

Discussion: The results in the experiment with goats are similar to other studies. Rumen fill levels reach their first maximum after the main morning meals, with a daily maximal rumen fill being reached after the evening meal. High rumen load after termination of the evening feeding bout compared with morning and afternoon period may indicate presence of physiological and feeding behavioural control mechanisms on rumen load.

Conclusion/Recommendation: Following starvation, time lapse had no effect on emptying of rumen load, however, further studies need to establish rumen fill at zero hour of meal termination.

Comparing rumen methanogenic archaeal counts in beef cattle fed diets with different fibre levels

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Background: The rumen microbes play a crucial role in ruminal fibre fermentation. The rumen microbial ecosystem consists of bacteria, fungi, viruses, protozoa and methanogenic archaea. Bacteria convert ingested feed to nutrients. Fungi physically break cellulose polymers, to increase surface area for bacteria attachment. Viruses shape the rumen microbial population. Protozoa produce hydrogen. Methanogenic archaea use hydrogen to reduce carbon dioxide, and produce methane as a by-product. If rumen hydrogen is not utilized, it can inhibit rumen metabolism. However, methane emitted by farmed livestock accounts for nearly one-third of anthropogenic methane emission. Methanogenic archaea use 2-12% of dietary gross energy, which is actually supposed to cater for animal production. The amount of methanogenic archaea depends on the quality of feed consumed by the host animal.

Aim of the study: To compare rumen archaeal counts in beef cattle fed diets with different fibre levels.

Methodologies: Rumen fluid was collected from 18 beef steers (9 Bonsmara and 9 Nguni) using a stomach tube. Steers were fed one of three treatment diets: diet 1 with 22% fibre; diet 2 with 16% fibre and diet 3 with 11% fibre levels. On arrival, animals were fed *Eragrostis Curvula* grass hay on *ad libitum* basis for 14 days as part of adaptation to the feedlot

environment. Animals were gradually adapted to treatment diets to prevent ruminal acidosis and bloat. Animals were then allocated randomly to treatment diets for ninety days. This study was arranged as a 3 x 2 factorial experiment, in a Completely Randomized Design. DNA extraction was done from rumen fluid, according to the DNA extraction kit manufacturer instructions. Universal primers were used to detect rumen archaeal counts, using a real time PCR molecular method. SAS (2013) software was used for data analysis and the means were separated using a least significant difference (LSD) statistic at 5%.

Results: Steers on diet 1 had the highest rumen archaeal count compared to other treatments: 0.90 ± 0.68 (Mean \pm SD) for Nguni and 0.82 ± 0.06 for Bonsmara. The Bonsmara steers had the lowest rumen archaeal counts across all treatments compared to the Nguni steers: Diet 2: 0.42 ± 0.03 for Nguni and 0.22 ± 0.10 for Bonsmara, Diet 3: 0.39 ± 0.05 for Nguni and 0.10 ± 0.82 for Bonsmara.

Discussions: Low dietary fibre (11%) in diet 3 resulted in low rumen archaeal counts, which shows that proper dietary fibre inclusion level during feed formulation can be used as an alternative strategy for reducing rumen archaeal counts in beef cattle. Low rumen archaeal counts observed from the Bonsmara shows that the use of feed efficient cattle breeds can be used as an alternative climate smart beef farming strategy.

Conclusions and recommendations: Further research should be done on the development of a feed formulation that will stimulate an alternative rumen hydrogen sink, to counteract rumen methanogenic archaea.

Growth performance and carcass quality of non-descript crossbred steers fed low-cost finishing diets

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Background: Smallholder beef production is mainly constrained by nutrient inadequacy, especially protein during the dry season. Commercial protein concentrates are expensive for resource-limited smallholder farmers. *Acacia mearnsii*, an abundant browse tree legume in the Eastern Cape Province, has a high protein content. However, its potential as a protein source in beef cattle diets has not been investigated.

Aim: The objective of the current study was to compare growth performance and carcass quality of non-descript crossbred steers fed commercial finisher diet (CM), *A. mearnsii*- (AM) and Lucerne-based diets (LM).

Materials and methods: Thirty-six 12-month-old steers with a mean weight of 157.88 ± 12.9 kg were randomly allocated to three diets. The AM diet, containing 47.9% *A. mearnsii* leaves, 31.9% grass hay and 20.2% maize had 10.5% CP, 46.3% NDF, 10.3% ADL and 28g/kg condensed tannins (CTs). The LM diet containing 46.7% Lucerne, 33.3% maize and 20% maize-stover had 11.9% CP, 42.36% NDF, 6.9% ADL and 2g/kg CTs. The CM diet had 13.3% CP, 30.8% NDF and 4.66% ADL. The steers were paired in feedlot pens with *ad lib* access to feed and clean fresh water for 120 days. Growth performance, carcass quality and gross margin data were collected and analysed using the PROC MIXED procedure of SAS.

Results: Steers fed AM (7.77 ± 0.16 kg) had lower ($P < 0.05$) average daily feed intake than steers fed LM (11.2 ± 0.16 kg) and CM (11.1 ± 0.16 kg). Consequently, the AM steers had lower ($P < 0.05$) slaughter weight (201.7 ± 12.9 kg) and average daily gain (0.29 ± 0.04) than

LM ($248.8 \pm 12.9\text{kg}$ and 0.78 ± 0.04) and CM steers ($248.9 \pm 12.9\text{kg}$ and $0.80 \pm 0.04\text{kg}$). Cold ($79.8 \pm 8.96\text{kg}$) and warm ($82.5 \pm 9.238\text{kg}$) carcass weights for AM steers were also lower than for LM ($119.7 \pm 8.96\text{kg}$, $123.3 \pm 9.24\text{g}$) and CM ($120.8 \pm 8.96\text{kg}$, $124.5 \pm 9.24\text{kg}$) steers. Steers fed the AM (5.36 ± 3.96) diet had lower ($P < 0.05$) feed conversion ratio than LM (10.8 ± 3.96) and CM (11.9 ± 3.96) steers. However, AM (R1045.83) diet had the highest gross margin compared to steers fed LM (R225.72) and CM (-R597.71) diets. Most (92%) steers were in age class A and 45% had score 1 and 80% had a confirmation score of.

Discussion: The observation that AM steers had poor growth and carcass attributes could be due to low feed intake attributed to astringent taste of tannins found in high concentrations in the diet. It may also be partly attributed to high ADL content in the diet compared to other diets. The observation that AM steers had better FCR may be because tannin-protein complexes inhibit microbial protein degradation in the rumen increasing bypass protein for digestion and absorption in the small intestines.

Conclusions: The CM and LM diets had positive effects on growth and carcass characteristics compared to the AM diet but were less economical than the AM diet.

Mineral composition of kikuyu in South Africa

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Background: Kikuyu pastures form an important part of the diet in dairy cows. Kikuyu is a natrophobic plant and the mineral fraction of kikuyu is typified by low sodium (Na) levels, high potassium (K) levels, low calcium to phosphorus (Ca:P) ratio and a poor ionic balance, potentially leading to production and metabolic problems in high producing dairy cattle.

Aim: To explain the variation in the macro-mineral composition of kikuyu pastures for dairy cows and the implications thereof.

Methodologies: Data from research trials on Cedara, samples submitted to the Cedara feed laboratory and from publications emanating from research trials throughout South Africa were reviewed.

Results: The data reviewed appears to fall within two populations, coastal samples with kikuyu grown on sandy (3 to 24% clay), less acidic soils (pH (KCl) >5.3), with soil Ca (1000–2000 mg/kg) and very high P concentrations (100-200 mg/kg) due to fertilization and liming in the Southern and Eastern Cape, did not display the typical inverse Ca:P ratio typically associated with kikuyu. Kikuyu in KwaZulu-Natal (KZN) grown on highly weathered, highly acidic soils (pH (KCl) of 4-5); with high clay contents (41-48%) and high acid saturation levels, soil Ca (769-1987 mg/l) and soil P (19-30 mg/l) exhibited lower Ca and P values with the typical inverse Ca:P ratios. Fertilization influences the mineral composition of kikuyu, with high levels of nitrogen (N) fertilization reducing P concentration, while increasing Mg. The effect of high N was variable on Ca. Calcium in the plant was increased by P fertilization. The natrophobic nature of kikuyu is clearly evident in

the Na composition of the kikuyu analysis for KZN and other inland sites which recorded mean Na concentrations of 0.3 g/kg. However, the coastal sites situated in the Tsitsikamma, Outeniqua and East London, with a mean Na concentration of 1.9 g/kg, do not reflect kikuyu's natrophobic status. Sodium and K concentrations in kikuyu are highly correlated, with Na concentrations extremely low (0.2-0.5 g/kg DM) at high K levels.

Discussion: The high Ca:P ratios found in the Eastern and southern Cape are atypical, not only to KZN and other inland values, but also to those measured in Australia. A Ca:P imbalance in kikuyu was the cause of nutritional osteodystrophy in dairy heifers younger than one year of age, while metabolic alkalosis has been associated with high K intakes by dry cows grazing kikuyu. Unpalatable pastures contain very high levels of K and usually (but not always) high N. Bite rate was greatly reduced when cows grazed on spring pasture containing K levels above 37 g/kg of dry matter. The Na content of these coastal area samples are 5-fold those of the inland samples and may be ascribed to the effect of sea spray depositing Na on the plants. Pastures grown within 10 km of the New Zealand coast have been shown to be 4 times richer in Na than samples from further inland.

Conclusion/recommendations: Soil acidity, nitrogen fertilization and proximity to the sea are major drivers of the mineral composition of kikuyu. Further studies have been initiated to further clarify the soil factors influencing the mineral composition of kikuyu.

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Background: The viticulture industry produces large quantities of grape pomace made of skins, seeds and few stalk parts. After grapes are harvested, they are processed into wine. Initially, the stem (or stalk) is removed due to the large amount of tannins contained within. Grape pomace is a fresh (65-68% water) and perishable product, and must be dried or ensiled if it cannot be fed immediately. Dried pomace can be mixed with small amounts of molasses to improve its palatability. Due to its high-fibre content (lignin), grape pomace is of low digestibility. It can be used to feed ruminants, in association with feeds having better nutritive value, but is not recommended for pigs and poultry as a source of energy and protein. Grape pomace can be fed fresh, dried, or ensiled before storage.

Aim of the study: Investigate the use of grape pomace as a dietary resource on performance of ruminants when fed dried grape pomace.

Methodologies: Grape Pomace (crude protein 13.3%; gross energy 16.79%; ether extract 6.47%; neutral detergent fibre 47.6%; acid detergent fibre 29%; acid detergent lignin 19.15%; dry matter (DM) 93.86%) was collected from Brenn-o-Ken, Wolseley in the Western Cape and brought to ARC-Irene for chemical composition and diet formulation. Dietary treatments (iso-energy) were: i) 50% grape pomace + 25% lamb pellets + 25% ground Lucerne hay (D1), ii) 60% Lucerne hay + 30% lamb pellets + 10% chopped pumpkin (D2), and iii) 50% D1 + 50% D2 (D3). These diets were fed to 24 indigenous bucks (± 20 kg live weight), with 8 bucks per treatment. Bucks were housed individually in metabolic cages and adapted for 14-days, with 7-days sample collection. Animals were fitted with harnesses and faecal collection

bags 3-days prior to the collection of faeces. Animals were fed *ad lib* and had free access to clean water. Feed intake was measured daily while faeces were collected during the last 7-days of the trial.

Results: Bucks fed the combination of D1 and D2 diets had higher ($P<0.05$) intake (1050 g/kg DM) compared to the other treatments (790 g/kg DM vs. 930 g/kg DM for D1 and D2, respectively). However, the digestibility of DM and protein was improved with D2.

Discussions: The improved digestibility of nutrients in bucks fed D2 might be related to the inclusion of chopped pumpkin, which supplies carotene that is convertible to vitamin A, or due to the lower tannin and ADL content. Chopped pumpkin played a significant role in the performance of the animals. Beta-carotene is an important precursor for synthesizing Vitamin A. The improved intake with combination of D1 and D2 did not result in improved nutrient digestion. This might be related to rumen gut fill.

Conclusions and recommendations: Combining D1 and D2 improved feed intake while D2 alone improved nutrient digestion.

Investigation into the precision feeding of Nguni cattle under feedlot conditions

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Background: The Nguni breed is well-known in South-Africa especially for their low production cost and ability to market a good grade carcass off the veld. Weaners are purchased by the feedlots and are then categorized into early-, medium- or late maturing breeds. The success of feedlots is dependent on the economical deposition of lean meat over an extended feeding period, on high final carcass mass, low fat coverage and conformation at slaughter. The Nguni breed is an early maturing breed. Feedlots discriminate against Nguni cattle and pay less per kilogram live mass than for other breeds.

Aim: To determine the most suitable ration for Nguni calves under feedlot conditions.

Methodologies: Nguni young male calves were sourced from 24 breeders from five provinces. The calves were divided into four groups of 50 animals per group. Each group were fed a different feeding regime. The rations fed was a starter (high roughage), grower (medium roughage), finisher (low roughage) and a feedlot grower commercial (low roughage) ration. These calves were backgrounded in the pre-conditioning phase for 30 days and received *ad lib* *Eragrostis* grass. After 105, 120 and 135 days these calves were slaughtered according to their weight, body condition and visual appearance.

Results: The low roughage group had the lowest average intake per animal per day, while the high and medium roughage groups had the highest average intake per day. Calves on the commercial ration did significantly better than the calves on the other rations for ADG (average daily gain) at slaughter (1.34 vs 1.24-1.27), total gain at slaughter (159.1 vs 147-

150), end weight (7 to 11 kg heavier) and carcass weight of 204 kg vs 196 – 198 kg for the other rations.

Discussion: Although the low roughage and commercial rations were more expensive per ton, the animals fed on them were the most profitable. The heavier the animal is when they arrive at the feedlot, the shorter the feeding period, the better the ADG and the heavier the carcass weight at slaughter. Nguni calves performed the best in the group with the most expensive ration (Low roughage and commercial rations) and also made the biggest profit due to the shorter feeding time and faster growth.

Conclusion and recommendations: Nguni cattle can be fed profitable in the feedlots with a low- and commercial roughage ration.

SMALL STOCK PRODUCTION

Evaluation of the nutritional potential of *acacia species* for indigenous farmers application on goat feeding at Port Saint Johns

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Background: Mortality rate in goat production systems in the Eastern Cape Province is about 40% of the total goats produced. Poor goat performance (growth) and mortality especially in winter has been associated to insufficient supply of nutrients, specifically proteins. Shrubs and trees are considered as potential feed sources for browsing and grazing ruminants especially in pastures where the quality is poor and quantity limited. Therefore application of alternative and relatively cheap and available sources of supplements such as *Acacia* species can play a major role in goat production systems for farmers in rural communities. However, the community farmers at Port St Johns in the Eastern Cape do not make use of these plants because of their lack of knowledge on its nutritional value.

Aim: The main aim of the study was to determine the nutritional composition of different *Acacia* species located at Port St. Johns as a potential feed supplement for ruminants.

Methodology: Seven different acacia Species (*A.karoo* (AK), *A.nolitica* (ANO), *A.nigrescens* (AN), *A.robusta* (AR), *A.erioloba* (AE), *A.ataxacantha* (AA) and *A.tortilis* (AT) were collected at Port St Johns rangelands. Leaves and mixture of Spines and Rachis were collected to determine dry matter (DM) content of these species, neutral detergent fiber (NDF), acid detergent fiber (ADF) and crude fiber (CF) were determined using Ankom fiber

analyser technology. Condensed tannin of *Acacia* species portions were determined using Acid butanol Assay while crude protein (CP) was determined using LecoTruspac nitrogen analyser.

Results: AN and AT leaves, spines and rachis mixture showed the highest ($P<0.05$) levels of dry matter than all other *Acacia Species*. NDF, ADL, ADF, CF & Hemicellulose for leaves were lower ($P<0.05$) than those of the mixture of spines and rachis. Spines and Rachis had the lowest ($P<0.05$) crude protein content than leaves across all acacia species. Crude protein for both leaves and mixture of spines and rachis varied ($P<0.05$) across all seven *Acacia* species. For leaves, AN had the highest crude protein content, followed by ANO and AK whereas for mixture of spines and rachis AR had the highest CP, followed by AA and AE.

Discussion: Lower fiber content across all *Acacia* species leaves confirmed the nutrient availability for ruminant's consumption of leaves as compared to spines and rachis. The difference in CP content of both leaves and spines and rachis is due to their genotypic variation not location difference as all plants were harvested in the same area. The results obtained complement other author's results that recommend *Acacia* species especially the leaves as a potential feed source for ruminants.

Conclusion/recommendations: Leaves of AN, ANO and AK are highly recommended for ruminants supplementation due to their high CP. However, *in vitro* and *in vivo* digestibility trials needs to performed to confirm its digestibility and nitrogen availability to small ruminants for proper recommendations on feeding procedure to community farmers at Port St. Johns.

Influence of dietary antioxidants supplementation on growth performance and oxidative status of intensively reared West African dwarf (wad) goats

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Adoption of compulsory intensive rearing methods (with no socialization) over the semi-intensive and extensive grazing in farm animals for higher yields might compromise both animal health and welfare and consequently increase the incidence of the metabolic and infectious diseases. This often leads to a poor immune system of the affected animals leading to build-up of pro-oxidants within the animals system. Oxidative stress sets in if the pro-oxidants are produced more than the biological system can tolerate. To combat the excess production in the animals system and to enhance optimum production, supplementation of dietary antioxidant supplementation is has been suggested as one of the ways out. Antioxidant vitamins and minerals like vitamin C, vitamin E and selenium have been reported to protect the biological system against the damaged caused by the reactive oxygen intermediate (pro-oxidants).

Growth performance and, oxidative stress biomarkers of intensively reared West African Dwarf (WAD) Goats. (n=30) are presented in this study.

Thirty intensively raised West African dwarf goats were divided into five groups of six animals per group and were randomly allotted to one of the five experimental diets: 0% of

dietary antioxidant, 200 mg/kg of feed of Vitamin E, 600 mg/kg of feed of Vitamin C, 200 mg/kg + 0.2mg/kg of feed of Vitamin E and Selenium, respectively, and 600 mg/kg + 0.2 mg/kg of feed of Vitamin C and Selenium, respectively. The animals were individually housed and offered the experimental diet. Performance characteristics and oxidative stress biomarkers were subjected to one way Analysis of Variance as contained in SPSS (2010). The goats were fed the concentrate diets at 4% of their body weight while *Enterelobium cyclocarpum* and water were fed *ad libitum*.

Dietary antioxidants supplementation increase ($P < 0.05$) the metabolic weight gain and daily weight gain except for those fed 600 mg Vitamin C/kg + 0.2 mg selenium /kg of Feed. Also, the oxidative status of the experimental goats was improved.

Vitamin E and selenium have been shown to play a role in growth, immune function enhancement, tissue integrity, reproduction, disease prevention, and as a biological antioxidant. These results confirmed the earlier report of several authors that dietary antioxidant supplementation can improve growth and oxidative status of goats.

Growth performance and immune functions of goats are enhanced through supplementation of dietary antioxidant like Vitamin E, Vitamin C with combination of Vitamin E and Selenium.

Effects of extensive and intensive conditioning on growth and gonadal characteristics in
South African Mutton Merino rams

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Background: Different practices for rearing and conditioning breeding rams for auction are used. Rams either enter veld ram clubs after weaning (e.g. on extensive pasture for 130 days, followed by intensive feeding for ca. 50 days), or intensive feeding until auction (usually 12 months of age). A previous study reported irreversible pathology of seminiferous tubules in bulls fed at a too young age. These histological changes decreased the fertility of bulls. Little is known about the effects of intensive feeding of young rams on their fertility and reproductive performance.

Aim: The present study investigated the effects of different feeding systems during the growing phase (five to 12 months of age) on gonadal development and fertility of South African Mutton Merino rams.

Methodologies: Three dietary treatments representing different production systems were evaluated, namely a control (rams kept on pasture only), treatment one (feeding in typical veld ram clubs) and treatment two (intensive system, where rams were fed a concentrate diet from the beginning of the trial). All growth, anthropometric and scrotal parameters were measured and semen quality was assessed. After the animals were slaughtered, the testes were dissected followed by histopathology.

Results: There were significant differences between the three conditioning groups in terms of final growth and anthropometric measurements. Subcutaneous fat and carcass fat differed

($P=0.000$) between the three conditioning groups, with intensively fed rams containing most fat. Final scrotal circumference differed ($P=0.02$) between the rangeland ($32.7 \pm 2.49\text{cm}$) and intensive groups ($34.6 \pm 2.81\text{cm}$). Scrotal mass and scrotal fat mass differed between the conditioning groups ($P=0.000$). Rams in the intensive group had the heaviest scrotal mass, but the rangeland-intensive combination group contained most scrotal fat. Scanned scrotal fat differed ($P=0.000$) between the conditioning groups and showed that the rangeland-intensive combination group had the most fat. The volume of semen produced differed ($P=0.013$) between the rangeland-intensive combination group ($2.27 \pm 1.02\text{ml}$) and the intensive group ($1.63 \pm 0.70\text{ml}$). Percentage normal sperm differed ($P=0.000$) between the rangeland group ($69.0 \pm 20.04\%$) and both the rangeland-intensive combination group ($81.7 \pm 9.88\%$) and the intensive group ($83.0 \pm 10.09\%$). Initial scrotal circumference (SCI) correlated negatively with the percentage normal sperm of the intensive group ($P=0.045$, $r=-0.766$), while the rangeland group showed a positive correlation ($P=0.007$, $r=0.820$). In intensively fed rams, subcutaneous fat (which closely reflects body fat content) correlated negatively with semen volume ($P=0.009$, $r=-0.882$).

Discussion: In accordance with other studies the present results show that hypernutrition, especially from a younger age, improves the animal growth, but with possible adverse effects on semen quality and hence fertility. The different correlations between SCI and percentage normal sperm for the rangeland and intensive groups suggest that the growth hormone cascade may have an influence on the gonadal axis.

Conclusions and recommendations: Intensive feeding of young rams benefits growth and fertility, provided that rams are not overfed from a young age. Feeding programs should monitor semen quality, scrotal fat accretion and carcass fat accretion.

Determination of proportion of feed consumed as an index for feed preference in sheep

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Background: Forage in rangelands vary in physical and chemical attributes with season and there is a noticeable underperformance during dry season (winter) than in wet season. During winter when there are reduced feed intake levels of already poor quality forages by ruminants due to erratic rainfall, supplement feeds (e.g. straws) are needed to sustain animals at least at maintenance level or minimal growth and production.

Aim (-s): Is to determine whether feed preference is influenced by both (a) feeding sheep in group relative to individuals and (b) removal of one feed (e.g. *Sorghum bicolor*) in offered feeds.

Methodologies: Experimental feeds were veld hay (VH), sorghum stover (SS), maize stover (MS), Lucerne (LH) and bean straw (BS). Three feeds (MS, SS and VH) were fed *ad-libitum*. LH and BS were fed in restriction of 0.15, 0.350 kg/day per sheep, respectively. LH was restricted to avoid overconsumption, which may lead to bloat; together with bean straw both gave supplementary protein. Twelve clinically healthy *Ovis aries* (Dohne merino sheep) with mean weight of 29.7 ± 4.63 kg were assigned to 3 treatments (G, I and R) in the trial. In G, all five feeds in five troughs were given to sheep fed in a group. In I, all five feeds fed to sheep penned in isolation and in R, four feeds with SS removed were fed to sheep penned in isolation.

Results: Proportion of BS, VH, LH and MS did not differ between sheep in G and I, however sheep in I consumed less SS ($p < 0.04$) in their diet than in G. Diet compositions were similar ($p > 0.05$) in the proportion of BS, VH, LH, and MS between sheep in R and I.

Discussion and Conclusion: Decreased proportion of SS consumed by sheep in I relative to sheep in G may be due to social facilitation behaviour and poor selection order usually observed in animals fed in groups with individuals less than five. Similarity in proportion of these dietary ingredients between R and I may be due to less preference of SS, therefore its removal did not influence their preference.

Knowledge and perception of small holding farmers on feeding sweet potato vines to goats

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Background: Goats in rural communities are often raised in conditions which do not allow them to achieve optimum performance nor express their genetic potential. They are raised on poor quality feeds, with low energy and protein content. For goats to perform to their full potential, it requires high nutritious feed especially in winter or high producing periods. However, commercial supplements such as fresh green feeds, protein blocks or vitamin can assist, but are often expensive. The need for cost-effective, indigenous crop residues, such as groundnut haulms and sweet potato vines, are encouraged.

Aim: This study assesses the knowledge and perception of goat farmers concerning feeding sweet potato vine to goats.

Methodology: A survey was conducted at KwaMthethwa community area, KwaMbonambi local Municipality, KwaZulu-Natal, consisting of seven wards. The survey was administered through a semi-structured questionnaire and 15 households were interviewed per ward, thus n=105 participants. Participants were randomly selected at their willingness to participate. Data was analysed using frequency procedure of SPSS 24 (2016).

Results: Results of this study showed that 56.2% of respondents were males and 43.8% were female, demonstrating male dominion in the farming sector. Results also revealed that 71.4% of households keep goats for socio-cultural purposes e.g. traditional functions and status,

whereas 15% and 9% is reared for income generation and consumption, respectively. Farmers (71.4%) were aware and do practice some sort of supplementary feeding. Supplementary feeds were either bought (34.3%), represented crop residues (26.7%) or represented indigenous trees (9%). Farmers (72.4%) cultivated sweet potatoes for different purposes such as generation of income (53.3%), consumption (27.5%) or both (8%) while 16% were not cultivating. Sweet potato vines were being discarded as waste or burnt, left on the field as manure, conserved as propagation material or fed to livestock by 32.4%, 25.7, 8.6% and 7.6% of the respondents, respectively. However, most of the participants (78.1%) rejected the use of vines as feed. Some farmers (48.4%) use traditional methods as anthelmintic, 30.6% do not treat, 19.4% use drugs and 1.6% use both drugs and traditional medicine.

Discussion: Domination of males in livestock production sector is still high and often reared livestock for socio-economic purposes, which concur with other previous studies. Most farmers seem to know about supplementation but have little understanding concerning the concept of supplementation, since most were giving maize to goats every afternoon for goats to come back for kraaling in the afternoons without herder. Sweet-potato vines are not fed because they assume that it causes fatal diarrhoea to goats which may not be true if they are aware of the right proportion of supplementation. Farmers use traditional plants in supplementation and curing diseases in livestock, which had been reported in several studies.

Conclusion: Apparently, the majority of farmers have heard or do some sort of supplementation, but lack basic knowledge on the importance of indigenous forages. Furthermore, there is a need to educate farmers on supplementary feeding of indigenous forages.

Histopathology changes in liver and kidney of yearling male pedi goats fed varying levels of
Vachellia karroo leaf meal in *Setaria verticillata* grass hay-based diet

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Background: *Vachellia karroo* (*Acacia karroo*) is becoming an increasingly important source of protein supplement for ruminants in animal nutrition. The only limitation to the use of this fodder tree is the presence of phenolic compounds, such as condensed tannins. A large intake of tannins may cause gastrointestinal irritation, kidney and liver damage.

Aim: A study was conducted to investigate the effects of tanniniferous *V. karroo* leaf meal feeding on the liver and kidney of yearling male Pedi goats fed a basal diet of *Setaria verticillata* grass hay.

Methodologies: Thirty yearling male Pedi goats, weighing 16.7 ± 3.2 kg, were allocated in a completely randomized design to five dietary treatments containing *V. karroo* leaf meal inclusion levels at 20 % (S80A20), 25 % (S75A25), 30 % (S70A30), 40 % (S60A40) and 50 % (S50A50) of the total diet. These inclusions include low and high condensed tannin levels as indicated in the literature. Each treatment had six replicates with one goat per replicate. The goats were raised from 1 to 40 days on a normal goat's diet consisting of 14 % CP and hay. The preliminary period was from 41 to 52 days of age while the collection period was from 53 to 60 days of age. The goats were housed in individual holding pens and offered the experimental diets once a day at 08h00. Feed intake was recorded on a daily basis during the collection period. The goats were weighed three times, at the start of the experiment, on day

53 and on the 60th day when data collection ended. All the animals were slaughtered humanely for histological analysis of the liver and kidney at the end of the experiment. Liver and kidney samples from each goat were collected and preserved in 10 % neutral buffered formalin for 24 h. From each sample, 60 – 65 µm sections were cut and mounted on glass slides before staining with haematoxylin and eosin. Slides were examined under light trinocular microscopy at 400X. Each slide was photographed with a DVC digital camera mounted on a BH-2.

Results: Daily dry matter intakes were similar across the dietary treatments, ranging from 638 to 786 g per goat. Similarly, dietary treatments had no effect on the final live weights and average daily gains of the goats. No histological alterations were found in the liver of goats on diets containing 20, 25 or 30 % leaf meal. Increased hepatocyte degradation was seen in goats fed 40 or 50 % leaf meal. Tubular necrosis was absent in the kidneys of goats fed diets containing 20, 25 or 30 % leaf meal while those on diets having 40 or 50 % leaf meal showed moderate renal nephrosis.

Discussion: Results are in agreement with other studies with tanniniferous diets. Higher *V. karroo* leaf meal inclusion levels of 40 or 50 % tended to adversely affect both the liver and kidney of indigenous Pedi goats.

Conclusion/recommendations: It is concluded that *V. karroo* leaf meal inclusion levels of 20 to 30 % did not cause any adverse effects in the liver and kidney of goats. These levels are thus recommended. Further studies are recommended to confirm these results.

Preliminary investigation of the response of sheep to high ambient temperatures

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Background: Climate change and its effect on agriculture is a growing concern. The consensus opinion is for average temperature to increase, resulting in hotter and dryer conditions. The impact of such changes on animal production and welfare is not well understood. Specific animals may have adapted to tolerate the hotter conditions foreseen. A clear measure is also required in order to determine how tolerant animals are to high temperatures.

Aim: To investigate the respiratory or panting response of different sheep breeds at temperate (<30°C) and hot (>30°C) ambient temperatures.

Methodologies: Studies were conducted on Langgewens research farm in the Swartland district (Western Cape), where it is common for the diurnal maximum temperature to exceed 33°C during the summer. An initial trial was conducted to determine the homeothermic response of seven sheep breeds (12 ewes per breed), namely Dohne, Dormer, Dorper, Meatmaster, Merino, South African Mutton Merino (SAMM) and White Dorper, by monitoring individual eye temperature using thermal imaging as well as respiration rate. A second study was performed to further assess the respiration rate of Dohne and Merino ewes (35 per breed). Respiration rate was determined by counting flank movements over a 30

second interval and then expressed as breaths per minute (bpm). Sheep were monitored during the cooler mornings and warmer afternoons over a three day period in both studies. The ambient temperature was grouped into four temperature ranges to analyse the data along with breed as main effects, using the GLM procedure of SAS.

Results: The first trial revealed that both temperature range and breed influenced the respiration rate of sheep ($P < 0.001$). The respiration rate was higher at temperatures exceeding 30°C, with Merino, Dormer and Dohne ewes exhibiting the highest average respiration rates (114, 112 and 103 bpm). Eye temperature was accordingly higher at ambient temperatures exceeding 25°C. The second trial revealed no differences in respiration rate between the Dohne and Merino ewes. Again respiration rate was seen to differ with temperature range, with the lowest respiration rate being achieved at temperatures below 25°C (48 bpm) which increased with temperature, resulting in sheep panting at an average of 149 bpm at temperatures higher than 33°C.

Discussion: Respiration rate increased as temperatures increased, with the response becoming more pronounced when temperatures exceed 33°C. Hair breeds, such as the Dorper or Meatmaster, appeared to be more tolerant to changes in temperature below 30°C, as they maintained lower respiration rates and eye temperatures at these temperatures.

Conclusions and recommendations: Further research is needed to determine how temperature influences the welfare and productivity of sheep. An easily recorded indicator trait such as respiration rate should be assessed as a tool to improve within-breed heat tolerance by selection.

Phenotypic characterisation of tankwa and unimproved indigenous goats

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Background: For the conservation and improvement of indigenous animals, phenotypic characterisation should be a first step to be undertaken before the use of their genetic material. Such characterisation provides information on the identification of unique characteristics within different populations.

Aim: The aim of this study was to characterise and compare phenotypic characteristics of unimproved indigenous and Tankwa goats.

Methodologies: Phenotypic characteristics of 44 unimproved indigenous and 41 Tankwa goats were assessed. Body measurements were assessed with the aid of a flexible tape, body weight was determined by using a weighing scale and body temperature was determined by using a thermometer (quantitative characteristics). The qualitative characteristics were assessed through visual appraisal. Body condition score was assessed based on a scale of 1 to 5. The age of the males was estimated by counting the number of incisors. Qualitative data

were analysed using Microsoft Excel and summarised as percentages. Quantitative data were analysed using GLM procedures of the Statistical Analysis Software. LS-means were compared using the LSD test ($\alpha = 0.05$).

Results: Body condition of unimproved indigenous goats (98 %) was more satisfactory when compared to that of Tankwa goats (74 %). None of the Tankwa goats had ticks under their tails while 53 % of unimproved indigenous goats had ticks under their tails. Most of the Tankwa goats had single or two colours as their main colours. Both goats' types had high proportion of moderate necks, brown eyes, average eye width and mouth shape. Moreover, unimproved indigenous goats had beards with no toggles. On the other hand, 92 % of Tankwa goats had beards and 90 % of them did not have toggles. Tankwa goats' horns and hooves were more damaged when compared to those of unimproved indigenous goats. Tankwa goats had higher body weight, length, height and depth, horns sizes, rump width, hind leg width, length, length below hock and knee, tail length, heart girth and testicular circumference when compared to unimproved indigenous goats. Unimproved indigenous goats' body temperature (40.3 °C) was higher when compared to Tankwa goats (38.5 °C).

Discussion: It was observed that, Tankwa goats had higher body weight, length, height and depth, horns sizes, rump width, hind leg width, length, length below hock and knee, tail length, heart girth and testicular circumference when compared to unimproved indigenous goats. Most of the differences observed between Tankwa and unimproved indigenous goats seems to be due to genetics, environmental factors (i.e. rainfall and temperature) and management factors (i.e. health practices and feeding systems).

Conclusion and recommendations: The phenotypic characteristics (qualitative) were comparable between unimproved indigenous and Tankwa goats. However, phenotypic characteristics (quantitative) of Tankwa goats were higher, with the exception of body

temperature. To avoid crossbreeding of Tankwa goats, it is recommended that they should be kept separate from other indigenous goat breeds, since some of their characteristics are unique.

The influence of breed and genotype on sperm subpopulation traits

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Background: The presence of sperm subpopulations within ejaculates may be considered as indicators of ejaculate quality. Heterogeneity of sperm subpopulations may potentially have functional relevance, with differences between sperm subpopulations linked to fertility. Subpopulations may form due to variation in sperm structure formation related to genotypic influences during spermatogenesis. Hypothetically, breed and genetic selection may influence the structure and distribution of subpopulations within a given sample.

Aim: To characterise the sperm morphometric subpopulation profile of Merino and Dorper rams, and to investigate the influence of breed and selection for prolificacy on sperm subpopulation profile.

Methodologies: Ethical approval reference: SU-ACUD15-00083. Trial animals (Dorper=6; Merino HL=6; and Merino LL=6) were maintained under uniform conditions, and semen samples were collected by means of electro-ejaculation. Fifty-four ejaculates were collected during three consecutive weeks, with sampling carried out three days per week, and six rams being sampled per day. Samples were evaluated according to standard macroscopic and microscopic sperm evaluation protocols. Sperm morphometric traits were analysed using ImageJ® open software. The PROC GLM procedure of SAS 9.3 and analysis of variance

(ANOVA) were used to determine the effect of breed and genetic selection on the structure and distribution of sperm subpopulations, and differences between breeds and genetically diverse lines. A non-hierarchical analysis using the k-means cluster model was performed to identify clusters, and multivariate k-means cluster analysis was performed to classify sperm to a specific subpopulation according to morphometric characteristics.

Results: Merino rams produced samples with higher sperm concentrations than the Dormer rams. Merino rams had in absolute terms, a lower mean percentage of sperm abnormalities, and a higher mean percentage of intact acrosomes, compared to Dormer rams. Selection for prolificacy did not affect sperm quality. Four distinct sperm subpopulations (S1, S2, S3 and S4) were identified for both Dormer and Merino rams. Breed did not influence subpopulation profile. However, subpopulation analysis of the HL and LL rams indicated minor differences in certain morphometric characteristics between subpopulations. No significant differences were found in the distribution of subpopulations between the two genetically diverse lines.

Discussion: The study is the first report on Dormer ejaculates in terms of sperm abnormalities and acrosome integrity, and also of a breed comparison based on sperm morphometric characteristics. The absence of a breed effect on sperm subpopulation characteristics may suggest that subpopulations are quite robust across genotypes. Each subpopulation, within a breed, differed significantly and represented a different sperm head phenotype. Results from this study corroborate certain studies, but are also contradictory to other studies on sperm subpopulation profile.

Conclusions and recommendations: Breed did not influence sperm quality characteristics or the sperm morphometric subpopulation profile. Research is warranted to standardize the classification of sperm subpopulations according to morphometric traits to elucidate on the relationship between subpopulation structure and the fertilizing ability of ovine sperm.

Fertilizing ability of sperm obtained from dormer and merino rams, as influenced by
subpopulation traits

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Background: Sperm binding assays are considered a valuable tool to assess sperm fertilizing potential in several species. The fertility of a ram can be assessed *in vitro* by quantifying the ability of its sperm to bind to and penetrate the *zona pellucida* of an oocyte. Studies reported that sperm subpopulation structure of ejaculates is highly correlated with *in vitro* and field fertility of males. Limited information, however, is available on the effect of breed/line of rams on sperm subpopulation composition and distribution, fertilizing ability and the correlation of specific subpopulations with fertility.

Aim: This study investigated the influence of breed and of selection for prolificacy in Merinos on the fertilizing ability of frozen-thawed sperm with an *in vitro* sperm-binding assay.

Methodologies: Ethical approval reference: SU-ACUD15-00083. Trial animals (Dormer=6; Merino HL=6; and Merino LL=6) were maintained under uniform conditions, and semen samples were collected by means of electro-ejaculation. Fifty-four ejaculates were collected during three consecutive weeks, with sampling carried out three days per week, and six rams sampled per day. Samples were evaluated according to standard macroscopic and

microscopic sperm evaluation protocols. Sperm morphometric traits were analysed using ImageJ® open software. Semen samples were diluted to an end concentration of 300x10⁶ sperm/mL, and equilibrated for 1.5h. Two straws were loaded per ram per collection, cryopreserved and stored for a month. After the assessment of post-thaw sperm viability and morphology, samples were subjected to a perivitellin membrane (PVM) binding assay. Correlations between sperm binding capacity of frozen-thawed sperm and sperm morphometry of fresh sperm were assessed using linear regression to derive Pearson's correlation coefficients.

Results: Merino sperm bound more successfully to the egg PVM than Dorset sperm. The mean number of sperm bound to the PVM tended to differ between the HL and LL rams ($p=0.058$) in favour of the HL. The mean number of sperm bound to the PVM varied significantly between rams within breeds and lines. No significant correlation between sperm binding capacity and sperm morphometric subpopulations was observed.

Discussion: Putative differences in seminal plasma protein content may have contributed to the binding difference observed between the Dorset and Merino sperm. Plasma proteins are considered as potential key regulators of sperm functionality. Dorset sperm may undergo capacitation at a slower rate than Merino sperm, as reflected by the lower binding capacity. Sperm from the HL possibly had larger acrosome coverage, which may explain the tendency of HL sperm to bind better than LL sperm. Acrosome enzymes are essential for the lysis of the *zona pellucida* and the penetration of the *corona radiata* of the oocyte.

Conclusions and recommendations: There were some evidence of breed/line variation in the PVM sperm-binding assay. The standardization of the classification of the sperm morphometric traits and the relationship with field fertility of rams should form the basis of future studies involving a larger sample size to confirm or refute the present results.

The effect of feed supplementation on the productivity of autumn- and spring-born
replacement ewe lambs

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Background: Weaned ewe lambs are one of the most important assets of the small stock producer. It is therefore essential to ensure that replacement ewes grow out and develop optimally, as this will determine their lifetime production and reproduction potential.

Aim: The aim of this study was to determine the effect of feed supplementation from weaning until first mating on the productivity of autumn- and spring-born replacement ewe lambs under natural veld conditions.

Methodologies: The project was conducted with Merino sheep on two farms in the Trompsburg (semi-arid grassland) and Graaff-Reinet (grassy dwarf shrubland) districts. Autumn- and spring-born ewe lambs were used at both localities. At each locality and for each season, 200 replacement ewe lambs were divided into two equal groups (Control and Treatment) after weaning. The animals of the two groups grazed separate camps, comparable in size and veld quantity and quality. The Control groups were treated according to the existing management program on the farm, while the Treatment groups received a commercial, pelleted supplement (250 g/kg crude protein, 8.1 MJ/kg ME) on a continuous basis from weaning (4-5 months of age) until first mating (17-18 months of age). Body weights from weaning until first mating and fleece traits for the first, second and third shearing were recorded at both localities.

Results and Discussion: Supplementary feeding from weaning until first mating increased the body weight change of the ewe lambs of the Treatment groups, compared to the Control groups, for both the autumn- (19.02 ± 0.20 kg *vs.* 15.90 ± 0.20 kg; $P < 0.0001$) and spring-born lambs (10.10 ± 0.25 kg *vs.* 9.26 ± 0.24 kg; $P = 0.0143$). The autumn-born ewes of the Treatment groups produced more wool than the ewes of the Control groups at the first (3.18 ± 0.03 kg *vs.* 2.96 ± 0.03 kg; $P < 0.0001$), second (3.23 ± 0.03 kg *vs.* 3.01 ± 0.03 kg; $P < 0.0001$) and third shearing (3.26 ± 0.03 kg *vs.* 3.06 ± 0.03 kg; $P < 0.0001$). However, no differences in wool production were observed in the spring-born animals. Supplementary feeding increased wool fibre diameter (19.33 ± 0.09 μ m *vs.* 19.71 ± 0.09 μ m; $P = 0.0042$) and staple length (72.26 ± 0.61 mm *vs.* 74.47 ± 0.62 mm; $P = 0.0100$) and decreased coefficient of variation of fibre diameter ($18.55 \pm 0.14\%$ *vs.* $18.09 \pm 0.15\%$; $P = 0.0228$) in the autumn-born animals, but no differences in these wool characteristics were observed in the spring-born animals. It would therefore appear that the effect of supplementation on growth rate, wool growth and wool characteristics was more pronounced for the autumn-born replacement ewe lambs than for the spring-born lambs.

Conclusions: The results of this study indicate that the supply of higher levels of supplementation to replacement ewe lambs from weaning until first mating had a positive effect on their production under natural veld conditions, especially for autumn-born lambs, weaned at a relatively low body weight. It would, therefore, appear that supplementation of replacement ewe lambs weaned at a lower body weight will have a greater beneficial effect on their lifetime production, compared to lambs weaned at a higher body weight.

Use of the wool buyers' fault reports to address the incidence of contamination and faults in
the South African wool clip

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Background: The wool price are determined by a number of factors and contamination as well as classing faults are some of the price determining factors. The South African wool is sought after and the clip is generally well classed. Contamination and classing mistakes convey a very negative image of the South African clip.

Aim: To determine the trends of the faults reported by wool buyers over a six year period from 2010 to 2016 and to put measures in place to curb these negative trends

Methodologies: The official Clip Fault reports published by Cape Wools SA were used in this analysis. The number of incidences was recorded and trends over this period were calculated. The effect of these faults on the wool processors were also investigated.

Results: The main faults reported were mixed lengths, polypropylene and plastic, paint and marking ink, Kemp fibre contamination and black hair. Mixed lengths increased over the seasons from 2010-11 to 2013-14 (205 to 929 incidences) thereafter it started to decrease over the next two seasons (811 to 311 incidences). The incidence of polypropylene and plastic increased dramatically from the 2010/11 season to the 2013/14 season (49 to 1297 incidences). The industry then introduced a fine for this type of contamination and this contamination decreased to 1228 in the 2014/15 season to 811 in the 2015/16 season. Paint and marking ink contamination constantly decreased over this period (368 to 59 incidences).

Kemp steadily increased over this period (6 to 65 incidences) and black hair also increased over this period from 12 to 98 incidences

Discussion: A big effort was made to bring the mixed lengths fault under the attention of wool producers and classers. The shearers' skill level plays a big part in reducing the incidence of mixed lengths. Polypropylene and plastic contamination reduced when a fine for this type of contamination were introduced. Kemp and black hair contamination occurs when crossbreeding with breeds with this fibres occur.

Conclusion/recommendations: Wool fetch very high prices and the South African clip is sought after. It is important to guard against these contamination to maintain the competitive advantage of the South African clip.

Lambing pattern changes in communal sheep during and subsequent to hormonal
manipulation

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Background: It has been established through several surveys and studies that peak lambing season in the communal areas of the Eastern Cape is around June and July, which coincides with poor grazing quality, quantity, extreme weather conditions and subsequent high lamb mortality rates. Medroxyprogesterone acetate treatment has been found to be effective in delaying conception in these ewes. However, it is not known whether there is a residual effect in the next production cycle after discontinuation of hormonal treatment

Aim: In this study the effect of Medroxyprogesterone acetate treatment around the time of potential seasonal cyclic activity on conception delay and subsequent lambing patterns was evaluated.

Methodologies: Communal ewes from two different flocks within the same community were used in the study. In production cycle 1, randomly selected ewes from each flock were treated with 150 mg Medroxyprogesterone acetate (Depo-Provera, Pfizer) during mid-November (Treatment)(N=60) and the rest of the ewes from these flocks (N=200) were used as a control. Ewes were exposed to an open mating season as traditionally practised in communal areas. Ultrasound scanning and physical examinations were performed on a monthly basis from March to October to determine the reproductive status. In production cycle 2, hormonal treatment was discontinued to assess if there was any residual effect on lambing patterns.

Results: In production cycle 1 the treatment resulted in a cumulative lambing percentage of 1.7; 1.9; 24.6; 39.6 and 54.9 during the months of June, July, August, September and October respectively. The control group (rest of the flock) had a 65.3; 78.9; 81.4; 72.9 and 64.3 percent cumulative lambing rate during the same period. The treatment group differed significantly ($p < 0.05$) from the control during June, July and August. After discontinuation of treatment (production cycle 2), the previously treated group had a cumulative lambing percentage of 58.3; 79.3; 89.5; 74.6 and 87.0 for the months of June, July, August, September and October respectively. During the same period, the control group had a cumulative lambing percentage of 48.9; 63.4; 74.5; 54 and 83 percent. There was no significant difference in cumulative lambing rate between the group treated in the previous production cycle and the control during production cycle 2.

Discussion: Medroxyprogesterone acetate treatment, if administered at the stipulated dosage and time, had a definite effect in delaying the onset of the lambing season in communal ewes. However, when this treatment was discontinued in the next production cycle, the ewes reverted back to non-treated lambing patterns. There was no residual effect and the later lambing in the previous cycle did not alter the pattern in the next production cycle.

Conclusion and Recommendations: Medroxyprogesterone acetate does have an effect on lambing patterns in communal sheep. However, it needs to be administered annually at a specific time and dosage to have a lasting effect.

Extra dietary vitamin E and selenium as a mitigation strategy against social Growth
performance and meat quality stress in Dohne Merino lambs

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Housing-induced social stress has the potential to negatively influence carcass characteristics and meat quality parameters in sheep. This study investigated the effect of social stress, as induced by single-pen (isolated) and paired-pen (socially interacting) housing, and extra dietary antioxidant (vitamin E-Se) supplementation, on growth performance, carcass and meat quality characteristics of twenty four Dohne Merino lambs (25.8 ± 2.7 kg). Lambs were randomly assigned to the following four treatment combinations in a completely randomized design: 1. single-pen housing (solitary confinement) with no extra vitamin E-selenium supplementation, 2. single-pen housing (solitary confinement) with extra vitamin E-selenium supplementation, 3. paired-pen housing with no extra vitamin E-selenium supplementation, and 4. paired-pen housing with extra vitamin E-selenium supplementation.. The animals were slaughtered at the end of the 60-day feeding trial to determine carcass and meat quality characteristics. Dietary supplementation of Vit E –Se significantly ($P < 0.05$) increased the feed intake, weight gain, metabolic weight gain. In addition. the interaction between the housing type and Vit E –Se supplementation significantly ($P < 0.05$) influenced feed intake, weight gain and metabolic Paired lambs had higher ($P < 0.05$) slaughter weight and dressing out percentage, weight gain. compared to those housed individually. However, housing had no effect ($P > 0.05$) on hot carcass weight, cold carcass weight, carcass conformation, fat score, carcass length, and temperature, water holding capacity, meat color, shelf life colour and ultimate pH (pHu). Dietary vitamin E

and selenium supplementation reduced ($P < 0.05$) drip loss (0.42 %) in meat from paired lambs. Supplementation increased slaughter weight, dressing percentage and pHu. Meat colour was also influenced ($P < 0.05$) by vitamin E-Se supplementation. A significant ($P <$

0.05) vitamin E-Se supplementation \times housing interaction was also observed for drip loss (%) and carcass length. Lambs housed in single pens had shorter ($P < 0.05$) carcass length compared to the paired lambs. It was concluded that housing had no influence on most of carcass and meat quality traits but vitamin E-selenium affected most meat quality parameters.

Key words: Growth performance, vitamin E, selenium, carcass characteristics, meat quality

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Introduction: In the previous years, the curiosity on developing breeding strategies for indigenous genetic resources conservation increased. The conservation of Nguni sheep is recommended at the small stock animal genetic resources bank. The genetic diversity within Nguni sheep breed should be improved as a baseline to preserve its unique genetic resource.

Aim: To investigate the genetic relationships among Nguni-type sheep based on Ovine50K Single Nucleotide Polymorphism markers.

Methodology: A total of 141 samples were selected from distinct individuals in each of three Nguni-type sheep breeds (Swazi, Zulu and Pedi) along with Namaqua Afrikaner, Damara and Dorper used as the control population. DNA from blood samples was extracted using the Qiagen DNeasy extraction kit and genotyped using the ovine50K SNP chip. PLINK software was used for data quality control (QC) measures. Samples rejection at the low genotyping call rate were set <90%, while SNP positions were removed based on average call rate per SNP (Geno <95%), minor allele frequency (MAF<0.05) and lack of Hardy-Weinberg Equilibrium (HWE p-value<0.001).

Results: 48 429 SNPs remained from a total of 54 241 SNPs for further analysis after QC. Expected heterozygosity (*He*) ranged between 0.28 (Namaqua Afrikaner) and 0.34 (Swazi),

while observed heterozygosity (H_o) varied between 0.21 (Damara) and 0.38 (Swazi). The Pedi sheep was clearly discriminated from other Nguni populations based on the PCA (principal component analysis).

Discussions: PCA also clearly revealed a distinction between Namaqua Afrikaner sheep and other populations. Low levels of admixture between populations were demonstrated in STRUCTURE analysis. The results obtained correlates with the finding of previous studies whereby Zulu and Swazi sheep were found closely related to Swazi sheep. The Pedi sheep population indicated a distant relationship from other Nguni sheep.

Conclusion: The findings of this study demonstrated that the Nguni sheep populations has a moderate level of genetic difference. However; Pedi sheep population demonstrated a distant cluster from other Nguni populations. The genetic evidence attained from this study will form the basis for future management strategies/programs of the pure Nguni-type sheep breeds.

Keywords: Nguni sheep, genetic diversity, conservation, SNP genotyping

Merinos producing coloured wool – Impediment or opportunity?

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Background: The occasional occurrence of lambs with pigmented fleece is a major concern in the traditional white wool Merino industry. However, in an environment where natural fibres are favoured, coloured wool may be highly sought after by small-scale processors. Limited local research has been done on wool from coloured Merinos as a potential valuable commodity.

Aim: Identification of genetic variants associated with pigmentation, quantification of objective wool colour traits, and to determine the desirability of pigmented fine wool for small-scale processors.

Methodologies: The *Agouti Signalling Protein (ASIP)* gene of 54 fine-wool (18.8 µm) Merinos were screened for known and novel polymorphisms. Repeated records (72-100) of pigmented fleeces were assessed for objective colour. Three to six measurements were taken on the surface of wool staples to determine lightness (L*: 0 = black; 100 = white), redness (a*: positive = red; negative = green) and yellowness (b*: positive = yellow; negative = blue). A repeated records model in ASReml was used to assess the fixed effects of year, age and subjective wool colour on objective colour. Repeatability was estimated from the between-

animal variance components. The desirability of pigmented wool was assessed by obtaining survey data from 22 small-scale wool processors.

Results: A duplication of *ASIP* and its promotor was associated with white fleece colour, while a single copy of the gene was present in the majority (86.7%) of pigmented individuals. A novel A>G SNP polymorphism in intron 2 was putatively associated with pigmentation. Least-squares means for L*-values were 15.7 ± 1.4 for black fleeces, 24.9 ± 2.3 for pied fleeces, 26.3 ± 2.7 for charcoal fleeces, 28.5 ± 3.5 for grey fleeces and 55.1 ± 1.4 for sandy fleeces. Corresponding means were respectively 2.56 ± 0.17 , 3.85 ± 0.28 , 4.03 ± 0.28 , 3.12 ± 0.43 and 2.89 ± 0.17 for a*-values and 5.48 ± 0.4 , 7.26 ± 0.7 , 7.53 ± 0.8 , 5.78 ± 0.8 and 11.74 ± 0.4 for b*-values. Derived repeatability estimates were 0.73 ± 0.10 for L*, 0.76 ± 0.08 for a* and 0.53 ± 0.14 for b*. All surveyed respondents were positive towards obtaining and working with pigmented wool. The majority (86.36%) preferred fine or superfine pigmented wool suitable for spinning and processing into apparel. Most respondents (54.51%) indicated that a large variety of colours and rare colours, such as grey, were desirable.

Discussion: The absence of known polymorphisms for pigmentation in pigmented individuals, indicates that additional polymorphisms may be involved with pigmentation. Colour measurements suggested clearly identifiable shades of coloured wool. All colour traits were repeatable, suggesting that early assessment of wool colour would persist in subsequent clips. Initial results indicate that local small-scale wool processors have a positive outlook towards processing pigmented wool.

Conclusions: Small-scale wool processors could utilise the clearly identifiable shades of coloured wool together with white wool to produce multi-coloured products without the need for dyeing. Further study of genic variation of wool colour will allow a better understanding

of its inheritance. The interest of local small-scale processors in pigmented wool warrants further surveys regarding consumer acceptance and economic feasibility.

Assessment of instantaneous intake rates of three *Cajanus cajan* browse varieties by nguni
goats in the subtropical region of South Africa

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Background: During prolonged dry seasons, browse foliage provides supplementary protein and energy, particularly when grasses and available forages have low nutritional value. This results in reduced voluntary feed intake and low digestibility in ruminants. An understanding of the variation in browse instantaneous intake rate (IIR) is thus desirable, especially in semi-arid regions where browse shortages are prevalent.

Aim (-s): To evaluate IIRs of three *Cajanus cajan* browse varieties by Nguni goats in the subtropical region of South Africa.

Methodologies: The IIRs of three *C. cajan* browse varieties (ICEAP 00557 (Cv1), ICEAP 01514 (Cv2) and CIMMYT 100/01 (Cv3) was studied using cafeteria-style trials by mounting a branch vertically on a 45 cm long stake driven 15 cm into the ground in a feeding pen (16 m x 7 m). Observations were made for a period of 6 minutes. Six weaned Nguni goats (20.2 kg) were randomly selected from a flock of twenty-four. During the trial, six goats were individually penned and allowed to feed in the morning. Each goat was offered a single browse variety daily. The trials were conducted for three days between 9:00 am and 12:00 am. The number of bites counted during feeding and time spent were used to calculate bite rates (bites/min), while bite sizes (g/bite) were calculated from initial and residual branch

mass divided by the number of bites. The browse preference index (PI) of varieties was calculated from the ratio of IIRs of each *C. cajan* variety.

Results: The different drought tolerant *C. cajan* varieties had no effect ($P>0.05$) on the IIR, 0.0275 ± 0.0089 , 0.0275 ± 0.0077 and 0.0409 ± 0.0109 for Cv1, Cv2 and Cv3, respectively. Day of trial and plant variety had an effect ($P<0.05$) on bite rate. However, day of trial had no significant effect ($P>0.05$) on both bite size and instantaneous intake rate. Individual goat had a significant effect ($P<0.05$) on bite rate. The result also revealed a weak positive correlation ($r= 0.30$) between intake rate and bite size ($P>0.05$) while a strong positive correlation ($r= 0.52$) was observed between intake rate and bite rate ($P<0.05$). The bite size and bite rate had a weak negative correlation ($r= -0.39$; $P>0.05$). The PI of Cv3 was higher than that of Cv1 and Cv2.

Discussion: Factors that restrict both bite size and bite rate will ultimately reduce IIRs. The highest IIRs of Cv3 may be due to large bites. The results of this study revealed a negative correlation between bite size and bite rate, which is in contrast with other authors who observed no relationship. However, other researchers have reported an inverse relationship. This relationship may be due to animals spending more time being vigilant due to the vulnerability of the bipedal position. Bite rate had a stronger influence on instantaneous intake rate than bite size. Thus, Nguni goats do not need to select browse varieties with larger leaves.

Conclusion/recommendations: Variety Cv3 had the highest IIR and was preferred more than other *C. cajan* varieties studied. However, further studies are recommended to evaluate browse intake during different growth stages.

Fertilizing ability of short term preservation of South African indigenous goats semen

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Background: The use of chilled semen shortly following semen collection may be an alternative method for use in artificial insemination (AI) programs compared to frozen semen. However, buck semen exhibits a decrease in sperm motility and sperm morphological integrity over time, accompanied with a decline in the survival rate of the sperm in the female reproductive tract. That causes a reduction in fertilizing ability and increased embryonic losses.

Aim (-S): The aim of the study was to evaluate the fertilizing ability of fresh and preserved semen from South African indigenous bucks.

Methodologies: Semen was collected from four South African indigenous bucks using artificial vagina (AV) during natural breeding season. Thereafter, semen samples were extended either with Tris extender (Tris + 0 h; Tris + 24 h) and Ovambo (OV) egg yolk extender (Tris + OV 0 h; Tris + OV 24 h) then stored at 5 °C. Artificial insemination (AI) was performed at 48 h and 60 h following CIDR® removal. Pregnancy diagnosis was performed with Ultrasonographic scanner at day 35 following AI. The data for oestrous

response, pregnancy and kidding rate were analysed using Chi-square test (SAS, 2003) to test the differences between the treatments.

Results: The does inseminated with Tris + OV 0 h egg yolk had significantly ($p < 0.05$) higher pregnancy (80.0%) and kidding rate (70.0%) than does inseminated with Tris 0 h (50.0%; 25.0), Tris 24 h (44.4%; 33.3%) and Tris + OV 24 h (50.0%; 40.0%) respectively.

Discussion: In this study results are in contrast with other studies showing low pregnancy and kidding rates. The low pregnancy rate reported by Ramukhithi *et al.* (2012) and Batista *et al.*, (2012) may be attributed to semen handling, processing and cryopreservation method. These clearly show that fertilising ability of frozen-thawed semen for South African indigenous goats and other goat breeds across the globe is still a challenge.

Conclusion/Recommendation: Goat semen extended with Ovambo chicken egg yolk source is suitable for preserving fresh goat semen as resulted in high pregnancy and kidding rate. It is therefore recommended that other avian egg yolk sources should be tested for short-term preservation of South African indigenous goat semen prior artificial insemination.

Preliminary results of selection for resistance / resilience to *Haemonchus contortus* in a South African Dohne Merino sheep flock

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Background: The farm Wauldby, in the Stutterheim district, has a well-documented history of heavy *Haemonchus contortus* challenge and of *Haemonchus* resistance to all five major anthelmintic groups on the market prior to 2011. At the end of 2011, a project aimed at selection for resistance to *Haemonchus* was implemented in the Dohne Merino stud on this farm.

Aim: The aim of this study was to evaluate the progress made in selecting for resistance / resilience to *Haemonchus contortus* in the Wauldby Dohne Merino flock to date.

Methodologies:

Selection in the stud was aimed at increasing resistance to *Haemonchus contortus*, while maintaining reproductive performance, body weight, wool weight and fibre diameter and improving wool quality traits. A select flock was established in 2012. The aim with this flock was to create a line in which the most resistant ewes were mated to the most resistant rams. Only ram and ewe lambs that were never drenched were considered for selection into the select flock. Selection for resistance to *Haemonchus contortus* was based on a selection index incorporating faecal egg counts (FEC), Famacha© score (FAM) and body condition score (BCS), as well as BLUP-EBV for FEC. FEC, FAM and BCS of all lambs were recorded

annually from January until July for the 2011- to the 2015-born lambs. FAM was recorded weekly and FEC and BCS every 14 days. Lambs were only drenched when they had a FAM of 2.5 or more, in conjunction with a BCS of less than 1.5. Body weight was recorded monthly.

Results and Discussion: During the first year of the trial, 43% of the ram lambs and 68% of the ewe lambs were not dosed after weaning. A total of 57% and 32% were dosed from one to three times during the 2012 recording period. In 2014, 58% of the ram lambs and 80% of the ewe lambs did not need dosing after weaning, while these percentages further increased to 81% for the ram lambs and 83% for the ewe lambs for the 2015-born lambs. One of the most significant results of the trial to date was the increase in percentage offspring of the sires that did not need dosing. The best performing sire used during 2011 had 53% lambs that did not need dosing, while 74% lambs of the poorest sire needed dosing. In 2015, 39% lambs of the poorest performing sire needed dosing, while 93% of the best sire did not need dosing. Furthermore, 70% of the offspring of the ewes in the selection line did not need dosing, while 50% of the offspring of the unselected ewes did not need dosing. Of the offspring of the unselected ewes, 37% were dosed once, 10% were dosed twice and 3% were dosed three times during the recording period between January and July. The corresponding percentages for the selected ewes were 24.5%, 5% and 0.5%. Body weight of the ram and ewe lambs that were not dosed after weaning was higher than the body weight of those lambs that were dosed.

Conclusions: The preliminary results indicated that progress was made when selecting for resistance / resilience to *Haemonchus contortus* in the Wauldby Dohne Merino flock.

Analysis of factors affecting pre-weaning survival of goat kids in the communal areas of
Sekhukhune District, Limpopo province

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Background: Kid mortality occurs at birth up until weaning age in various goat production systems. However kid mortality is high in communal production systems due to farmer's poor management and lack of knowledge of causative factors. Identification of factors that have effects on kid mortality in communal production system has potential in increasing the survival rate of kids and better return for the communal goat farmers.

Aims: The aim of the study was to investigate factors influencing survival of goat kids from birth up to weaning in communal areas.

Methodologies: A total of 491 kids from 25 herds were monitored from birth up to weaning. Factors studied on pre-weaning survival of goat kids included doe age, body condition score, litter size, season of birth, sex, adequate grazing, prevalence of diseases, feed supplementation, grazing system, internal and external parasites control, and livestock ownership. A General Linear Model (GLM) procedure was used to determine the influence of management factors on goat herd pre-weaning survival. The FREQ procedure was used to analyse simple frequency of survival. The data was further analysed using logistic regression

procedure with individual kid's survival being treated as binary response variable given a set of explanatory variables.

Results: The goat herd pre-weaning survival recorded was 66.82%. Management factors such as feed supplementation, adequate grazing and external parasites control had effect ($P < 0.05$) on goat herd pre-weaning survival of kids. Doe age, body condition score, season of birth, adequate grazing, diseases, external parasites control and grazing system had effect on pre-weaning survival of kids when modelling the probability of pre-weaning survival of goat kids.

Discussion: Management factors such as feed supplementation, adequate grazing and external parasites control have influence on goat herd pre-weaning survival of kids.

Conclusion/Recommendation: It is, therefore, important to consider the above-indicated factors, as they had influence on pre-weaning survival of kids. This will help in improving the overall production performance of goats and livelihoods of communal goat farmers.

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Background: Oestrous synchronisation is an important reproduction management tool that forms an essential part of artificial insemination. The response to oestrous synchronisation is largely dependent on the protocol used.

Aim: The present study evaluated the reproductive performance of Saanen does following two oestrous synchronisation protocols during the breeding season.

Methodologies: A total of 40 Saanen does aged between 1-6 were used. The factors in the experimental design were two oestrous synchronisation protocols, progesterone (P4) + equine chronic gonadotrophin (eCG) (n= 20) and P4 + male effect (n=20). All animals were treated with controlled internal drug release (CIDR) for 11 days. In the eCG group does were intramuscularly injected with 300 IU eCG at CIDR withdrawal while for the male effect group bucks wearing aprons were introduced. Cervical insemination was performed twice at a fixed time (48 and 60 h) after CIDR withdrawal with fresh undiluted semen.

Results: Conception rate was 80 % and 75 % in the male effect and eCG group, respectively. Oestrous synchronisation protocols did not have a significant difference on the number of follicles and size of the corpus luteum. However, there was a significant ($P < 0.05$) difference in the diameter of the largest follicle. No significant difference was recorded in respect to the onset of oestrus between the male effect and eCG group. The duration of oestrus was significantly ($P < 0.05$) shorter in the eCG group than the male effect group.

Discussion: The conception rate between the male effect and eCG obtained in this study is comparable with the findings of Gore (2016) which was higher in the male effect than eCG. The duration of oestrus which was shorter in eCG group is also similar to other studies (Motlomelo *et al.*, 2002). However, other studies observed no significant difference on the diameter of the largest follicle in the male effect group and eCG group (Gore, 2016).

Conclusion: The results indicate that both oestrous synchronisation protocols are efficient in synchronising oestrus. Addition of male effect in progesterone synchronised oestrous improved oestrus parameters and conception rate.

A survey of the production system, management and marketing strategies for Tswana goats in semi-arid area around Mafikeng, North West province.

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Goat production in communal areas is faced with numerous challenges which may differ with geographical locations. Marketing of goats in North West province has a potential to help diversify the economy and alleviate poverty in rural communities. To characterize the economic, social and nutritional importance of goats as perceived by existing goat farmers in the Molopo district of North West region of South Africa. The research was based on 150 farmers who have livestock from three villages put together, but only 75 farmers had goats within their livestock. They were randomly selected and interviewed. Data was collected using a structured questionnaire. Questionnaires were designed to obtain information from respondents on socio- economic profiles, animal productivity, nutrient supplementation practices, disease incidence, goat utilization and marketing strategies. Results obtained showed that 57% of farmers sold animals without weighing and were also affected by poor market value for goat. About 29% of farmers mentioned that they encountered abortion due to droughts and mineral deficiencies. Other factors that affect goat production include poor housing, low soil fertility for forage production. Amongst three villages reported in the study, the main reason for keeping goats was to generate income. They depend on livestock for survival. Condition and diseases such as brucellosis, abortions and heart water were reported, which explain the reduction of goat production and management. Most of the farmers with goats were older than 70 years (old age) which makes it clear that it was difficult for them to secure their goats. This explain why stock theft is the main constraint in these areas.

Management aspects, such as record keeping on production and economic records should be encouraged, so as to develop skills to improve the whole communal production system to benefit the local farmers. Development of markets is a sure incentive for farmers to appreciate the need to improve the levels of management, disease control, parasites and improve nutrition levels. It is therefore important to train farmers and develop programmes to address these constraints.

Evaluating infestation of internal parasites on sheep respectively grazed on predominantly
pennisetum clandestinum and *eragrostis curvula* pasture in the highveld

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Internal parasite infestation at the Highveld region of Mpumalanga province has been identified as the factor elevating the mortality rate of sheep flocks. The species of grass pastures under which sheep are grazed has led to much speculation on the variation of infestations and mortalities of sheep under different pastures.

This study was done to evaluate and determine the internal parasite infestation levels of sheep grazed under two different pasture species in the Highveld grassland.

The experiential trial was conducted at Athole research farm with data collected on a monthly basis during all four seasons. A total of 50 Dohne Merino sheep breed were divided into two groups of 25 sheep each and grazed in two camps one on predominantly *Pennisetum clandestinum* (Kikuyu) and the other on predominantly *Eragrostis curvula* pasture camps. The Infestation levels were determined at the parasitology veterinary laboratory using the quantitative faecal egg count for egg flotation examination from the collected samples. Standard deviation mean bars for faecal egg count overlapped for both *P. clandestinum* and

E. curvula pasture grazed sheep groups, whereby an overlap gives assurance that faecal egg count mean is not statistically significant ($P>0.05$).

The line graph between various seasons showed a positive correlation between moisture content and faecal egg count infestation as illustrated that the faecal egg count declined in both grass species as the moisture content declined, whereas higher faecal egg count values were observed to increase during the moist spring to summer rainy seasons and decreased during the dry autumn to winter seasons. The *P. clandestinum* grass showed higher moisture retention capacity due to its broader leaf and rhizome root structure that allowed less exposure of soil to the sun which thus created a conducive environment for internal parasite infestation to sheep grazing those camps. On the contrary, *E. curvula* grass showed a lesser moisture retention capacity due to the narrower and standing structure thus allowed for less soil cover and high evaporation. This in turn lessen the risk of this grass species for internal parasite infestation.

Though, statistically the variation is insignificant between the two species but the average egg count varies, which has led to more small stock mortalities from internal parasite infestation on sheep grazed on predominantly *P. clandestinum* than on *E. curvula* camps. The risk variation between the two grass species is more insignificant during the dry season.

It is therefore recommended that the *P. clandestinum* grass species can be best preserved for the dry winter season when the risk of parasite infestation to sheep is low. This strategy will ultimately reduce the challenges of sheep mortalities from internal parasites in the Highveld grassland region of the Mpumalanga Province.

An Investigation of Coat Colour Distribution of West African Dwarf Goats

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Background: Goat has proved useful to man throughout the ages, based on their adaptability to varying environmental conditions and nutritional regimes. Coat colour is very amiable and irregular which helps in comparative genetics and to establish level of adaptation including black and brown, pied and mixed colour. It is influenced by a large number of genes that are involved in determining the presence, distribution and biochemical activities of the melanocytes. It has a highly repeatable and heritable (53%) trait. It is majorly controlled by alleles on three loci (A, B and S) and two pigments: eumelanin and pheomelanin.

Aim: This study was carried out to determine coat colour distribution of West African Dwarf Goats in Abeokuta South and Abeokuta North Local Government Areas of Ogun State.

Methodology: West African Dwarf goat colour inheritance was examined based on coat color chart description. 1852 kids, 486 sires, 972 dams from uncontrolled crosses between thirteen village goat populations were randomly sampled. Hardy Weinberg equation was used for this study “ $p^2 + 2pq + q^2 = 1$ ”. Data was analyzed using descriptive statistics PROC Freq and chi-square (χ^2) independent test of SPSS version (2013) software package

Results: According to mendellian law of inheritance, 19 alleles were observed based on phenotypic expression, with black, brown badger-face, grey being mostly dominant allele while white, bezoar, spotted brown, lateral stripes and swiss-marking are less predominant, The gene frequency was estimated using Hardy-Weinberg equilibrium equation which resulted as 0.70 and 0.30 for eumelanin and pheomelanin respectively. Chi-square (χ^2) analysis was further carried out, which revealed that the difference between observed frequency and expected frequency was significant ($P < 0.05$) implying that the segregation in the area of study was not supported by Mendellian ratio of 3:1.

Discussion: Based on the predominant coat colour, this shows that high levels of tyrosinase are produced by the animal which could be related to the structure of an insulating coat, serving as a determinant for the probability per unit coat depth, while the less predominant coat colour are mostly affected by high ambient temperature and intensive solar radiation. The farmers embrace uncontrolled mating system, unconscious selection resulted in segregation from mendellian ratio.

Conclusion and Recommendation: High level of variation was observed in coat colour among goats in the areas studied with black coat colour being the predominant. Hence, conscious selection could be embarked upon to investigate the influence of coat colour on adaptation, thermoregulation, growth and productivity.

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Background: Indigenous Tswana goats are renowned for their valuable adaptive traits to local conditions and their contribution to the livelihoods and food security of rural people. This breed is currently threatened due to random crossbreeding and breeds replacement with exotic breeds. The genetic characterisation of this breed will assist in their conservation and creation of future sustainable development programmes.

Aim: The aim of the study was to investigate genetic diversity and population structure of Tswana goats from the central region of Botswana using the Illumina Goat 50K Single Nucleotide Polymorphism (SNP) Bead chip.

Methodology: Hair samples were collected from forty-eight (48) unrelated animals and genotyped with the Illumina Goat 50K SNP chip. Quality control (QC) and diversity parameters were analysed using PLINK version 1.07 (Purcell *et al.*, 2007). After QC, 49 328 SNPs remained for downstream analyses. Pairwise linkage disequilibrium was assessed through the correlation coefficient (r^2) using Plink 1.07 software. Genome-wide Complex Trait Analysis was used to construct a genetic relationship matrix, and eigenvalues and eigenvectors were estimated for principal components analysis (PCA). To investigate whether there was any genetic structure within the Tswana goats an ADMIXTURE (Alexander *et al.*,

2009) was performed. Effective population (N_e) size was calculated using SNep version 1.1 (Barbato *et al.*, 2015).

Results: After QC and LD pruning, a set of 25239 SNPs remained. The results revealed 94.9% polymorphic SNPs ($MAF > 0.05$) with a mean of 0.32. The average observed and expected heterozygosity of Tswana goats was 0.419 ± 0.02 and 0.423 ± 0.03 , respectively. The average inbreeding coefficient (FIS) of the studied population was estimated at 0.009 ± 0.05 . Linkage disequilibrium (LD) decayed rapidly with a short range (0-10kb), and decreased as the distance between markers increased. Average correlation coefficients (r^2) were 0.44, 0.23, 0.14, 0.09, and 0.05 at marker distances 10, 20, 40, 100, and 1000 kb, respectively. PCA clustered animals together with a few outliers. The effective population size in the last 50 generation was estimated to be 1700.

Discussion: The results revealed a high level of genetic diversity and low levels of inbreeding in the Tswana goat. The low LD and high N_e values indicated that the studied population have not been under intense selection over generations. Tswana goats have never been artificially selected and are mostly kept under communal production systems where random mating is common. The high genetic diversity and effective population size observed in this population implies that high genetic responses may be expected in future breeding programmes.

Conclusion: This is the first study on indigenous Tswana goats based on Illumina Goat50K SNP Bead chip. The study has demonstrated the utility of the chip with an insight on genetic diversity of indigenous Tswana goat which will enhance national conservation and further genetic studies.

Chemical composition of *Lablab purpureus* and *Vigna unguiculata* and their subsequent effects on methane production in goats

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Key Words: Cowpea, goats, Lablab, methane, nutritive value,

Background- Livestock production is a critical and perhaps the most successful business enterprise for the underprivileged small scale farmers living in marginalized drought prone areas .This business is characterized by severe animal feed shortages, particularly during the dry season. Forage legumes are known to correct this anomaly. Furthermore they posses anti-nutrients which can help to ameliorate the negative effects of methane (a green house gas) from all ruminant production systems.

Aim- The objective of this study was to evaluate the nutritive value, anti-nutrient content of *Lablab purpureus* and *Vigna unguiculata* and their effects on methane production in goats

Methodology - Legume forages were grown and harvested at three stages of growth of pre-anthesis, anthesis and post anthesis and samples were collected at each stage and examined for proximate analysis, total phenolics, condensed tannins and saponnins using standard methods. Hay was harvested at anthesis stage and used in a growth study to evaluate the effects of forage legumes on methane production. Eighteen, one year old goats; nine male and nine female, were used in the feeding trial .The goats were subjected to three treatment diets with six goats in each treatment equally representing both sexes, for a period of 60 days in a

complete randomized block design. Methane was measured using a Laser methane detector [LMD].

Results - Cowpea showed higher. Ash (13.11%) , ADF (38.42%) and CP (20.23%) compared to Lablab which had values of 11.45 %, 36.17% and 19%, for ash, ADF and CP, respectively . Lablab had significantly higher fat content (2.41%), NDF (49.27%) and hemicellulose (13.07%) than Cowpea 2.1%; 46.91% and 8.48% respectively. Cowpea exhibited higher ($P < 0.05$) ADL and NDIN content compared to Lablab, which showed a significantly ($P < 0.05$) higher ADIN content. The legume forage species and stage of growth significantly ($P < 0.05$) influenced CT, total phenolic and saponin levels; Lablab exhibited higher ($P < 0.05$) average tannin content compared to Cowpea ($3.345 \pm 0.047 \text{mgCAE/gDM}$ vs $1.494 \pm 0.047 \text{mgCAE/gDM}$). Lablab showed significantly higher average phenolic content of $13.47 \pm 0.0693 \text{mgGAE/gDM}$ than Cowpea; $9.402 \pm 0.0693 \text{mgGAE/gDM}$ ($P < 0.05$). The average saponin content was higher ($P < 0.05$) for Lablab than for Cowpea. Lablab and Cowpea had a significant effect on methane production. On average animals on pelleted feed exhibited higher ($P < 0.05$) methane emissions compared to Lablab and Cowpea diets; $35.62 \pm 0.0032 \text{ppm-m}$, $34.89 \pm 0.0032 \text{ppm-m}$ and $31.04 \pm 0.0032 \text{ppm-m}$ for Cowpea, pellets and Lablab respectively

Discussion - Results are in agreement with other studies showing high nutritional value for Cowpea and Lablab. Results also confirm that these forages have the capacity to reduce methanogenesis in goats.

Conclusion and recommendations - Forage legumes meet animal requirements for fat, ADF, NDF, and CP. The energy and tannin levels of forage legumes have shown to reduce enteric methane production in goats. The diet and sex of the animal significantly affects enteric methane production

Effects of enzyme and bacterial additives on the ensilability of lucerne and nutrient utilization
by South African indigenous Pedi goats

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Background: Inadequate feed resources serves as a major constraint to animal production in the tropics, and this is more prevalent during the dry season. Therefore, forage preservation is important to supplement inter-seasonal variations in forage quality and availability. Combination of enzymes with bacterial inoculants have been reported to improve lucerne silage quality and animal performance when used in rations.

Aim: To establish the influence of combining fibrolytic enzyme (Viscozyme) with lactic acid bacteria (LAB) inoculant (Sil-All) on lucerne silage quality and nutrient utilization of the silage by indigenous Pedi goats.

Methodologies: Third-cut wilted lucerne (418 g DM/kg) was ensiled in a 4 (Viscozyme) × 4 (Sil-All) factorial arrangement in a completely randomized design (CRD). The enzyme application levels were: control (no additive), 0.19 mL/kg FM (ET1), 0.38 mL/kg FM (ET2) & 0.57 mL/kg FM (ET3). The LAB application levels were: control (no additive), 1.25×10^5 cfu/g FM (LT1), 2.5×10^5 cfu/g FM (LT2) & 5.0×10^5 cfu/g FM (LT3). Each of the enzyme levels were combined with all of the LAB inoculant levels to produce 16 treatments. These treatments were ensiled in 1.5 l anaerobic glass jars and 210 l drums for 90 days. Triplicate

samples per treatment were collected on Day 0 and analysed for chemical composition, and samples of Day 90 were analysed for fermentation characteristics of the silage. Further, silage samples of Day 90 were subjected to aerobic stability test that lasted for 5 days. The silage from the drums was mixed with a feedlot diet and fed to Pedi goats in a CRD to determine nutrient utilization of the silage.

Results: Enzyme + LAB inoculant improved and had a significant effect ($P < 0.05$) on the quality of lucerne silage. Enzyme + LAB inoculant optimized ($P < 0.05$) water-soluble carbohydrates (23.29 g/kg DM), lactic acid (54.71 g/kg DM), acetic acid (0.04 g/kg DM), ammonia-N (1.67 g/kg DM) contents of lucerne silage. Enzyme + LAB inoculant optimized ($P < 0.05$) Fibre (NDF = 326.2 g/kg DM and ADF = g/kg DM) and CP (162.5 g/kg DM) contents of lucerne silage. Enzyme + LAB inoculant optimized ($P < 0.05$) aerobic stability of lucerne silage (CO_2 = 29.96 g/kg DM; pH = 6.68). Enzyme + LAB significantly improved ($P < 0.05$) digestible energy (10.7 MJ/kg DM) and crude protein (CP) digestibility (767.5 g/kg DM) by Pedi goats compared to control (9.6 MJ/kg DM and 655.4 g/kg DM, respectively).

Discussion: There are interaction effects between enzyme level and bacterial inoculant level on lucerne silage quality. The performance of goats in this study is in agreement with that reported in other studies and can be attributed to rumen microbial interaction with silage additives.

Conclusion: Silage quality was improved as well as the performance of the goats, thus improved silage preservation can be a strategy to overcome feed shortages in dry season and during times of drought

Farmers' perception on sheep production constraints in the communal grazing areas of the
Eastern Cape Province, South Africa

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Background: Sheep have a great potential to contribute more to the livelihoods of the people in low-input, small-scale mixed crop livestock production systems (Kosgey and Okeyo, 2007). Increase in the current level of productivity of sheep is essential to meet the demands of the ever-increasing human population, increase household income and improve export earnings. Several studies found that productivity per unity of animal and the contribution of communal farming to the economy is low compared to the commercial sector (Bembridge, 1989; Devendra, 1990).

Aim: The aim of the study was to investigate the main constraints limiting sheep production in the communal areas of the Eastern Cape Province of South Africa.

Methodology: The study was conducted between July 2009 and September 2010 in Sinqumeni Administrative Area in Ngcobo Local Municipality which falls under Chris Hani District Municipality. Sinqumeni is located 50 km North of Ngcobo town and 35 km East of Ugie town. Sinqumeni is situated within 31°12'30"S longitude and 28°13'45"E latitude. The mean annual rainfall was ±620mm. The vegetation is classified as Drakensberg Foothill

Moist Grassland (Mucina & Rutherford, 2006). The most common grass species is *Themeda triandra*.

Sixty two farmers were selected randomly based on their willingness to participate in the study. The sample population comprised of households that reared sheep. Data was collected through semi-structured questionnaire administered through personal interviews. Data gathered was subjected to statistical analysis using Statistica Version 12 (Statistica 2013).

Results :More than 70% of the surveyed farmers were males and 62.5% of the farmers were between the ages of 52-80 years. The most important challenges of sheep production perceived by the farmers were disease and parasites (27.6%), lack of infrastructure (19.1%), lack of organized market access (17.8%), shortage of feed (14.2%), lack of water availability (10.2%), high cost of drugs/vaccines (6.2%) and stock theft (4.9%).

Discussion: These findings are consistent with other studies that reported that, diseases and parasites, shortage of feed, lack of infrastructure, lack of organized market access, lack of water availability, high cost of drugs/vaccines and stock theft, were the major constraints limiting sheep production.

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Background: The viticulture industry produces large quantities of grape pomace made of skins, seeds and few stalk parts. After grapes are harvested, they are processed into wine. Initially, the stem (or stalk) is removed due to the large amount of tannins contained within. Grape pomace is a fresh (65-68% water) and perishable product, and must be dried or ensiled if it cannot be fed immediately. Dried pomace can be mixed with small amounts of molasses to improve its palatability. Due to its high-fibre content (lignin), grape pomace is of low digestibility. It can be used to feed ruminants, in association with feeds having better nutritive value, but is not recommended for pigs and poultry as a source of energy and protein. Grape pomace can be fed fresh, dried, or ensiled before storage.

Aim of the study: Investigate the use of grape pomace as a dietary resource on performance of ruminants when fed dried grape pomace.

Methodologies: Grape Pomace (crude protein 13.3%; gross energy 16.79%; ether extract 6.47%; neutral detergent fibre 47.6%; acid detergent fibre 29%; acid detergent lignin 19.15%; dry matter (DM) 93.86%) was collected from Brenn-o-Ken, Wolseley in the Western Cape and brought to ARC-Irene for chemical composition and diet formulation. Dietary treatments (iso-energy) were: i) 50% grape pomace + 25% lamb pellets + 25% ground Lucerne hay (D1), ii) 60% Lucerne hay + 30% lamb pellets + 10% chopped pumpkin (D2), and iii) 50% D1 + 50% D2 (D3). These diets were fed to 24 indigenous bucks (± 20 kg live weight), with 8

bucks per treatment. Bucks were housed individually in metabolic cages and adapted for 14-days, with 7-days sample collection. Animals were fitted with harnesses and faecal collection bags 3-days prior to the collection of faeces. Animals were fed *ad lib* and had free access to clean water. Feed intake was measured daily while faeces were collected during the last 7-days of the trial.

Results: Bucks fed the combination of D1 and D2 diets had higher ($P<0.05$) intake (1050 g/kg DM) compared to the other treatments (790 g/kg DM vs. 930 g/kg DM for D1 and D2, respectively). However, the digestibility of DM and protein was improved with D2.

Discussions: The improved digestibility of nutrients in bucks fed D2 might be related to the inclusion of chopped pumpkin, which supplies carotene that is convertible to vitamin A, or due to the lower tannin and ADL content. Chopped pumpkin played a significant role in the performance of the animals. Beta-carotene is an important precursor for synthesizing Vitamin A. The improved intake with combination of D1 and D2 did not result in improved nutrient digestion. This might be related to rumen gut fill.

Conclusions and recommendations: Combining D1 and D2 improved feed intake while D2 alone improved nutrient digestion.

Determination of selection criteria for socio-economic breeding objectives of communal goat farmers in Limpopo province: preliminary results

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Background: Communal goat farmers keep goats for several purposes including economic, social and cultural. It is not clear what selection criteria are used to select the best animals for the purposes they keep them. The knowledge of the breeding objectives and trait preferences of the goat farmers is important in designing effective goat breeding programs.

Aim: To determine the selection criteria applied by communal goat farmers to attain their socio-economic breeding objectives.

Methodologies: A total of 264 farmers were interviewed in Mopani and Vhembe districts of Limpopo Province. A structured questionnaire was used to acquire production information, aspects of purpose of goat keeping and selection traits of value to the communal farmers. Simple frequencies were analysed for farmer selected objectives and selection criteria. Means procedure was applied to get the mean ranks of objectives of goat farming and selection traits of communal goat farmers.

Results: Goat farming for sale had the highest mean rank (1.51 ± 0.65); followed by milk for consumption (1.88 ± 0.83), meat for consumption (1.95 ± 0.77), social and cultural purposes (2.05 ± 1.10). Similarly, sale was identified in highest frequency (0.36) as a main objective, however frequencies also showed meat for consumption (0.32) to be the second most

preferred objective followed by social and cultural purposes (0.27). Highest ranked production selection traits were body size (1.39 ± 0.73), milk production (1.60 ± 1.03), and growth rate (1.87 ± 0.82) with respective frequencies of 0.30, 0.11 and 0.27. Means \pm SD and frequencies for reproduction traits of fecundity, birth status, and mothering ability were 1.41 ± 0.65 and 0.27, 1.62 ± 0.80 and 0.32, and 1.99 ± 0.74 and 0.23 respectively. The non-production trait of colour ranked highest (1.16 ± 0.57) with the frequency of 0.49 followed by coat type (1.89 ± 0.96), presence of horns (2.30 ± 1.33), horn size/shape (2.32 ± 0.79).

Discussion: The top ranking objectives of sale, milk for consumption, meat for consumption and social and cultural purposes show that communal goat farmers combine social and economic objectives in managing their herds. Intervention breeding programs should therefore take this into consideration to ensure holistic improvement of farmer's livelihoods.

Conclusion: The study is ongoing and proper conclusions will only be derived when other districts of the province have been completed.

WILDLIFE PRODUCTION

Influence of production system on the carcass yield of blue wildebeest (*Connochaetes taurinus*)

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Background: Within the next 35 years Africa needs to double its food production to avoid food shortages brought on by the ever-growing human population, increase in desertification caused by climate change and overgrazing of suitable land. Game farming offers the practical solution for meat production as it provides the much needed animal protein that will improve food security while being economically sustainable and maintaining biodiversity. With the popularity of game farming, due to its economic, low-input and multifunctional factors, various combinations of intensive and extensive systems have developed to optimise animal production.

Aim: The aim of this study was to generate baseline data on the meat production potential of blue wildebeest bulls from contrasting production systems, as well as the consumable offal yields.

Methodologies: Sixteen blue wildebeest bulls were harvested in March 2016 in the Modimolle region of Limpopo, South Africa. Eight from a semi-extensive system (received an additional 3kg high quality feed daily) and eight from an extensive system. Care was taken to ensure that the sampling between treatments was balanced for animal age. All animals were processed according to standard South African operating procedures and necessary weights recorded and subjected to appropriate statistical analysis.

Results: Semi-extensive wildebeest had higher ($p \leq 0.05$) undressed carcass weights ($208.2 \pm 11.14 \text{ kg}$), carcass weights ($112.1 \pm 6.38 \text{ kg}$) and dressing percentages ($53.8 \pm 0.49\%$) than the extensive ($168.8 \pm 14.59 \text{ kg}$, $84.9 \pm 7.55 \text{ kg}$ and $50.2 \pm 0.34\%$, respectively) animals. Semi-extensive animals produced 14.4% higher weights for external and internal offal components than the contrasting production system. The total muscle yield of the selected muscles was 33% higher in the semi-extensive system than the extensive system, with differences being associated with the loin and hindquarter muscles and not the forequarter muscles.

Discussion: The difference in the average weights can be explained by the difference in the level of activity and forage consumed affecting development and growth. The dressing percentage of an animal is important when determining its meat production potential, with a higher percentage being obtained by the semi-extensive animals, which was comparable to or higher than other antelope and domestic livestock. During the harvesting of game edible by-products are obtained as a low-cost protein source. Higher yields were seen in semi-extensive animals postulated to be due to better quality nutrition received allowing more energy to be allocated to the growth and maintenance of tissues. This aids in explaining why higher muscles yields for high value cuts were also obtained from this production system. No difference was observed in the percentage contribution of muscles measured indicating that relative to their size, animals from both production systems deliver similar meat percentages.

Conclusion and recommendations: The results obtained show that a semi-extensive farming system has the potential to increase the carcass yield of blue wildebeest bulls. While this study was able to give baseline data on the carcass yield of this species it was limited to only males. Therefore more research is required on the effects of other extrinsic (season) and intrinsic (gender) factors on the meat production potential. Before the meat from this species

can successfully enter the meat industry, studies on the effect of the different production systems on the meat quality parameters are essential.

The effects of clipping the toenails of ostrich chicks with and without the use of analgesia

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Background: The toenails of day-old ostrich chicks are clipped to reduce toenail-related injuries. Even though the toenails regrow, clipping is presumably painful due to tissue damage caused, leading to welfare concerns. It is difficult to measure pain in birds, but a noxious stimulation of an extremity normally result in acute pain, which usually elicits a protective, reflexive withdrawal of the limb away from the source of injury. This response can therefore be used as indicative of acute pain. A persistent state of pain may however develop after injury to peripheral tissue. This chronic pain is known to cause distress, which is related to changes in biologic functions, resulting in failure to grow, abnormal behaviour and/or mortality. Pre-emptive analgesia is increasingly recommended for painful procedures.

Aim: To evaluate the effects of toenail clipping, with and without the provision of analgesics, on pain, stress and production indicators in ostriches.

Methodologies: Three treatments, namely sham clipping, clipping without analgesia, and clipping with analgesia were compared. For the analgesic treatment meloxicam, a non-steroidal anti-inflammatory drug (NSAID) was dosed at 1mg/kg 20 minutes before clipping the toenails. A topical anaesthetic was also applied directly after clipping. Toenails of day-old chicks were clipped with an electrical debeaker according to standardised methodology.

Survival and growth were compared and three indicators of pain were evaluated: behavioural, physiological and production. Withdrawal reactions during the procedure (sham or clipping) were evaluated. Blood smears were prepared from blood obtained by venepuncture of the wings prior to and 24 hours after treatment. Log-transformed ratios of heterophils to lymphocytes (H/L) in the blood smears were used to assess stress. Toenail length and live weight were measured at 2, 4 and 6 weeks post treatment. Percentage mortality to 2, 4, 6 and 12 weeks of age was transformed with the arcsine transformation. Each treatment was applied to five groups of chicks, and repeated over two production seasons. Two groups were compromised due to environmental factors and had to be removed from the data. The data was subsequently analysed according to a completely randomised design based on group means.

Results and discussion: When the toenails were clipped a withdrawal reaction was evident, despite the use of a NSAID. With the sham clipping no withdrawal was noted. No treatment differences were evident in H/L ratios of blood smears taken prior to and 24 hours after treatment ($P>0.05$). Toenails regrew to about the same length as the unclipped nails within 6 weeks. Growth was not significantly influenced by treatment ($P>0.05$), but survival to two weeks of age was lower in clipped groups treated with analgesics (85.27 ± 2.15) compared to unclipped groups ($95.17 \pm 2.46\%$). Survival to 4, 6 and 12 weeks did not differ significantly ($P>0.05$).

Conclusion: Clipping of day-old ostrich chicks' toenails is performed to increase the long-term welfare of the ostriches with regard to injury prevention. Although the pain experienced seems to be short-lived, the decreased early survival of groups that received the analgesic treatment needs to be investigated further.

Changes in the physico-chemical attributes of salami made from blesbok, eland, fallow deer, springbok, black wildebeest and pork during drying

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Background: Salami is a popular fermented sausage that is enjoyed by a large number of consumers worldwide and usually prepared using pork or beef. The growth of the game meat industry in South Africa has created a niche area to develop shelf stable products such as salami so as to further expand and add value to game meat. In this regard, little information is available on the changes that occur during the production of game salami which is critical for developing standard production procedures.

Aim: The study investigated changes in the weight loss, pH, water activity, lipid oxidation, salt content and proximate composition of salami made from pork and different game meat species.

Methodology: Four batches of salami from each species of game meat were produced separately on different days using a typical commercial recipe (70% meat, 30% fat, spice mix). Pork salami was also prepared as a control using the same procedure. Samples for analysis were collected throughout drying (day 0, 4, 7, 12, 18 and 23) for weight loss, pH, water activity, and TBARs development. Proximate composition and salt content were determined on day 0 and day 23 of production.

Results: Drying time was a significant factor on all measured attributes whilst species affected ($P \leq 0.05$) pH, water activity, weight loss and moisture content. Generally, all salami types experienced a decrease in weight, moisture and water activity whilst the TBARs, fat, protein, ash and salt content increased. The lowest pH was observed for blesbok salami on day 4 (from an initial 5.6 to 4.63); after which a gradual increase ensured till the end of drying (day 23). The final pH of the different types of salami ranged from 4.7 to 5.4. Pork salami had lower ($P \leq 0.05$) water activity (0.888) and higher ($P \leq 0.05$) weight loss (36.3%) at the end of drying compared to salami made from different game species. Salami from black wildebeest exhibited a higher ($P \leq 0.05$) pH, water activity and moisture content and a lower ($P \leq 0.05$) fat content than the rest of the salami types at the end of drying. No differences ($P \geq 0.05$) among species were noted for TBARs and all values were less than 1 by the end of drying.

Discussion: The control salami exhibited attributes that are similar to those reported in literature. With the exception of black wildebeest salami, all measured attributes from other game meat salami were within acceptable ranges (final pH < 5.2; A_w < 0.91) to be classified as semi-dry and shelf stable.

Conclusion and recommendations: Results indicate that meat from game species (although they differ from pork) may be utilized in salami production. More research work is required in evaluating the textural and sensory attributes of salami made from different game meat species.

Physicochemical meat quality attributes of black wildebeest (*Connochaetes gnou*) muscles

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Background: Studies have been conducted on the meat quality of several common South African game species. Black wildebeest (*Connochaetes gnou*) is an endemic Southern African antelope commonly farmed in the game industry; this species therefore has meat production potential. Research on the physicochemical quality of its meat is important for the meat industry and improving consumer perception thereof.

Aim: To study the physicochemical meat quality attributes of male (n = 9) and female (n = 8) black wildebeest muscles.

Methodologies: Seventeen black wildebeest were harvested at Bredasdorp in the Western Cape. The animals were dressed at the abattoir and transported to Stellenbosch University meat laboratory for analysis. Six muscles [*Longissimus thoracis et lumborum* (LTL), *Biceps femoris* (BF), *Infraspinatus* (IS), *Supraspinatus* (SS), *Semimembranosus* (SM) and *Semitendinosus* (ST)] were removed from the hind- and forequarter and stored at 4°C until analysis. Standard methods were used to analyse ultimate pH, surface colour, drip loss and cooking loss percentage, Warner-Bratzler shear force and chemical composition of the different muscles.

Results: Gender showed no effect ($p > 0.05$) on the measured physicochemical parameters. pH_u (6.5-6.6), CIE a* and drip loss % did not differ ($p > 0.05$) between muscles. The IS had a

lighter ($p \leq 0.05$) red colour with the lowest CIE L^* (33.43) and a high b^* value (9.72); whilst the SM had a darker red colour with the lowest CIE L^* value (27.05). The LTL, BF and SS did not differ significantly from each other in the CIE L^* values nor did the BF, SM and LTL differ significantly from each other in their CIE b^* values. ST had the highest ($p \leq 0.05$) Chroma and hue angle values (15.92, 39.69 respectively); whilst the LTL had the lowest ($p \leq 0.05$) values (13.99, 34.39). Muscle type had an effect ($p = 0.001$) on the cooking loss % and WBSF values; the ST had the highest cooking loss % while the IS had the lowest value, the IS and SS were more tender than other muscles. The chemical composition varied ($p \leq 0.05$) between muscles; SS had the highest moisture content (78.1%) whilst the LTL had the lowest (75.6%). The LTL muscle had the highest protein content (22.6%) whilst the IS had the lowest (19.4%) protein content. LTL muscle had the highest fat content (1.8%) while the ST had the lowest (1.3%). BF muscle had the highest ash content (1.3%) whilst the ST had the lowest value (1.1%).

Discussion: pHu values of the muscles ranged between 6.48-6.59 and are indicative of dark, firm and dry (DFD) meat. DFD is produced due to high ultimate pH (above 6.0) in the muscle from *ante-mortem* stress; this depletes glycogen stores which produce insufficient lactic acid *post mortem* causing the pH to remain high. This species is renowned for its tendency to show running bursts, typically experienced during harvesting which could explain these results. The LTL and SM muscles had an overall lighter red colour than other muscles. The IS and LTL muscles had the lowest cooking % which indicates a higher water holding capacity than the ST muscle which had the highest cooking loss %. Arranging the muscles from the least to most tender in terms of WBSF values the result as follows; SM>ST>BF>LTL>SS>IS. The moisture content and protein content of the muscles in the study are higher than that of beef and the fat content is lower than that of beef.

Conclusions and recommendations: According to the physical attributes values the meat can be classified as DFD. The IS and SS are the most tender muscles. According to the chemical attributes, black wildebeest compares well with other game meat. Black wildebeest meat is a healthier red meat alternative due to its higher protein content and low fat content. Future studies on the sensory quality and consumer acceptability of DFD game meat are recommended.

Feeding preferences of grower ostriches towards diets containing increasing levels of full-fat
canola seed

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Background: Intensive ostrich production is a relatively new practice compared to other livestock production systems, thus much improvement can be made which creates opportunity for research. The demand for protein, particularly animal protein, is rising and production systems need to be optimized to aid in meeting this demand. Ostrich meat is considered healthy and can contribute to the local and international protein supply. The largest expense of an intensive ostrich production unit is feed cost (*ca.* 75%). Protein makes up a great portion of any animal feed and protein scarcity contributes to the high cost of feed. This expense can be lowered by utilizing locally produced feedstuffs such as canola. Since the development of canola, it has been extensively used in animal feeds as a protein source. Canola has lower levels of glucosinolates and erucic acid, which previously limited the inclusion of rapeseed in animal feeds.

Aim: This study was conducted to determine the optimal and ideal full-fat canola seed (FFCS) inclusion level for grower ostrich diets based on animal preference, without reducing DMI.

Methodologies: Sixty South African Black ostriches averaging 82.2 ± 1.06 kg in live weight were placed in ten identical camps of six animals per camp. Each camp had five identical

feed troughs each containing diets where FFCS incrementally replaced the soybean oilcake meal (9.8% of the total diet composition) as protein source in commercial ostrich grower diets. Soybean oilcake meal was replaced in the trial diets by FFCS at levels of 0%, 25%, 50%, 75% and 100% as the main protein source. Dry matter intake (DMI) was measured on a daily basis and compared between diets, feed colour characteristics were measured based on L*, a* and b* colour attributes. Feed and water were available *ad libitum*.

Results: No differences ($P > 0.05$) were observed between camps for DMI. The 25% FFCS showed a 41.5% higher DMI ($P \leq 0.05$) than the other diets which did not differ from each other. Although there were slight differences between some colour attributes of the feed, it is believed to have had no effect on DMI.

Discussion: Considering that the 25% FFCS was the only diet favoured by the ostriches and that the 0% FFCS, 50% FFCS, 75% FFCS and 100%FFCS did not differ in DMI, it can be ruled out that the taste or the presence of anti-nutrients in FFCS were responsible for these results. A similar conclusion can be drawn regarding feed colour, as feed colour attribute differences did not explain the higher DMI of the 25% FFCS. The results showed that the ostriches preferred a small amount (6.8% of the total diet) of FFCS in their diets.

Conclusion and recommendations: Based on the results of this study, FFCS can be used to replace 25% soybean oilcake meal; resulting in an inclusion level of 6.8% FFCS in the ostrich diet to achieve a higher DMI

Physicochemical attributes of warthog cabanossi with three different levels of pork fat

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Background: Warthogs are a known high risk species as agricultural pests that are commonly culled as a control measure. Warthog carcasses produce lean meat with a favourable fatty acid profile comparable to other game species. Some carcass parts that cannot be served as fresh meat cuts can be used in meat products such as cabanossi. Cabanossi is meat product usually produced with pork and pork back fat. Increasing awareness of detrimental health effects of fat, there is need for reduced fat meat products that mimic the original ones. This can be done by using leaner meat sources and purposeful fat reduction.

Aim (-s): The purpose of this study was to determine the effects of different pork fat inclusion levels on the physicochemical attributes of warthog cabanossi.

Methodologies: Eight replicates (3 kg) of three cabanossi treatments (A: 10%, B: 20% and C: 30% pork back fat) were produced. To control the meat to fat ratio, warthog meat was trimmed of visible excess fat and sinews. Before stuffing into 22 mm diameter sheep casings, meat, fat and spices were minced using a 5 mm grinding plate. The sausages were dried over 16 hours in a smoking chamber. Physicochemical attributes (pH, weight, salt content, water activity, proximate analysis and lipid oxidation) were measured on the raw batter and the finished cabanossi product.

Results: There were differences ($P \leq 0.001$) for all attributes between the raw batter and the final cabanossi product. The pH was higher in the 10% fat cabanossi and decreased as fat level increased. Cabanossi lost considerable moisture during drying, as a result, fat, ash, protein and salt increased. Fat content was lower in treatment A ($15.7\% \pm 1.46$) followed by B ($23.2\% \pm 1.77$) and C ($28.8\% \pm 1.45$) whilst ash content decreased with increasing fat. Generally warthog cabanossi showed higher protein content with treatment A being higher ($P \leq 0.05$) than B and C. Salt content was also higher in 10% cabanossi than the other cabanossi ($P \leq 0.05$). There were no differences ($P > 0.05$) in the lipid oxidation of all cabanossi treatments.

Discussion: Results for the changes in physicochemical attributes are comparable to those reported by various authors. For cabanossi to be shelf-stable, the moisture content must be lower than 60% and the cabanossi in this study had moisture in the range 42 – 46%. The high protein and ash content of all cabanossi suggest that warthog meat can be used to produce a nutritious semi-dry product.

Conclusion/recommendations: Different pork fat inclusion levels influence the physicochemical quality of warthog cabanossi. Nevertheless, at these levels warthog meat produces a reduced fat meat product with acceptable physicochemical quality. Further research should focus on the effects of fat levels on the sensorial attributes and consumer acceptance of warthog cabanossi.

Human-animal interactions at an early age: effects on docility and stress responses in juvenile ostriches

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Background: Despite the progress made towards developing the ostrich industry, farming with ostriches is still challenging because of their temperament and relatively wild behaviour. However, some ostriches display willingness to associate with humans. Such behaviour could be used to derive adapted husbandry practices that could assist in resolving these constraints, ultimately benefiting ostrich welfare.

Aim: To examine the effect of extensive human presence and regular gentle handling performed at an early age on stress responses and docility of farmed juvenile ostriches.

Methodologies: 416 day old chicks of mixed sex and genotype hatched at the Oudtshoorn Research Farm were exposed to three husbandry practices for 3 months over two breeding seasons. The husbandry practices were I1 (imprint 1: extensive human presence with audio, visual and touch stimuli, $n=66+70$), I2 (imprint 2: extensive human presence with audio and visual stimuli, $n=68+76$) and S (standard: human presence limited to feed and water supply, $n=66+70$). Birds were managed as a single group during data recording. Short term stress

responses were evaluated at 7.5 months old, by comparing the plasma Heterophil/Lymphocyte ratio (H/L; $n=187$) before and 72 hours after feather harvesting, while long term stress response was evaluated using the enzyme-linked immunosorbent assay ($n=64$) by quantifying corticosterone (CORT) concentration from the floss feathers. At 12 months old social behaviours such as inclination to approach human, allowing touch by human, aggressiveness and sexual behaviours were recorded three times a week for 5 months. Data was analyzed using t-test and generalized linear mixed models procedure of SAS, version 9.3 (Ethical clearance: Ref No.: R13/81).

Results: The H/L ratio was significantly higher 72 hours after feather harvesting than before harvesting (H/L0 vs H/L72: 7.61 ± 0.44 vs 10.80 ± 1.17 ; $P < 0.05$). While I1 birds showed no increase in H/L ratio, I2 and S birds showed increase H/L ratio 72 hours after feather harvesting ($P < 0.05$). Feathers from S birds had higher CORT concentrations compared to I1 birds (S vs I1: 15.62 ± 1.04 vs 12.87 ± 0.84 pg/mg; $P < 0.05$). Husbandry practices did not have a conclusive effect on the willingness of birds to approach the human, allow touch interactions and expression of aggressiveness and sexual behaviours ($P > 0.05$). However, birds were more inclined to approach a familiar human observer than an unfamiliar person ($P < 0.05$).

Discussion: Ostriches exposed to extensive human presence and regular gentle handling at early age revealed no change in H/L ratio and had the lowest CORT concentration suggesting reduced acute and chronic stress sensitivity, while husbandry practices had no effect on aggressiveness and sexual behaviour.

Conclusion/recommendations: Extensive human presence and regular gentle handling at early age reduce stress and improve docility of ostriches when exposed to a familiar handler. Further studies are needed to evaluate the long term effects of these husbandry practices on

reproductive performance of these birds in natural mating and artificial insemination conditions and on welfare implications for this species.

The effect of production system on carcass yield of impala (*Aepyceros melampus*) rams

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Background: Game meat is a sustainable resource that has the potential to contribute to the food security of South Africa. The South African wildlife industry has significantly expanded, leading to the development of partial intensification of production systems and consequently an increase in animal production and the availability of game meat. However, despite increasing development of more intensive production systems such as boma systems, the conventional extensive (free range) production system is still widely used due to low input requirements of farming wildlife species. It is necessary to quantify the effect, if any, of these different production systems on the carcass yields of game animals such as the impala, which are suitable for sustainable yearly cropping regimes.

Aim: The aim of this study was to quantify the effect of two different production systems on the carcass yield of impala rams.

Methodologies: Impala were sampled at Castle de Wildt in the Limpopo Province of South Africa. Twelve sub-adult impala rams (± 15 months old) per production system (free range vs. boma from 9 months of age to harvesting) were harvested and processed according to standard South African operating procedures. All necessary weights were recorded and subjected to statistical analysis.

Results: No differences ($p>0.05$) were found between the carcass yields of sub-adult impala from the two different production systems, with the exception of heart and kidney weights, which were heavier ($p\leq 0.05$) in impala from the boma system. The mean live weights (kg) of the impala were 36.39 ± 3.28 for the free range production system and 37.85 ± 3.13 for the boma production system. The mean impala dressing percentages were 58.37 ± 1.93 for the free range system and 57.87 ± 1.62 for the boma system.

Discussion: Dressing percentages for impala rams obtained in this study were similar to those obtained in previous studies, when expressed as a percentage of live weight. The lack of significant differences in carcass yields for impala between extensive (free range) and intensive (boma) production systems may be due to the fact that the most important growth phase occurs straight after birth until weaning at 4 – 6 months, prior to transfer into the boma production system at 9 months. The latter may be more effective if implemented from this important growth phase, or if animals are maintained in the boma system until mature body mass is reached, although the feed efficiency may then be compromised.

Conclusions and recommendations: When compared to a free range production system, carcass yields of sub-adult impala rams do not seem to be influenced by maintenance in a boma production system for duration of a 6 month period prior to harvesting. Based on these results, use of more intensive boma production systems may not be necessary if the desired outcome is to achieve significantly higher carcass yields in sub-adult impala rams. Further studies are recommended to compare the nutritional value of impala meat from animals kept in a boma system to that of impala raised in free range production systems. Repetition of the experiment with impalas of different age

groups (sub-adult vs. adult) to quantify the effect of nutrition on growth rates and yields is also recommended.

Hatch traits of artificially incubated ostrich eggs from different genotypes as affected by the drilling of holes into the air cells

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Background: The understanding of aspects underlying artificial incubation in ostriches is still poor compared to domesticated poultry. Problems with artificial methods of incubation and chick rearing are currently still amongst the most important constraints to the ostrich industry. High levels of reproductive failure, particularly during the artificial incubation and the subsequent chick rearing phases, are compromising the economic viability of the commercial industry.

Aim: To investigate the effect of drilling holes in the air cell of late stage artificially incubated ostrich eggs on hatchability. .

Methodologies: Eggs used during this trial were collected during the 2015 - 2016 breeding seasons from the commercial, pair-bred ostrich flock at the Oudtshoorn Research Farm of the Western Cape Department of Agriculture, South Africa. The flock included pure South African blacks (SAB), Zimbabwean blues (ZB), Kenyan reds (KR), as well as crosses between the SAB and the other pure breeds. On 35 days of incubation 1723 fertile eggs were randomly distributed and a number of holes (0, 2, 4 or 6) were drilled into the air cell to

provide the developing embryo with additional oxygen during the final development stage. This procedure was repeated during the breeding season to include winter, spring and summer to also monitor the effect of season. On day 38 of incubation, the eggs were weighed again to determine moisture loss after drilling. The data were subjected to analysis, using ASREML software with individual eggs as experimental units.

Results: The percentage moisture loss (ML38) from day 35 to day 38 of incubation was influenced by the number of holes drilled into the air cell of the fertile egg; 1.2%, 1.3%, 1.6% and 2.1% for 0, 2, 4 and 6 holes respectively ($P < 0.05$). Both year and season affected ML38, ranging between 0.99 ± 0.04 and 1.71 ± 0.05 ($P < 0.05$). Although the number of holes did not have any significant effect on either pipping time or the number of chicks hatched. Genotype influenced day-old chick weight ($P < 0.05$) and was the lowest for SAB chicks and crosses with SAB dams (between 889g and 905g) and the highest for the pure ZB (938g). Day-old chick weight for KR chicks was intermediate at 899g.

Discussion: It is possible that the increase in O₂ under the shell in the area close to the air cell would not significantly increase the availability of O₂ to the embryo. It could be that number of hole drilled into the air cell was too few to have a significant effect on hatchability. Further investigation is needed to explore the effect of more holes in the air cell.

Conclusion/Recommendations: No conclusive advantage in improving hatchability was found with an increasing number of holes in the air cell. Further investigation is needed to determine if this procedure can be optimised by increasing the number and size of the holes, as it did impact on ML38.

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Addendum

Freemartism in wildlife: A case study

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Background: Freemartinism is a particular form of intersexuality where the freemartin phenotype appears in twins of different sexes, usually rendering the female twin sterile. In cattle, this condition is observed in 90 – 97% of male/female twin pregnancies and have also been recorded in other livestock species, but is less prevalent. To date, some research (Iannuzzi *et al.*, 2005) has been done on freemartinism in river buffalo (*Bubalus Bubalis*), while the occurrence of the condition remains generally unknown in most wildlife species. If undetected (often in free-roaming populations), the condition can have damaging effects on closed wildlife populations.

Aim (-s): The aims of this presentation is to report the first confirmed case of freemartinism in African buffalo (*Syncerus caffer*).

Methodologies: Heterosexual twins born from an African Buffalo cow was identified and blood samples were collected from the suspected freemartin (female) for genetic testing. A clinical observation of body conformation was also performed. DNA was extracted from whole blood samples and subjected to PCR amplification with Y chromosome specific primers for the diagnosis of the XX/XY genotype (Olsaker *et al.*, 1993).

Results: The clinical observation revealed some bull-like characteristics such as large base horn circumference and prominent withers. Information on the anatomy of the internal reproductive organs was not available, while reproductive ability will only be confirmed once

breeding age is reached. However, the DNA test did indeed detect the Y chromosome, confirming the diagnosis of the freemartin syndrome.

Discussion: The molecular results confirmed that freemartinism occur in African buffalo. According to observations with river buffalo, lesser kudu and red deer it is likely that the freemartin African Buffalo (female) will be sterile. The general reproductive inability of the freemartin (female) results from varying degrees of damage to the internal sex adducts caused by the presence of the Y-chromosome fragments.

Conclusion/recommendations: Much more research is required to determine the incidence, pathology and morphology of the freemartin syndrome in African buffalo as well as other wildlife species, particularly those of the bovidae family.