



# 53<sup>rd</sup> Annual SASAS CONGRESS

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Proceedings



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## Foreword

It gives me great pleasure to pen this foreword for our 53<sup>rd</sup> SASAS congress book of abstracts for 2022. The past few years have seen our world transformed and thrown into chaos at the same. Covid-19 pandemic has caused sadness and divisions with people losing loved ones and separating all of us from the normality of spending time together and socializing. With the changes we faced with, like the now well-known virtual meetings, this has further put most scientist in isolation causing us to work individually and not share and communicate as we did before.

The KZN SASAS Congress committee decided on the “hybrid” congress to bring back that face to face engagement and socializing with our peers while we also embrace the new normality for those that cannot join us in person. The theme for this year’s congress **“Changing paradigms in livestock production – confronting a new reality”** is appropriate for the times we currently find ourselves in. The rapid changing global warming, the aftermath of the pandemic and possible future diseases and last but not least the crisis of misinformation all around us. All these require a change of mind set and a new focus on how Animal scientists will play a role in maintaining food production while adjusting to the changes.

Our renowned panel of speakers will shed the light on how we confront the new reality, with interesting deliberations expected. Due to the 53<sup>rd</sup> congress being the first in person congress after the pandemic we had a large number of people wishing to present oral presentations however due to time constraints we could only take the number that was appropriate and the rest being asked to do posters. The views and ideas shared in all these presentations are of the authors and do not reflect or represent the KZN SASAS committee or the SASAS council.

We appreciate the guidance received from the SASAS council and also the hard work from Vetlink in simplifying some of the many complications that come with hosting a congress. The KZN SASAS committee is also appreciative for their hard work commitment from start to finish for the different roles played in making the 53<sup>rd</sup> congress a success. Our committee was a mix of young and old and complemented each other well. I would also like to extend our gratitude to all our sponsors who made this event more possible with their different contributions.

Finally, our deepest sympathies go out to all those that lost loved ones, including our own SASAS KZN committee member Mrs Karen Yardley who passed on recently, to you all I say **“ninqine”** be strong.

**Sibo Gcumisa**

**Chairperson: SASAS KZN**

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## **Early farmers in KwaZulu-Natal: the archaeological evidence**

**Gavin Whitelaw**

KwaZulu-Natal Museum

The Iron Age period in KwaZulu-Natal began around AD 300 and lasted some 1500 years, if we take the settlement of white hunter-traders at Natal Bay (Durban) in 1824 as marking a convenient end-date. Iron Age farmers introduced a new way of life to the region that including domestic animals, crops, settled homestead life and, of course, metallurgy. Archaeologists generally divide the period in two at AD 1050, based on differences in material culture and settlement locations. This talk covers the earlier period and draws on archaeological data from Lake Sibaya, the uThukela and uMngeni basins, as well as sites along the coast. Also, where necessary it draws on data from elsewhere in southern Africa to present a picture of Early Iron Age lifeways.

## **Sustainable, climate resilient production systems for South African livestock?**

**J.M. Rust**

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South African livestock production systems are diverse with a commercial and developing component which cover both extensive and intensive practices. Due to the climate and natural resource composition of South Africa, eighty percent (80%) of agricultural land is non-arable and only suitable for extensive livestock production. This in turn is most effectively utilized by ruminants such as cattle, sheep and goats. It is predicted, and although empirical evidence is still lacking, it is becoming less disputable that climate change will moderately to severely affect all livestock production systems. Although a balanced approach is needed for both extensive and intensive systems, it is undoubted that the effect of changing climatic conditions will be more severe for extensively farmed livestock. As scientists we tend to focus more on developing mitigating technologies in an attempt to measure and minimize the contribution of livestock to greenhouse gas emissions/global warming and subsequent climate change. More needs to be done on developing adaptive strategies to be able to deal (sustainability and resilience) with the effects of climate change. These concepts of sustainability and resilience are multi-faceted and needs a holistic approach in order to address it comprehensively. This presentation will deal with the importance of livestock production for the South African population/economy. The different extensive livestock production components are discussed and the predicted effects climate change will have on them. Manipulation of these production elements are suggested to potentially ensure sustainability and resilience within the system. The recommendations and suggestions also aim to create an enabling environment to facilitate necessary changes. The South African livestock industry with its extremely diverse elements, and of which some components already lack production effectiveness and efficiency, will require a concerted effort to ensure future sustainability and resilience while maintaining high production levels.



## **Emerging & re-emerging disease challenges due to increased environmental temperatures**

**Dr Sikhumbuzo Mbizeni**

(UNISA)

Climate change affects the entire veterinary domain. Veterinary Services is expected to add climate change to their list of responsibilities. The aim of the presentation is to summarize the current state of knowledge regarding the influence of climate and climate change on the health of food-producing animals. Climate change have direct and indirect impacts on animal determinants of health in multiple, interacting ways, across a range of scales. Veterinary services will therefore need to work across the spectrum of health determinants if they intend to both address pre-existing problems expected to worsen with climate change and prepare for unanticipated threats. Animals will feel the impact of climate change through multiple, often interacting, means including changing patterns of infectious diseases, increased exposure to heat, contaminants and extreme weather. Animal health could also be affected by emergence and re-emergence of vector- and non-vector-borne pathogens that are highly dependent on climatic conditions. The response to these challenges requires community participation in the adaptation of animal production systems to new environments and strengthening the efficiency of veterinary services delivery combined with well-coordinated public health services, since many emerging human diseases are zoonotic.

## **The biggest challenges facing livestock farmers (and, therefore, animal scientists)**

John Roche,

Chief Science Adviser, Ministry for Primary Industries

*“the first farmer was the first man and all historic nobility rests on the possession and use of land”*

- Ralph Waldo Emerson

For more than 8,000 years, a select group of people have taken it upon themselves to toil for the betterment of their families and communities: farmers. Despite their diligence and hard work, however, food security was by no means a certainty. Until the advent of improved genetics, chemical fertilisers, and ‘-icides’ (e.g., pesticides) during the Green Revolution, and a greater understanding of pests and disease, food security in advanced economies was only a bad harvest away from ‘famine’, a reality still experienced in developing economies. As a result, the urban community thrived or failed on the success of farmers.

Some of the successes in improving food security have, however, come with real challenges. Excessive or inappropriate use of fertiliser has contributed to issues associated with freshwater quality and aquatic ecosystem health, greater numbers of ruminant animals have contributed to greater atmospheric methane concentrations, and the need to feed 8+ billion people has contributed to a decline in natural ecosystem abundance; for example, wetlands and forests in some countries have been ‘reclaimed’ for the production of food for humans or feed for animals. In addition, the exponential increase in greenhouse gases from population growth and the associated use of fossil fuels for energy is altering weather systems, exacerbating droughts and rainfall events, and challenging food security once more. Furthermore, supply chain disruptions and war have led to input price increases (inflation) not experienced in 40+ years and already small margins are being eroded by many in food production.

In addition to the biological and economic challenges to sustainable food production outlined, social challenges have recently come to the fore. The ubiquity of social media has led to mis- and disinformation circulating widely on the contribution that different foods make to environmental sustainability challenges and human wellness; this and humanity’s tendency towards confirmation bias and ‘banding’ with like-minded individuals have established a greater divide between science and society and between farmers and those consuming food.

With challenges, of course, come opportunities. As a science society, we need to embrace these opportunities to ensure sufficient high quality nutritious food is enjoyed by all in a sustainable future.

## **Revisiting the matching of livestock with their environment in an era of new challenges**

**Dr M D MacNeil**

Deltag, USA

The aim of this presentation is to examine environmental changes that are likely to affect livestock production going forwards, to suggest research agendas that could accelerate addressing new environmental conditions, and to put forth suggestions about how South African farmers might go about better using the available genetic resources.

## **Improving rural livestock – changing the mind set and market availability**

**Dr FV Nherera-Chokuda**

CEO NERPO

Who is changing and for what? All role players (personal, professional, and institutional) and must change to achieve “responsible well- being” for all (inclusive, sustainable, and competitive growth), against a flux of uncertainty and social, economic, and climate change. Historical context indicates that in 1973 the World Bank (WB) identified the rural smallholder producers as the most vulnerable group and as such prime targets for poverty reduction, redressing enormity and discrimination of women, discrepancies in class, age, physical and mental capabilities, and dominants of politics, legal, economics, ethics, and socio-cultural issues. The WB recommended the infamous macro policy change-“structural adjustment programs” in Sub-Saharan African (SSA) countries that resulted in heavy indebtedness, and impoverishment of the smallholder due to massive job losses and loss productive capacity, however the bank and other institutions continue to provide supportive measures. Although millennium development milestones suggest some measurable progress and trends in access to food, shelter and health, the deterioration in access to food and services as shown by the low human development indices is overwhelming.

The situation of South Africa agriculture sector is aggravated by an economically polarized agriculture sector that runs on a dualist system -a developed commercial sector vs the emerging and communal sector which consist mostly of subsistent farmers. Policy changes for privatization of markets by the end of the 20<sup>th</sup> century improved growth of the agriculture sector however, gains on the later sector are not significant as access to cheaper finance and markets is poor. Policies for transformative growth including BBBEEE, policy for the recapitalization and program (agrarian transformation toward vibrant, sustainable, and equitable rural communities), and currently the post-settlement development support and the agriculture masterplan (2030) are some of the enablers for achieving the reality of improved smallholder sector well-being. Supportive producer platforms such as the SERNICK model, Kalahari kid, Nguni initiative, Mohair, National wool growers, Jobs Fund, the KyD and genomics programs, training and research, custom feeding programs, strategic commodity interventions (NERPO) among others are enabling commercialization and market access for the emerging sector, however at a snail pace. The communal sector has been renegaded to subsistence level interventions due to land policy issues which leaves millions of households impoverished. At country level the Redmeat Industry, is adopting inclusive development model to achieve offtakes of at least 250 000 high quality weaners from the smallholder sector by 2030 and vertical integration. At regional and continental level, the Africa Union international Bureau for Animal Genetic Resources -through the Live-2-Africa program, One Health and CCARDESA programs are developing and implementing continental and regional appropriate interventions for integrating the smallholder livestock producer in the redmeat and live animal value chains. Access to finance, however, remains the biggest constraint for livestock farmers.

The smallholder sector is complex and diverse, hence the challenge is for us all is to develop new and share knowledge, act and make things better for all.



## **Meat Traceability – its impact on South African producers and international markets**

**Dewald Olivier**

SAFA

South Africa has long been discussing the possibility of implementing a National traceability system. Many discussions in boardrooms, around braai's and on farms were held and every conclusion was that a traceability system in the livestock industry would solve a multitude of the issues that the value chain has to deal with daily.

When we think of traceability we inadvertently think of cattle and not necessarily meat. However, if we do not use traceability in livestock for disease control, what would we then be using traceability for? Traceability is an instrument to traceback the origin of a product or the roadmap that the product or item took to reach its destination. This roadmap could include as little or as much information as you would like.

Many commentators refer to data as the new oil. The red meat value chain as a collective can tap into data and utilise data collected over the lifespan of the product as a competitive advantage, nationally and internationally.

Meat Traceability can have an immense advantage to the price of livestock and red meat products, how will we use the data to our advantage and what are the South African red meat value chain's strategy?

## **Biosecurity measures**

**Prof Neil Duncan**

Poultry Consultant and Veterinary Pathologist

Biosecurity must be an essential component of all animal production systems. While biosecurity measures are more detailed in the high intensity production systems of pigs and poultry, the basic principles apply to all systems.

As they say: It ain't complicated – it's actually all common sense, but systems have to be in place to prevent the introduction of disease and often the main challenge is the people. Everyone, not just the staff, must be educated and informed so as to comprehend the devastating effect the introduction of a disease into the operation will have. Taking into consideration the human factor, systems must also be in place to enforce compliance.

**Fundamental aspects of successful livestock production on veld: Challenging conventional wisdom.**

## **Johann Zietsman**

### **Six Decades of Performance Testing**

What can cattle breeders show for over sixty years of performance testing?

Limited research and much anecdotal evidence point to the fact that the “unimproved” breeds outperform the “improved” breeds in veld tests. The best that has been achieved by conventional performance testing is the breeding of genotypes that require greater inputs (feed; chemicals; medicine) in order to be “productive”.

### **The Complexity and Simplicity of Nature**

In the natural world interactions are non-linear leading to great complexity. Studying or concentrating on detail, therefore, has little or no relevance to a whole comprising a myriad of non-linear interacting “parts”. For example, selecting for absolute growth or feed conversion efficiency (kg feed: kg gain) results in indirect selection for low inherent body condition which is a fundamental requirement for veld productivity (practical fertility). Rather than focusing on detail in order to achieve a desirable outcome we should focus on a desirable outcome that reflects an appropriate interaction of all detail.

### **The Role of Cattle**

Cattle have a dual role - efficient grass conversion **and** veld improvement.

#### **1. Efficient grass conversion.**

Current selection criteria are resulting in “lean and ‘efficient’ (feedlot)” genotypes that are inefficient grass converters (low inherent body condition).

#### **2. Veld improvement.**

Prerequisites of veld improvement and higher stocking rate are non-selective grazing and high animal impact. A genotype with high inherent body condition is essential in order to achieve acceptable individual animal performance (cow fertility; fattening ability).

### **Goal**

The biggest paradigm shift required is changing from the current goal of “maximum production / profit per animal” to “maximum sustainable profit per hectare”.

Most breeding and management practices for either goal are diametrically opposed.

### **The Foundation of a Veld Productive Genotype**

1. Relative Intake / Grass Conversion Efficiency / Inherent Body Condition
2. Hormonal Balance

**Maximum sustainable profit per hectare** can only be achieved through **high stocking rate** and **high fertility**

### **Summary**

In order to go forward we need to look backwards:

### **Mimic Nature**

### **Use “Unimproved” Genotypes**

## **Practical application of BLUP/EBV's in grazing livestock systems**

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**Background:** Genetic improvement through selection has been used successfully to increase productivity in livestock. The current state-of-the-art genetic technology used in livestock improvement is called estimated breeding value (EBVs) calculated mainly using the Best Linear Unbiased Prediction (BLUP) methodology or its current variants such as Genomic BLUP (GBLUP) and similar statistical methodologies. Recently, the livestock breeding sector has witnessed a proliferation of EBVs which inadvertently creates challenges in breeding as it is sometimes not easy for breeders to distinguish indicator traits from economically relevant traits. While significant progress has been made to improve the accuracy of EBVs, limited progress has been made in terms of development and adoption of breeding objectives especially in extensive livestock production systems. Therefore, breeding for adaptation in extensive grazing systems has remained largely elusive.

**Aim:** This paper reviewed progress made in practical breeding programmes in South African grazing systems and proposed an approach that could be followed to breed genotypes that are adapted to extensive grazing systems using EBVs.

**Discussion:** The definition of clear breeding objectives is a critical step in designing a breeding programme. This is even more important in extensive grazing systems where environmentally optimal genotypes are defined by production constraints inherent in this production system. Application of EBVs without due consideration of the limitations imposed by the grazing system would result in breeding for genotypes that are less adapted and not productive.

The EBV technology is an effective tool if used with due cognizance to the contextual production environment. Unfortunately, use of EBVs technology in the context of narrow selection goals based mainly on growth and easy-to-measure traits with minimal attention to reproduction and adaptation has resulted in less adapted genotypes especially in extensive grazing systems. The use of EBVs to improve production in grazing systems requires careful attention to balanced breeding objectives that takes into consideration the production environment.

**Conclusions:** Constraints imposed by extensive grazing systems should receive careful considering when designing breeding programmes under this production system. Specific recommendations are made about breeding programmes that should be considered for sustainable beef production under grazing systems. Breeders should set realistic selection targets to breed optimal genotypes for sustainable livestock production under extensive grazing system.



## **The 21<sup>st</sup> Century Animal Scientists: skills and mindset for the future**

**Mrs. Jackie Tucker, Keystone Collection**

Animal science studies form part of the integrated area of the STEM (science, technology, engineering, and mathematics) approach to learning. With agriculture being the backbone of our society, this highly technical and scientific field, offers many job opportunities in an attractive and dynamic industry. The current structures of under/postgraduate programs focus on science and research and primarily train animal scientists for the commercial livestock industry, which contributes 48% to the total gross value of agricultural production in South Africa. The traditional teaching models of modern animal science cannot be fully replaced, however there is a need for future professionals to have further capabilities. There is a need for multidisciplinary approaches that address modern-day topics, find solutions to grand challenges, and drive economic development. Navigating the modern-day world requires the development of so-called T-shaped skills, where depth in discipline specific knowledge is balanced by a breadth of soft skills. Taking into consideration the importance of entrepreneurship that is expected in economic development, these combined skill sets must be positioned as essential supplements to disciplinary knowledge.

The increased demand for sustainable food security offers new opportunities for creative animal scientists who can work and communicate across disciplines and adopt new problem-solving and strategic thinking skills. It is envisioned that agricultural scientists will play an important role in assisting scientists from other disciplines in addressing sustainability issues such as global warming in a more holistic and sustainable approach. People need to be learning faster than the rate of change happening in our world, therefore, we require creative and innovative people that are focused on humanity, integrity, and ethics in business to look at challenges and opportunities differently.

## **Effects of Bioresource groups on scavenging indigenous chicken production systems, population demographics, reproduction characteristics and challenges in KwaZulu-Natal**

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**Background:** KwaZulu-Natal has different ecological zones which have effects on differences in rainfall and temperature. Such variations determine the type of farming and levels of production. This in turn has the potential to affect productivity and management systems of indigenous chickens. Therefore, understanding the effects of different ecological zones on chicken production systems will unveil more information to determine the type of farming system suitable for each ecological zone.

**Aim:** The aim of the study was to determine the effects of different ecological zones (bioresource groups (BRGs)) on indigenous chicken production systems, population demographics, reproduction characteristics and challenges. It was hypothesized that the different ecological zones will not affect indigenous chicken production systems.

**Methodology:** Structured questionnaires (250) were administered in face-to-face interviews with farmers in five BRGs (BRG 1, 5, 8, 14 and 22). Data were collected on indigenous chicken population dynamics, reproductive characteristics and challenges affecting their productivity.

**Results:** Bioresource groups did not affect ( $P>0.05$ ) the total number of birds. However, chick numbers were highest ( $P<0.05$ ) in BRG 14. The total number of adult birds and cocks were highest ( $P<0.05$ ) in BRGS 1, 5 and 14. Birds in BRG 5 and 8 were provided with more ( $P<0.05$ ) feed per day than in the other three. Chickens in BRGs 1 and 8 forage for longer ( $P<0.05$ ) distances. The percentage of laying hens was higher ( $P<0.05$ ) in BRGs 1, 8 and 22 while more hens were brooding in BRG 14 and less ( $P<0.05$ ) in BRG 4.

**Discussion:** Indigenous chickens are widely adaptable to different ecological conditions.

**Conclusion and recommendations:** It was concluded that BRG impact was minimal but could be higher if the challenges faced by farmers could be minimized. Future studies should focus on minimising challenges to farmers.

## The role of effective microorganisms on broilers' performance, litter odour emission and other gases

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**Background:** Poultry production is one of the fastest growing segments of agriculture and animal husbandry sector. This is because the layer and broiler production systems do not only produce a good source of protein but a cheaper one as well. These cheaper protein sources are available to all class levels in the community. Because of the higher demand for cheap protein in the market, it has the potential to eliminate poverty in less fortunate communities and promoting entrepreneurship. The massive increase in intensive poultry production has led to high odorous gas emissions which have a negative effect on the environment, the production system, animal health, works and communities around the farm. Numerous strategies have been investigated but odour and high emissions of potential hazardous gas remain a problem.

**Aim:** The aim of the study is to investigate the role of effective microorganisms (Prowell L) on broiler performance, litter odour and other gaseous emissions. It was hypothesized that effective microorganisms (EM) will not effect broiler performance, litter odour and other gaseous emissions.

**Methodology:** A six-week biological experiment study was conducted at the University of Zululand on a poultry farm. A total of 180 broiler chicks bought from National Chicks, Petermaritzburg, were randomly assigned to 4 treatment groups with 3 replicates of 15 birds each. The birds were reared in brooder cage system for first two weeks (0-14d), then placed in grower cages for 2 weeks (15-28d) and another 2 weeks (29-42d) for finisher till the end of the experiment. Effective microorganism (EM) was provide in water (T1), feed (T2), water and feed (T3) and no EM as control (T0). Broiler performance was examined which included water intake, feed intake, weight gain, feed conversion ratio and carcass characteristics. Gaseous emissions were trapped from different litter and determined using a coupled Varian 3800 gas chromatograph (GCMS).

**Results:** Broiler feed and water intake in the first two weeks did not vary ( $P>0.05$ ) across the weeks in all treatments. Water intake increased in week 5 and 6 for all treatments but was the highest ( $P<0.05$ ) in T3. Feed intake decreased for all treatments in week 5 and 6 except in the control. No significant differences ( $P>0.05$ ) were observed between treatments in ADG from week 1 to 5 but week 6 tended to increase from control to T1, T2 and T3. The highest ( $P<0.05$ ) ADG was seen in T3 birds. Feed conversion ratio did not differ from week1 to 4 between treatments. However, T2 seem to showed the lowest ( $P<0.05$ ) FCR than T3, T1 and the control from wk5 to wk6. A total of 51 gases were detected in this experiment. These gases were grouped into nine groups namely; alcohols (6), aldehydes (2), aliphatic acids (10), furans (4), terpenes (8), ketones (3), phenolics (9), sulphur compounds (3) and nitrogen compounds. Aliphatic compounds, phenols and ketones were the highest compounds produced. It was also observed that diet on its own had an effect on gases emitted which increased from starter to grower. Treatment with EM decreased gas emissions with T3 showing the highest reduction of gases.

**Discussion:** This study showed that effective microorganism supplementation does not only have the potential to decrease gaseous emissions but can decrease the cost of production since feed intake decreased with T3 treatment without any significant difference in weight gain when compared to the control. The study also revealed that there are so many other non-odorous compounds that are being emitted from chicken litter that can have the potential to be odorous. Prowell L (EM) could be recommended for odour control because of its dual effect especially at T3 supplementation. EM potential to decrease odour was similar to other studies and its mechanism was suggested to be its ability to destroy harmful bacteria and promote a healthy environment.

**Conclusion/recommendations:** It was concluded that type of feed had an effect on type and number of gases emitted while treatment of broiler feed or water with EM decreased feed intake and increased water intake from week 5-6. Treatment T3 showed the highest potential to decrease gases in poultry. production systems. However, further experimentation in a larger production system is required for better application on-farm.

## **Mating strategies, stillbirth incidence and other factors on sow productivity in Landrace and Large White crossbreeding programs**

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**Background:** Sow productivity performance is central to profitable pig productivity. Favourable increases in productivity using narrow breeding goals lead to undesirable consequences. Mating strategies were designed to also improve performance of sow reproductivity.

**Aim:** The study evaluated the mating strategies, stillbirths and other factors affecting sow productivity traits of Landrace and Large White crosses. Different mating strategies, incidence of stillbirth, sire line, sire breed, dam breed, filial generation, dam parities, birth seasons and birth years do not affect sow productivity traits of Landrace and Large White crosses.

**Methodology:** A total of 6245 sows with complete reproductive and growth performance records from a commercial pig farm in Limpopo Province were used. The dataset from 2009 to 2020 evaluated the following factors; sire, mating strategies, sire line, dam breed, sire breed, filial generation, piglet sex (male, female), dam parity (1-8), birth season (summer, autumn, winter, spring) and birth year to assess the degree of performance on litter size (LS), incidence of stillbirth, number born alive (NBA), birth weight (BW), pre-weaning litter mortality (PWM), weaning weight (WW), and average daily gain (ADG). The significance of fixed effects was tested by conducting least squares analyses of variance using the GLM procedure of Minitab 18.1 statistical software.

**Results and Discussion:** Piglet sex and season of birth did not significantly affect the performance traits. The Large White double backcross showed significantly higher performance results across all sow productivity traits as follows: LS (15,60); NBA (15,60); BW (1,58); WW (10,25); ADG (0,31) and PWM (0%), significantly followed by the Large White double cross and the Sire Landrace DBC respectively. NBA significantly declined as the number of stillbirths occurrence increases whereas PWM increased with an increase in number of stillbirths. The parental generation has shown exceptional results for all traits of concern. The first filial generation (F1) had the lowest NBA hence the highest PWM. The parity number had a significant influence on sow productivity traits ( $P < 0.05$ ). Parity was positively correlated to LS, stillbirth and year. Stillbirths was positively correlated to PWM ( $r=0,612$ ) and negatively correlated to year ( $r=0.152$ ). Other correlations were not significant.

**Conclusion/recommendation:** Season of birth and piglet sex do not influence performance traits. Between parental purebreds and their F1 crosses there were considerable breed variances. To represent favourable mating strategy effects on all traits, double backcross of Large White sows significantly improved all sow productivity traits. Optimal strategies are required to reduce PWM associated with an increased number of stillbirths with the aim to maximize the overall productivity and make genetic selection more efficient. Suitable selection programs and mating strategies are necessary for improving reproductivity of sows.

## Impact of Heartwater (*Ehrlichia ruminantium*) Vaccination on Mineral Homeostasis as reflected in Bone, Faecal and Blood Phosphorus, Calcium and Magnesium in Friesian calves reared in South Africa

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**Background:** There is currently no information on the effect of heartwater (*Ehrlichia ruminantium*) vaccine in faecal, bone and blood mineral concentrations of Friesian calves reared in South Africa.

**Aim:** This experiment was therefore, conducted to determine the effect of heartwater vaccine on phosphorus, calcium and magnesium status of bone, faecal and blood in Friesian calves reared in South Africa.

**Methodology:** The study was performed in Molelwane village of North-West Province, South Africa with an annual rainfall of 390 mm maximum. Sixteen dairy Friesian calves with a mean body mass of 100 - 300 kg were randomly assigned into two groups designated treated and control. Experimental calves were given water and roughage composed of 50% lucerne and 50% buffalo grass ad libitum and the study lasted for 6 weeks. Calves in the treated group received heartwater vaccination via intravenous administration of a cryopreserved preparation of blood taken from a sheep infected with virulent *E. ruminantium* organisms of the Ball 3 genotype, whereas those in the control group were not vaccinated and served as the control. Faecal, blood and bone samples were collected from both groups and analysed statistically.

**Results and Discussion:** The results indicated that there was no significant difference ( $p>0.05$ ) between calves in control and treated groups in faecal and bone phosphorus and magnesium concentrations. Similarly, there was no significant difference ( $p>0.05$ ) between calves in control and treated groups in blood phosphorus levels. However, the reverse was the case for conical bone thickness. Calves in control group had significantly ( $p<0.05$ ) higher bone calcium concentration than those in treated group. In contrast, calves in control and treated groups had similar ( $p>0.05$ ) faecal calcium concentrations.

**Conclusion/recommendation:** The calcium contents of bone were influenced by heartwater vaccination, indicating that calcium supplementation should be given to calves during heartwater vaccination.

## **Modelling environmental suitability and estimating effective population size of South African indigenous chickens: Implication for conservation**

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**Background:** Indigenous chickens are important animal genetic resources and are well adapted to prevailing production and climatic environments. Currently they are threatened by genetic extinction due to changing production systems to suit new and emerging markets, diseases and predators. Small populations become vulnerable to extinction due to decreased genetic diversity and they become less resilient to environmental changes, leading to unfit alleles within a population and high inbreeding levels, affecting their ability to survive and reproduce.

**Aim:** To investigate the environmental suitability of indigenous chickens and estimate the risk status in uMzinyathi and Harry Gwala Districts of KwaZulu-Natal, and Capricorn District and Sekhukhune District of Limpopo Province, South Africa.

**Methodology:** Blood samples were collected in 21 villages, in Capricorn and Sekhukhune districts 88 and 144 indigenous chickens were sampled respectively and in Harry Gwala and uMzinyathi 27 indigenous chickens were sampled for each districts. Genomic DNA was extracted from dried blood on FTA using QIAamp micro kit and SNP genotyping was done using Illumina chicken iSelect SNP60k beadchip. Plink software was used for quality control. To portray the population structure PCA and admixture analysis were used. For PCA adegenet package in R was used to plot PCA and for admixture analysis LEA package was used and each Q files produced were visualized using Genesis software.

**Results:** Preliminary results of population structure analysis indicates the genetic variation among individuals and admixture analysis infers the most probable ancestry among individuals. PC1 in accounted for 3% of total variance and PC2 accounted for 2.82% , with both districts having some few outliers. The optimal K-value for admixture was K= 3 , by increasing K to 8 showed that that some individuals remained separated from the rest of the population for both districts.

**Discussion:** The analysis of population structure involves the identification of shared genetic variations among individuals and the grouping of similar individuals into subpopulations. This indicates that there is genetic variation among some individuals from both districts and with such indication the hypothesis of study is that the estimated effective population size and investigated environmental suitability of indigenous chicken will be significantly different among individuals.

**Conclusion:** Assessing the population structure indicated the level of genetic diversity and population differentiation. This is of importance as it will assist in conservation strategies, such as the recovery of small and inbreeding populations and management of important genetic resources for future demands.



## **Application of convolution neural networks in the detection and quantification of tick burdens on cattle**

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**Background:** Currently, it remains a challenge to accurately quantify tick infestation levels on cattle to effectively select for tick resistance using conventional tick counting methods. This study explored the convolutional neural networks algorithms for detection and quantification of tick burdens on cattle.

**Hypothesis:** The present study aimed to evaluate the efficacy of convolution neural networks in detection and quantification of tick burdens on cattle as an alternative for conventional visual methods. It is hypothesised that application of CNNs on the algorithms can detect and quantify ticks in cattle.

**Methodology:** The dataset with 1124 thermograms captured using a FLIR ONE camera (FLIR Systems) was used in this study. An area with a known number of ticks was labelled as the region of interest (ROI). Animal care procedures throughout the study followed protocols approved by the Research Ethics Committee: Animal Care and Use (REC: ACU) at Stellenbosch University, protocol number ACU-2020-14957. Deep learning (DL) algorithms for image classification were trained using two DL architectures, viz, ConvNet and MobileNet. The algorithm was evaluated and validated for rapid and accurate tick detection.

**Results and discussion:** The transformation of images during training was observed. When training with ConvNet, the training accuracy gets closer to 90% while the validation accuracy stalls at 60%. The validation loss reached its minimum after only 15 epochs. For MobileNet, data augmentation and feature extractor layers were rescaled using Keras Functional API to build a model. After fine-tuning, the model nearly reaches 98% accuracy on the validation set. The performance of the model was evaluated on new data using a train set. After evaluation, the model was then ready to predict the number of ticks in a thermogram. .

**Conclusion:** The algorithms trained with convolutional neural networks (CNNs) to detect and quantify ticks on cattle successfully produced accurate tick counts. The results proved that CNNs can be used to enumerate ticks on cattle as an effective alternative method to the conventional visual counting methods.



## Genetic and environmental parameters for behavioural responses towards humans in farmed ostriches

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**Background:** The relationship between commercially farmed ostriches and humans has been inconsistent due to their wild and unpredictable behaviour, as well as a lack of clearly defined management practices. However, some birds demonstrate a willingness to associate with humans. Recent literature has suggested that extensive human care shortly after hatch led to several subsequent benefits. Therefore, ostrich behaviour towards humans could presumably be improved by genetic selection and/or modifying husbandry practices.

**Aim:** To study the effect of early human-ostrich interactions on behavioural responses towards humans later in life, while also estimating genetic parameters for behavioural responses towards humans.

**Methodologies:** A total of 1 092 mixed-sex juvenile ostriches that were exposed to 4 treatments with varying levels of human presence and interactions (Human Presence 1- HP1; Human Presence 2- HP2; Standard and Foster) for 3 months after hatch were used. HP1 birds were exposed to human voice, gentle touch and visual interactions, while HP2 birds were exposed to human voice and visual interaction, but without touch interactions. The Standard treatment were chicks reared using the standard chick rearing practice at the research farm with human presence limited to feed and water supply, while Foster birds were raised by foster parents. Behavioural responses to human observers recorded during observations sessions at flock level included willingness to approach a human, allowing touch interactions, keeping a distance, as well as wing flapping and excessive pecking. In addition, heritability was estimated for the recorded behavioural traits. Data from this study was analysed using ASReml software. (Ethical approval: Ref No.: R13/81).

**Results:** HP1 and HP2 birds were more inclined to approach the human and allow touch interactions, while they were less likely to keep a distance from the human compared to Standard and Foster reared birds ( $P < 0.001$ ). In addition, HP1 and HP2 birds were more willing to interact with a familiar than an unfamiliar human recorder ( $P < 0.05$ ). Males were more likely to approach, allow touch interactions and engage in wing flapping, while they were also less likely to keep their distance from the human compared to females ( $P < 0.001$ ). Heritability estimates for willingness to approach the human handler, allow touch interactions, keep a distance, wing flapping and excessive pecking were high at  $0.55 \pm 0.02$ ,  $0.54 \pm 0.02$ ,  $0.55 \pm 0.02$ ,  $0.33 \pm 0.02$  and  $0.38 \pm 0.03$ , respectively.

**Discussion:** The human-ostrich relationship can be improved by integrating extensive human presence and regular gentle handling in the husbandry practices for ostrich chicks as well as by selection for desirable behaviour.

**Conclusion/Recommendations:** Extensive human presence and gentle handling will improve human-ostrich interactions in the short-term. Selection of birds willing to associate with humans could accelerate domestication of the species in the longer term. Further research should focus on genetic correlations of temperament traits with other traits of economic importance.

## **Assessing the efficiency of smallholder wool farmers in the changing paradigms in South Africa**

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**Background:** In South Africa, wool farming plays an important role as a source of livelihood for many smallholder farmers. However, there has been a continuous decline in national wool production over the past three decades (Cape Wools SA, 2019). The lack of research evidence on efficiency levels of smallholder wool farmers in the different sheep production systems hampers effective policymaking on optimal allocation of resources to improve efficiency of wool farming.

**Hypothesis/Aim:** The purpose of this study was to analyse the efficiency of smallholder wool farmers and identify the determinants of technical inefficiency in smallholder wool production in Thaba 'Nchu and Botshabelo.

**Methodology:** A multistage sampling technique was used to select 351 participants. The study used a quantitative research design. An exploratory survey which applied both questionnaires and interviews was utilized, and a stochastic frontier model was employed to analyse the efficiency of wool farmers.

**Results:** The results show that feed cost and veterinary cost have partial production elasticities of -0.21 and -0.18, respectively. Non-farm income, poor extension services and poorly managed farmers' associations have a positive and significant coefficient. The results also show that the coefficient of social media and wool quality are negatively signed and has a statistically significant influence on the variation in efficiency of wool production. The results further show that only 7% of smallholder wool production farms in this study were found to be efficient, with scores ranging between 0.81 and 1.

**Discussion:** The better the wool quality and use of social media, the higher the probability of farmers production efficiency. Feed cost, veterinarian costs, non-farming income and poor extension services have a positive correlation with the inefficiency of smallholder wool farmers– a finding supported by Zewdie et al. (2021). Furthermore, only 7% of smallholder farmers are efficient and most smallholder wool farmers are not producing at full capacity. Therefore, there is much room to improve production.

**Conclusion/recommendations:** The study recommends that smallholder wool farmers are trained in the correct methods to improve wool quality and, consequently, increase the wool price they can obtain. The study also recommends improvement of extension services, better management of farmers' associations, production of feed by farmers and utilisation of free government-supplied veterinary services to improve the overall efficiency of smallholder wool production in Thaba 'Nchu and Botshabelo.

## Ovicidal and larvicidal activity of indigenous medicinal plant extracts on *Haemonchus contortus* in sheep

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**Background:** Gastrointestinal nematodes like *Haemonchus contortus*, challenge profitable animal agriculture, especially sheep production. Unfortunately, these helminths have developed resistance to the commonly used pharmaceutical anthelmintics. The quest for more effective anthelmintic alternatives prompted this investigation into the use of ethno-medicinal plants like *Leucosidea sericea* and *Monsonia burkeana*. These indigenous plants are traditionally used by smallholder livestock farmers for ethnoveterinary purposes. Therefore, parasitological investigations to determine the plants' anthelmintic activity against the eggs and larva of *H. contortus* was conducted.

**Aim:** This experiment aimed to determine the in vitro anthelmintic activity of the extracts from two indigenous medicinal plant species against the different developmental stages of *Haemonchus contortus*. It is hypothesized that since these plants are traditionally used to treat internal parasitism in ruminants, they may possess anthelmintic properties.

**Methodology:** Plant extracts from leaves were prepared using different solvents. For the Egg Hatch Assay (EHA), faecal samples from naturally parasitized sheep were collected and sent to the Veterinary Laboratory. *H. contortus* eggs were isolated and concentrated to 50-100 eggs/200µL and aliquoted into a 96 microtiter plate. An Albendazole drug group was used as the positive control (PC). All plant extracts, including the PC, were prepared with concentrations of 1, 0.5, 0.25, 0.125 0.0625 and 0.0313 mg/ml, and replicated thrice. The same procedure was used for the Larval Development Assay (LDA), after the incubation of faecal oocytes to yield the L<sub>3</sub> larval stage. All procedures were carried out according to the guidelines of the World Associations for Advancement of Veterinary Parasitology (WAAVP). The IBM® SPSS® software was used for statistical analysis.

**Results:** Results showed that *L. sericea* extracts generally recorded higher egg inhibition than the extracts of *M. bukeana* and PC. Both PC and acetone extracts of *L. sericea* exhibited 100% larval inhibition at 50 µg/mL and 25 µg/mL respectively. Comparison of the LD50 revealed that *L. sericea* recorded lower values than *M. burkaena* in the Probit Analysis.

**Discussion:** It was noted that at a lower concentration of 25 µg/mL, *L. sericea* exhibited better larval inhibition than the Albendazole drug group. The lower LD50 values observed with *L. sericea* may indicate that small doses of *L. sericea* are capable of both ovicidal and larvicidal activities.

**Conclusion/recommendations:** It is concluded that the acetone extract of *Leucosidea sericea* exhibited the highest relative inhibition and anthelmintic activity against *Haemonchus contortus* eggs and larva. The cytotoxicity evaluation of both plant extracts and their in vitro synergistic action is recommended.

## An update on the ecological distribution of free-living ticks infesting cattle in the Eastern Cape Province

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**Background:** The seasonal dynamics and tick distribution are of significance in the epidemiology of tick-borne diseases. Tick abundance varies with time, habitat, agro-ecological zones and species to species due to variations in the daily duration of light and darkness to which an organism is exposed.

**Aim:** Free-living and engorged ticks of cattle vary with agro-ecological zones and season in the Eastern Cape Province, South Africa. The study aimed at determining the distribution of questing ticks under different ecological zones in the western-central regions of Eastern Cape Province.

**Methodologies:** Free-living ticks from six replicate drags of the vegetation over a period of 1 year at Bedford Dry Grassland (BDG), Kowie Thicket (KT) and Bhisho Thornveld (BT). Special attention was paid to the lower perineum, neck, dewlap and ventral body parts which are the preferred sites for blue ticks during sampling.

**Results:** In this study, 9 species of ticks which grouped under 5 genera were identified. The identified species of ticks were *Amblyomma hebraeum*, *Haemaphysalis elliptica*, *Hyalomma rufipes*, *Ixodes pilosus*, *R. (B.) decoloratus*, *R. appendiculatus*, *R. evertsi evertsi*, *R. follis* and *R. simus*. Of the ticks ( $n = 2885$ ) collected from the vegetation, *R. (B.) decoloratus* was the most abundant species with a relative prevalence of 58.16%, followed by *R. appendiculatus* (18.37%) and *R. evertsi evertsi* (16.90%). Least abundant ticks were *H. rufipes* (2.98%), *A. hebraeum* (2.46%), *H. elliptica* (0.38%), *R. follis* (0.34%), *I. pilosus* (0.24%) and *R. simus* (0.17%). The distribution of *R. (B.) decoloratus* ticks differ significantly ( $P < 0.05$ ) among the vegetation types. Significantly more ( $P < 0.05$ ) engorged *R. (B.) decoloratus* were collected in KT during summer season ( $1.39 \pm 0.063$  females and  $1.30 \pm 0.063$  males) compared to other vegetation types. The *R. (B.) decoloratus* larvae were significantly higher ( $P < 0.05$ ) in BT ( $20.56 \pm 1.154$ ) and KT ( $18.50 \pm 1.154$ ) vegetation types during the spring season.

**Discussion:** The distribution and abundance of tick species infesting cattle in the Eastern Cape Province vary greatly from one area to another. From the overall tick species recovered from the tick survey, *R. (B.) decoloratus* were found to be the most abundant in the study areas when compared to other tick species. This study presents a high count of adult *R. (B.) decoloratus* in thicket regions during the summer season compared to dry grassland and thornveld veld types respectively.

**Conclusion/recommendations:** In conclusion, agro-ecological differences and seasonal variations had an influence on tick abundance and distribution. The aforementioned absence of *R. (B.) microplus* in this study highlights the importance of further research as this tick invades new areas previously colonised by *R. (B.) decoloratus* in the continent.

## Characterization of small-scale broiler production in rural areas of Limpopo Province, South Africa.

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**Background:** Broiler production is an important subsidiary occupation that supplements the income of small-scale farmers in most developing countries. Although the indications are that small-scale broiler production is a profitable venture, insufficient knowledge and skill to manage resources make farmers vulnerable to a number of challenges. Therefore, this study was carried out anticipating that the findings will assist in addressing the production gaps faced by small-scale broiler producers of the Limpopo Province and it provides baseline data to complement the decision-making process ultimately to improve future extension interventions.

**Aim:** The study was aimed at characterization of the small-scale broiler production in Limpopo Province. Small-scale broiler producers lack knowledge in broiler husbandry, disease control and marketing.

**Methodology:** The study was conducted on 124 randomly selected small-scale broiler producers in five districts of Limpopo Province South Africa; using structured questionnaires through personal interviews. Data were analysed using the one-way frequency of SAS (2022).

**Results:** The majority of respondents were between 51-65 years (41.93%) old with over five years' experience in broiler farming. About 51.61% of producers have received training in broiler production whereas 70.97% indicated that they still need to be trained. Record keeping was well practiced and 96.77% of farmers used a deep litter system (wood shavings). Most of the producers (91.13%) don't measure broiler house temperature and only 91.13% practice brooding of chicks. Feed was purchased from local feed suppliers. Only 19% of the small-scale broiler producers practice restrictive feeding and 55.65% of them record feed supplied to the broilers. The majority of respondents were accustomed to vaccinating their chickens. The selling age of broilers ranged between <6 weeks (16.93%) and 6 weeks (70.97%). Their market was dependent on selling live chickens to the community 65.32% while 34.69% depended on both vendors/hawkers and the community for sales.

**Discussion:** It was observed in the study that broiler production was more practiced by older producers than the youth. Moreover, a high number of producers need to be trained as they understood that trained producers were more efficient and profitable compared to those who have no training on broiler production. Feed restriction was used by producers to decrease mortality and sudden death syndrome to a certain extent and to reduce feed costs. Furthermore, vaccination of chickens was well practiced among the small-scale broiler producers. Small-scale broiler producers in the province lack slaughter facilities and see the community as their main market.

**Conclusion/recommendations:** Small-scale broiler producers in the province should be trained periodically on various aspects of husbandry, disease control and marketing so that they can apply their knowledge successfully and be sustainable.

## **Determination of the economic and environmental impact of dairy production in South Africa: A system dynamics approach**

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**Background:** Amid the dairy sector's invariable and ongoing cost increases and squeeze on profit margins, it faces mounting pressure to become sustainable and regenerative. Inaccurate interpretations, especially via social media platforms regarding the sector's perceived environmental impact, has become a profound liability. This led to an increasing threat of losing a significant degree of its market share as a protein supplier. This necessitates that the sector, and the producer specifically, demonstrate a positive contribution toward sustainable production through science-based adaptive management practices. It has become critical to effectively calculate, monitor and reduce the environmental impact from dairy farms and assist farmers to become more resilient especially within the complex and integrated systems involved in dairy production. Consequently, a project to calculate and evaluate the on-farm carbon footprint by means of a web-based system dynamics tool was initiated.

**Aim:** The aim of this study is to develop, assess and analyse a web-based system dynamics tool that can assist dairy farmers in calculating and evaluating their on-farm carbon footprint. Through this freely available web-based tool, dairy farmers should be able to take informed actions when incorporating management decisions that can lead to a lower environmental impact and increased resilience towards climate change.

**Methodology:** Given the complexity and interactive dynamics that exist on a dairy farm, a technical tool with the ability to be versatile, model complex systems and investigate a range of different management strategies, a system dynamics method was applied. Key environmental indicators were identified and incorporated in the model, using a combination of existing formulae and where possible, derived from related South-African research. The model encompasses five sub-models, namely herd management, herd energy flow, feed management, GHG emissions and an economic sub-model. Following the development, the tool was tested and calibrated on seven farms. Results were indicated in terms of fat and protein corrected milk (FPCM) produced, per hectare and in livestock units and finally expressed in terms of kg CO<sub>2</sub>e/kg FPCM

**Results:** Evaluation of results indicated emissions varied between 0.49 and 1.14 kg CO<sub>2</sub>e/kg FPCM/kg, using a GWP\* of 8 as the warming potential for CH<sub>4</sub>; which compare favourably to international standards. Comparing the calibrated farms suggested that the environmental sustainability of a dairy farm and its profitability are not conflicting objectives, for example the farm with the lowest emissions per kg FPCM also showed the highest profit per kg FPCM. Furthermore, application of the system dynamics tool demonstrated to be an effective method to assist farmers in better understanding their carbon footprint.

**Discussion:** The web-based tool, backed by science and evidence can assist the dairy sector in measuring and tracking their environmental footprint. This can support the sector in addressing the dual challenge that originates from misinformation about the sector's environmental impact and support farmers to reduce emissions and implement strategies to combat challenges related to climate change. Opportunities for emission reduction and increased resilience include improving feed efficiencies rates, improving herd management strategies, increasing productivity and improving nitrogen use efficiencies.

**Conclusion/recommendations:** This freely available web-based tool indicated it could assist dairy farmers to calculate on-farm, identify the critical environmental indicators and simulate scenarios to determine the best and most profitable mitigation strategies. The tool is under continual development with the aim of introducing additional modules, such as the on-farm carbon sink capabilities.



## Assessment of biochemical methane potential from various agricultural substrates

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**Background:** Anaerobic digestion of agricultural waste is a promising technology for sustainable energy development in South Africa. A significant amount of agricultural waste is generated daily and effectively disposal such highly biodegradable agricultural waste is challenging. Biogas production from agricultural waste such as feedstock can be used to generate renewable energy (biogas) whilst simultaneously disposing the waste in a sustainable manner.

**Aim:** The study aims to evaluate biochemical methane production from various agricultural substrates.

**Hypothesis:** Null hypothesis was used in the study to hypothesize that there would be no significant difference between the means of methane production from different substrates.

**Methodology:** The biochemical methane potential tests were carried out in triplicates using bioprocess control AMPTS II. The substrates used were chicken manure, cattle manure, tomatoes, mixed fruits, mixed vegetables, dog food and co-digestion of mixed vegetables, fruits and dog food. The VS and TS were determined according to AOAC (2000). The inoculum was collected from an already running biogas digester plant. 500 ml digester, with an adequate volume of 400 ml, was used for biogas production, which had a headspace of 150 ml. The temperature of the process was kept constant at the mesophilic temperature of 37°C. The initial and final pH of the inoculated substrates were recorded. The produced biogas was sent to the flow cell to determine the volume of bio-methane. The biogas composition was determined using BIOGAS 5000. Data were analysed using Minitab-19 software.

**Results:** All substrates were significantly different ( $p < 0.05$ ), with tomatoes producing the highest methane production (762.51 Nml/g VS), followed by mixed vegetables (678.60 Nml/g VS), mixed fruits (557.90 Nml/g VS), cabbage (471.61 Nml/g VS) and chicken manure (470.30 Nml/g VS) respectively. The lowest methane production was observed with no significant difference between cattle manure (153.80 Nml/g VS) and inoculum (150.40 Nml/g VS).

**Discussion:** From the results, agricultural waste can be used to generate renewable methane gas. The results also show that different agricultural substrates will produce more methane. For running biogas plants, substrates with the highest methane yield are preferred.



## A comparison of various growth models for the modelling of growth in pure- and crossbred lambs

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**Background:** Implementation of precision livestock farming requires extensive information to be gathered on the production cycle of slaughter lambs. Constructing accurate growth models for crossbred sheep from South African flocks would provide valuable information towards this goal.

**Aim:** The study aimed to monitor and compare the growth of purebred wool (Merino) and dual-purpose (Dohne Merino) lambs relative to various crossbred lines. It was expected that the crossbred lines would grow faster than the purebred lines and, based on literature, that the Gompertz model would provide the best fit for the data.

**Methodology:** Two dam lines, Dohne Merino and Merino, were mated to rams of their own breeds and to three sire lines, namely Dorper, Dormer and Ile de France to generate two purebred control and six crossbred trial groups. Four ram and four ewe lambs from each group were grown out until maturity was reached at one year of age and weighed weekly. Four growth models (Brody, Gompertz, Logistic and von Bertalanffy) were fitted to the age-weight data thus recorded and the accuracy of fit determined. Model parameters were compared among groups using an 8 (breed combinations as specified) x 2 (sexes; male or female) factorial ANOVA in Statistica 14.

**Results:** All four growth models fitted the data well ( $R^2 > 0.86$ ). However, the Brody model overestimated the asymptotic mature weight of the animals and was considered unsuitable. Comparison of RMSE values as well as predicted and observed weights based on results from the remaining models showed that the Gompertz model was the best suited to predict lifetime growth. The A (asymptotic mature weight), c (age at inflection point) and k (maturation rate) parameters of the Gompertz model were compared among genetic groups. No interactions between main effects were present for these parameters and only the A parameter differed between groups ( $P < 0.001$ ). Rams (119.85 kg) displayed significantly higher asymptotic mature weights compared to ewes (98.05 kg). The Dohne x Dormer group (126.96 kg) had the highest and purebred Merinos (96.00 kg) the lowest mature weights respectively ( $P = 0.003$ ). Mean maturation rate and age at inflection point did not differ between either sexes ( $P = 0.721$ ;  $P = 0.115$ ) or genotypes ( $P = 0.204$ ;  $P = 0.378$ ).

**Discussion:** The Gompertz model was deemed to best describe the growth of cross- and purebred lambs in this study, supporting findings from previous studies on pure breeds. As expected, rams were heavier than ewes due to sexual dimorphism. Neither maturation rate (k) nor age at inflection point (c) differed between sexes, potentially due to the high plane of nutrition the animals were on.

**Conclusion:** The better fit provided by the Gompertz growth model confirms its status as the model of choice for predicting the growth curves of lambs. Crossbred lambs achieved higher growth rates than their purebred dam line contemporaries. Hence, crossbreeding may offer a means of improving production output by harnessing the effects of heterosis and breed dimorphism between sire and dam lines.

## Morphological and genetic characterisation of three Mozambican indigenous cattle breeds

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**Background:** Indigenous cattle are major contributors to rural livelihoods and food security in Mozambique (MASA, 2011). They also serve as vital animal genetic resources due to their adaptability to the local environment. Despite their importance benefits, however, limited studies have been carried out to characterise these genetic resources or their genetic relationships with other indigenous cattle populations in the region.

**Aim:** To assess phenotypic and genetic variations among indigenous cattle breeds in Mozambique.

**Methodology:** The study was conducted in four provinces including Maputo, Gaza, Inhambane and Tete. Measurements of different body traits (heart girth (HG), muzzle circumference (MC), body length (BL), horn length (HL), top line length (TL), height at withers (WH), height at rump (RH), rump width (RW), hock circumference (HC) and body weight (BW)) were collected from Angone (n=140), Landim (n=292) and Tete (n=182) cattle populations. General Linear Model and Discriminant Analysis procedures of SPSS were used to analyse these traits. Hair samples from 228 of these phenotyped animals were collected and genotyped with the IDBV3 SNP BeadChip array. South African genotypes, which included SA Nguni (n=150), SA Tuli (n = 150) and SA Boran (n = 150), were included in a between-population analysis. These genotypes were generated using the GeneSeek Genomic Profiler (GGP) 80K panel and compared with the Mozambican Nguni (MZ Nguni) cattle. Basic population parameters, as well as inbreeding based on runs of homozygosity (ROH), were estimated using PLINK v1.09. The effective population size (Ne) was estimated using SNeP version 1.1. Population differentiation and admixture were investigated using principal component analysis (PCA) (GCTA version 1.24; Yang et al.), ADMIXTURE 1.21 (Alexander et al., 2009) and Adegenet, an R package version 3.3.2.

**Results and Discussion:** Landim cattle were significantly ( $p < 0.05$ ) heavier than their Tete and Angone counterparts. A combination of six morphometric traits (BL, WH, HL, RH, RW and TL) could be used for individual assignment using discriminant function analysis, with a success rate exceeding 70% for both Angone and Landim cattle. Population parameters showed limited variation, with estimates of expected heterozygosities ( $H_e$ ) ranging between  $0.304 \pm 0.166$  (Angone) and  $0.329 \pm 0.148$  (Tete). All three populations had low positive ( $0.065 \pm 0.109$ ) inbreeding rates. A downward trend was observed in the effective population sizes of all three populations, indicating a narrowing genetic pool for the genetic resources. Both PCA and admixture analysis indicated poor between-breed differentiation. Medium levels of genetic diversity, measured as  $H_e$ , were observed, ranging from  $0.284 \pm 0.158$  (SA Boran) to  $0.324 \pm 0.153$  (SA Tuli). ROH analysis revealed low inbreeding rates with the average FROH ranging from 0.003 (SA Nguni) to 0.006 (SA Tuli). A high frequency of short ( $ROH \leq 5\text{Mb}$ ) ROH segments suggested ancient inbreeding in all populations. PCA and Admixture analyses revealed a tight cluster of the two Nguni populations, while SA Tuli and SA Boran diverged, as expected, into two distinct clusters.

**Conclusion/recommendations:** This research indicates low genetic differentiation among the studied cattle populations, which could be a consequence of both common ancestry and high gene flow rates. Most importantly, the study confirmed that the MZ Nguni and the SA Nguni have similar genetic ancestry.

## Genetic analysis of predicted gross feed efficiency in first-parity South African Holstein cows

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**Background:** Gross feed efficiency (GFE) is a trait of outstanding importance in dairy production. However, it is not included in the breeding objective for South African dairy cattle. This is mainly due to a lack of dry matter intake measurements from lactating cows, which are required to calculate GFE. Dry matter intake is generally difficult and costly to measure in dairy cattle. Models for predicting GFE phenotypes from live weight and routinely measured milk components were developed in a recent study (Madilindi et al., unpublished), however, there is no knowledge on the genetic aspects of these predicted traits.

**Aim & Hypothesis:** To determine the heritability and genetic change in recent times of GFE predicted from milk components in first-parity South African Holstein cows. It was hypothesized that there is genetic variation in GFE and genetic merit for the trait has changed in recent times.

**Methodology:** Test-day and pedigree data were obtained from the Integrated Registration and Genetic Information System of South Africa. The data consisted of 4,762 test-day records of 1150 first-parity Holstein cows from 8 intensively-fed herds that calved between 2009 and 2019. An equation that was developed in a previous study (Madilindi et al., unpublished) was used to predict daily gross feed efficiency (pGFE) from test-day butterfat yield. Test-day measurements of pGFE were considered as repeated measures of the same trait. The heritability of pGFE was estimated by a repeatability animal model, fitting lactation stage, age at calving and herd-test-day as fixed effects, using the ASReml program (Gilmour et al., 2009). The genetic trend for pGFE across the entire lactation was assessed by plotting average estimated breeding values (EBVs) by year of birth.

**Results & Discussion:** The heritability estimate of daily pGFE was low at  $0.14 \pm 0.05$  for the entire lactation, suggesting that there is scope for genetic improvement of pGFE through selection, although the accuracy of selection would be low. The accuracy of selection may be improved through multiple trait selection, including traits that are correlated with pGFE such as milk and butterfat yields (Madilindi et al., unpublished). The genetic trend showed an increase in daily pGFE in recent years. The average EBV for pGFE increased from -0.014 in 2006 to 0.001 in 2017, which could be a correlated response to selection for a trait that is correlated with pGFE such as milk yield. Positive EBVs were observed from most animals in recent years, demonstrating the existence of young cows that are available to be selected.

**Conclusion & Recommendation:** Genetic improvement of feed efficiency in South African Holstein cattle can be achieved through selection on pGFE, although the accuracy of selection would be low. It might be necessary to explore random regression modelling to improve accuracy of selection for feed efficiency in multi-trait analyses. There has been a marginal improvement in pGFE in the South African Holstein cattle population in recent times, which may be attributable to selection for genetically correlated traits.

## Multibreed genomic predictions in South African Holstein and Jersey dairy cattle

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**Background:** Accuracy of genomic predictions is dependent on the size of the reference population, which requires a large number of genotyped animals. However, assembling a large reference population remains challenging and hence pooling genotypes from different breeds into one multibreed reference population is an alternative to increase the accuracy of predictions. In addition, multi-trait (MT) genomic prediction using single-step genomic BLUP (ssGBLUP) is expected to increase the prediction accuracy more than single-trait (ST) predictions.

**Aim:** To assess the accuracy of multibreed genomic predictions using single-trait and multi-trait models in South African Holstein and Jersey cattle.

**Methodology:** The pedigree and performance data for Holstein cattle are available from the INTERGIS. The edited phenotype data used for analysis contained 1 289 836 lactation yield records (305d) for milk (kg), protein (kg) and fat (kg) traits and the final pedigree data included 865 073 animals. There were 2 574 cattle (1 428 Holstein and 1 146 Jersey) genotyped for 26 600 SNP markers after quality control. The ST, 2-trait MT (MT2) and 3-trait MT (MT3) were used to evaluate EBVs and GEBVs from the ABLUP and ssGBLUP models, respectively. The accuracy of prediction was calculated for all the models as the Pearson correlation between the EBV and the GEBV within each of the 3 validation populations performed separately for Holstein (HOL), Jersey (JER) and combined for both breeds (HOLJER). The ABLUP and ssGBLUP models were classified into two, with breeds treated as one (SAME) and breeds included as a fixed effect (DIFF).

**Results:** The accuracies for ST ssGBLUP in HOL, JER and HOLJER validation populations were 0.12, -0.10 and -0.14 for milk; 0.20, 0.01 and -0.23 for protein and 0.11, -0.15 and -0.22 for fat, respectively using DIFF model. Corresponding accuracies for SAME model were 0.17, 0.06 and -0.08 for milk; 0.10, 0 and -0.17 for protein and -0.19, 0.02 and -0.01 for fat. In MT ssGBLUP model, it was 0.20, -0.090 and -0.15 for milk; 0.28, 0.01, -0.22 for protein and 0.20, -0.14 and -0.22 for fat in DIFF model, while for SAME the accuracies were 0, -0.080 and -0.020 for milk; 0.18, 0.01 and 0.17 for protein and 0.05, -0.14 and -0.14 for fat in HOL, JER and HOLJER validations, respectively.

**Discussion:** The HOL validation group resulted in the highest accuracy for all the models and traits as compared to JER and HOLJER. The MT models resulted in a maximum prediction accuracy that is more than the ST model with protein as the highest amongst the traits. These results are similar to those in other studies, which reported low accuracy of predictions when breeds were combined in reference populations.

**Conclusion:** Accounting for breed as a fixed effect and 2-trait model in ssGBLUP tended to increase the accuracy of multibreed genomic predictions of SA Holstein and Jersey cattle. Holstein as validation showed more improvement as compared to Jersey or the combination of the two breeds.

## The benefit of marker data in the prediction of production traits in South African Merinos: ssGBLUP vs A-BLUP

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**Background:** Genomic selection (GS) has become commonplace in sheep breeding programs in Australia and New-Zealand, but requires validation in South Africa (SA). The vast majority of genotyping of date has been initiated by the research sector, with a large bulk of genotypes originating from Merino resource/research flocks. The development and testing of GS methods in SA currently depends on a reference population consisting of both commercial and research datasets, which have rarely been concatenated in a single analysis. It is thus essential that this structure is appropriately validated for its potential benefits in wider industry.

**Aim:** The aim of this study was to compare the accuracy of single step genomic BLUP (ssGBLUP) to pedigree BLUP (ABLUP) in predicting production traits in South African Merinos from a single analysis including both commercial and research datasets. It was hypothesized that the inclusion of marker data would add accuracy to breeding value predictions.

**Methodology:** Animals in this study originated from 5 resource and 5 commercial Merino flocks and included a maximum of 71842 records for weaning weight (WW), yearling weight (YW), fibre diameter (FD), clean fleece weight (CFW) and staple length (SL). The combined H-matrix was derived using 2811 medium density (~50k) genotypes and the pedigree of 88600 animals using the PreGS90 software. Accuracy of prediction was evaluated by a 'cross-validation' design where the data of candidates were set to missing in order to produce 'part' breeding values (EBV<sub>p</sub>) which could be compared to the estimates obtained from the original 'whole' (EBV<sub>w</sub>) dataset. Validation candidates were assigned according to scenario (I): born after 2013; and scenario (II): born in a particular flock. The accuracy of ABLUP and ssGBLUP was compared according to the "LR-method" following repeated single trait analysis using ASREML V4.2 software.

**Results and Discussion:** In the 'forward validation' design (scenario I), ssGBLUP increased the accuracy of prediction for all traits, ranging between + 0.06 (0.63 to 0.69) for FD and + 0.17 (0.37 to 0.54) for WW. This showed a promising gain in accuracy despite a modestly sized reference population. In the 'across flock validation' (scenario II), overall accuracy was lower, but with larger differences between ABLUP and ssGBLUP, ranging between +0.08 (0.26 to 0.34) for SL and + 0.20 (0.19 to 0.39) for WW. A compromised overall accuracy in scenario II was expected, since prediction could only depend on information recorded in other flocks with fewer and/or more distant relatives, but it was apparent that GS could be a useful strategy for enabling predicting across these boundaries. However, there were marked differences between individual flocks and in selected instances, ssGBLUP did not prove beneficial.

**Conclusion/recommendations:** These results were the first to validate the benefit of genomic information in South African Merinos and including genomic information generally benefitted genetic prediction of production traits. However, it is essential to note that the industry flocks were selected due to their known links to research flocks and the establishment of genetic linkage will remain an essential strategy in further development. The variable results indicate that continuous validation will be essential if GS methods were to be extended to the wider industry. Across-flock predictions of sex-limited or difficult to measure traits should be tested in future.



## Estimation of breed effects and non-additive genetic variation for ostrich slaughter and skin traits

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**Background:** Crossbreeding increases the performance of the hybrids over the midparent value of pure breeds through heterosis. A structured crossbreeding plan can therefore also potentially assist in improving productivity in the ostrich industry. Previous studies on genetic diversity within and between ostrich strains suggested that crossbreeding could lead to heterosis in economically important traits.

**Aim:** To quantify additive breed effects and putative non-additive genetic variation for slaughter and quantitative and qualitative skin traits in three pure breeds: South African Black (SAB), Zimbabwean Blue (ZB), Kenyan Red (KR) ostriches and the reciprocal crosses of the KR and ZB with the SAB.

**Methodology:** The study took place at Oudtshoorn Research Farm. Data from SAB, ZB and their reciprocal crosses (N=666 to 762), as well as of SAB, KR and their reciprocal crosses (N=544 to 594), were analysed separately. The 2x2 diallel crossbreeding design was used for assessing the crossbred combinations. When crossbreeding analyses were conducted, degrees of freedom for genetic groups were used to derive linear contrasts to partition the effects of additive breed, direct heterosis and the damline effect.

**Results:** The ZB strain outperformed SAB birds for most size-related traits. Additive breed effects were significant for slaughter weight (10.4%), crust skin size (3.9%), skin weight (13.4%), crown length (1.5%) and nodule shape score (1.6%). Significant heterosis were found for slaughter weight (4.3%), crust skin size (1.7%), skin weight (3.5%), nodule size score (3.7%) and hair follicle score (12%). Significant damline effects were observed for skin weight (4.1%), crown shape (2.4%), neckline width at the middle (4.5%) and hair follicle score (4.1%). In the analyses involving the SAB and KR and their reciprocal crosses, additive breed effects were mostly similar to ZB strains with SAB. Heterosis estimates were significant for slaughter weight (5.7%), crust skin size (2.9%), crown length (1.7%), crown shape (2.7%) and nodule size score (4.4%). Damline effect was significant for slaughter weight (3.7%), neckline total length (3.9%), neckline crown length (3.4%), neckline width in the middle (5.6%), as well as nodule size score (3.8%). Inclusion of live weight to account for size differences among strains mostly eliminated additive breed and heterosis effects.

**Discussion:** The superior performance of the ZB relative to the SAB could be attributed to positive correlations of size and/or weight with crust skin size as well as nodule traits. The reciprocal crosses outperformed the midparent value of pure breeds for size-related traits, showing that it would be viable to combine the relatively high live weight of ZB with the better reproduction of the SAB for economic gain in a commercial crossbreeding system. Heterosis for slaughter weight between SAB and KR crosses shows that the body weight could be improved above the midparent values by crossbreeding. Hair follicle score was subject to unfavourable heterosis as a high occurrence of hair follicles was observed for the reciprocal cross with the KR compared to the SAB strain, which negatively affects skin quality.

**Conclusion:** ZB and KR birds performed better for weight and size-related traits than their SAB contemporaries. Commercial crossbreeding could improve slaughter weight and other size-related traits of hybrids over the mid-parent value of purebreds. With the exception of hair follicle score in KR birds, subjective quality traits were either improved in ZB and KR birds or their crosses, or were similar to values recorded in the SAB strain. Crossbreeding may thus benefit commercial ostrich production in a structured system based on scientific information.

## **Profiling the diversity of the village chicken faecal microbiota using 16S rRNA and shotgun sequencing data**

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**Background:** Several studies reported that cataloging and annotating the functional role of the animal microbiome can reveal a complex interplay between the microbiome and the host's immune system and metabolism. Next Generation Sequencing (NGS) technology has the ability to detect all of those abnormalities using less DNA than required for traditional DNA sequencing approaches and is also less costly and has a faster turnaround time. The production environment of extensively raised chickens requires adaptable animals and the hypothesis was that the gut microbial population plays a critical role in the animals' ability to thrive.

**Aim:** The aim of this study was to investigate the diversity and within- and between-community variations in village chicken faecal samples using 16S rRNA gene and whole metagenome shotgun sequencing from chicken faecal samples from Limpopo and KwaZulu-Natal provinces. This study was based on the hypothesis that environmental factors have an effect on the gut microbial composition of indigenous chickens.

**Methodology:** A total of 60 village chicken faecal samples, a total of 45 samples for 16sRNA and 15 samples for NGS were collected from individual village chickens from Limpopo and KwaZulu-Natal. Shotgun and 16S rRNA sequencing were carried out on an Illumina NextSeq platform at the ARC-BTP. Principal component analysis was performed to summarize climatic variations between villages, districts and both provinces using only climatic variables with cross-correlation coefficient value (Pearson correlation  $r$ )  $\leq 80\%$ . Analysis of principal components will be performed using R-packages RASTER and STATS. Custom scripts are to be used to handle and represent data in R 4.2.0.

**Results:** Preliminary result showed abundances of Actinobacteria, Proteobacteria and Firmicutes in the faecal samples. These abundances varied per geographical locations, with the greatest variations between provinces. Beta diversity of the bacteria was identified as a result of varying climatic variables and vegetation index.

**Discussion:** The abundance of Actinobacteria, Proteobacteria and Firmicutes is due to them being involved in normal intestinal homeostasis and immunity. Bacterial reads and abundances varied due to exposure to various environmental factors and due to climatic variables. Climatic variables and vegetation indexes varied distinctively between provinces and less variation was identified between districts due to proximity of the chicken. Beta - diversity of the populations showed variation in the samples because of environmental factors.

**Conclusion:** Diversity of the gut microbiota of the sampled populations varies due to exposure to different agro-ecological zones. A further study of the village chicken faecal samples should be initiated to further understand the bacterial effects on the production of indigenous chicken and dysbiosis.



## Effective population size, inbreeding coefficient and risk status classification of Kalahari Red goats from 1977 to 2018 in stud flocks of South Africa

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**Background:** Genetic contribution determines the maximum potential of an animal's performance. Inbreeding has been known to affect responses in growth parameters which may lead to traits of economic importance being affected by inbreeding depression. However, past inbreeding coefficient studies have been done in other goat breeds, making the Kalahari Red goats' study effective.

**Aim:** Assess small population genetic parameters in Kalahari Red goats in stud flocks of South Africa.

### Null hypotheses:

- I. Inbreeding coefficients are the same across different generations of Kalahari Red goats in South Africa.
- II. The effective population sizes ( $N_e$ ) of the Kalahari Red in South Africa are the same across generations.
- III. The Kalahari Red Goats are not at risk of extinction.

**Methodology:** Data was analysed with Brian Kinghorn's Pedigree Viewer© software version 5.5., and the following formulas:

Objective 1: Coefficient of inbreeding -

Objective 2: Effective Population Size -  $N_e =$

Objective 3: Risk status classification - Risk status Classification template

**Results:** Generations 1 and 2 were 0% inbred. From generation 3 there was a steady increase until a peak was reached in generation 8 (68.82%). Generations 9 to 13 had a steady decline in % inbred. The highest inbred levels of 76.36% were noted in generation 14. As of 2018 (generation 17) 67, 91% Kalahari red goats' population were inbred. The  $N_e$  from generation 1-4 was >1000, generations 5-9 experienced a rapid decrease, generations 10-14 had >1000 animals. Generations 15, 16 and 17 had  $N_e$  of 780, 40.78 and 181 respectively. The risk status classes from generations 1-2, 3-9, 10-12, 13-14, 15 and 16-17 was not at risk, endangered, not at risk, endangered, critical and endangered respectively.

**Discussion:** The Kalahari Red goat has a high inbreeding %, meaning they were mated with their parents, siblings and relatives. The  $N_e$  was below the acceptable range, placing the population at high risk of inefficiency in the long run. Therefore, the higher the effective population size the lower the inbreeding coefficient and the risk status classification of the animals.

**Conclusion/recommendations:** As of 2018 (generation 17) 67, 91% of the Kalahari Red goat populations were inbred. The  $N_e$  of Kalahari Red goats was not secure and Kalahari Red goats are endangered. More research should be carried out in future to enhance conservation, utilization and management of indigenous goats, including assessing trait performance and the development of breeding objectives for Kalahari Red goats in South Africa.

## The effect of incomplete reproduction data on the prediction of Genomic Estimated Breeding Values

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**Background:** Selection of replacement animals in a sheep flock based on reproduction should be included as a selection objective because of its direct and indirect influences on the income of the flock. The success in selection of a trait can be hampered and rendered ineffective by the incompleteness and inaccuracy of the phenotypic records for that trait. It is important to note that information on ewes that failed to lamb or rear a lamb until weaning is an integral part of the reproduction data and should not be treated as missing data. Therefore, completeness of reproduction data can be defined as all data with regard to ewes that weaned a lamb, ewes that lambed that did not wean a lamb and ewes that were mated but did not lamb.

**Aim:** The aim of this study was to determine the effect of incomplete reproduction data on the prediction of genomic estimated breeding values in a Merino stud. The hypothesis was that the inclusion of genotypes of a proportion of ewes will have a positive effect on the selection of replacement animals despite incomplete reproduction data.

**Methodology:** Data collected on total weight of lambs weaned (TWW) of ewes born in the Grootfontein Merino stud from 1968 to 2015 were used for this study. The project protocol was approved by the Ethical Committee of the Grootfontein Agricultural Development Institute (AP10/1/3). For the purpose of this study, subsets of the data were created by deleting or including the reproduction performance of ewes. This was done to simulate different levels of data completeness. The first subset (TR; N=3866) included all reproductive data, the second subset (TL; N=3565) included only reproductive data from ewes that lambed and the third subset (TW; N=3340) included only reproductive data from ewes that weaned lambs. Traditional breeding values (EBVs) were estimated using the MIX-99 software package. Genomic breeding values (GEBVs) were thereafter estimated by including genomic data (N=372) with implementation of a Single-Step GBLUP model using the MIX-99 package.

**Results:** The TWW averages for TR, TL and TW were 24.52 kg, 31.28 kg and 36.97 kg respectively and the coefficient of variance decreased from 58.09% for TR to 25.35% for TW. The traditional estimated breeding values (EBV) ranged from -5.51 to 7.22 for TR and the genomic estimated breeding values (GEBV) ranged from -4.99 to 9.72 for TR, -4.95 to 9.65 for TL and -4.63 to 6.63 for TW. The accuracies of the EBV for TR ranged from 9.28 to 38.79 and accuracies of the GEBV ranged from 9.28 to 80.54 for TR, 11.6 to 80.76 for TL and 14.07 to 81.01 for TW. The Spearman rank correlations between the EBV for TR and the GEBV for TR, TL and TW ranged from 0.56 to 0.69.

**Discussion:** The upper boundaries of the GEBVs for TR and TL were in the same order and substantially higher than that of the EBVs of TR, while the upper boundary for the GEBV of TW was substantially lower. The Spearman rank correlation between the EBVs of TR and GEBVs of the three subsets indicated that there was a substantial re-ranking of the animals.

**Conclusion/recommendations:** It can be concluded that despite including genotypes of some animals in the flock, incomplete reproduction data of ewes will have a negative effect on the selection of replacement animals.

## The development of a biological index for cow-calf efficiency for beef cattle

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**Background:** Livestock agriculture is the largest user of land resources in South Africa, where 71% of the surface area is only suitable for extensive livestock farming, which is dominated by beef cattle. Consequently, primary beef cattle farming (cow-calf production cycle) is largely extensive. Improvement of the productivity of beef per unit of feed used over the whole production system will thus be important to beef producers. Improving beef cattle productivity will have positive sustainability implications, as it will reduce resource use and greenhouse gas emissions. Achieving optimal cow-calf efficiency is therefore important, but measuring it in extensive cow-calf production systems is not easy. Under extensive beef cattle farming conditions, an efficient cow will be the one with minimum maintenance requirements and the ability to convert available energy (forage) into the most kilogram of weaned calf, without increasing the mature weight (or the maintenance requirements) of the cow. In spite of the fact that the ratio of calf weight at weaning to cow weight is biased in favour of smaller cows, it has been used as a proxy for efficiency since 1947 and is still used frequently.

**Aim:** The aim of this study was to use the three components traits of cow efficiency, viz. weaning weight (WW), cow weight (CW) and inter-calving period (ICP) to develop an index (I) for cow-calf efficiency.

**Methodology:** Information from the literature and own research (with data from the Afrikaner breed) was used to develop a metric to evaluate annual cow-calf efficiency.

**Results:** The proposed cow-calf efficiency index (I), using estimated breeding values (EBV's), is as follows:

$$I = EBV_{WW_d} + EBV_{WW_m} - 0.39EBV_{CW} - 0.39EBV_{ICP}$$

where: WWd = weaning weight direct, WWm = weaning weight maternal, CW = cow weight, and ICP = inter-calving period.

This index should be implemented based on a multi-trait genetic evaluation that simultaneously estimates the EBV's. This index, that includes ICP, had a moderate rank correlation ( $r = 0.53$ ) with the weaning weight to cow weight ratio in the dataset of the Afrikaner breed. Thus, it represents a significant improvement over the ratio of weaning weight to cow weight that has been used traditionally.

**Conclusion:** It is recommended that the use of the ratio of calf weight to cow weight be replaced by an index that includes reproductive performance. Because the components of cow efficiency are correlated, additional accuracy can be gained in their genetic evaluation using multiple trait models. The recommended index can be derived from the genetic evaluation for the component traits. One advantage of using the EBV's to calculate annual cow-calf efficiency is that it can be calculated for every individual, including bulls and young animals with incomplete records.

## Genetic and environmental parameters for birth weight and behaviour of neonatal Merino lambs in relation to cold stress

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**Background:** Lamb mortality remains a significant welfare and production issue, constraining ethical and sustainable sheep production. Lamb survival is benefitted by early suckling and colostrum intake, while it is impaired by inclement weather involving a combination of rain, wind and a low temperature. It is important to understand the effect of cold exposure on neonatal behaviour and progress to suckling in lambs to curb lamb mortality.

**Aim:** To use historic behavioural data to establish the relationship of neonatal lamb behaviour with cold stress and to derive genetic parameters for early lamb behaviour. It was hypothesized that cold stress conditions would impair early suckling activity and that lamb behaviour was heritable.

**Methodology:** Historic data of Merino lambs born from 1993 to 2002 of the Elsenburg Merino flock for birth weight (BW in kg) and behaviour latencies (time intervals in minutes), namely: <sup>(1)</sup>from birth to first standing for >10 sec (LTBS); and <sup>(2)</sup>from standing to first suckling for >10 sec (LTSS) were analysed in relation to a cold stress gradient (CSG). The CSG was derived from a combination of wind, rain and temperature. The flock consisted of a line selected for number of lambs weaned per ewe mated (NLW; the High or H-Line) and a line selected against NLW (Low or L-Line). ASReml was used to obtain regressions of fixed linear and random cubic components of LTBS and LTSS on the CSG and to derive genetic parameters for all traits.

**Results and Discussion:** Overall, H-line lambs were somewhat heavier at birth and progressed faster from standing to first suckling than L-line lambs ( $p > 0.05$ ). Regressions of neonatal lamb progress on random spline components as well as interactions of the regression variables with selection lines were not significant ( $p > 0.05$ ) and the analyses reduced to modelling the fixed linear component. Increased levels of cold stress resulted in faster progress in LTBS ( $p < 0.05$ ). Expressed relative to mild conditions at a CSG of  $800 \text{ kJm}^{-2}\text{h}^{-1}$ , LTBS was reduced by 17.6% on the observed scale at a higher CSG of  $1200 \text{ kJm}^{-2}\text{h}^{-1}$  ( $p < 0.05$ ). In contrast, LTSS was compromised at higher CSG values ( $p < 0.05$ ), increasing markedly by 76.0% from  $800 \text{ kJm}^{-2}\text{h}^{-1}$  to  $1200 \text{ kJm}^{-2}\text{h}^{-1}$ . Direct single-trait heritability estimates ( $\pm$  SE) were  $0.16 \pm 0.05$  for BW,  $0.22 \pm 0.07$  for LTBS and  $0.06 \pm 0.05$  for LTSS. The inclusion of the maternal genetic variance ratio ( $m^2$ ) resulted in an improvement in the log-likelihood ratio for BW and LTBS, yielding single-trait estimates of respectively  $0.37 \pm 0.03$  and  $0.06 \pm 0.03$ . Single-trait dam permanent environment variance ratio ( $c^2$ ) was  $0.09 \pm 0.03$  for LTSS. Three-trait genetic parameters were close to the corresponding single-trait values. Genetic correlations among traits were not significant.

**Conclusion and Recommendations:** Cold stress compromised LTSS in neonatal lambs, explaining the higher levels of lamb mortality under cold stress conditions. Selection in the H-Line improved the ability of lambs to progress to suckling across the range modelled for the CSG. Furthermore, there was evidence of genetic variation in neonatal lamb behaviour. Further research is required to understand the response to cold stress that differed between LTBS and LTSS.

## Population structure and genetic diversity within and amongst three South African dairy cattle breeds

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**Background:** The South African (SA) dairy cattle industry predominantly utilizes the Ayrshire, Holstein, and Jersey breeds for commercial dairy production. All three of these breeds have been applying estimated breeding values (EBVs) and/or have been part of a Multiple Across Country Evaluation (MACE). Since 2021/22, the SA Holstein has had access to genomic estimated breeding values (GEBVs). The use of reproductive technologies such as artificial insemination (AI) has allowed for the use of imported semen from high-impact dairy bulls. Government and industry investments in projects such as the Dairy Genomics Project (DGP) have allowed for genotyping of SA dairy animals for establishing reference populations for these three breeds. Genotypes available for these breeds include local and international bulls. The sharing of genetic resources between high-impact dairy bulls and their progeny affects the genetic diversity amongst populations. It is, therefore, of interest to investigate the current genetic architecture of genotyped animals to evaluate the existing diversity, or lack thereof, within these dairy cattle breeds and to ensure sustainable breed management and selection strategies in the future.

**Aim:** To perform a single nucleotide polymorphism (SNP) based genomic analysis of three SA dairy cattle breeds, namely the Ayrshire, Holstein, and Jersey using population structure and diversity parameters.

**Methodologies:** Single nucleotide polymorphism (SNP) data was available for the Ayrshire (n=535), Holstein (n=1 257), and Jersey (n=1 133) dairy cattle breeds, consisting of predominantly SA animals and a few international bulls. A set of 51 448 autosomal SNPs (Illumina® BovineSNP50v3 BeadChip) were retained for downstream genomic characterization. After standard quality control in PLINK version 1.9 software, observed and expected heterozygosities ( $H_E$  and  $H_O$ , respectively), as well as mean minor allele frequencies (MAF) and linkage disequilibrium (LD), were calculated. Principal component analysis (PCA) for genetic relatedness was performed with GCTA v 1.94.1 software, and ADMIXTURE v 1.3.0 software was utilized for ancestry estimation.

**Results:** The observed heterozygosity ( $H_O$ ) ranged from 0.336 for the JER to 0.364 for the HLS. For the AYR and JER breeds, the  $H_O$  was 0.020 and 0.025 lower than expected ( $H_E$ ), whereas the HLS breed showed a negligibly small gain in diversity (0.003). The mean MAF values for the AYR, HLS and JER breeds were 0.22, 0.23, and 0.19, respectively. The longer range ( $\leq 1\text{Mb}$ ) mean  $r^2$ -values of LD ranged from 0.123 (HLS) to 0.161 (JER), whilst the shorter range ( $\leq 100\text{kb}$ ) ranged from 0.236 (HLS) to 0.281 (JER). The PCA results illustrated three separate clusters corresponding to the three studied breeds, with the most outliers (dispersion) observed for the HLS breed, and this was supported by population admixture estimates.

**Discussion:** Heterozygosity (and overall) results indicated the greatest genome-level diversity within the HLS breed, followed by AYR and then JER breeds, and this supported the inclusion of a greater number (and variety) of international bulls in the sampled reference population (considering that only a portion was included in this study). Weaker LD levels for the HLS breed are indicative of smaller haplotypes shared amongst these animals (due to younger and less influential animals included) and a lack of persistence of long-range LD between countries (i.e. genomic diversity between global populations). The outliers depicted in the PCA results could further support less genetic relatedness between local and international animals. Similarly, the tighter clustering for AYR and JER breeds can be attributed to fewer international animals within the genotyped reference populations of these breeds.

**Conclusion/recommendations:** The analyzed results support the influences of globalized dairy genetics and their observed influences on the diversity of the JER, HLS, and AYR reference populations in South Africa thus far. Since the erosion of genetic diversity limits long-term genetic gain and impedes sustainability amidst future challenges, these results may assist in strategies to improve and update reference populations for genomic selection.



## Growth performance and carcass characteristics of early castrated, late castrated and intact South African Mutton Merino lambs

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**Background:** Ram lambs are castrated for management reasons. Entire lambs increase management time. Sexes must be kept separate and buyers are often reluctant to purchase intact males as these carcasses are harder to skin on the slaughter line. However, keeping males intact may be advantageous. Entire lambs grow faster, have improved feed efficiency, can be slaughtered earlier and produce leaner carcasses. Castration means aggressive male behaviour is eliminated. The effect of age and method of castration in comparison with keeping males intact have not been investigated.

**Aim:** To compare the growth performance and carcass characteristics of lambs castrated at one week of age, eight weeks of age and entire Mutton Merino lambs.

**Methodology:** Approval from the Animal Ethics Committee (UFS-AED2019/0136/2410) was obtained and the project was conducted at the Paradys Experimental Farm of the University of the Free State. From thirty (n = 30) South African Mutton Merino lambs, ten (EC; n=10) were castrated at one week of age with a rubber ring, ten (LC; n=10) were castrated at eight weeks of age with a Burdizzo and ten (NC; n=10) were not castrated. Lambs were fed a feedlot diet for  $\pm 60$  days or until  $\pm 50$  to 55 kg live weight. Individual intake and weight were recorded weekly. Cold carcass weight, dressing percentage, external length, shoulder circumference and buttock circumference were recorded. Carcass composition was determined (muscle %, fat % and bone %). Fat depth and eye muscle depth and width were measured between the 12<sup>th</sup> and 13<sup>th</sup> rib. The surface area of the *m. longissimus* between the 12<sup>th</sup> and 13<sup>th</sup> rib was measured using a video image analysis system (Soft Imaging System: analysis® 3.0).

**Results and discussion:** Intact lambs (NC) had higher ( $p < 0.05$ ) total weight gain, lower ( $p < 0.05$ ) FCR, higher ( $p < 0.05$ ) weight increase and higher ( $p < 0.05$ ) ADG compared to EC. There were no differences in total weight gain, FCR, weight increase and ADG between LC and EC groups as well as between LC and NC groups. Although not significant, NC lambs had greater final weights compared EC and LC groups. There were no differences in cold carcass mass, dressing percentage, external length, shoulder circumference, buttock circumference, muscle depth, muscle width or eye muscle area between any of the groups. Intact lambs (NC) had lower ( $p < 0.05$ ) fat depth compared to EC. There was no difference in fat depth between LC and EC groups as well as between LC and NC groups. In terms of carcass composition, NC lambs had higher ( $p < 0.05$ ) muscle % compared to EC and LC lambs and LC had higher ( $p < 0.05$ ) muscle % compared to EC lambs.

**Conclusion/Recommendation:** In terms of feedlot performance, NC lambs performed better than EC animals, but not significantly better than LC lambs. Later castrated lambs perform equally well under feedlot conditions with the added management benefit of castration. In terms of carcass composition and muscle %, NC lambs performed better than EC and LC lambs. Although NC lambs produced leaner carcasses than EC, there were no differences in carcass quality of LC lambs compared to EC and NC. Later castrated animals produce an acceptably lean carcass. It is therefore recommended to castrate lambs at eight weeks of age with a Burdizzo to benefit maximally.

## Effects of BCS, parity and postpartum period on conception rates and days to conception of Bonsmara cows in TAI programs

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**Background.** The world population is expected to increase over the next 50 years (United Nations, 2019) and there will be an increase in demand for meat products. Improved beef production through improvements in the number of offspring produced will assist in the increase in demand in future. Reproductive techniques may contribute to more efficient beef production by improving the management of cows and offspring. The aim of this study was to assess the effects of various factors that affect fertility and conception rates in cattle and which will assist in improving the management of reproduction.

**Aim:** The aim of this research was to study the effects of BCS at time of AI, the number of parities and length of the recovery period on the conception rates of extensively raised Bonsmara beef cows in TAI breeding programs.

**Methodology:** Cows in TAI breeding programs were selected from a larger cohort of non-pregnant Bonsmara cows on different farms with data obtained from SA studbook. Animals with missing information were excluded from the data set. Data was analysed by means of Generalised Mixed model analysis and survival analysis to test the effects of the main factors on conception rates of cows. Farm was included as random factor in the Mixed model analysis.

**Results.** The random effect of farm was not significant in this analysis and therefore omitted from the analyses. Both BCS and length of the recovery period were significant ( $p < 0,05$ ) in the mixed model analysis, after adjustment for parity. Cow mass and age at the last calving tended to influence conception rates, although not significant ( $p > 0,05$ ). The effect of time of AI on conception rate was not significant ( $p > 0,05$ ). The change in dam mass ( $p = 0,08$ ) and dam age ( $p = 0,09$ ) had a negative relationship with the conception rate. The time of AI tended to improve conception rate later in the day ( $p = 0,27$ ). The survival analysis, corrected for cow parity, showed that cows between the third to sixth parity had the shortest days to conception. Cows in parity six had the shortest average number of days to conception ( $91,1 \pm 12,66$  days), followed by those in the fifth parity ( $98,5 \pm 13,87$  days) and then the fourth parity ( $107,6 \pm 13,40$  days).

**Discussion:** Cows in good condition have been shown to have fewer follicular waves before ovulation occurs while those in a poor body condition could have up to 10 waves before ovulation occurs. A cow with a BCS  $< 3,0$  (which suggest a state of nutritional deficiency) will struggle to conceive. The majority of the cows with a BCS  $> 3$ , but still did not conceive, had an insufficient amount of time to recover ( $>60$  days) post-partum. By contrast, cows that had more than 60 days post-partum recovery but did not conceive were over conditioned in terms of BCS

The BCS of cows within a specific parity had a significant effect on their conception rates. Cows that were over conditioned were more likely not to conceive, while those inseminated with a BCS of 3,00 had the best conception rates. The postpartum recovery period was important because cows inseminated too early had a high probability of not conceiving. Cows in their 6th parity had the highest conception rates.



## Provision of different degrees of shade influences the physiology and thermoregulatory behaviour of ostrich chicks

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**Background:** The frequency of extreme weather events, including heat waves, are increasing with climate change. The thermoregulatory stresses resulting from hotter climates have catastrophic impacts on physiological paradigms in animals, leading to mass mortalities. The ostrich industry has the potential to become a growing industry in the face of climate change, however, high ostrich mortality rates are still a major concern in summer months.

**Aim:** We tested whether provision of shade during summer influenced the behaviour, physiology and mortalities of ostrich chicks up to 4 months of age managed under an intensive system.

**Methodology:** Treatments were 50% shade cloth and 95% shade cloth. Groups of chicks (n=14) were used as experimental units and shade treatments were blocked, with seven groups for each treatment. Body temperature was measured using data loggers implanted in 28 week-old chicks – 2 per group. Behavioural observations were done 2 to 3 times per week between 14h00 and 16h00 and mortalities were recorded daily up to three months of age.

**Results/discussion:** The body temperature of chicks in the 50% shade treatment were high compared to those in 95% shade cloth ( $P < 0.001$ ) and decreased with age. The chicks with 95% shade cloth showed less ( $P=0.02$ ) thermoregulatory behaviour (such as panting and lifting of wings) than those in the 50% shade treatment. Chick mortality was significantly higher in the 50% shade treatment groups than in the 95% shade treatment (73% and 51%, respectively;  $P < 0.001$ ). Activity level, pecking, feeding, drinking, excreting, preening and dustbathing behaviours did not differ among treatments.

**Conclusion/recommendations:** In conclusion, chicks with 50% shade cloth had a physiological and behavioural stress response to heat load that negatively affected survival. Our findings highlight the importance of providing sufficient shade cover to young ostrich chicks. Provision of 95% shade is recommended for improved wellbeing, since it may assist in reducing the high chick mortality rates experienced during summer.

## Assessment of the post-insulation viability and potential fertilizing ability of ejaculated spermatozoa using a sperm functional test

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**Introduction:** Global warming is a reality that livestock farmers face daily and need to incorporate in the management of their animals to ensure sustainable and optimal food production. Sheep are known to be more effective producers under arid conditions; however, little is known about how resilient sheep are to the expected increase in ambient temperature and the associated effects on physiological processes that are involved in reproduction. Understanding how heat stress affects sperm viability and fertilizing ability in vivo and in vitro will allow sheep producers to identify rams and ewes that produce gametes that are more resilient to heat stress.

**Aim:** The aim of this phase of the study was to determine whether a sperm hyperactivation functional test is effective in discriminating between Dohne Merino rams that differ in terms of the resilience of their spermatozoa to heat stress.

**Methodology:** Ethical clearance (#ACU-2019-9835) for this study was obtained from the Stellenbosch University Research Ethics Committee (Animal Care and Use). Twelve adult Dohne Merino rams, classified according to fresh and post-thaw sperm morphology as high resilience (HR) or low resilience (LR), were used in the study. Five semen samples were collected from each ram over a period of two weeks. Semen samples were subjected to macroscopic evaluation and was diluted with a skim milk-egg yolk extender to an end concentration of  $300 \times 10^6$  spermatozoa/mL. After dilution, the sperm samples were subjected to a sperm hyperactivation functional test using 10mM procaine hydrochloride. Semen samples were incubated at 38.5°C for 30 minutes after the addition of the procaine hydrochloride, and were evaluated at 0min, 15min, and 30min of incubation. Parameters recorded included sperm viability, sperm morphology and sperm acrosome integrity.

**Results & Discussion:** No significant differences were observed between the HR and LR groups for percentage live and abnormal acrosome at all time intervals (i.e. 0min, 15min, and 30min, respectively). A significant difference was however observed for percentage abnormal spermatozoa at all time intervals, respectively. The LR group also showed a faster rate in the reduction of quality for sperm abnormalities than the HR group. Rams displayed significant individual differences for sperm viability and sperm morphology, but not for acrosome integrity when considering the entire 30 minutes of incubation.

**Conclusions/Recommendations:** The influence of ejaculation frequency and subpopulation structure of ejaculates should be considered when using induced hyperactivation as a sperm functional test, especially when ejaculation frequency is high. Simulations of the in vivo environment of the female reproductive tract in an in vivo environment may assist to obtain a more predictive determination of fertilizing ability from heat-stressed spermatozoa.

## **Resilience of ram spermatozoa to heat stress, induced using scrotal insulation**

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**Background:** Global warming is a reality that livestock farmers face daily and need to incorporate in the management of their animals to ensure sustainable and optimal food production. Sheep are known to be more effective producers under arid conditions; however, little is known about how resilient sheep are to the expected increase in ambient temperature, and the associated effect on physiological processes that are involved in reproduction. Understanding how heat stress affects spermatogenesis will assist in the design of studies that can determine the resilience of sheep to heat stress.

**Aim:** The aim of this part of the study was to determine the influence of scrotal insulation on sperm sample quality and the resumption of normal spermatogenic activity in the testes of adult Dohne Merino rams.

**Methodology:** Ethical clearance (#ACU-2019-9835) for this study was obtained from the Stellenbosch University Research Ethics Committee (Animal Care and Use). Twelve adult Dohne Merino rams were classified according to fresh and post-thaw sperm morphology as high resilience (HR) or low resilience (LR) and were subsequently subjected to scrotal insulation for a period of seven consecutive days. Semen samples were collected using electro-ejaculation prior to the fitting of the scrotal insulation bags (Week 0), on the last day of scrotal insulation (Week 1), and then every fortnight for a further 10 weeks. Temperature loggers (iButtons) that logged humidity as well, were placed in the scrotal insulation bags to monitor the immediate scrotal environment during insulation. Infrared thermography was used to measure body and scrotal temperature, respectively. Semen samples were stored at 4-5°C for 48h, and sperm viability, sperm morphology and acrosome integrity were assessed at 0h, 12h, 24h, 36h, and 48h of liquid storage.

**Results & Discussion:** The HR, LR, and control group did not differ in terms of percentage abnormal and live spermatozoa, respectively, during liquid storage. Individual rams did however display differences in the ability of their spermatozoa to offer resilience to heat stress over the 11-week period. Sperm morphology took approximately 70 days to recover to pre-insulation levels (below 40% for most rams), indicating that early spermatogenesis was most affected by the heat stress. The body temperature of the rams increased due to scrotal insulation to compensate for the increase in testicular temperature. Scrotal temperature took 42 days to return to normal (18.64°C – 24.84°C), which coincides with the time it takes for spermatozoa to be produced from spermatogonia. The changes in scrotal and iButton temperatures differed between the rams, which are indicative of individual differences in the testicular thermoregulatory ability of rams.

**Conclusion/recommendations:** Future studies should determine the diurnal body and testicular temperature regulation in rams, as well as determine the difference in the seminal plasma protein composition between rams subjected to testicular heat stress.

## PLASMA METABOLIC BIOMARKERS OF INDIGENOUS, EXOTIC AND CROSSBRED GROWING PIGS ON ROASTED OR SPROUTED COWPEA-MAIZE DIETS

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**Background:** In pigs, many phenotypes with economic relevance are known to vary among breeds or lines, meaning that several traits are expressed or determined in different ways in different genetic backgrounds (Bovo *et al.*, 2016). Metabolites are biochemical intermediates or final products of metabolic pathways that constitute the basic biological mechanisms that directly or indirectly affect phenotypic traits, like production traits in farm animals (Bovo *et al.*, 2016). Esonu *et al.*, (2001) stated that haematological constituents reflect the physiological responsiveness of the animals to its internal and external environment, which include feed and feeding. (Ekenyem and Madubuike, 2007) concluded that feed affects animal physiology.

**Aim:** Formulation of roasted or sprouted cowpeas based diets for growing pigs of different genotypes does not affect plasma metabolic biomarkers for changes in protein.

**Methodology:** Twelve male pigs of each genotype of respective initial live weights 15±2, 39±1 and 37±1 kg were allocated to a standard (17.5 MJ ME/kg, 160g CP/kg), commercial maize-soybean diet (control) and similarly balanced roasted or sprouted cowpea-maize growing pig test diets in equal numbers and balanced live weight in a 3 x 3 factorial experiment replicated 4 times. The study was performed in a customized open trial house in which pigs of different treatments were randomly allocated to individual crates (1.2 x 1.4 m). Feed and water were provided ad-libitum, dispensed from individual self-feeders and nipple drinkers, respectively.

**Results:** Creatinine and total protein were only significantly ( $P < 0.05$ ) affected by genotype, while urea was only significantly ( $P < 0.05$ ) affected by diet. Whereby higher values were observed for LWxLR (Creatinine = 71.46  $\mu\text{mol/L}$ ) and total protein (WxLWxLR = 73.63 g/L). Urea showed higher values for sprouted cowpeas (5.30 mmol/L). However, albumin, ALP and cholesterol were significantly ( $P < 0.05$ ) affected by both genotype and diet. Higher values were observed for WxLWxLR (albumin = 39.67 g/L), LWxLR (ALP = 125.70 U/L) and LWxLW (cholesterol = 2.02 mmol/L). Pigs showed higher values when fed control (albumin = 39.25 g/L), roasted (ALP = 130.13 U/L) and sprouted cowpeas (cholesterol = 1.82 mmol/L).

**Discussion:** All dietary treatments according to indicators were adequate in proteins in terms of quality and quantity. As the most important metabolic organ, the liver is the primary organ involved in lipid synthesis, secretion and transportation (Matsubara *et al.*, 2011). Clinical liver injury is assessed by means of clinical symptoms, serum biomarkers and invasive liver biopsies (Chen *et al.*, 2017). Hepatic enzymes, albumin, total bilirubin are routinely used to assess liver injury (Ozer *et al.*, 2008). (Juliene, *et al.*, 2004) stated that nutrition is another determinant of the albumin synthetic rate, with the most profound decreases occurring with protein malnutrition. (Juliene, *et al.*, 2004) reported that decreased albumin levels result in decreased carrier capacity for substances that are primarily transported by albumin (i.e., some medications, bilirubin and free radicals). The degradation rate is essentially the same as the synthetic rate in healthy animals (Peters, 1996).

**Conclusion/recommendations:** It is concluded that current findings could form a base for selecting processing method of choice for ANFs detoxification and protein improvement along with pig genotype improvement.

## Effect of ecotype and season on the production and reproductive performance of Nguni cattle in Limpopo Province of South Africa

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**Background:** Evidence from literature shows that there are phenotypic and genotypic differences amongst Nguni cattle breed ecotypes. However, the difference in performance with regards to production and reproduction is not documented. The supposition of differences in production and reproduction therefore suggests that there should be different management strategies applied to these ecotypes for optimal production and reproduction, which has far reaching consequences in both the communal and commercial beef farming sector. In a quest to provide answers and much needed management guidelines, this study aims to investigate the effect of ecotype and season on the production and reproductive performance of Venda, Pedi and Shangaan ecotypes of the Nguni cattle breed in Mara Research Station in Limpopo province.

**Methodology:** Production data on 644 (142 Venda, 65 Shangaan, 264 Pedi ecotypes) calf births at Mara Research Station were analysed to determine differences in production and reproduction parameters of birth weight, weaning weight, days to reconception, weight of cow at breeding, weight of cow at weaning, intercalving period and weaning efficiency of these three Nguni cattle breed ecotypes. Seasons 2009, 2010, 2011, 2012 and 2013 were included as specific seasons for which analysis has taken place. Mixed models procedure of SAS was used to analyse for variance in production and reproduction parameters due to ecotype and season. Least square means were separated using pdiff function by employing the Bonferroni multiple range test method due to the unbalanced nature of the data set. The relationship between live weight and body measurements was explored using GPLOT procedure in SAS.

**Results:** The Venda and Pedi ecotypes were similar but different from the Shangaan ecotype for birth weight, weaning weight and weight of cow at weaning across all seasons. Shoulder height and weaning efficiency of Shangaan and Pedi ecotypes were similar but different from that of Venda ecotype. Ecotype had no effect on days to reconception and intercalving period. Season influenced birth weight, weaning weight, weaning efficiency and intercalving period. Season 2012 had the highest birth weight, weaning weight and weaning efficiency at 27.67 kg, 159.78 kg and 0.47 respectively. The longest intercalving period was observed in season 2011 (545 days).

**Discussion:** Observed differences amongst these three ecotypes were weight related production and reproductive performance. As a function of the environment, however, the lack of meaningful differences in key reproduction indicators suggest similarity in performance amongst these three ecotypes. Either of the three ecotypes would fare well in beef production systems in sub-tropical regions. The implication therefore is that no differences are required in the management of these three ecotypes for optimal production, thus farmers can choose either ecotype and if well managed they should be able to produce a calf each year.

**Conclusion:** Due to the lack of differences among the three Nguni cattle breed ecotypes, as was observed in the study, there is no need to manage the Nguni ecotypes differently at Mara Research Station of the Limpopo province.

## Effects of dietary flaxseed oil and ascorbic acid on the reproductive performance of South African indigenous sheep

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**Background:** Dietary inclusion of omega n-3 is proven to improve the reproductive performance of domestic animals. However, mammalian species, including sheep, cannot synthesize omega n-3 fatty acids de novo due to the lack of delta 12 and 15 desaturase enzymes. The lack of polyunsaturated fatty acid conversion in mammals' systems necessitates the supplementation of omega n-3 sources to catalyze conversion.

**Aim:** This study aimed to evaluate the effects of dietary inclusion of flaxseed oil and ascorbic acid on semen quality and fertility of South African indigenous sheep. It was hypothesized that there would be no fertility improvement following dietary enrichment with flaxseed oil and ascorbic acid.

**Methodology:** Fifteen South African indigenous rams (7 Pedi, 6 Zulu and 2 Namaqua Afrikaner; at an average age of 6 years and body weight of  $64.4 \pm 1.6$  kg), were randomly subdivided into five treatment groups i.e. negative control (standard diet), positive control, diet 1 (5% flaxseed oil), diet 2 (4% ascorbic acid) and diet 3 (5 % flaxseed oil + 4 % ascorbic acid). Semen samples were collected from April–July. Following collection, semen samples were evaluated for macroscopic (semen volume, pH and sperm concentration) and microscopic (morphology, lipid peroxidation, membrane permeability and motility) semen characteristics. Eighty ewes were synchronized using control intravaginal drug devices containing 0.3 g progesterone for 10 days. Data was subjected to the General Linear Model (GLM) in Minitub® 2017. Cross-tabulated Chi-Square ( $\chi^2$ ) was used to track the frequencies of in vivo fertility parameters. Treatment means were separated using Student's Least Significant Difference (LSD) and considered significant when alpha was less than 0.05.

**Results/Discussion:** A diet supplemented with flaxseed oil + ascorbic acid (diet 3) resulted in higher semen volume ( $1.1 \pm 0.1$  mL), intact sperm membrane ( $84.1 \pm 2.3$ ), and low malondialdehyde levels ( $0.1 \pm 0.1$ ). Total sperm motility was higher in diet 3 ( $95.8 \pm 0.8$  %). The group supplemented with 5% flaxseed oil (diet 1) and that supplemented with flaxseed oil + ascorbic acid (diet 3) resulted in higher conception rates (100% and 94%) and lambing rates (100% and 94%) respectively. Interestingly, the flaxseed oil + ascorbic acid group (diet 3) was the only group that produced quadruple lambs (6%).

**Conclusion/Recommendations:** It was concluded that the inclusion of flaxseed oil + ascorbic acid (diet 3) improves both the semen quality and fertility of South African indigenous sheep.



## A comparative study on the reproductive performance of South African indigenous sheep breeds following oestrus synchronization

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**Background:** The use of oestrus synchronization in South African indigenous sheep breeds is limited, hence continuous breeding is practiced and preferred by various farmers. This means that South African indigenous sheep lamb and can be weaned at any time of the year. Therefore, provided the negative effects posed by climate change, this implies that lamb mortality will increase on the occasions where the climate is unfavourable.

**Aim:** The aim of the study was to compare the effects of age and live body weight on the oestrus response, duration, pregnancy rate and lambing rate among South African indigenous sheep breeds.

**Methodology:** Study animals used in this study were Zulu sheep = 36, Bapedi sheep = 26, Damara sheep = 10 and Namaqua Afrikaner sheep = 9. Control Intravaginal Drug Release Dispensers (CIDR's) were inserted into the vagina for 10 days. The twitching of the tail and standing to be mounted in the presence of the teaser ram were the most targeted signs of oestrus. The data was subjected to an appropriate analysis of variance (ANOVA). The scores were subjected to a 1:1 frequency table and a Chi-Square ( $\chi^2$ ) test for the equal proportions test.

**Results and Discussion:** One Bapedi ewe lost CIDR before the removal date, hence was removed from the experimental animals. All Namaqua Afrikaner (100%) ewes responded to the synchronization protocol with the longest oestrus duration ( $70.7 \pm 7.2$  h). However, Namaqua Afrikaner sheep scored the lowest rates for conception (44%) and lambing (44%). No significant difference ( $P > 0.05$ ) was observed for the onset of oestrus among the breeds. Four-year-old ewes responded better to oestrus synchronization than  $\leq 3$ , 5 and  $\geq 6$  years. Nevertheless, ewes that were  $\geq 6$  years old had a higher conception rate (94%) and lambing rate (84%). Zulu sheep had a higher (89%) lambing rate than Damara (60%) sheep and Namaqua Afrikaner (44%) sheep. Lighter ewes had a higher conception rate (83%) and lambing rate (90%) than heavier (77 and 64%) and moderate (68 and 78%).

**Conclusion/Recommendations:** In conclusion, Zulu sheep were more fertile than other South African indigenous breeds following oestrus synchronization. On the other hand, young ewes ( $\leq 3$  years) produced heavier lambs and weaning weight but had a higher mortality rate due to inexperience.

## **Carcass composition of early castrated, late castrated and intact South African Mutton Merino lambs**

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**Background:** Producing the ideal meat has become a balancing act. The meat production chain has to focus on efficient on-farm production to fulfil the needs of the health-conscious consumer that prefers lean muscle meat while in the same time meet the gustatory demands of the dining customer. It is the dining customer that looks for affordable, juicy tender meat and intramuscular fat plays an important role in palatability. While ram lambs are castrated for management reasons, entire lambs have improved feed efficiency and produce leaner carcasses. The effect of age and method of castration in comparison with keeping males intact on carcass composition of South African Mutton Merino lambs have been investigated.

**Aim:** To compare carcass and proximate composition of lambs castrated at one week of age, eight weeks of age and entire Mutton Merino lambs.

**Methodology:** Approval from the Animal Ethics Committee (UFS-AED2019/0136/2410) was obtained and the project was conducted at the Paradys Experimental Farm of the University of the Free State. From thirty ( $n = 30$ ) South African Mutton Merino lambs, ten (EC;  $n=10$ ) were castrated at one week of age with a rubber ring, ten (LC;  $n=10$ ) were castrated at eight weeks of age with a Burdizzo and ten (NC;  $n=10$ ) were not castrated. Lambs were fed a feedlot diet for  $\pm 60$  days or until  $\pm 50$  to 55 kg live weight. All lambs were transported and slaughtered using the same slaughter technique at the nearest commercial abattoir. The 3-rib cut was dissected in order to calculate the % bone, fat and muscle (carcass composition). Proximate analysis was performed in order to obtain the % dry matter, moisture, protein, fat, organic matter and ash.

**Results and discussion:** Muscle percentages were 37.25, 37.11 and 40.81 for the EC, LC and NC groups respectively. Age of castration and no castration had a significant effect on muscle percentage. Intact lambs (NC) had higher ( $p<0.05$ ) muscle percentages than EC and LC lambs. Late castrated (LC) lambs had higher ( $p<0.05$ ) muscle percentages than EC lambs. There were no differences in fat or bone % between any of the groups. Intact (NC) lambs had higher ( $p=0.05$ ) moisture percentages than LC while EC did not differ from both LC and NC lambs. Keep in mind that water accounts for approximately 75% of muscle mass. There were no differences in protein, fat and ash percentages between any of the groups. Intact (NC) lambs had lower ( $p<0.05$ ) organic matter content compared to EC and LC lambs. Meat from LC lambs had higher ( $p<0.05$ ) DM content ( $p<0.038$ ) compared to NC lambs. This could be as a result of NC lambs having higher muscle percentages when dissected into muscle, bone and fat.

**Conclusion:** These preliminary results indicated that keeping lambs intact will lead to a muscular carcass and meat that contains more muscle in comparison to bone and fat. Lower DM % and higher moisture % in meat from NC lambs confirmed that meat from these animals contained more muscle than fat. Keeping rams intact may have a positive effect on producing leaner carcasses, followed by late castrated lambs and then early castrated lambs while there were no difference in fat content.

## **Preliminary results on the influence of feather harvesting practices on the welfare of ostriches**

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**Background:** Ostrich feather harvesting practices need to be revisited against the background of consumer concerns about animal welfare and ethical husbandry practices. Internationally, governments prohibited the practice of feather harvesting using plucking because of consumer concerns about the associated potential stress and discomfort in ostriches. It is therefore imperative to determine the influence of feather harvesting on the potential stress and discomfort experienced by ostriches, to ensure that standard operational protocols can be formulated to ensure that animal welfare concerns can be addressed as best possible. The ratio of heterophils to lymphocytes (H:L) is considered as a reliable indicator of stress responses in avian species.

**Hypothesis:** The H:L ratio can be used to determine the degree of discomfort experienced by ostriches where feathers were harvested.

**Methodology:** Adult male and female breeder ostriches (N=220) were randomly allocated to the respective treatment groups. The treatments used for Sampling event 1 included no harvesting (control), removal of ripe wing plumes and clipping of plumes. For Sampling event 2, the respective treatments included no harvesting (control), removal of quills and removal of quills combined with removal of other ripe wing and body feathers. Blood smears were made to determine the H:L ratio for birds allocated to the respective treatments groups to establish baseline H:L values for ostriches prior to feather harvesting (0h) and 72h post-harvesting. A minimum of 100 leukocytes were counted per smear and the number of heterophils were divided by the number of lymphocytes to obtain the H:L ratio. Data were subjected to a factorial analysis involving treatment, sex and age.

**Results:** A comparison was made between plucking, quilling and a combination of quilling and plucking on the H:L ratio on adult ostriches. Age category did not affect the H:L ratio ( $P>0.05$ ), regardless of treatment. There was no interaction between age and treatment. There was a significant treatment effect on H:L ratio at T0 ( $P<0.05$ ).

**Discussion:** Based on the preliminary results, it is evident that ostriches do not retain any carry-over effect of the handling and feather harvesting, given the absence of a significant treatment effect 72h after harvesting. Despite the absence of a relationship between bird age and treatment, the influence of bird age and thus habituation to handling on the degree of stress experienced during feather harvesting warrants further study, for this may influence the H:L ratio. Since the findings represent preliminary results, the existing data set will be supplemented with additional data, which may address the large degree of variation that was observed for the H:L ratio in this study.

**Conclusion:** The large variation observed for the H:L ratio in birds prior to harvesting potentially indicate that birds respond differently to handling, and thus the extent of habituation to handling, which can be linked to bird age, warrants elucidation. It should be noted that findings are reported on a treatment group level and future studies need to investigate the influence of feather harvesting on a bird level to determine how individual birds respond to feather harvesting.

## Semen analyses of Swakara sheep based at the Karakul Research Station, Upington

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**Background/Introduction:** Swakara sheep (Karakul sheep) are known for their luxurious pelts. Pelt quality is determined by various factors such as the wave, curl and shine of the pelt hair, as well as pelt thickness and colour. Since pelt quality determines the primary income for Swakara farmers, it is the most essential trait for ram selection. With such a strong emphasis on pelt characteristics, farmers inadvertently could have selected against reproductive fitness in their herds. Certain pelt colours are more favourable than others and have resulted in some colours being more difficult to proliferate. A pilot study was conducted to determine if there are differences in semen characteristics between rams of different pelt colours.

**Aim:** The aims of this project were to determine if the fertility problems on Karakul Research Station were due to low quality semen and to quantify the differences in sperm parameters among the four pelt colour subgroups. It is hypothesized that grey rams have inferior sperm parameters.

**Methodology and treatments:** Fourteen rams (4 white, 3 brown, 4 black and 3 grey) from Karakul Research Station (Upington, Airport Road, Northern Cape) were electro-ejaculated to obtain semen samples whereafter both macro- and microscopic semen characteristics were assessed. Four media were used to dilute the semen, namely PBS, HD Sperm Wash (HDW), HD Sperm Capacitation (HDC) and Hams F10 with procaine (HAMSPRO). For sperm concentration and motility the Sperm Class Analyzer computer-aided sperm analysis system, in conjunction with a digital camera and brightfield microscopy, were used.

**Results and Discussion:** There were no differences ( $p > 0.05$ ) between pelt colours regarding macroscopic semen characteristics except for mass movement. The grey rams had significant lower movement than the other colored rams. Sperm kinematics among the four pelt colours were not significantly different in three of the dilution media. But exposure to the hyperactivation medium (Hams-F10 + procaine) indicated that the grey rams' sperm had the least potential to be hyperactivated, thus failing a functional sperm characteristic. Grey rams also had a lower percentage progressive motile sperm compared to the other three lines. The lower motility of grey rams was anticipated seeing that mass movement was also significantly lower despite its high sperm concentration.

**Conclusions and Recommendations:** The study indicated that brown rams had similar concentration and motility parameters to black and white rams. Grey rams, however, lacked the ability to hyperactivate and therefore the probability of fertilizing an oocyte is also low. In conclusion, the reason for the lack of farmers with brown Swakaras in South Africa is probably not due to underlying fertility problems but rather a fashion/market related matter. The opposite could be true for farmers with grey Swakaras seeing that these rams' sperm motility were lower than the normal values expected from sheep. A larger population size that includes various commercial farmers is recommended to affirm the outcomes of this study.

## The age at which a ram reaches puberty and the contribution of landrace sheep to sub-Saharan Africa's production systems

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**Background:** A breeding standard that can be used to compare landrace and exotic breeds is the age at attainment of puberty – This parameter allows farmers to decrease the generational interval, to synchronise market demand with lambing and to increase the overall production of food and fibre.

**Aim:** This study aimed to use phenotypic morphometry and hormonal assays and to estimate attainment of puberty in indigenous ram lambs.

**Methodology:** The study was conducted at the Agricultural Research Council Animal Production, South Africa and laboratory work at the University of Pretoria, South Africa; with ethical approval obtained from both institutions (APAEC 2020/07 and NAS207/2020, respectively). Seven ram lambs of each breed (Bapedi, Namaqua-Afrikaner and Zulu) were used in this study from the age of 4 months to 8 months – reared in a semi-extensive production system, grazing on natural pasture with ad-lib access to water. On a bi-weekly basis, bodyweight, scrotal circumference and blood samples were collected. Blood was collected using a 21-gauge needle and red-cap vacutainers. Blood serum was harvested by pipetting 24 hours after collection and stored at -20 degrees Celsius until analysis. Analysis was done using a competitive enzyme immunoassay.

**Results:** It was observed that at most ages, the studied breeds had similar bodyweights (4, 5, 5.5, 6.5, 7, 7.5 months) ( $P>0.05$ ) and similar blood serum testosterone concentrations (4, 4.5, 5, 5.5, 6.5, 7, 7.5, 8 months) ( $P>0.05$ ). However, the studied breeds had statistically significant between-breed differences in scrotal circumferences (4 to 8 months) ( $P<0.05$ ).

**Discussion:** Bapedi, Namaqua-Afrikaner and Zulu ram lambs attained puberty at the age of 7 months while their average body weight was 23.3 kg, their average scrotal circumference was 17.5 cm and their blood serum testosterone was 4.3 ng/ml. This is comparable to other landraces like the D'Man of Morocco and the Awassi of Jordan that achieved puberty at 4.8 to 5.4 and 8.0 months respectively, and to exotics like the Merino that achieved puberty at 6.8 to 7.2 months.

**Conclusion/Recommendations:** In summary, our results show that the studied breeds exhibit homogeneity in their bodyweights and blood serum concentrations. However, there were significant differences found in scrotal circumferences between the breeds. We hypothesise that these South African landraces are not inferior to exotic breeds as they attain puberty at a similar age. More studies are necessary to compare other breeding standards between landraces and exotic breeds for informed breeding decisions.

## Effect of *Moringa oleifera* seed extract on growth performance and haematological parameters in Cobb 500 broiler chickens

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**Background:** Sustainable large-scale intensification of broiler chickens to meet the demand for animal protein by the rapidly growing human population is restricted by oxidative stress that disrupts the equilibrium between the chicken's oxidative and antioxidant defence systems. Also, prophylactic antibiotics have been utilized to enhance feed conversion ratio (FCR) and performance in broiler chickens. However, their usage has been outlawed in many countries due to the risk of transmitting drug-resistant pathogenic bacteria to humans and traces of antibiotic residues in meat products. Phytogetic products are being widely used as safe alternatives to antibiotics. *Moringa oleifera* seed extract (MSE) contains putative phytochemicals that have the potential to improve the physiological performance of broiler chickens.

**Aim:** This study investigated the effect of MSE administered through drinking water on growth performance and haematological parameters of broiler chickens.

**Methodology:** The study was reviewed and approved by the Animal Production Research Ethics Committee (approval no. NWU-02002-20-A5) of North-West University, South Africa. 250 one-day-old Cobb 500 male broilers ( $58.11 \pm 0.23$ g) were randomly allocated into 5 treatments with 5 replicates of 10 birds each. The treatments included a negative control containing drinking water only (T1); a positive control with 5g of a multi-strain probiotic (500M CFU/g)/L of drinking water (T2); 60 mL of MSE/L of drinking water (T3); 90 mL of MSE/L of drinking water (T4); and 120 mL of MSE/L of drinking water (T5). They were fed commercial diets consisting of the starter phase (0–21 days) and finisher phase (22–42 days). Feed intake (FI) and water intake (WI) were measured while average daily weight gain (WG), FI, WI and FCR were calculated. Blood samples were analysed using an automated IDEXX LaserCyte Haematology Analyzer (Johannesburg, South Africa).

**Results:** Weight gain in one-week-old birds and overall WI linearly increased ( $p < 0.05$ ) as the MSE levels increased. Birds reared on T3 and T4 had lower ( $p < 0.05$ ) overall FI and FCR compared to the other treatment groups. There was an increase ( $p < 0.05$ ) in haematocrits, a quadratic decrease in platelets and a linear increase in reticulocyte count as MSE levels increased.

**Discussion:** Repeated measures analyses showed significant treatment  $\times$  week interaction effects on WG, which indicates the ranking of treatments in terms of WG changed as the birds grew older. The lower FI could be due to the reduced fibre content of the MSE, which did not require compensatory FI, which explains the lower FCR observed. The increased WI suggested the birds did not have any challenge in utilizing MSE. T1 promoted similar haematocrits as T3, T4, and T5, indicating that the increase was not induced by MSE. The quadratic and linear responses on platelets and reticulocytes, respectively, indicate that MSE has the potential to improve oxygen transport to tissues and blood clotting. Indeed, the concentration of blood parameters found in this study was within normal ranges for healthy birds.

**Conclusion:** MSE administration decreased FI and FCR and improved some haematological parameters.



## The effect of extrusion of canola oilcake meal and sweet lupins on the production performance of Meatmaster lambs under feedlot conditions

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**Background:** With increasing commodity prices, animal feed protein sources becoming more expensive and cumulative import prices, the need arises to explore more affordable, locally produced plant protein sources, which could be processed (extrusion) for optimal use by the animal. High quality plant protein sources like canola oilcake meal (COM) and sweet lupins (SL) could potentially be extruded to attempt increasing the amount of rumen undegradable protein and enhance animal production.

**Aim:** The aim of this study was to determine the effect of extrusion of canola oilcake meal and sweet lupins and its effect on the performance of lambs under feedlot conditions. The effect of processing (extrusion) and protein sources on average daily gain (ADG), feed intake (FI) and feed conversion ratio (FCR) performance parameters were determined. It is hypothesized that extrusion processing will increase the performance parameters of lambs under feedlot conditions.

**Methodology:** Sixty nine Meatmaster lambs (live weight of ca 22.91 kg) were used for this study (Ethical clearance number #21726 and #TB103). A 7-day adaptation period was in place to ensure gradual adaptation of the rumen to a concentrated diet. During adaptation the lambs were supplied with ad libitum chopped lucerne hay and 300g pellets per lamb for the first three days. Feeding commenced twice a day. Each lamb was supplied with a specific concentrated feed, based on the treatment group allocated to them. Treatment groups were: canola oilcake meal control (CC), canola oilcake meal extruded (CE), sweet lupin control (LC) and sweet lupin extruded (LE). Lambs were randomly allocated, with 7 ewes and 9 rams per group. Weekly weighing of lambs and feed refusals were weighed back to determine their weekly feed intake.

**Results:** Statistical analysis of the production data revealed no significant interaction between extrusion and protein source. With processing (extrusion) and protein source (COM and SL) as the main factors, no significant differences were present in the study. Additionally, no significant differences are present for either protein sources or processing on the carcass fat thickness of Meatmaster lambs.

**Discussion:** A slightly improved FCR for extruded feed (4.62) versus feed not extruded (4.85), and a similar FI for extruded feed (1.44kg/day) versus not extruded (1.43kg/day) is present. Lambs fed extruded feed obtained an ADG of 0.31kg/day, relative to 0.30kg/day ADG of lambs fed non-extruded feed. Lack in results could possibly be due to the extrusion conditions not being optimal in terms of temperature and the duration of time spent in the extruder barrel. Canola oilcake meal presented a 5.6% improved FCR versus sweet lupins. Overall, lambs fed COM represented slightly better performance parameters. Extrusion did not have an evident effect on the crude protein content of COM and SL either being extruded or not. However, extrusion decreased the neutral detergent fiber content of both COM (5.3%), SL (9.8%), decreased acid detergent fiber of SL (3.2%) and increased ADF of COM (4.2%). An overall carcass fat thickness level of 4 (7-9mm) was obtained during the study.

**Conclusion/recommendations:** No significant differences were present in the research study for the main effects between protein sources (COM and SL) and processing (extrusion). Nonetheless, sweet lupins are identified as an inexpensive plant protein source, in comparison to canola oilcake meal which obtains similar performance parameters in lambs under feedlot conditions. With lupins being easily adaptable to poor soil and requires less nitrogen fertilization, it's the ideal strategy to increase sweet lupin production in South Africa.

## Effects on nutrient digestibility of 10% dietary inclusion of high-fibre Macadamia (*Integrifolia tetraphylla*) oil cake with supplementary exogenous enzymes

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**Background:** In Southern Africa, recent disruption of global trade amid intensifying, deleterious climate change have caused scarcity and drastic increase in the cost of conventional pig feeds, which threatens the economic sustainability of commercial pig production. There is a need for research on sustainable, economically viable alternative feeds, particularly the readily available agro-industrial by-products. Macadamia oil cake is a candidate dietary plant protein source which contains 19.5% crude protein and 24.9% crude fibre. However, there is limited information on the nutritive value of Macadamia oil cake in monogastric livestock. The high fibre, more complex diet may require application of exogenous enzymes which are correctly matched to the chemical matrix to guarantee digestive efficacy. The aim of the study was to investigate effects on nutrient digestibility of 10% inclusion of high fibre Macadamia (*Integrifolia, tetraphylla*) oil cake (MOC) as a supplementary protein source in a growing pig diets when fortified with a multi-enzyme cocktail.

### Hypotheses:

- i. A 10% dietary inclusion of high fibre macadamia oil cake should not affect total dietary and key nutrient digestibility in growing pigs.
- ii. Supplementary exogenous enzymes do not enhance growing pig total dietary and key nutrient digestibility at 10% MOC dietary inclusion.

**Methodology:** In a digestibility trial, a standard (control diet) and its 16% CP iso-nutrient, 10% MOC containing reformulation, each with a duplicate supplemented with a multi-enzyme cocktail (6-phytase, endo-1,4-beta-xylanase, alpha amylase, subtilisin protease and endo-1,4-beta-glucanase) were assigned to eight commercial male weaner pigs (15.25 +/-1.91 kg initial live weight) in a 2 x 2 factorial arrangement. The enzyme activities were 6-phytase (IUB 3.1.3.26), 3000 FTU/g, Endo-1,4-Beta-Xylanase (EC-3.2.1.8) 7270 U/g, Alpha Amylase (EC-3.2.1.1) U 300U/g, Subtilisin Protease (EC-3.4.21.62) 6000 U/g and Endo-1,4-beta-glucanase (IUB 3.2.1.6) 532 U/g of product, administered at 500g/tonne. Digestibility was evaluated within balanced, duplicate 4x4(diets) Latin squares with 8-day *ad libitum* feeding periods, consisting of 3 days adaptation, plus 5-day total faecal collection.

**Results:** Dietary inclusion of MOC at 10% significantly reduced (73%-52%) ( $P<0.05$ ) the digestibility of neutral detergent fibre, with no significant effect ( $P<0.05$ ) on the digestibility of dry matter (86.3 versus 83.60), crude protein (71.8 versus 73.2) and organic matter (85.4% - 87.5). The exogenous enzymes did not alter the diet or any of the measured nutrient digestibility ( $P>0.05$ ).

**Discussion:** Low digestibility of neutral detergent fibre suggested the 10% dietary inclusion of MOC sufficiently altered the dietary fibre to a less digestible chemical matrix, for which the exogenous enzymes were not correctly matched to ameliorate the effect. This was despite the pig's substantial capacity to digest fibre in its sacculated colon. This suggested potential deleterious fibre effects on overall nutrient digestion and energy extraction if MOC is included at higher dietary levels.

**Conclusion:** To effectively replace conventional dietary protein sources, further research is recommended to determine optimum MOC dietary inclusion based on protein utilisation and overall nutrient digestion, and to identify exogenous enzymes with correct chemical match to the MOC fibre matrix.

## Se sources on egg quality and Se level in eggs

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**Background:** A large proportion of the human population has sub-optimal selenium (Se) intake (Haug et al., 2007). Eggs remain an affordable source of protein in many countries and can be enriched with Se as a strategy to supplement our Se intake. Se is an important trace mineral and acts as a cofactor in the antioxidant function of enzymes like glutathione peroxidase. Consequently, increasing the Se level in eggs could potentially also improve shelf-life of eggs by reducing the rate of oxidation of proteins in the albumen.

**Aims:** The aim of this study was to evaluate the efficacy of different Se sources on Se deposition in eggs from commercial laying hens. A second objective was to assess if Se source, or egg Se status resulted in changes in egg shelf-life as measured by effects of storage time on albumin height and Haugh units.

**Methodology:** 130 Hy-Line Silver Brown hens at 42 weeks of age were used in a study with 5 treatments and 26 replicates per treatment. A Se deficient depletion diet was fed for two weeks before the start of the trial. Se was supplemented to test diets from five different sources at 0.6 ppm and fed for 21 days. Sources consisted of a Se yeast, Se proteinate, zinc-L-selenomethionine, sodium selenite and hydroxy-selenomethionine. Albumen height and Haugh unit were evaluated using the ORKA EggAnalyzer®. A total of 24 eggs from each treatment were collected over 4 days for shelf-life assessments at 0-, 8- and 15-days storage at room temperature. Another 24 eggs per treatment were collected and 3 eggs were pooled to make one replicate forming 8 replicates per treatment and homogenized for Se level analysis. This was determined using inductively coupled plasma mass spectrophotometry (ICP-MS) AOAC 2015.06. Data was analysed using JMP 16.0 (SAS, Institute, Cary, NC) statistics software and means separated using a protected Tukey HSD at  $P < 0.05$ .

**Results and Discussion:** Storage time resulted in a significant decline in albumin height and Haugh unit, but there was no dietary treatment x storage time interaction ( $P > 0.05$ ). Eggs from hens fed diets containing hydroxy-selenomethionine and zinc-L-selenomethionine had significantly higher Se levels versus Se yeast, Se proteinate and sodium selenite with no differences in egg Se content between eggs from hens fed Se yeast, Se proteinate and sodium selenite.

**Conclusion/recommendations:** In conclusion, Se sources did not affect the internal egg quality parameters and did not have an effect at 8- and 15-day storage. Significant differences were observed in the efficacy of 'organic' Se sources to increase egg Se status with zinc-L-selenomethionine and hydroxy-selenomethionine being more effective than Se yeast and Se proteinate that were no more effective than inorganic sodium selenite at increasing egg Se level. Due to the affordability and acceptance of eggs in diets of consumers, the supplementation of laying hen diets with zinc-L-selenomethionine and hydroxy-selenomethionine can therefore be used as an effective strategy to supplement Se to human populations that may be marginal in their Se status.

## Effect of inclusion of specific encapsulated fatty acids in sow's diets on the quality of IgG and weaned piglet performance

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**Background:** Pre-weaning mortality of piglets born from hyper-prolific sows is highly correlated with reduction in average birth weight due to increases in numbers born. The naïve immunological status of new-born piglets depends on obtaining maternal antibodies via the immunoglobulins in the sow's colostrum. Colostrum intake is positively correlated with daily weight gain post weaning.

**Aim:** Establishing if including a specific mix of encapsulated short and medium chain fatty acids into a sow's diet will increase the quality of IgG and weaned piglet performance.

**Methodology:** The trial was conducted on a commercial farm in the Western Cape, South Africa. Eighty-two control (C) sows received their normal gestation and lactation diets. Ninety-three treatment (T) sows received an integration of the specific encapsulated fatty acid mix (ColfaPig Devenish Nutrition Ltd, UK) at the rate of 2.8kg/ton for the last 56 days of gestation and 1.0kg/ton in the lactation diet. Colostrum samples were taken within three hours of farrowing. The quantity of IgG present was estimated using a digital refractometer. Two hundred piglets from each treatment were individually identified and weighed at weaning and again 33 days post weaning. Individual daily live weight gain (DLWG) was measured. A Chi-square test was used to analyse the IgG categories between control and treatment. The DLWG data was analysed by GLM ANOVA using SAS 9.4. Statistical difference was established at  $P \leq 0.05$ .

**Results:** Categories of the IgG results were split into two groups, "poor" and "borderline" were classified as unacceptable, whilst "adequate" and "very good" were classified as acceptable. The T group tended ( $P=0.06$ ) to have higher IgG values. The T piglets grew significantly faster than the C group ( $P<0.001$ ). Further subdivisions of the piglets depending on the parity of the sows showed significant differences in DLWG ( $P>0.05$ ) over the first four parities. The DLWG was further analysed depending on the IgG quality of the dams. As the IgG improved, so did the DLWG, but significant differences ( $P<0.05$ ) were observed between the treatments for each IgG category. Finally, the DLWG was analysed depending on the individual weaning weight. Heavier pigs grew better in both treatments, but significant differences ( $P<0.05$ ) were observed in each weight category between control and treatment. Even the lightest T piglets grew fastest than the heaviest C piglets.

**Discussion:** Lighter birth weight pigs have been shown to have a lower duodenal mucosal height. Many publications indicate the role of fatty acids in increasing villi height. This mix of encapsulated fatty acids has been shown to significantly improve birth weights, weaning weights and subsequently DLWG post weaning. The quantity and quality of IgG intake over the first twenty-four hours will provide more protection, alleviate the stress of weaning and enable higher DLWG in the weaner phase. Increased weaning weights will have a profound effect on lifetime performance of the pig. The use of a digital refractometer provides a reliable pen side method for assessing the sow's colostrum and can be used as a predictor of post weaning piglet growth rate. This could lead to differentiated feeding regimes for lighter weight pigs.

**Conclusion:** The use of this specific mix of encapsulated fatty acid mix in sow nutrition will improve the quality of IgG in colostrum and stimulate faster weight gain post weaning. This growth could have a profound effect on cost of production and longevity of the pigs being produced as less mortalities should occur.

## Pre-weaning antioxidant capacity, immunity and growth of calves fed milk from *Moringa oleifera* supplemented cows

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**Background:** Periparturient period induces oxidative stress in cows, which fluctuates hormonal and metabolic function and causes immune suppression. In addition, oxidative stress decreases the quality in colostrum and milk, which compromise the well-being of calves and often leads to death. Supplementation of *Moringa oleifera* leaf meal (MOLM) during the transition period is known to increase both colostrum and milk quality, IgG absorption in newborn calves. Health and performance of calves consuming milk from MOLM-supplemented dams have not been evaluated and need to be explored.

**Aim:** Antioxidant enzymes, blood biochemistry, diarrhoeal incidence and growth performance of calves consuming colostrum and milk from MOLM-supplemented dams were evaluated. As South African dairy farmers use whole colostrum and milk for calf rearing, we hypothesised that health and performance of calves fed milk from MOLM-supplemented dams will be improved.

**Methodology:** Thirty-two pregnant Holstein cows were blocked by weight and expected day of calving and randomly assigned to one of two treatments: (1) no additive (CON) or (2) 16.66 g of MOLM/100 kg of body weight (MOLM). Cows were dosed daily from d -35 to +21 relative to calving. Blood and milk were sampled in dams to determine antioxidant capacity and quality. Post calving, calves received colostrum meals and milk from their respective dams until day 42. Blood IgG and antioxidant enzymes, growth and diarrhoeal incidence were evaluated in calves during study period: d 0-42 of age.

**Results:** Serum IgG ( $P = 0.04$ ), antioxidant capacity ( $P < 0.01$ ) and milk total antioxidant capacity ( $P < 0.01$ ) in MOLM-supplemented dams were higher than control group. Maternal MOLM increased calf serum antioxidant capacity ( $P < 0.05$ ) during pre and post colostrum. This trend was more noticeable in female calves ( $P < 0.05$ ) compared to male calves. Serum IgG ( $P < 0.05$ ) in maternal MOLM-calves was higher relative to control group. Calves that received maternal MOLM tended to eat more DMI, have higher final bodyweight and a reduced faecal score ( $0.05 < P < 0.01$ ) during the pre-weaned period.

### Discussion:

Likewise, Olvera-Aguirre et al., (2020) observed unchanged growth performance and weaning weight in lambs suckling lactating ewes were that were supplemented with MOLM extracts. Increased serum antioxidant capacity in MOLM calves prior colostrum feeding could be due to antioxidant nutrients and MOLM' polyphenols were transferred to the foetus in-utero as reported in humans (Toumi et al. 2013), rats (Du et al. 2019). Whereas the increased serum antioxidant capacity and IgG with a slightly reduction of diarrhoeal incidence during milk feeding may be due to high levels of immunomodulation, antioxidant and antimicrobial properties of MOLM' flavanones found to be accumulated in milk (Lee et al., 2017).

**Conclusion/recommendations:** MOLM supplementation to transition cows did not negatively affect the growth and diarrhoeal incidence but improved serum antioxidant capacity in calves. Validating in-utero transferability of polyphenols in bovine could set an oxidation foundation to curb the risk of birth-associated diseases in calves' life particularly during the incidences of delayed colostrum feeding.



## Effect of Acacia karroo leaf meal inclusion levels on performance and gut morphology of broiler chickens

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**Background:** Poultry meat is the most preferred meat by consumers and is considered healthier than meat from other livestock (Alahakoon and Jayasena, 2016). However, feed costs have risen above 70% of the total cost for producing broiler chickens (FAO, 2013). There is therefore a need to explore nutritionally beneficial alternative feed sources that can be used in broiler chicken diets to improve production and subsequently reduce feed costs. Tanniniferous plants such as Acacia karroo have been reported to contain high levels of natural antioxidants which can improve meat quality and animal performance (Jiang et al., 2016; Huang et al., 2018; Atiba et al., 2021). Acacia karroo leaves have high content of condensed tannins (Hassan et al., 2020). However, it has been reported that dietary inclusion of tanniniferous leaf meals at low levels can improve growth parameters and gut morphology of broiler chickens (Huang et al., 2018; Miya et al., 2019). Unfortunately, information on the use of dietary tanniniferous leaf meals to improve growth performance and gut morphology of broiler chickens is limited.

**Aim:** The study was conducted to determine the effect of Acacia karroo leaf meal (AKLM) incremental levels in diets on growth performance and gut morphology of Ross 308 chickens from day-old to 6 weeks of age. Hypothesis: AKLM inclusion levels has no effect on feed intake, feed conversion ratio, growth rate, live weight and gut morphology of male and female Ross 308 broiler chickens aged one to 42 days.

**Methodology:** 320-day-old Ross 308 broiler chicks were assigned to a 2 (sex) × 4 (dietary treatment levels) factorial arrangement in a CRD, having 8 treatments, replicated x4 with 10 chicks/replicate. AKLM inclusion levels were at 0, 0.5, 1.0 or 1.5g/kg dry matter (DM). Weekly feed intake (FI), live weight (LW) and growth rate (GR) were measured to obtain the feed conversion ratio (FCR). Gut characteristics were measured on day 21 and 42 of age. Data was analysed using the General Linear Model (GLM) procedures of the Statistical Analysis System. Results: FI, FCR, GR and LW of both sexes were the same ( $P>0.05$ ) across all treatments for the first 2 weeks. During the 3<sup>rd</sup> week, AKLM inclusion levels significantly ( $P<0.05$ ) affected DM intake, FCR, GR and LWs of both sexes. On the last 3 weeks of the trial, FI, FCR, GR and LW for both male and female broilers were similar ( $P>0.05$ ) across all treatments. AKLM did not affect ( $P>0.05$ ) gut organ digesta pH, length and weight values of male and female broilers aged 21 days. At day 42 of age, AKLM inclusion levels in the diets affected ( $P<0.05$ ) gastrointestinal tract (GIT), ileum and large intestine lengths of male broilers. Female broiler chickens on a diet having 1.0 g of AKLM had longer ( $P<0.05$ ) GIT than those without AKLM inclusion. Female broiler chickens on a diet having 1.0 g of AKLM per kg DM had higher ( $P<0.05$ ) gizzard weights than those diets with no AKLM inclusion at 6 weeks old.

**Discussion:** In the current study, AKLM inclusion levels had no effect on FI, FCR, GR and LW of both male and female broilers during the first two weeks and last 3 weeks of the trial. This is in agreement with Olugbemi et al. (2010), Madzimure et al. (2018), Lerdsuwan and Nalinanon (2017) and El-Galil et al. (2019) who reported similar results. Male broilers on a diet with 1.5g of AKLM had longer GIT and ileums than those fed on a diet without AKLM. Similarly, female chickens on a diet having 1.0g of Acacia karroo leaf meal had longer GIT than the control diet. Similar observations were detected by Madzimure et al. (2018) and Huang et al. (2018).

**Conclusion:** It is concluded that AKLM up to 1.5g/kg DM could be included in broiler chicken diets without any adverse effects on the performance and gut morphology.



## Effect of different inclusion levels of dietary green seaweed (*Ulva* spp.) on live performance, blood parameters, visceral organs, carcass and meat quality traits in Jumbo quail

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**Background:** The amount of dietary seaweed (*Ulva* sp.) meal (SM) that can be included in Jumbo quail (*Coturnix coturnix*) diets as a source of nutrients and functionally active substances is unknown. The use of naturally available nutraceutical sources in quail diets would deliver profitable and organic quail enterprises and ensure that humans consume safe and high-quality quail products. One putative nutraceutical source, which is largely available across diverse ecological regions and exist globally in intertidal zones of marine environments, is green seaweed.

**Aim:** To evaluated the effects of different inclusion levels of seaweed meal (SM) on live performance, haematology, serum biochemistry, visceral organs, carcass characteristics and meat quality parameters in Jumbo quail. It was hypothesized that the inclusion of seaweed meal would improve feed intake, and physiological and meat quality parameters of the birds.

**Methodology:** A total of 385 one-week-old quail chicks ( $67.7 \pm 3.44$  g live-weight) were randomly allocated to 5 experimental treatments, each with 7 replicate pens carrying 11 birds. The 5 dietary treatments were formulated by incorporating SM in a standard grower diet (SM0) at a rate of 2 (SM2), 4 (SM4), 6 (SM6) and 8% (SM8).

**Results:** Regression results showed no significant linear and quadratic effects to different levels of dietary SM for overall weight gain, average weekly feed intake, haematological parameters, visceral organ sizes and carcass and meat quality characteristics of the birds. However, overall feed conversion efficiency (FCE) [ $R^2 = 0.282$ ;  $P = 0.0001$ ] and slaughter weight [ $R^2 = 0.159$ ;  $P = 0.026$ ] linearly declined as dietary SM levels increased. Serum glucose [ $R^2 = 0.471$ ;  $P = 0.0001$ ] quadratically responded to increasing dietary SM levels, which was optimised at 4%. Significant dietary influences were observed on feed intake in weeks 3, 4 and 5 with the highest intake observed for birds fed with the SM8 diet. Birds reared on diets SM0 and SM2 had higher ( $P < 0.05$ ) overall weight gain than those reared on diet SM6.

**Discussion:** Simple stomach non-ruminants such as quails have been reported to have a depressed growth rate when reared on a high fibrous diet. In this study, diet-induced changes in feed intake depended on the age of the birds. In weeks 3, 4, and 5, dietary effects were detected on AWFI, in which birds reared on the SM8 diet had the highest feed intake, possibly indicating a nutrient dilution mechanism to cope with high dietary fibre and lignin levels in the diets. Dietary seaweed had no adverse effect on the health and welfare of quail as indicated by the haemo-biochemical parameter.

**Conclusion/recommendations:** It can be concluded that the inclusion of green seaweed meal in Jumbo quail diets compromises feed conversion efficiency and slaughter weights but not blood parameters, internal organs and carcass and meat quality traits.

## Apparent ileal nutrient digestibility of broilers fed maize-soy-based diets with elevated levels of sunflower meal supplemented with enzymes

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**Background:** Soyabean meal (SBM) is the most-used protein source in broiler feeds around the world. Although it is a rich source of protein that is well digested, its use may be limited due to its inaccessibility in some regions, supply variations and high price. It is therefore of interest to investigate the use of alternative protein sources that can reduce the dependence on SBM and also reduce cost of broiler diets. Sunflower meal (SFM), an oil industry by-product, is one such promising feed ingredient that has the potential to replace soyabean meal in broiler diets. However, due to lower digestibility of amino acids and high fibre levels, its use is generally restricted to less than 5% of broiler feed. Exogenous enzyme supplementation of SFM-based meals could potentially allow higher inclusion rates of SFM in poultry diets, thus significantly reducing the cost of feed.

**Aim:** The study was aimed at evaluating the apparent nutrient digestibility (AID) of broilers fed maize- and soy-based diets, or the same diets formulated with elevated levels of sunflower meal and either a single xylanase or a xylanase, amylase and protease (XAP) enzyme complex.

**Methodology:** The experiment included three treatments: A control diet formulated using maize and SBM with 3% SFM, a second diet the same as the control diet but with 10% SFM supplemented with either a single xylanase or a combination of XAP enzyme complex. The inclusion rate for both enzymes was 100 g/t. Day-old Ross 308 male broiler chicks were raised in floor pens in an environmentally controlled house and moved to metabolic cages at day 14 with six birds per cage and eight replicate cages per treatment. Broiler body weight (BW) and feed intake were determined at 14 and 21 days of age and feed conversion ratio (FCR) calculated. On day 21, broilers were euthanised using a three-way gas mixture and ileal digesta collected for determination of apparent dry matter (DM) and crude protein (CP) digestibility.

**Results and discussion:** Compared to the control diet, diets containing higher levels of SFM with added XAP enzymes had significantly ( $P < 0.05$ ) higher apparent ileal CP and DM digestibility. The diet containing only the xylanase enzyme resulted in a CP digestibility similar to the control diets. Compared to the control diet, broiler FCR was significantly ( $P < 0.05$ ) improved by inclusion of the XAP enzyme complex, but not by the single xylanase enzyme. This suggests that the combination of higher levels of SFM (up to 10%) with an XAP enzyme complex can be an effective strategy to improve nutrient digestibility and performance of broilers.

**Conclusion and recommendations:** It can be concluded that the XAP enzyme complex was more efficacious than xylanase in hydrolysing arabinoxylans in the soluble and insoluble dietary fibre component of the SFM in the diet. The improved nutrient digestibility and broiler performance with diets containing increased levels of SFM together with XAP enzymes can potentially reduce the dependence on SBM in broiler diets and reduce feed cost per kilogram broiler.

## Effects of zingerone on growth performance, feed intake and utilisation efficiency, carcass yield and viscera macromorphometry of Cobb500 broiler chickens

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**Background:** Commercial broiler and pullet chicken producers supplement chicken diets with sub-therapeutic doses of antibiotics that act as growth promoters to enhance productive performance and meat and egg yield and quality. The prolonged use of these subtherapeutic doses of antibiotics in chicken production causes the development and proliferation of antibiotic-resistant bacteria strains that compromise human and animal health. The antibiotic residues in poultry wastes pollute the environment. The health and environmental challenges associated with this use of antibiotics as growth promoters have led some countries to enact legislation that minimise, curb and prohibit the use of antibiotics as growth promoters in poultry feeds. However, withdrawal of the antibiotics from chicken feeds has been shown to compromise productive performance and product quality hence the need to search for natural acceptable alternatives to antibiotics. Zingerone, a phytochemical found in high concentrations in ginger, has antimicrobial, antifungal, antioxidant, immuno-modulating and growth promoting properties and thus can possibly substitute antibiotics as a growth promoter in broiler chicken feeds.

**Aim:** We sought to evaluate the potential of zingerone to substitute zinc bacitracin as a growth promoter in broiler chicken diets by determining its effects on growth performance, feed utilisation efficiency, gastrointestinal tract (GIT) organ and GIT accessory organ macromorphometry and carcass yield.

**Materials and methods:** One hundred and twenty unsexed 3-day old Cobb500 broiler chicken chicks (10 chicks per replicate with 3 replicates per diet) were, in a completely randomised design, allocated to four dietary treatments where zingerone substituted zinc bacitracin (ZnBcTN) as a growth-promoting supplement. The zingerone substituted ZnBcTN at 0mg kg<sup>-1</sup> (control: 500mg/kg of zinc bacitracin), 40mg kg<sup>-1</sup>; 80mg kg<sup>-1</sup> and 120mg kg<sup>-1</sup> in the starter, grower and finisher diets. The chickens were fed ad libitum for 6 weeks: 2 weeks for each of the starter, grower and finisher phases. Induction, weekly and terminal body mass (TBM), daily feed intake (FI), body mass gain (BMG), average daily gain (ADG) and feed conversion ratio (FCR) were determined. On slaughter, GIT and accessory GIT viscera organs were extracted and their masses and the lengths of the small and large intestines were measured. Empty carcass mass was measured and dressing percentage computed.

### Results and discussion:

Across growth phases and overall, supplemental zingerone had similar ( $P>0.05$ ) effects on the chickens' TBM, BMG, ADG, FI, FCR and on their empty carcass masses, dressing percentage and GIT and GIT accessory organ macromorphometry as dietary ZnBcTN in the control diet. Our findings suggest that zingerone can replace ZnBcTN as a growth-promoting dietary supplement in Cobb500 broiler chicken diets and thus could potentially mitigate the antibiotic-induced negative effects on consumer and chicken health and environmental pollution. Even the lowest dose of zingerone mediated equal productive performance by the chickens similar to that mediated with ZnBcTN. Zingerone, therefore can potentially be exploited to reduce the cost of fortifying broiler chicken diets.

**Conclusion:** This study shows that zingerone can be used to replace zinc bacitracin as a growth promoter in broiler chicken diets without compromising growth performance, feed utilisation efficiency and meat yield.

## Supplementation of *Aspergillus oryzae* metabolites to Jersey cows grazing kikuyu/ryegrass pasture in spring

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**Background:** Milk production of cows on pasture is limited by energy intake. Jersey cows grazing high quality pasture would typically ingest 10kg DM of pasture and be fed 6kg of a dairy concentrate per day. Pasture often contains 40 to 50% neutral detergent fibre and fibre digestion as well as rate of fibre digestion limits intake and milk production. Fungi have the potential to breakdown lignin-hemicellulose bonds.

**Aim:** To determine the effect of *Aspergillus oryzae* metabolites (AOM) on milk production and milk composition of Jersey cows grazing kikuyu/ryegrass pasture in spring. Hypothesis: Supplementing AOM to cows grazing kikuyu/ryegrass in spring will increase milk production and improve milk composition.

**Methodology:** The study was conducted during spring 2021 at the Outeniqua Research Farm, situated in the Western Cape province of South Africa (22° 25' 16''E and 33° 58' 38''S). Cows grazed nine hectare kikuyu/perennial ryegrass pasture under irrigation and were supplemented with 6 kg concentrate/cow/day. Forty Jersey cows from the Outeniqua Research Farm were used in a randomized block design with two treatments. Treatments were control concentrate and control concentrate plus AOM supplemented at 3g Amaferm/cow/day. Cows were milked twice a day and concentrates were fed during milking. Cows were adapted to treatments for 21 days followed by a 40 day measurement period. Pasture and concentrate samples were collected weekly during the measurement period. Cows were weighed and body condition score was determined at the beginning and at the end of the study on two consecutive days before afternoon milking. Cows were milked using a 20-Point Waikato/Afikim swing over milking machine with electronic meters. Milk production was recorded daily. Composite milk samples were taken four times during the measurement period and analysed for fat, protein, lactose, somatic cell count (SCC) and milk urea nitrogen (MUN) content.

**Results and discussion:** Supplementation of AOM significantly ( $P < 0.05$ ) increased 4% fat corrected milk, milk fat % and milk protein % and was 22.3 and 24.0kg/cow/day, 4.77 and 5.09% milk fat and 3.98 and 4.12% milk protein for the control and AOM treatment respectively. The milk lactose content, milk urea nitrogen content and somatic cell count was not affected by treatment and was 4.65 and 4.70%, 8.12 and 8.40 mg/dl and 169 000 and 162 000 cells/ml for the control and AOM treatment respectively. Cows on both treatments gained weight during the study and live weight of cows was not affected by treatment. The average live weight of cows at the end of the study was 424kg for the control and 422kg for the AOM treatment. Pasture grazed by cows was of high quality with metabolizable energy:  $10.6 \pm 0.18$  MJ ME/kg, protein:  $18.5 \pm 2.48\%$ , NDF:  $40.0 \pm 1.80\%$  on a dry matter basis. Pasture contained Ca:  $0.42 \pm 0.017\%$ , P:  $0.38 \pm 0.050\%$ , Mg:  $0.31 \pm 0.005\%$ , K:  $3.91 \pm 0.254\%$ , Na:  $0.41 \pm 0.11\%$ , Cu:  $6.42 \pm 1.52$  ppm, Zn:  $32.2 \pm 5.40$  ppm, Mn:  $40.6 \pm 12.85$  ppm and Fe:  $162 \pm 31.3$  ppm.

**Conclusion/recommendations:** Supplementation of *Aspergillus oryzae* metabolite product at 3g/cow/day to Jersey cows grazing ryegrass pasture during spring significantly increased 4% fat corrected milk production, milk fat % and milk protein %.

## Growth performance, methane emission, ruminal fermentation and microbial composition of the Meatmaster lambs fed barley sprout

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**Background:** Fodder sprout is the fresh, green and nutritious fodder that is produced hydroponically in a period of about 10 days. The technology is becoming popular in South Africa even under emerging farmers because the technology demands less space, less water with no necessity for fertilizer.

**Aim:** The objective of this study was to determine the effect of supplementing Meatmaster lambs with barley sprout on growth performance, methane emission, ruminal fermentation and bacterial profile.

**Methodology:** twenty-one Meatmaster weaners with initial body weight of  $23.09 \pm 0.69$  kg were randomly assigned into three dietary treatments, seven animals per treatment. Treatments were Eragrostis curvula grass hay as basal diet (T1), grass hay plus 25% barley sprouts (T2) and grass hay plus 50% barley sprouts (T3). Each animal was offered 300 g of concentrates. Barley sprout was produced in a room without fluorescent light. Animals were housed individually and fed twice a day at 8h00 and 15h00 with free access to water. The experiment lasted for 70 days excluding 10 days for adaptation, animals were weighed every two weeks. Methane data was recorded from day 61 to 69 using a hand held laser detector. Rumen fluid was collected on day 70 for volatile fatty acid and DNA sequencing using a stomach tube. Data were subjected into one-way ANOVA using SAS program and significant difference was declared at  $P \leq 0.05$  and tendency declared at  $0.05 < P \leq 0.10$ .

**Results and discussion:** Barley sprout supplementation significantly ( $P < 0.05$ ) improved animal performance. Animals that were fed sprout had a higher ( $P < 0.05$ ) weight than the ones that had no sprout. In addition, the methane yield of animals that were fed sprout were lower ( $P < 0.05$ ) with 16.7% and 27.8% less for T2 and T3, respectively as compared to animals in T1. Similarly, a trend was observed on ammonia nitrogen ( $\text{NH}_3\text{-N}$ ) content, acetic acid and acetic/propionic acids ratio concentration. The observed values for  $\text{NH}_3\text{-N}$  were 42.8 % and 49.5% for T2 and 3, respectively as compared to T1. The observed differences in bacterial profiles at phylum level among the treatments were not statistically significant ( $P > 0.05$ ). However, there was a shift in phylum abundance from animal in T1 and those in T2 and T3.

**Conclusion and recommendation:** Barley fodder sprout may be strategically used as a climate-smart feed resource for ruminant animals. The potential of barley sprout supplementation on rumen biohydrogenation need to be further investigated.



**Determination of the AMEN of maize using in-Vitro vs. in-Vivo methods and determination of the effect of maize quality on efficacy of a xylanase, amylase, and protease enzyme combination.**

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**Background:** The chemical and physical composition of maize has been shown to vary widely, which contributes to variations in nitrogen-corrected apparent metabolisable energy (AMEN). Therefore, the ability to rapidly and accurately quantify the AMEN of maize used in feed formulation is of economic and nutritional importance. The methodologies that have been used to determine AMEN in vivo include the direct feeding method (DF) or basal substitution method (BS), while prediction equations are used to estimate AMEN in practical feed formulation. More recently, near infrared transmittance (NIT) technology has been developed that can rapidly predict the AMEN in vitro and it was of interest to compare these methodologies in the quantification of maize AMEN, as well as quantifying the increment in AMEN of maize from exogenous enzymes.

**Aims:** This study was conducted to determine the AMEN of European and South African maize samples in vivo using two different methods (DF or BS) and compare the AMEN determined in vivo with the predicted AMEN using NIT as well as current prediction equations used in commercial feed formulation. A second objective was to quantify effects of a xylanase, amylase and protease (XAP) enzyme combination on maize AMEN and matrix values using the BS method.

**Methodology:** Five maize samples were analysed for proximate composition and scanned using a Foss Grain analyzer (Infratec<sup>TM</sup> 1241 Grain Analyser, Foss, Denmark) to determine NIT AMEN and calculate AMEN from WPSA (1986) and CVB (2021) prediction equations. Maize samples were fed to broilers using two methods (DF and BS) to determine in-vivo AMEN with an additional five treatments using the BS method to determine AMEN uplift from added XAP. An experimental unit was a cage of 6 male Ross308 broilers with 8 replicate cages/treatment. For the DF method, birds (n=240) were fasted six hours followed by a six hour feeding and an additional 12 hour fasting period, after which total excreta was collected. For the BS method, birds (n=528) received treatment diets 24 hours before the three-day collection period during which excreta samples were collected every 24 hours.

**Results and discussion:** There were significant differences in maize AMEN between the five maize samples evaluated. Maize AMEN determined by DF and BS methods were similar but significantly lower than the NIT AMEN ( $P < 0.05$ ) for all five maize variants. AMEN from WPSA and CVB vs in-vivo AMEN differed depending on the maize variant. On average, the XAP enzyme significantly increased the AMEN value of maize by approximately 70 Kcal/kg dry matter (DM), with no interaction of XAP enzyme effect and maize variant ( $P > 0.1$ ).

**Conclusion and recommendations:** The consistent difference between AMEN determined by NIT vs DF and BS in-vivo methods implies that, following a BIAS adjustment of the NIT results, this can be used as a rapid method to quantify AMEN of maize and provide more accurate estimates than conventional prediction equations used in current feed formulation. In addition, the use of exogenous XAP enzymes were effective in increasing maize AMEN by ~70 Kcal/kg DM.



## Effect of different dietary protein allowances on performance and nitrogen metabolism of Nguni and Hereford heifers

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**Background:** Previous studies have shown that Nguni cattle are less dependent on dietary protein than other breeds yet maintain elevated blood urea levels when the nitrogen content of pasture drops (Bester et al, 2003). The study seeks to provide valuable information in understanding protein metabolism, especially urea N salvaging in Nguni and Hereford cattle breeds.

**Hypothesis:** It was hypothesized that diet protein allowance will not have an effect on weight change, dry matter feed intake, dry matter digestibility and protein digestibility in Nguni and Hereford heifers.

**Methodology:** An experiment was carried out to determine the effect of different diet protein allowances on body weight change, dry matter feed intake, dry matter digestibility and protein digestibility in Nguni and Hereford heifers. Four heifers were allocated per treatment group per breed. The treatments were 4.5%, 5.25%, 7%, 8.25% and 9.5% diet CP allowances in a factorial arrangement in a completely randomized design. The experimental animals were all weighed at the beginning and end of the experiment to determine their weight change. Crude protein content of the feeds and faecal samples were determined by Kjeldahl method. Feed dry matter and crude protein digestibility were also determined.

**Results:** Results show that both Nguni and Hereford heifers lost weight despite the difference in dietary CP allowances they were exposed to. The heifers were, however, different ( $P > 0.05$ ) in their body weight losses which was not dependent on the daily CP allowance. Dietary CP allowance levels used in the study did not have any effect ( $P > 0.05$ ) on the final live weights, daily live weight change and percentage live weight change of Nguni heifers. There was no difference ( $P > 0.05$ ) in feed protein content and protein digestibility between Nguni and Hereford heifers. However, there was a significant difference ( $P < 0.05$ ) in faecal crude protein content. Daily protein allowance did not affect digestibility of the diet.

**Discussion:** The tendency of Nguni heifers to show a better protein digestion at 4.5% and 5.25% protein allowances can also be associated with the low water intake that was observed. Overall, the Hereford heifers ate relatively more ( $P < 0.05$ ) feed when compared to Nguni heifers. The difference in feed intake of the two breeds was proportional or relative to the live weights of the two breeds. The opposite response of the two breeds to DM digestibility as the treatment level changed may be an indication of the differences in genetic abilities of the two breeds.

**Conclusion:** Results suggest that the Nguni heifers utilized low feed protein better than the Hereford heifers. More work needs to be done to determine whether water intake and GIT passage rate of digesta do not play a role in breed feed utilization efficiency.

## Effect of dietary calcium and phosphorus specifications and limestone solubility on performance, bone mineralization and cost of broiler production

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**Background:** Limestone (LS) solubility has been shown to alter Ca and P digestibility in broilers and can therefore potentially altering the total dietary requirements for these nutrients.

**Aim:** The study objectives were to assess effects of different Ca and P recommendations (REC) on broilers performance, bone mineralization and production costs when diets were formulated using LS with different solubility.

**Methodology:** All experimental procedures were approved by the Animal Ethics Committee at Neuro Livestock Research (NLR2107/2021). A 3 x 2 factorial design with five-phase broiler diets formulated to three different Ca and P REC (Ross308 breed guidelines (Ross); Dutch nutrition group (NL); or University of Maryland (UMD). Each diet was also formulated using LS with two solubilities (fast and slow), as per method of Kim et al. (2019). As hatched Cobb 500 chicks were placed in 72-floor pens, 50 broilers/pen, 12 replicates per treatment allocated using a randomized complete block design. Body weight (BW) and feed intake were determined at 10d and 32d and feed conversion ratio (FCR) calculated. Defatted tibial ash was determined at 10d and 32d from 5 broilers/pen. Feed cost/kg broiler was calculated using commercial feed ingredient prices in South Africa, December 2021. Data was analysed in JMP 15.0 (SAS Inst. Inc., Cary, NC, 2016) by two-way ANOVA with block as a random effect and means separated with Tukey HSD at  $P < 0.05$ .

**Results and Discussion:** BW at 10d was higher ( $P < 0.05$ ) on UMD (324g) REC vs. Ross (317g) and NL (317g) ( $P < 0.05$ ). FCR at 10d was improved ( $P < 0.05$ ) by the UMD REC vs. Ross and NL, with no effect of LS. At 32d, broilers fed Ross (2038g) and UMD (2033g) REC were heavier than NL (1980g) ( $P < 0.05$ ). FCR at 32d for UMD was lower ( $P < 0.05$ ) than Ross and NL (1.33, 1.35, and 1.36, respectively). Slow soluble LS improved ( $P < 0.05$ ) 32d BW (2028 vs. 2006g) but had no impact on FCR. An interaction ( $P < 0.05$ ) was observed between LS and Ca and P REC on 10 and 32d tibia ash weight (wt). Fast soluble LS reduced ( $P < 0.05$ ) tibia ash wt in birds fed UMD REC at 10d but had no effect on tibia ash wt in birds fed NL or Ross REC. At 32d, fast soluble LS reduced tibia ash in birds fed the NL REC, but not UMD or Ross REC. Feed cost/kg broiler at 32d was improved by the UMD REC, followed by Ross and NL ( $P < 0.05$ ), with no effect of LS.

**Conclusion:** These results suggest Ca and P REC and LS used in commercial broiler diets can impact performance, bone mineralization and production costs. Feeding the reduced Ca and P Rec from UMD in combination with slow soluble LS levels can be used as a strategy to reduce feed cost/kg broiler with no difference in live performance or bone mineralization.

## Response in growth performance of South African indigenous Windsnyer pigs to dietary inclusion of Amarula oil cake diets

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**Background:** The global production of animal feed has experienced soaring prices of cereal grains and soybean meal commonly used in livestock diets due to competition with the ethanol industry and human consumption which is expected to double by 2050. Large-scale livestock producers, particularly pig and poultry, rely heavily on soybean meal as a protein source due to its high nutritional value. Dietary inclusion of Amarula oil cake in Windsnyer pig diets can ease pressure of relying on non-native feed sources and benefit the swine industry. Windsnyer pigs have the potential of alleviating poverty in rural communities and contribute positively to human nutrition, particularly in local populations in small scale subsistence farming systems, therefore, identifying and characterizing alternative high quality feedstuffs for Windsnyer pigs needs attention.

**Hypothesis:** The study was conducted to determine the growth performance of Windsnyer pigs fed different levels of Amarula oil cake (AOC). It was hypothesized that the inclusion level of AOC would elicit a quadratic response in growth parameters of Windsnyer pigs.

**Methodology:** Twenty-five clinically healthy growing male boars with an initial body weight of  $19.92 \pm 8.74$  kg were used in the study that lasted six weeks, excluding one week of adaptation period. Five experimental diets were formulated to contain 0, 50, 100, 150 and 200 g/kg DM of Amarula oil cake. All pigs were allocated to diets in a completely randomized design. The average daily feed intake (ADFI), average daily gain (ADG), feed conversion ratio (FCR), scaled average daily feed intake (SADFI), scaled average daily gain (SADG) and body weight (BW) were calculated weekly. Data for the effect of AOC inclusion level, week and their interaction on ADFI, ADG, FCR, SADFI, SADG and BW were analyzed using the PROC MIXED procedure of SAS and the polynomial procedure of SAS was also used to determine the relationship between AOC inclusion level and growth performance of pigs.

**Results:** The diet affected ADFI, ADG, FCR and SADG ( $P < 0.05$ ). Scaled average daily feed intake was not affected by the diet ( $P > 0.05$ ). There was a significant interaction between AOC inclusion and weeks of feeding on ADFI, ADG and FCR ( $P < 0.05$ ). Age of pigs decreased FCR quadratically ( $P < 0.001$ ). A quadratic relationship between ADFI and increasing levels of AOC was observed ( $P < 0.05$ ). Average daily gain, FCR and SADG decreased linearly with increasing AOC levels ( $P < 0.05$ ).

**Discussion:** High levels of the oil cake linearly reduced ADG, FCR and SADG while increasing ADFI quadratically. The quadratic response between increasing level of AOC and ADFI was however negative, suggesting that high inclusion levels of AOC diets are detrimental to growth performance of Windsnyer pigs which was also supported by the linear reduction in ADG, FCR and SADG. The dietary components of the feed which increased with the inclusion level of AOC such as the bulk content, fiber content and ether extract were the factors which influenced average daily feed intake and other growth parameters of Windsnyer pigs.

**Conclusion:** Amarula oil cake inclusion level was optimal at 102.17 g/kg DM, suggesting that AOC can be included in pig diets up to 100 g/kg DM without compromising the average daily feed intake and other growth performance parameters of indigenous pigs. When formulating AOC based diets for pigs, both feed bulk and fat content should be considered. Feed bulk may also influence weight of internal organs and carcass traits of pigs.

## Manipulation of the rumen environment with the inclusion of canola oil to increase the rumen undegradable protein fraction of feedstuffs

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**Background:** A greater need for protein resources for both humans and animals necessitate better protein utilization techniques, especially in ruminant diets. By increasing the percentage of rumen undegradable protein (RUP) in diets, this can possibly be accomplished. The amount of amino acids that are available for absorption in the lower intestines increases with an increase in protein that does not undergo rumen breakdown. By modifying the rumen environment with the addition of higher levels of plant oils such as canola oil, it is suggested that the RUP fraction might be raised, along with altering other factors organic matter digestibility (OMD).

**Aim:** The aim of the study was to investigate the potential manipulation of the rumen environment by including higher canola oil levels in the diet. Additionally, the effect of higher dietary oil levels on organic matter digestibility (OMD) was determined.

**Methodology:** This study received ethical approval (ACU-2019-9100). Five cannulated wethers were fed a 50:50 mixture of lucerne hay and wheat straw with inclusion of canola oil with increasing increments (0.00%, 0.75%, 1.50%, 2.25% and 3.00%). Rumen fluid was taken once a week for five weeks after a 14-day adaption period. For each inclusion level, an in vitro protein degradation analysis of canola oilcake meal was performed for 8 incubation periods (0, 2, 6, 12, 24, 48, and 96 hours). The Øskrov and McDonald (1979) formula,  $p = a + b(1 - e^{-ct})$ , was used to describe the protein degradation curves and parameters ("a", "b" and "c"). Rumen fluid obtained from the wethers on the different treatments was used to evaluate the effect of increasing dietary oil levels on in vitro OMD of oat hay.

**Results:** The parameters "a"-rapidly soluble fraction (%), "b"-fraction that will degrade over time (%) and "c"-rate of degradation of the b fraction (%/h), yielded no significant differences with DM and CP disappearance. A mean CP disappearance of  $32.2 \pm 2.0$  (%) amongst the inclusion levels was observed for parameter "a". Similarly, no differences were seen with the other two parameters. Crude protein effective degradation of canola oilcake meal averaged  $62.8 \pm 0.8$  for 0.02/h,  $54.0 \pm 0.9$  for 0.04/h,  $49.4 \pm 1.0$  for 0.06/h and  $46.4 \pm 1.0$  for 0.08/h outflow. No significant differences between treatments were detected. Organic matter digestibility of oat hay was respectively  $54.24 \pm 1.12$ ,  $54.12 \pm 0.80$ ,  $51.73 \pm 1.29$ ,  $51.65 \pm 1.51$  and  $50.04 \pm 1.68$  (%) with the use of rumen fluid collected from wethers fed diets with dietary oil levels from 0.00% to 3.00%. No significant differences were observed between treatments for in vitro OMD.

**Discussion:** No significant differences were found in the RUP fraction of canola oilcake meal with the use of rumen fluid collected from wethers fed a basal diet with dietary oil supplementation up to 3%. Similarly, no significant effect on the in vitro OMD of oat hay was observed with the use of rumen fluid collected from wethers fed diets with respectively 0.00%, 0.75%, 1.50%, 2.25% and 3.00% additional oil supplementation.

**Conclusion/recommendations:** It was concluded that the supplementation of diets with canola oil up to 3% did not affect the RUP fraction of canola oilcake meal. Supplementation of oil to the basal diet up to 3% did not significantly affect in vitro OMD of oat hay.

## B-sitosterol as an alternative to oxytetracycline: effect on growth performance, feed intake and utilization efficiency and meat quality of broiler chickens

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**Background:** Antibiotics are used at sub-therapeutic doses as growth promoters in broiler chicken feeds. However, they elicit antibiotic resistance and pollute the environment due to antibiotic residues deposited in chicken tissue and waste. To mitigate the challenges of antibiotic resistance and environmental pollution, alternatives to antibiotics that are natural and acceptable must be explored. The phytosterol, beta-sitosterol, has antimicrobial, antioxidant, digestive and immune system modulating activities. It therefore can potentially replace antibiotics as growth promoting feed supplements in broiler chicken feeds.

**Aims:** The aim of this study was to evaluate the effect of  $\beta$ -sitosterol, as a substitute growth promoting dietary supplement to oxytetracycline, on growth performance, feed intake and utilization efficiency and meat quality of broiler chickens. We hypothesised that  $\beta$ -sitosterol can replace oxytetracycline as a growth promoting feed supplement in broiler chicken diets.

**Methodology:** Two hundred and forty-one-day old Cobb 500 broiler chicks were in a completely randomized design allocated to four diets where  $\beta$ -sitosterol replaced oxytetracycline at 0 mg kg<sup>-1</sup> (control diet; 50 mg kg<sup>-1</sup> oxytetracycline as growth promoter), 500, 1000 and 1500 mg kg<sup>-1</sup> feed as growth promoting supplement.  $\beta$ -sitosterol doses were the same for the starter, grower and finisher diets. Diets were replicated 3 times with 20 chicks per replicate. The chickens were fed for 6 weeks: 2 weeks for each of the starter, grower and finisher growth phase. Induction, weekly and terminal body mass and daily feed intake were measured. Body mass gain, average daily gain and feed conversion ratio were computed by growth phase. Terminally, the chickens were fasted for 4 hours, weighed and then humanely slaughtered and dressed and empty carcass mass and dressing percentage were measured. Initial and ultimate pH (pH<sub>i</sub>, pH<sub>u</sub>) and meat colour were determined 45 minutes and 24 hours post-slaughter. The thawing loss (TL), cooking loss (CL), water holding capacity (WHC), tenderness and myofibrillar fragmentation length (MFL) were also determined.

**Results:** Dietary  $\beta$ -sitosterol as a growth promoting feed supplement had similar outcomes on the broiler chickens' growth performance, feed intake, feed utilization efficiency as the control diet supplemented with oxytetracycline. There were no significant differences ( $P>0.05$ ) in slaughter and empty carcass mass and dressing percentage of the chickens across dietary treatments. Graded dietary supplementation with  $\beta$ -sitosterol had similar ( $P>0.05$ ) effects as oxytetracycline-fortified diet on the chickens' breast meat colour, pH, TL, CL, WHC, tenderness and MFL.

**Discussion:** We demonstrate that  $\beta$ -sitosterol is equally effective a growth promoting dietary supplement in broiler chicken diets as is oxytetracycline. Our findings suggests that  $\beta$ -sitosterol can replace oxytetracycline and mitigate antibiotic resistance and environmental pollution associated with the fortification of broiler chicken diets with antibiotics at sub-therapeutic doses.

**Conclusion:**  $\beta$ -sitosterol should be further explored as a replacement for oxytetracycline as a growth promoter in broiler chicken diets as it showed no risk of compromising growth performance, feed intake, feed utilization efficiency and meat quality.

## Effect of game species on shelf life, volatiles compounds and fatty acid profiles of impala, springbok and mountain reedbuck

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**Background:** Game meat is regarded as a healthier alternative to beef, lamb or pork as it is low in saturated fats and cholesterol. Game meat comes from stress-free raised animals that have lived in a natural environment and fed on grasses and herbs. Thus, most consumers consider game meat an organic product since no fertilisers or growth promoters are used in the production system. Therefore, game meat production is crucial to the growth of the South African wildlife industry as it could contribute significantly to food and nutrition security while providing a healthy source of protein to consumers and economic returns to game ranchers. However, there is no comparative data regarding the fatty acid profiles of impala (*Aepyceros melampus*), mountain reedbuck (*Reduncula fulvorufula*) and springbok (*Antidorcas marsupialis*), which is critical regarding the shelf life of retail displayed.

**Hypothesis:** Species has no effect on fatty acid and volatile profiles or shelf life of game meat from impala, mountain reedbuck and springbok.

**Methodology:** Six animals of each species were randomly selected during cropping. The animals were hunted during the day and shot in the neck or head with 0.243 or 0.270 calibre rifle. At slaughter, the Longissimus thoracis et lumborum was removed after 24 hours of chilling (4°C) for meat fatty acid, volatile profile and shelf life analysis. All data was analysed using generalised linear model procedure of SAS v 9.4.

**Results:** Palmitic acid (16:0) and total saturated fatty acids (SFA) were affected by species with mountain reedbuck and springbok having higher ( $P \leq 0.05$ ) proportions than impala. Impala and springbok had higher ( $P \leq 0.05$ ) proportions of oleic acid (c9-18:1) and total mono-unsaturated FA (MUFA) than mountain reedbuck. Overall, omega (n)-6 polyunsaturated FA (PUFA), linoleic acid (18:2n-6) and alpha-linolenic acid (18:3n-3) were higher ( $P \leq 0.05$ ) in impala and mountain reedbuck than springbok. A total of 41 volatile compounds were identified and presented according to their chemical classes: 1 acid, 9 alcohols, 11 aldehydes, 17 esters, 1 ketone, 1, lactone and 1 furan. For meat colour, redness ( $a^*$ ) and chroma decreased over time, while yellowness ( $b^*$ ) and hue showed an upward trend during the same period for all species ( $P \leq 0.05$ ). Both lipid and protein oxidation had species  $\times$  day interactive effects ( $P \leq 0.05$ ).

**Discussion:** Overall, it was observed that species affected the total proportions of fatty acids and volatiles with regards to game meat. However, no species effects were observed with regards to game meat. Based on the above, it may be concluded that game meat can be on retail display as it is within the threshold of shelf life values and in an acceptable range.