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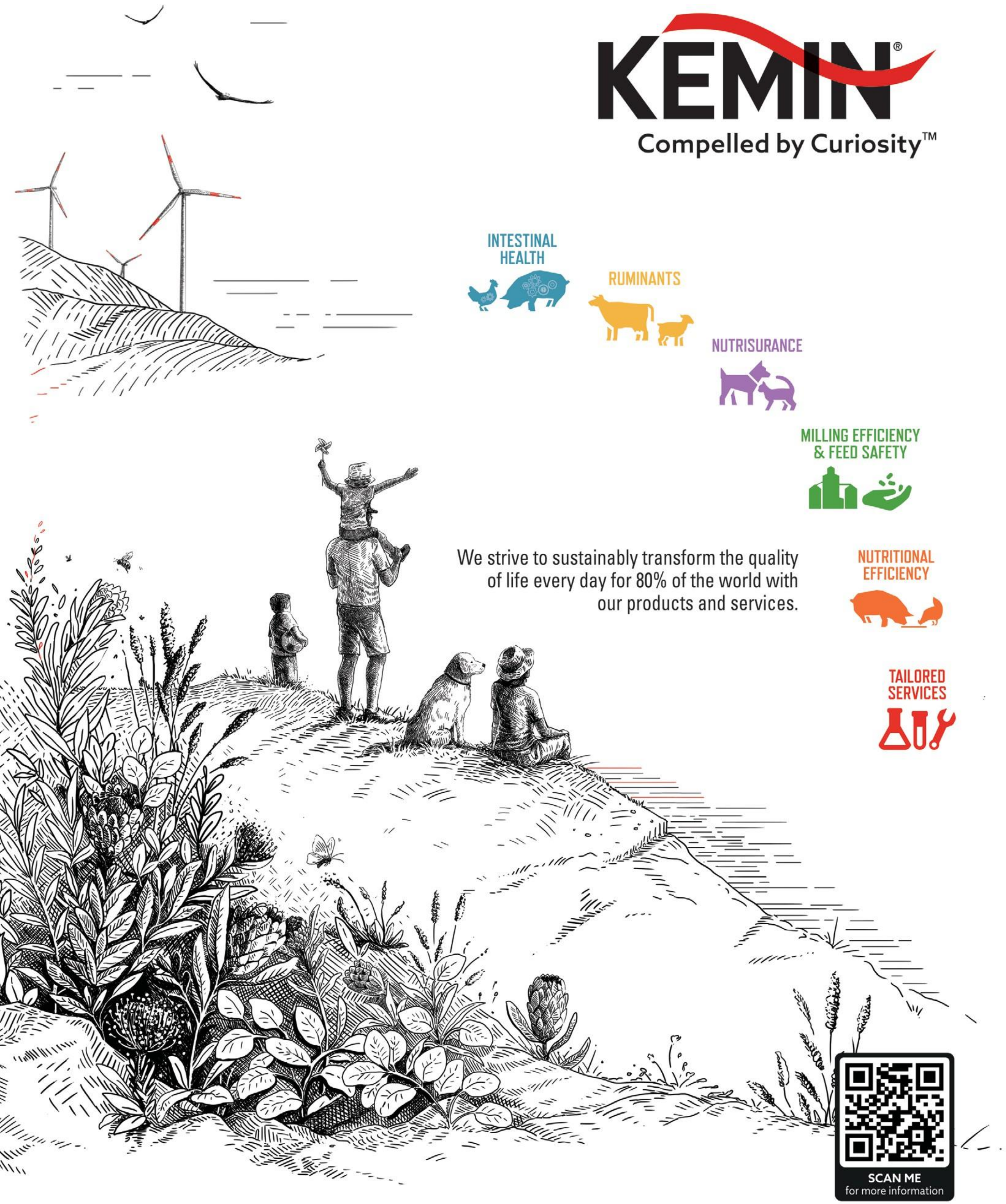
Matrix

Quarterly magazine of the Animal Feed Manufacturers Association

Rendering • Oilcake supply • Feed outlook • Zinc sources • Enteric methane
Methionine • Sclerotia in feed • Mycotoxins • Probiotics
Yeast additives • Pellet durability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Building confidence in a changing feed environment

By Liesl Breytenbach, executive director, AFMA

South Africa's animal feed industry continues to operate in a changing and demanding agricultural environment. Feed manufacturing is closely linked to key parts of the agricultural value chain, including grain and oilseed production, animal production and health, logistics and regulation. These linkages ultimately influence broader outcomes in food security in terms of availability and affordability, and the long-term sustainability of the animal protein sector. When pressure builds in one part of the chain, the effects are felt across the entire value chain, from primary producers to processors and ultimately consumers.

So far this year, the local agricultural environment has brought both relief and pressure. Better crop prospects have improved the availability of key raw materials, creating a favourable supply situation and lower feed input costs for livestock and poultry producers. At the same time, it places pressure on grain and oilseed producers who continue to face high fuel, fertiliser, and other input costs. This again shows how closely the value chain is connected: relief in one part of agriculture often creates pressure elsewhere.

Regulations support stability

Practical industry engagement and adaptive regulatory frameworks remain essential in this environment to support agro-processors and primary producers. AFMA therefore welcomes the official confirmation by the minister of agriculture that hominy chop will not require registration as a feed ingredient under the *Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947)* and that the status quo can be upheld. This is positive news for the industry and reflects the value of constructive engagement with regulatory authorities.

Liesl Breytenbach.

The Animal Feed Manufacturers Association (AFMA) appreciates the input received from members and industry stakeholders, whose technical knowledge and practical insight helped shape a balanced industry position. The outcome is also a reminder that effective regulation must remain risk-based, proportionate, and aligned with the practical realities of the feed value chain.

AFMA's recent media and industry day was well attended by media representatives, members and industry role-players, and provided an important platform to communicate strategic issues affecting the feed industry. A central message was that industry assurance systems are becoming more important in strengthening regulations, consumer confidence, and market access for animal protein products. A collaborative effort is needed between all stakeholders in the livestock sector to provide inter-linked industry assurance of responsible manufacturing practices, traceability, and accountability for the sustainable production of animal-derived proteins.

Engagement strengthens resilience

AFMA's participation at NAMPO also provided valuable one-on-one engagement with members and industry partners. These discussions offered practical insight into what members are experiencing on the ground and will shape AFMA's priorities to remain aligned with industry realities.

This edition of *AFMA Matrix* carries these themes further, with articles that explore global feed production, efficiency and resilience in ruminant feeding systems, changing soya oilcake supply patterns, and a practical perspective on *Sclerotinia* in feed and grazing material. Together, these contributions highlight the importance of informed decision-making, technical awareness, and industry preparedness in a changing feed environment.

Investing in the next generation

Building future industry capability also remains a priority. In collaboration with AFMA members, including De Heus and Kemin Industries, AFMA hosted three student outreach initiatives involving North-West University, the University of Venda, and the University of Limpopo. These engagements exposed students to the practical realities of modern feed manufacturing and helped bridge the gap between classroom learning and industry practice. With the industry becoming more technical, regulated and innovation-driven, continued investment in student development and tertiary collaboration is essential to building a strong future skills pipeline.

The challenges facing agriculture will continue to change, but the responsibility is the same: to ensure that South Africa's feed sector remains competitive, credible, sustainable, and plays a pivotal role in supporting a growing livestock sector.

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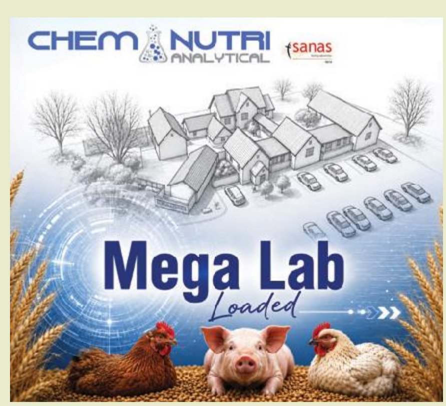


NEWS & VIEWS

High-oleic soya beans to advance dairy nutrition

More than a decade after their commercial introduction, high-oleic soya beans are continuing to attract attention across the dairy sector. What began as a novel crop innovation is now an active area of research, with feeding trials helping to clarify how these beans can be used to improve home-grown ration design, animal performance, and farm efficiency.

Katelyn Goldsmith, dairy outreach specialist at the University of Wisconsin-Madison, says high-oleic soya beans share many similarities with conventional soya beans. Both are rich in protein, typically containing around 40% crude protein and 20 to 22% fat. The key distinction lies in their fatty acid profile. Conventional soya beans contain a high proportion of linoleic acid, whereas high-oleic varieties are characterised by a much greater concentration of oleic acid. This shift in fatty acid composition has important implications for dairy nutrition.

"High-oleic soya beans give producers another way to bring homegrown fat and protein into the ration while lowering some of the milk fat depression risk we typically associate with full-fat soya beans," says Goldsmith.

While not a universal solution, high-oleic soya beans represent a promising development in the evolution of dairy feeding systems, with ongoing research playing a central role in unlocking their full potential, she concluded. – *Food & AgriBusiness*

Potential winning goat feed combo revealed

A combination of emu apple and oats has proven the winner in an Australian-first comparison trial into greenhouse gas-restricting feed for goats. The sub-tropical browse emu apple (*Owenia acidula*) combined with green fresh-cut oats had the most desirable fermentation pattern and lowest methane emissions than other alternatives, according to laboratory analyses led by the University of Queensland. The researchers were looking for the best balance of feed to improve digestibility and reduce methane emissions from goats in Australia's tropical arid and semi-arid regions.

The research team found that oats were the most digestible feed and had the lowest methane production. Research lead, associate professor Sarah Meale, said goat production is rapidly expanding in tropical arid and semi-arid regions, yet limited knowledge exists on the feed they consume. She said that, while methane from goat farming accounts for 4pc of global enteric methane emissions, goat populations have expanded faster than any other ruminant species since 2000, increasing by 39pc and surpassing 1,2 billion head globally in 2023.

She added that goats could offer the opportunity to respond to changes in plant growth patterns due to climate change. – *Sheep Central*

New AI platform to tackle emerging toxins

An artificial intelligence (AI)-powered platform designed to predict exposure to foodborne contaminants and rapidly identifying toxin-degrading enzymes could offer new tools for managing food and feed safety risks, according to researchers from the National University of Singapore (NUS).

The technology, developed by Prof Eric Chan and Dr Dachuan Zhang from the Bezos Centre for Sustainable Protein NUS, was recently recognised through the inaugural Grantham Foundation Detox Award by Future Fit Asia. The researchers say the platform could support toxin management in aquaculture, animal feed, and broader food production systems.

The platform originated from discussions between Chan and Zhang after Zhang joined NUS in 2025. Their shared interest in food toxin detoxification let to the development of a system aimed at identifying solutions for both food and feed contamination challenges.

The researchers emphasised that technology could function both as a preventive tool and as a post-contamination mitigation strategy. However, they believe prevention offers the most reliable and effective approach to toxin management within aquaculture production systems. – *AquaFeed.com*

Orffa opens new science lab in Breda

In June this year, Orffa officially opened the Orffa Science Lab in Breda, The Netherlands, marking an important step in the company's commitment to science-driven innovation in animal nutrition. The lab strengthens Orffa's scientific capability by connecting research, diagnostics and expertise with practical application. The opening brought together colleagues, customers, partners and scientists around a shared purpose: to understand more, learn more, and explore how science can create customer value across the animal nutrition chain.

The programme featured keynote presentations by two leading academics in animal nutrition and health, underlining the scientific foundation of the Orffa Science Lab. Prof Richard Ducatelle and Prof Leo den Hartog shared their expertise on gut health, novel diagnostic techniques, antimicrobial resistance, and developments shaping the future of the sector. Following the presentations, guests joined guided tours of the laboratory, where they saw how Orffa translates scientific research into practical application. – *Orffa*

dsm-firmenich opens new premix facility

dsm-firmenich announced the opening of NextGen Itatiba, a fully dedicated pet nutrition premix facility developed in partnership with Globalfood in São Paulo state, Brazil. The site will focus on the production of vitamin and mineral premixes for cats and dogs and serve as the company's main pet nutrition manufacturing and supply hub in South America.

The investment follows the recent launch of dedicated pet premix facilities in Austria and the United States, expanding dsm-firmenich's connected global production network for pet food applications across Europe and the Americas. Industry demand for specialised pet nutrition continues to grow globally, particularly in emerging markets. – *Feed Planet*

Animal nutrition market to reach US$48,7 billion by 2034

The animal nutrition market size is expected to be worth around US$48,7 billion by 2034 from US$25,2 billion in 2024, growing at 6,8% during the forecast period 2025 to 2034.

Based on product type, the market is categorised into antioxidants, eubiotics, amino acids, and fibre. Among these, the amino acids segment dominated the market in 2024, capturing a revenue share of 54,5%. By application, the market is segmented into poultry, ruminant, aquaculture, swine, and others. The poultry segment emerged as the leading category, accounting for 51,8% of the overall market share in 2024. In terms of end users, the market is divided into veterinarians, animal feed manufacturers, households, farms, and others. The farms segment held the largest share of 58,5%, reflecting the increasing adoption of advanced animal nutrition products in commercial farming operations.

Regionally, North America maintained its leading position in the global animal nutrition market, securing a market share of 38,3% in 2024. – *media.market.us*

Feed flavours market forecast points higher

According to the latest IndexBox report on the global feed flavours market, the market enters 2026 with broader demand fundamentals, more disciplined procurement behaviour, and a more regionally diversified supply architecture. The global feed flavours market represents a critical and sophisticated segment within the broader animal nutrition industry, serving as a nexus between animal science, ingredient technology, and evolving agricultural production systems.

As of the 2026 analysis period, this market is characterised by its essential role in enhancing feed palatability, masking undesirable tastes from functional additives, and supporting animal performance metrics crucial for modern, high-efficiency livestock, aquaculture, and pet food production. The industry's trajectory is inextricably linked to the macro-trends shaping global protein demand, supply chain resilience, and the intensification of farming practices aimed at optimising feed conversion ratios and herd health.

For the complete report, visit *www.indexbox.io*

Astral earnings rebound on lower feed costs

Astral Foods has reported a significant turnaround in profitability for the six months to 31 March 2026, driven by lower feed costs, improved operational efficiencies, and sustained consumer demand for poultry in an unpredictable agricultural environment. The company held an online media briefing on 18 May, during which it discussed its performance.

The Johannesburg Stock Exchange-listed poultry producer reported operating profit of R1,21 billion, up from R271 million in the comparable period, while revenue increased 11% to R11,9 billion. Headline earnings per share surged 467% to 2,318 cents.

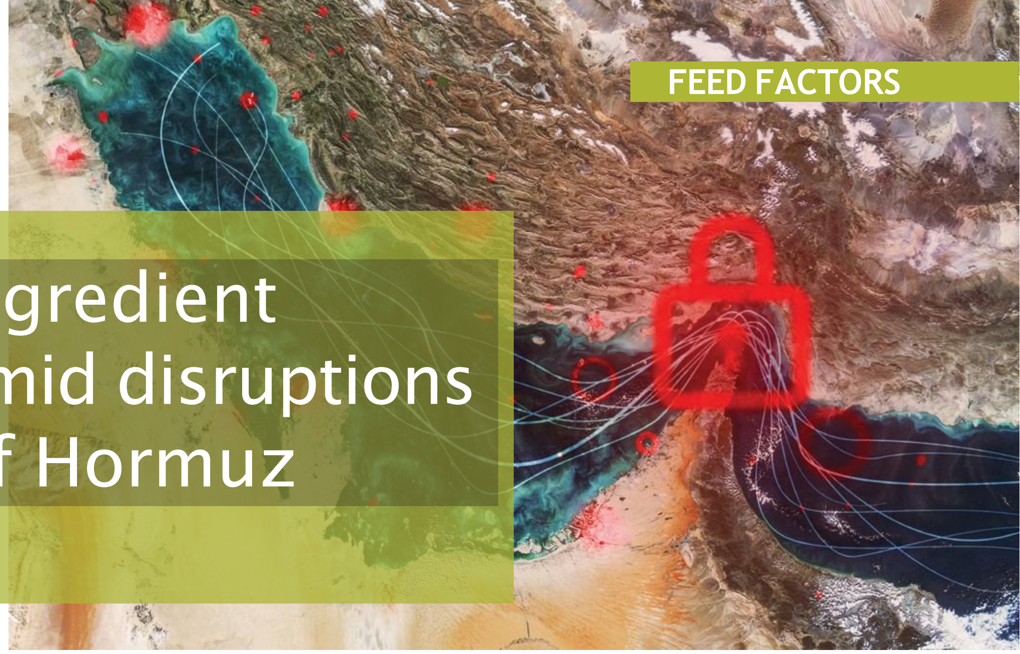
Chief executive officer Gary Arnold said the results reflected a combination of favourable cost conditions and operational discipline. "A number of stars aligned enabling this performance, underpinned by strong demand for poultry, a softening in feed costs, and good execution of Astral's best-cost strategy," he said.

The group's recovery was led by a strong turnaround in its poultry division, which moved from an operating loss of R26 million in the prior period to a profit of R848 million. – *AgriOrbit*

Women lead in insect feed value chain

A CABI-led review involving an international team of scientists has revealed that women dominate the value chain of insects used as food and feed in Africa but that their role varies with insects and regions. In Africa, insects such as locusts, crickets, grasshopper, the mopane worm, and flies have long been used as human food and animal feed. This practice is presently being promoted to reduce malnutrition and provide new opportunities for the economic development of the rural poor, in particular women.

With regards to insects for animal feed, it is hoped that this practice will promote sustainable industrialisation, increase employment and local technology development in low-income communities, and it is also expected to improve gender equality. In Africa, private enterprises and public programmes are being developed at various scales to provide fly larvae meal to be used directly on the farm and for the feed market. – *Africa.com*



Global feed ingredient supply risks amid disruptions in the Strait of Hormuz

By Dr Lucius Phaleng, trade advisor, AFMA

Chokepoints are narrow channels along widely used global sea routes that are critical to energy trade and security, as large volumes of petroleum, other liquids, and liquefied natural gas pass through them. International energy markets depend on reliable transport routes. The blockage of oil transit through a major chokepoint, even temporarily, can lead to substantial supply delays and higher shipping costs, resulting in higher world energy prices.

Although most chokepoints can be circumvented by using alternative routes, often at the cost of longer transit times, some have no practical substitutes. This article examines the Strait of Hormuz chokepoints, the world's most strategically significant in terms of oil and related product volumes transported. Understanding the strategic importance of the Strait of Hormuz is essential in assessing the broader implications of ongoing geopolitical tensions on global commodity and agricultural supply chains.

Significance of Hormuz

Located between Oman and Iran, the Strait of Hormuz connects the Persian Gulf to the Gulf of Oman and the Arabian Sea. It is both deep and wide enough to accommodate the world's largest crude oil tankers, making it one of the most important oil transit routes globally. Large volumes of oil pass through the strait, and if it were to be closed, alternative routes would only be able to handle a portion of this oil volume.

Saudi Arabia and the United Arab Emirates have infrastructure in place that can bypass the Strait of Hormuz, which may partially mitigate transit disruptions. However, the strategic significance of the strait extends beyond the energy sector, as disruptions in oil and gas flows have direct consequences for industrial production, transport systems, and agricultural input markets globally.

Given the current active disruptions at the Strait of Hormuz, oil prices are the most important cross-cutting variable for the feed additive industry. Nearly all manufacturing inputs, such as energy for fermentation and synthesis, are sensitive to oil and gas prices. The prolonged disruptions could push prices higher, significantly increasing manufacturing energy costs, freight surcharges, and fertiliser prices, while placing additional pressure on feed additive and amino acid production costs.

Impact on the feed industry

As one of the world's most critical maritime chokepoints, the area handles nearly 20% of global oil trade and large volumes of liquefied natural gas exports. Recent disruptions have negatively impacted global supply chains and added further pressure on shipping and logistics costs, increasing expenses for the animal feed sector and the broader food industry. Consequently, the ripple effects of these disruptions are being felt across the agricultural value chain, particularly within the fertiliser, feed manufacturing, and livestock production sectors.

For the feed industry, the impact extends beyond fuel prices. Rising natural gas and crude oil costs are driving fertiliser nitrogen prices, feed ingredient transport costs, and fermentation-based amino acid production expenses. Under severe circumstances, manufacturing energy costs could increase by 40 to 60%, leading to repricing of manufactured feed additives and contributing to global food inflation and stagflationary economic pressures.

Wider supply risks

The conflict may be unfolding far from South Africa, but its effects are impacting one of agriculture's most sensitive supply chains. For fertiliser and animal feed manufacturers, the US-Iran conflict has emphasised a familiar reality: fertiliser is not only a farm input but also a geopolitical commodity.

Animal feed production depends on more than maize; it also depends on mineral supplementation, especially phosphorus. Without adequate mineral inclusion, feed quality suffers and animal performance declines. Taken together, these developments highlight the extent to which geopolitical instability in strategic maritime corridors can rapidly translate into operational and cost pressures across global food production systems.

The ongoing Hormuz disruptions represent one of the largest oil supply shocks in modern history, with the resulting volatility creating uncertainty across agricultural, feed, and food supply chains worldwide.

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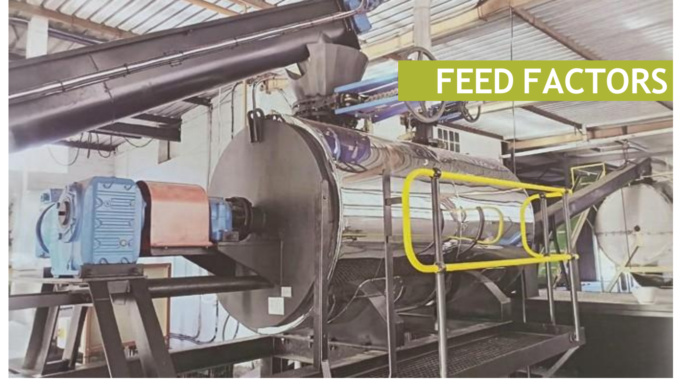

Photograph: RSA Renderers.

Rendering sector in South Africa's livestock value chain

By Nikilene Steenkamp, Plaas Media

Rendering facilities play a critical but often overlooked role in South Africa's livestock industry. These facilities convert animal by-products into regulated, usable materials while supporting biosecurity and environmental management.

Jimmy Bekker, chairperson of RSA Renderers, explains that the sector operates under strict regulatory oversight and serves as a formal link between primary production and downstream industries. "Rendering plants are there to ensure that animal material is recycled safely and correctly," Bekker says.

RSA Renderers, established as a non-profit organisation in 2013, represents operators involved in the collection and processing of animal matter, with a focus on ensuring the industry operates within a structured, compliant framework.

What is rendering?

Rendering is the controlled process of converting animal by-products not used for human consumption into secondary materials that can be reintroduced into the economy. These by-products originate primarily from farms and abattoirs and include blood, bones, offcuts, feathers, fats, and condemned meat.

Rather than being discarded, these materials are processed into usable products such as protein meals and oils, allowing the livestock sector to recover value from products that would otherwise be treated as waste.

How does rendering work?

The process follows a regulated industrial pathway designed to ensure safety and consistency. Animal by-products are transported to approved facilities and processed using either batch or continuous systems. The material is subjected to high temperatures and pressure to eliminate pathogens and stabilise the organic matter.

Following sterilisation, the material is separated into protein solids and fats, then refined and dried into stable, low-moisture products. Samples are taken to verify that it meets registered specifications, including moisture content limits and processing standards.

Regulation and traceability

Rendering facilities operate under a regulatory system overseen by the National Department of Agriculture. Facilities must be approved under the *Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947)* and issued a facility registration number linked to the materials they are permitted to process. This registration is valid for a fixed period and must be renewed to maintain compliance.

Each facility has a unique identifier, and products require separate approval. Once approved, products receive registration numbers to ensure traceability. No product may be sold or distributed without approval, and labelling ensures correct identification and use. Certain materials, particularly those derived from specific species, are subject to additional restrictions and must be identified accordingly.

Oversight and compliance

Rendering operations are subject to ongoing oversight from regulatory authorities, including the National Department of Agriculture, veterinary services, and environmental bodies. These inspections are supported by internal quality control systems at each facility, which monitor compliance continuously. This combined approach ensures that both the processing environment and the final products meet the standards required for safe use in the agricultural and industrial sectors.

Why is rendering important?

By processing animal by-product materials in regulated facilities, the sector supports biosecurity by reducing the risk of disease transmission. At the same time, it contributes to environmental protection by reducing the risk of soil and groundwater contamination associated with unmanaged disposal.

It also supports regulatory compliance, particularly where animal by-products are classified as hazardous waste and require specialised handling. In this context, rendering provides a structured and recognised pathway for dealing with such materials.

Products and industry use

The outputs of rendering facilities are used across multiple industries, forming part of established agricultural and industrial value chains. Protein-based products such as meat and bone meal, blood meal, poultry meal, and fish meal are widely used in animal and pet nutrition, while fats and oils are used in agricultural and industrial applications. Each product is manufactured and distributed in line with its approved registration and intended use, ensuring consistency and traceability from production to end user.

Where do renderers fit in?

Within the livestock value chain, renderers are an important link between primary production and downstream industries. Rendering is therefore a functional and necessary component of the broader agricultural sector, supporting safe operations, regulatory compliance, and the continued use of valuable biological resources.

For more information, contact Jimmy Bekker at 013 667 9097.

Future of the feed ingredient trade under AfCFTA

By Dr Lucius Phaleng, trade advisor, AFMA

The African Continental Free Trade Area (AfCFTA) has the potential to be among the largest free trade areas in the world once fully implemented – trade under the AfCFTA began on 1 January 2021. It could connect 1,3 billion people across 55 countries with a combined gross domestic product valued at US$3,4 trillion, according to the World Bank.

The free trade area could have a particular influence on African agricultural trade, as growth in member economies increases demand for processed agricultural products, such as sugar, beverages, prepared foods, animal and vegetable oils, dairy, poultry, and prepared cereals. Currently, demand outpaces production, leaving Africa a net importer of agricultural goods.

Although external partners such as the United States are not yet part of the free trade area, AfCFTA may present immediate investment opportunities and longer-term prospects for further trade liberalisation. Recent trade developments also show a shift towards regional sourcing, particularly in Southern Africa, where cross-border trade in oilseeds and feed ingredients is expanding along key trade corridors.

Benefits for the feed industry

The agreement aims to utilise trade policies, including the establishment of a single continental market and the promotion of industrial development, as an engine of growth and sustainable development. This will be achieved by eliminating tariff and non-tariff barriers to trade, starting with the removal of tariffs on 90% of goods. Reducing non-tariff barriers, such as cutting the time it takes to move goods across borders by just 20%, could deliver greater economic benefits for Africa than eliminating all import tariffs.

The intention is to create opportunities to develop regional value chains and enhance the continent's competitiveness in global value chains, thereby expanding both intra-African and external trade.

The AfCFTA agreement is therefore not only about the exchange of goods and services but also a roadmap for Africa's development. Once fully realised, it would represent a milestone in reducing poverty across the continent.

For the feed industry, this could lead to increased regional trade in raw materials and feed ingredients, with feed manufacturers increasingly sourcing maize, soya oilcake, sunflower meal, phosphates, and additives from neighbouring countries under improved trade conditions.

Feed sector growth potential

Driven by population growth, technological advances, and infrastructure improvements, Africa's feed sector is well positioned for investment across the value chain.

However, only 4% of investment in Africa and 3% of global development funding currently goes to agriculture, highlighting a significant opportunity for targeted investment. High-growth segments are emerging, such as livestock and dairy production, particularly cattle, poultry, and dairy, offering opportunities across feeding, breeding, and production systems.

South Africa's animal feed industry is well placed to expand into African markets by increasing exports and investing in regional feed production to meet rising demand driven by livestock growth and changing diets. The key prospects include exporting high-quality poultry and livestock feed, developing local manufacturing facilities in other countries, and upgrading logistics to reduce reliance on imports.

Infrastructure challenges

While infrastructure in Africa continues to pose challenges, it is also undergoing significant expansion and improvement, creating investment opportunities to participate in its development and benefit from its growth. According to the African Union, these constraints have long hindered intra-African trade. Countries face extended customs delays, limited paved road networks for freight transport, and higher rates of goods loss due to underdeveloped cold chain systems compared to other regions globally. Even when goods can move through these constrained transport networks, the associated costs remain high.

Similarly, *Business Day* noted a shortage of road connectivity into Africa's 16 landlocked countries, with alternative transport options often being costly.

Compounding these challenges is a weak regulatory framework governing customs and border processes. Intra-African border crossings are frequently characterised by inefficiencies, delays, and corruption, largely driven by lengthy wait times and bureaucratic procedures at border posts.

Logistics challenges

In addition, logistics systems depend heavily on information technology and coordinated supply chain management – areas in which many African countries remain underdeveloped. Some logistics operators still rely on manual inventory systems to track and distribute goods. These constraints negatively impact the movement of goods and services across the continent, including the timely delivery of feed ingredients to feed manufacturers and livestock producers.

Against this backdrop, the AfCFTA presents a unique opportunity to address longstanding logistics and supply chain inefficiencies, ensuring that the movement of goods, services, and people within the continent becomes more efficient and cost-effective, without imposing high costs on end users.

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SA's soya oilcake supply shifts towards local and regional sources

By Dr Lucius Phaleng, trade advisor, AFMA

The South African Revenue Service (SARS) reported a notable increase in soya oilcake imports from neighbouring countries during the first quarter of 2026, reflecting changing sourcing patterns within the domestic animal feed industry. Historically, South Africa relied heavily on imports from the Americas, particularly from Brazil and Argentina, to meet the protein requirements of the feed manufacturing sector.

However, import tariffs on selected soya oilcake encouraged a gradual shift in procurement, with greater emphasis on locally produced supply and sourcing from neighbouring countries. This transition coincided with expanded domestic crushing capacity and stronger regional trade flows, reducing dependence on overseas suppliers.

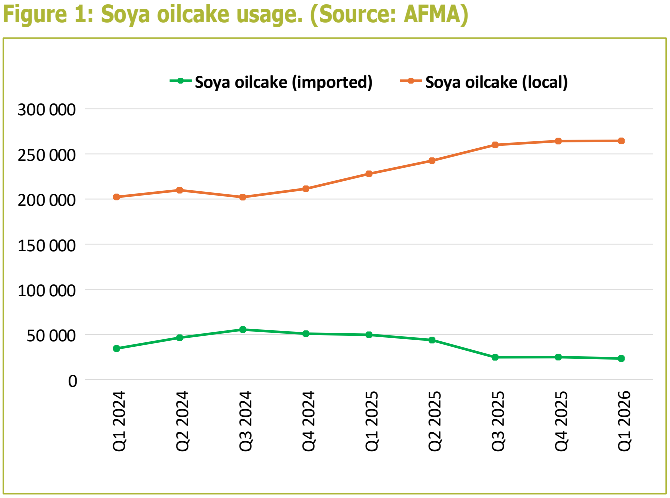
As illustrated in *Figure 1*, the Animal Feed Manufacturers Association's (AFMA) soya oilcake usage trends indicate a shift from imported to locally produced soya oilcake. Imported volumes declined from around 35 000 tonnes in Q1 of 2024 to below 25 000 tonnes by Q1 of 2026. Local production grew steadily from nearly 200 000 tonnes in Q1 of 2024 to over 260 000 tonnes Q1 of 2026.

The widening gap between imported and local volumes reflects the increasing reliance of the South African feed manufacturing industry on domestic crushing capacity and regional supply chains. This transition appears to have been influenced by a combination of import tariff measures, increased domestic crushing capacity, local soya bean availability, and changing procurement patterns.

Growth in regional imports

The increased inflow from neighbouring countries during the first quarter of 2026 therefore highlights the growing importance of regional trade partnerships to support South Africa's agricultural value chain amid changing market conditions, evolving trade policies, and sustained feed demand. The data further indicates that Africa remained the dominant source of soya oilcake imports during the latter part of the period under review.

Figure 1: Soya oilcake usage. (Source: AFMA)



Imports from African countries increased from 1 376 tonnes in December 2025 to 2 057 tonnes in January 2026, followed by 1 450 tonnes in February 2026 and a further increase to 2 867 tonnes in March 2026. This strong growth suggests that neighbouring markets continue to play a critical role in supplementing local protein meal requirements.

Most of South Africa's soya oilcake imports from the African region came from neighbouring countries, with the largest volumes entering via Eswatini through the Oshoek and Jeppe's Reef border posts. Zambia was the second-largest supplier, with imports mainly transported through the Grobler's Bridge border post. In contrast, Mozambique contributed relatively small volumes, indicating a more limited role in regional soya oilcake trade flows into South Africa.

Decline in overseas imports

Imports from America, which historically contributed the largest share earlier in 2025, declined substantially after May 2025. Volumes peaked at 41 819 tonnes in February 2025 and 28 599 tonnes in May 2025, before dropping to negligible or zero volumes from July 2025 onwards. This shift points to imposed import tariffs, changing sourcing patterns, or improved availability from regional suppliers.

European imports remained relatively small and inconsistent throughout the reporting period, contributing marginal volumes ranging from 26 to 208 tonnes. Imports from Asia were almost non-existent, with only isolated shipments recorded during February 2025 and February 2026.

Final thoughts

The first quarter of 2026 saw a significant transformation in South Africa's soya oilcake sourcing patterns, with regional suppliers filling the gap left by overseas markets. The continued growth in imports from neighbouring countries, particularly through key border posts linked to Eswatini and Zambia, highlights the strengthening role of regional trade integration in supporting the domestic feed manufacturing industry.

At the same time, the increase in locally produced soya oilcake demonstrates the positive impact of import tariff measures in encouraging domestic crushing capacity and reducing reliance on long-distance imports from the Americas. Collectively, these developments indicate a more regionally integrated and resilient supply chain capable of supporting South Africa's growing demand for animal feed under evolving global trade conditions.

For more information, send an email to Dr Lucius Phaleng at trade@afma.co.za

AFMA calls for strengthened feed security and regulatory efficiency

By Nikilene Steenkamp, Plaas Media

The Animal Feed Manufacturers Association (AFMA) hosted its second annual media and industry day in Pretoria on 28 May, where it announced plans to modernise its code of conduct into a risk-based, technology-driven assurance system to strengthen traceability, accountability, and consumer confidence across the integrated feed and food value chain.

Liesl Breytenbach, executive director of AFMA, identified the growing integration of feed and food systems as the central theme of the event. "The days when the feed chain operated separately from the food chain are long gone; these chains are becoming more and more intertwined," she said.

She emphasised that the formal animal feed industry operates within one of the most prescriptive agricultural regulatory environments in South Africa, governed by the *Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947)*. Under this *Act*, feed ingredients, additives, formulations, manufacturing practices, and traceability systems are subject to regulatory oversight before products enter the market.

"By comparison, large segments of the retail food sector rely more heavily on food safety standards, post-market enforcement, consumer protection legislation, and common law after products have already entered circulation," Breytenbach said.

The speakers at the 2026 AFMA media and industry day are, from the left, Petru Fourie, operations manager at AFMA, Thea Laufs, director of CPG, Dr Lucius Phaleng, trade advisor at AFMA, Karla Zietsman, general manager of Sappo, and Liesl Breytenbach, executive director of AFMA.

This fundamental difference in regulatory approach is why AFMA considers modern industry assurance systems essential, not to replace state regulation, but to strengthen traceability, accountability, audit consistency, and consumer confidence across integrated value chains. AFMA confirmed that it is reviewing and strengthening its code of conduct framework to support a more practical, risk-based and technology-enabled audit and compliance environment, including improved traceability, electronic audit systems, and reporting capabilities.

AFMA's national footprint

Petru Fourie, operations manager at AFMA, outlined the association's reach and strategic position within South Africa's feed value chain. AFMA currently has 177 members, including 69 full feed manufacturing members, 85 associate members – of which 44 are raw material suppliers and 39 premix and feed additive companies – as well as 23 affiliate members, including six laboratory service providers and 13 equipment suppliers.

AFMA's reported feed production data for 2024/25 shows that members produced 7 248 984 tonnes of feed. When compared with the estimated national feed production figure of 12 450 363 tonnes, this represents 58% of total national feed production. Broiler production is the dominant category, with AFMA members producing 3 673 606 tonnes of broiler feed, representing 99,8% of the national total of 3 680 328 tonnes. Layer feed stands at 86% (860 574 tonnes of 1 006 295 tonnes nationally), while pigs account for 43% (517 010 tonnes), dairy 38% (1 033 877 tonnes), and beef and sheep 34% (1 084 947 tonnes).

Fourie also highlighted the association's role as a consumer of raw materials. Based on a five-year average derived from crop estimates, the animal feed industry utilises 85% of South Africa's total soya bean crop – 1,93 million tonnes of 2,31 million tonnes – while animals consume 64% of yellow maize, equivalent to 4,86 million tonnes of 7,65 million tonnes. Together, livestock account for 39% of total maize production, equal to 5,99 million tonnes of 15,54 million tonnes.

Poultry, basis of feed demand

Fourie identified poultry as the primary driver of feed demand in South Africa. Poultry accounts for approximately 60% of AFMA members' total feed sales, underscoring its dominant role in the

Izaak Breitenbach, CEO of Sapa's Broiler Organisation, Liesl Breytenbach of AFMA, and Ruan Stander of Meadow Feeds.

animal feed industry. Per capita consumption of poultry meat has increased from 11,6kg per year in 1980 to 35,9kg in 2025 – an increase that far exceeds that of other protein categories. Per capita beef consumption declined from 24,1 to 15,1kg over the same period, while pork stands at 6kg and eggs at 8,4kg.

In her interview with Plaas Media, Breytenbach explained the feed industry's dependence on the poultry sector. "Whatever happens to poultry numbers in our country – whether the industry is challenged by disease outbreaks, constrained by increased imports, or able to expand export markets – has an impact on the demand for animal feed," she said. AFMA members are responsible for feeding virtually all locally produced chicken.

Feed production data also show clear resilience following the highly pathogenic avian influenza outbreaks that affected the sector in previous years. The *AFMA Monthly Animal Feed Report* of January 2026 confirms this recovery trend: Total feed production increased from 518 064 tonnes in January 2024, a decline of 13,9% during the outbreak year, to 577 217 tonnes in January 2025 (+11,4%) and 585 164 tonnes in January 2026 (+1,4%), although volumes remain below the 2023 peak.

Supply and infrastructure pressure

Dr Lucius Phaleng, trade advisor at AFMA, outlined the global and local disruptions currently confronting feed manufacturers. Geopolitical tensions, such as the Russia-Ukraine war, the partial closure of the Strait of Hormuz, and changing trade policies, directly affect the availability and affordability of imported feed additives and vitamins.

He highlighted the exposure of vital inputs: Methionine is closely tied to international chemical markets and is vulnerable to energy and logistics shocks; vitamin E is derived from petrochemical intermediates and is sensitive to crude oil price movements; feed phosphates are sourced from concentrated mining regions with export restrictions; and sulphur, a by-product of energy production, is directly exposed to geopolitical risk.

China's removal of sulphur products from its value-added tax exemption list, combined with Russia's export ban on industrial sulphur, has further driven up prices. Because sulphur is a key input in the production of sulphuric acid and phosphates, disruptions in sulphur supply chains can have far-reaching consequences across multiple feed ingredient categories.

At a local level, Dr Phaleng noted several vulnerabilities: More than 60% of the industry's inputs are imported, Transnet port congestion causes delays that disrupt production planning and damage time-sensitive products, and the industry relies heavily on an unstable and costly energy supply.

Breytenbach emphasised AFMA's role as a representative voice in this environment. "Government cannot engage simultaneously with 180 different companies, but they can engage with one representative body that brings forward the key challenges and frustrations that prevent us from operating efficiently," she said.

Members are diversifying their sourcing strategies, expanding procurement beyond suppliers in the Middle East to include partners in Asia and Europe. They are also taking a more proactive approach to inventory management.

Code of conduct

Breytenbach highlighted the revision of the *AFMA Code of Conduct* as a key focus of the day's message – the code has been in place since 2008 and requires mandatory compliance from all feed manufacturing members.

The revised framework is based on three pillars:

- **Pillar 1:** Quality and safety, including good manufacturing practices (GMP), food safety management systems, compliance with the *Occupational Health and Safety Act, 1993 (Act 85 of 1993)*, and feed formulation by nutritionists registered with the South African Council for Natural Scientific Professions.
- **Pillar 2:** Legal and ethical standards under *Act 36*, competition law, and the *Basic Conditions of Employment Act, 1997 (Act 75 of 1997)*.
- **Pillar 3:** Market and community, including consumer protection, genetically modified organism labelling, AgriBEE compliance, independent third-party auditing, and commitment to AFMA's mission.

The audit framework itself is also undergoing significant revision. The previous approach, heavily document-driven and with evaluation tools embedded directly in the code's principles, is being replaced by a modernised approach that separates code principles from the operational audit instrument.

The new framework aims to align with International Organization for Standardisation/preventive control-style systems (hazard analysis and critical control points + GMP + management controls) and a risk-based approach targeting 70% practical verification and only 30% documentation. Food defence and fraud are integrated directly into existing safety controls. The overarching objective is to reduce audit fatigue by delivering a single integrated audit accepted by all customers, supported by electronic audit systems.

Effective assurance as a lever

Thea Laufs, director of CPG, presented the broader case for modern assurance systems as a regulatory lever. She warned that delayed pre-market approval systems become counterproductive

Benita Oelofsen of AFMA, Anina Hunter, chairperson of AFMA, and Anneli Liebenberg, also of AFMA.

Dr Francois van de Vyver of Kemin Industries with well-known veterinarian, Dr Faffa Malan.

to innovation, competitiveness, supply continuity, and ultimately food security. "Strong industry assurance frameworks provide an opportunity to support regulatory efficiency without compromising feed safety, transparency, or accountability," she said.

Laufs described modern assurance systems as characterised by shared accountability and responsibility, a risk-based approach, traceability, integration across value chains, and mutual trust. She also emphasised that rising regulatory and market assurance expectations, growing pressure for transparency, and a stronger focus on food safety make reviewing existing systems essential.

Pork 360: Assurance in action

Karla Zietsman, general manager of the South African Pork Producers' Organisation (Sappo), presented Pork 360 as a relevant case study for the feed industry. Pork 360, established in 2009 and formally published in 2013, is a producer-driven certification system based on six pillars, namely animal welfare, biosecurity, food and feed safety, antimicrobial stewardship, environmental stewardship, and traceability through record-keeping.

As of May 2026, the system comprised 377 pig producers, 139 681 sows, and 492 units, of which 61 producers farming 97 320 sows were certified. Auditing is conducted by Certification Partner Global and includes farm, feed mill, and abattoir standards, which are verified by independent veterinarians and the South African Meat Industry Company (Samic). Traceability is supported by the World of Pork online platform, which digitally integrates movement records, veterinary visits, and audit capture.

Zietsman summarised the lessons from Pork 360 as the necessity of self-regulation, which remains practical and achievable, the importance of industry buy-in for long-term success, and the growing role of data and traceability systems. She also highlighted the strategic value of self-regulation for industry-government partnerships: during disease outbreaks, industry systems with reliable data are often better positioned to engage constructively with regulators and decision-makers.

Consumer confidence

Breytenbach addressed the issue of consumer confidence in the informal market, stating that food safety requirements are enforced mainly through the retail sector, while a larger and less visible segment of consumer markets falls outside this framework.

"If you do not want to be regulated or transparent about your operations, you cannot expect to build consumer confidence." She noted that many consumers are largely unaware of the extensive regulatory oversight governing animal products and the feed used in their production. Addressing this knowledge gap is a key objective of AFMA's communication initiatives.

Skills development and training

AFMA reaffirmed its commitment to training and skills development by highlighting three training programmes: the *Act 36* in practice workshop, the *Act 36* registration workshop, and the technical writing skills workshop.

At an operational level, the association also offers a blended learning feed mill operator programme, a feed miller short course, and a biosecurity self-study programme. For the next generation of practitioners, four initiatives are in place: the AFMA Intervarsity Writer's Cup, the AFMA Student of the Year Award, the AFMA Student Nutrition Poster Award, and student outreach programmes.

The key message of the day was that sectors can no longer operate in isolation. "As the environment becomes more complex, stronger industry coordination and assurance systems become essential to support food security and public trust," Breytenbach concluded.

Visit *www.afma.co.za* for more information.

AFMA student outreach update

By Petru Fourie, operations manager, AFMA

In April this year, the Animal Feed Manufacturers Association (AFMA), in collaboration with some of its members, including De Heus and Kemin Industries, hosted three student outreach initiatives involving North-West University, the University of Venda, and the University of Limpopo. These outreach initiatives form part of AFMA's broader strategic focus on training, skills development, and raising awareness of career opportunities within the animal feed and agricultural sectors.

University of Limpopo students and the De Heus feed mill in Modimolle.

Industry exposure

The outreach commenced on 8 April with students from North-West University visiting the De Heus feed mill in Klerksdorp. This was followed by an outreach initiative hosted by Kemin Industries in Pretoria on 10 April for students from the University of Venda. The final outreach initiative took place on 17 April at the De Heus feed mill in Modimolle and was attended by students from the University of Limpopo.

The initiatives gave students first-hand insight into the operational environment of the animal feed industry – exposure that is difficult to replicate in a classroom setting alone. During the visits, students gained practical insight into feed manufacturing processes, raw material handling, quality control systems, feed safety procedures, logistics, and technical support functions within the industry.

Kemin Industries welcomed students from the University of Venda.

Students had the opportunity to interact directly with industry professionals, including plant managers and production coordinators, technical advisors, safety officers, and raw material specialists. Exposure of this nature is particularly valuable for students studying Animal Science and related agricultural disciplines, as it helps bridge the gap between academic theory and practical industry application.

One of the key highlights of the outreach programme was the guided feed mill tours, where students observed feed manufacturing operations first-hand. This allowed them to gain insight into the complexity of feed production systems, the role of quality assurance and feed safety protocols, and the level of precision required within modern feed manufacturing facilities. The exposure provided a practical perspective on how nutrition science, operational management, technology, and quality systems integrate within a commercial production environment.

Students from North-West University at the De Heus feed mill in Klerksdorp.

Preparing students for the future

This initiative further helped students better understand the important role the animal feed industry plays within South Africa's agricultural and food value chain, while highlighting the wide range of specialised career opportunities available within the sector.

Additional emphasis was placed on professional readiness and career preparation. Representatives from the South African Council for Natural Scientific Professions engaged with students on professional registration and career development in the natural sciences, while Agrijob provided guidance on CV preparation, interview skills, and navigating the transition from university to the professional workplace.

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AFMA INTERVARSITY WRITER'S CUP 2026: WINNER ROUND 3 / LITERATURE REVIEW

Effect of different limestone sources and phytase doses on CA and P digestibility in broilers

By A Herbst, C Jansen van Rensburg, KM Venter, P Plumstead, and BC Hillen

Since the 1950s, broilers have been intensively selected for rapid growth and improved production efficiency (Van den Brand, 2021). This genetic progress has resulted in modern broilers having markedly different nutritional requirements, particularly for calcium (Ca) and phosphorus (P), compared with birds from three decades ago.

As a result, outdated or inaccurate mineral formulation practices may fail to meet the new mineral requirements of broilers, driven by the birds' accelerated growth physiology. Such inadequacies, together with early rapid growth, have been associated with a range of skeletal problems, including bone abnormalities, deformities, and poor bone mineralisation (Proszkowiec-Weglarz and Angel, 2013).

Given these challenges in maintaining skeletal integrity in fast-growing broilers, understanding the roles of Ca and P in bone development is essential. The importance of Ca and P in broiler nutrition stems from the minerals' central roles in bone formation and the maintenance of skeletal integrity. The cations (Ca^{2+}) and anions (Pi) form hydroxyapatite crystals ($Ca_{10}(PO_4)_6(OH)_2$), which confer rigidity and strength to bone (Veum, 2010; Proszkowiec-Weglarz and Angel, 2013). Consequently, the skeleton serves as the primary mineral reservoir, containing approximately 99% of body Ca and 80% of body P (Veum, 2010; Suttle, 2022).

Limestone as a Ca source

Limestone is the main feed ingredient used to supplement Ca in broiler diets, as it is a readily available and cost-effective source of Ca (Anwar *et al.*, 2016; Jafari Arvari *et al.*, 2024). Due to the chemical composition of limestone, it can contain up to 40,04% Ca (Gilani *et al.*, 2022), and according to the NRC (1994), the average Ca concentration of limestone is 38%. However, Gilani *et al.* (2022) conducted a global survey which showed variation in limestone particle size and Ca concentration within and between regions. This could be due to differences in the rock's geological origin, which lead to impurities and differing macro mineral concentrations.

Furthermore, historically, limestone quality has been determined by its Ca and other mineral content, and in more recent times, particle size and solubility (Plumstead *et al.*, 2020), and these physical and chemical properties influence the utilisation and digestibility of Ca and P.

Phytate

In plant-based feed ingredients, phytic acid (IP_6) constitutes the primary storage form of P, accounting for 60 to 80% of total P in typical broiler diet ingredients (Walters *et al.*, 2019). Despite its abundance, phytate-P is poorly available to broilers (Amerah *et al.*, 2014; Dersjant-Li *et al.*, 2018). As a result, only 10 to 50% of dietary P is metabolically available in monogastric animals (Walters *et al.*, 2019).

Beyond being indigestible, phytate-P exerts several antinutritional effects, whereby phytic acid becomes negatively charged under broiler physiological pH conditions and chelates divalent and trivalent cations, including Ca^{2+}, Zn^{2+}, and Fe^{3+} (Dersjant-Li *et al.*, 2018). Chelation reduces the availability not only of P but also of the minerals and nutrients bound to phytate.

The solubility of the resulting phytate-mineral complexes is pH-dependent, remaining soluble below pH 3,5 but precipitating from pH 4 onwards, with maximal insolubility near pH 7 – the pH of the small intestine (Dersjant-Li *et al.*, 2014). Once precipitated, these complexes become inaccessible to hydrolysing enzymes such as phytase, as inositol phosphate esters must remain soluble for enzymatic degradation (Amerah *et al.*, 2014).

Phytase

Exogenous phytases are routinely used in commercial broiler diets to hydrolyse phytate, improving the availability and utilisation of phytate-bound P and other nutrients (Fernandez *et al.*, 2019; Walk *et al.*, 2024). Phytase (inositol hexaphosphate phosphohydrolase) is an enzyme capable of hydrolysing phytic acid and sequestering inorganic orthophosphate groups from phytic acid in a stepwise manner (Adeola and Cowieson, 2011).

Hydrolysis begins with fully phosphorylated phytate (IP_6), when the first phosphate group is cleaved to form inositol penta-phosphate (IP_5). The successive dephosphorylation then yields inositol tetra-phosphate (IP_4) and progressively smaller phosphate esters (Zeller *et al.*, 2016). Although *in vivo* degradation is rarely complete, this stepwise process reduces phytate's mineral-binding affinity, as higher esters such as IP_6 and IP_5 exhibit the strongest chelating capacity (Dersjant-Li *et al.*, 2014; Levya-Jiminez *et al.*, 2019). Thereby, phytase improves P and other nutrient utilisation by preventing the chelation of phytate with nutrients.

Phytase activity peaks in acidic environments; therefore, most phytate hydrolysis occurs in the crop and gizzard (Menendez-Blackburn *et al.*, 2015). Rapid hydrolysis in the acidic proventriculus and gizzard prevents soluble phytate esters from entering the small intestine, where Ca-phytate complexes become insoluble, thus improving Ca and P utilisation (Li *et al.*, 2017; Bello *et al.*, 2020).

Ca, phytate, phytase interaction

Broiler physiological responses to supplemental phytase may be influenced by dietary Ca concentration, the Ca:P ratio, and the diet's PP content (Amerah *et al.*, 2014). This is mainly due to the formation of insoluble Ca-phytate complexes in the small intestine, which reduces the complex's susceptibility to phytase hydrolysis (Dersjant-Li *et al.*, 2018).

Walk *et al.* (2012a) demonstrated that AID P increased linearly as dietary Ca decreased from 0,9 to 0,45%, and AID Ca improved with increasing phytase supplementation up to 2 500 FTU/kg at low Ca levels. Similarly, Dersjant-Li *et al.* (2018) showed that reducing dietary Ca while supplementing phytase (500 to 1 000 FTU/kg) significantly increased Ca digestibility compared with control diets. Supporting this, Akter *et al.* (2017) observed that elevating Ca in low non-phytate P diets decreased ($P < 0,001$) the AID of both Ca and P, due to reduced phytase efficacy.

Despite the inhibitory effects of excess dietary Ca, phytase supplementation may partially alleviate the mineral's negative impact on broiler performance (Powell *et al.*, 2011; Krieg *et al.*, 2021). Kim *et al.*, (2018) found that regardless of Ca levels in the diet, the supplementation of 1 000 FTU/kg diet of phytase improved Ca and P digestibility. Similarly, Dersjant-Li *et al.* (2018) showed that reducing dietary Ca while supplementing phytase (500 to 1 000 FTU/kg) significantly increased Ca digestibility compared with control diets.

Inclusion of phytase super doses

Inclusion of phytase beyond commercially recommended doses, referred to as super-dosing, typically involves phytase inclusion rates greater than 1 500 or 2 500 FTU/kg diet (Adeola and Cowieson, 2011; Martínez-Vallespín *et al.*, 2022). The utilisation of elevated phytase levels could promote near-complete hydrolysis of phytate and the formation of lower inositol phosphate esters, thereby mitigating phytates' antinutritive effects and allowing efficient utilisation of phytate-bound nutrients (Walk *et al.*, 2014).

The improvements in BW gain and growth performance are largely attributed to greater availability of P and other nutrients bound to phytate (Adeola and Cowieson *et al.*, 2011). In addition, superdoses of phytase may have extra-phosphoric effects that cannot be explained solely by improved P availability, but may be due to changes in the gut and improvements in overall broiler health (Walk *et al.*, 2019; 2020).

Broiler gut health could improve due to reduced inhibition of digestive enzyme function and reduced risk of hind-gut microflora colonisation and proliferation (Beeson *et al.*, 2017). Supporting this, Dersjant-Li *et al.* (2022) found an exponential increase ($P < 0,001$) in AID P as their phytase dose increased from 0 to 4 000 FTU/kg diet, but the magnitude by which P's digestibility improved, decreased as the phytase dose increased.

The effect of limestone

Limestone particle size and solubility are key determinants of Ca and P availability, as limestone must dissolve in the gizzard and small intestine for Ca absorption to occur. Solubilisation is strongly influenced by gizzard retention time, with larger particles retained longer and achieving greater total dissolution, whereas fine particles dissolve rapidly *in vitro* but often show reduced *in vivo* solubility due to faster passage (Majeed *et al.*, 2020).

Consequently, coarse limestone releases Ca more gradually, allowing phytase sufficient time to hydrolyse phytate before Ca^{2+} becomes available for chelation. In contrast, fine limestone rapidly increases Ca^{2+} concentrations in the upper GIT, promoting Ca-phytate complex formation and potentially reducing phytase efficacy (Majeed *et al.*, 2020; Li *et al.*, 2021). As a result, the slower solubility and longer retention of coarse limestone support improved Ca and P digestibility, whereas the rapid dissolution and passage of fine limestone can reduce mineral availability and AID Ca (Kim *et al.*, 2018).

Kim *et al.* (2018) proposed that if phytate binds Ca more rapidly than phytase can hydrolyse IP_6, phytase efficacy will decline, a prediction supported by their findings. Coarse limestone allowed sufficient time for phytate hydrolysis before Ca^{2+} release, whereas fine limestone did not. Fine limestone, particularly when supplemented with additional Ca, reduced AID P ($P < 0,05$), while coarse limestone had no detrimental effect. Similarly, Li *et al.* (2021) showed that reducing limestone particle size increased Ca^{2+} concentrations in the GIT, promoted phytate chelation, and reduced Ca and P digestibility.

Conclusion

Ca and P are essential for broiler skeletal development, but phytate reduces their availability and impairs nutrient digestibility. Phytase improves utilisation, though its efficacy depends on limestone characteristics. Understanding interactions between limestone and phytase dosing is critical to optimise nutrient availability and broiler performance.

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AFMA INTERVARSITY WRITER'S CUP 2026: WINNER ROUND 3 / OWN RESEARCH

Zinc sources matter: Broiler zinc requirements under a high dose of phytase

By Jamie Fourie

In 1994, the National Research Council (NRC) published a recommended total dietary zinc (Zn) requirement of 40 ppm for broilers. These requirements, however, were established using semi-purified diets and are therefore not fully representative of the commercial poultry industry. Subsequent research redetermined Zn requirements using maize-soya bean meal diets, resulting in substantially higher recommendations. Today, major breeding companies such as Cobb-Vantress and Aviagen recommend supplementing broiler diets with 100 to 120 ppm Zn (Aviagen, 2022; Cobb-Vantress, 2022).

An increasingly important consideration in Zn nutrition is the global shift towards high inclusion rates (1 500 to 2 000 FTU/kg) of modern, highly efficacious phytase enzymes. These enzymes significantly improve phytate degradation and greatly increase mineral availability, including Zn (Yu *et al.*, 2018).

In addition to phytase dose and efficacy, the chemical source of Zn plays a critical role in determining dietary requirements for modern broilers. Numerous studies have compared inorganic and organic sources of Zn (Abd El-Hack *et al.*, 2017; Mwangi *et al.*, 2017; De Grande *et al.*, 2020, 2022), often demonstrating that organic Zn sources tend to exhibit a higher bioavailability relative to inorganic forms (Star *et al.*, 2012; De Grande *et al.*, 2020).

With this in mind, the present study aimed to determine the Zn requirements of modern broilers as influenced by the Zn source under conditions of high phytase inclusion.

Background

Experimental design

All animal care protocols were approved by the University of Pretoria Ethics Committee. A total of 5 760 day-old, mixed-sex Ross 308 broiler chicks were allocated to 84 floor pens (60 birds per pen), providing 12 replicate pens per treatment in a completely randomised block design.

The pens were situated in a commercial broiler house and managed according to a standard commercial temperature and lighting programme (Aviagen, 2022). Feed and water were offered *ad libitum* throughout the experimental period.

Feed and treatments

Seven dietary treatments were evaluated using two different Zn sources. Treatment 1 served as a negative control with no supplemental Zn. The remaining diets were supplemented with either 30, 60, or 90 ppm Zn supplied as zinc sulphate (ZnS; treatments 2 to 4, respectively) or as a zinc amino-acid complex (Zn-AA; AvailaZn, Zinpro Corporation, Minnesota, United States) for treatments 5 to 7, respectively.

All treatment diets were supplemented with 2 000 FTU/kg phytase (AxtraPHY GOLD, Danisco Animal Nutrition & Health, IFF) to maximise phytate hydrolysis. Diets were manufactured as pelleted feed and fed across five dietary phases.

Parameters measured

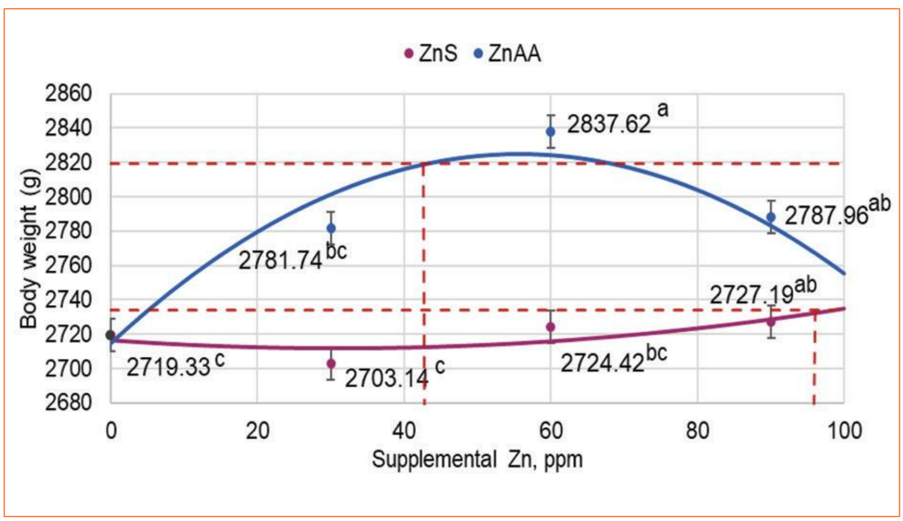
Broiler bodyweight (BW) was recorded at placement and at the end of each feeding phase (at ten, 16, 24, 30, and 37 days of age). Feed intake (FI) was measured per phase and used to calculate feed conversion ratio (FCR), which was subsequently corrected for mortality to determine mortality-corrected FCR (mFCR).

Table 1: Effects of Zn source and Zn dose on FI, BW, FCR and mortality of broilers from d0 to d37.

Treatment	Zn source[1]	Zn dose, ppm	BW, g	FI, g[2]	mFCR, g/g[3]	Mortality, %
T1	-	0	2 719,33^{c}	3 680,29^{ab}	1,353^{a}	3,83
T2	$ZnSO_4$	30	2 703,14^{c}	3 661,14^{b}	1,355^{a}	2,33
T3	$ZnSO_4$	60	2 724,42^{bc}	3 646,46^{b}	1,329^{ab}	2,83
T4	$ZnSO_4$	90	2 727,19^{bc}	3 701,30^{ab}	1,355^{a}	1,83
T5	Zn-AA	30	2 781,74^{abc}	3 723,25^{ab}	1,330^{ab}	4,73
T6	Zn-AA	60	2 837,62^{a}	3 770,03^{a}	1,315^{b}	2,66
T7	Zn-AA	90	2 787,96^{ab}	3 715,70^{ab}	1,323^{b}	3,16
Pooled SEM			17,51	23,54	0,007	0,83
P-value (ANOVA)			< 0,001	< 0,001	< 0,001	0,158
Effects based on factorial analysis (Zn dose x Zn source)						
Source			< 0,001	< 0,001	0,759	0,160
Dose			0,030	0,557	0,002	0,032
Dose x dose			0,058	0,339	0,013	0,922
Dose x source			0,113	0,542	0,400	0,734
Dose x dose x source			0,013	0,001	0,727	0,681

[a, b, c]Means within a column with different superscript letters differ ($P < 0,05$). [1]Zn supplementation either through zinc sulphate (ZnS) or a zinc amino-acid complex (Zn-AA). [2]Feed intake, g. [3]Mortality-corrected feed conversion ratio, based on mortality weights.

Figure 1: Regressions of broiler BW responses to increase Zn supplementation as affected by Zn source at d37.



At the end of the trial, two birds per pen with BWs closest to the pen mean were selected for carcass evaluation. Birds were weighed to determine slaughter weight and then electrically stunned, bled, and eviscerated. Hot carcass weight (HCW) was recorded, after which breasts were removed and weighed. Breast yield was expressed both in grams and as a percentage of carcass weight.

Statistical analysis

Data were analysed using JMP 16 (JMP, 2022), with each pen considered as an experimental unit. Statistical significance was declared at $P < 0,05$. Means were separated using Tukey's HSD test. Regression analyses were conducted separately for each Zn source, and Zn requirements were estimated at 95% of the maximum biological response, following the method described by Pesti *et al.* (2010).

Discussion

Performance

Organic Zn sources such as Zn-AA are absorbed via multiple amino-acid transport pathways that are less susceptible to dietary antagonists (Sauer *et al.*, 2017), which contributes to their higher relative bioavailability compared with inorganic Zn sources (Star *et al.*, 2012; De Grande *et al.*, 2020). These differences are further influenced by interactions between Zn, phytate, and phytase.

Phytate, the primary storage form of phosphorus (P) in plant-based feed ingredients, readily chelates divalent cations such as Zn^{2+}, thereby reducing mineral availability (Humer *et al.*, 2015; Phillippi *et al.*, 2023). Phytase counteracts this effect by hydrolysing phytate, releasing bound P, and decreasing its capacity to bind to these minerals (Philippi *et al.*, 2023; Maria *et al.*, 2024). As a result, greater quantities of free divalent ions become available for absorption, potentially increasing competition at intestinal transporters (Wang *et al.*, 2012; Jenkitkasemwong *et al.*, 2012; Fujishiro and Himeno, 2019).

These factors combined may help explain the performance responses observed in the present study. On days ten and 37, broilers receiving 60 or 90 ppm Zn-AA were the only treatment groups to achieve significantly higher ($P < 0,05$) BW and lower mFCR compared with birds fed no supplemental Zn (*Table 1*).

Table 2: Effects of zinc source and zinc dose on carcass yield on broilers at d37.

Treatment	Zn source[1]	Zn dose (ppm)	Slaughter weight, g	Hot carcass, weight, g[2]	Dressing, %[3]	Breast yield, g	Breast[4], %
T1	-	0	2 605,75^{b}	2 175,42^{b}	83,49	630,15^{b}	28,96
T2	$ZnSO_4$	30	2 648,50^{ab}	2 215,29^{ab}	83,66	656,23^{ab}	29,63
T3	$ZnSO_4$	60	2 678,75^{ab}	2 250,54^{ab}	84,01	655,73^{ab}	28,98
T4	$ZnSO_4$	90	2 677,67^{ab}	2 229,96^{ab}	83,28	645,70^{ab}	28,78
T5	Zn-AA	30	2 690,79^{ab}	2 268,75^{ab}	84,29	663,20^{ab}	29,21
T6	Zn-AA	60	2 750,25^{a}	2 307,75^{a}	84,03	678,19^{a}	29,33
T7	Zn-AA	90	2 707,04^{ab}	2 278,17^{a}	84,15	684,92^{a}	29,74
Pooled SEM			25,16	22,69	0,31	9,42	0,28
P-value (ANOVA)			0,011	0,004	0,262	0,015	0,102
Effects based on factorial analysis (Zn dose x Zn source)							
Source			0,027	0,010	0,297	0,280	0,785
Dose			>0,001	>0,001	0,569	0,009	0,516
Dose x dose			0,006	>0,001	0,071	0,010	0,425
Dose x source			0,499	0,202	0,287	0,140	0,072
Dose x dose x source			0,231	0,276	0,862	0,920	0,256

[a, b]Means within a column with different superscript letters differ (P < 0,05). [1]Zn supplementation either through zinc sulphate (ZnS) or zinc amino-acid complex (Zn-AA). [2]Calculated from slaughter weight after evisceration. [3]Calculated as HCW divided by the slaughter weight, expressed as a percentage. [4]Calculated as the breast yield as a percentage of the HCW.

The estimated Zn requirement for optimal BW up to 37 days was, therefore, substantially lower when Zn-AA was used compared with ZnS (44 vs 98 ppm, respectively).

Interestingly, the opposite trend was observed for mFCR, where the Zn requirement was higher for Zn-AA (52 ppm) than for ZnS (35 ppm). This difference can be attributed to the response asymptotes between Zn sources; where, regardless of the Zn inclusion level, broilers fed ZnS exhibited a consistently less efficient mFCR compared with those fed Zn-AA. Both BW and mFCR responded quadratically to increasing Zn levels, with the mFCR response differing significantly by Zn source (P < 0,01).

Collectively, these findings indicate that Zn requirements under high phytase inclusion are markedly lower than current breed recommendations, particularly when organic Zn is used. This highlights the importance of considering both Zn source and phytase strategy when formulating modern broiler diets.

Carcass characteristics

For all carcass parameters measured (*Table* 2), broilers fed diets without supplemental Zn produced the lowest yields (P < 0,05), including slaughter weight (2 605,75g), HCW (2 175,42g), and breast yield (630,15g). In contrast, broilers supplemented with 60 ppm Zn-AA achieved significantly higher (P < 0,05) slaughter weight (2 750,25g), HCW (2 307,75g), and breast yield (678,19g). Across all carcass traits, broilers fed ZnS did not differ significantly from those fed the negative control diet. These results align with previous studies reporting improved carcass and breast yield in broilers supplemented with organic Zn sources compared with inorganic forms (Saenmahayak *et al.*, 2010; De Grande *et al.*, 2022; Ma et al., 2024).

Using asymptotic regression models, the Zn requirement for optimal slaughter weight, HCW, and breast yield was estimated at 58, 50, and 40 ppm for ZnS, and 50, 48, and 54 ppm for Zn-AA, respectively.

Conclusion

Re-evaluating Zn requirements for the modern broiler is justified on two key fronts. First, organic Zn sources demonstrate higher bioavailability than inorganic forms, primarily due to their use of alternative absorption pathways. Second, the widespread adoption of modern, high-dose phytase enzymes increases phytate degradation and may intensify competition among inorganic minerals within the gastrointestinal tract, further disadvantaging inorganic Zn sources.

The present study clearly demonstrates that Zn inclusion levels can be substantially reduced in broiler diets when high phytase doses are employed – particularly when organic Zn sources are used. These findings support more precise Zn supplementation strategies with improved growth and carcass performance, as well as better reflecting modern enzyme technologies and matrices.

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Efficiency under pressure: Global ruminant feed outlook

By Petru Fourie, operations manager, AFMA

While poultry and pig production continued to drive much of the global feed industry's growth during 2025, the *2026 Alltech Agri-Food Outlook* shows that ruminant production systems are operating in a pressured environment. Dairy and beef sectors continue to face challenges linked to climate volatility, rising costs, and changing market conditions.

At the same time, global demand for dairy and beef products is relatively resilient, particularly in developing regions where urbanisation, population growth, and changing diets support the long-term demand for animal protein.

The report highlights a global ruminant industry focussed on efficiency, productivity, feed optimisation, and operational resilience rather than large-scale expansion alone. *Table 1* reflects moderate growth across the major ruminant feed sectors during 2025. Dairy feed recorded stronger growth than beef feed, reflecting continued intensification in commercial dairy systems across the globe. Beef production, however, remained under pressure in several regions as producers faced shrinking herds and difficult operating conditions, including climate-related pressures and profitability challenges.

Dairy systems intensify

Global dairy feed production increased by 2,6%, supported by increasing milk demand, improved dairy prices in some regions, and continued investment in commercial dairy systems. The report highlights strong growth in dairy in Africa and Asia, where rising urban demand for milk and other dairy products is driving the expansion of commercial dairy operations. Countries such as India remain key contributors to dairy growth, driven by commercialisation and improved feed utilisation.

The focus in modern dairy systems is on producing more milk from fewer animals by improving production efficiency and refining on-farm management practices.

Beef systems under pressure

Global beef feed production recorded more moderate growth during 2025, increasing by only 0,5%. According to the report, beef production systems in several regions face structural pressures linked to drought, climate variability, herd rebuilding cycles, and sustainability concerns. Despite these challenges, investment in more intensive and commercially managed beef systems continues in several regions. Feedlot operations are key to improving efficiency and supporting a more consistent supply of beef to the market.

The report highlights the growing importance of feed efficiency, as producers seek to reduce costs and maximise productivity. Producers are placing greater emphasis on efficiency and feed utilisation, as well as tighter production management, to remain competitive amid challenging operating conditions.

Sustainability and resilience

The 2026 Alltech report indicates growing pressure on ruminant systems to improve sustainability and production efficiency. Global focus on methane emissions, climate variability, and environmental performance is reshaping how dairy and beef systems operate.

Drought conditions, water constraints, and rising production costs are placing pressure on producers across several major livestock-producing regions. As a result, many producers are focussing more closely on improving efficiency and strengthening the long-term resilience of their operations.

The report also shows that future competitiveness within global ruminant systems will depend on efficiency rather than expansion alone. Feed costs remain among the largest input expenses in dairy and beef systems, underscoring the importance of feed optimisation and effective nutritional management. For feed manufacturers, this creates more opportunities for nutritional precision and improved production performance.

Looking ahead

The *2026 Alltech Agri-Food Outlook* makes it clear that global ruminant systems are entering a period of transition. Dairy and beef sectors are facing pressure from climate variability, sustainability expectations, volatile input costs, and changing market dynamics. At the same time, long-term demand for milk and beef products remains relatively stable, particularly in developing regions where urbanisation and population growth bolster demand for animal protein.

The report therefore highlights resilience and operational adaptability as vital competitive advantages in ruminant production operations worldwide. For South Africa's feed industry, these trends reinforce the important role that feed efficiency, sustainability readiness, climate resilience, and sound nutritional management play in dairy and beef production.

Table 1: Growth in major ruminant feed sectors (2024 vs 2025).

Sector	2025 feed tonnes (million mt)	2024 feed tonnes (million mt)	Growth (million mt)	Growth (%)
Dairy	170,294	165,924	+4,370	+2,6%
Beef	134,181	133,578	+0,603	+0,5%

For more information, download the complete *2026 Alltech Agri-Food Outlook* at *www.alltech.com/agri-food-outlook*

Challenges to key components of the red meat industry

By Moeketsi Edward Mokoena, Department of Agricultural Economics, University of the Free State

The global red meat industry has faced several constraints over the years, including the Covid-19 pandemic, geopolitical conflicts, declining consumer purchasing power, rising input costs, climate change, and livestock diseases (Red Meat Industry Services [RMIS], 2025). On 2 January 2019, South Africa also lost its foot-and-mouth disease (FMD)-free status. Nevertheless, global beef consumption is projected to grow by around 13% by 2034 (OECD-FAO, 2025).

The loss of South Africa's FMD-free status has led to several changes in the red meat value chain's operations. This article examines developments across key components of the value chain, including slaughter trends, imports and exports, and the movement of other products.

Number of slaughtered livestock

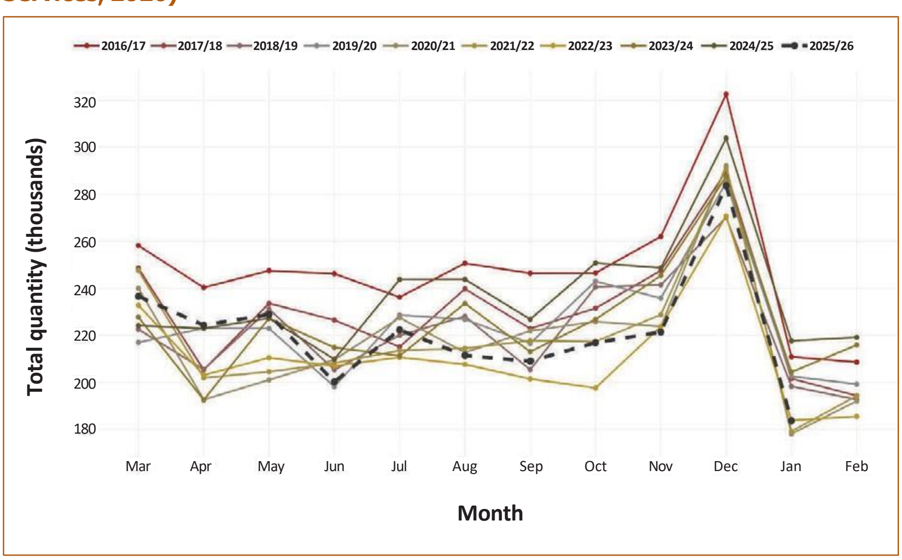
South Africa slaughtered a total of 27 095 950 cattle from 2016 to 2025, averaging 2 709 595 animals annually. During this period, Mpumalanga recorded the highest number of cattle slaughtered on a provincial basis. Annual slaughter numbers fluctuated, ranging from a low of 2 539 139 animals in 2022 to a peak of 3 001 602 animals in 2016 (RMIS, 2025).

According to the former Department of Agriculture, Land Reform and Rural Development (DALRRD), the high number of cattle slaughtered in 2016 was largely due to the 2016/17 drought, which forced many producers to reduce herd sizes (DALRRD, 2021).

Although 2022 recorded the lowest number of slaughtered cattle, slaughter numbers subsequently increased by 4,4%, from 2 539 139 animals in 2022 to 2 649 701 animals in 2023. This upward movement continued into 2024, when slaughter numbers increased by 6,5% to 2 822 464 animals, the second-highest level recorded after 2016. However, a decline re-emerged in 2025, with slaughter numbers decreasing by 139 964 animals, from 2 822 464 in 2024 to 2 682 500 in 2025 (RMIS, 2025).

Monthly slaughter data also reveals seasonal patterns. According to RMIS (2025) data (*Figure 1*), cattle slaughter numbers usually increase from September through the festive season, peaking in December, before returning to normal levels in January.

Figure 1: Monthly slaughter (2016/17 to 2025/26). (Source: Red Meat Industry Services, 2026)



Beef trade

South Africa's beef trade remained in a relatively strong position from 2016 to 2025. During this period, exports averaged 30 759,9 tonnes per year, with total exports reaching 307 599 tonnes valued at R24 064 million. Major export destinations included the Middle East, particularly the United Arab Emirates, Jordan, and Kuwait, as well as Mozambique. Total imports amounted to 87 947 tonnes, valued at R3 250 million (RMIS, 2025).

Despite the re-emergence of FMD cases in 2019 and the subsequent loss of South Africa's FMD-free status, beef exports increased by 54,1%, rising from 22 716 tonnes in 2019 to 35 007 tonnes in 2020 (the second-highest level after 38 817 tonnes recorded in 2024) (RMIS, 2025). This growth was supported by strong demand from China, accounting for more than 30% of total beef exports in 2020.

A notable decline in trade occurred in 2025. Beef import volumes fell by 51,8%, down from 3 746 tonnes in 2024 to 1 941 tonnes in 2025, while import values dropped by 48,1%, from R160 million to R77 million. Similarly, beef export volumes declined from 38 817 tonnes (R3 661 million) in 2024 to 28 698 tonnes (R3 182 million) in 2025. These declines may be attributed to outbreaks that affected several major feedlots in 2025.

Cattle offal

According to RMIS (2025), South Africa imports more offal than it exports. From 2016 to 2025, total offal imports amounted to 275 780 tonnes, valued at R3 406 million, while exports reached only 13 398 tonnes, valued at approximately R260 million.

A comparison of 2024 and 2025 shows a noticeable decline in imports. Import volumes fell by 7 532 tonnes, from 20 806 tonnes in 2024 to 13 274 tonnes in 2025, while import values decreased from R334 million to R292 million. In contrast, offal exports experienced significant growth, increasing by 62,97% in volume, while export values doubled from R28 million in 2024 to R56 million in 2025 (RMIS, 2025).

Hides and skins

Cattle raw hides and skins are among the most traded by-products of the South African beef industry and play a vital role in the leather value chain. The availability of hides and skins is directly linked to the number of cattle slaughtered (DAFF, 2012).

Over the past decade, using 2016 as the base year, South Africa exported more than 200 000 tonnes of hides and skins, valued at over R2 407 million, while imports amounted to just over 40 000 tonnes, valued at approximately R320 million (RMIS, 2025).

When examining trade from 2024 to 2025 more closely, export volumes and values remained relatively stable. In contrast, imports declined sharply, with volumes falling from 1 257 tonnes in 2024 to only 404 tonnes in 2025, while import values declined from R3,3 million to R1,9 million (RMIS, 2025).

Cattle weaners

From 2016 to 2025, South Africa exported a total of 245 467 cattle weaners, valued at R2 583 million. Export numbers peaked in 2021, when more than 45 000 weaners were exported, generating R319 million in revenue.

In contrast, imports exceeded three million weaners, valued at R17 463 million (RMIS, 2025). The highest number of weaners imported was in 2023, when 397 102 animals valued at R1 874 million were brought in. Most of the weaners imported from 2016 to 2025 originated from Namibia, Botswana, and Swaziland, while key export markets included Mauritius and Zimbabwe.

A sharp decline in weaner imports was observed in 2025, when import numbers dropped by approximately 80,5%, from 357 190 weaners in 2024 to 69 537 in 2025 (RMIS, 2025). This decline may reflect stricter biosecurity measures implemented by trading partners following renewed FMD outbreaks.

Stud cattle

Since 2016, South Africa has exported approximately 18 905 stud cattle, valued at around R80 million. The years 2016, 2017, 2019, and 2024 collectively accounted for around 91,2% of total exports.

A notable decline occurred from 2020 to 2021, when stud cattle exports fell sharply from 349 animals to only 47 animals (RMIS, 2025). Meanwhile, imports totalled around 6 855 animals, valued at R12 million, with 2020 alone accounting for around 76,9% of total imports. Imports were extremely limited in certain years; for example, only two stud animals were imported in total during 2018 and 2021, with one animal imported in each year (RMIS, 2025).

These fluctuations in trade activity can largely be attributed to outbreaks of FMD, which significantly disrupted South Africa's livestock trade. As a result, stud cattle exports declined from 2019 to 2023, then recovered in 2024 (RMIS, 2025).

From 2016 to 2025, South Africa's stud cattle imports originated exclusively from African countries such as Namibia, Botswana, and Nigeria. Exports were primarily destined for several trading partners across the African continent, particularly Tanzania, Zimbabwe, Zambia, Kenya, and the Democratic Republic of the Congo (RMIS, 2025).

Final remarks

The trade performance of South Africa's beef industry over the past decade demonstrates both resilience and vulnerability in the face of evolving global and domestic conditions. While the country has maintained its position as a surplus producer of beef, several challenges continue to put pressure on the industry. Going forward, improving disease control systems, market access, and value chain efficiency will be essential to sustaining the competitiveness of South Africa's beef industry in regional and global markets. ❖

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Fate of enteric methane in the atmosphere and biogenesis

By Dr Heinz Meissner, research and development programme manager, Milk SA

Methane (CH_4) produced by ruminants (enteric methane) is in the spotlight due to its assumed high global warming potential. This has resulted in perceptions and policies with profound effects on global ruminant production, especially cattle.

This article will show that methane emissions should be considered in the context of their different fates and timelines in the atmosphere, their warming effects, and the limitations of counting only CH_4 emissions in life cycle analysis (LCA), rather than carbon in and out.

Sources of methane and definitions

Methane is released from many sources other than ruminants, such as belowground fauna, shellfish, blue-green algae, saprophytic fungi, wetlands, lakes, landfills, rice paddies, fossil fuels, and fires. It is classified into biogenic and anthropogenic sources, the latter two of which are thermogenic and pyrogenic.

Biogenic sources are from natural sources, thermogenic sources are from fossil fuels, and pyrogenic sources are CH_4 released by fires. It is important to note that these forms have different atmospheric lifespans and global warming potentials due to their distinct breakdown rates, as discussed here.

CH_4 in the atmosphere

Methane accumulates primarily in the troposphere. Its activity is expressed in one of three ways: half-life, lifespan, and perturbation time. Half-life is the time it takes for 50% of the methane to break down in the troposphere. Lifespan is the average time CH_4 takes to break down in the troposphere, and perturbation time is the time for all lingering effects of CH_4 to subside.

Currently, the half-life is about seven years, the average lifespan is nine to 12 years, and the perturbation time is around 13 years. So, if 100 units of CH_4 are emitted at one time, 50 would have disappeared in six to seven years. The breakdown, however, occurs along an exponential curve, so some CH_4 will break down very quickly (within a few minutes), while others that escape into the stratosphere can last as long as 144 years. The average of nine to 12 is the median point of the exponential curve.

Breakdown of methane

Methane is oxidised by hydroxyl radicals in the atmosphere to carbon dioxide (CO_2) and water vapour (H_2O); the extent of this process is referred to as the atmospheric oxidation capacity. A hydroxyl radical is an OH molecule with an unpaired electron, primarily formed from ozone (O_3) photolysis, although there are other ways as well.

The hydroxyl radical is super reactive and referred to as the 'atmospheric cleaner', which removes or breaks down numerous trace gases; the most important being carbon monoxide (CO), CH_4, numerous anthropogenic volatile organic compounds from industrial processes and burning of fossil fuels, and biogenic hydrocarbons from plants, phytoplankton, and algae.

The removal of CH_4 is influenced by both the staying time and the amount in the atmosphere. Since the start of the industrial revolution, the half-life, average lifespan, and perturbation time of methane have all increased. The half-life has increased from approximately four to seven years, the average lifespan from about six to between nine and 12 years, and the perturbation time has also increased significantly.

There are several reasons for this, the most obvious being the burning of fossil fuels. Burning fossil fuels does three things. Firstly, it releases much more CH_4 than was previously accounted for in the biogenic CH_4 cycle. Secondly, it releases CO, which reduces the atmospheric oxidation capacity for CH_4 by consuming the hydroxyl radicals needed to break down methane.

Thirdly, the added air pollution and smog interfere with the wavelengths of light needed for ozone photolysis. Thus, with longer half-lives and lifespans for CH_4, more methane accumulates in the atmosphere, increasing atmospheric warming.

Biogenesis and CH_4

The earth harbours a mostly closed and repetitive system with a finite number of elements, including carbon, that exist in molecules or radicals in solid, liquid, or gaseous states. These elements cycle and recycle through phase changes in various molecules at different speeds and time scales.

With carbon (CH_4 in this case), the problem has been that science has concentrated mainly on emissions rather than on total carbon accounting analysis (clearly because of the global warming scare). However, with the recent introduction of isotope and satellite methodologies and carbon budget analysis, it has been shown that the amount of CH_4 emitted is closely matched by the amount oxidised.

If the amount emitted exceeds the amount oxidised, the excess persists and accumulates in the atmosphere. The biogenic cycle shows a balanced carbon budget because it involves the same carbon being cycled, whereas carbon (CH_4) accumulates during thermo- and pyrogenesis. This results from OH being largely consumed by additional anthropogenic CH_4 emissions and by CO produced through the combustion of fossil fuels and fires.

A further reason for the balance being disturbed is that atmospheric carbon has also increased due to the reduction of photosynthetic carbon cycling capacity through industrial and tilled agricultural practices, degradation, desertification, and deforestation, as well as the weakening of soil and tropospheric sinks. Soil sinks rely on microbial and chemical processes, while tropospheric sinks rely on hydroxyl radical availability (i.e. the atmospheric oxidation capacity). Agricultural practices and livestock production have been implicated in all of these, and hence, there is a responsibility for reversal and regeneration.

Increasing atmospheric oxidation capacity

All pathways of OH formation are directly and indirectly tied to moisture and biogenic activity. In ecosystems rich in vegetation, organic volatiles, soil microbes, and photochemical flux – essentially 'alive air' – OH production can be orders of magnitude higher than in dry or desert-like air. More humid ecosystems produce a lot more hydroxyl radicals during both day and night. So, when the hydroxyl radical concentrations are increased, the half-life and lifespan of CH_4 and other hydrocarbons are reduced, even though the rate constants (reactivity of the molecule) of the various gases stay the same.

Thus, biogenic methane emitted into the troposphere in an ecosystem context where precursors for hydroxyl radical formation are present will be oxidised faster than its average lifespan of nine to 12 years. This is due to the greater availability of hydroxyl radicals and, therefore, to an increased atmospheric oxidation capacity compared with other systems.

To bring this into a CH_4 management context: Reducing thermogenic and pyrogenic methane emissions should be the first priority. Reducing deforestation, degradation, and desertification should be a further priority.

Rehydration of degraded landscapes

- Increase soil carbon through increasing organic matter via decomposition and microbial carbon metabolites and necromass (dead microbes).
- Improve soil structure via mycorrhizal (fungal) associations, which will increase oxygen, water infiltration and retention, root zones for water, phosphorus and micronutrients, and photosynthetic rates and root exudates.
- Increase above- and belowground biomass (plant and microbial), which will increase plant transpiration, biogenic volatile organic compounds (BVOCs), microbial diversity, and facultative and obligate endophyte (e.g. fungus that lives in a plant) diversity. BVOCs have two functions: Together with nitric oxides in the soil, they form OH via O_3 photolysis, and in combination with OH, they form secondary organic aerosols, which can seed clouds and consolidate water vapour into rainfall. An increase in endophyte diversity reduces methanotrophs (microorganisms that metabolise CH_4 in the soil), thereby limiting the total CH_4 load entering the troposphere.

Implications for agricultural practices

In crop production, soil organic matter and carbon must be protected and maximised. This requires minimal or no tilling, the use of cover crops, and, where appropriate, the introduction of livestock through regenerative (RA) practices.

Here, and in sole ruminant livestock systems, well-managed rotational grazing programmes, such as adaptive management or quick rotation high intensity systems, the following benefits may accrue:

- Grazing redirects photosynthetically fixed carbon in plant vascular tissue from going to the leaves and seeds down to the roots and being exuded as exudates for minerals. This action will increase soil organic matter.
- Grazing causes the release of BVOCs.
- Breakdown and decomposition of plant material will be promoted, particularly in semi-arid and arid environments with less moisture. Decomposed materials will increase organic matter.
- Manure, which is approximately 30% microbes (bacteria, fungi, protozoa), contributes to soil organic matter as microbial necromass, especially in ecosystems with lots of soil fauna (e.g. dung beetles, worms, termites) that quickly break down and mix manure into the topsoil, subsoil, and further down.

Implications for LCA accounting

Well-managed RA practices will improve soil health and structure, thereby increasing water infiltration and retention. Such practices will also increase plant growth, water vapour, and BVOC emissions. This will increase the relative humidity on such managed farms due to increased evapotranspiration from a greater plant biomass, which in turn will lead to greater OH formation and availability. Therefore, the atmospheric oxidation capacity will increase, resulting in faster oxidation of biogenic CH_4.

In terms of RA grazing, it doesn't just offset enteric CH4 via soil carbon sequestration; it also offsets it by enhancing the atmospheric oxidation capacity of the troposphere due to increased OH formation and availability. To a lesser extent, there is also an increased capacity of the soil to oxidise methane via both the methanotrophs and chemical processes.

In addition, with the increased biomass/biodiversity (plants, animals, microfauna, and the like) above- and belowground under RA management, there is substantial transfer of photosynthetically fixed carbon to higher trophic levels that should also be accounted for in LCA models.

Concluding remarks

The international LCA counting methodology, which calculates only methane emissions, is inadequate and harmful to ruminant production, particularly cattle, which account for 70% of global enteric methane emissions from ruminants. This should be revised to account for biogenesis and ways OH oxidation can be enhanced at the farm, ecosystem, and global levels. Some of these principles and counting methodologies have been implemented in published models of dairy and wool farming by South African scientists.

Article developed from the blog *lachefnet.wordpress.com*. For other references and more information, send an email to heinz@milksa.co.za

Beyond modes of action: The measurable results of yeast products in ruminant systems

By Zané Orffer, Nu3enta

In the article "Yeast-based additives in ruminant nutrition: Modes of action and practical relevance" in *AFMA Matrix* of April 2026, the different categories of yeast-based additives used in ruminant nutrition were discussed, including live yeast, yeast culture, hydrolysed yeast, and yeast cell wall fractions. While understanding their modes of action is important, the question remains: What measurable response should a nutritionist realistically expect from each type of yeast product?

Under commercial conditions, nutrition is evaluated not on theoretical mechanisms, but on measurable improvements in rumen stability, feed efficiency, animal health, and profitability. One of the biggest mistakes in evaluating yeast products is treating all yeast technologies as if they function identically. A live yeast product designed to stabilise rumen fermentation should not necessarily deliver the same response as a hydrolysed yeast product aimed at immune support and stress resilience. The expected response must therefore align with the product's biological role.

Live yeast: Measuring rumen stability

Live yeast products containing viable *Saccharomyces cerevisiae* primarily function as rumen modulators. Their main role is to stabilise rumen fermentation through oxygen scavenging, stimulation of cellulolytic bacteria, and support of lactate-utilising microbial populations (Chaucheyras-Durand *et al*., 2008).

Because of this, measurable responses should largely focus on rumen function: Improved dry matter intake consistency, fibre digestion, feed conversion ratio, and manure consistency; reduced rumen pH fluctuations, sorting behaviour, and subacute ruminal acidosis.

These products are especially valuable in high-concentrate feedlot systems, during dietary transitions, and under heat-stress conditions, where rumen instability becomes a major economic risk. Importantly, live yeast responses are often subtle but cumulative. A more stable rumen environment may not always lead to dramatic short-term production gains, but it can significantly improve long-term feed efficiency and consistency.

Yeast culture: Measuring fermentation efficiency

Yeast culture products differ from live yeast because they contain not only yeast cells, but also fermentation metabolites and soluble growth compounds capable of stimulating microbial activity within the rumen (Poppy *et al*., 2012). These products are generally evaluated more broadly in terms of fermentation efficiency and nutrient utilisation. Expected measurable responses may include improved milk yield, milk solids, fibre digestibility, average daily gain (ADG), and feed efficiency, as well as increased volatile fatty acid production.

Dias *et al*. (2018) reported that supplementation with a yeast culture combination product reduced lactate accumulation, shortened periods of low ruminal pH, and improved fibre digestibility in dairy cows. The same work demonstrated improved milk fat percentage, milk protein, and fat-corrected milk yield. Unlike pure live yeast products, yeast culture technologies are often expected to influence both rumen stability and fermentation efficiency simultaneously.

Measuring resilience and recovery

Hydrolysed yeast products function very differently from live yeast. These products contain released intracellular nutrients and functional compounds, including nucleotides, peptides, amino acids, ß-glucans, and mannan oligosaccharides (MOS). Their primary role is not direct rumen modulation but rather support of resilience, recovery, and immune function during periods of stress.

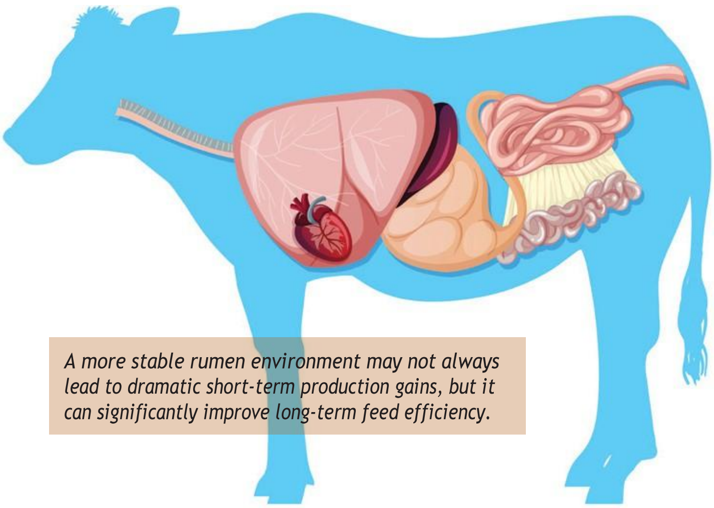
Under commercial conditions, measurable responses should therefore focus on reduced morbidity, mortality, and treatment costs, as well as improved recovery after stress, feed intake, and immune responsiveness.

Pontarolo *et al*. (2021) reported that steers supplemented with autolysed yeast showed a 5,3% increase in ADG and an 8% improvement in feed conversion during finishing. Similarly, D'Souza *et al*. (2019) demonstrated that newly received beef heifers supplemented with autolysed yeast showed 66% lower mortality, 83% lower morbidity, and substantially reduced health-related costs. These responses highlight the important practical principle that hydrolysed yeast products are often most valuable not because they maximise peak production, but because they reduce the biological and economic losses associated with stress.

Measuring gut health and immunity

Yeast cell wall fractions, such as MOS and ß-glucans, are used as targeted tools for gut health and immune modulation. MOS may reduce pathogen attachment within the gastrointestinal tract, while ß-glucans influence immune receptor activity and innate immune responses (Spring *et al*., 2015; Pukrop *et al*., 2018). Expected measurable responses include reduced incidence of diarrhoea, pathogen shedding, and somatic cell count, as well as improved faecal consistency, vaccine responsiveness, and immune competence.

Delazeri *et al*. (2023) reported that supplementation reduced *E. coli* counts in faeces and reduced carcass contamination with potentially pathogenic microorganisms in feedlot steers. Additional calf work demonstrated improved immunoglobulin A and immunoglobulin B circulation, reduced incidence of diarrhoea, and improved weight gain during stressful production phases.



A more stable rumen environment may not always lead to dramatic short-term production gains, but it can significantly improve long-term feed efficiency.

These products are therefore often most valuable in calf programmes, receiving periods, transition phases, and high health-risk systems.

The shift towards 'double modulation'

Modern yeast technologies combine multiple yeast fractions into integrated ruminal and intestinal modulation systems rather than relying on a single mode of action alone. For example, some products combine viable yeast cells, soluble metabolites, fermentation compounds, MOS, and β-glucans into a combined ruminal and intestinal modulation strategy. This allows measurable responses to extend beyond rumen stability towards improved fibre digestion, immune function, carcass efficiency, and milk solids, while reducing respiratory disease and diarrhoea.

These types of products reflect the reality of modern production systems, in which rumen health, gut integrity, and immune resilience are interconnected.

Measuring the correct response

One of the most common mistakes when evaluating yeast products is measuring the wrong parameter. For example, a live yeast product should not necessarily be judged only on milk yield, while a hydrolysed yeast product should not necessarily be expected to dramatically alter rumen pH.

Before selecting a yeast technology, nutritionists should first identify:

- The primary production challenge.
- The biological response required.
- The parameter most likely to reflect success.

The question should therefore not simply be 'does this yeast product work?' but rather 'what response should this yeast technology realistically deliver, and are we measuring the correct outcome?' ❖

References available upon request. Send an email to Zané Orffer at zane@nu3enta.co.za

Boosting cow health and performance: The power of methionine and immunometabolism

By Dr Danielle Sherlock, global ruminant technical and scientific support manager, Adisseo

Over the last two decades, we have learned that the immune system and metabolism are closely interconnected, leading to the emergence of the field of immunometabolism. In dairy cattle, research in this area is helping us to understand how changes in metabolism and immune function influence production, with a specific emphasis on how nutrition influences immunometabolism. One of the key nutritional regulators of immunometabolism is the mechanistic target of rapamycin (mTOR), which is sensitive to nutrients such as the amino acid (AA) methionine (Met).

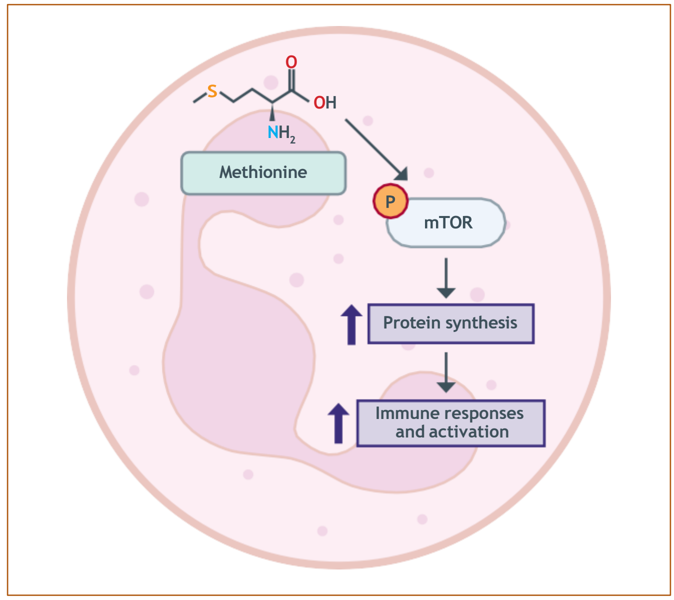
A core aspect of the field of immunometabolism is investigating how dietary and metabolic interventions can enhance immune health and responses to stressors (Basso *et al.*, 2024). Researchers have explored how a variety of nutrients may influence and support immunometabolism, with AA of particular interest (Miyajima, 2020). Likely, the first thing that comes to mind when thinking about AA is its need for protein synthesis. However, there is growing knowledge that many AAs have functional roles beyond protein synthesis.

The classical functions of methionine and mTOR

One of the AAs that has been recognised for its extensive functional roles is Met, which is needed for methyl donor provision and the production of the antioxidants glutathione (GSH) and taurine (Coleman *et al.*, 2020). These functions stem from the central role of Met in the one-carbon pathways where it is metabolised. Via those pathways, Met supports not only antioxidant production but also lipid metabolism and DNA methylation. These functions represent one way in which Met supports immunometabolism.

Methionine is also a known activator of mTOR, a kinase (enzyme that transfers a phosphate group to molecules) that integrates signals from growth factors, nutrients (particularly AA),

Figure 1: Example of mTOR signalling in immune cells using neutrophil.



and energy (Powell *et al.*, 2012). One of the main functions of mTOR is regulating protein synthesis. The mechanistic target of rapamycin itself is activated via phosphorylation (p) in response to AA such as Met, upon which it will activate downstream targets that upregulate protein synthesis (Appuhamy *et al.*, 2011).

This function of mTOR is one of the mechanisms by which Met supplementation enhances milk protein in dairy cattle. However, mTOR activation can also activate pathways of fatty acid synthesis, providing a mechanism for the commonly observed increases in milk fat when rumen-protected Met (RPM) is added to dairy cow diets.

Novel insights into met's role in immune function

Beyond its effects on protein and fat synthesis, emerging research indicates that mTOR is an important component of immunometabolism due to its key role in detecting and directing cellular processes (Saravia *et al.*, 2020). In immune cells specifically, mTOR regulates protein synthesis and cell proliferation, as well as integrates metabolic signals during immune cell activation (Weichhart *et el.*, 2008). Moreover, mTOR-target proteins have been reported to mediate inflammatory responses in immune cells, suggesting that Met can enhance immunometabolism not only through antioxidant pathways but also via mTOR signalling.

Modulation of immunometabolism

While the transition period is one of the most challenging times in the life of dairy cattle, it has been well-documented that enhancing Met supply through RPM improves immunometabolism in transition cows via better liver function, greater GSH production, lower oxidative stress and inflammation, and improved immune function (Osorio *et al.*, 2013 and 2014; Zhou *et al.*, 2016a and 2016b).

These improvements in immunometabolic markers have been associated not only with better DMI and performance but also with better health. Moreover, Met supplementation supports immunometabolism and performance during heat stress by reducing oxidative stress and improving mTOR signalling in the mammary gland and liver.

However, one question was whether Met supplementation could also improve the health and performance of dairy cows in response to a specific health disorder, such as mastitis, and whether Met influences mTOR signalling of immune cells.

Methionine in mastitis challenge

Those questions were tackled by a recent publication utilising a subclinical mastitis challenge (SMC) in cows supplemented with or without RPM (Smartamine M; SM) at 0,09% DM (Paz *et al.*, 2024). The diets were fed for 21 days before the right rear quarter of the mammary gland was infused with *Streptococcus uberis*. Cows were followed for three days following the challenge.

Improved milk production

While DMI was not affected by dietary treatments, SM cows tended to have higher milk yield per milking and per day after the SMC. The SM cows also had greater milk fat and protein percentages and yields than unsupplemented control (CON) cows. These changes resulted in greater energy-corrected milk (ECM) yield in SM cows (*Figure 2*). Such improvements in milk yield and components underscore the importance of Met in maintaining production during periods of stress.

Less inflammation and oxidative stress

Additionally, changes in liver and plasma biomarkers indicated that SM cows decreased both local and systemic oxidative stress and inflammation during the SMC. The improvements in immunometabolic markers likely contributed to the enhanced production of Met-supplemented cows.

Figure 2: Effect of methionine supplementation on ECM yield.

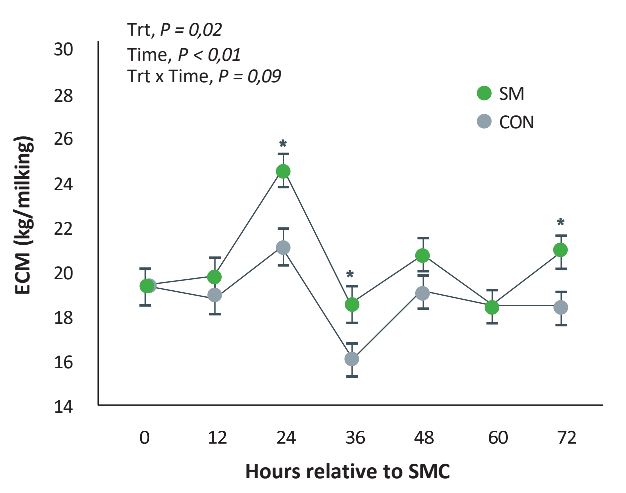


Table 1: Information on the mTOR pathway proteins that were altered by Met supplementation during an SMC.

Parameter*	Cell type	Function
Blood cells		
L-selectin	Leukocytes	Mediates leukocyte migration to sites of inflammation or injury.
p4EBP1:4EBP1	Neutrophils	Phosphorylation allows initiation of protein synthesis.
Milk cells		
pAKT:AKT	Neutrophils and leukocytes	Activates mTOR when phosphorylated.
pS6RP:S6RP	Neutrophils and monocytes	Phosphorylation promotes mRNA biogenesis and translation of ribosomal proteins.

**The ratio of phosphorylated (p) to total protein abundance was reported for 4EBP1, AKT and S6RP. Methionine supplementation increased the ratio, indicating greater phosphorylation of each protein.*

Greater mTOR signalling

Interestingly, beyond those improvements in immunometabolism, Met further mediated immunometabolism by modulating mTOR signalling in immune cells. Phosphorylation of key mTOR pathway proteins, AKT, S6RP and 4EBP, was increased in milk and blood immune cells from SM cows. These three proteins are key players in mTOR signalling, and their phosphorylation initiates protein synthesis (Laplante and Sabatini, 2009). Thus, their increased phosphorylation in immune cells of SM cows suggests greater mTOR signalling and protein synthesis in those cells, which could drive immune cell activation and function compared to CON.

Indeed, we see evidence for this hypothesis in the expression of the mTOR target L-selectin: leukocytes from SM cows tended to have higher abundance than in CON. L-selectin mediates leukocyte migration to sites of inflammation (Ivetic *et al.*, 2009). Its greater expression in Met-supplemented cows provides further evidence of mTOR activation and improved immune responses resulting from that activation compared to CON cows. By supporting better immune responses via mTOR, Met likely helped cows to better handle the SMC from an immunometabolic standpoint, leading them to perform better.

Conclusion

Across multiple stress conditions, Met supplementation plays a critical role in modulating immunometabolism in dairy cows. These effects are driven in part by enhanced mTOR activation in immune cells, alongside improved antioxidant capacity and metabolic function. Together, these benefits enable cows to better cope with health challenges such as subclinical mastitis, supporting both performance and resilience. ❖

For more information, visit *www.adisseo.com*

A practical perspective on sclerotia in livestock feed and grazing material

By Dr Lisa Rothmann, senior lecturer in Plant Pathology, University of the Free State

Sclerotinia stem rot, caused by the fungus *Sclerotinia sclerotiorum*, is a well-known disease of broadleaf crops worldwide. It has an exceptionally wide host range, with more than 600 plant species reported globally. Among the affected crops in South Africa are cabbage, canola, soya bean, and sunflower.

The pathogen is classified as a necrotroph, meaning it kills plant tissue and then feeds on the dead material. In the field, this dead and dying tissue is often seen as water-soaked lesions. White, fluffy fungal growth develops on infected tissue as the disease progresses; this growth later melanises, becoming dark and hardened, and forms sclerotia. These sclerotia are the pathogen's survival structures, allowing it to survive between seasons. This raises the question of whether the presence of sclerotia in animal feed should be a cause for concern.

Sclerotia allow the pathogen to survive for extended periods (around eight years) under adverse environmental conditions and are commonly found in infected crop residues and on/in soil. They may also enter harvested grain or grain destined for feed when infected plants are collected during harvesting operations. This distinction is important because when sclerotia occur in feed, they primarily represent a feed quality concern rather than a feed safety hazard.

Feed quality impact

The more realistic concern relates to physical contamination. Sclerotia can reduce the proportion of clean, digestible grain or feed material and may indicate high *Sclerotinia* disease pressure in the field, though this should be viewed in context. In South Africa, sclerotia recorded at silo delivery are quantified after sieving, with the smallest retained material collected around the 18mm size fraction. This means that many of the sclerotia being measured are relatively small and unlikely to constitute a substantial proportion of the feed mass. In practical terms, a very large quantity of sclerotia would be required before they could meaningfully replace usable feed material.

National silo data show that sclerotia are detected in soya bean and sunflower deliveries in South Africa, although levels vary by crop, region, and season, with most deliveries remaining within accepted threshold limits (Rothmann and McLaren, 2022). At very low levels, sclerotia are unlikely to reduce feed value or affect livestock performance on their own.

Sclerotia spread and survival

Another important question producers raise is whether cattle or sheep grazing infected crop residues may contribute to the spread of the pathogen between fields. Earlier work showed that sclerotia can be disseminated when livestock graze infected residues and are moved to non-infested lands (Weston *et al.*, 1946). Despite these concerns, relatively little research has examined the survival of sclerotia after passing through livestock digestive systems.

Sclerotinia disease symptoms on infected soya bean, showing water-soaked lesions, white fungal growth and developing dark sclerotia, seen also on the pods.

Sclerotia of S. sclerotiorum embedded in sunflower residue collected from the field, illustrating how the pathogen survives in infected crop material.

Research conducted within our own group at the University of the Free State, Plant Pathology Division, showed that very few sclerotia remained viable after passing through cattle. From 21 manure pieces, 104 sclerotia were recovered, but only 3,8% germinated (Meiring *et al.*, under preparation). In practical terms, this means that passage through the rumen and digestive system greatly reduced the sclerotia's survival potential. Similar observations were made by Brown (1937), who reported that fewer than 2% of sclerotia exposed to the digestive system of sheep remained viable after passage through the animal.

These findings suggest that livestock grazing on infected crop residues may contribute to the degradation of sclerotia in the field. The digestive process itself appears to reduce survival, while compounds and microorganisms present in manure may further suppress fungal viability. Producers should remain cautious when moving livestock directly from heavily infested fields into clean production areas. Although only a small percentage of sclerotia may survive digestion, *S. sclerotiorum* remains an efficient pathogen. A single surviving sclerotium may produce multiple apothecia, which can release millions of airborne spores under favourable environmental conditions (Turmel *et al.*, 2015).

In short

Sclerotia in feed should therefore be interpreted in context. They are not regarded as a feed safety concern from a mycotoxin perspective. Theoretically, feed quality could be affected if large amounts of sclerotia replaced clean, usable feed material, but in practice, this is highly unlikely. Grazing infected crop residues may also move sclerotia from infested to non-infested fields, although this risk is reduced because passage through the rumen of cattle substantially decreases sclerotial viability and germination. Overall, sclerotia in feed and grazing material are best understood as a plant disease and inoculum management issue rather than a livestock feed safety concern.

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Affordable proteins drive global feed growth

By Petru Fourie, operations manager, AFMA

The global feed industry continued to grow in the previous year, but the latest *Alltech Agri-Food Outlook* shows that feed manufacturers are operating in a far more uncertain environment than just a few years ago.

Global feed production increased by 2,9% to 1,44 billion metric tonnes. However, rising disease pressure, geopolitical uncertainty, volatile raw material markets, and supply chain disruptions continue to impact the global feed industry. As a result, feed manufacturers are focussing on resilience, efficiency, biosecurity, and operational flexibility.

Much of last year's growth came from monogastric production systems, particularly the broiler and pig sectors. These sectors continue to drive global feed demand because they produce affordable protein efficiently and can respond quickly to changing consumer demand.

Records clearly show the continued dominance of poultry within global feed systems. Broiler and layer feed remained the largest contributors to feed demand, while pig and aquaculture feed also recorded strong growth. *Table 1* highlights the growth recorded across the major monogastric feed sectors during 2025.

Poultry leads global protein

Globally, chicken and eggs are among the most affordable sources of animal protein available to consumers. During periods of economic pressure and rising food inflation, consumers often shift towards more affordable proteins, which continues to support demand for poultry products.

The report underscores strong growth in poultry across Africa, Asia, and parts of the Middle East. Importantly, the poultry sector continued expanding despite recurring outbreaks of highly pathogenic avian influenza (HPAI). This reinforces the growing importance of biosecurity, disease management, and operational preparedness within modern poultry production systems.

In South Africa, poultry remains critical to the feed industry. Poultry feed accounts for the largest share of local feed production and plays a key role in supporting affordable protein and food security. Continued growth in the poultry sector is therefore closely linked to feed demand and the affordability of this protein for consumers.

Pig feed production recovery

Global pig feed production increased by 3% in 2025, reflecting improved recovery in several major pork-producing regions. China remains the dominant player in the global pig sector, with much of the growth in 2025 driven by expanded commercial feed systems and large-scale, integrated pork production.

At the same time, African swine fever (ASF) continues to pose one of the biggest risks to global pig production. Although many countries have strengthened their disease management and biosecurity systems, the sector remains highly sensitive to disease outbreaks, feed costs, and shifting consumer demand.

The report also notes that profitability in the pig sector remains under pressure in many regions due to volatile input costs and uncertain economic conditions. As a result, producers continue to focus on efficiency, scale, and tighter cost management to remain competitive in a challenging operating environment.

Aquaculture continues to expand

Aquaculture feed recorded one of the strongest growth rates among the major feed sectors in 2025, increasing by 4,7%. After several difficult years marked by disease outbreaks, weaker demand, and high feed costs, the aquaculture sector gained momentum in 2025, particularly in Africa and Latin America.

The report notes that the aquaculture sector is becoming more commercialised and technologically advanced. Feed manufacturers are under growing pressure to improve feed efficiency while meeting sustainability targets and managing both production costs and performance expectations.

Global seafood demand also continues supporting long-term growth in aquaculture production systems, particularly in urban markets where seafood is an important protein source. As aquaculture production continues to intensify globally, feed quality, nutritional



Photographs: Magnific

Table 1: Growth in major monogastric feed sectors (2024 vs 2025).

Sector	2025 feed tonnes (million mt)	2024 feed tonnes (million mt)	Growth (million mt)	Growth (%)
Broiler	400,379	386,267	+14,112	+3,7%
Pig	380,907	369,915	+10,992	+3%
Layer	180,126	174,474	+5,652	+3,2%
Aquaculture	55,470	53,000	+2,470	+4,7%
Pet	39,276	38,359	+0,917	+2,4%

Poultry is reported separately as broiler and layer feed production in the 2026 Alltech Agri-Food Outlook.

precision, and operational efficiency are becoming important drivers of competitiveness within the sector.

Disease and geopolitical pressure

One of the strongest themes throughout the report is the growing pressure created by disease outbreaks and geopolitical instability. The report notes that outbreaks such as HPAI and ASF continue disrupting global livestock production and trade flows. At the same time, geopolitical tensions, including the Russia-Ukraine war, Red Sea shipping disruptions, and freight instability, are affecting feed ingredient markets and global supply chains.

These challenges are particularly significant for monogastric operations, which depend on consistent supplies of maize, soya bean oilcake, oils, amino acids, vitamins, and other feed ingredients.

In addition, the report notes a shift away from 'just-in-time' supply models towards more resilient strategies that prioritise continuity and flexibility. This reflects a move towards better risk management across the industry.

For South Africa's feed industry, these global risks are especially relevant given the country's reliance on imported feed ingredients and its vulnerability to fuel costs, exchange rate volatility, and global logistics disruptions. Operational flexibility and procurement planning are important competitive considerations for feed manufacturers amid ongoing global uncertainty affecting feed ingredient markets.

Looking ahead

The *2026 Alltech Agri-Food Outlook* confirms that monogastric production systems will remain central to future global feed growth. Poultry, pigs, and aquaculture will continue to drive demand due to their efficiency, scalability, and alignment with consumer preferences. At the same time, the operating environment facing feed manufacturers is becoming more complex. The report therefore highlights resilience, adaptability, and operational efficiency as important competitive advantages within the global feed industry.

For more information, download the complete *2026 Alltech Agri-Food Outlook* at *www.alltech.com/agri-food-outlook*

Industry stewardship in the SA pork industry

By Dr Thandi Chiappero, head: consumer assurance, Sappo

Across global agriculture, industries are recognising that long-term sustainability depends not only on compliance with legislation but also on demonstrating accountability, transparency, and continuous improvement. The South African pork industry has embraced this responsibility by developing Pork 360 – a producer-driven certification and industry assurance system designed to strengthen standards across the value chain and build trust with consumers, retailers, regulators, and trading partners.

Pork 360 represents far more than an audit checklist; it reflects a strategic industry commitment to responsible production, food safety, animal welfare, traceability, and biosecurity. Importantly, it demonstrates how industry stewardship can support resilience and credibility within a modern livestock sector.

Origins and purpose of Pork 360

The South African pork industry operates in a highly regulated environment governed by legislation on animal health, food safety, environmental management, and animal welfare. However, as market expectations evolved and consumers became more aware of how food is produced, the industry recognised the need for a structured system that could provide assurance beyond minimum legal compliance.

Pork360 was therefore developed as an industry-led certification framework aimed at:

- Standardising best practices across commercial pork production.
- Creating measurable and auditable standards.
- Supporting producer accountability and continuous improvement.
- Strengthening confidence throughout the value chain.
- Providing credible assurance to retailers, processors, regulators, and consumers.

The system has evolved from a framework focussed primarily on animal health and biosecurity into a sustainability and risk-management programme encompassing multiple aspects of responsible production. Today, Pork 360 integrates animal welfare, biosecurity, food and feed safety, antimicrobial stewardship, environmental stewardship, traceability, and recordkeeping.

This evolution reflects the reality that modern livestock production requires a holistic approach rather than isolated compliance measures.

Stewardship as a strategic tool

One of the greatest strengths of industry-led oversight systems is their ability to proactively address risks before they become crises. Rather than relying solely on external enforcement, industry stewardship encourages ownership, accountability, and participation from producers.

For the pork industry, this has become particularly important in the context of emerging disease threats such as African swine fever (ASF) and foot-and-mouth disease (FMD), increasing retailer and consumer expectations, heightened scrutiny around animal welfare, global emphasis on traceability and responsible antimicrobial use, as well as the need to protect market access and industry reputation.

> Certification systems such as Pork 360 allow the industry to demonstrate that robust controls are already in place, which is especially valuable when engaging with government, retailers, financial institutions, and consumers.

Industry assurance systems also create consistency across the sector. Producers operate under shared standards and measurable expectations, helping to reduce variability in practices and improve industry performance.

Traceability and accountability

The ability to track animals, movements, treatments, and production inputs is essential for disease control, food safety, and supply chain confidence. Pork 360 supports traceability through structured record-keeping requirements and integration with the World of Pork online platform. Accurate records of animal movements, disease status, and veterinary interventions support operational management and disease preparedness.

The growing role of digital platforms and centralised data systems offers significant opportunities for the pork industry. Improved data collection can support faster disease response and containment, better benchmarking and performance analysis, enhanced verification during audits, improved transparency throughout the value chain, and greater confidence from downstream buyers and regulators.

Animal welfare and biosecurity

Good welfare outcomes are difficult to achieve without proper health management, while effective biosecurity supports disease prevention and animal wellbeing. Pork 360 places strong emphasis on practical, measurable welfare standards, such as housing design and space allowances, staff competency and training, humane handling and euthanasia procedures, access to feed and water, environmental management, and monitoring of animal health and behaviour.

The system recognises that welfare is not only about infrastructure but also about management practices and stockmanship. Pork 360 welfare auditing is based on the *Sappo Welfare Code* published in 2025.

Disease outbreaks can have devastating economic and trade consequences, making prevention and preparedness critical priorities. Within Pork 360, biosecurity principles include controlled farm access, movement management, cleaning and disinfection protocols, vehicle and visitor controls, staff hygiene

procedures, isolation and quarantine measures, and disease monitoring and reporting.

Auditing and improvement

A defining feature of effective industry assurance systems is independent verification. Pork 360 incorporates auditing processes designed to assess compliance against defined standards. Auditing serves several important functions: verifying implementation of standards, identifying gaps and areas for improvement, supporting consistency across farms, providing accountability and credibility, and encouraging ongoing development rather than one-time compliance.

Auditing within an industry stewardship framework should not be viewed purely as a policing mechanism. Its greatest value lies in promoting continuous improvement and encouraging producers to progressively strengthen systems and management practices over time.

The culture created by regular auditing also supports greater awareness and engagement among farm teams. Staff training, documentation, operational discipline, and management oversight all tend to improve when systems are consistently monitored and reviewed.

Lessons learned along the journey

The journey towards effective industry stewardship has not been without challenges. Developing industry-wide standards requires collaboration, practical implementation, technical expertise, and ongoing adaptation. Several key lessons have emerged:

- Industry-led systems must remain practical and achievable for producers.
- Industry buy-in is essential for long-term success.
- Standards must evolve alongside scientific knowledge and market expectations.
- Data and traceability systems are becoming more important.
- Training and communication are critical components of implementation.
- Continuous improvement is more valuable than perfection.

The pork industry has also learned that credibility depends on transparency and consistency. Certification systems only retain value when standards are measurable, independently verified, and meaningfully implemented.

Future opportunities

Looking ahead, industry assurance and responsible production frameworks will likely play an even greater role in livestock industries worldwide. Increasing demands around sustainability, welfare, environmental stewardship, and food system transparency are reshaping agricultural markets.

For the South African pork industry, future opportunities may include expanded digital traceability systems, enhanced disease preparedness frameworks, greater alignment with retailer and export requirements, strengthened antimicrobial and environmental stewardship initiatives, and increased consumer engagement and assurance.

There is also growing recognition that industry stewardship can support more effective partnerships between industry and government. During disease outbreaks or sector-wide challenges, industries with robust systems and reliable data are often better positioned to engage constructively with regulators and decision-makers.

Conclusion

Pork 360 demonstrates how industry stewardship can become a strategic asset rather than simply a compliance exercise. By combining measurable standards, auditing, traceability, welfare, biosecurity, and continuous improvement, the system supports industry accountability and long-term sustainability.

For the South African pork industry, the journey of Pork 360 reflects an important shift: from compliance as an obligation to responsible production as a shared industry commitment.❖

For more information, visit *www.pork360.co.za*

Benefits of immunomodulation in poultry and swine production

By Dr Charles Gilfillan, technical services manager, health, Kemin sub-Saharan Africa

The swine and poultry industries have achieved substantial improvements in productivity and feed efficiency over the past several decades. These advances can be attributed to improved genetic selection for production and feed efficiency, combined with advances in nutrition, disease control, and farm management practices.

Genetics determines the maximum production potential of poultry and swine, such as growth rate, egg production, reproductive performance, and lactation; nutrition, farm and disease management influence the extent to which animals realise this genetic potential.

Disease management in intensive animal production has, for many decades, successfully relied on antibiotics not only for treatment but also for prevention and growth promotion. However, the emergence of antimicrobial resistance has highlighted the need for a more comprehensive approach to disease management in intensive operations. Such approaches include improved biosecurity measures, vaccination programmes, and the use of feed additives to maintain intestinal health and immunomodulation.

Immunomodulation in animal production refers to the intentional regulation of both innate and adaptive immunity to enhance the immune resilience of livestock. Improving immune resilience aims to increase disease resistance and enhance vaccine responses while modulating the associated inflammatory responses. This limits the energy cost of the immune system, improves production, and lowers the reliance on antibiotics for disease management.

Algal-derived linear β-1,3-glucans

ß-1,3-glucans are naturally occurring polysaccharides found in the cell walls and membranes of numerous pathogenic organisms, including fungi, yeasts, and bacteria. ß-1,3-glucans are recognised by Dectin-1 receptors on vertebrate immune cells as pathogen-associated molecular patterns (PAMPs). Binding of ß-1,3-glucans to Dectin-1 receptors on immune cells such as macrophages and dendritic cells triggers a cascade of immune responses. Consequently, ß-1,3-glucans can be used to prime the immune system, thereby improving the immune resilience of production animals.

ß-1,3-glucans are typically found as mixtures of ß-1,3-glucans and ß-1,6-glucan side chains in the cell walls of yeasts and fungi. Another source of ß-1,3-glucans is the unicellular alga *Euglena gracilis*. When grown in low light and in a carbohydrate-rich environment, *Euglena gracilis* accumulates unbranched, linear ß-1,3-glucan granules, known as paramylon, in its cytoplasm. The paramylon granules are not bound to any cell structures, and the cell is surrounded by proteinaceous pellicle, making *Euglena gracilis* algae a highly bioavailable source of linear ß-1,3-glucans that can be used as immunomodulators in the feed of production animals.

Benefits in poultry and swine

Immunomodulators that prime innate immunity, such as ß-glucans, are valuable tools for disease management in poultry and swine. They are particularly beneficial in young animals with immature immune systems and during periods of stress caused by disease challenges, environmental conditions (such as heat, cold, or high stocking densities), and biological stressors, including vaccination.

Vaccination is widely used in intensive animal production systems to reduce losses associated with morbidity and mortality caused by various pathogens. Vaccines expose animals or birds to attenuated (less virulent) forms of a pathogen to stimulate an immune response without causing the associated disease. The primary objective of vaccination is to prevent the animal or bird from developing clinical signs of disease when exposed to the field strain (virulent) of the pathogen, thus lowering the morbidity and mortality associated with the disease and maintaining production despite disease challenges.

Vaccination, whether by injection, eye drop, spray, wing stab, drinking water, or other methods, does not always guarantee adequate immunisation or stimulation of an immune response to the disease vaccinated against. One way to improve immunisation levels is to use algal-derived linear ß-1,3-glucans.

Application in poultry production

The inclusion of algal-derived linear ß-1,3-glucans in poultry feed has been shown to improve antibody titres following vaccination against Newcastle disease, avian encephalomyelitis, infectious bursal disease (gumboro), and avian influenza.

Coccidiosis is a ubiquitous disease in poultry that causes substantial economic losses, particularly in the broiler industry. Broilers challenged with *Eimeria* and given algal-derived linear ß-1,3-glucans exhibited reduced lesion scores and improved feed conversion efficiency, even in the absence of coccidiostats. The density of immune cells in the intestine of *Eimeria*-challenged birds receiving algal-derived linear ß-1,3-glucans was also increased, indicating that these glucans can mitigate the immune suppression effect of *Eimeria* in poultry. Algal-derived linear ß-1,3-glucans can

Adding algal-derived linear ß-1,3-glucans to sow diets prior to farrowing can improve the quality and concentration of immunoglobulins in colostrum, supporting more effective transfer of maternal immunity to piglets.

therefore be used to improve the efficacy of coccidia control programmes in poultry.

Environmental stress can significantly impair growth and reproductive performance in production animals because of immunosuppression. A commercial free-range layer pullet trial evaluated the impact of algal-derived linear β-1,3-glucan supplementation on a flock with a history of low 18-week transfer weights, which had negatively affected the future egg production of the birds. Adding algal-derived linear β-1,3-glucans to the feed not only improved vaccine titres but also reduced mortality and boosted growth performance. As a result, the pullets achieved the target transfer weight by 17,5 weeks of age.

Application in swine production

Adding algal-derived linear β-1,3-glucans to sow diets from four weeks prior to farrowing has been shown to improve the quality and concentration of immunoglobulins in colostrum. Improved colostrum quality and quantity support more effective transfer of maternal immunity to piglets. Furthermore, supplementation from four weeks before farrowing through to weaning has been associated with improved piglet survival and increased weaning weights.

During the post-weaning period, weaning stress elevates plasma cortisol levels, resulting in immune suppression, which, combined with waning maternally derived immunity, increases the risk of disease from viral and bacterial pathogens. Algal-derived linear β-1,3-glucan supplementation can improve the intestinal barrier function of piglets and reduce the incidence of post-weaning *Escherichia coli* diarrhoea.

In addition, algal-derived linear β-1,3-glucans can enhance antiviral immune responses. Improvements were seen in virus-specific T-lymphocyte, cytotoxic T-lymphocyte, and circulating memory T-lymphocyte responses in supplemented pigs. Algal-derived linear β-1,3-glucans have been shown *in vitro* to protect porcine alveolar macrophages from African swine fever (ASF) virus infection, demonstrating the potential of algal-derived linear β-1,3-glucans to lower the risk of ASF infection in swine herds.

In a nutshell

Immunomodulation via algal-derived linear β-1,3-glucan supplementation contributes to improved disease management on poultry and swine farms via:

- Innate immune support in young animals.
- Enhanced vaccine responses by mitigating the negative effects of vaccination.
- Improved resistance to viral, bacterial, and parasitic diseases.
- Improved transfer of maternal immunity.
- Mitigation of environmental stress on the immune system.

These benefits support antibiotic stewardship by reducing the reliance on antibiotics and helping to limit antimicrobial resistance, preserving the efficacy of antibiotics for future generations. ❖

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Mycotoxin occurrence in poultry feed and feed ingredients

By Anthony Pokoo-Aikins, Trevor R Mitchell, Quentin D Read, Revathi Shanmugasundaram, and Anthony E Glenn

Feed is a major component of poultry production because it constitutes 70% of production cost. Poultry feed is also made up of many components, with maize and soya bean meal accounting for around 80% of the total diet, especially in North America (Ravindran, 2013). These ingredients are often contaminated with fungi due to adverse temperature, humidity, and insect damage conditions that induce plant stress (Battilani *et al.*, 2020; Magnoli et al., 2019).

Many of the fungi that contaminate feed ingredients are known to produce harmful secondary metabolites known as mycotoxins (Richard, 2007). Some of the mycotoxins commonly found in feed ingredients are aflatoxin (AFLA), fumonisin (FUM), deoxynivalenol (DON), zearalenone (ZEA), T-2 toxin, and ochratoxin (OTA) (Binder *et al.*, 2007). These mycotoxins can affect health, growth performance, yield, egg production, and meat quality of poultry when ingested (Magnoli *et al.*, 2019; Munkvold *et al.*, 2019). Due to the negative effects mycotoxins can have on production, testing feed and feed ingredients for the mycotoxins before feeding them to poultry is vitally important.

A challenge with ensuring the safety of finished feed is knowing which of the many ingredients should be tested for mycotoxin presence before feed mixing (Juan *et al.*, 2019). There is great variability in the mycotoxin levels in feed ingredients, with high levels being caused by many factors including the previously mentioned weather conditions as well as mycotoxin contaminated soil, poor harvesting of crops, and storage environments conducive for fungal growth (Mokubedi *et al.*, 2019). Grains should be dried quickly after harvest, ideally to 14% moisture or lower, as moisture in grain encourages mould growth and mycotoxin production (Magan and Aldred, 2007).

Many times, testing attention is given to maize because it is the primary ingredient in poultry feed and has high reported levels of mycotoxin contamination. Soya bean meal, which is mixed with maize and other ingredients, receives less attention due to its historically low levels of mycotoxin contamination (Binder *et al.*, 2007; Ravindran, 2013). Recent surveys have shown a high rate of co-contamination of raw feed ingredients, especially in maize (60-80%) contaminated with DON and other *Fusarium* toxins, and to a lesser extent, AFLA. (Weaver *et al.*, 2021). While extreme, some maize samples have an average of nine mycotoxins per sample (Fusilier *et al.*, 2022).

Because co-contamination of mycotoxins can act synergistically and become detrimental to poultry, it is important to pay attention to the levels of mycotoxins in soya bean meal as well as lesser feed ingredients because they contribute to the total amount of mycotoxins in finished poultry diets (Shanmugasundaram *et al.*, 2022).

In this study, we analysed separate sets of maize, raw soya beans, soya bean meal, finished broiler feed, and finished layer feed obtained from grain elevators, feed mills, and farms within the southeastern United States. Samples were analysed for prevalence and co-occurrence of AFLA, DON, FUM and ZEA to better understand the level and diversity of mycotoxins in feed ingredients.

Results and discussion

Distributions

The distribution of mycotoxin values for all mycotoxin/sample type combinations, with the exception of FUM in broiler feed, were highly right skewed with values clustering near 0, and the presence of limited numbers of samples with very large values. The distribution of FUM levels for broiler feed samples was approximately normal.

Single mycotoxin results

Across the maize samples, all four tested mycotoxins were present in at least one sample, with 99,4% of maize samples containing FUM, 49,7% containing DON, 33% containing ZEA, and 13,4% containing AFLA. With maize being the largest contributing ingredient in feed and the most susceptible to a variety of mycotoxins, it is important to know the mycotoxin content of the maize being used when formulating poultry diets (Richard, 2007; Wood, 1992).

FUM was the only mycotoxin detected in soya bean samples, 52% of which contained no mycotoxins. Of the soya bean meal samples tested, 27% contained ZEA, 23% contained DON, and 5% contained FUM. No AFLA was detected in any soya bean meal samples. Soya bean meal, the second-most contributing ingredient in feed, is normally less prone to mycotoxin contamination comparatively, but it should also be analysed for mycotoxins prior to use.

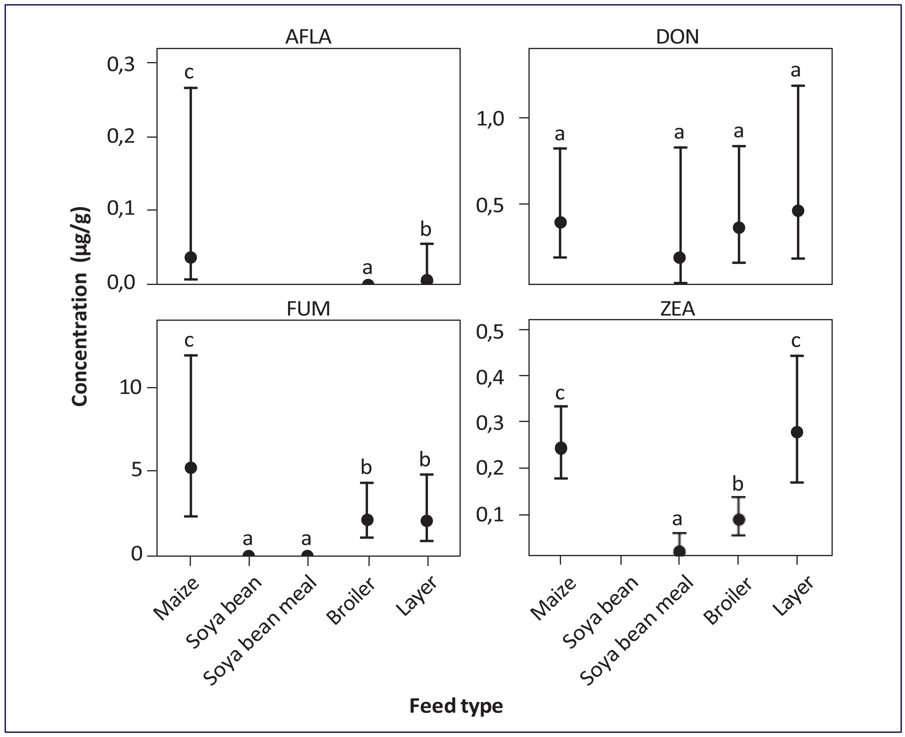
Both broiler and layer feeds were found to be contaminated with all four major mycotoxins, but only 4,69% of broiler feed samples and 16,18% of layer feed samples were contaminated with AFLA. A total of 100% of both types of feed samples were contaminated with FUM and contained similar levels of DON and ZEA, with 64 and 62% respectively. Across all sample types, FUM (86,87%) was the most frequently occurring mycotoxin, followed by DON (45,8%), ZEA (36,54%), and AFLA (10,33%). Information on the mycotoxin levels in finished feed, and the effects of processing raw soya beans into soya bean meal on mycotoxin levels, is limited.

Variability in contamination

Statistical analysis revealed significant differences in the levels of mycotoxin contamination across various feed and ingredient types for a given mycotoxin (*Figure 1*). AFLA levels were significantly higher in maize and layer feed samples compared to the levels in broiler feed samples. No AFLA was detected in soya bean and soya bean meal samples.

The level of DON was not significantly different between the four sample types in which DON was detected (maize, soya bean meal, broiler feed, and layer feed). The highest level of FUM was detected in maize, followed by broiler and layer feeds, which were in turn significantly higher than those detected in soya bean and soya bean meal. The levels of ZEA in maize and layer feed were significantly higher than those in broiler feed, which were in turn significantly higher than the levels in soya bean meal; no ZEA was detected in soya bean samples.

Figure 1: Estimated mean mycotoxin concentrations across feed types where mycotoxin was detected.



Error bars represent 95% confidence intervals adjusted for multiple comparisons; within a mycotoxin, two means that do not share a letter are significantly different (adjusted p < 0,05).

Soya beans and soya bean meal samples: Soya beans have comparatively less fungal load/microbial contamination compared to maize, which may be due to the differences in their nutritional contents (Garcia *et al.*, 2016; Ochandio *et al.*, 2017). For several decades now, it has been reported in US surveys that soya beans are not a good substrate for AFLA contamination, except in uncommon conditions such as delayed harvesting coupled with rainfall (Nesheim and Wood, 1995).

The only mycotoxin detected in soya bean in this study was FUM (48% of samples), and three mycotoxins were detected in soya bean meal samples (ZEA 25%, DON 23%, FUM 2%). Contrary to the multiple co-contamination of different mycotoxins in maize, co-contamination of mycotoxins in soya bean samples was not observed, while only a single sample of soya bean meal (2%) was contaminated with more than one mycotoxin. In our study, both the soya bean and soya bean meal samples were free of AFLA.

In contrast to our results, Valenta *et al.* (2002) reported the presence of AFLA in a number of soya bean samples, while finding very few DON-contaminated samples, and a large number of ZEA-contaminated samples relative to our results. As reported by Daga *et al.* (2015), the presence of aflatoxin can be associated with storage conditions of soya beans or soya bean meal.

It is intriguing to note that only FUM was found in the soya beans with no DON or ZEA. This could be due to the type/types of *Fusarium* species that are most prevalent in soya beans. The *Fusarium* could be producing FUM but not DON or ZEA. *Fusarium* species such as *F. fujikuroi*, *F. graminearum*, *F. proliferatum*, *F. asiaticum*, *F. incarnatum-equiseti*, and *F. verticillioides* have been reported to be associated with soya bean pods/seeds (Chang *et al.*, 2020; Naeem *et al.*, 2019). It is important to note that the diversity of the *Fusarium* can vary based on geographic location.

Soya bean is normally processed into a meal through various processes such as cooking, roasting, expelling, and then grinding before it is incorporated into poultry diets. Some studies suggest that soya bean meal processing methods can reduce the mycotoxin level in the product (Maciel *et al.*, 2025). The percentage of our soya bean and soya bean meal samples containing FUM was 48 and 2%, respectively. A likely hypothesis for the drastic difference in the types and levels of mycotoxins observed between our soya bean and soya bean meal samples is that the processing of soya bean into meal has a significant effect on mycotoxin levels.

Soya beans are normally heated using thermal heat processing to inactivate anti-nutritional factors such as trypsin and lectins (Ozolina *et al.*, 2023; Di *et al.*, 2025), and it is believed that this process may be able to suppress mycotoxins, which have been shown to break down during high temperature cooking (Kaushik, 2015; Maciel *et al.*, 2025). However, there is a high level of variability in the effectiveness of reducing mycotoxins across various cooking methods and temperatures, with the effects also varying on a per mycotoxin basis.

Oil extracted from oilseeds has also been showed to contain traces of mycotoxins, indicating that pressing soya beans to remove the oil can also influence the mycotoxin content of the material (Ji *et al.*, 2024). Since our soya bean and soya bean meal samples were not paired measurements of the same samples taken before and after processing, a more specialised study design is needed to further investigate the effects of processing soya beans on mycotoxin load.

Maize samples: Our results showed that the maize samples analysed had higher levels of mycotoxins than the soya bean and soya bean meal samples, in line with results reported in previous studies

(Piotrowska *et al*., 2013). The maximum amount of DON contamination in the maize samples was seven times higher than soya bean meal samples, although the median values were the same. The concentration of FUM in the maize samples were 58 times higher than that in the soya bean meal, whereas ZEA was 15 times higher than soya bean meal.

Our maize results agree with what was reported by Gruber-Dorninger *et al*. (2025), that DON + FUM +ZEA were the most prevalent mycotoxins co-detected in maize samples and give support to the theory that the majority of mycotoxin contamination is entering the feed system via maize.

Feed samples: All analysed finished feed samples were found to contain at least one mycotoxin. The mean and maximum values of all mycotoxins analysed in the feed samples were higher in layer feeds than in broiler feeds. The maximum level for AFLA was around five × higher, DON two × higher, FUM 0,25 × higher, and ZEA four × higher in the layer feed samples than in the broiler diets.

One of the reasons for the differences between broiler and layer feed could be due to the duration of feed storage at the farm, with layer feed spending more time exposed to the elements due to lower rates of consumption. Because of this, the average supply of feed to broiler farms is about seven to ten days versus about 14 days or more for layer farms. This leads to a larger potential window for fungal pathogens to grow on a delivery/batch of layer feed, and for it to be exposed to environmental conditions which can contribute to fungal growth such as high moisture or temperatures. It has been well documented that some toxigenic fungi, such as *Aspergillus*, are better suited for growth during feed storage (Gao, 2025).

Another potential cause for the differences between broiler feed and layer feed is how they are processed. Broiler feed is normally pelleted, which means that it goes through heat treatment such as conditioning, pre-conditioning and pressure (extrusion), whereas many layer feed programmes use mash diets where heat/steam is not used (Jones *et al*., 2025; Munoz *et al*., 2021; Steghöfer *et al*., 2021). These differences in processing could affect mycotoxin levels (Kaushik, 2015).

In a similar study on poultry feeds by Anjum *et al*. (2012), the percent of layer feed samples that were positive for AFLA (238 samples/44%) was higher than for broiler feed (114 samples/38,5%). It is possible that the addition of fungal mitigation products, such as organic acids and binders, may help to reduce fungal growth in feed components and finished feeds.

Broilers consume more feed than layers, which have controlled/stable diets with a relatively lower feed consumption (Pym, 2005). If feed delivery is not based on the number of birds and how long it would take them to consume an amount of feed delivered, but rather based on just logistics such as filling feed bins to reduce the number of feed deliveries, then there is the opportunity for toxins to accumulate in the feed during prolonged storage, especially during hot and humid seasons. The percentages of mycotoxin contamination in finished feed were previously reported: FUM 91%, DON 82%, and ZEA 35% (Alvarado, *et al*., 2017; Magnoli, *et al*., 2019; Pereira, *et al*., 2019).

Similarly, in our study the frequency of mycotoxin contamination in the samples analysed were FUM 100%, DON 64%, ZEA 62%, and AFLA 10%. The slight differences in the reported numbers could be due to the different sources of the raw feed components, duration of storage, and any fungal control that may have been applied to the ingredient during storage. Several studies have reported that raw poultry feed ingredients analysed for AFLA were higher in samples that were harvested during the rainy season (Anjum *et al*., 2012; Okoli *et al*., 2006; Tangendjaja *et al*., 2008). Ram *et al*. (2010) observed that AFLA levels in maize samples were higher in humid and warm conditions.

Co-contamination results

Of the 572 total samples analysed for mycotoxins, only 9% had no mycotoxin contamination whatsoever, while 34% were contaminated with a single mycotoxin, 31% of which were exclusively contaminated with FUM, with DON and ZEA being exclusively detected in roughly 2% of the samples respectively. The remaining 56% of samples were found to be co-contaminated with multiple mycotoxins, 25% of which had two mycotoxins (13% of the samples containing DON + FUM, 7% containing AFLA + FUM, and 5% containing FUM + ZEA). A total of 30% of co-contaminated samples had three mycotoxins, with the bulk being contaminated with DON + FUM +ZEA (28%, primarily maize and feed samples). Only 1% of samples had all four major mycotoxins detected.

In this study, most of the tested maize and feed samples were below the FDA regulatory action levels for poultry, except for 13 maize samples that exceeded the limits for AFLA (100µg/kg), eight maize samples that exceeded the limit for DON (5 000µg/kg), and eight finished feed samples that exceeded the limit for AFLA (20µg/kg). These results demonstrate that, despite regular testing, batches of feed and feed ingredients containing high levels of mycotoxin can still be present in the feed supply. This underlines the need for more thorough testing of feed components across all levels of the supply chain.

Our results agree with a previous study by Bulgaru *et al*. (2025) who reported that 58% of feed samples tested had detectable levels of six different mycotoxins. Bulgaru *et al*. (2025) similarly reported a low level of mycotoxins detected in finished feeds analysed for poultry and swine. In contrast to the samples containing mycotoxin levels above regulatory limits in our study, Bulgaru *et al*. (2025) found mycotoxin levels which were all below regulatory limits. These differences were likely driven by the studies having been conducted in different locations and conditions.

One of the limitations of this study is the highly heterogenous distribution of mycotoxins within samples. To combat these effects, we homogenised all our feed and grain samples before removing subsamples for testing. Regular testing of raw feed components and finished feeds is essential for making sure that feed is safe for poultry. Rapid analysis can help with faster detection, and mitigation strategies should be adopted early. The data suggest the poultry industry should monitor mycotoxins in poultry feed and feed ingredients holistically and consistently.

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Getting consistent results from probiotics: A framework for the feed industry

By Judi Rosenstrauch, technical support scientist (Can. Sci. Nat. 118654), Envarto

The science behind probiotics is well established. Whether that science reaches the animal, however, depends on a chain of conditions that most product evaluations never interrogate.

Open any feed additive catalogue, and the probiotic section is predictably crowded with products promising improved gut health, stronger immunity, and better performance. Most carry limited evidence. Some carry none at all. Scepticism has therefore been the reasonable industry response, and often a well-placed one. Applied too broadly, however, it carries its own cost: The science underpinning a well-formulated probiotic is solid, and the producers who understand it are getting consistent results.

The gap between what probiotics can do and what they sometimes deliver on farm is not a biology problem but rather a chain-of-custody problem. The Food and Agriculture Organization and World Health Organisation definition, which has anchored the field since 2001, states that a probiotic must be live microorganisms, administered in adequate amounts, conferring a demonstrable health benefit on the host – three conditions, each of which can fail independently. Most on-farm disappointments trace back to one of them failing quietly, long before the animal is ever fed.

The right organism for the right job

The first condition is the most fundamental and the most frequently ignored in commercial practice: strain identity matters. The term 'probiotic' describes a regulatory category, not a mechanism. What a bacterial strain does in the gastrointestinal tract depends entirely on its specific genetic and enzymatic characteristics. Two products with identical genus and species labels can produce entirely different outcomes if the strains differ. Efficacy established for one strain cannot be extrapolated to another, even within the same species.

Bacillus-based probiotics have built the strongest case across both monogastric and ruminant production systems, for both biological and practical reasons. *Bacillus* species produce a wide spectrum of enzymes, including proteases, amylases and cellulases, support competitive exclusion of pathogens, modulate immune responses, and contribute to gut barrier integrity.

In ruminant systems, specific *Bacillus* strains germinate in rumen fluid, consume available oxygen, and, in doing so, create more favourable conditions for the strictly anaerobic, fibre-digesting bacteria that drive rumen fermentation efficiency. This mechanism is not shared by all probiotic genera. It is strain-dependent, and it is one reason why choosing an organism based on a general category claim rather than documented strain-level evidence is a formulation risk.

The influence of gut microbiome health extends well beyond the gut itself. Research across cattle, pigs and poultry has established that the gastrointestinal microbiome communicates bidirectionally with multiple body systems, including pulmonary and reproductive function, mediated through circulating immune cells, metabolites and microbial signalling, with far-reaching immune consequences. A healthy, stable gut microbiome has a reach that most production-focussed evaluations have yet to fully account for.

Surviving the journey

Understanding what an organism can do in the gut is irrelevant if it does not arrive there intact. This is where many products fail in practice, and where the feed manufacturing industry specifically has the most at stake.

Spore-forming bacteria, primarily *Bacillus* species, have a structural survival advantage that no other probiotic genus replicates. The endospore is metabolically inert but fully viable, resistant to heat, desiccation, pH extremes, and extended storage under variable conditions. A quality *Bacillus*-based probiotic should demonstrate verified spore survival at conditioning temperatures exceeding 95˚C, the upper range encountered in commercial pelleting operations, as well as stability through extended storage under variable field conditions.

Pelleting is not the only threat: Loose lick supplements, blocks, and mineral mixes are exposed to equally hostile conditions in the field. The spore-forming characteristic is therefore not a minor technical advantage, but a prerequisite for consistent performance.

When evaluating any probiotic for a pelleted or processed feed application, heat stability as a general claim is not sufficient. Ask for survival data at temperatures above 95˚C, under the conditioning times used in your mill, and under the storage conditions relevant to your supply chain.

Arrival in sufficient numbers

Survival through processing is necessary but not sufficient: The organism must still reach the gut in a biologically meaningful dose. Products with low colony-forming units per gram concentrations create a compounding problem: Achieving an adequate dose per kilogram of complete feed demands high inclusion rates, and at those rates, even distribution through a multi-tonne batch becomes difficult.

Uneven dosing follows, and the result presents as probiotic failure when it is, in fact, a manufacturing and formulation problem. A product can only claim probiotic status if it contains an appropriate viable count at the end of shelf life, not at manufacture. The count that matters is the one delivered to the animal's gut after processing, storage, and transit through the gastrointestinal tract.

Context determines response

The fourth condition is the most subtle. A probiotic's mechanisms operate differently depending on the challenges the animal faces. An animal under pathogenic challenge, weaning stress, transport, or heat load presents a different biological environment from that under stable, low-stress conditions. The same product can produce different measurable outcomes across these contexts, not because of product inconsistency, but because the match between the probiotic's specific modes of action and the animal's challenge profile determines which mechanisms are activated, and to what degree.

Strain identity, survival data, viable dose delivery, and species-specific trial evidence under comparable production conditions are not unreasonable demands. They are the baseline for a rational purchasing decision. Suppliers with well-formulated products should be able to provide this information without hesitation.

In the end, probiotics are neither a shortcut nor a guarantee. As a precision nutritional tool, performance depends on selecting the right product for the job and applying it correctly. The industry that holds probiotics to this standard will achieve consistent returns, but those that do not will continue to draw the wrong conclusions from inconsistent results. ❖

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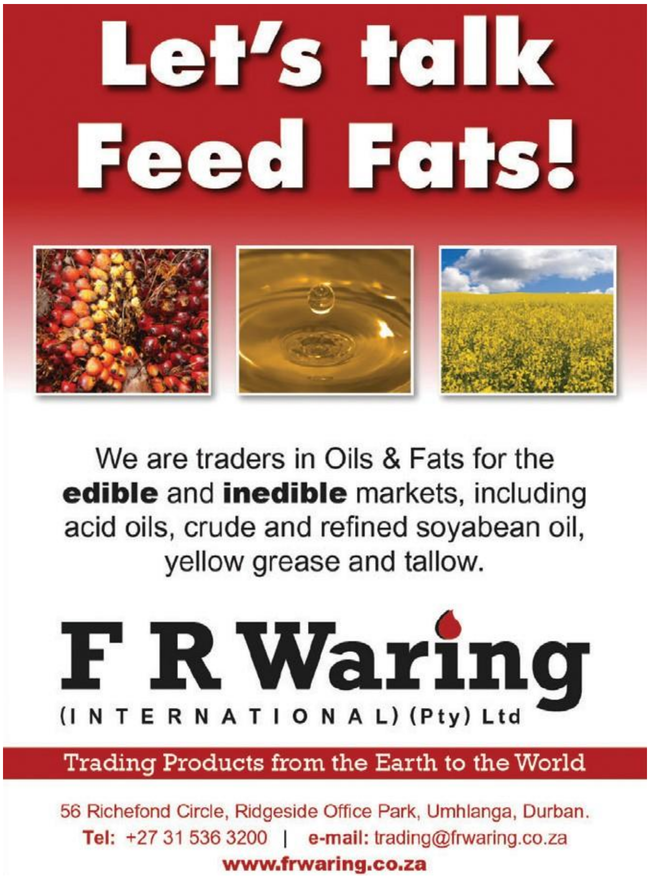
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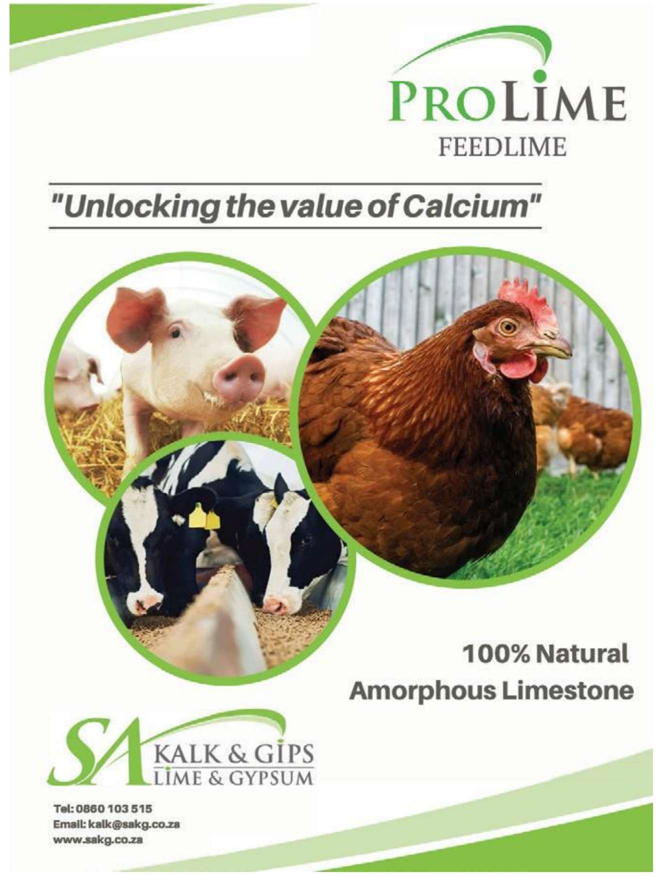
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Evaluating variables affecting PDI in pelleted maize-soya-based feeds for swine and poultry: A meta-analysis

By Jihao You, Kendra Hall, Jessica Civiero, Mark C Malpass, Dan Tulpan and Jennifer L Ellis

Pelleting is one of the most common feed processing methods and presentation approaches for poultry and swine species. Pelleting has been shown to increase feed intake and improve average daily gain (Svihus *et al.*, 2004), boost feed efficiency while reducing production costs (Moritz *et al.*, 2002), minimise ingredient segregation (Poholsky *et al.*, 2021), and decrease feed wastage (Abdollahi *et al.*, 2018). Pellet quality is typically defined by the pellet's ability to withstand fragmentation during packaging, transport, and handling, ensuring the pellets reach the animals with minimal degradation into fines or small particles.

To evaluate the effect of transport and handling, the pellet durability index (PDI) is often used as a predictive measure of pellet quality, assessed through tests such as the tumbling method (ASAE, 1997) or the Holmen method (Major, 1984). The PDI result is calculated as the percentage of pellet weight after testing versus the intact pellet weight before testing.

Factors affecting pellet quality

Pelleting is a process that uses moisture, heat, and pressure to agglomerate sometimes unpalatable and difficult-to-handle individual feed ingredients into nutritionally balanced and homogeneous pellet 'packages'. Depending on the specifics of the manufacturing plant, ingredients may pass through equipment such as mixers, scalpers, rollers, presses, and coolers to produce the final compacted pelleted product.

The steps and conditions of feed manufacturing may vary between and within feed manufacturing plants. Variables such as steam temperature and pressure, conditioning and cooling duration, die specifications for pellet size, die speed, grinder type, and the use of an expander may vary (Buchanan *et al.*, 2010). Additionally, feed formulation and nutrient composition play a critical role in determining pellet quality (Buchanan and Moritz, 2009).

While all these factors are known to influence pellet quality, identifying the primary contributors to poor-quality pellets in production is challenging due to the complex interactions between numerous variables in a commercial feed mill setting (Fahrenholz *et al.*, 2013).

Approach and research objectives

There is a substantial body of literature that has explored the relationships between the factors outlined here and pellet quality. However, deriving clear, actionable insights from these studies is often challenging due to the numerous confounding and interacting factors involved within and between published studies. Examining and building models using commercial mill data is another option, as exemplified in the work by You *et al.* (2022, 2025), though this approach has its own set of limitations due to being based on commercial production data (limited variability in PDI and driving variables, due to the objective of the mill to produce good pellets).

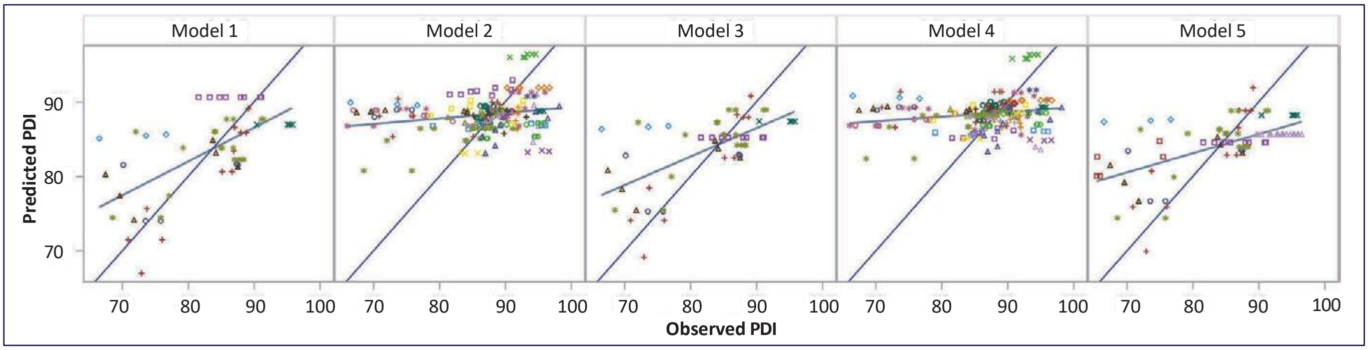
A meta-analysis offers a powerful method to synthesise findings across studies, enabling the evaluation of intervention effects and the identification of potential sources of variability in responses across the published body of knowledge (Duffield *et al.*, 2012). Therefore, the objective of this research was to conduct a meta-analysis of published papers evaluating manufacturing and formulation impacts on PDI, and to develop predictive equations for PDI based on published research. The research goals were to develop a pipeline for selecting and building predictive models for enhancing pellet quality. We hypothesised that PDI would be influenced by a combination of manufacturing and formulation factors.

Results

In this study, eight predictor variables from 29 studies were filtered and used for model development. Five bivariable models (Model 1 to Model 5) were selected among all combinations (N = 28) of two individual variables, which met the development criteria. These bivariable models were constructed using five variables.

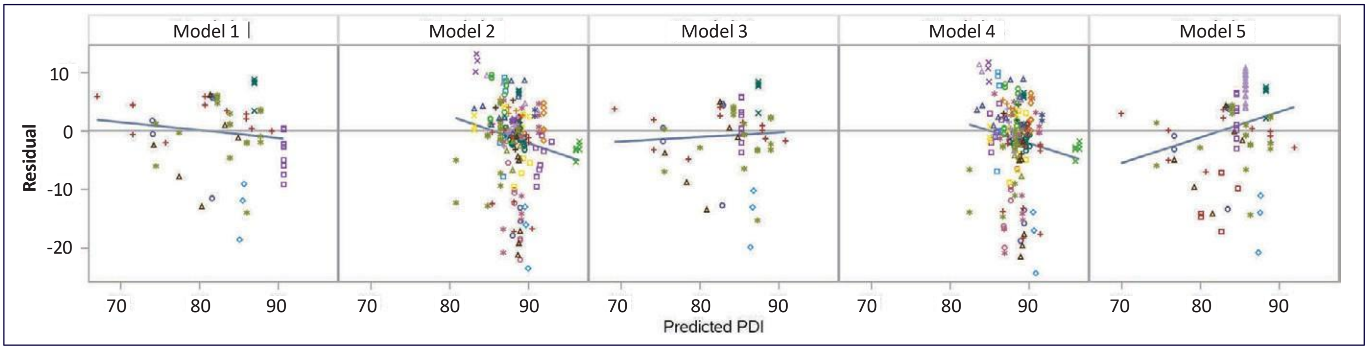
Univariable analysis of these five variables revealed that all were also significantly associated with tPDI ($P < 0,05$) at the univariable level. Among the significant univariable models, maize (g/kg)

Figure 1: Plots of marginal prediction (back-transformed PDI) versus observations (PDI) plots for five selected bivariable models.



Predicted PDI was calculated by back-transforming the predicted tPDI based on the models. Symbols that share the same shape and colour are observations from the same study. Model 1 was based on maize (g/kg) and lipid (g/kg); Model 2 was based on maize (g/kg) and steam temperature (°C); Model 3 was based on lipid (g/kg) and soya bean meal (g/kg); Model 4 was based on soya bean meal (g/kg) and steam temperature (°C); Model 5 was based on lipid (g/kg) and protein (g/kg).

Figure 2: Plots of marginal prediction (back-transformed PDI) versus marginal residuals for five selected bivariable models.



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and lipid (g/kg) were negatively correlated with tPDI, while the remaining variables (protein [g/kg], soya bean meal [g/kg], steam temperature [°C]) had a positive relationship with tPDI. The impact of each variable in the bivariable models agreed with its impact in the univariable models.

Figure 1 shows the fit plots comparing marginal PDI prediction (back-transformed PDI) to observed PDI. All twelve models exhibited a similar tendency to overpredict when PDI was below 80, predict well in the range 80 to 90, and underpredict when PDI was above 90. *Figure 2* displays the plots of marginal prediction against marginal residuals. Model evaluation using a three-fold cross-validation approach is shown in *Table 1*.

Model 2 (maize [g/kg] and steam temperature [°C]) and Model 4 (soya bean meal [g/kg] and steam temperature [°C]) achieved lower rMSPE (%) (7,85 ± 2,092; 7,86 ± 2,350) than the other three models. Additionally, Model 2 (maize [g/kg] and steam temperature [°C]) had the highest ED (%) (88,4 ± 1,56), indicating that most errors stemmed from random variation. Model 5 (lipid [g/kg], and protein [g/kg]) had the highest CCC (0,57 ± 0,076), followed by Model 1 (maize [g/kg] and lipid [g/kg]) with a CCC of 0,45 ± 0,287. Conversely, some models showed neither agreement nor disagreement between the predictions and observations based on CCC, including Model 2 (maize [g/kg] and steam temperature [°C]) (0,02 ± 0,075), and Model 4 (soya bean meal [g/kg] and steam temperature [°C]) (-0,01 ± 0,134).

Discussion

Pellet quality can be difficult to control in a commercial production setting, due to the complexity of the manufacturing process and variability of feed ingredients and diet formulations. While numerous studies have investigated the effects of individual or combined factors (Van der Poel *et al.*,1997; Gilpin *et al.*, 2002; Svihus *et al.*, 2004; Tillman *et al.*, 2020), relatively few have attempted to develop multivariable predictive models for PDI (Schroeder *et al.*, 2020; You *et al.*, 2022, You *et al.*, 2025). To our knowledge, none of them applied a meta-analysis approach.

This approach provides a broader assessment of the factors affecting pellet quality across published studies, and facilitates the development of practical, easy-to-apply empirical models for predicting PDI in real-world applications. Additionally, a pipeline with a set of statistical criteria was applied to efficiently select bivariable models from all possible combinations (models). While multivariable models with three variables using the same pipeline were explored, none met the criteria.

Ingredient and processing effects

The formulated level of lipid in the diet, particularly the addition of free liquid oils and solid fats during the mixing stage

Table 1: Model evaluation for the selected bivariable models using three-fold cross-validation.

Model[1]	rMSPE (%)	MSPE	ECT (%)	ER (%)	ED (%)	CCC	Cb	R
Model 1	9,13 ± 2,463	62,12 ± 38,150	21,4 ± 18,67	41,1 ± 50,63	37,6 ± 34,10	0,45 ± 0,287	0,60 ± 0,393	0,81 ± 0,194
Model 2	7,85 ± 2,092	48,28 ± 24,597	7,5 ± 5,35	4,1 ± 3,84	88,4 ± 1,56	0,02 ± 0,075	0,36 ± 0,263	0,01 ± 0,151
Model 3	9,41 ± 2,731	66,68 ± 42,993	17,7 ± 15,60	43,9 ± 48,78	38,5 ± 33,18	0,41 ± 0,337	0,59 ± 0,445	0,78 ± 0,237
Model 4	7,86 ± 2,350	48,87 ± 27,893	4,4 ± 3,50	10,4 ± 8,86	85,2 ± 10,88	-0,01 ± 0,134	0,41 ± 0,124	-0,08 ± 0,298
Model 5	8,12 ± 0,378	47,15 ± 9,122	6,5 ± 4,82	8,7 ± 4,90	84,7 ± 5,61	0,57 ± 0,076	0,91 ± 0,092	0,63 ± 0,137

C_b is a bias correction factor; ECT (%): the ECT (error due to overall bias) fraction of MSPE; ER (%): the ER (error due to the regression slope deviation) fraction of MSPE; ED (%): the ED (error due to random error) fraction of MSPE; CCC: concordance correlation coefficient; MSPE: mean square prediction error; R: Pearson correlation coefficient; rMSPE (%): the percentage of root mean square prediction error to observed mean. [1]Model 1 was based on maize (g/kg) and lipid (g/kg); Model 2 was based on maize (g/kg) and steam temperature (°C); Model 3 was based on lipid (g/kg) and soya bean meal (g/kg); Model 4 was based on soya bean meal (g/kg) and steam temperature (°C); Model 5 was based on lipid (g/kg) and protein (g/kg).

of feed manufacturing, has a significant negative impact on pellet quality. Briggs *et al.* (1999) reported that increasing oil content above 7,5% resulted in a decrease in pellet quality. According to Moritz *et al.* (2002), increasing the oil inclusion level in broiler diets from 30 to 65g/kg decreased PDI from around 87 to around 74.

The results of this meta-analysis, which were specific to maize-soya-based diets for swine and poultry, align with this understanding, as three of the five bivariable models included lipid (g/kg), with consistently negative parameter estimates ranging from -0,016 to -0,014 (unit change in tPDI/unit change in lipid, g/kg). This negative effect is attributed to the hydrophobic properties of lipids, which hinder pellet binding by blocking moisture transfer during the steam treatment of mash ingredients. This interference prevents the gelatinisation of starch and denaturation of proteins, ultimately weakening the adhesion between particles (Thomas *et al.*, 1998; Abadi *et al.*, 2019). Moreover, the negative effect can also be attributed to the formation of a lubrication layer between mash and the die wall, which reduces friction during pelleting (Bastiaansen *et al.*, 2025).

Protein (g/kg) was included in Model 5 (lipid [g/kg] and protein [g/kg]) in this study, consistent with many studies showing a positive correlation between higher protein content and improved pellet quality. As reported by Briggs *et al.* (1999), increasing the protein content from 16,3 to 21% improved PDI from 75,8 to 88,8. The heat and moisture applied during the pelleting process cause the denaturation and reconstitution of proteins, which exhibit a property of gelatinisation that can contribute to increased pellet durability (Svihus and Zimonja, 2011).

Steam temperature (°C) positively influenced PDI prediction in Model 2 (maize [g/kg] and steam temperature [°C]) and Model 4 (soya bean meal [g/kg] and steam temperature [°C]), aligning with reports in the literature highlighting its beneficial impact on pellet quality. Abdollahi *et al.* (2010) reported increasing the conditioning temperature from 75 to 90°C could improve the PDI for broiler diets based on maize or sorghum. Similarly, Cutlip *et al.* (2008) reported that the high conditioning temperature of 93,3°C increased the pellet quality, compared to the low conditioning temperature of 82,2°C. Steam temperature (°C), along with steam pressure (kPa), reflects steam quality, a key factor influencing gelatinisation of starch and protein denaturation. However, steam pressure (kPa) was not included in the developed models due to less frequent reporting compared to steam temperature (°C) in the analysed studies.

Soya bean meal (g/kg) and maize (g/kg) were found to be highly negatively correlated (SCC = -0,597), as they are the major constituents of the maize -based diets we examined. However, this means their impacts could not be separated from each other (collinear), and thus they were not included in the same models together. The study-level constant percentage was 26,92% for both soya bean meal (g/kg) and maize (g/kg), indicating that most studies in the collected database reported varying inclusion levels of these two ingredients. Their inclusion was typically adjusted to formulate diets to explore the impact of nutrient factors on PDI, rather than investigating their direct impact.

The estimated parameters of soya bean meal (g/kg) in the two selected bivariable models were positive (0,001 in two models), indicating a positive impact on PDI. This could be attributed to protein denaturation, as soya bean meal (g/kg) is a primary protein source in diets, and it showed a strong positive correlation with protein (g/kg) (SCC = 0,787). Conversely, the estimated parameters of maize (g/kg) in the two selected bivariable models were both negative (-0,001 in two models), which might result from the confounding effects among ingredients, as indicated by the Spearman's rank correlation coefficient between maize and soya bean meal (-0,597).

In the study by You *et al.* (2022), maize was an important feature (variable) in some machine learning models, but the direction of its effect was not shown. Another study by You *et al.* (2025) predicting pellet quality from commercial data reported that the directional impact for maize was negative as well.

Model validation and comparison

A threefold cross-validation at the study level was performed to evaluate the prediction performance of the developed models. The limited number of studies posed a constraint on this analysis. For example, Models 1 (maize [g/kg] and lipid [g/kg]) and Model 3 (lipid [g/kg] and soya bean meal [g/kg]) were based on observations from nine studies, necessitating the use of three-fold splitting for cross-validation. However, a limitation of study-level cross-validation is that significant variability between observations across studies can inflate negative model performance.

The cross-validation results indicated that Model 5 (lipid [g/kg] and protein [g/kg]) achieved a higher CCC (0,57 ± 0,076) than other selected bivariable models, despite not having the lowest rMSPE (%) (8,12 ± 0,378). Unlike rMSPE (%), which primarily measures error, CCC accounts for both precision and accuracy, represented by R and C_b, respectively, making it a more comprehensive measure of model performance evaluation.

Three prior studies reported PDI prediction using empirical models (Schroeder *et al.*, 2020; You *et al.*, 2025), and machine learning models (You *et al.*, 2022), respectively. The best model in this study, which was Model 5 (lipid [g/kg] and protein [g/kg]), had a CCC of 0,57 ± 0,076, compared to CCC values of 0,636 and 0,550 reported by You *et al.* (2022) and You *et al.* (2025), respectively. Notably, Schroeder *et al.* (2020) did not use CCC as an evaluation measure. The CCC in this study was achieved by the inclusion of only two variables in Model 5 (lipid [g/kg] and protein [g/kg]), whereas the models in the other studies incorporated more predictors.

From a predictor perspective, five variables were used for the construction of bivariable models. Among them, steam temperature (°C) was selected for PDI prediction by Schroeder *et al.* (2020), while lipid (g/kg) was incorporated as a key predictor in the best-performing model by You *et al.* (2025), where it was identified as a significant factor influencing PDI. However, the aforementioned models may be more difficult to implement in practice, in particular in smaller mills or mills lacking automated data capture.

Limitations and future opportunities

This meta-analysis study developed simple empirical models using two predictor variables for PDI prediction, offering a practical solution for situations where large-scale data collection is not feasible, yet potentially yielding more accurate estimations of PDI compared to qualitative consideration of literature studies. The previous modelling studies (Schroeder *et al.*, 2020; You *et al.*, 2022, You *et al.*, 2025) used large-scale datasets generated in commercial feed mills settings, where the focus is on producing high-quality pelleted feed using a wide variety of ingredients.

In contrast, the data in this study was collected from a diverse range of published sources under experimental settings, resulting in greater variability. Those experimental studies often work with smaller-scale datasets and intentionally explore extreme conditions, including very low values for pellet quality, while typically using a narrower range of ingredients.

This meta-analysis, along with the studies by Schroeder *et al.* (2020) and You *et al.* (2022), may be limited by the exclusion of two important factors that affect PDI. One such factor is particle size, which is well documented as beneficial for improving PDI when reduced (Muramatsu *et al.*, 2015). However, particle size was inconsistently reported in the literature, with some studies providing information for all ingredients while others only reported it for specific ingredients such as maize, making it unsuitable for inclusion in the analysis.

Another important factor is the use of pellet binders, which was reported in five collected studies. While it could be included as a categorical variable indicating 'yes' or 'no' for the use of the pellet binders, Models 1 (maize [g/kg] and lipid [g/kg]), Model 3 (lipid [g/kg] and soya bean meal [g/kg]), and Model 5 (lipid [g/kg] and protein [g/kg]) included only one study that used the pellet binders. Moreover, different pellet binder products, such as calcium lignosulfonate (Corey *et al.*, 2014) and Spirulina algae (Boney and Moritz, 2017), were used across these studies, so they could not be grouped into a single category. Therefore, we did not include pellet binder use in the final analysis.

Additionally, this study could not consider certain dietary nutrients (e.g., starch and fibre) and manufacturing-condition variables (e.g., steam pressure) due to limited data reporting. Lastly, in this study, the meta-analysis was restricted to maize-soya-based diets for swine and poultry due to data availability and to align objectives and diet types among studies, which may limit the generalisation of the findings to other diet types (e.g. wheat-based diets). However, this study succeeded in producing simple-to-implement prediction equations, useful in practice where information may be sparser, and demonstrates the utility of the meta-analysis approach to synthesising published literature on feed manufacturing data to guide practical decision making.

Conclusions

Many studies have demonstrated that PDI is influenced by a variety of factors, including feed ingredients, manufacturing parameters, and the nutrient composition of the pellet. This study employed a meta-analysis approach to systematically integrate findings from published studies on maize-soya-based diets for swine and poultry, providing a broader understanding within this dietary context of the relationships between experimentally investigated factors and PDI. Results showed that Model 5 (lipid [g/kg] and protein [g/kg]) exhibited the best PDI prediction performance among five selected bivariable models, based on a CCC of 0,57 ± 0,076, C_b of 0,91 ± 0,092, and R of 0,63 ± 0,137. According to Model 5, increasing protein (g/kg) ($P = 0,0017$) and limiting lipid (g/kg) ($P < 0,0001$) were associated with higher-quality pellets.

This study developed a pipeline for selecting bivariable models based on a set of statistical criteria. Bivariable models were selected for predicting PDI by integrating diet/nutrition and manufacturing-condition factors based on data from published literature using a meta-analysis approach. The findings provide straightforward, practical models for predicting PDI using experimental research data. ❖

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Two updates in 2026 for employers to recap

By Hannes Latsky, training and compliance manager, LWO Employers Organisation

The first half of 2026 saw two important labour law developments that companies across South Africa should revisit to ensure proper implementation. These updates relate to the increase in the national minimum wage under the *National Minimum Wage Act, 2018 (Act 9 of 2018) (NMWA)* and the adjustment of the earnings threshold under the *Basic Conditions of Employment Act, 1997 (Act 75 of 1997) (BCEA)*.

Although both adjustments may appear administrative in nature, they have significant practical implications for payroll structures and administration, updating of employment contracts and general compliance obligations.

Minimum wage update

The first update was the national minimum wage which increased with effect from 1 March 2026. In terms of the *NMWA*, the National Minimum Wage Commission reviews the national minimum wage annually and submits recommendations to the minister of employment and labour regarding possible adjustments.

Following the latest review, the minister published the revised national minimum wage in the *Government Gazette* in February 2026. With effect from 1 March 2026, the national minimum wage increased to R30,23 per hour for ordinary hours worked.

When making recommendations, the Commission always considers several factors, including inflation, the consumer price index (CPI), cost of living, collective bargaining outcomes, employment levels, and the broader economic environment. The 2026 adjustment reflected the CPI at the time, as reported by Statistics SA, plus approximately 1,5%. That total was then added to the previous national minimum wage rate and used to calculate the new updated wage.

Employers should note that the national minimum wage of R30,23 per ordinary hour worked applies to farmworkers and domestic workers as well, and that remuneration structures must be assessed carefully to ensure compliance. Failure to comply with at least the prescribed minimum wage may expose employers to complaints, inspections, compliance orders and possible fines by the Department of Employment and Labour.

Earnings threshold update

A second important development followed shortly thereafter, namely the *BCEA* earnings threshold which also increased. On 17 April this year, the Department of Employment and Labour published *Government Notice No 7384* in the *Government Gazette*, confirming an increase to the *BCEA* earnings threshold.

The earnings threshold increased to R269 600,90 per year with effect from 1 May. This represents an increase of approximately R7 852,45 per year from the previous threshold of R261 748,45, which had been effective since 1 April 2025. The adjustment amounts to a 3% increase and aligns with the CPI inflation rate of February 2026, as reported in March.

The earnings threshold remains a critically important figure in labour law compliance because it determines the applicability of several provisions of the *BCEA* to certain employees. Employees earning below the threshold enjoy specific protections relating to, among others, ordinary working hours, overtime, compressed working weeks, averaging of hours, meal intervals, and Sunday pay.

Employers are therefore urged to urgently review remuneration structures, contracts of employment, payroll systems, and overtime practices to determine whether any employees now fall above or below the new threshold. Where employers are not sure of the implications, it is recommended that advice and assistance be obtained from labour law experts regarding the applicability of these labour law protections. It is also very important to update employment contracts accordingly.

Always monitor legislation

The increases to both the national minimum wage and the *BCEA* earnings threshold serve as an important reminder that labour law compliance is not static. Employers should continuously monitor legislative developments and ensure that remuneration frameworks, payroll systems, and employment practices remain aligned with current legal requirements.

Failure to properly implement these adjustments may expose employers to unnecessary compliance risks, disputes and financial liability. Regular compliance reviews and proactive labour law management remain essential in navigating South Africa's evolving employment law landscape.