

Matrix

Quarterly magazine of the Animal Feed Manufacturers Association



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of the **next decade**.

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AFMA FORUM 2026:

Programme, speaker and sponsor profiles, and speaker articles

Salmonella • Mycotoxins • Global trade shifts • Heat stress • Methane inhibitors



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with curiosity.



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Why this year's Forum is different

By Liesl Breytenbach, executive director, AFMA

Welcome to the 12th AFMA Forum. Whether you are joining us for the first time or have attended many Forums before, thank you for investing your time in the conversations that will help shape our industry's future.

It is a great privilege to welcome you to Sun City for three days of engagement, learning and connection under the theme "The Feed Factor: The Chain That Feeds a Nation". With more than 800 local and international delegates expected to attend, this will be the biggest AFMA Forum to date – a significant milestone for an event that brings our industry together only once every three years.

Our theme recognises the essential role the feed industry plays in connecting crop production with livestock agriculture and, ultimately, food security. By converting grain, oilseeds and other raw materials into safe, nutritious feed, our industry supports animal health, production efficiency, food safety, and the supply of affordable meat, milk, and eggs.

Twelve instalments later, the purpose of this event remains unchanged: **to bring our industry together**. What has changed is the pace, scale and complexity of the environment in which we operate. For this reason, AFMA made a conscious decision to approach the 2026 Forum somewhat differently.

A broader industry conversation

Scientific and technical knowledge remain fundamental to our industry and to the AFMA Forum. But the challenges facing our businesses today extend well beyond nutrition and feed manufacturing alone. This year's programme therefore brings together science with markets, animal health, technology, leadership, artificial intelligence (AI), skills development, and practical industry experience.

For the first time, senior leaders from South Africa's major producer organisations will come together to discuss the competitiveness of the grain, feed

and livestock value chain. Representatives from government, regulatory authorities, the veterinary profession, animal health and the feed sector will engage on antimicrobial stewardship, while local and international experts will explore developments ranging from global animal protein markets and nutrition to AI, digitalisation, precision feed manufacturing, and the resilience of our future food systems.

Over the next three days, we want you to not only hear new information, but also to consider what these developments mean for your own organisation and for our industry collectively. We hope the programme challenges established thinking, broadens perspectives and contributes to better-informed decisions across the feed-to-food value chain.

Innovation beyond the stage

And the learning does not stop when you leave the conference room. At the heart of the Forum is an exhibition featuring **almost 40 world-class exhibitors**, bringing together some of the leading companies serving our industry. I encourage you to spend time in the exhibition hall, explore the latest technologies, products and services available to the feed sector, ask questions and engage with the people behind the innovations.

We are also especially proud to introduce AFMA's first **Student Industry Case Challenge**. This initiative reflects our belief that the industry's future must be actively shaped. By exposing university students to a real industry challenge, we hope to strengthen the connection between academia and industry while encouraging practical problem-solving, collaboration, and critical thinking.

Of course, the true value of the AFMA Forum has never been limited to what happens on the stage. Some of the most valuable ideas shared over these three days may never appear on a presentation slide. They may emerge over coffee, through a question after a session, while visiting an exhibitor, during an introduction to someone new, or while reconnecting with a colleague from another part of the value chain.

Building connections that matter

The challenges and opportunities facing agriculture do not sit neatly within the boundaries of one sector. Competitiveness, animal health, market access, food security and value creation require us to look beyond individual industry interests and consider what can be achieved collectively.

Our strength as an industry has never been that we all think alike. It lies in our willingness to come together, share knowledge, listen to different perspectives and work towards practical solutions. That is what makes the AFMA Forum more than a conference. It gives us an opportunity to step away from our daily responsibilities, look at the bigger picture and strengthen the relationships on which a resilient and competitive industry depends. So, participate fully. Ask questions. Challenge ideas. Visit the exhibitors. Share your own experiences and make time to speak to people beyond your usual network.

Thank you for being part of the 12th AFMA Forum. I hope you leave Sun City with new ideas, valuable relationships, a broader perspective and renewed confidence in the future of the industry we are proud to serve.

We truly hope that you enjoy the Forum and its specially curated content. ♦

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AFMA FORUM 2026

AUTOMILL AGENDA

**8-10 SEPTEMBER 2026****SUN CITY | SOUTH AFRICA**

TUESDAY 08 SEPT

09:00 - 16:00

AUTOMILL INVITATIONAL GOLF

Tee off with us at The Gary Player Golf Course and Country Club - a relaxed start to three days of connection.

18:30

AFMA WELCOME FUNCTION

MEET THE "SMARTSERVE" EXPERIENCE

Discover Automill SmartServe - a fast, precise and refreshingly automated beverage experience.

22:00

AUTOMILL AFTERPARTY

Spend the night with us at our afterparty at Hard Rock Cafe

WEDNESDAY 09 SEPT

07:00 - 17:00

LIVE DEMOS + EXHIBITION

See Automill in action throughout the day in the Expo Centre. Experience our system firsthand and see how Automill can assist you with exceeding your KPIs and Company Goals.

EXCLUSIVE COMMERCIAL SESSION

AUTOMILL PRESENTS FEEDMILL OF THE FUTURE

**17:30 - 18:30**

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ASSOCIATED ENERGY SERVICES**BITEK
INDUSTRIES****19:00 - 23:00**

AUTOMILL DINNER (PER INVITE)

Join us for dinner at Legends Restaurant - per invite.

THURSDAY 10 SEPT

07:00 - 12:00

LIVE DEMOS + EXHIBITION

Visit Automill in the Expo Centre or a final morning of live demonstrations.

17:30 - 18:30

AUTOMILL HAPPY HOUR

Connect, unwind and toast a successful AFMA Forum before the closing function.

18:30

AFMA CLOSING FUNCTION

Join the industry as AFMA Forum 2026 comes to a close.

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Let's shape the future of animal feed -together

2026 AFMA FORUM PROGRAMME

The Feed Factor: The chain that feeds a nation

Time	Description	Venue
TUESDAY, 8 SEPTEMBER 2026		
Reflection of our journey & legacy: The industry we operate in		
07:00 – 17:00	Registration open	King's Ballroom Foyer
12:30 – 22:00	Exhibition open	Superbowl
12:30 – 14:00	Lunch	Superbowl
14:00 – 16:20	CONFRONTING THE REALITY DRIVING THE CHAIN	King's Ballroom
	Welcome and conference opening GP van Rheede van Oudtshoorn Master of Ceremonies	King's Ballroom
	Official opening of the AFMA Forum 2026 Liesl Breytenbach Executive Director, AFMA	King's Ballroom
	Chairperson's address: The state of the feed industry Anina Hunter Chairperson, AFMA	King's Ballroom
	Ministerial address Willie Aucamp Minister of Agriculture, South Africa	King's Ballroom
	Future of animal feed manufacturing Prof Henrik von Scheel Industry 4.0 originator and strategic intelligence expert <i>Sponsored by AFMA</i>	King's Ballroom
	Event Partner: Victam Corporation	King's Ballroom
16:20 – 16:40	Tea/coffee break	King's Ballroom Foyer
16:40 – 17:30	AFMA annual general meeting (all AFMA members)	King's Ballroom
18:30 – 22:00	Welcome function	King's Ballroom

WEDNESDAY, 9 SEPTEMBER 2026		
Responding to the reality for a sustainable feed industry		
07:00 – 17:00	Registration open	King's Ballroom Foyer
07:00 – 20:00	Exhibition open	Superbowl
07:00 – 08:00	Welcome refreshments	Superbowl
08:00 – 10:15	ANTIMICROBIAL RESISTANCE – SCIENCE, STEWARDSHIP AND INDUSTRY ACTION	King's Ballroom
08:00	The role of animal nutrition in reducing reliance on antimicrobials: Global feed industry perspective Prof Coen Smits Director Sustainability, Trouw Nutrition; Professor Animal Nutrition, Wageningen University & Research <i>Sponsored by Trouw Nutrition</i>	King's Ballroom

08:45	Panel discussion: Antimicrobial stewardship in South Africa Facilitator: Margaret Churchill (SAAHA) Panel: Dr Ziyanda Qwalela (SAVA) Dr Alice Sigobodhla (SAHPRA) Dr Mphane Molefe (Department of Agriculture) Anina Hunter (AFMA)		King's Ballroom
10:15	10:55	Tea/coffee break	Superbowl
10:55	13:10	GLOBAL SIGNALS, LOCAL IMPACT: MAKING SENSE OF MARKET VOLATILITY	King's Ballroom
10:55	Global animal protein markets: Signals every feed manufacturer should be watching Nan-Dirk Mulder Senior Global Specialist – Animal Protein, Rabobank <i>Sponsored by AFMA</i>		King's Ballroom
11:40	Panel discussion: Market volatility and performance: The collective role of industry associations Facilitator: Prof André Jooste (Chairperson, NAMC) Panel: Izaak Breitenbach (SAPA) Dr Marlene Louw (SAPPO) Dr Frikkie Maré (RPO) Fanie Ferreira (MPO) Dr Tobias Doyer (Grain SA)		King's Ballroom
13:10	14:20	Lunch: Sponsored by Voermol	Superbowl
14:20	17:00	NUTRITION: DRIVING EFFICIENCY & PERFORMANCE Parallel breakaway sessions	King's Ballroom 1 & 2
		MONOGASTRIC BREAKAWAY Moderator: Rick Kleyn	RUMINANT BREAKAWAY Moderator: Dr Pieter Henning
14:30	Increased usage of saponins in animal feeds, a global perspective Dr Ken Bafundo Adjunct, Poultry Diagnostic and Research Center, University of Georgia <i>Sponsored by Huvepharma</i>		Opportunities for targeted feed additives to improve metabolic efficiency, performance, and environmental sustainability in dairy cows Dr Sion Richards Ruminant Technical Service Manager EMEA, Balchem <i>Sponsored by Vitam International</i>
15:00	The impact of dietary energy on early egg production and body composition in laying hens, using a novel NIR technology Dr Lieske van Eck Senior Poultry Researcher, Cargill <i>Sponsored by Cargill Provimi SSA</i>		Optimising vitamin D status in dairy cows to enhance calcium-phosphorus metabolism, immune function, and milk production efficiency Ignacio Artavia Marketing & Business Development Manager, dsm-firmenich <i>Sponsored by dsm-firmenich</i>
15:30	Updated mineral requirements of chickens Prof Michael E Persia Iowa State University; Director of the Egg Industry Centre and Iowa Egg Council <i>Sponsored by Allied Nutrition</i>		Fatty acid nutrition in sustainable ruminant systems – production, environmental, consumer targets and raw material sourcing Dr Richard Kirkland Global Technical Manager, Volac Wilmar Feed Ingredients Limited <i>Sponsored by Nutribase</i>
16:00	Sustainable technologies, digital solutions and overall innovation to improve production Prof Aaron Cowieson Head of Digital Consultancy & Solutions, dsm-firmenich; Extraordinary Professor, University of Aberdeen <i>Sponsored by dsm-firmenich</i>		Feedlot efficiency and mineral nutrition Prof Stephanie Hansen Chair for Faculty Excellence in Animal Science, Iowa State University <i>Sponsored by Chemuniqué</i>
16:30	Combined Q&A		Combined Q&A
17:00	Tea/coffee break		Superbowl
17:30	19:30	Commercial session: Automill Feed mill of the future: Innovations future-proofing the feed industry's bottom line	King's Ballroom

Evening	Evening at leisure. No official social function. Exhibitions open until 20:00.	Sun City
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THURSDAY, 10 SEPTEMBER 2026

Innovating for tomorrow

07:00	14:00	Registration open	King's Ballroom Foyer
07:00	14:40	Exhibition open	Superbowl
07:00	08:00	Welcome refreshments	Superbowl
08:00	09:40	AI & DIGITAL TRANSFORMATION IN THE FEED INDUSTRY	King's Ballroom
08:00		AI in Agri-food: Where are we now, and what will the future be? Cynthia Zhu Founder & AI Consultant, Agri-ai.nl <i>Sponsored by AFMA</i>	King's Ballroom
08:50		Sustainable feed manufacturing of the future driven by novel ingredients, digitalisation, moisture management and optimised quality Dr Dejan Miladinovic Head of Center for Feed Technology, Norwegian University of Life Sciences <i>Sponsored by Kemin Industries South Africa</i>	King's Ballroom
09:40	10:50	AFMA Student Industry Case Challenge	King's Ballroom
10:50	11:30	Tea/coffee break	King's Ballroom
11:30	13:10	FROM DATA TO DECISIONS: INNOVATION IN FEED MANUFACTURING	King's Ballroom
11:30		Decoding and solving limitations for animal performance using AI-based transcriptomic analyses Dr Luis Romero CEO, Biofractal <i>Sponsored by AFMA</i>	King's Ballroom
12:20		Real-time protein monitoring, and automatic recipe adjustment, advancing precision feed milling, consistency, efficiency, and raw material optimisation Oliver Brägger Head of Business Development: Digital Solutions, Bühler Group <i>Sponsored by Bühler</i>	King's Ballroom
13:10	13:50	AFMA Awards	King's Ballroom
13:50	14:50	Lunch	King's Ballroom Foyer
14:50	16:40	PREPARING FOR THE NEXT DECADE	King's Ballroom
14:50		Building resilient food systems: The feed industry's next chapter Constance Cullman Board Chairperson, IFIF <i>Sponsored by AFMA</i>	King's Ballroom
15:40		Disruption doesn't knock: Rebuilding strategy, resilience and leadership in the animal feed system Dr Abdullah Verachia CEO, The Strategists <i>Sponsored by AFMA</i>	King's Ballroom
16:20		Closing of conference	King's Ballroom
16:40	17:30	Tea/coffee break	King's Ballroom Foyer
17:30	18:30	Happy hour: Sponsored by Automill	Seers Court
18:30	22:00	Closing function	Valley of the Waves

FRIDAY, 11 SEPTEMBER 2026

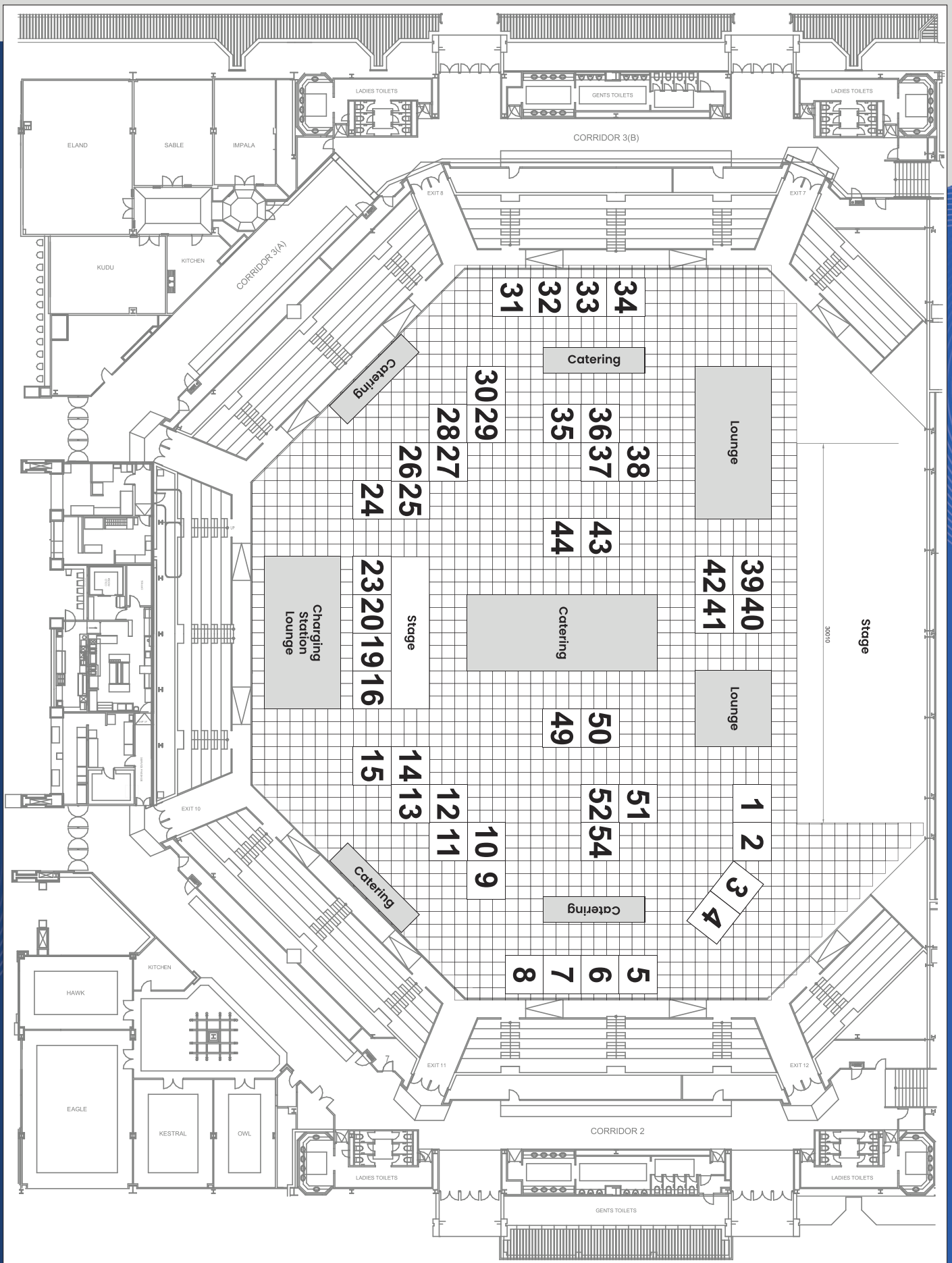
10:00	Delegates check out and departure	Various hotels
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Afma Forum
ANIMAL FEED CONFERENCE

Exhibitor List & Exhibition Floor Plan

STAND NO	COMPANY
1 & 2	Andritz
3 & 4	Bitek Industries
5	Labworld
6	Sovereign Foods
7	Rhine Ruhr
8	VETPAC Animal Health
9	Phileo by Lesaffre
10	Evonik Africa
11	Bühler Group
12	AE Solutions
13	SA Lime & Gypsum
14	Orchem
15	Verder Scientific
16	dsm-firmenich
19 & 20	Nutribase
23	Nu-Pro Commodities
24	Pretoria Protein Company
25	Chem Nutri Analytical
26	Huvepharma South Africa
27	CAL Laboratories
28	Vitam International
29 & 30	Dalein Agriplan
31	Elanco Animal Health
32	Bupo Animal Health
33 & 34	Kemin Industries
35	La Meccanica
36	CFAM Technologies
37 & 38	Automill
39–42	Victam Corporation
43 & 44	Adisseo
49 & 50	Allied Nutrition
51 & 52	AFMA
54	Unitrans



SPEAKER PROFILES



Liesl Breytenbach

Liesl Breytenbach, executive director, AFMA

Liesl Breytenbach was appointed executive director of AFMA on 1 August 2023, bringing nearly two decades of industry experience to the role. She holds an MSc in Agriculture (monogastric nutrition) from Stellenbosch University and began her career as a formulator at Meadow Feeds in 2004. Her career path includes roles in operational nutrition and technical advisory services at AFGRI Animal Feeds, as well as a long-standing tenure at AFMA. With a strong foundation in feed legislation, nutrition, and regulatory management, Liesl is passionate about enabling growth through collaboration.



Anina Hunter

Anina Hunter, chairperson, AFMA

Anina Hunter is managing director of Epol Feed at Rainbow Chicken and chairperson of AFMA. With over 22 years' experience in the feed industry, she holds degrees in Animal Science and Business Administration. She prioritises creating an enabling environment that supports long-term industry growth, emphasising collaboration between industry and government to address challenges such as infrastructure constraints and rising energy costs. Under her leadership, AFMA has focussed on strategic areas including maintaining feed affordability, promoting industry self-regulation, and investing in skills development.



Prof Henrik von Scheel

Prof Henrik von Scheel, Industry 4.0 originator and strategic intelligence expert

Prof Henrik von Scheel is best known as the originator of the 4th Industrial Revolution and of today's digital themes. For the past two decades, he has set the global agenda for nations and leading organisations via the Strategic Intelligence. As a professor of strategy management and economics, his work has helped evolve mainstream business practices. His work has influenced national economies and 23% of Fortune 500 high-growth companies, earning him recognition from the *Financial Times* as the "leading authority on strategy".



Prof Coen Smits

Prof Coen Smits, global sustainability director, Trouw Nutrition, and professor in Animal Nutrition, Wageningen University & Research

Coen Smits is global sustainability director at Trouw Nutrition, and professor holding the Chair of Functional Ingredients for Sustainable Animal Nutrition at Wageningen University & Research. He is an internationally recognised expert in animal nutrition and health with extensive experience in innovation and sustainability leadership. Throughout his career, Coen focussed on the development and application of nutritional strategies that improve animal health, welfare, productivity, and the sustainability of livestock production. He actively collaborates with international organisations, research institutions, and industry partners to advance evidence-based approaches to animal nutrition and sustainability.



Nan-Dirk Mulder

Nan-Dirk Mulder, senior global specialist in animal protein, Rabobank

Nan-Dirk Mulder joined Rabobank's Food & Agribusiness Advisory and Research department (FAR) in 2001. He graduated in agricultural economics, marketing and market research from the Netherlands' Wageningen Agricultural University in 1996. Before his appointment at Rabobank International, he worked for the Product Boards for Livestock, Meat and Eggs (PVE) and the Agricultural Economic Research Institute (LEI) in the Netherlands. He was also a member of the Livestock Management and Expert Committees at the European Commission.



Dr Ken Bafundo

Dr Ken Bafundo, adjunct professor, Poultry Diagnostic and Research Center, University of Georgia

Dr Ken Bafundo received his PhD in poultry nutrition from the University of Illinois. His 40-year career has been devoted to research on avian intestinal health and to developing products used to control coccidiosis. Dr Bafundo is currently an industry consultant, advising clients on feed additives and their effective use in broiler production. He is an adjunct professor at the Poultry Diagnostic and Research Center at the University of Georgia and has served as section editor for *Poultry Science*. In 2025, he edited a special issue of *Animals* devoted to recent advances in coccidiosis research.



Dr Lieske van Eck

Dr Lieske van Eck, senior poultry researcher, Cargill

Dr Lieske van Eck is a senior research scientist within the global R&D team of Cargill Animal Nutrition and Health. She obtained her doctorate from Wageningen University. Together with her colleagues, she received an Edison Innovation Award for the development of REVEAL Layers, a handheld near-infrared (NIR) device designed to assess body composition in laying hens. Her scientific expertise lies in laying hen nutrition, with a decade of experience leading research projects in the fields of laying hen and broiler breeder nutrition, laying persistency, egg and eggshell quality, and mineral nutrition.



Prof Michael E Persia

Prof Michael E Persia, Iowa State University and director of the Egg Industry Center and Iowa Egg Council

Prof Michael Persia is the director of the Egg Industry Center and the Iowa Egg Center Endowed Professor of Animal Science at Iowa State University, specialising in applied poultry nutrition. A prominent leader in the poultry science community, he served as programme chair for the 2023 Poultry Science Association Annual Meeting and held a three-year term as a director on the PSA Board. He is also involved with the Southern Poultry Science Society and serves on the boards of the National Egg Quality School and the Virginia Egg Council. He earned his BS from Penn State, MS from Ohio State, and PhD from the University of Illinois.



Prof Aaron Cowieson

Prof Aaron Cowieson, head of digital consultancy & solutions, dsm-firmenich, and extraordinary professor, University of Aberdeen

From 2001 to 2010, Prof Cowieson worked for two major biotechnology businesses where his research focus was feed enzymes, ingredient quality, and amino acid and mineral nutrition of poultry. From 2010 to 2013, he was associate professor of Poultry Nutrition and Director of the Poultry Research Foundation within the Faculty of Veterinary Science at the University of Sydney. Currently, he is senior science fellow and head of Digital Consultancy and Solutions at dsm-firmenich. He is retained as adjunct professor of Animal Science at Purdue University and Honorary Governor of the Poultry Research Foundation at the University of Sydney.



Dr Sion Richards

Dr Sion Richards, ruminant technical service manager EMEA, Balchem

Dr Sion Richards is the ruminant technical services manager for EMEA at Balchem and an expert in transition cow nutrition and feed additives in dairy systems. He holds a degree in Animal Science and a PhD in Nutritional Biochemistry from the University of Nottingham. Starting his career as a commercial ruminant nutritionist with Provimi, he progressed into various research and technical management roles. His international experience includes roles at DSM Nutritional Products and Adisseo. Currently, Dr Richards' work emphasises evidence-based nutritional interventions for transition cows.



Ignacio Artavia

Ignacio Artavia, marketing and business development manager, dsm-firmenich

Ignacio Artavia is marketing and business development manager for South Europe and Africa at dsm-firmenich Animal Nutrition & Health. He holds a bachelor's degree in Sustainable Tropical Agriculture from EARTH University in Costa Rica and a European master's degree in Sustainable Animal Nutrition from Wageningen University. His professional background combines technical expertise in ruminant nutrition and health with a strategic commercial perspective in global animal production systems. He has delivered technical training and presentations across Europe, Latin America, Asia and Africa, engaging with feed millers, veterinarians, and producers.



Dr Richard Kirkland

Dr Richard Kirkland, global technical manager, Volac Wilmar Feed Ingredients Limited

Dr Richard Kirkland has many years' experience specialising in fatty acid supplementation for dairy cows. As global technical manager at Volac Wilmar Feed Ingredients, he provides guidance to milk producers. Having completed a PhD thesis evaluating aspects of energy metabolism in dairy cows at Queen's University Belfast, Northern Ireland, and collaborating on research with global institutions such as Michigan State University, Cornell University, Wageningen University and the Tasmanian Institute of Agriculture, he has great experience in advancing nutrition strategies to help producers tackle key challenges.



Prof Stephanie Hansen

Prof Stephanie Hansen, chair for Faculty Excellence in Animal Science, Iowa State University

Stephanie Hansen is a professor in the Department of Animal Science at Iowa State University. She earned her Bachelor of Science from Iowa State and her master's and PhD degrees from North Carolina State University. With well over 100 peer-reviewed publications, she has established an original and impactful beef cattle research programme. A major focus of her programme is refining mineral requirements for feedlot cattle. Prof Hansen is passionate about training the next generation of animal scientists and, in 2025, published *The Graduate Mentor's Trail Map* to help others on their mentoring journey.



Cynthia Zhu

Cynthia Zhu, founder and AI consultant, Agri-AI.nl

Cynthia Zhu, founder of Agri-AI BV, is a pioneering force in integrating artificial intelligence into the agricultural and food sectors. She holds a degree in Business Economics and an MBA in Strategy and Innovation from the University of Amsterdam (UvA). She serves as a columnist for leading agri-food industry journals in the Netherlands and holds a position as visiting professor specialising in AI applications in agriculture. Her diverse technological background includes spearheading major infrastructure projects in 4G network deployment, Fibre to the Home (FTTH), and Amsterdam's smart-city initiatives.



Dr Dejan Miladinovic

Dr Dejan Miladinovic, head of the Center for Feed Technology, Norwegian University of Life Sciences

Dr Dejan Miladinovic is a leading expert in feed manufacturing technologies, with over two decades of experience in research, education, and innovation. He holds a PhD in Science and Technology, a master's in Feed Manufacturing Technology from the Norwegian University of Life Sciences, and a master's in Innovation and Entrepreneurship from the University of Oslo. As head of the Center for Feed Technology at the Norwegian University of Life Sciences, he oversees advanced research in moisture management, single-cell protein-based ingredients, and advanced feed manufacturing technology.



Dr Luis Romero

Dr Luis Romero, CEO, Biofractal

Dr Luis Fernando Romero is the Founder and CEO of Biofractal, a company focussed on detecting and solving nutritional limitations and subclinical issues that limit the profitability and sustainability of animal production by using gene expression technologies and AI. He has 20+ years of international experience in innovation leadership, animal nutrition and health, and animal production. He obtained a PhD in Animal Science at the University of Alberta in Canada in 2008. He led innovation teams, innovation strategy and project portfolio, in Danisco/DuPont Animal Nutrition (UK, 2008–2017) and DSM Animal Nutrition and Health (Switzerland, 2017–2020).



Oliver Brägger

Oliver Brägger, head of business development: digital solutions, Bühler Group

Oliver Brägger is an international sales leader with 20+ years of end-to-end industry experience. He began his career in 1998 as a millwright apprentice, progressed to five years as an international installation supervisor, then spent two years in project management. For the past 14 years, he has led international sales, bridging deep technical expertise with commercial strategy to grow global accounts and deliver measurable customer value.



Constance Cullman

Constance Cullman, board chair, IFIF

As chair of the International Feed Industry Federation (IFIF), Constance Cullman leads the global feed sector's engagement on sustainability, food security, animal health, and the industry's Road to 2050 vision. She is also president and CEO of the American Feed Industry Association and president of the Institute for Feed Education and Research, AFIA's public charity. She also serves on the board of the Global Feed LCA Institute, the US Department of Agriculture's Agricultural Policy Advisory Committee, and the Nationwide Insurance Board Council. She holds bachelor's and master's degrees in agricultural economics from The Ohio State University.



Dr Abdullah Verachia

Dr Abdullah Verachia, CEO, The Strategists

Dr Abdullah Verachia is the CEO of The Strategists, where he leads a team supporting organisations in developing competitive strategy and driving innovation. He is also a senior faculty member at GIBS, where he serves as Head of Faculty for Strategy, Sustainability and Digital, and leads the Harvard Business School Senior Executive Programme for Africa. He has facilitated numerous high-level strategy engagements across the public and private sectors, held senior executive and board roles, contributed to the development of competitive strategies for leading global companies, lectured at top business schools, and co-founded several ventures.

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Afma Forum
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PANEL DISCUSSION: Antimicrobial stewardship in South Africa

Panel members: Dr Ziyanda Qwalela (SAVA), Dr Alice Sigobodhla (SAHPRA), Dr Mphane Molefe (DoA), and Anina Hunter (AFMA)

Facilitator: Margaret Churchill (SAAHA)

Antimicrobial resistance occurs when bacteria no longer respond effectively to antimicrobial treatment, making infections more difficult to manage. Preserving the effectiveness of these medicines therefore requires responsible and prudent antimicrobial use, effective disease prevention and cooperation across the livestock value chain.

Effective antimicrobial stewardship begins long before antimicrobial treatment becomes necessary, with disease prevention through sound nutrition, feed safety, biosecurity, animal husbandry and appropriate veterinary oversight.

Safe, high-quality and nutritionally balanced feed supports animal health, intestinal integrity, gut resilience and immune function, helping to improve animal resilience. While nutrition is not a substitute for antimicrobial treatment, it can contribute to reducing disease risk when combined with vaccination, biosecurity, clean water, good animal husbandry and appropriate veterinary care.

How can South Africa strengthen antimicrobial stewardship while continuing to support animal health, animal welfare, sustainable livestock production and food security?

This panel brings together representatives from government, the veterinary profession, regulatory authorities, the animal-health industry and the animal feed sector. They will consider the responsibilities of the different role-players, current regulatory and industry developments, and the practical collaboration required to support responsible antimicrobial use.

By bringing these perspectives together, the discussion aims to strengthen shared understanding and identify opportunities for coordinated action across the animal production value chain. For anyone involved in animal health, livestock production, veterinary services, animal nutrition, feed manufacturing or regulatory affairs, this is an important discussion not to be missed.



FACILITATOR:
Margaret Churchill

Executive director,
South African Animal
Health Association
(SAAHA)



Dr Ziyanda Qwalela

President, South African
Veterinary Association
(SAVA)



Dr Alice Sigobodhla

Manager: veterinary
medicines, South
African Health Products
Regulatory Authority
(SAHPRA)



Dr Mphane Molefe

Director: veterinary
public health,
Department of
Agriculture (DoA)



Anina Hunter

Chairperson, Animal
Feed Manufacturers
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PANEL DISCUSSION: Market volatility and performance – the collective role of industry associations

CEO leadership panel: Izaak Breitenbach (SAPA), Dr Marlene Louw (SAPPO), Dr Frikkie Maré (RPO), Fanie Ferreira (MPO), and Dr Tobias Doyer (Grain SA)
Facilitator: Prof André Jooste (chairperson, NAMC)

South Africa's food security conversation often focusses on access and affordability. But behind both lies an equally important question: Can our agricultural production systems continue to produce enough food sustainably and profitably into the future?

South Africa's grain, feed and livestock sectors are closely interconnected and face many of the same pressures. Rising production costs, changing market conditions, trade pressures, infrastructure constraints, biosecurity and animal health risks, policy uncertainty and investment constraints, and the pace of technology adoption all influence their ability to remain competitive.

Grain producers supply the raw materials that feed manufacturers convert into safe, nutritious animal feed, which in turn supports livestock production. The feed industry sits between crop and livestock production, and the performance of one part of this chain directly affects the others.

At the same time, South African agriculture has demonstrated considerable resilience. With production growth in several sectors expected to exceed growth in domestic demand, expanding export markets and adding more value to locally produced agricultural commodities will become increasingly important. This creates an opportunity to complement primary commodity exports with greater local value addition through feed and livestock production, generating higher-value products for domestic and export markets.

The question is therefore not only how individual sectors respond, but which challenges require a shared response. Are industry associations doing enough together to support their members, unlock growth opportunities and strengthen South Africa's agricultural competitiveness? This high-level panel brings together the chief executives of key producer organisations to examine their shared priorities and where stronger collective action is needed across the grain, feed, and livestock value chain.



FACILITATOR:
Prof André Jooste
Chairperson: National Agricultural Marketing Council (NAMC)



Izaak Breitenbach
CEO Broiler Organisation, South African Poultry Association (SAPA)



Dr Marlene Louw
CEO, South African Pork Producers' Organisation (SAPPO)



Dr Frikkie Maré
CEO, Red Meat Producers' Organisation (RPO)



Fanie Ferreira
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Prof Coen Smits

The role of animal nutrition in reducing reliance on antimicrobials

By Coen HM Smits, professor in Animal Nutrition, Wageningen University & Research, and global sustainability director, Trouw Nutrition

Antimicrobial resistance (AMR) is recognised as one of the most significant global health challenges of our time. The World Health Organization considers AMR a major threat because it reduces the effectiveness of antibiotics that are essential for treating bacterial infections in both humans and animals. Without effective antimicrobials, routine medical procedures, treatment of infectious diseases, and livestock production systems become increasingly vulnerable.

The development of antimicrobial resistance is driven primarily by the use and misuse of antibiotics in human medicine. Human antibiotic consumption is the largest contributor to AMR affecting human health. However, the use of antibiotics in livestock can also contribute to the emergence and spread of resistant bacteria and resistance genes, making it an important risk factor that must be managed carefully. Consequently, reducing unnecessary antimicrobial use in animals is an important part of the global One Health strategy that recognises the interconnectedness of human, animal, and environmental health.

Over the past two decades, major progress has been made in reducing antimicrobial use in food-producing animals. Many countries have banned antimicrobial growth promoters, strengthened veterinary oversight, improved surveillance systems, and implemented responsible-use guidelines. Europe has demonstrated that substantial reductions in antibiotic use can be achieved while maintaining animal productivity, welfare, and farm profitability. Similar initiatives are now emerging in North America, Latin America, Asia, and across Africa.

Africa represents both a challenge and an opportunity. Livestock production is expected to expand significantly in the

coming decades as populations grow and demand for animal-source foods increases. At the same time, access to veterinary services, disease surveillance systems, and farm infrastructure remains variable across the continent. As livestock operations continue to intensify, there is a unique opportunity to build responsible antimicrobial stewardship into future production systems from the outset, avoiding some of the mistakes made elsewhere during earlier phases of intensification.

Prevention before treatment

One of the most important lessons learned from successful antimicrobial reduction programmes worldwide is that there is no single solution. Sustainable reduction of antibiotic use requires a combination of preventive health measures that work together to reduce disease pressure and improve animal resilience. Four pillars emerge as the foundation of successful programmes: biosecurity, vaccination, best farming practices, and nutrition.

Sound biosecurity prevents pathogens from entering and spreading within farms through measures such as hygiene protocols, controlled farm access, sanitation, quarantine procedures, pest control, and manure management. Effective vaccination programmes provide immunity against key diseases before exposure occurs and have become an important tool for reducing disease incidence and the subsequent need for antimicrobial treatment. Good farming and animal health practices further contribute to disease prevention by optimising housing conditions, ventilation, water quality, stocking density, animal welfare, and early disease detection.

Perhaps the most important lesson, however, is that prevention delivers better results than treatment. The most successful livestock systems do not simply focus on treating disease efficiently when it occurs;

they focus on creating conditions that make disease less likely to occur in the first place. This shift from reactive treatment to proactive prevention is becoming the cornerstone of antimicrobial stewardship strategies around the world.

Nutrition as a health strategy

Within this preventive framework, nutrition represents one of the most promising opportunities to further reduce reliance on antimicrobials. It is a key component of sustainable antibiotic reduction programmes, supporting animal health, resilience, and disease prevention. Rather than being viewed solely as a means to optimise production performance, nutrition should be recognised as a proactive tool that helps strengthen natural defences, improve robustness, and reduce disease risk at herd and flock level.

This concept can be described as prophylactic nutrition – using nutritional strategies to help prevent disease before it occurs. Rather than responding to health problems after animals become ill, prophylactic nutrition focusses on strengthening the biological mechanisms that enable animals to remain healthy under commercial production conditions. Healthier animals ultimately require fewer antimicrobial interventions.

Several nutritional interventions can contribute to this preventive framework, offering multiple opportunities to strengthen disease resistance and resilience while reducing the need for antimicrobial interventions. An important first step is the inclusion of bulking dietary fibres and coarse feed particles, which stimulate gut motility, enhance peristalsis, and promote digestive secretions, thereby supporting gastrointestinal function and health. In broiler chicken production, including exogenous non-starch polysaccharide-degrading enzymes is a common strategy to alleviate the dysbiosis risk induced by viscous soluble fibres.

A second approach involves using acidifiers and other feed additives with antimicrobial properties, such as medium-chain fatty acids. These compounds have been shown to modulate and balance the intestinal microbiota, creating conditions that may enhance the animal's resistance and resilience to enteric pathogen challenges. Nutritional strategies can also target substrate availability for undesirable microbial growth. In swine and poultry, reducing excess dietary protein can contribute to a more favourable hindgut environment for beneficial microorganisms, decreasing the risk of dysbiosis and associated health challenges.

Furthermore, ingredients with anti-inflammatory properties, including butyrates and specific phytogenic compounds, may help modulate immune responses and reduce the risk of excessive or counterproductive inflammation. Together, these and other dietary interventions can support gut health, strengthen natural defence mechanisms, and contribute to a more robust and resilient animal capable of coping with disease challenges.

Importantly, nutritional interventions are not intended to replace antibiotics when treatment is necessary. Therapeutic antibiotics remain indispensable tools for protecting animal welfare. Nutrition offers a preventive approach that reduces the frequency of treatment, thereby supporting responsible antimicrobial stewardship.

Looking ahead

The future of antimicrobial reduction will be shaped by integrated, data-driven, and preventive approaches. Governments, food companies, retailers, investors, and consumers are demanding greater transparency regarding antimicrobial use throughout food production systems. As a result, livestock producers and the feed industry can expect stronger antimicrobial stewardship requirements, enhanced monitoring and benchmarking systems, increased veterinary oversight, and greater emphasis on animal welfare and preventive health management.

The considerable progress already made in reducing antimicrobial use in livestock demonstrates that

improvements in animal health, welfare, productivity, and sustainability can go hand in hand. Nevertheless, the battle against antimicrobial resistance is far from over. While antibiotic use in humans remains the primary driver of AMR affecting human health, the livestock sector has a clear responsibility to minimise its contribution to this global challenge. Through continued investment in biosecurity, vaccination, best management practices, and prophylactic nutrition in particular, the livestock industry can further reduce reliance on antimicrobials while safeguarding animal welfare and food security.

Significant ground has been gained, but maintaining the effectiveness of antimicrobials for future generations requires continued commitment, innovation, and collaboration across the entire animal production value chain. ♦

For more information and references, send an email to coen.smits@trouwnutrition.com

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The use of plant saponins in chickens: Effects on intestinal health and efficiency

By Ken Bafundo, adjunct professor, Poultry Diagnostic & Research Center, University of Georgia

Saponins are a broad group of plant-derived compounds that display surfactant (detergent) properties because their chemical structures contain both water-soluble and fat-soluble components. These properties allow them to form soaps in aqueous solutions, and this simple fact has led to a wide variety of commercial applications, ranging from use in foaming soft drinks to the preparation of cosmetics and shampoos.

In addition, study of their pharmacologic properties has shown them to be constituents of many plant drugs, and they are thought to provide the active moieties associated with many folk medicines. In recent years, saponins have also been applied to animal production because they are known to reduce environmental ammonia, diminish inflammation, promote intestinal health and, as a result, improve growth and feed conversion. Largely influenced by the reduction of antibiotic usage in animal production, saponin usage is common in many countries and is now viewed as a practical means of improving intestinal health.



Although saponins are found throughout the plant kingdom, only a few have been shown to produce meaningful effects in animal production systems. According to Cheeke (2000), saponins sourced from *Yucca schidigera* (the desert Yucca plant of the American Southwest) and *Quillaja saponaria* (the Chilean soapbark tree) are among those with the greatest potential for influencing animal production performance. While reports associated

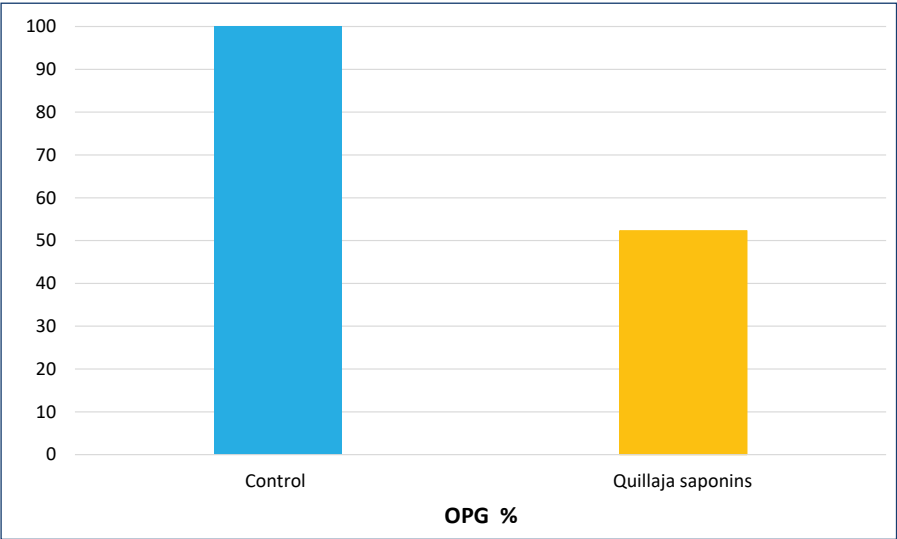
with other saponins often appear in scientific literature, the majority of global use in animal agriculture is associated with *Yucca* and *Quillaja*. At present, these saponins are used both alone and in combination and are also used as active components of other products that influence animal performance.

Global adoption of saponins

While it is difficult to provide exact usage figures from different countries around the world, it is likely that the United States and China are the largest users of saponin-based products. Where China is concerned, estimates indicate that a substantial proportion is used in aquaculture, but as one of the world's largest poultry producers, saponin-based products are also widely used in broiler and layer production, reaching as much as 20%.

In the United States (US), the introduction of no antibiotics ever (NAE) production in 2014 has led to saponins being used in approximately 25% of the broilers reared each year. With annual US broiler production in the range of ten billion birds, an estimated 2,5 billion broilers consume saponins yearly. Even with reductions in NAE production in recent years, saponin usage has remained relatively consistent as new product forms

Figure 1: Results of 17 pooled trials demonstrating the effects of Quillaja saponins on oocysts per gram of faeces.



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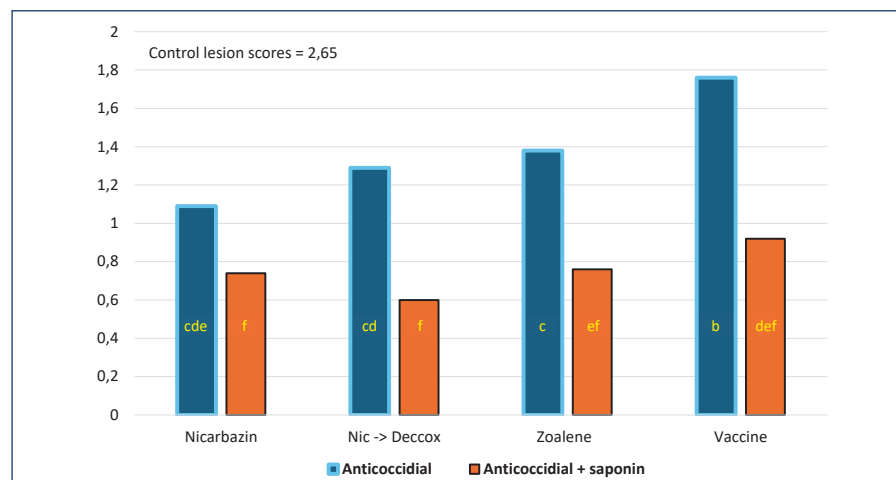
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Figure 2: A 21-day evaluation of *Eimeria maxima* lesion scores as affected by chemical anticoccidials and a coccidiosis vaccine. (Data from Bafundo *et al.*, 2022)



In each case, saponins significantly improved lesion scores compared to the anticoccidial alone.

and price competitiveness have come into play.

Use has also expanded into no antibiotics important to human medicine (NAIHM) production, where ionophores continue to be used. Recent data indicates that saponin use in this niche improves coccidiosis control and intestinal health.

Saponin use is well established in both Asian and South American broiler-producing countries; however, usage is largely dependent on cessation of antibiotic application in these regions. Since antibiotics are often used in many locations, uptake and use of saponins has been slower.

Drivers of saponin use

Early studies with saponins showed activity against *Eimeria* spp., and given the ever-present concerns about the effects of coccidial parasites on growth and feed conversion, initial saponin use focussed on improvements in coccidiosis control. After more than 15 years of commercial use, many broiler producers now recognise that saponins not only enhance anticoccidial

effects but also improve the responses of other anticoccidial agents.

Data in Figure 1 illustrate the overall effect of Quillaja saponins in reducing oocyst production following a challenge, showing a reduction of around 50% compared to the non-medicated control. While efficacy is apparent, this response is well below the levels the industry requires for a standard anticoccidial. As a result, using saponins in combination with other anticoccidials (ionophores, chemicals, and coccidiosis vaccines) has been shown to improve efficacy and promote better performance.

Data shown in Figure 2 illustrate the reduction in *Eimeria maxima* lesion scores when saponins are combined with different chemical anticoccidials and a coccidiosis vaccine. Performance measured during these trials followed a similar trend (Bafundo *et al.*, 2022).

Benefits for intestinal health

Recent research also illustrates the effects of saponin use on the microbial flora of the intestine, and results now show

that significant changes in bacterial populations occur as a result of saponin administration. Dai *et al.* (2023) reported that saponins significantly reduced the numbers of harmful bacteria commonly associated with intestinal disease and poor production performance. This study confirms other observations of reductions in bacterial numbers and reduced incidence of bacterial complications during Quillaja usage (Bafundo *et al.*, 2021; Fink and Filip, 2022; Blue *et al.*, 2023).

Studies have also shown that increases in villus height and reductions in crypt depth are often used to assess intestinal health, and when coupled with trial results demonstrating improved barrier function of the intestinal mucosa, reliable assessments of intestinal integrity can be made. Multiple studies using these procedures have shown that saponin feeding positively affects villus height: crypt depth ratios and promotes the formation of the chemical linkages involved in maintaining intestinal desmosomes. As a result, intestinal integrity is improved by saponin feeding.

Improved nutrient utilisation

Because nutrient absorption is the ultimate measurement of intestinal health, improvements in nutrient digestibility serve as the best indicators of a saponin's influence on the gut. In this regard, results show that saponin feeding promotes digestibility of dry matter, energy, and nitrogen. The data in Table 1 illustrate these effects clearly by showing that digestibility of these nutrients improved regardless of the time saponins were administered. Notably, significant improvements in the digestibility of dry matter, energy, and nitrogen were observed after as little as seven days of saponin exposure (days 35-42).

Results such as these help to explain the performance improvements that are routinely generated when production chickens consume saponins. Both research findings and field results often show similar trends that now have been shown to occur in broilers, layer breeders, and commercial egg layers. ♦

Table 1: Effects of Quillaja saponins (250mg/kg) on nutrient digestibility when administered in feed to broiler chickens for different time periods. (Data from Stefanello *et al.*, 2022)

	Duration of saponin feeding			
	0	Days 1-42	Days 28-42	Days 35-42
Dry matter %	68,9 ^b	72,3 ^a	73,7 ^a	71,4 ^a
IDE ¹ kcal/kg	3 370 ^b	3 493 ^a	3 533 ^a	3 438 ^a
Nitrogen %	85,8 ^b	87 ^{ab}	87,9 ^a	88 ^a

¹ Ileal digestible energy.

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Innovation with Integrity

Opportunities for targeted feed additives to improve metabolic efficiency, performance, and environmental sustainability in dairy cows

By Dr Sion Richards, ruminant technical service manager EMEA, Balchem

A technical review for dairy nutritionists, consultants, and feed industry professionals on how targeted feed additives can support transition metabolism, amino acid supply, nitrogen efficiency, and lifetime productivity in modern dairy systems.

Dairy nutrition is moving from a formulation philosophy based on nutrient supply towards one centred on biological efficiency. The objective is not simply to feed more energy, crude protein or additives, but to improve the conversion of absorbed nutrients into milk, milk solids, reproductive performance and cow longevity. This shift is driven by feed economics, environmental pressure and dairy genetics. High-yielding cows place exceptional demands on hepatic metabolism, rumen function, immune competence and mammary nutrient partitioning, so small imbalances in nutrient supply, rumen synchrony or metabolic adaptation can disproportionately affect performance and resilience.

Targeted feed additives are vital tools that can enhance and accentuate precision nutrition programmes to optimise the health and performance of high producing dairy cows. Examples of targeted feed additives include rumen-protected choline, rumen-protected amino acids, biotin, yeast products, buffers and other functional additives. Deriving their full value and maximising return on investment is dependent upon understanding how to efficiently and effectively utilise them in modern ration balancing programmes and dairy management systems.

Transition period efficiency

The transition period is one of the most important windows for improving whole-lactation performance. During the final weeks before calving, dry matter intake declines while nutrient demand from the gravid uterus, mammary gland and

immune system increases. Immediately after calving, energy requirements rise rapidly, but intake typically lags output, leading to a negative nutrient balance.

The cow's natural biological response is to mobilise adipose tissue to supply energy in the form of non-esterified fatty acids to the liver. This process occurs in every cow regardless of body condition score, health, or previous lactational performance. The cow's capacity to oxidise, export or manage this lipid load influences ketosis risk, immune function, milk yield trajectory, reproductive recovery and herd retention. As a result, it is essential to ensure that the liver is healthy and functioning optimally so this normal biological process can proceed smoothly and allow the cow to transition into her next lactation as a healthy and high producing animal.

While this process does not always proceed as efficiently or effectively as expected, there are nutritional feed additives, such as rumen-protected choline and rumen-protected amino acids, which can be utilised to ensure a healthy transition is achieved.

Another important aspect of the transition period that needs to be considered is sustainability. From this perspective, transition success is critical to ensuring sustainability goals are achieved as premature culling, disease treatment, extended days open, sub-optimal milk and milk component production negatively impact sustainability initiatives through decreased feed efficiency, land, labour, and replacement heifer rearing investments. Cows that complete more productive lactations spread their rearing footprint

over more kilograms of milk and milk components, benefiting both profitability and environmental performance.

Liver function and choline

The liver is central to transition cow efficiency. It coordinates gluconeogenesis, fatty acid oxidation, ketone body production, urea synthesis and triglyceride export as very-low-density lipoprotein. A healthy liver results from efficient export and transport of fatty acids to target tissues, driving increased milk production, health, and gluconeogenesis with lasting results throughout the cow's entire lactation.

Choline is a required nutrient and is essential to a healthy and optimally functioning liver. It serves a myriad of roles in the metabolism of dairy cows, including its use in phosphatidylcholine synthesis, methyl-group metabolism and lipoprotein assembly (VLDL). In ruminants, unprotected choline is extensively degraded in the rumen, limiting intestinal delivery and metabolic availability. Rumen-protected choline increases choline supply to the small intestine; research in transition cows has demonstrated that supplementation increases milk and energy-corrected milk, colostrum production, as well as selected immune and metabolic indicators.

In a recent meta-analysis published by Arshad *et al.* (2020), the researchers reported an energy-corrected milk yield response of approximately 2,2kg/day throughout the entire lactation as well as a tendency for reducing metabolic disorders from 12,9g/day of choline ion supplied for three weeks prepartum and three weeks postpartum.

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Over 25 years of published peer-reviewed research data demonstrates that supplementing rumen-protected choline during the transition period improves liver and metabolic health by increasing the synthesis and export of VLDL to target tissues, which leads to increased milk production and improved health and productivity of the animal.

Protein efficiency

Protein is one of the largest opportunities for improving ration efficiency. Crude protein has often been used as a safety margin against forage variability, uncertain microbial protein yield or imprecise ingredient evaluation. Although this approach can be beneficial, it is metabolically and environmentally inefficient. Excess nitrogen must be eliminated from the body, which costs energy and contributes to urinary and faecal nitrogen losses. Overfeeding crude protein can increase feed costs while adding pressure to manure management and ammonia emissions.

Amino acid balancing offers a more precise alternative. The goal is to formulate for metabolisable protein and individual essential amino acid supply rather than relying on crude protein alone. Methionine and lysine are central in many dairy diets, while histidine is often third limiting particularly in low-protein diets. The challenge is to maintain microbial protein synthesis with adequate rumen-degradable protein and fermentable carbohydrate while using rumen-protected amino acids to correct post-ruminal limitations. The CNCPS approach links amino acid supply with energy availability using a target of 1,14g of metabolisable methionine per Mcal of metabolisable energy and 3g of metabolisable lysine per Mcal of metabolisable energy.

The rationale is a straightforward concept as nitrogen retained in milk protein is a productive output, while nitrogen excreted in urine and faeces is inefficient and a lost financial gain. Precision protein strategies aim to match metabolisable amino acid supply more closely to requirements. However, this approach is not simply a matter of removing protein sources and adding a protected amino acid.

It requires accurate forage analysis, realistic estimates of rumen microbial protein synthesis, attention to rumen nitrogen adequacy, and monitoring of milk urea, milk protein yield, dry matter intake and manure consistency.

Circular feed use

Circular feed manufacturing is gaining attention as dairy systems seek to reduce reliance on human-edible feeds and high-footprint ingredients. Co-products (e.g., brewers' grains, beet pulp, distillers' feeds, etc.) can contribute valuable nutrients when correctly characterised. Variability in nutrient content can erode the benefits of use if not managed through routine analysis and formulation discipline.

Ration models, forage testing, and feed additive strategy must therefore work together. Replacing cereals with fibrous by-products changes rumen fermentation, physically effective fibre, starch supply and microbial protein synthesis. Reducing dietary protein at the same time increases the importance of metabolisable amino acid prediction. Targeted additives can support these systems, but they should fine-tune a ration that is already biologically coherent. The key is to identify the constraint before selecting the intervention.

An efficiency endpoint

Sustainability discussions often focus on emissions, manure, land use, and feed sourcing, yet much of dairy efficiency is determined within the cow. The mammary gland transforms nutrients into milk components, with glucose, amino acids, and fatty acids driving production. When metabolic or health challenges impair nutrient utilisation, the same ration generates less saleable milk, reducing efficiency and sustainability.

A robust additive programme should establish expected biological responses before implementation, including energy-corrected milk, component yield, nitrogen efficiency, health, fertility, culling risk, and lifetime production, not just milk yield.

Measurement and decision criteria

Effective additive decisions should be guided by data, with performance evaluated through production, health,

fertility, longevity, and feeding metrics. Precision technologies can help identify key constraints, whether related to intake, rumen stability, metabolic health, cow comfort, or nutrient balance.

Producers are more likely to embrace sustainability when it delivers practical benefits, including healthier cows, improved milk production, enhanced fertility, and lower replacement costs. The consultant's role is to connect environmental objectives with cow-level outcomes by improving protein efficiency, lifetime productivity, and utilisation of circular feed resources.

Framework for feed additive use

A practical framework starts with five questions:

- What biological function is being targeted?
- Is the basal ration balanced properly to demonstrate additive efficacy?
- Is the product delivering the active nutrient to the correct site within the digestive tract?
- What response is realistic in the herd and ration context?
- How will success be measured?

This framework sets the stage for effectively measuring the benefits of feed additives, as even modest improvements in production, health, and reproductive performance can yield profitable rewards.

Conclusion: Precision, not addition

The future of dairy nutrition will be defined by feeding closer to the cow's biological requirement, reducing avoidable nutrient losses and supporting the cow through key physiological pressure points. Targeted feed additives have a vital role in that future, particularly where they improve metabolic efficiency, amino acid supply, nitrogen capture, rumen function or lifetime productivity. Their value lies not in replacing good nutrition, but in increasing its precision.

For dairy consultants, nutritionists and feed manufacturers, this creates a clear opportunity: By linking mechanistic nutrition with practical ration formulation and measurable farm outcomes, the industry can move beyond input-based feeding and towards biological efficiency. ❖

For more information, send an email to Sion.Richards@external.balchem.com

Feeding long-producing hens using NIR technology to measure body composition

By Dr Lieske van Eck, senior poultry researcher, Cargill

In a rapidly evolving environment, informed feeding and management decisions are essential. Measuring the body composition of laying hens enables more precise nutritional programmes, helping to optimise long-term egg production.

The egg production industry continues to grow, due to an increasing demand for this healthy, nutritious and relatively cheap source of protein. Over the past 80 years, the egg production potential of a hen in her first laying cycle has increased to 500 eggs at 100 weeks of age. This figure is expected to increase by eight eggs every three years through genetic selection. The increase in laying persistency means a shift in the nutritional requirements for hens at different life stages.

Understanding egg production

It is important to understand the biology of egg production to improve the nutritional requirements of hens. Part of the nutrients required for egg formation originate directly from the feed, some are produced by the liver (such as lipoproteins), and the remainder is withdrawn from body reserves (such as fat or medullary bone). Body fat reserves not only supply the nutrients for egg production but also produce adipokines (fat hormones) that influence bird bodyweight, appetite, and fertility.

Bodyweight and body fat levels in laying hens are poorly correlated: the body fat levels of laying hens with a specific body weight can vary (Figure 1). Moreover, a negative correlation between body fat and (long-term) egg production was found. So, to maintain long-term egg production and formulate diets that supply the right nutrients, body composition should be considered to prevent too high or too low body fat levels.

More precise feeding strategies

Recent advances in near-infrared (NIR) spectroscopy have made it possible to measure the body composition of

laying hens, enabling researchers to assess the effects of dietary nutrient changes.

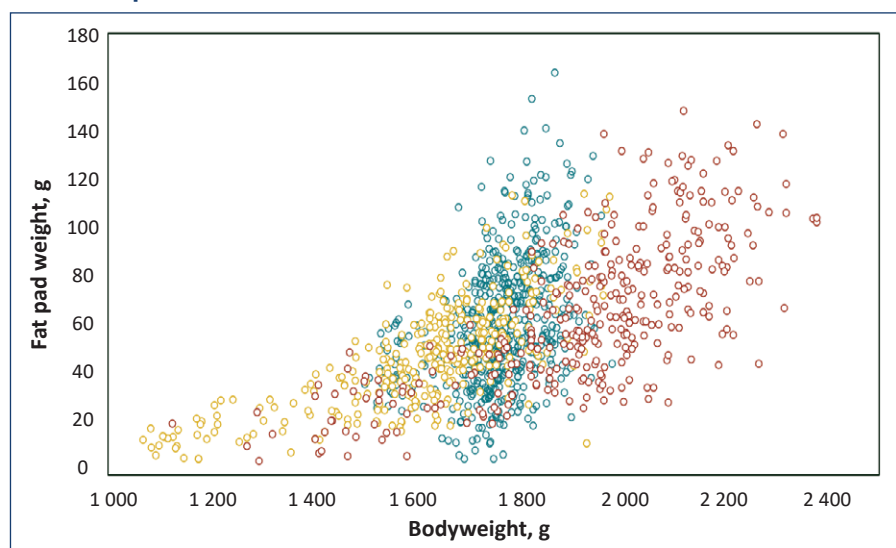
It also supports the formulation of diets with more precise nutrition. This novel technique was used to evaluate the effects of dietary energy and amino acids (AA) on early egg production and fat deposition.

In a recent study, a total of 540 Dekalb White hens were allocated to 60 pens (nine hens/pen) and fed five diets at the Cargill Animal Nutrition Innovation Centre in Elk River, United States. Diets included three metabolisable energy (ME) levels (low, medium, and high) and three AA levels (low, medium, and high). Other nutrients were standardised, and AA:Lys ratios followed breed guidelines. Eggs were collected daily; egg weights and average feed intake (ADFI) were recorded weekly.



Scanning the abdominal fat pad of a laying hen using a novel NIR tool. The NIR tool is connected to a mobile phone to retrieve results directly.

Figure 1: Bodyweight (g) versus fat pad weight (g) of hens sampled in different studies. (Copied from Van Eck, 2026)



Each dot represents one hen. Yellow and blue dots are white hens, and red dots are brown hens of various flocks.

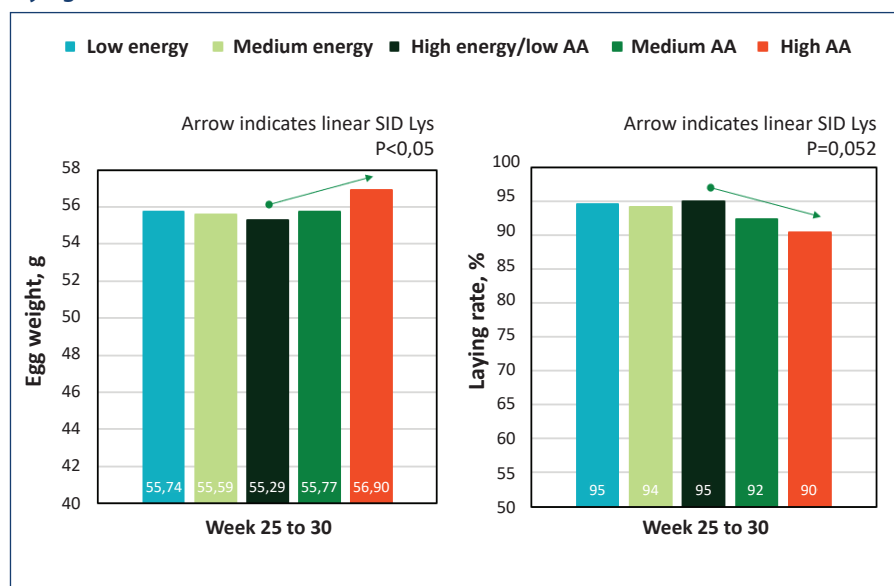
At weeks 17, 21, 25, and 30, bodyweight and fat pad weights were measured using a hand-held NIR tool.

Increasing dietary AA did not impact egg mass ($P>0,05$), but linearly reduced laying rate from weeks 25 to 30 ($P=0,052$; -4,5%; *Figure 2*) while increasing egg weights across all periods ($P<0,05$; +1,8g; *Figure 2*). Dietary ME level did not impact laying rate or egg weights. ADFI decreased linearly with higher ME diets in all periods ($P<0,05$; -3,7g), improving feed conversion ratio ($P<0,05$; +0,07). Bodyweight and gain were unaffected by diet density ($P>0,05$). Hens fed high ME diets had increased abdominal fat pad weights at weeks 21 and 30 ($P<0,05$). This might indicate energy oversupply but could also be functional for energy storage.

In conclusion

Dietary AA affected egg weight and laying rate, while dietary ME influenced feed intake, feed efficiency, and body composition. NIR is a useful tool to assess diet impact and guide feeding strategies to support hen productivity. ❖

Figure 2: Impact of dietary energy (low, medium, and high) and amino acids (low AA, medium AA, high AA) on egg weight and laying rate from weeks 25 to 30 of age in laying hens.



Send an email to Dr Lieske van Eck at Lieske_van_eck@cargill.com for more information.

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Beyond calcium: The emerging role of vitamin D in dairy cow resilience and productivity

By Ignacio Artavia, marketing and business development manager,
South Europe & Africa, dsm-firmenich Animal Nutrition & Health

Modern dairy cows are producing more milk than ever before. While advances in genetics, nutrition and management have driven remarkable gains in productivity, they have also increased the physiological demands placed on dairy cows.

Despite significant progress in dairy management, reproductive disorders, mastitis, metabolic diseases and transition-related health challenges remain among the leading reasons for premature culling. Replacement rates above 30% are still common in many dairy systems, reducing profitability and limiting the number of cows that reach their full productive potential. Multiparous cows can produce approximately 20% more milk than first-lactation animals, making longevity and lifetime performance important drivers of dairy farm profitability.

As producers continue looking for ways to improve resilience, health and productive efficiency, vitamin D is attracting growing interest. Traditionally associated with calcium and phosphorus metabolism, vitamin D is now recognised as a key regulator of immune function and transition success.

The modern dairy cow challenge

The dairy industry has developed highly effective nutritional strategies to help cows cope with the sudden increase in calcium demand around calving. Low-calcium dry cow diets, negative DCAD programmes, anionic salts, and calcium supplementation have substantially improved the industry's ability to stimulate calcium mobilisation during periods of high demand. However, modern dairy cows face a challenge that continues to evolve.

At the onset of lactation, milk production can remove between 20 and 80g of calcium per day, while the readily available calcium

pool circulating in blood remains relatively small (Van't Klooster, 1976; McGrath *et al.*, 2015). Historically, cows were estimated to experience a calcium deficit of approximately 10g/day during early lactation (Kronfeld, 1976). As milk production has increased substantially over the last decades, so has the amount of calcium and phosphorus exported through milk.

An interesting perspective emerging from recent research is that while considerable attention has been directed towards improving calcium mobilisation around calving, comparatively fewer solutions have been available to help cows replenish and maintain calcium reserves throughout their productive life. Modelling data suggest that highly productive cows may enter successive lactations with progressively lower calcium reserves, potentially increasing vulnerability as parity increases (McGrath *et al.*, 2015).

This has prompted renewed interest in nutritional strategies capable of improving calcium and phosphorus absorption and retention throughout lactation rather than solely during the transition period.

Vitamin D: Not just for bone health

Vitamin D has traditionally been viewed through the lens of calcium and phosphorus metabolism. Its active metabolite, 1,25-dihydroxyvitamin D₃, regulates intestinal calcium and phosphorus absorption, supports calcium conservation by the kidneys and coordinates calcium mobilisation from bone when blood calcium declines (Nelson *et al.*, 2020).

Today, however, vitamin D is recognised as an important regulator of immune function. Research has shown that immune cells, including macrophages, neutrophils, dendritic cells, and lymphocytes, contain vitamin D receptors and actively utilise vitamin D metabolites during immune responses (Nelson *et al.*, 2010; Poindexter *et al.*). Vitamin D influences pathogen recognition, antimicrobial peptide production, oxidative burst activity, and inflammatory regulation. For dairy producers, this is particularly relevant because the transition period represents one of the highest disease-risk periods of a cow's productive life.

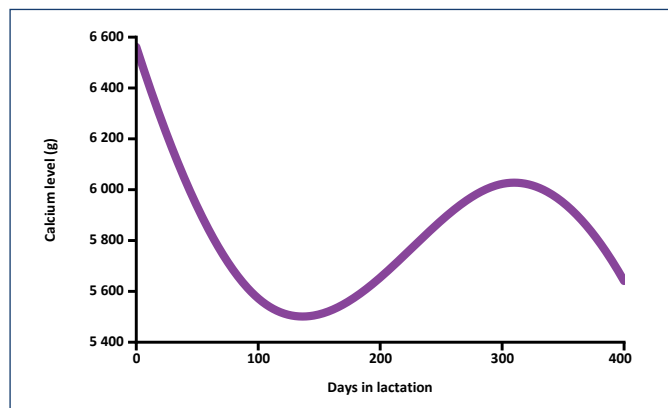
This dual role places vitamin D at the intersection of two of the most important challenges facing modern dairy cows: mineral balance and immune resilience.

Reaching optimal vitamin D status

If vitamin D status influences both mineral metabolism and immunity, the next logical question is how to achieve optimal vitamin D status consistently. And if vitamin D is supposed to be synthesised from sunlight, why would even cows exposed to the sun be able to benefit from higher blood vitamin D levels?

The marker of vitamin D status is blood concentration of 25-hydroxyvitamin D₃ (25-OH-D₃), also known as calcidiol,

Figure 1: Calcium levels in a high-performing dairy cow over time. (Source: J McGrath, D Savage, J Nolan, and R Elliott, 2012a)



Ca reserves may not be replenished prior to the next lactation, increasing the risk of hypocalcaemia in older animals.



the major circulating form of vitamin D (Nelson and Merriman, 2014). Traditionally, vitamin D nutrition has relied on sunlight and dietary supplementation with vitamin D₃. However, vitamin D₃ must first be converted by the liver into calcidiol before it can effectively circulate throughout the body. This conversion step in the liver is viewed as a biological bottleneck, independent of its health status.

Recent field assessments in 21 dairy herds across seven European countries demonstrated that almost none of the cows achieved blood concentrations above 100ng/mL despite routine vitamin D supplementation programmes. Furthermore, the relationship between dietary vitamin D₃ supplementation and blood 25-OH-D₃ concentrations was relatively weak, suggesting considerable variability in conversion efficiency between animals.

Direct supplementation with calcidiol bypasses this conversion step, providing the exact metabolite measured in blood and allowing more efficient increases in circulating vitamin D status. Research by Poindexter *et al.* (2020) demonstrated substantially greater blood 25-OH-D₃ concentrations following calcidiol supplementation at the same dosage (IU) compared with vitamin D₃ supplementation, while tripling the vitamin D₃ dosage did not yield any significant difference in calcidiol concentration in blood.

Translating Biology into Farm-Level Outcomes

The physiological effects associated with higher vitamin D status are reflected in measurable farm outcomes. Studies have reported improvements in calcium and phosphorus metabolism,

Figure 2: How vitamin D plays a key role in Ca/P metabolism (green boxes) and immunity (purple boxes).

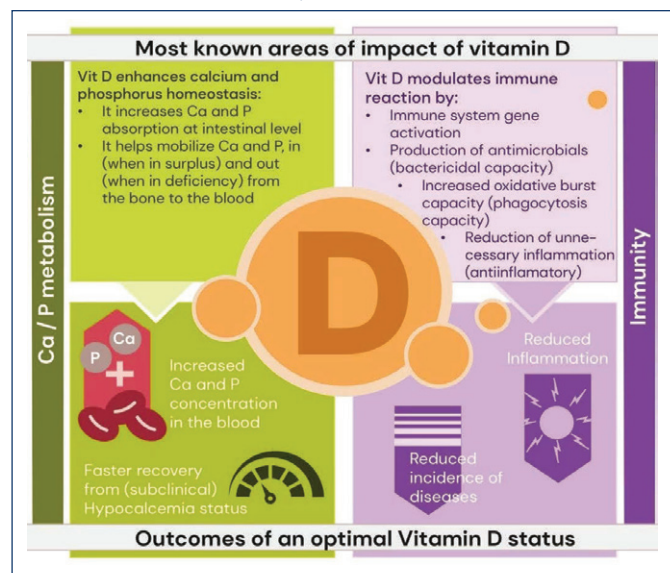


Table 1: Effect of dietary cation-anion difference (DCAD) and vitamin D source in pre- and post-partum diets. (Source: Martinez *et al.*, 2018a)

Clinical diseases	(+) DCAD		(-) DCAD		P-value	
	D3	Hy-D®	D3	Hy-D®	DCAD	Vit. D source
Colostrum yield, kg	5,86	↗ 7,68	6,21	↗ 7,96	0,61	↗ <0,01
Fat yield, kg	0,25	0,43	0,30	0,39	0,93	0,12
True protein yield, kg	0,66	↗ 1,20	0,88	↗ 1,17	0,57	↗ 0,02
Lactose yield, kg	0,18	0,19	0,17	0,19	0,87	0,50
IgG, g/ℓ	45,3	↗ 57,7	50,6	↗ 60,1	0,31	↗ 0,005

including higher circulating mineral concentrations and improved mineral retention (Xu *et al.*, 2021, Lashkari *et al.*, 2026). This may help cows better cope with the considerable mineral demands associated with calving and early lactation.

Evidence also suggests benefits for immune resilience. Martinez *et al.* (2018) reported lower incidences of retained placenta, metritis and multiple disease events in transition cows receiving calcidiol supplementation. Other studies have demonstrated improved neutrophil function and enhanced immune responsiveness around calving (Vieira-Neto *et al.*, 2021).

Benefits appear to extend beyond transition. Research evaluating mammary health reported lower somatic cell counts and reduced severity of mastitis challenges in cows achieving higher vitamin D status (Ribeiro *et al.*, 2019; Xu *et al.*, 2021). Improved vitamin D status may also benefit the next generation. Studies have demonstrated increases in colostrum yield, immunoglobulin concentration, and vitamin D transfer from dam to calf (Martinez *et al.*, 2018; Nelson *et al.*, 2016).

Productivity is the result of better resilience

Ultimately, dairy profitability is influenced by far more than peak milk yield. Across multiple studies, increased circulating 25-OH-D₃ concentrations have been associated with improvements in milk or energy-corrected milk production, with responses ranging from approximately 1 to 4kg/day depending on lactation stage and production system (Martinez *et al.*, 2018; Silva *et al.*, 2022; Rodney *et al.*, 2016; Ribeiro *et al.*, 2019; Xu *et al.*, 2021; Holub, 2023). However, the greatest value may ultimately lie in improved resilience. Healthier cows are more likely to maintain productive performance, experience fewer disease disruptions, and remain in the herd longer.

As dairy production continues to evolve, the conversation around vitamin D is also changing. The focus is no longer solely on preventing deficiency, but on supporting optimal mineral metabolism, stronger immune responses, and greater lifetime performance. For producers seeking healthier, longer-lasting and more productive cows, optimising vitamin D status may represent an important component of modern dairy nutrition. ❖

Send an email to Ignacio Artavia at ignacio.artavia@dsm-firmenich.com for more information.



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Updated mineral requirements of chickens

By Michael E Persia, Iowa State University and Director of the Egg Industry Centre and Iowa Egg Council

While dietary minerals are essential nutrients required in relatively small amounts in chicken diets, they nevertheless play a critical role in maintaining poultry production, health, and welfare.

Dietary minerals are classified into two categories: macro-minerals and trace minerals. Macro-minerals are generally needed at no more than 1% of the diet, with the exception of calcium (Ca) in laying hens. These minerals are essential for bone structure and health, blood buffering capacity, energy metabolism, muscle contraction, and ionic balance.

Trace minerals, while still essential, are required in smaller amounts (mg/kg of diet). They support numerous physiological functions, including energy metabolism, immune and antioxidant activity, structural integrity, enzyme function, and other critical metabolic processes.

Calcium and phosphorus

Calcium and phosphorus are typically discussed together because they form the mineral component of bone, known as hydroxyapatite, and their digestibility is also linked. Ionic calcium can interact with the negatively charged phosphate groups on the outside of the phytate molecule under the acidic conditions found in the proventriculus, ventriculus, and first part of the duodenum (Selle *et al.*, 2009). As intestinal pH increases, the ionic interaction between calcium and phytate phosphorus becomes insoluble and reduces the digestibility of both minerals.

Calcium is essential for muscle contraction, nerve transmission, blood coagulation, and skeletal structure. Compared with the United States National Research Council's (NRC) 1994 recommendations, calcium requirements for broiler chickens have generally

been reduced. Establishing calcium requirements for laying hens, however, is more complex because recommendations have shifted from dietary concentrations to daily intake, reflecting the importance of feed consumption in determining nutrient requirements.

Calcium requirements in laying hens are generally lowered during the early stages of egg production but remain unchanged or are increased later in the laying cycle. These reductions are supported by the literature reviewed and acknowledge that excessive dietary calcium can negatively affect nutrient digestion (David *et al.*, 2023).

Digestibility issues

Phytate, phytase, the solubility of mined calcium, and previously documented calcium-related digestibility issues all support the use of digestible calcium in poultry dietary formulations. Using digestible calcium can help address the phytase formulation issue, as it contains little or no total calcium, but should be given calcium credits with subsequent removal of dietary calcium from the formulation. Switching to digestible calcium will foster further understanding of calcium utilisation and the intestinal lumen.

Although digestible calcium corrects inconsistencies in phytase formulation, it does not completely address the effect of vitamin D and its metabolites on calcium and phosphorus utilisation. The active form of vitamin D, 1,25 dihydroxycholecalciferol, is responsible for increased calcium and phosphorus digestibility, which is

covered directly by digestible calcium. It also increases calcium and phosphorus retention in the kidneys, and facilitates calcium and phosphorus modulation from long bones that is not directly accounted for using digestible calcium (Garcia *et al.*, 2013). Because of bone mineralisation, calcium is stored primarily in the skeletal system and is a first indicator of deficiency. Therefore, bone ash, bone breaking strength or other bone mineralisation measurements (DXA) are the primary methods to evaluate dietary calcium requirements.

Phosphorus is critical for energy metabolism, acid-base balance, lipid metabolism, and cellular signalling in addition to skeletal structure. In broilers, non-phytate phosphorus (nPP) requirements remained unchanged, especially during early production, and were reduced later in the production cycle. The slower growth of laying hen pullets resulted in a reduction in nPP requirements, or no change where data were not available for older pullets. In adult laying hens, nPP requirements were slightly higher, but still well below primary breeder recommendations.

Digestible phosphorus is a more desirable method to determine phosphorus requirements, but recent publications suggest that the phosphorus digestibility assay must be further refined (Rodehutsord *et al.*, 2017). Despite the failed ring test, the recommendation is to still switch to a digestible phosphorus requirement going forward, as it will allow for more direct phosphorus

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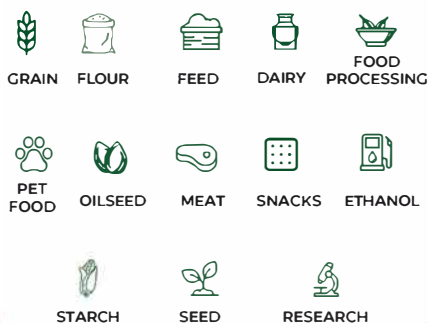


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incorporation in the phytase value during dietary formulation.

As with calcium, phosphorus deficiency first becomes visible during decreased skeletal mineralisation. Bone ash and bone-breaking strength measurements, or other less invasive imaging, should still be used to validate dietary phosphorus requirements.

Sodium, chlorine, and potassium

While several experiments have used sodium, potassium, and chlorine supplementation methods or ratios thereof to address heat stress, recent literature suggests little to no research into their actual requirements and, hence, no proposed requirement updates. Current literature appears to indicate that total dietary concentrations of these minerals are sufficient for general feeding and meeting requirements.

Requirements are based on dietary concentrations that support feed intake to maximise growth and minimise deficiencies. Notably, sodium, chlorine, and potassium are critical for ensuring ionic balance in the diet; excesses and imbalances are linked to increased water consumption that can lead to wet litter and poor environmental conditions (Collett, 2012).

Trace minerals

Copper is an important cofactor for enzymes that support energy metabolism, stabilisation of extracellular proteins, antioxidant defence, iron metabolism, and pigmentation. The laying hen requirement for Cu was increased for broiler chickens. In addition to its inclusion at physiological concentrations in the diet, copper is used at pharmacological concentrations as an antimicrobial with growth-promoting properties and to treat crop mycosis.

As copper will bioaccumulate in the liver, these concentrations have been used to determine copper bioavailability of various compounds. Dietary copper requirements are typically set using copper supplemented in sulphate form. Using other forms, either inorganic or organic, can result in variable copper bioavailability and alter the amount of supplemental copper needed

to satisfy the requirement, if different from copper sulphate. As with other minerals, copper can interact with other dietary ingredients, including phytic acid, resulting in reduced copper bioavailability. Higher concentrations of copper can reduce selenium utilisation (Banks *et al.*, 2004).

Iodine and iron

Iodine is an integral part of triiodothyronine (T_3) and thyroxine (T_4). Little research has been done to further understand the dietary requirement of iodine since the last NRC publication in 1994, and no updates were reported.

“With the low tolerance of excess selenium in mind, the bioavailability differences among various selenium sources, both inorganic and organic, need to be accounted for when formulating poultry diets.”

Iron is a critical component of oxygen transport and storage proteins, including haemoglobin, myoglobin, and cytochromes. Free iron causes tissue damage via reactive oxygen molecules, resulting in lower extracellular free iron concentrations than other minerals. This also limits iron availability for bacterial growth, including several pathogens. Iron requirements remained unchanged early in broiler life but were reduced when broilers aged and were able to increase their feed intake. As with copper, iron can interact with several dietary components, further complicating digestion. This includes phytic acid, tannins, fat, zinc, manganese, and copper.

Manganese

Manganese functions as a cofactor for metalloenzymes and has a regulatory role in several other enzymes, especially those important for bone and cartilage development. The dietary manganese

requirement was reduced for broilers and remained unchanged for adult laying hens. Indicators used to determine manganese requirements were performance, bone manganese accumulation, and perosis or swelling of the condyle within the hock joint.

Attention should be given to the variation of bioavailability of inorganic and organic sources of manganese to ensure that higher bioavailable sources are not oversupplied and that lower bioavailable sources do not result in deficiencies. Phytic acid and other dietary components can also have a negative effect on manganese utilisation (Halpin and Baker, 1986).

Selenium and zinc

Selenium serves as a cofactor for enzymes that catalyse redox reactions. Selenium requirements have generally remained unchanged, but care should be taken as selenium toxicity occurs at concentrations only moderately higher than the requirement. With the low tolerance of excess selenium in mind, the bioavailability differences among various selenium sources, both inorganic and organic, need to be accounted for when formulating poultry diets. Requirement values are typically related to preventing exudative diathesis and glutathione peroxidase activity, as growth responses are relatively unaffected by selenium.

Zinc is associated with approximately 300 enzymes across critical metabolic pathways including metabolism, pH, and protein-DNA interactions. Zinc is also involved in the pigmentation of feathers and required for immune function (Kidd *et al.*, 1996). Zinc requirements have been reduced for broiler chickens, and remain unchanged for adult laying hens. Bone is the primary storage organ for zinc and can be used to determine a deficiency/sufficiency status.

Zinc's wide-ranging metabolic effects mean that reliable reductions in bodyweight gain, feed intake and egg production are commonly used to determine requirements, although maximising birds' immune function has also been explored as a basis for dietary zinc requirement. ❖

For more information and references, send an email to Michael E Persia at mpersia@iastate.edu

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Fatty acid nutrition in sustainable ruminant systems: Production, environmental, consumer targets, and raw material sourcing

By Dr Richard Kirkland, global technical manager, Volac Wilmar Feed Ingredients Limited

Fat is one of the key macronutrients in dairy production, and considerable research on animal requirements has been conducted over several decades. While fat has long been viewed as an energy-dense supplement to meet the high energy demands of lactating dairy cows, established and emerging research has shown it has the potential to have a much more significant impact beyond traditional caloric thinking.

Dietary fat is a unique nutrient and provides flexibility in ration formulation. Because it is not fermented in the rumen, it allows nutritionists to formulate higher-energy-density diets without adding to the acid load in the rumen that we would get from starchy sources of energy such as cereals, leading to potential acidotic issues.

However, from the early days it was clear that adding higher levels of oils, or higher-fat ingredients, to rations had detrimental effects on fibre digestibility and milk fat. This led to the development of the calcium salt technology in the early 1980s, and other processes such as fractionation and hydrogenation. These developments were a revolution in providing the ability to supplement rations with high-energy fat without the associated negative effects on production, including understanding and reducing the risk of trans fatty acid-induced milk fat depression.

Effect of fatty acids

Recent years have seen a strategic move from considering crude fat in diets to the specific effects of individual fatty acids. Much of this effort has been driven by research at Michigan State University in the United States (US), with particular emphasis on the effects of C16:0 (palmitic) and C18:1 (oleic) fatty acids and their impacts on cow performance.

These pioneering studies have reported effects of C18:1 on insulin concentration and adipose sensitivity, driving partitioning of nutrients to adipose tissue stores and reducing lipolysis. In contrast, C16:0 increases the partitioning of nutrients to milk, particularly milk fat production, potentially at the expense of body fat reserves. These findings highlight the beneficial effects of C18:1 during early lactation for energy balance purposes and enable nutritionists to select fatty acid blends that meet on-farm targets.

Furthermore, the improvement in total diet fat digestibility from post-ruminal delivery of C18:1 is now well established, leading to increased energy supply from the basal diet and greater feed efficiency.

Achieving fertility success

The benefits of increased dietary fat concentrations to improve fertility are well known, with numerous studies having

demonstrated enhanced conception and pregnancy rates. While an improved energy supply is fundamental to reproductive success, dietary fat is also a key precursor for the production of progesterone – the main ‘hormone of pregnancy’.

Increasing levels of milk production in dairy cows creates greater challenges as clearance of steroidal hormones by the liver also increases. Ensuring sufficient fat supply in the diet is a key nutritional factor influencing progesterone, an important element driving improvements in fertility as production increases.

Regarding individual fatty acids, detailed *in vitro* studies have demonstrated the effect of oleic acid in driving development of fertilised oocytes, counteracting adverse effects of palmitic and stearic acids. Similarly, the anti-inflammatory omega-3 fatty acids aid maternal recognition of pregnancy and embryo survival compared with the

Table 1: Methane outputs from dairy cows supplemented with rumen-protected fat supplements. (Cornell University, 2024)

	High-C16 (85%)			Megalac (Ca salt)					
	Feed level (% DM)								
	0	1,5	3,0	0	1,5	3,0	SEM	Product	Feed level
Milk									
Yield (kg/d)	38,2	40,4	40,6	39,0	42,2	42,8	0,73	0,11	<0,05
Fat (kg/d)	1,71	1,83	1,88	1,78	1,85	1,89	0,04	0,43	<0,05
Methane									
g/d	459	443	424	462	450	433	15,36	0,76	0,02
g/kg milk	12,2	11,0	10,7	12,1	10,9	10,2	0,39	0,62	<0,01
g/kg DMI	16,9	16,1	15,4	16,6	16,1	15,4	0,60	0,9	0,01

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pro-inflammatory omega-6 fatty acids. The imbalance between omega-6 and omega-3 fatty acids becomes more severe with increasingly intensive dairy systems, as the contribution from omega-3-rich grazed pasture is reduced. Achieving effective rumen-protection of omega-3 in supplements remains a challenge.

Impact on the environment

Dietary fat is unique among nutrient sources in that it is not fermented to volatile fatty acids in the rumen, enabling increased energy supply without adding to fermentation-induced enteric hydrogen production and associated methane release. Results from meta-analyses studies indicate a reduction in methane production (g/d) of between 1 and 5% per 1% increase in dietary fat concentration. Mechanisms include replacement of fermentable organic matter, inhibition of protozoa and methanogens, acting as a hydrogen sink through biohydrogenation, and reduction of fibre digestibility.

However, the potential for methane mitigation using 'rumen-active' lipids is limited due to negative effects on animal production. In contrast, rumen-protected fat supplements offer a largely unique approach to methane mitigation efforts where beneficial effects on methane reduction are achieved more as a side-effect of dietary inclusion, in addition to the performance gains for which these supplements are typically used for economic return. With minimal negative effect on the ruminal environment or microbiota, the primary mechanism for rumen-protected fat-mediated reduction of methane is via direct replacement of fermentable organic matter in the diet to reduce substrate availability for hydrogen production.

Recent data from Cornell University in the US demonstrate the potential for methane mitigation from inclusion of rumen-protected fats (*Table 1*). Supplementation with either Megalac (calcium salt of palm fatty acids) or an 85% C16:0 fat supplement significantly reduced all measures of methane determined. Importantly, these effects were achieved without negatively

impacting milk production; milk yield increased from between 2,2 and 3,8kg/d across treatments, leading to reductions in methane intensity of up to approximately 15,5% per litre of milk.

Mitigating heat stress

As climate change leads to more frequent periods of elevated and variable temperatures worldwide, dietary fat is becoming more important in maintaining production efficiency. Aside from the fundamental benefits of energy density, increasing supply of MJ in every mouthful during periods of low dry matter intake, fat can also be regarded as a 'cool' nutrient for use in heat stress conditions.

Not being fermented in the rumen, and with a high metabolic efficiency of use as an energy source or for conversion to milk fat (kl around 0,82), fat has a low associated heat increment, generating minimal heat during digestion and metabolism compared to other nutrient sources. These attributes encourage the formulation of higher-fat diets during periods of heat stress to maintain milk production and herd efficiency.

Dairy products

Milk from dairy farms has multiple end uses across liquid and manufacturing markets. While specific fatty acids can effectively increase the milk fat percentage, which is of great value to many processors, the physical characteristics and functionality of milk fat are also of interest.

Unsaturated vegetable oils and calcium salt products such as Megalac can soften milk fat, while increasing the supply of palmitic acid can increase the hardness of milk fat to impart different characteristics to manufactured dairy products. The key message for producers and processors is that it is possible to choose a supplement to best reflect the requirements of the final use of milk from an individual farm.

Fatty acids for beef

Fat supplements are increasingly used in the beef industry as stakeholders strive to improve productivity, enhance feed efficiency, and address growing environmental challenges. The fatty acid

profile of supplements can also influence key consumer trends such as marbling.

Recent novel data from Clemson University in the US have demonstrated beneficial effects on adipocyte hypertrophy, hyperplasia and expression of adipogenic and lipogenic genes, when cultured with a balanced saturated:unsaturated fatty acid blend. In contrast, extremes of either saturates or unsaturates result in poor cell development. This is an exciting and developing area of research providing new understanding of how we can influence key production traits of specific economic value.

Raw material usage

Sustainability is at the heart of agricultural production and raw material type and origin are increasingly important. Palm oil fractions remain key ingredients in farm rations, utilising by-products produced from different stages of refining and commercial outlets. More than 40% of the world's vegetable oil production comes from palm, despite only accounting for 7,4% of land devoted to vegetable oil crops, making it by far the most efficient oil crop available. Furthermore, a large proportion of this is grown by smallholders where the crop is essential in providing access to basic requirements for food, electricity, education, and healthcare.

The feed industry has an obligation to ensure sustainability across supply chains. Rumen-protected fats are primarily based on vegetable oils, including by-products from the palm oil sector; responsible sourcing, including adherence to non-deforestation policies, and/or certification according to the Roundtable on Sustainable Palm Oil (RSPO), including 'mass balance' and 'segregated' classifications, ensures this highly efficient oil crop can be part of sustainable animal production.

Summary

Sustainable ruminant production systems require consideration of inputs, targeted outputs, and efficiency. Fatty acids can influence key drivers of these challenges. Research also continues to provide data to support sustainable, data-driven decisions. ❖

For more information and references, send an email to richard.kirkland@volac.com

Trace minerals as tools to improve feedlot efficiency

By Stephanie Hansen and Emily Partee, Iowa State University

Efficiency in a feedlot is more than gain-to-feed. It is determined by how cattle get onto feed, respond to an implant and beta-agonist, and hold up under environmental conditions. Trace minerals support each of these pillars of efficiency. The key is strategic supply matched to demand, not blanket overfortification.

Getting cattle off to a healthy start

Cattle arriving to the feedlot may arrive with variable status and are the population most likely at risk for mineral deficiency. Lightweight cattle arriving after weaning often eat poorly, compounding a period of high stress with low nutritional intake. The longer cattle are transited, the greater their potential for stress, but all transit induces at least some degree of both oxidative stress and inflammation, leaving cattle more vulnerable to a disease challenge (Chirase *et al.*, 2004). Even mildly trace mineral deficient steers lose more weight in transit and are slower to recover intake than steers with adequate status (Genther and Hansen, 2014).

Trace minerals critically support a healthy immune system, both in helping cattle fight off disease and in undergoing a proper response to vaccines. Zinc is required for immune cells to divide, signal one another, and produce the cytokines that coordinate the response to a pathogen; copper and selenium support the enzymes those cells use to kill bacteria, and to shield the animal's own healthy tissue from the collateral damage of that attack. So, when an animal is challenged, it needs more of these minerals at a time when intakes are very low.

The body also redistributes what it has: Circulating zinc and iron drop while copper rises, a defensive pattern called nutritional immunity that starves an invading pathogen of the minerals it needs to multiply (VanValin *et al.*, 2021). This is why consulting nutritionists in the

United States commonly feed about 100mg Zn/kg DM at receiving, well above the NASEM (2016) requirement of 30mg (Samuelson *et al.*, 2016), and why 100mg Zn/kg DM has tended to lower respiratory disease in newly weaned calves (Galyean *et al.*, 1995).

Supporting growth

Today's feedlot animal is an athlete. They have often been genetically selected for their ability to grow quickly and efficiently and, when coupled with improved husbandry practices and growth promoting technologies, the potential for these cattle to perform is outstanding. While cattle have basal trace mineral requirements, there is evidence that implants and beta-agonists both increase demand for at least some trace minerals to optimise response. However, producers are cautioned against broadly overfeeding all trace minerals, as the old adage 'more is better' does not universally apply to trace minerals. Rather, there is opportunity to strategically select which trace minerals best support rapid growth.

Supplementing zinc from 0 up to 150mg/kg DM linearly increased early post-implant bodyweight and gain in implanted steers, alongside increased expression of muscle growth-signalling genes, with no such response in non-implanted cattle (Messersmith and Hansen, 2024). Across several studies, implanted steers eat more and convert better, and zinc source can further shift gain-to-feed (Messersmith and Hansen, 2021).

Feeding 120mg Zn/kg DM from a combination of inorganic and organic zinc



Photograph: Deidre Louw

has also improved growth in cattle fed the beta-agonist ractopamine hydrochloride (Genther-Schroeder *et al.*, 2016). Zilpaterol has been less studied in terms of trace mineral requirements, but supporting both muscle growth (zinc, copper) and nutritional energy availability (cobalt for vitamin B12, zinc) are likely essential. Additionally, there is no benefit from going to very high zinc supplementation (i.e. 300mg Zn/kg DM) during any phase, including beta-agonist feeding.

While feeding more zinc could be beneficial, there is limited evidence this is necessary for manganese or copper. Despite manganese's roles in growth and antioxidant defence, supplementing above NASEM did not affect growth in

implanted or non-implanted steers; a basal 14mg Mn/kg DM was sufficient (Smerchek *et al.*, 2024). Work so far with feeding copper suggests caution against over supplementation, as feeding 20mg Cu/kg DM decreased both implant-induced growth and ractopamine hydrochloride induced growth in cattle (Messersmith *et al.*, 2021).

One consideration, however: Both manganese and copper are highly susceptible to antagonism, where other minerals block their absorption or use by the animal. Iron is a potent manganese antagonist, and if soils are red, iron is likely quite high. Checking not only feedstuff but also water concentrations of trace mineral antagonists like iron, sulphur, and calcium is an essential part of building a balanced diet for cattle.

Holding up under heat and stress

Growth, digestion of a high-concentrate maize ration, transit, and summer heat all generate reactive oxygen species: Unstable by-products of normal metabolism that damage cell membranes, proteins and

DNA if allowed to accumulate. Luckily, the body has a set of antioxidant defences to protect against this. Trace minerals crucially support many of the enzymes in the antioxidant system.

Superoxide dismutase, the first enzyme to disarm these by-products, is built around copper and zinc, or around manganese; glutathione peroxidase, which finishes the job, is built around selenium (Deters and Hansen, 2020). Vitamins A, C, and E further support this protective mechanism. Without enough of these minerals, the animal cannot make enough of the enzymes, and oxidative damage accumulates.

Of the three pillars, this is the hardest to quantify, because a working antioxidant system prevents losses rather than adding gain. Antioxidants can decrease during heat, transit, and disease challenges, all crucial times for the feedlot calf to have its best nutritional support. Following transit, manganese-SOD activity rises while copper/zinc-SOD activity and circulating vitamin C fall (Deters and Hansen, 2020), and heat independently increases

free-radical production. Keeping copper, zinc, manganese and selenium adequate keeps the enzyme system ready to battle oxidative stress across feedlot phases.

The bottom line

Trace minerals support feedlot efficiency at three stages: Getting cattle onto feed and through the immune challenges of receiving, supporting the growth an implant and beta-agonist make possible, and holding up under the oxidative load of finishing and summer heat. Done well, this may result in fewer pulls for illness, an optimised response to the growth technologies, and fewer gains lost to stress.

Remember to be strategic in your supplementation and build the diet around real availability by checking feed and water for antagonists such as iron, sulphur and calcium. Handled this way, trace minerals protect the performance the rest of the programme has already paid for. ❖

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Sustainable feed manufacturing of the future: A framework for novel ingredients, digitalisation, and precision quality

By Dr Dejan Miladinovic, head of the Centre for Feed Technology, Norwegian University of Life Sciences

The global livestock and aquaculture industries face major challenges. Demand for animal products is growing, while environmental sustainability has become increasingly important. Feed technology plays a key role in producing nutritious diets that support animal growth, health, and food security.

To address these challenges, feed mills must adopt new approaches that combine advanced technology, sustainability, and quality control. A clear framework for sustainable feed manufacturing is therefore essential, and valuable lessons can be learned from other industries to improve performance and operational excellence.

Novel ingredients

The foundation of a resilient and sustainable feed system lies in diversifying protein sources and reducing dependence on conventional ingredients such as soya bean meal and fishmeal. Circular feed ingredients that valorise industrial by-products, agricultural residues, and food system side streams into high-value feed materials are essential for improving environmental sustainability and supply chain resilience.

Among the most promising alternatives, insect proteins can efficiently convert low-value organic substrates into nutrient-dense meals and oils. These alternative feed raw materials require significantly less land and water than traditional protein sources.

On the other hand, single-cell proteins (SCPs), produced through the cultivation of microorganisms such as yeast, bacteria, filamentous fungi, and microalgae, represent another rapidly expanding category. Commercial SCP production already utilises

substrates including methane, methanol, food-processing residues, whey permeate, lignocellulosic hydrolysates, and other carbon-rich side streams. Products based on yeasts, methanotrophic bacteria, and filamentous fungi have demonstrated considerable potential as sustainable replacements for fishmeal and soya bean meal in aquaculture, poultry, swine, and pet food applications.

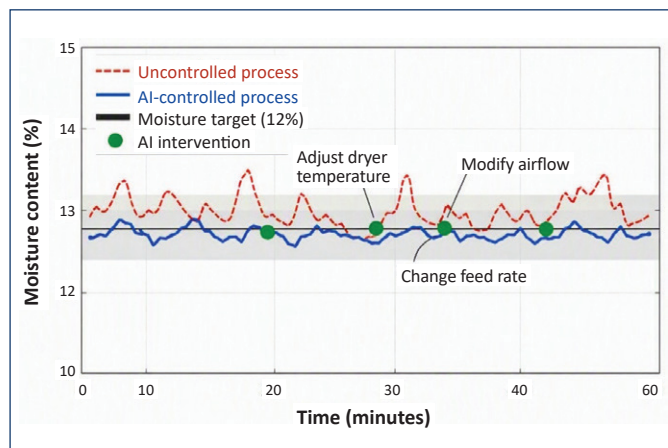
Fungal proteins, including mycoprotein and biomass derived from filamentous fungi, are also attracting growing interest due to their high protein content and favourable amino acid profile. In addition, their ability to grow on diverse agro-industrial residues makes them potent. Likewise, microalgae provide high-quality protein and valuable bioactive compounds, pigments, essential fatty acids, vitamins, and antioxidants.

Fermentation-derived ingredients further expand the portfolio of sustainable feed materials. Scientific evidence has shown that microbial biomass, postbiotic products, and functional metabolites support animal health and performance. Protein hydrolysates produced by the enzymatic processing of animal and plant co-products enhance nutrient digestibility, palatability, and gut functionality, while bioactive peptides may provide additional health benefits.

The utilisation of circular side streams, including wheat middlings, rice bran, brewers' grains, distillers' grains, fruit and vegetable processing residues, and other underutilised biomass streams, contributes to closing nutrient loops within the agri-food system. By transforming waste and side streams into valuable feed ingredients, the feed industry can reduce environmental impacts, improve resource efficiency, and strengthen long-term feed security.

Now more than ever, the feed industry has a vital role to play in adopting life cycle assessments (LCA) to lead the sustainable management of downstream industries.

Figure 1: AI-controlled versus only sensor-controlled moisture levels during continuous fish feed drying.



The smart data frontier

The transition of the feed industry reflects a broader digital transformation in which every process step must be measurable, connected, and data driven. Through the integration of the Internet of Things, sensors installed on equipment such as hammer mills, mixers, conditioners, pellet mills, coolers, and conveyors continuously collect data on key process variables, including temperature, moisture, power consumption, vibration, throughput, and machine performance. Interconnected systems generate vast amounts of data that can improve efficiency and process understanding.

At the heart of this transformation are several foundational pillars, one of the most promising being the digital twin – a dynamic virtual representation of a physical feed mill that is

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continuously synchronised with real-time operational data. As data accumulates, it becomes a powerful tool for optimising formulations, process settings, equipment performance, and production planning. This is why reliable process data is essential.

Artificial intelligence (AI), machine learning, and near-infrared spectroscopy further enhance this capability by rapidly analysing large datasets. These technologies enable a dynamic understanding of ingredient composition, raw material variability, process performance, and production costs, allowing continuous process optimisation. They support formulations that maximise manufacturing efficiency and animal performance while minimising costs.

AI-driven systems can also adjust formulations in real time when changes in ingredient quality are predicted to affect feed quality or production efficiency. Such systems optimise grinding, ensure mixing uniformity, and regulate conditioning and pelleting parameters.

Together, these technologies create a connected, adaptive manufacturing environment that improves quality assurance, resource utilisation, traceability, and production performance. A good example is the use of AI to predict moisture levels during continuous feed drying (Figure 1), supporting faster operator decisions and a better understanding of process fingerprints.

Mixing and moisture management

Achieving a constant, high-quality end product is impossible without optimised mixing and the precise addition of surfactants. Moisture and mixing are no longer secondary considerations but strategic pillars of manufacturing excellence.

Not all mixing devices perform the same. The superiority of IsDeCa mixing technology has been proven by the Norwegian University of Life Sciences. Traditional twin-shaft paddle mixers have notable limitations in modern mills, particularly when it comes to hygiene and the handling of novel, wet ingredients. They are often prone to caking, contamination, and the formation of large lumps when liquid inclusion exceeds 25%, leading to non-homogeneous feed.

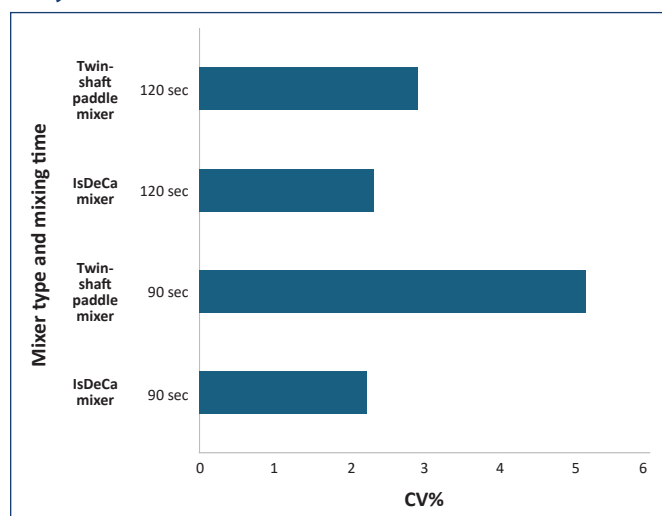
In contrast, the IsDeCa mixer (a patented 2019 breakthrough) provides the controlled dynamics required to integrate dry and wet ingredients with precision under 2,5% CV (Figure 2). Furthermore, IsDeCa can handle up to 65% added water without blocking the machine or forming lumps, making it the ideal choice for circular diets that rely on wet side streams.

Moisture kinetics and surfactants

Precision moisture control transforms water from a source of uncertainty into a strategic parameter. Most feed ingredients exhibit a sharp increase in moisture uptake during the first 30 seconds due to surface wetting. Therefore, understanding the rehydration kinetics of each feed raw ingredient is essential.

Absorption indications are significantly higher at 80°C compared to 20°C, particularly for materials such as sugar beet pulp. In this context, surfactants can play a major role when used correctly. Water's high surface tension (~72 mN/m) often results in poor absorption, leaving 'free water' on the surface that promotes mould growth. Specialised surfactants lower surface tension to <30 mN/m, allowing moisture to penetrate the starch and protein matrices deep within the feed particles.

Figure 2: Compared mixing performance within the timeframe of 90 and 120 seconds. Mixing done with dry SBM HM-1 mm and yttrium oxide 0,01%. Twin shaft 60 lit.; IsDeCa 60 lit.



Using surfactants is not only an economic driver that can lead to direct savings of €10 to €11 per tonne by mitigating shrinkage losses. It also conveys the message that recovering just 3% of lost moisture can translate to 3 000 tonnes of saleable product annually for a 100 000-tonne feed mill. Surfactants act as lubricants, reducing pellet die friction that lowers energy consumption between 19 and 23%.

Optimised feed quality

The evolution of quality management requires integrating digital technologies with traditional management practices. Optimised quality is built on a holistic system that ensures transparency, responsiveness, and performance.

Physical pellet quality depends on optimal moisture, the main driver of starch gelatinisation and other chemical changes that occur during pelleting. Nutritional quality focusses on preserving heat-sensitive additives such as vitamins, enzymes, and probiotics. Feed safety and traceability involve monitoring contaminants, pathogens, and water activity. Blockchain technology provides secure traceability from source to final product, strengthening consumer trust in ethical and sustainable sourcing.

Conclusion

The future of sustainable feed manufacturing requires an integrated approach where moisture is a controlled parameter, novel ingredients drive circularity, and digitalisation converts complexity into strategic decisions. Operational excellence is achieved when precision technologies ensure high feed quality while reducing energy use and improving the nutritional value of animal feed.

This is the only road where the feed industry can balance productivity with environmental goals, securing food for a growing population while mitigating its ecological footprint. ♦

Send an email to dejan.miladinovic@nmbu.no for more information and references.

Innovation in feed manufacturing

By Oliver Brägger, head of Business Development: Digital Solutions, Bühler Group

Artificial intelligence (AI), automation, and digitalisation are reshaping industrial manufacturing, and the feed industry is no exception.

Across compound feed production, there is strong momentum to use digital technologies to improve efficiency, reduce waste, and enhance product consistency. AI is often positioned as a key enabler of the next step in feed mill optimisation.

However, while AI is a powerful tool, it is not a standalone solution. Precision feed milling is defined not by algorithms alone, but by the interaction between process engineering, measurement technology, automation systems, and human expertise. Without a stable and trustworthy foundation of process data, even the most advanced AI systems cannot deliver reliable and safe outcomes.

Data drives feed milling

In any digital system, data quality determines performance. The principle of 'garbage in, garbage out' is particularly relevant in feed production, where small deviations in input data can lead to significant variations in output quality.

Feed manufacturing environments are highly dynamic. Raw material quality changes continuously, formulations are frequently adjusted, and operating conditions shift in response to production demands. On top of this, manual interventions, maintenance activities, and gradual machine wear introduce variability that is not always captured by conventional sensors.

For AI systems to function reliably in such conditions, data must be accurate, stable, and comparable over time. This requires not only advanced analytics but also robust measurement infrastructure and disciplined process control. Without this foundation, digital systems risk amplifying noise rather than improving decision-making.

A complex production environment

A compound feed mill consists of multiple interconnected process stages,

each contributing variability to the final product. Grinding, batching, mixing, conditioning, pelleting, cooling, and conveying all influence physical and nutritional feed properties. At the same time, customers expect consistently high feed quality regardless of raw material fluctuations or operational conditions. Meeting these expectations requires continuous monitoring and fast, precise process adjustments.

Some variables change gradually, while others shift abruptly due to mechanical issues, operational interventions or disturbances. A key challenge for digital systems is therefore distinguishing between normal variability and deviations that require corrective action. AI can support this interpretation, but only when it is built on reliable process data and a sound understanding of feed manufacturing dynamics.

Measuring the real process

Near-infrared (NIR) spectroscopy is a vital technology in modern feed plants. It enables fast, non-destructive measurement of key nutritional parameters such as moisture, protein, fat, fibre, and starch directly during production. However, measuring bulk solids presents a fundamental challenge: representativeness.

An optical sensor typically measures only a small surface area of moving material. Feed, however, is inherently heterogeneous at particle level. A single measurement may therefore not represent the full batch composition. Moisture tends to be relatively evenly distributed and is easier to measure reliably. Nutrients such as protein or fat are linked to specific raw material particles. If these are not sufficiently represented in the measurement zone, results can vary significantly.

Reliable process insight therefore depends on high measurement frequency, continuous sampling of moving material, and advanced spectral processing. The objective is not a single reading, but a statistically robust representation of product quality.

Why measurement stability matters

As feed mills become more automated, sensors form the key interface between the physical process and digital decision systems. For AI-based optimisation or autonomous control to function safely, measurement systems must be stable under harsh industrial conditions such as dust, vibration, temperature fluctuations, and mechanical stress. At the same time, they must detect drift or malfunction before incorrect data affects production decisions.

Modern approaches combine physical measurement with software intelligence, including self-diagnostics, redundant signals, and soft sensor models. These mechanisms help maintain data integrity even when operating conditions change. Only when measurement quality is guaranteed can AI reliably contribute to optimisation and control.

From measurement to decisions

Digitalisation in feed manufacturing is not about collecting more data. Its real value lies in transforming measurements into actionable decisions. Modern control systems link quality data directly to process parameters such as moisture addition, steam conditioning, throughput, and energy input. Instead of reacting to deviations after they occur, advanced systems enable proactive adjustments based on early trend detection.

Pelleting illustrates this well. Temperature, moisture, mechanical energy and die conditions interact continuously and directly influence pellet quality. Coordinating these variables in real time improves consistency while reducing energy consumption and stabilising production.

AI can support optimisation, but it cannot replace the underlying process knowledge required to control physical systems effectively.

Measurement frequency is key

In both batch and continuous processes, timing is critical. A measurement is only useful if it reflects the process at the

right moment. In batch mixing, material composition changes continuously during the cycle. While end-of-mix conditions are relatively homogeneous, intermediate phases may show significant variability at particle level.

Higher measurement frequency improves representativeness by capturing more data points from moving material. When combined with appropriate filtering and spectral analysis, this leads to more reliable estimation of key nutritional parameters such as protein content. Faster measurement is therefore not just a technical improvement but is essential for statistical robustness.

Evolution of NIR technology

Industrial NIR technology has evolved significantly over the past decade in terms of robustness, connectivity, and performance. Earlier systems typically used a central spectrometer connected to multiple measuring points via fibre optics. While reliable and cost-effective, this architecture limited measurement speed and responsiveness, particularly in batch processes.

Recent advances now allow each measuring point to operate with its own dedicated spectrometer. This distributed architecture enables continuous measurement with significantly higher spectral acquisition rates and improved temporal resolution. Modern platforms also provide real-time access to quality data through digital dashboards, improving transparency across production, quality assurance and management.

Integrated quality intelligence

The next step in precision feed milling is not only better sensing, but integration of measurement, analytics and process control. By increasing measurement density and improving stability across process points, feed producers gain a more complete understanding of product quality in real time, enabling tighter control of key parameters such as protein content, moisture, and energy density.

Equally important is accessibility. When operators, engineers and quality managers share a single reliable data source, decision-making becomes faster, more consistent, and less dependent on

individual interpretation. This shift from isolated measurements to integrated quality intelligence is a key milestone in feed industry digitalisation.

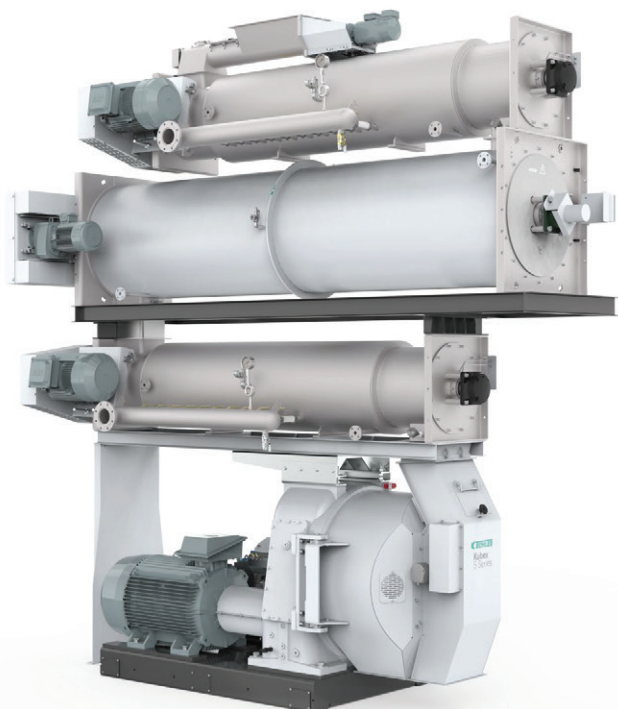
A system engineering challenge

Despite rapid progress in AI and digitalisation, precision feed milling remains a systems engineering challenge. Success depends on the interaction between mechanical equipment, process design, measurement technology, and digital intelligence.

Precision feed milling will not be defined by AI alone, but by the ability to convert reliable data into meaningful decisions. Feed producers who invest in robust measurement systems, integrated automation, and sound process understanding will be best positioned to benefit from digital transformation.

Ultimately, the key shift is conceptual: moving from data collection to decision-making, and from digital potential to operational reality. ❖

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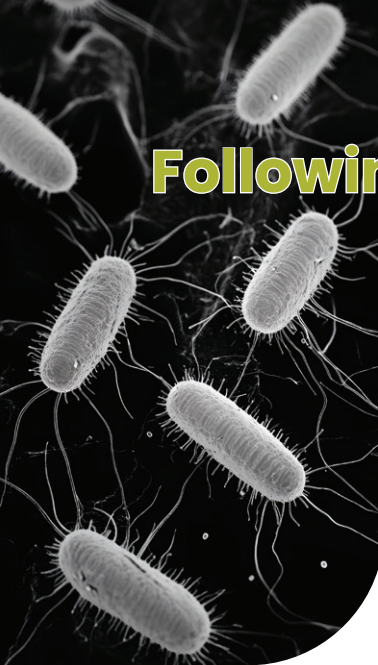
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Following *Salmonella* through the feed mill

By Cilé-Mari Bredenkamp, technical intern, AFMA

When salmonellosis makes headlines, the attention usually turns to eggs, poultry meat, or food-processing facilities. Yet the bacterium's journey can begin much earlier. Contaminated feed ingredients may carry *Salmonella* into a feed mill, from where it can move into feed, animals, and the wider food production system. Some animals may carry the organism without obvious signs of disease, making prevention and surveillance especially important.

Since feed manufacturing is an important early control point, preventing contamination here can reduce opportunities for *Salmonella* to travel further along the feed-to-food chain.

A feed mill is not a uniform environment. Raw materials are received, stored, ground, weighed, mixed, processed, cooled, and dispatched. Steam conditioning and pelleting are important steps for reducing *Salmonella* in compound feed. The combined effects of heat, moisture, retention time and pressure can substantially reduce the number of viable *Salmonella* cells. However, the effectiveness of the process depends on the conditioning temperature, exposure time, feed moisture, ingredient composition, initial level of contamination, and how evenly the feed is heated.

Salmonella cells in very dry feed may become more resistant to heat, while heat tolerance may also differ between serovars and even between strains of the same serovar. In one broiler-mash study, *S. Agona* and *S. Montevideo* were more heat resistant than *S. Senftenberg*, *S. Mbandaka* and *S. Tennessee* under the tested steam-conditioning conditions (Steghöfer *et al.*, 2021). Heat resistance also varied between strains. This means cells may survive when conditioning temperatures are too low, exposure times are too short, feed moisture is insufficient, or cold spots occur within the feed mass.

Successfully heat-treated feed can also be recontaminated during cooling, storage, load-out or transport. Contamination should therefore be viewed as a process-linked event. *Salmonella* may enter at the intake, spread through equipment, become established in a protected niche, or reappear after heat treatment.

However, it can miss localised contamination because *Salmonella* often occurs at low levels and is unevenly distributed. A small sample may not contain contaminated particles. Settled dust tells a different story. It is produced during unloading, grinding, conveying, mixing, pelleting, cooling and load-out, and accumulates material from many movements through a location. It can therefore reveal intermittent or localised contamination.

In a Spanish survey of 523 feed mills, *Salmonella* was detected in 12,5% of dust samples. Of this, 3,5% were detected in feed-material samples and 3,3% in compound-feed samples (Torres *et al.*, 2011). However, a positive dust result does not prove that every feed batch is contaminated. It identifies an environmental location that requires investigation.

Four locations to take note of

No single location is the main hotspot in every mill. Layout, ingredients, cleaning practices, moisture and production systems differ. Even so, international studies repeatedly identify several locations where contamination can enter, collect, or reappear.

1 Raw-material receiving and intake

areas: Contamination may occur before ingredients reach the mill. Crops and ingredients may be exposed to contaminated manure, irrigation water, wildlife, rodents, storage environments, or transport equipment. Unloading then

generates dust which settles on intake-pit gratings, floors, ledges, and conveyors. In the Spanish survey, *Salmonella* was detected in 26,6% of intake-pit dust samples (Torres *et al.*, 2011). Supplier approval, incoming-load inspection, dust control and prompt spill removal are practical barriers at this stage.

2 Conveyors and transfer equipment:

Conveyors, augers, elevators, bins, grinders and mixers connect production areas. They can also retain dust and feed between batches. Residues inside enclosed or difficult-to-clean equipment can shield *Salmonella* from cleaning and disinfection. Dust, feed particles and fatty deposits may collect in cracks, joints and dead spaces. These residues can remain between production runs and contaminate feed moving through the equipment later. A Brazilian study detected *Salmonella* in 16,1% of conveyor samples, the highest proportion among the sampled locations (Da Cruz Payão Pellegrini *et al.*, 2015).

Conveyors can retain contaminated dust and feed residues, especially where equipment is enclosed or difficult to clean. These residues may contaminate material moving through the system later. Movement between production zones can extend the same pathway when people, tools or mobile equipment carry contaminated dust.

3 Pellet coolers:

Pellet coolers require particular attention because they follow the main heat-treatment step. They work

by drawing large volumes of ambient air through warm pellets. Contaminated airborne dust may therefore enter with the cooling air. As warm pellets contact cooler air and equipment surfaces, moisture may condense within the cooler, which can dampen retained fines, dust and fatty deposits. The added moisture may improve *Salmonella* survival and, where conditions permit, support limited multiplication.

Warm internal surfaces, restricted cleaning access and accumulated organic material can further protect the organism from drying and sanitation. Air movement may then spread contaminated dust through the cooler and into downstream equipment. Australian surveillance found that cooler samples had twice the odds of *Salmonella* detection compared with finished-feed samples (Parker *et al.*, 2019).

4 Waste-handling areas: Waste areas collect sweepings, spills, dust, and rejected material. They may also provide feed and shelter for pests. Equipment used in these areas can transfer contamination if it returns to production zones without cleaning. A large British feed-mill study

identified waste-handling sites among the locations most likely to test positive (Gosling *et al.*, 2022). Waste areas should therefore form part of environmental surveillance. They should not be treated only as housekeeping spaces.

Sampling results and control

Scientists call the proportion of samples testing positive the apparent prevalence. It describes what the surveillance system actually detected. It does not capture every occurrence of *Salmonella* within a facility. A mill collecting many dust samples from known problem areas may detect more positives than one testing only a few finished-feed samples.

Sampling frequency, sample handling and laboratory methods also influence detection. A higher apparent prevalence may indicate a contamination problem. However, it may also reflect a more intensive monitoring programme. Mill results should therefore be interpreted alongside sample numbers, sampled locations, testing methods, production changes, and corrective actions. Detection shows that the monitoring programme has identified a location requiring attention.

Its value depends on investigation, corrective action, and follow-up verification.

Turning data into evidence

International studies identify potential risk locations, but their findings cannot be applied directly to South African feed mills since ingredients, climate, mill design, production practices and surveillance systems differ between regions. AFMA has therefore made its anonymised voluntary *Salmonella* Monitoring Programme data available for an MScAgric study in Animal Nutrition at the University of Pretoria. The dataset includes more than 60 000 environmental dust samples from South African feed mills, collected between 2016 and 2025.

The study aims to show where and when *Salmonella* is most likely to be detected. This evidence can support targeted surveillance, prioritise high-risk locations and improve the allocation of sampling, laboratory and sanitation resources. ❖

For more information, send an email to Cile-Mari Bredenkamp at intern@afma.co.za



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From road to rail: Why rail reform matters for South Africa's agriculture and feed industry

By Dr Charl van der Merwe, general manager, Agbiz Grain

Grain and other raw materials constitute a substantial portion of the production costs of feed mills. The efficiency of the logistics chain for these inputs is directly linked to the efficiency and competitiveness of feed mills. Reliable and cost-effective logistics are consequently critical to the industry.

South Africa is entering a crucial period in the transformation of its freight logistics system. For many years, the deterioration in rail performance has resulted in a growing dependence on road transport. While road freight remains essential to agriculture, the increasing pressure on road infrastructure, higher logistics costs and congestion have highlighted the need for a more balanced road-and-rail freight system.

The current rail reform programme therefore represents more than an initiative to improve rail performance. It creates an opportunity to reconsider how agricultural commodities move from farms and silos to mills, feed mills, processors, and export ports.

The process also provides an opportunity to plan and develop an

integrated transport network that offers flexibility, reliability, affordability, and efficiency. The future logistics system should therefore be viewed as an integrated network: road transport connecting farms and storage facilities to rail terminals, trains moving bulk freight over longer distances, and road transport completing the final leg of delivery.

A broader rail reform programme

The current reforms should be viewed as a process rather than a single project. The foundation includes the *National Rail Policy* of 2022, the *Freight Logistics Roadmap* of 2023 and the *Economic Regulation of Transport Act, 2024 (Act 6 of 2024)*. These reforms seek to separate infrastructure management from train operations, introduce greater competition and create an environment in which private sector role-players can participate more extensively in the rail system.

An important part of this restructuring has been the unbundling of Transnet. The emerging structure separates functions such as train operations, infrastructure management, and port operations.

Transnet Rail Infrastructure Manager (TRIM) is responsible for rail infrastructure, while Transnet Freight Rail (TFR) and private-sector participants are responsible for operating trains on the TRIM network. This change is significant because it introduces a model in which the infrastructure provider and the users of the infrastructure are no longer necessarily the same organisation.

For agricultural businesses, however, the success of the reform will ultimately be measured in practical terms: Can grain and other agricultural products be moved reliably, competitively, and predictably?

A plan to reposition rail

The *Draft National Rail Master Plan* (NRMP) was approved by Cabinet for public consultation in April 2026. The NRMP is intended to provide a long-term framework for the revitalisation, expansion and modernisation of South Africa's rail system and translates the *National Rail Policy* into a phased investment and implementation programme. Importantly for agriculture, the NRMP seeks to reposition rail as the backbone

of the national transport system and to rebalance the distribution of freight between road and rail.

This long-term vision is important because rail infrastructure cannot be restored through isolated projects. A branch line may be rehabilitated, but if there is no reliable connection to the mainline, insufficient train capacity or no suitable terminal at the destination, the investment will not deliver the desired economic benefit. The NRMP therefore provides the strategic framework.

The Network Statement

While the NRMP provides the strategic direction, the Network Statement is more directly relevant to companies that want to use or operate on the rail network. TRIM's Draft Network Statement Version 4, released for public consultation in July 2026, is an important component of the emerging open-access framework. It sets out the commercial, operational and regulatory framework within which prospective rail users and operators will access the national network.

Among the issues being developed through the rail reform process are rail access tariffs, slot allocation rules, rail access agreements, interface and safety arrangements, rolling-stock arrangements, and requirements applicable to train operating companies. For agricultural users, these mechanisms matter because a competitive rail service requires more than a functioning railway line. Users need certainty about train slots, access fees, and liability aspects regarding potential losses and consequential damages due to reliability or efficiency issues, and how the different parts of the logistics chain will interact.

The B-Network RFI

One of the most interesting opportunities for agriculture is the TRIM RFI relating to the B Network and associated branch lines. The B Network generally provides the local or feeder connection between production areas and the mainline network. For agriculture, this could mean connecting storage facilities, mills, feed mills and other facilities to the national rail system.

The RFI asks participants to provide information on routes, freight volumes, possible operating models, investment requirements, tariffs, commercial structures, and risk allocation. TRIM may not be able to operate these lines in the future, and it is gauging the potential for private sector interest in developing and managing some of these lines.

An important principle is that the B Network cannot be considered in isolation. Grain movement could start at a silo, travel along a B Network branch line, connect to the A Network and continue to a mill, feed mill, distribution centre, or export harbour. The complete journey must therefore be considered when assessing whether a particular railway corridor is viable.

Volume aggregation

One of the biggest challenges for agricultural rail is that individual freight users may not generate sufficient volume to support an effective train service. This creates an important role for volume aggregation. Instead of considering a single silo, mill or feed mill as the customer, volumes from several facilities can be combined. Smaller B Network flows can be consolidated into larger trains when they reach the A Network, reducing loaded train-kilometres and locomotive running hours.

For agriculture, this opens the possibility of developing multi-commodity and multi-user corridors. Grain, animal feed, raw materials, fertiliser and other agricultural commodities could contribute to the same logistics corridor. Cooperation between grain producers, grain traders, silo operators, feed manufacturers, processors and logistics companies is therefore important.

For this reason, the B Network RFI needs to be evaluated from an end-to-end perspective. A rehabilitated branch line will not solve the problem if there are insufficient A Network train paths. Similarly, delays at interchange points, yards or terminals can undermine the entire service.

The responsibilities of the different parties must consequently be clearly defined. A possible corridor model could involve the cargo owner providing volumes,

a concessionaire maintaining the B Network, a train operator providing locomotives and wagons, TRIM providing A Network access, and terminal operators handling the freight at its destination.

What it means for AFMA members

For the feed industry, the current reforms provide an opportunity to become more actively involved in shaping future freight corridors. Feed manufacturers should understand their current and potential freight flows: where grain and other raw materials originate, annual volumes, current road transport costs, destinations, storage capacity and the level of reliability required.

The next step is to identify where aggregation could create a viable rail opportunity. This is already happening at the industry level. Agbiz Grain is gathering information from its members and engaging with organisations, including AFMA, Grain SA, SACOTA, and the National Chamber of Milling. Potential grain flows from silos to mills, feed mills and export harbours are being mapped to identify potentially viable rail lines.

This collaborative approach is important as individual companies may not have the volumes to support a rail service, but an industry corridor may.

Conclusion

The opportunity should not be viewed simply as restoring old railway lines. It is about designing the complete logistics chain, lowering logistics costs, ensuring greater reliability and improved access to markets, which would strengthen the competitiveness of the entire agricultural value chain.

Collaboration between government, TRIM, private rail operators, agricultural organisations, grain handlers, traders, processors, feed manufacturers, and logistics providers is essential.

The current process provides the opportunity to ensure that agriculture is not merely a user of the reformed system, but an active participant in designing a supply chain of the future that is modern, commercially viable and includes road, rail, storage, terminals, and ports. ❖

For more information, contact Dr Charl van der Merwe at charl@agbizgrain.co.za

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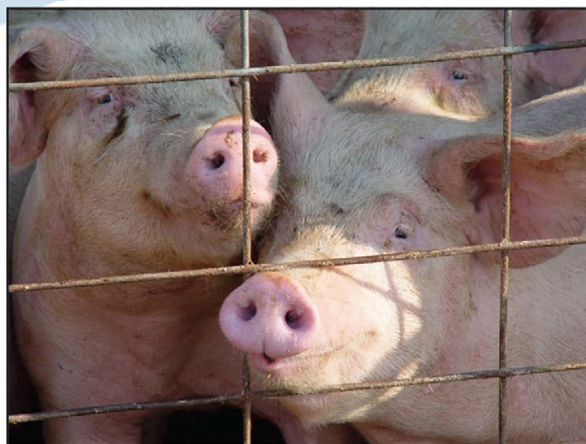
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Feed mill operator blended learning programme: What AFMA members say

By Petru Fourie, operations manager, AFMA

Modern feed manufacturing depends not only on efficient production systems, well-formulated feeds and automated processes, but also on the competence of the people operating the feed mill every day.

Feed mill operators work at the point where raw materials, machinery, production schedules, quality requirements, and safety controls come together. Although they generally work within established procedures and under supervision, the accuracy with which they perform their tasks, monitor processes and report deviations can influence production efficiency, equipment performance, feed consistency, contamination risk, downtime, and workplace safety.

As production requirements become more demanding, operators need more than the ability to follow instructions. They require a practical understanding of the production process, the ability to recognise and report deviations, and an awareness of how their responsibilities affect the wider feed mill operation. AFMA's Feed Mill Operator Blended Learning Programme was developed to address this need.

Learning within the workplace

The programme combines self-paced theoretical learning with structured workplace application. Each participating feed mill becomes a learning and evaluation site, supported by an internal facilitator who guides learners through the practical component.

The theoretical content covers the feed milling environment, material handling, receiving and storage, production, processing, feed science, and operational team leadership. Learners then apply this knowledge to the equipment, procedures, and standards used in their own workplace. Practical learning is therefore not limited to generic descriptions of conveyors, bucket elevators, batching systems, or pellet mills. It is applied directly to the equipment and processes learners work with every day.

Feedback from AFMA members identifies this workplace-based approach as one of the programme's main strengths. Reported benefits include greater operational awareness, confidence, communication, feed safety awareness, and the identification of employees with potential for further development.

Understanding each task

Employees may become highly experienced in one section of a feed mill without fully understanding how it connects to the wider production process. An operator may know how to operate a machine or follow a procedure but have limited insight into how a deviation in one area could affect production elsewhere.

Member feedback indicated that the programme broadened operators' understanding of plant processes and helped them recognise how their specific responsibilities contribute to the

wider production system. This improved their ability to identify deviations, understand potential consequences, and respond more appropriately within their areas of responsibility.

Facilitators also observed that learners began to view equipment differently. A bucket elevator or drag-chain conveyor was no longer simply something to operate; learners better understood its purpose, associated risks, and role in the production process.

Greater confidence and responsibility

A recurring theme in member feedback is increased learner confidence. This does not mean that operators act beyond their authority, but that they are better able to perform their responsibilities correctly, recognise deviations, and report concerns clearly.

Nutri Feeds observed that employees who completed the programme became more confident and better able to identify operational challenges within their areas of work. The company also noted a visible difference in their understanding of plant processes and approach to daily responsibilities. De Heus highlighted the value of structured learning for experienced employees. The programme links practical knowledge to the technical principles underpinning their work, while also providing formal recognition for the roles they perform.

Learners therefore gain more than information. They develop a clearer understanding of why procedures matter and greater confidence in discussing operational issues with colleagues and supervisors.

Knowledge becomes particularly valuable when it begins to influence behaviour. Participating companies have observed that trained employees show greater responsibility in carrying out their work, are more willing to report concerns, and may contribute practical suggestions for improvement. At Nutri Feeds, learners became more willing to share observations and take ownership of their responsibilities. Some also began stepping forward to assist new employees by explaining the processes and equipment within their sections of the feed mill.

Feed safety and quality awareness

Feed safety and quality depend heavily on the consistent application of procedures on the production floor. Contamination prevention, correct material handling, housekeeping, traceability, and adherence to operating requirements all rely on employees' understanding of the risks associated with their work.

AFMA members identified improved feed safety and quality awareness as another of the programme's most significant outcomes. Following the training, operators demonstrated a better understanding of contamination risks and were better able to identify and report potential problem areas.

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Learners from De Heus, Epol and Nutri Feeds receiving their certificates upon completing the AFMA Feed Mill Operator Blended Learning Programme.

Companies indicated that this supported more consistent preventive practices and improved feed quality.

The programme also introduces learners to occupational health and safety, storage risks, quality concepts and safety considerations associated with material-handling and processing equipment. It does not replace the company's formal feed safety, quality or occupational safety systems. Instead, it strengthens employees' ability to understand why those controls exist and how to apply them in practice.

Fewer errors and better efficiency

Although the impact of training is not always easy to isolate from other operational factors, participating companies have identified practical improvements. De Heus reported that the newfound knowledge contributed to a reduction in internal errors and improved efficiency. The programme has also become part of the company's internal training approach, with employees enrolled on a recurring basis.

Nutri Feeds similarly indicated that trained operators were better able to perform their tasks, recognise deviations and communicate problems, supporting greater efficiency in day-to-day activities. These outcomes are consistent with improved process understanding. Employees who recognise and report problems earlier, communicate more accurately and understand the consequences of incorrect execution are less likely to repeat mistakes and are better able to support supervisors in resolving operational issues.

Training should nevertheless be viewed as one part of a broader operational-improvement strategy. Equipment condition, supervision, systems and management practices remain equally important.

Supporting succession planning

Members are using the programme not only to develop current operators, but also to prepare employees for future roles. Among the potential learners are senior operators, team leaders, shift workers, assistants, general workers and employees being considered for supervisory positions. Molatek enrolled senior operators and team leaders with the potential to progress into more senior roles, including future responsibilities as shift controllers. Nutri Feeds also uses the programme to identify employees with potential and support their further development.

This helps companies build an internal talent pipeline before vacancies arise and gives management an opportunity to observe how employees apply knowledge, follow procedures, take responsibility and demonstrate leadership potential.

Management support is essential

Positive outcomes depend on active management support. Learners need sufficient time, guidance and access to workplace learning opportunities for the programme to deliver its intended value. De Heus emphasised that management buy-in is critical. Companies benefit most when managers, facilitators, supervisors and experienced employees support the learning process.

Facilitators do not need expertise in every technical area. Skilled employees, line supervisors and subject specialists can assist with practical learning, while the facilitator coordinates and oversees the process. This helps integrate employee development into normal feed mill operations rather than treating it as a separate training exercise.

More than an operator course

The consistency of feedback from participating AFMA members provides the strongest indication of the programme's value. Across different feed mills, companies report that trained employees understand their work better, communicate more clearly, take greater ownership, and are more confident. They also demonstrate stronger awareness of feed safety, quality and contamination risks, while the programme helps identify employees with potential for further development.

The Feed Mill Operator Blended Learning Programme is not about turning operators into production managers. It is about helping them become more competent, informed and reliable in their current roles, while supporting the development of those with potential to progress.

AFMA members who have not yet participated are encouraged to consider how structured workplace learning could support their operational priorities, succession planning and employee development. ❖

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Seven years of *ad hoc* testing: Mycotoxin trends in maize and maize-derived products

By Martin Brits, SAGL

The Southern African Grain Laboratory NPC (SAGL) has been involved in numerous annual mycotoxin monitoring projects as part of crop quality surveys and post-storage pre-processing projects. While these annual surveys provide valuable historical baseline data on regional mycotoxin trends across harvest seasons, *ad hoc* testing serves as an immediate risk-management tool for manufacturers and producers operating in real-time supply chains.

Over the past seven years (2019 to 2026), the SAGL has performed more than 7 500 *ad hoc* mycotoxin analyses for commercial clients both locally and internationally. The sample matrices ranged from raw major grains to processed final products. From this comprehensive dataset, meaningful operational insights for the feed and milling sectors can be extracted by focussing on maize and maize-derived products.

Results from 3 491 samples, separated across five distinct product groups that include raw yellow and white maize and their processed products, are presented.

Aflatoxins and ochratoxin A were excluded from the primary discussion due to extremely low detection rates – aflatoxins were only detected in 30 and ochratoxin A in 15 out of 3 491 samples, respectively. Zearalenone was also omitted because the mean concentrations remained below critical guidance thresholds despite an increase this season.

While the *ad hoc* dataset provides valuable real-time diagnostic insight, it must be interpreted with care. Because submissions are predominantly problem-directed, the data carries an inherent selection bias that may skew mycotoxin levels higher than those observed in randomised monitoring programmes.

Shifting contamination patterns

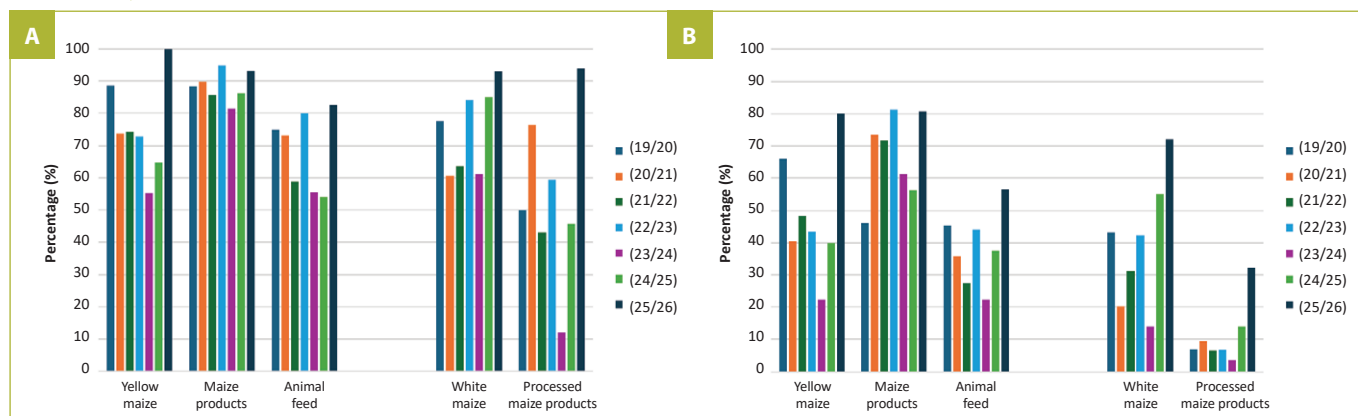
Figure 1 shows mycotoxin occurrence across five selected matrices, comparing animal feed products (yellow maize, maize by-products, and finished animal feed) with human food products (white maize and processed maize meal products). The trends highlight key differences between mycotoxin occurrences in the animal feed and human food production streams.

Over the seven-year *ad hoc* testing period, contamination patterns shifted from a constant, moderate baseline (2019/20 through 2022/23) to a low-risk level during the 2023/24 season, with only 12% of processed maize products containing at least one mycotoxin (Figure 1A). However, this interval was followed by an increase in mycotoxin occurrence for nearly all maize and maize-derived products in the 2025/26 season.

During the current season, 100% of analysed yellow maize samples contained at least one mycotoxin. Processed maize meal products showed large variation across seasons and followed the same trend as the white maize sample in the current season, with 94% of samples containing at least one mycotoxin. Maize products (used as animal feed ingredients) could be considered high-risk, with mycotoxin occurrence ranging from 82 to 95% over the seven-year testing period. The occurrence of mycotoxins in animal feed maintained a relatively consistent contamination profile over time, with single mycotoxin occurrence ranging from 54 to 83%.

Similar to the overall mycotoxin occurrence, the samples containing more than one mycotoxin tended to be higher for the current season than in the previous

Figure 1: Mycotoxin occurrence in *ad hoc* samples for maize and maize-derived products over seven seasons.



(A) Percentage positive samples containing at least one mycotoxin. (B) Percentage positive samples containing more than one mycotoxin.

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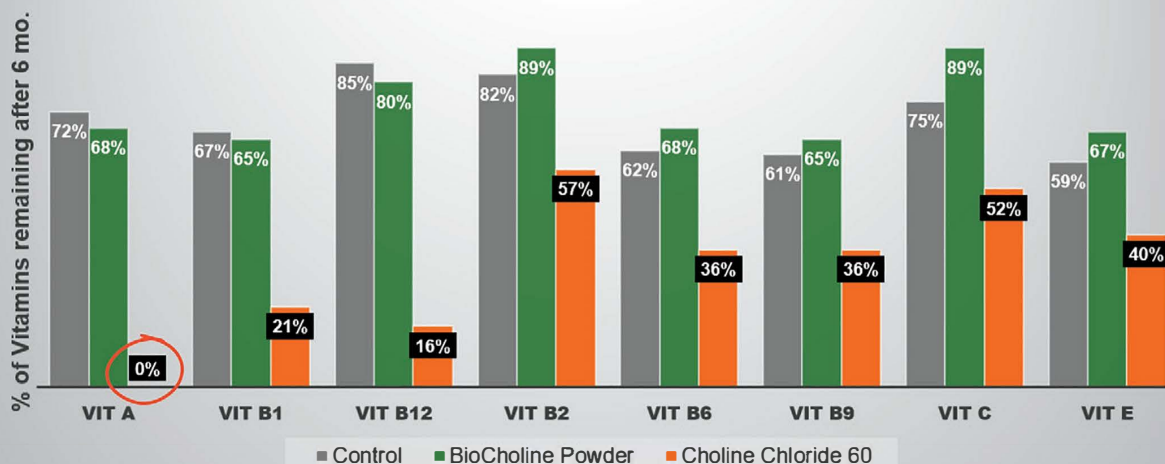
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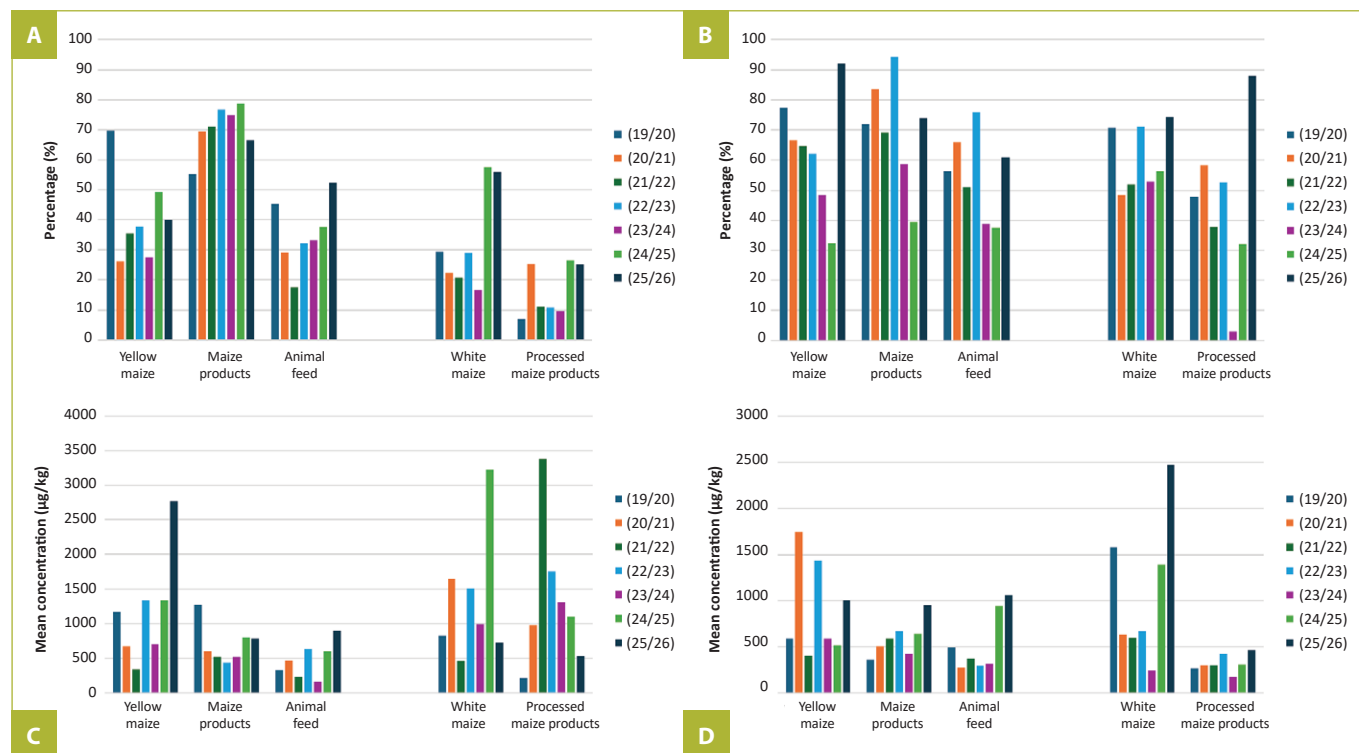


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Figure 2: Fumonisin and deoxynivalenol occurrence and mean concentrations in positive *ad hoc* maize and maize-derived samples over seven seasons.



(A) and (B) show the percentage of positive samples containing fumonisins (sum of FB₁ and FB₂) and deoxynivalenol, respectively. (C) and (D) show the corresponding mean concentrations (µg/kg) in positive samples for each mycotoxin.

six seasons (Figure 1B). The multi-mycotoxin co-occurrence in animal feed remained lower than reported for yellow maize and maize products for most seasons, ranging from 22 to 57%. Although multi-mycotoxin co-occurrence in processed maize meal products increased from 14% in the 2024/25 season to 32% in the current season, the percentage remained the lowest among all evaluated matrices.

Fumonisin and DON in focus

The percentage of positive samples containing fumonisin decreased for yellow maize and maize products used in animal feed from the last season, whereas the percentage of animal feed samples containing fumonisin increased to just more than 50% of the samples. Although there was a notable increase in the mean concentrations for samples analysed in the current season (2 770 µg/kg) from the 2024/25 season (1 330 µg/kg), these concentrations for the animal feed products remain below the regulatory limits for complete and supplement feed. The white maize and processed maize meal products showed similar fumonisin occurrence

to the previous season, but the mean concentrations in the positive samples were lower and still complied with national regulatory limits.

Deoxynivalenol (DON) contamination was more persistent across the maize and maize products than fumonisins. The mean DON concentrations in the matrices associated with the animal feed stream for the current season were similar and all higher than those reported for the last season (2024/25). Although there was a meaningful increase in the mean DON concentrations in white maize, the concentrations in processed maize products intended for human consumption remained similar to those in previous seasons and were compliant with national regulatory limits.

Unlike the previous season, the relative fumonisin profile between yellow and white maize changed for this season, as mean concentrations shifted from being higher in white maize to higher in yellow maize.

Balancing prevalence and severity

Although *ad hoc* samples (typically submitted when quality is suspected)

carry an inherent selection bias compared to annual monitoring projects, they remain the most practical tool for making real-time informed operational decisions. It is important to evaluate mycotoxin prevalence and concentration together, as high occurrence rates show how widely a toxin has spread, but mean concentrations influence toxicological severity. Evaluating both is critical to distinguish between isolated increases in mean concentration (such as fumonisins in yellow maize) and situations presenting high prevalence paired with low mean concentrations (as seen with DON in processed maize products during the 2025/26 season).

Additionally, there appears to be an indication that the relative fumonisin profile between yellow and white maize changed this season, as mean concentrations shifted from higher levels in white maize to higher levels in yellow maize. ♦

Contact the SAGL at 012 807 4019
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Global trade shifts reshape feed additive markets: Implications for South Africa

By Dr Lucius Phaleng, trade advisor, AFMA

For decades, feed additive markets were largely shaped by familiar economic fundamentals such as production capacity, raw material availability, and global demand. Today, however, the industry is operating in a markedly different environment. Current market developments indicate that feed additive markets have entered a new era in which trade policy increasingly influences commercial outcomes. Government interventions, including tariffs, anti-dumping measures and broader geopolitical considerations, are major determinants of pricing, sourcing decisions, and supply security, often outweighing traditional supply-and-demand fundamentals.

Global feed additive markets are experiencing one of the most significant structural shifts in decades. Although production capacity remains sufficient for many products, geopolitical tensions, trade remedies and the growing concentration of manufacturing in Asia are changing how feed additives are sourced, priced, and traded internationally. For South Africa's animal feed industry, these developments extend well beyond procurement. They have direct implications for feed costs, supply chain resilience, livestock competitiveness and, ultimately, national food security.

As feed manufacturers continue to operate in an interconnected global marketplace, understanding these evolving dynamics has become essential for informed procurement strategies and long-term business planning.

Supporting livestock production

Feed additives are indispensable components of modern livestock production. Amino acids such as lysine, methionine and tryptophan enable nutritionists to formulate least-cost diets while maintaining optimal animal performance and improving feed conversion efficiency. Vitamins, enzymes, organic acids and other speciality additives further contribute to animal health, productivity, food safety, and environmental sustainability.

Without reliable access to these products, feed manufacturers would struggle to maintain nutritional standards and control production costs. This is particularly important in South Africa, where feed typically accounts for roughly 60 to 70% of total livestock production expenses. Any disruption in additive supply or increase in international prices will filter through the value chain, affecting the profitability and competitiveness of the poultry, dairy, pig, beef, and aquaculture sectors.

The global feed additive industry has also become more concentrated. China now produces a significant share of the world's key amino acids and vitamins, giving it considerable influence over international supply chains. Current estimates indicate that China accounts for approximately 92% of global threonine production, 76% of lysine production, 36% of methionine production – with methionine's share expected to exceed 50% by 2030 – and around 65% of vitamins A and E production. China also produces around 64% of vitamin B2.

While this concentration has created remarkable manufacturing efficiencies and economies of scale, it has simultaneously increased global dependence on a single production region. Consequently, environmental inspections, energy shortages, logistics bottlenecks, plant shutdowns or geopolitical tensions in China have the potential to disrupt global supply chains and influence international pricing.

South Africa is not immune to these developments. Although local importers source products through multiple international trading companies, many feed additives originate from Chinese manufacturing facilities. As a result, even when global production capacity is adequate, market access remains vulnerable to disruptions that are well beyond local control.

Oversupply does not equal lower prices

Current market analysis indicates that several major feed additives are technically oversupplied from a global production perspective. Yet oversupply alone no longer necessarily translates into lower prices. Instead, trade measures such as anti-dumping duties, countervailing duties, and retaliatory tariffs are influencing the landed cost of imported feed additives.

This represents a fundamental shift from traditional commodity markets, where prices were driven primarily by supply-and-demand dynamics. Today, government policy decisions often have a greater influence on market prices than actual production shortages.

The United States (US), European Union (EU) and Brazil have all introduced anti-dumping measures against lysine imports from China to protect domestic manufacturers from lower-priced products. While these measures primarily target imports into their respective markets, they also alter global trade flows by redirecting Chinese exports towards alternative destinations.

Countries including Indonesia, Thailand, India, the Philippines, and Russia have consequently experienced substantial increases in Chinese lysine imports as exporters seek new markets. For relatively open import markets such as South Africa, these changing trade patterns create both opportunities and risks, depending on future policy developments and market conditions.

The market to watch

Among all feed additives, methionine deserves particular attention. Unlike several other amino acids that currently exhibit surplus production capacity, methionine remains comparatively tight in terms of global supply. However, several new Chinese production facilities are expected to come online before 2028, potentially shifting the market from relative tightness to oversupply.

At the same time, US trade policy has specifically targeted methionine through Section 301 tariff measures, adding another layer of uncertainty to international markets. As these policy developments continue to unfold, manufacturers are likely to adjust production strategies, export destinations and investment decisions, with implications for global pricing and availability.

Feed manufacturers should closely monitor developments in the methionine market over the coming years, as this product may become one of the most influential indicators of market changes.

Europe's growing dependence

Europe was historically one of the world's leading producers of vitamins, particularly vitamins A and E. Over the past decade, however, manufacturing capacity has progressively shifted towards China, increasing Europe's reliance on imported products. This growing dependence has prompted policymakers across the EU to reconsider supply chain resilience, strategic sourcing and the need to maintain domestic manufacturing capability for essential feed ingredients.

South Africa may not face identical circumstances, but similar strategic questions warrant consideration. While establishing local feed additive manufacturing may not be commercially viable across every product category, greater supplier diversification, strategic procurement and improved supply chain risk management could significantly reduce exposure to future disruptions.

Implications for South Africa

Although South Africa is not directly affected by the anti-dumping measures imposed by the US and the EU, local feed manufacturers are indirectly influenced through adjustments to global trade flows and international pricing. Consequently, procurement strategies need to evolve alongside these changing market dynamics.

International policy decisions can rapidly influence additive prices even when physical supplies are readily available.

Procurement teams should therefore monitor international trade policy developments alongside traditional market indicators when making purchasing decisions. Relying heavily on a single country or supplier inevitably increases exposure to geopolitical risks and supply chain disruptions.

Maintaining appropriate inventory levels may become more important during periods of heightened market uncertainty, while continuous monitoring of global trade developments enables earlier responses to changing market conditions and emerging supply risks.

Protecting feed security

Feed additive procurement can no longer be viewed solely as a cost-management function. In an environment where trade policy, geopolitical risk and supplier concentration influence availability and pricing, reliable access to essential additives should be viewed as part of broader feed security.

For South African feed manufacturers, the priority is to build greater resilience into sourcing decisions. This includes strengthening supplier diversification where possible, monitoring international policy developments more closely, and aligning procurement strategies with longer-term supply chain risk. Protecting reliable access to feed additives is ultimately part of protecting feed efficiency, livestock competitiveness, and national food security. ❖

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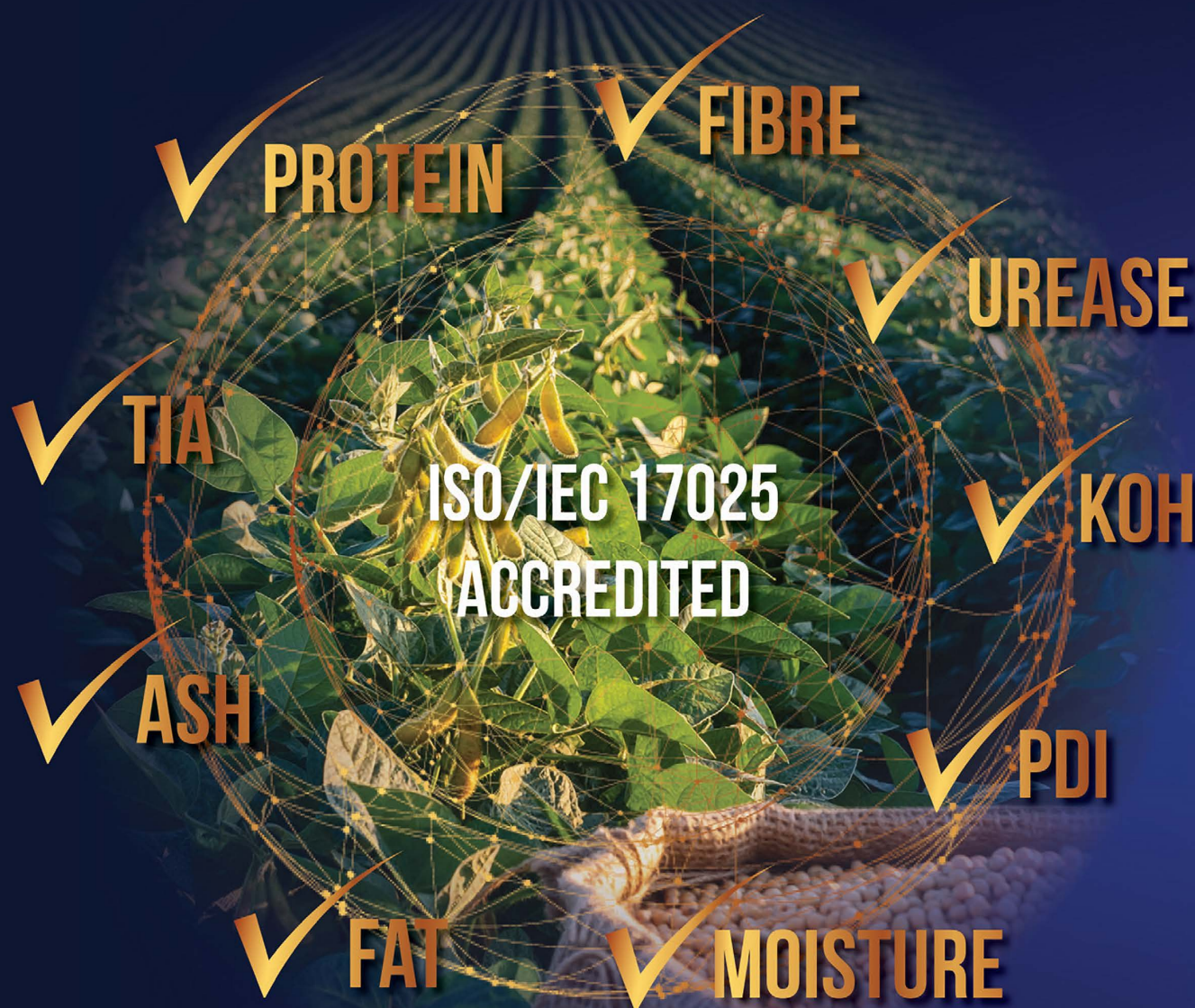


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Grain on legs: Can protein exports drive feed demand?

By Dr Dirk Strydom, managing director, Nampo (Pty) Ltd

South Africa knows how to produce grain. In good seasons, maize and oilseed supplies can comfortably exceed domestic requirements, leaving the industry dependent on exports to balance the market. Raw grain exports will always be important. However, there is another way to move grain beyond South Africa's borders: first convert it into beef, mutton, chicken, pork, and eggs. This is the idea behind 'grain on legs'.

Using the Agricultural Protein Requirement (APR) model, the potential impact of doubling South Africa's current exports of beef, mutton, eggs, broiler meat, and pork was assessed. Under normal export levels, these five sectors consume an estimated 9,14 million tonnes of feed. In the doubled-export scenario, demand rises to 9,51 million tonnes which represents an increase of 365 564 tonnes of total feed, including 202 609 tonnes of grain and 51 413 tonnes of oilcake.

The remainder consists of milling by-products, roughage, minerals, amino acids, and other feed ingredients. Across the South African feed market, the scenario lifts demand from around 12,6 to 12,96 million tonnes. That represents growth of about 2,9% from export expansion in only five protein categories.

Beef delivers the biggest increase

Beef creates the largest gain in the model. Beef sector feed demand rises from around 2,56 to 2,7 million tonnes, an increase of about 144 274 tonnes. The feedlot finishing phase creates demand for maize, roughage, molasses, and milling by-products.

Greater export demand can therefore support additional weaner calf purchases, more cattle entering feedlots, longer or more intensive finishing programmes, greater throughput at abattoirs, and improved returns from the entire carcass.

Poultry and eggs

Broilers provide the second-largest increase in the scenario. Broiler feed demand rises from roughly 3,85 to 3,97 million tonnes – an increase of 115 517 tonnes, or roughly 3%. This includes nearly 69 000 tonnes of additional grain, and 34 000 tonnes of additional oilcake.

Poultry production cycles are short, biological efficiency is high, and processing facilities can supply different products to different markets. South African consumers may prefer specific portions, while export markets create demand for specialised cuts or processed products. Poultry exports should not be viewed only as competition for domestic supply. Managed correctly, they can support industry growth, better processing efficiency, and a larger market for feed ingredients.

Egg feed demand increases by 34 233 tonnes under the doubled-export scenario, moving from roughly 1,19 to 1,22 million tonnes. Egg production is valuable to the feed industry because it drives demand year-round. Regional shortages,

supply disruptions and demand for processed egg products may create export opportunities.

Pork and mutton

In the model, pork feed demand rises from around 1,26 to 1,33 million tonnes, an increase of 70 057 tonnes. Commercial pigs depend on formulated diets throughout their production cycle. Additional pork production, therefore, translates directly into higher demand for maize, soya bean meal, sunflower meal, minerals, and specialised feed products.

Pork exports could also support better utilisation of cuts and products for which the local market provides limited value. South Africa does not need to compete immediately as a large global bulk supplier. Regional markets and carefully selected specialist destinations may offer a realistic route to growth.

The mutton scenario adds only 1 483 tonnes to total feed demand as sheep production is still predominantly based on veld and grazing. However, mutton exports can encourage greater use of supplementary feeding and specialised finishing systems.

Feed capacity is not a constraint

South Africa has the grain, oilseed, and feed manufacturing expertise, as well as the livestock industries required to pursue this opportunity. The real constraints lie in reliable animal health services, disease surveillance, rapid outbreak response, traceability, export-approved production and processing facilities, veterinary agreements with importing countries, consistent electricity and cold-chain infrastructure, as well as efficient ports and certification systems.

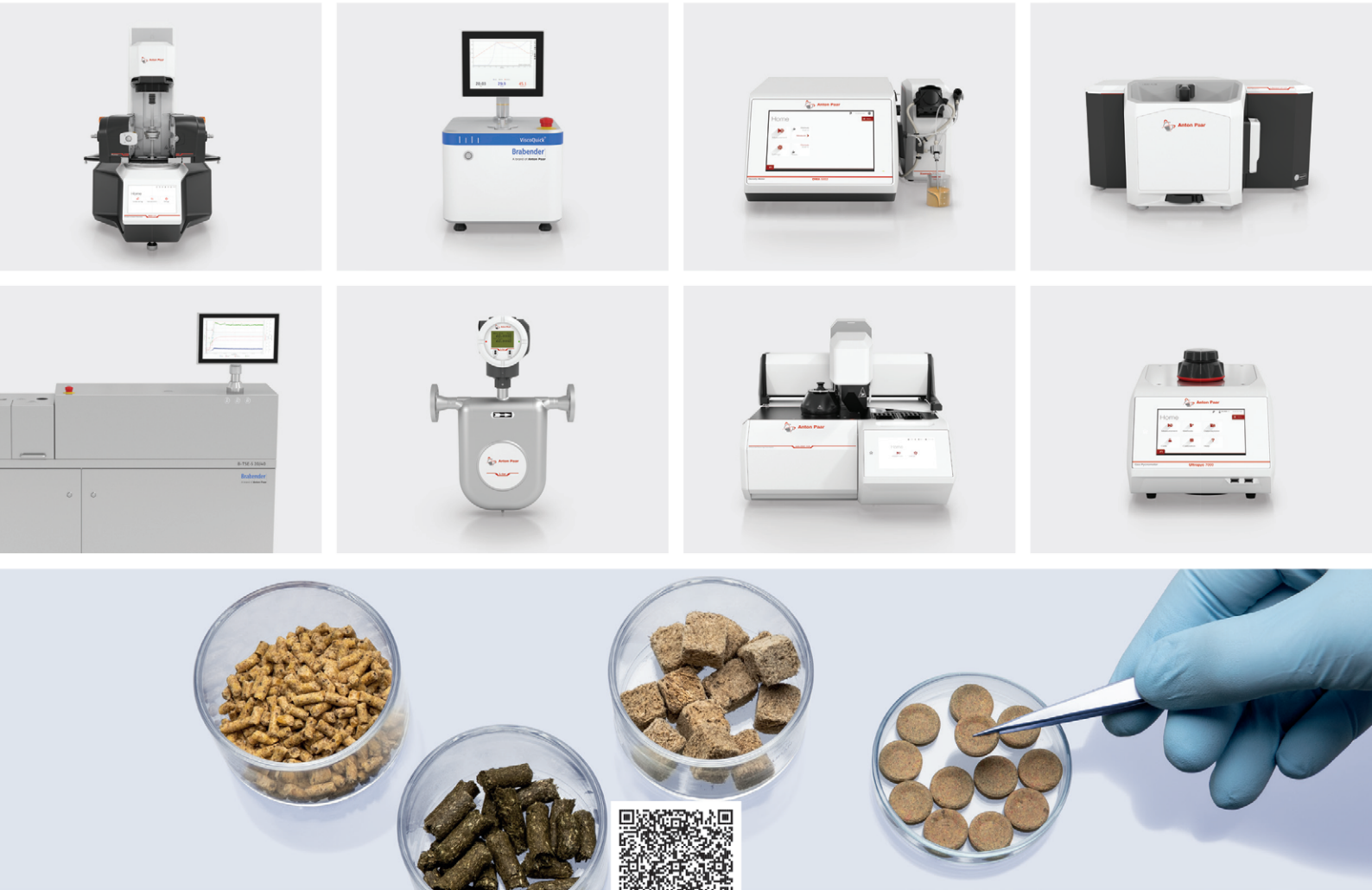
Foot-and-mouth disease, avian influenza and African swine fever can close markets almost overnight. Animal health systems must therefore be treated as economic infrastructure.

More than a livestock strategy

'Grain on legs' is a demand development strategy for South Africa's grain, oilseed, and feed industries. The model shows that doubling current exports of five animal protein categories could generate demand for an additional 365 000 tonnes of feed. That means additional throughput for feed mills, greater demand for maize and oilcake, more work for transporters, and stronger activity across livestock and processing businesses.

Raw grain exports will remain essential, but where South Africa can convert grain into animal protein competitively, it should capture the additional value before the product leaves the country. The future of grain demand may not always move by rail or ship as a raw commodity. Sometimes, it will leave the country on hooves, trotters, feathers, or inside an eggshell. ❖

Contact the author at dirks@grainsa.co.za for more information.



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The history of the *Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947*

By Herman van Zyl, portfolio manager, Afri Compliance,
and former national head of Inspection Services,
Department of Agriculture

It can be accepted with certainty that today's *Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947* (Act 36 of 1947) originated from the *Fertilizers, Farm Foods, Seeds and Pest Remedies Act, 1921* (Act 21 of 1917). Act 36 has been amended several times over the years, the most significant of which was arguably the control over 'pest control operators', effective from 1980. Other amendments were considered minor as they did not relate to implementation or application.

The Act also contained no technical details; consequently, development could still be implemented via regulations to this day.

Enforcement of the Act

From 1948 until 1980, the application of the Act and its regulations was limited to administrative actions and to selected cases referred to the authorities for investigation and prosecution. These attempts were mostly unsuccessful, as police officers and prosecutors struggled significantly with the required investigation methodology.

Inspection service

This gave rise to the need to establish a specialised unit to comprehensively implement the Act. From the mid-1970s, momentum for establishing such a unit began to build. Various investigations were launched and, consequently, such a unit came into operation in April 1980.

Regional offices were established in all the former provinces of Transvaal, Natal, and the Cape. At that stage, it was based on the number of registration holders per province.

Training sessions were launched, and a decision was made to implement a 12- to 15-month observation period before stricter measures would follow. The implementation also entailed a comprehensive quality-control programme, and the Department of Agriculture had its own laboratories at its disposal. Furthermore, officials were exceptionally well-equipped in terms of vehicles, equipment, and operational budgets.

Following the phasing-in period, conditions were evaluated, and training programmes were developed in collaboration with the Department of Justice and the College of Justice. These were rolled out annually, accompanied by examinations.

Some officers were selected for formal prosecutor training. By the year 2000, the law-enforcement division had developed to the point where it had the capacity to handle the entire process, from investigation through to the actual role prosecution. At the time,



the unit was widely regarded as the best of its kind in the entire public service.

Repeal of Act 36 of 1947

Towards the end of 1998, Act 36 faced a threat to its existence – a one-sided attempt to incorporate large parts of Act 36 into a new law succeeded: the *South African Medicines and Medical Devices Regulatory Authority Act, 1998* (Act 132 of 1998), or the SAMMDRA Act. This was initiated by a technical advisor at the time and a university professor, both of whom were well connected with officials from the Department of Health.

In short, it would place all stock remedies and farm feeds containing stock remedies under the control of the SAMMDRA Act. Act 36 was subsequently stripped of key mechanisms, rendering it unenforceable. However, the SAMMDRA Act was challenged by various role-players, resulting in it being put on hold by 2002. It never came into effect, however, and the originators lost interest in the Act.

Looking to the future and proposed developments, a fitting conclusion would be: Act 36 – QUO VADIS! ❖

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The power of collective strength

By Wimpie Groenewald, membership liaison officer, AFMA

South Africa's animal feed industry is one of the critical, yet often unseen, foundations of national food security. Every litre of milk, tray of eggs and kilogram of meat depends on one essential input, namely safe, scientifically formulated animal feed. By linking crop production with animal production, the feed industry plays a central role in supporting the reliable supply of affordable, high-quality animal protein.

As the recognised representative body of South Africa's formal animal feed industry, the Animal Feed Manufacturers Association (AFMA) brings together feed manufacturers, suppliers, researchers, regulators and value-chain partners to promote feed safety, responsible industry practices, and a competitive and sustainable sector. In a complex regulatory, economic and global trading environment, the value of belonging to a credible industry association has never been more important.

Many of the issues affecting feed manufacturers, such as legislation, regulatory compliance, raw material availability, trade, sustainability and food safety, cannot be addressed effectively by individual companies alone. They require a coordinated and credible industry voice.

Representing around 58% of South Africa's commercial animal feed production, AFMA advocates on behalf of its members through ongoing engagement with government, regulatory authorities, research institutions, commodity organisations, and international feed bodies. This helps ensure that industry perspectives are represented in discussions that influence policy, regulation, and the broader operating environment.

Supporting safe feed for safe food

Consumer confidence in animal-derived food starts with confidence in animal feed. AFMA's guiding principle of 'safe feed for safe food' reflects the association's commitment to promoting responsible

feed manufacturing throughout the feed-to-food value chain.

Through the *AFMA Code of Conduct* and related industry initiatives, members are encouraged to uphold high standards of legal compliance, good manufacturing practice, traceability, risk management, and promote continuous improvement. Membership therefore demonstrates a commitment to quality, responsibility, and professionalism while strengthening the reputation of individual businesses and the formal animal feed industry.

Information that adds value

In a fast-changing industry, informed decisions depend on reliable and relevant information. AFMA collects and analyses production statistics and raw material usage data submitted by participating members, providing industry-level market intelligence that helps businesses monitor production trends, anticipate demand, assess raw material requirements, and identify emerging opportunities and risks.

Regular industry reports, market insights and technical updates provide members with practical information that supports strategic planning, benchmarking, and informed business decisions.

Developing skills for the future

A successful feed industry depends on skilled people as much as it depends on modern technology. Through the AFMA Feed Academy, technical workshops, workplace learning programmes and student development initiatives, AFMA helps develop the knowledge and skills needed to support operational excellence, compliance, and future industry capability.

Training opportunities cover feed manufacturing, feed safety, regulatory compliance, operational excellence and professional development, helping members build capable teams while supporting the sustainability of the sector.

More than membership

AFMA membership is about more than representation – it is about belonging

to a professional network committed to strengthening South Africa's feed industry. Members gain opportunities to collaborate with manufacturers, suppliers, researchers, universities, producer organisations, and policymakers through the AFMA Forum, specialist committees, workshops, and *AFMA Matrix*. These platforms encourage the sharing of knowledge, innovation, and practical solutions to shared common industry challenges.

Membership also enhances business credibility and visibility. Being associated with South Africa's recognised representative body for the formal animal feed industry shows a commitment to responsible business practices, continuous improvement, and industry leadership.

AFMA offers membership categories designed to support participation across the feed-to-food value chain:

- **Full membership** is available to animal feed manufacturers that meet the association's governance and compliance requirements.
- **Associate membership** is intended for businesses that supply products and services to the feed manufacturing industry.
- **Affiliate membership** welcomes organisations linked to the broader agricultural and feed value chain.

Building the future together

South Africa's demand for safe and affordable animal protein continues to grow. Meeting that demand requires collaboration, scientific innovation, skilled people, and responsible industry leadership. AFMA provides the platform where these elements come together.

Membership is more than joining an association – it is becoming part of the collective voice shaping the future of South Africa's animal feed industry. ❖

For enquiries, contact the author at admin@afma.co.za

Tee off with SAPPO's Pig & Putter Golf Day



Block out your calendars for 24 November 2026 when the South African Pork Producers' Organisation (SAPPO) will be launching an exciting new tradition with the inaugural Pig & Putter Golf Day at the picturesque Magaliespark.

More than just a day on the golf course, the Pig & Putter Golf Day will bring together the entire pork value chain in a relaxed environment where relationships can be strengthened, new connections forged, and business conversations continue beyond the boardroom.

Whether you're a producer, nutritionist, veterinarian, supplier, processor, financial partner or service provider, this event offers the perfect opportunity to spend quality time with colleagues and customers while enjoying one of South Africa's favourite pastimes.

A day of networking and opportunity

The industry's response has already exceeded expectations, with leading companies securing sponsorships to help make this inaugural event a memorable success. Their enthusiastic support reflects the value of creating opportunities for collaboration and networking outside the traditional conference environment.

A limited number of sponsorship opportunities and four-balls are still available, providing an excellent platform for businesses to showcase their brands, host clients, and engage directly with industry decision-makers. From branded hole activations

and competitions to prize sponsorships and networking opportunities, there are numerous ways to become part of the experience.

More than just a round of golf

Golfers can look forward to a professionally organised day featuring golf carts, halfway refreshments, exciting competitions, prize-giving, and an evening dinner where players, sponsors, and guests can celebrate the day's highlights together.

As SAPPO's first golf day, this promises to be one of the standout networking events on the agricultural calendar and the beginning of what we hope will become an annual tradition for the South African pork industry.

We extend our sincere appreciation to the companies that have already committed their support, including DanBred Africa, Lynca Meats, Vitam International, Elanco Animal Health, Hipra Southern Africa, Chemuniqué, PIC Africa, FNB, Trouw Nutrition South Africa, DIAG Import & Export, B&T Steel, Nutrochem, TLU-Agri, Bupo Animal Health, Cargill, and Meadow Feeds.

Join us on the fairway and be part of history as SAPPO tees off its very first Pig & Putter Golf Day. ❖

For bookings or sponsorship enquiries, contact events@sappo.org



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24 NOVEMBER 2026

Magalies Park Golf Course

Email events@sappo.org to book your sponsorship & 4-ball today and be part of history!



Jamie Fourie: 2026 AFMA Intervarsity Writer's Cup winner

The Animal Feed Manufacturers Association (AFMA) congratulates Jamie Fourie of Stellenbosch University, who has been named the winner of the 2026 AFMA Intervarsity Writer's Cup. Her article "Zinc source matters: Broiler zinc requirements under a high dose of phytase" achieved the highest overall score among the category-winning articles evaluated after three competitive rounds during 2026.

Jamie's article examined how the source of supplemental zinc affects the zinc requirements of modern broilers when a high dose of phytase is included in the diet. The study involved 5 760 Ross 308 broilers allocated to seven dietary treatments. Birds received either no supplemental zinc or 30, 60, or 90 ppm zinc supplied as zinc sulphate or a zinc amino acid complex. All diets contained 2 000 FTU/kg phytase.

Zinc source affects broiler performance

The results showed that the zinc source influenced the birds' response. Broilers receiving 60 ppm zinc from the amino acid complex achieved the highest bodyweight and showed strong feed conversion and carcass results. The estimated zinc requirement for optimal bodyweight up to 37 days was 44 ppm

when the amino acid complex was used, compared with 98 ppm for zinc sulphate.

The findings indicate that zinc supplementation may be reduced when high phytase doses are used, particularly when zinc is supplied from a more bioavailable organic source. The research also shows why zinc source and phytase strategy should be considered together when formulating modern broiler diets.

Congratulations to Jamie and her promoter Prof Christine Jansen van Rensburg on this achievement. Her article is an excellent example of research being translated into clear and relevant information for the animal feed industry. ♦

Jamie Fourie.

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First place went to Team Trouw Nutrition. From the left are Liesl Breytenbach, executive director of AFMA, Johnny Esterhuizen and JW van Niekerk of Trouw Nutrition, Karla Zietsman of SAPPO, and Jaco van der Westhuizen of prize sponsor, Graininvest. Absent: Kyle Westergaard of Epol.



Team Cargill RSA was second. From left to right are Liesl Breytenbach, executive director of AFMA, Paul Saunders of Sovereign Foods, Anina Hunter, chairperson of AFMA, Gavin Schultze of Cargill, Jaco van der Westhuizen of prize sponsor, Graininvest, and Johan van Heerden of Cargill. Absent: Tanya Erwee of Premier Foods.

Celebrating women and driving connections at the AFMA Golf Day 2026

By Cilé-Mari Bredenkamp

The annual AFMA Golf Day took place at Centurion Country Club on 5 August, bringing 140 golfers together for a day of golf, networking, and good company.

With the event taking place during National Women's Month, the theme was carried through to the course, with sponsors adding their own creative touches to the day. From themed displays and giveaways to games and photo opportunities, there was plenty happening between rounds of golf.

The AFMA Golf Day Spirit Award was presented to the Envarto crew, recognising their enthusiasm and sporting spirit throughout the day.

On the leaderboard

The competition was close, with the top three teams finishing as follows:

- **First place:** Team Trouw Nutrition consisting of JW van Niekerk (Trouw Nutrition), Johnny Esterhuizen (Trouw Nutrition), Karla Zietsman (SAPPO), and Kyle Westergaard (Epol).
- **Second:** Team Cargill RSA with Paul Saunders (Sovereign Foods), Gavin Schultze (Cargill), Johan van Heerden (Cargill), and Tanya Erwee (Premier Foods).
- **Third:** Team Chem-Nutri Analytical with Chantelle Fryer (Orchem), Willem Wolfaardt (TWK Agri), Johan Gouws (TWK Agri), and André Cornelius (Orchem).

The individual honours went to:

- **Closest to the pin – ladies:** Tanya Erwee, Cargill RSA.
- **Closest to the pin – men:** Johan Scholtz, Free State Oil.
- **Longest drive – ladies:** Zelani Wessels, Epol.
- **Longest drive – men:** Marius Els, Bühler.

The Golf Day prizes were sponsored by Graininvest. Congratulations to all the winners and to everyone who took part in the day. AFMA also thanks all the sponsors, golfers, guests, service providers, and the Centurion Country Club team for their contributions. AFMA looks forward to welcoming the industry back to the fairways in 2027. ❖



Third Place went to Team Chem Nutri. From the left are Anina Hunter, chairperson of AFMA, Liesl Breytenbach, executive director of AFMA, Chantelle Fryer of Orchem, Jaco van der Westhuizen of prize sponsor, Graininvest, and Willem Wolfaardt and Johan Gouws of TWK Agri. Absent: Andre Cornelius of Orchem.



Johan Scholtz of Free State Oil won the closest-to-the-pin competition in the men's section. To his right is Jaco van der Westhuizen of prize sponsor, Graininvest.



Zelané Wessels of Epol won longest drive in the ladies section. Here she is with Jaco van der Westhuizen of prize sponsor, Graininvest.



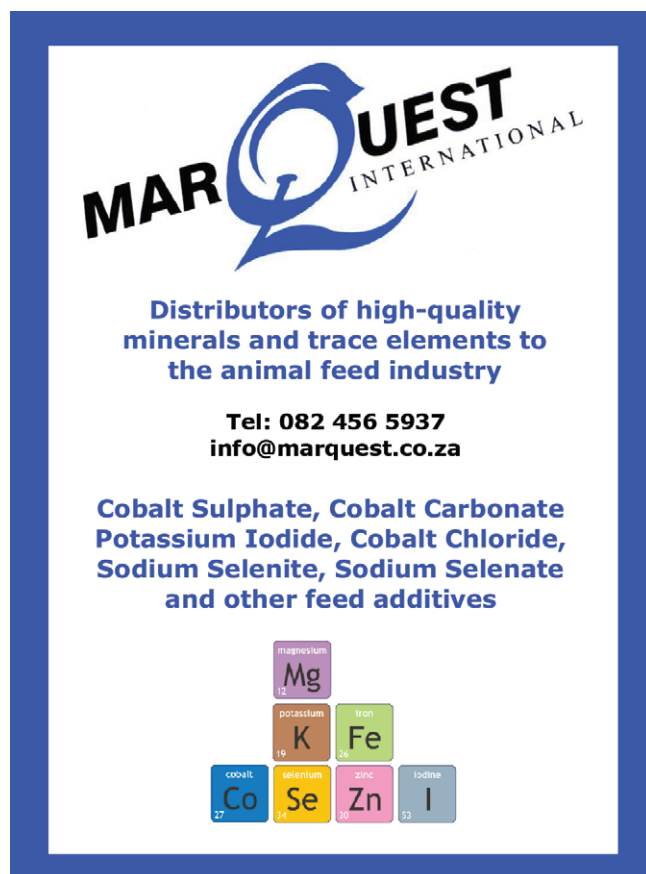
Team Envarto won the spirit award at this year's AFMA golf day. In the photograph below, from the left, are Alma Schiebusch, Vaudette van der Merwe, Liesel Breytenbach of AFMA, Judi Rosenstrauch, and Jacolien Oellerman.




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The Feed Factor Nobody Talks About: Why Better Decisions Will Shape the Future of Animal Production

The animal feed industry has always been exceptionally good at solving technical problems.

Over the past few decades, we have improved formulations, feed safety standards, nutritional modelling, ingredient technologies, production efficiencies and biological performance at a pace few industries can match.

Today, producers, nutritionists, veterinarians and feed manufacturers have access to more information than ever before. Artificial intelligence is also beginning to influence how information is analysed and applied throughout the value chain.

From a technical perspective, the animal nutrition industry has never been better equipped. Yet the challenge is no longer access to information. If anything, the industry is overwhelmed by data, products, recommendations and research findings that are abundant but difficult to navigate.

One challenge remains consistent: determining which information truly matters, what actions should be taken, and how scientific understanding can be translated into better decisions that improve performance.

Information has little value on its own. Its value emerges when it deepens understanding, shapes decisions and drives meaningful action. Science creates value when it delivers better outcomes.

The real challenge lies in practical application. It requires the ability to interpret complexity, challenge conventional thinking, apply independent judgement and translate scientific understanding into better decisions that produce measurable results.

Every decision made within the value chain carries consequences. Decisions about nutrition, health, feed efficiency, sustainability and risk management determine biological performance, profitability and long-term resilience. This is where independent thinking becomes indispensable: the ability to distinguish what truly matters, simplify complexity and translate scientific knowledge into measurable results.

As the animal nutrition industry embraces digital transformation, artificial intelligence will reshape the way we work. It can analyse vast datasets, uncover patterns and support decision-making. However, it cannot replace judgement or understand the biological realities that shape decisions on the farm or in the feed mill. Technology can inform decisions, but people remain responsible for making them.

This is the thinking behind REVO's positioning, Practical Science: not as an alternative to technology, but as the discipline of translating scientific insight and technological capability into practical decisions that deliver measurable results.

Practical Science is not about generating more complexity, data or research. It is about translating scientific understanding into practical solutions that work under commercial production conditions. It is where validated science meets practical application, biological understanding becomes management action, and understanding enables better decisions that create measurable value.

As scientific knowledge expands, those who can distinguish what truly matters and translate scientific understanding into practical, science-based solutions will be best positioned to create lasting value. Producers do not invest in science for its own sake. They invest in practical solutions that improve animal health, feed efficiency, profitability and sustainability.

In the end, the true value of science is not measured by what we discover, but by what it enables us to do. Science creates its greatest value when it improves understanding, strengthens judgement and leads to better decisions that improve biological performance and deliver measurable value.

In an industry challenged to feed a growing global population more efficiently and sustainably than ever before, Practical Science may prove to be one of the industry's greatest competitive advantages because it transforms scientific understanding into practical action, practical action into measurable results and measurable results into lasting value.

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The impact of methane inhibitors on ruminants: A systematic review and meta-analysis

By Guanghui Hu, Jian Gao, Varijakshapanicker Padmakumar, Najuma Joshi, Weiyun Zhu and Yanfen Cheng

The methane emissions from ruminants account for about one-third of global anthropogenic greenhouse gas (GHG) emissions, with 88% originating from the digestive tract of ruminants and the remainder from manure fermentation, and the energy loss resulting from this process accounts for 2 to 12% of the total energy intake of ruminants (Ungerfeld and Pitta, 2025; Xie *et al.*, 2025). This will not only lead to a further increase in global temperatures but also result in a decrease in feed energy utilisation efficiency.

The application of methane inhibitors is expected to alleviate this dilemma. The current methane reduction strategies mainly include pasture management, diet regulation, and the addition of methane inhibitors (Smith *et al.*, 2022). The main types of methane inhibitors include lipids, ionophores, nitrates, plant secondary metabolites, saponins, essential oils, tannins, halogenated methane analogues, probiotics, prebiotics, and others (Fouts *et al.*, 2022).

Mechanisms of methane production

The production of methane in the rumen occurs in three main stages. In the first stage, after ruminants consume their diet, hydrolytic or fermentative microbial communities break down the polymers in the cell walls into organic acids, alcohols, hydrogen, and carbon dioxide. In the second stage, acetate-producing microbes use the products from the first stage to generate acetate and hydrogen, providing energy for bacterial growth. In the third stage, methane producing archaea use the products from the previous two stages to generate methane and carbon dioxide (Mackie *et al.*, 2024).

The electrons produced during rumen fermentation combine with NAD^+ , and these electrons are transferred by microorganisms carrying H_2 -evolving

hydrogenases in the rumen. They couple with reduced ferredoxin to produce H_2 (Xie *et al.*, 2025). The pyruvate produced from carbohydrate metabolism in the rumen tends to form acetate when the partial pressure of hydrogen is low. This is because the thermodynamic reaction of NADH (reduced form) oxidation to produce hydrogen gas is nonspontaneous, unless the hydrogen concentration is low, in which case the hydrogen gas produced by this reaction is used by methanogens to produce methane. When the hydrogen concentration is high, pyruvate forms propionate and even butyrate, iso-butyrate, lactic acid, and other products.

The hydrogenotrophic methanogens generate methane using hydrogen and methyl or carbon dioxide under the action of methyl-coenzyme M reductase (MCR; Pitta *et al.*, 2022a). The hydrogenotrophic pathway is the main route for methane production in the rumen (Mackie *et al.*, 2024). The MCR of methanogenic archaea is composed of three subunits: α , β , and γ , which are encoded by the *mcrA*, *mcrB*, and *mcrG* genes, respectively. In the final step of methane generation, it reduces substrates such as carbon dioxide, formate, methyl compounds, and acetate to methane. The inhibition of MCR activity is considered a key point in controlling methane emissions (Kumar *et al.*, 2009; Duin *et al.*, 2016).

According to current research, methods for reducing methane emissions can be divided into two categories. The first category is to reduce the availability of hydrogen (Hristov *et al.*, 2022). When the rumen produces propionate, protons are consumed, whereas the production of acetate is a process that generates protons (Czatzkowska *et al.*, 2020). Therefore, propionate-type fermentation leads to a reduction in methane production.

For example, a high-concentrate diet can lead to an increase in hydrogen partial pressure, enhanced pyruvate metabolism, increased production of

reductive propionate, and a decrease in the concentrations of acetate, carbon dioxide, and other compounds (Mackie *et al.*, 2024). Additionally, providing hydrogen acceptors or sinks is also an important method for reducing methane production (Sejian *et al.*, 2011). Representative substances are nitrates, which are competitive electron acceptors with methyl groups and carbon dioxide, offsetting the reducing equivalents of hydrogen during fermentation (Božic *et al.*, 2009).

Another important method is to provide inhibitors that directly suppress the activity of methane-producing microorganisms in the rumen, thereby inhibiting methane production. For example, medium- and long-chain fatty acids inhibit methane production by disrupting the cell membranes of methanogens, thereby reducing their activity. Among them, medium-chain fatty acid lauric acid inhibits methane production by 89% *in vitro* and by 76% *in vivo* (Machmüller *et al.*, 2002; Soliva *et al.*, 2003; Božic *et al.*, 2009).

Furthermore, MCR, as the key enzyme catalysing the final step of methane production by reducing methyl-CoM to methane, plays a central role in the methane generation pathway. Due to its significance, many studies target MCR as a primary point of inhibition to reduce methane production (Dinh and Allen, 2024).

Effects of methane inhibitors

According to current research, there is no consensus on the effect of methane inhibitors on ruminants. The effects of methane inhibitors on ruminants cannot be generalised. This is mainly influenced by various factors such as the type of methane inhibitor, the dosage of the inhibitor, the species of livestock, and the physiological condition of the animals (Liu *et al.*, 2025). Furthermore, even for the same type of inhibitor, contradictory research results may exist. For example, in Almeida *et al.* (2023), the final BW increased gradually with the

addition of 3-nitrooxypropanol (3-NOP), although the difference was not significant, whereas the results from Meale *et al.* (2021) were opposite this result.

There are also some common issues regarding the effect of the same type of inhibitor on the rumen microbial structure. For example, in Patra and Yu (2015), saponins led to a significant increase in the total number of bacteria in the rumen, whereas in Ramírez-Restrepo *et al.* (2016), a notable significant decrease in the total bacterial count was observed.

Therefore, the aim of this study is to collect data from published research and conduct a comprehensive analysis of the effects of methane inhibitors on ruminant intake, digestion, growth, rumen fermentation, and the rumen microbial community structure.

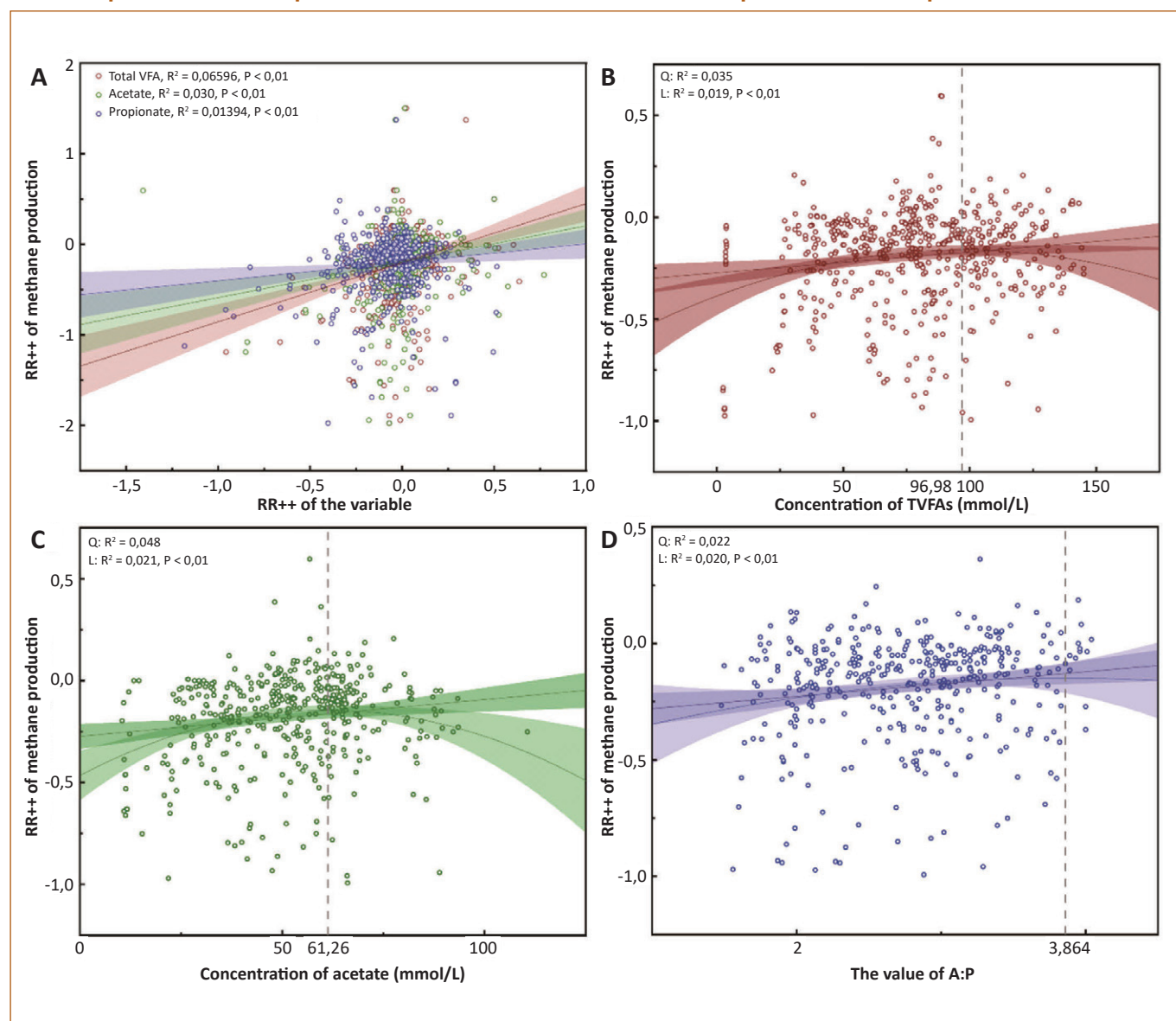
Results

Publication bias assessment

We generated funnel plots for each effect size and performed Egger's test to assess publication bias in the included results.

Among all 94 metrics evaluated, the majority of funnel plots exhibited good symmetry; however, Egger's test results suggested potential publication bias in 21 metrics ($P < 0,05$), including: CP intake, NDF intake, BW, methane, microbial Chao1, archaeal β -diversity, bacterial structure, protozoan α -diversity, archaeal structure, *Butyrivibrio*, *Bacteroides*, *Tenericutes*, *Pseudobutyrvibrio*, *Selenomonas*, *Methanobrevibacter*, *Succinivibrio*, protozoa, methanogen, *Butyrivibrio fibrisolvens*, and *Butyrivibrio proteoclasticus*.

Figure 1: The linear relationship between methane production and TVFA, acetate acid, and A:P. (A) The trend relationship between methane production and TVFA, acetate, and A:P. (B) The linear relationship between methane production and TVFA. (C) The linear relationship between methane production and acetate. (D) The linear relationship between methane production and A:P.



The R^2 represents the coefficient of determination, Q represents the quadratic curve, and L represents the linear curve. The dashed line represents the value on the x-axis at the vertex of the quadratic curve. The shaded area in the figure indicates the 95% CI.



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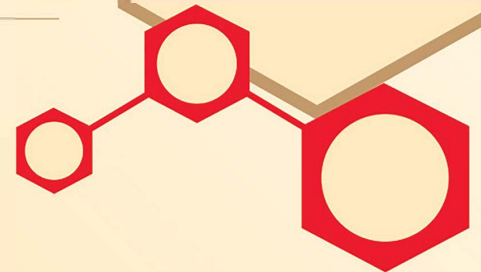
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To mitigate the effect of publication bias, we applied a Z-score filter to the results. Effect sizes with an absolute Z-score greater than three were considered outliers and were excluded from the meta-analysis.

Effects on ruminant performance

Although the addition of methane inhibitors did not significantly reduce DMI and OM intake in ruminants ($P > 0,05$), the intake of feed was reduced. Similarly, the digestibility in ruminants generally decreased, especially with the digestibility of OM, CP, NDF, and ADF, which all significantly decreased ($P < 0,05$). The addition of methane inhibitors did not have a significant effect on BW ($P > 0,05$). In rumen fermentation, the addition of methane inhibitors significantly reduced the production of acetate, caproic acid, and lactic acid ($P < 0,05$). The ratio of acetate to propionate (A:P) was also significantly reduced ($P < 0,05$).

In other effect sizes, the H_2 production significantly increased ($P < 0,05$), whereas the total gas production, methane, and carbon dioxide (CO_2) significantly decreased ($P < 0,05$). Additionally, hydrogen production and propionate levels significantly increased ($P < 0,05$).

Relationship between effect sizes and methane

The effect sizes of ruminant performance showed no significant correlation with methane yield ($P > 0,05$). The relationship between rumen fermentation effect sizes and methane yield showed significant positive correlations with total VFA (TVFA), acetate, and the A:P ($P < 0,05$), whereas correlations with other effect sizes were not significant ($P > 0,05$).

Additionally, α -diversity of the rumen microbial community showed no significant correlation with methane yield ($P > 0,05$), and neither did the relative richness structure nor relative richness β -diversity ($P > 0,05$).

Linear relationship between major effect sizes and methane emissions

Methane production gradually increases with the rise in TVFA, acetate, and the value of A:P. When fitting a quadratic polynomial model, the peak of the quadratic fitting curve between methane and acetate was 61,26mmol/L ($R^2 = 0,48$, $P < 0,01$), the peak of the quadratic fitting curve between

methane and TVFA was 96,98mmol/L ($R^2 = 0,035$, $P < 0,01$), and the peak of the quadratic polynomial fitting curve between methane and the value of A:P was 3,86 ($R^2 = 0,021$, $P < 0,01$; Figure 1).

Discussion

Conducting a systematic risk-of-bias assessment is an essential component of the literature screening process. The asymmetry observed in the funnel plots, coupled with significant Egger's test results, suggests potential under-publication of small-scale or statistically nonsignificant negative outcomes. This may lead to systematic overestimation of the overall effect size (Afonso *et al.*, 2024).

To evaluate the potential effect of this bias on the robustness of our conclusions, we performed a sensitivity analysis applying a Z-score criterion to identify and exclude extreme outliers. After removing outliers, the core effects remained stable and statistically significant. Furthermore, the preliminary conclusions of this study were not unduly influenced by individual extreme studies.

Effects on animal performance

The reduction of methane not only helps control GHG emissions but also reduces energy losses in livestock (Kennedy and Charmley, 2012). It is important to note the effect of adding methane inhibitors on the intake, digestion, and growth performance of ruminants. Assuming that the addition of methane inhibitors has a positive effect on feed intake, digestion, and growth of livestock, or that the reduction in methane production can offset its negative effects, it is considered that the methane inhibitors are beneficial to the performance of livestock. In fact, methane inhibitors reduce the feed intake of ruminants, but most studies suggest that their effect is not significant (Martinez-Fernandez *et al.*, 2016; Araújo *et al.*, 2023).

At the same time, the addition of methane inhibitors can lead to a decrease in the feed digestibility of livestock (Morgavi *et al.*, 2023). The energy contained in the reduced methane cannot be simply redistributed and produced, which means that adding methane inhibitors does not improve animal performance (Ungerfeld, 2018). Our research results also support this, indicating that the energy from reduced methane emissions may not offset

the negative effects of decreased feed intake and digestibility, as the increase in BW is not statistically significant ($P > 0,05$).

Previous studies have shown that the addition of methane inhibitors leads to the accumulation of H_2 in the rumen, and high concentrations of H_2 could inhibit microbial dehydrogenase activity, resulting in decreased feed intake and digestibility (Janssen, 2010). This is consistent with our research findings.

The VFA in the rumen are also influenced by the partial pressure of hydrogen gas. When the partial pressure of hydrogen is high, it favours the production of propionate, although the opposite is true when the partial pressure of hydrogen is low, favouring the production of acetate (Roque *et al.*, 2019; Glasson *et al.*, 2022). The total VFA content is not affected by the addition of methane inhibitors (Morgavi *et al.*, 2023). Relevant studies indicate that, compared with higher rumen pH values, lower rumen pH values lead to a reduction in methane emissions from dairy cows, with lower pH even resulting in a 54% decrease in methane emissions (Della Rosa *et al.*, 2024).

Shifts in microbial communities

For bacteria, researchers are more focussed on the changes in fibre-degrading bacteria. For the rumen microbiota structure, the addition of methane inhibitors does not affect the total bacterial count but leads to significant changes in bacterial composition (Jayanegara *et al.*, 2018; Kim *et al.*, 2020). Due to the change in acetate production to propionate production caused by methane inhibitors, it is estimated that the number of propionate-producing bacteria will increase (Ungerfeld and Pitta, 2025).

This study observed an increase in the number of *Prevotella*, but the change in the number of *Selenomonas* was not significant. The potential reason is that the genus *Prevotella* encompasses multiple metabolically versatile species capable of utilising hydrogen to promote propionate production (Betancur-Murillo *et al.*, 2022), which may confer a competitive advantage under high-hydrogen conditions. In contrast, although certain *Selenomonas* species are also involved in propionate synthesis, their growth appears to rely more heavily on specific substrates such as lactate or succinate, rather than direct hydrogen

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utilisation (Cabral and Weimer, 2024). Consequently, their response to changes in hydrogen partial pressure is less pronounced than that of *Prevotella*.

The main fibre-degrading bacteria in the rumen include *Fibrobacter succinogenes*, *Ruminococcus flavefaciens*, and *Ruminococcus albus*. These bacteria may be inhibited due to the influence of hydrogen partial pressure. However, because *Fibrobacter succinogenes* does not produce hydrogen, it is not affected by methane inhibitors, whereas *Ruminococcus flavefaciens* and *Ruminococcus albus* may be inhibited due to the accumulation of hydrogen (Mitsumori *et al.*, 2012). This is consistent with the results of this study.

For archaea, suppressing methane production will reduce the abundance and composition of rumen archaea (Ungerfeld, 2018; Ungerfeld and Pitta, 2025). This study indeed observed a decrease in archaeal α -diversity and an increase in β -diversity. The number of *Methanobrevibacter*, among others, is not necessarily affected by methane inhibitors but is influenced by a combination of factors such as animal age, species, physiological state, and the type of methane inhibitor used (Martinez-Fernandez *et al.*, 2017, 2018).

The decrease or increase in protozoa abundance is not absolute (Dai and Faciola, 2019), and this may be related to the type of additives used. Protozoa provide the necessary hydrogen for methane production, and studies have shown that even in cases of hydrogen accumulation in the rumen, methane inhibitors do not lead to a decrease in protozoa numbers (Jayanegara *et al.*, 2018; Kim *et al.*, 2020); although other studies have reported that methane inhibitors can reduce the number of protozoa (Ando *et al.*, 2003; Guyader *et al.*, 2014).

Methane inhibitor type and dosage

Different methane inhibitors reduce methane emissions in different ways, and there are also differences in the effects of different doses of methane inhibitors on livestock. The different effects of various methane inhibitors may be due to their action on different mechanisms within the livestock gut microbiota. For example, 3-NOP, as a methyl-CoM analogue, inhibits methane production and simultaneously reduces the relative abundance of *Methanobacteria* (Pitta *et al.*, 2022b).

Saponins can bind to sterol-like substances on the surface of protozoa, causing cell lysis (Goel *et al.*, 2008), whereas essential oils not only inhibit the growth of protozoa but also increase the abundance of *Bacteroides* sp. and *Succinivibrio* sp. (Lei *et al.*, 2019; Martins *et al.*, 2024).

Furthermore, the dose of these inhibitors affects the extent of microbial activity suppression. Higher doses may lead to more pronounced effects but could also result in potential side effects, such as changes in feed intake or overall animal health. In contrast, lower doses may be less effective at reducing methane emissions but carry fewer risks to the animals (Zhang *et al.*, 2021). These findings suggest that optimising the type and dose of methane inhibitors is crucial for achieving effective and sustainable methane reduction in livestock production.

Feed intake and digestion

The general view is that, without the addition of methane inhibitors, there is a significant correlation between methane emissions from ruminant animals and their feeding and digestion (McDonnell *et al.*, 2016). In our study, no significant correlation was observed between methane production and feed intake and digestion. A possible reason for this could be that the addition of methane inhibitors hindered the influence of feed intake and digestion on methane production.

However, the strong correlation between the concentration of VFA in the rumen and methane production may be used to simply predict methane output as an alternative to the current complex and cumbersome methane measurement methods (Niu *et al.*, 2021). Although there is a highly significant positive correlation between the total VFA, acetate, propionate, and methane production in the rumen, this relationship does not follow a simple linear pattern (Williams *et al.*, 2019). There is still no consensus on the specific concentrations of acetate and propionate in the rumen that would result in the maximum methane production efficiency.

Although we used linear models, including both first-order and second-order curves, to fit methane production with TVFA, acetate, and propionate, and obtained the threshold values for the variables that lead to the highest methane production, the R^2 value was relatively small.

The reason for this phenomenon is that the factors influencing methane production are not singular; they include genetic factors, diet quality, growth stages, environmental factors, and others (Wang *et al.*, 2025).

One molecule of glucose fermentation releases eight molecules of [H] when yielding acetate, whereas four molecules of [H] are consumed when producing propionate. Although thermodynamically lower concentrations of [H] in the rumen favour the production of acetate and methane, the formation of both acetate and methane in the rumen is in a dynamic equilibrium (Wang *et al.*, 2023). Excessively high acetate concentrations lead to a reduction in [H] concentration, thereby inhibiting methane production.

Although the fitted results in the study have limited biological significance, the variation does indeed follow a parabolic trend. Therefore, it is most effective to inhibit methane production only when the ratio of acetate concentration to propionate concentration in the rumen is below a certain level.

Conclusions

A comprehensive analysis of 256 articles collected for this study reveals that there are small differences in the overall effects of different methane inhibitors on ruminants. Moreover, the dosage of the inhibitor is more crucial than its type. The addition of methane inhibitors has a negative impact on the feed intake and digestion of ruminants, reduces the α -diversity of the rumen, but increases the β -diversity of the rumen, enhancing the stability of the overall microbial community structure in the rumen.

Given the nonlinear relationship between methane emissions and the A:P, the threshold effect of VFA, and the potential inhibitory effects of methane inhibitors on feed intake and nutrient digestibility in ruminants, we recommend adopting a low-dose, continuous feeding strategy in practice to achieve an optimal balance between emission reduction benefits and production performance. ❖

This open-source article was condensed for publication in *AFMA Matrix*. For the full article, doi.org/10.3168/jds.2025-27479 or send an email to yanfencheng@njau.edu.cn



A decade of growth, innovation and partnership:

Celebrating ten years of Trouw Nutrition South Africa

In 2026, Trouw Nutrition South Africa celebrates a major milestone: ten years of serving the livestock industry as part of the global Nutreco family. While the company officially began its journey in South Africa through the acquisition of Advit on 1 October 2016, its connection to the local agricultural sector extends much further back through longstanding technical collaborations and industry partnerships.

Over the past decade, Trouw Nutrition South Africa has grown from a respected local operation into an integral part of a global network focussed on advancing animal nutrition, feed safety, and sustainable food production. Throughout this journey, the company has remained committed to combining world-class expertise with local knowledge to help producers meet the evolving challenges of modern agriculture.

Building the foundation

The acquisition of Advit marked an important chapter in the development of Trouw Nutrition's presence in Southern Africa. However, the foundation had already been laid through years of technical engagement and knowledge sharing in the region. The acquisition created an opportunity to bring together local market understanding and customer relationships

with Nutreco's global research, technology, and innovation capabilities.

Following the acquisition, significant investment was made in facilities, systems, and people. Infrastructure upgrades, enhanced quality processes and expanded technical capabilities strengthened the company's ability to deliver value to customers while positioning the business for long-term growth.

As the business evolved, so too did its workforce and operational footprint. Continued growth required additional capacity and investment, reflecting confidence in both the South African market and the future of animal production across the region.

Growing with purpose

The livestock industry has changed considerably over the past decade. Producers face pressure to improve efficiency, optimise performance, maintain animal health, and operate more sustainably. These changing needs have driven Trouw Nutrition South Africa's evolution from a company primarily focussed on premixes and minerals to a provider of comprehensive nutritional and technical solutions.

Today, customers benefit from a broader portfolio that includes feed additives, young animal nutrition solutions,

and technical support services. In addition to products, the company provides expertise through on-farm support, laboratory services, mycotoxin analysis, and feed safety programmes designed to help producers make informed decisions.

This holistic approach reflects the simple philosophy of helping customers solve challenges rather than simply supplying ingredients. By understanding the realities of modern livestock production, the business has developed partnerships that contribute to long-term producer success.

Global expertise at a local level

One of the key advantages of being part of Trouw Nutrition and Nutreco is access to world-class research and development. With global expertise across the dairy, poultry and other livestock sectors, South African producers gain access to science-based solutions developed, tested and refined through international research programmes.

The company's role is not simply to transfer technology from one market to another. Rather, it is to adapt global knowledge to local conditions, ensuring that producers and feed manufacturers receive practical solutions that address the unique challenges of Southern African production systems.

This commitment extends beyond nutrition. International quality standards, traceability systems and feed safety protocols support product integrity throughout the supply chain. By combining these global systems with local expertise, Trouw Nutrition South Africa helps customers operate with confidence in an increasingly demanding industry environment.

Innovation driving purpose

Innovation has remained a cornerstone of the business throughout its first decade. The animal nutrition industry continues to evolve rapidly, requiring solutions that improve performance while supporting responsible production practices. Trouw Nutrition's global investment in research and development plays a critical role in addressing these challenges.

Across the organisation, innovation extends far beyond product development. Advances in feed safety, data-driven decision-making, animal health support, and management practices all contribute to helping producers improve productivity and profitability.

One area where this commitment has had a visible impact is calf rearing. Through research-backed nutritional programmes, technical support and specialised solutions, Trouw Nutrition has contributed to the advancement of calf-rearing practices in South Africa.

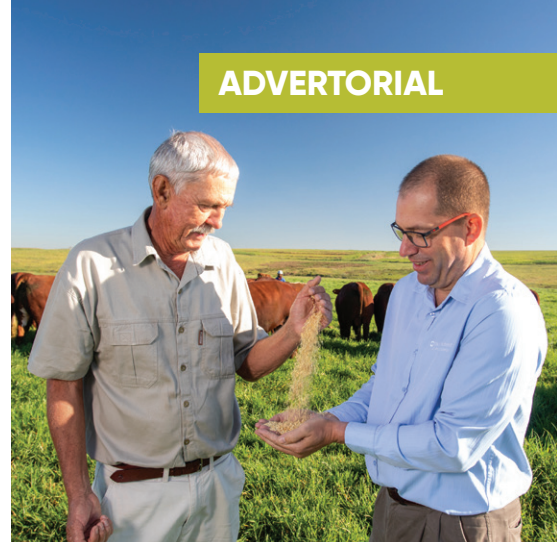
This focus demonstrates the company's broader goal of supporting livestock producers through both science and practical application

The business also continues to strengthen its capabilities in feed safety and quality assurance. Services such as laboratory support, nutritional analysis and specialised technical expertise help customers address complex production challenges while maintaining high standards throughout the value chain.

Feeding the future sustainably

As demand for animal protein continues to grow globally, sustainability remains one of the defining challenges facing agriculture. For Trouw Nutrition South Africa, sustainability is closely linked to innovation, efficiency, and responsible food production. Guided by the Feeding the Future ambition, the company works to support producers in meeting the nutritional needs of a growing population and reducing their environmental impact. This includes developing solutions that improve feed efficiency, support animal health, and contribute to more sustainable livestock systems.

The focus on antimicrobial reduction, feed safety and nutritional efficiency reflects a broader commitment to helping the industry navigate changing market expectations and regulatory requirements. Through science-based innovation and



Trouw Nutrition customers benefit from a broad portfolio that includes on-farm technical support services.

practical support, Trouw Nutrition aims to contribute to a future in which productivity and sustainability go hand in hand.

Looking ahead

Ten years is an important milestone, but it also represents the start of an exciting new chapter. Continued investment in facilities, people, and capabilities reflects Trouw Nutrition South Africa's confidence in the future of the agricultural sector. The company's growing footprint within Southern Africa and ongoing participation in wider African markets demonstrate its commitment to supporting livestock production across the continent.

As new technologies emerge and producer needs continue to evolve, Trouw Nutrition South Africa remains focussed on delivering practical, science-based solutions that create real value for customers. By building on a decade of growth, innovation, and partnership, the company is well-positioned to contribute to the future of sustainable animal agriculture for years to come.

"Our success over the past decade has been built on combining global expertise with local knowledge to help producers navigate an increasingly complex agricultural landscape."



Trouw Nutrition team members, showcasing the people behind the business.

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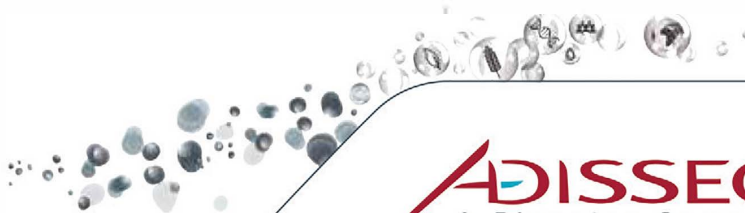
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Shielding dairy cows from heat stress: Why choosing the right antioxidant matters

By Drs Danielle Sherlock and Mohammed Amine Hachemi, global ruminant technical and scientific support managers, Adisseo

Heat stress (HS) is not only about panting and lower intakes – it is a systemic oxidative and inflammatory challenge. During HS, aspects such as respiration rate, core temperature, stress hormones, immune responses and blood markers of inflammation rise, and metabolic fuel is reallocated away from production, resulting in greater maintenance requirements and increased health risk. Moreover, decreased intakes mean there is a shortage of antioxidants to fight the increase in oxidative stress (OS) and inflammation. These metabolic changes also have long-term consequences on offspring performance when they are exposed to HS *in utero*.

While heat abatement strategies such as fans and soakers remain the first line of defence against HS, ensuring you have the right source of selenium (Se), methionine (Met) and vitamin E is essential to support the redox system and strengthen endogenous defences to fight OS, helping to maintain productivity and health of dairy cows.

What is oxidative stress?

The body produces reactive oxygen species (ROS) during its normal metabolic activity, and as part of the immune system's defence against invading microorganisms. If ROS or other free radicals are produced in excess, it leads to cellular damage of membranes, lipids, proteins, and DNA. To fight these free radicals, the body relies on antioxidants and the redox system. If there is an imbalance between excess free radical production and the availability of antioxidant defences, OS occurs.

There are numerous consequences of OS in cattle. One of the most studied is its effects on the immune system, where it is well-documented that OS disrupts neutrophil function and exacerbates inflammation, which increases

disease susceptibility. In the mammary gland, exposure to OS damages milk secretory cells, leading to reduced milk production and increased risk of mastitis. Meanwhile, in the reproductive tract, OS after parturition impairs immune function and induces excess inflammation, making cows more susceptible to metritis. Oxidative stress can be triggered by many factors (e.g. disease, transition period/calving, dietary issues), but as temperatures continue to rise, HS is becoming a common trigger.

From OS to lost production

Heat stress elevates the production of ROS, leading to OS and cellular damage. This increase in OS is the result of several physiological changes, such as metabolic adaptations that occur as the cow attempts to maintain homeostasis and dissipate excess heat. Additionally, HS is well-known to decrease feed intake, leading to reduced milk production.

However, this decrease in intake, as well as decreased blood flow to the gut as part of thermoregulation mechanisms, is also associated with disrupted intestinal barrier function (leaky gut), which is associated with increased passage of microorganisms into the bloodstream. This leads to activation of immune cells, resulting in increased ROS production and pulling more nutrients away from milk production to fuel the immune cells' energy demands.

Late gestation heat stress

The maternal environment is known to influence the dam and the development of her offspring. Over the last decade, we have learned that exposure of dry cows to HS is detrimental, not only to their health and lactation, but also to their offspring and future generations; the calf exposed to *in utero* HS during late gestation is born smaller and produces less milk in her lactation, as does her

future offspring. One factor driving these effects on multiple generations is OS, as maternal OS negatively affects foetal growth and offspring health. This makes mitigating HS-induced OS in transition cows critical for both the cow and calf.

Selenium and selenoproteins

Selenium is an essential trace element involved in multiple physiological processes, particularly antioxidant defence, immune function, and redox regulation. Its biological activity is primarily mediated through selenoproteins containing selenocysteine (SeCys) at their catalytic site, including glutathione peroxidases (GPx) and thioredoxin reductases, which play a central role in controlling ROS and maintaining cellular redox homeostasis.

However, it is important to consider the source of Se. Dietary Se can be supplied in inorganic (e.g., sodium selenite [SS]) or organic forms (e.g., selenised yeast [SY]) that contain variable proportions of selenomethionine (SeMet) and inorganic selenium species, as well as pure organic Se sources including SeMet and hydroxyselenomethionine (OH-SeMet).

Unlike other Se species, including SeCys, SeMet can be non-specifically incorporated into body proteins in place of Met, allowing the formation of a functional selenium reserve that can be mobilised during periods of increased oxidative challenge. Supplementation of OH-SeMet consistently improves Se status of dairy cows compared to inorganic sources or selenoyeast, and improves transfer of Se to calves, which supports newborn health. This reserve capacity is particularly relevant under stressful conditions such as HS to support the cow, as well as enhance antioxidant availability to the foetus.

Improvement of systemic redox status and maintenance of performance: In dairy cows exposed to HS, supplementation with OH-SeMet compared with SS during a 28-day feeding period followed by

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nine days of heat challenge resulted in a marked improvement in systemic redox status. This was evidenced by increased GPx activity and total antioxidant capacity, along with reduced circulating ROS and lipid peroxidation markers such as malondialdehyde (MDA). These improvements were associated with better maintenance of productive performance (+1,8kg milk yield with OH-SeMet vs SS) during HS.

Enhancement of antioxidant capacity and protection of the blood-milk barrier:

In a recent trial, 32 mid-lactation Holstein cows were fed total mixed rations containing either SS or OH-SeMet as the Se source for 30 days during HS exposure. The results demonstrated that OH-SeMet supplementation improved systemic antioxidant capacity and immune status, while upregulating the expression of tight junction proteins in the mammary gland (Figure 1). This protective effect on the blood-milk barrier contributed to alleviating heat stress-induced mammary damage and helped limit milk yield losses under thermal stress conditions.

Supporting antioxidant synthesis

Via its metabolism in the one-carbon metabolic pathways, Met supports the synthesis of the antioxidants glutathione (GSH) and taurine, giving it a role in mediating OS. Rumen-protected Met (RPM) supplementation has been well documented to improve defences against OS (more GSH and antioxidant enzymes) in transition cows, with recent work also reporting benefits during HS:

- **Lactating and transition cows:** RPM supplementation during HS improved markers of antioxidant synthesis, protected mammary cell integrity, and decreased inflammation. These improvements supported greater milk protein synthesis during lactation and the transition period.
- **The calf:** The immune-metabolic improvements in the transition cow mean that the calf is exposed to less inflammation and OS *in utero*, creating a more favourable environment for foetal growth. Indeed, Met supplementation during late gestation HS exposure led to taller heifers at birth, which was linked to a larger placenta with greater AA transfer compared to heifers from unsupplemented cows.

Lipid shield against peroxidation

Vitamin E is a chain-breaking antioxidant that interrupts lipid peroxidation in membranes, which is crucial under OS when ROS attack unsaturated fatty acids. While vitamin E's antioxidant functions are crucial throughout the body, it plays a particularly important role in immune cells; in neutrophils, it preserves membrane stability by inhibiting lipid peroxidation and increases intracellular killing capacity and chemotactic response. Moreover, a low vitamin E status is associated with increased risk of intramammary infections. This means that under stress situations, such as HS, vitamin E is essential for increasing antioxidant status to combat OS and reduce disease risk.

Additionally, colostrum is the primary source of vitamin E for neonatal calves, and maternal supplementation with vitamin E enhances its concentration in colostrum. Thus, in the case of late gestation HS, ensuring maternal vitamin E status will have the mentioned benefits for the cow, while also exposing the calf to less OS *in utero*, and providing them with more antioxidants via colostrum.

A powerful trio during heat stress

The redox system functions best when all components are working together – Met, Se and vitamin E have complementary and synergistic roles that ensure antioxidant protection. Vitamin E alone cannot neutralise peroxyl radicals; it requires the involvement of both (1) GPx, the Se-dependent enzyme, and (2) Met to replenish GSH to fully convert these reactive compounds into non-reactive products and sustain protein synthesis and repair pathways.

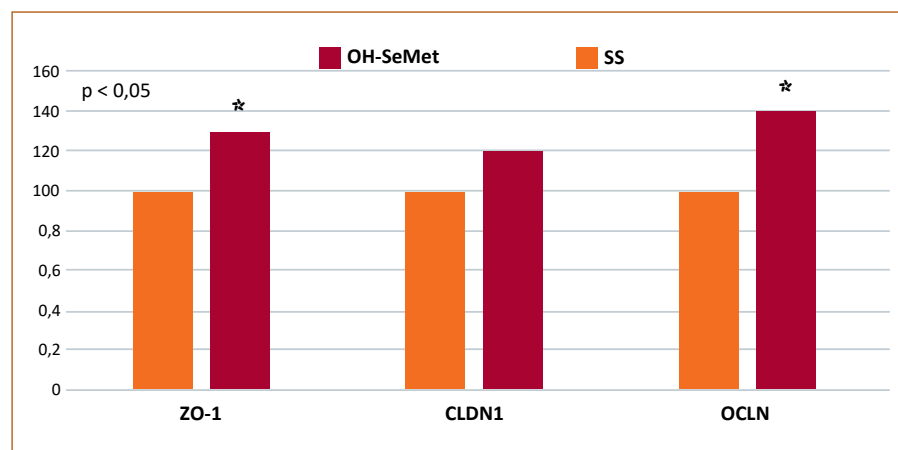
Moreover, Met, Se in the form of OH-SeMet, and vitamin E can all be stored in the body, providing reserves for challenges like HS. Together, this trio of essential nutrients lowers oxidative damage, stabilises membranes, and supports immunity, thereby enhancing resilience to OS.

Conclusion

Heat stress is a predictable, recurring oxidative challenge where decreased intakes limit the availability of key antioxidants. Strategic supplementation of Se as OH-SeMet, as well as vitamin E and Met, implemented alongside robust cooling strategies, can protect milk production and mammary integrity, stabilise cellular membranes, lower oxidative damage, and improve immune function.

Ensuring adequate supplementation of these nutrients during late gestation HS has the potential to support the dam and the developing heifer by reducing OS and enhancing antioxidant supply. These added nutritional protections during HS translate into improved milk production and health, supporting farm productivity and profitability now and for future generations. ♦

Figure 1: Relative mRNA expression of tight junctions at the mammary gland of lactating dairy cows under HS fed either hydroxyselenomethionine (OH-SeMet) or sodium selenite (SS).



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Discover how Evonik Animal Nutrition is helping shape a more sustainable future for animal agriculture.

Feed more efficiently, reduce environmental impact

By Faazilah Zainab Adam, sustainability director at Evonik, and Natasha Davison, business manager, Evonik South Africa

Sustainability has become a key priority across the global landscape, and animal protein producers are encouraged to assess the environmental impact of their production processes. These assessments include looking into the energy efficiency of facilities, waste management, water use and land use change, to name a few. Lifecycle assessments (LCA) are carried out to determine the environmental impact of producing animal protein products from inception (raw materials) to the final product (meat, milk, and eggs).

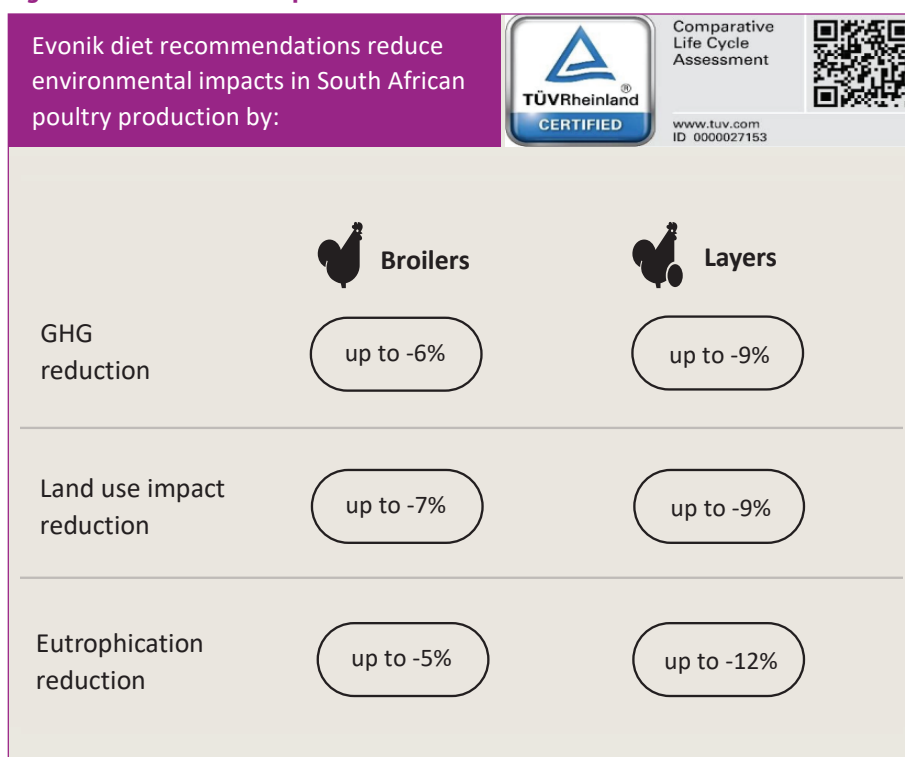
New local data supports production

At Evonik, we are committed not only to reducing greenhouse gas (GHG) emissions and minimising the environmental impact of our own production facilities, but also to partnering with our customers to improve their production efficiency and the environmental footprint of animal protein production.

In the past, obtaining accurate reports for all regions was challenging due to the lack of raw material granularity in global databases. For the first time, however, Evonik has published new LCA data that quantifies these environmental benefits specifically for South African poultry production.

Low crude protein diets supplemented with crystalline amino acids remain a strong lever to achieve greater efficiency and reduce environmental impacts. The data shows that, compared with local reference diets, these formulations can reduce

Figure 1: Environmental impact reductions in numbers.



GHG emissions by up to 6% in broiler production and up to 9% in layer production.

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The importance of NDF digestibility

By Dr RE Taljaard, Labworld

Evaluating NDF (neutral detergent fibre) and ADF (acid detergent fibre) in silage, pasture and other forage samples is standard in commercial feed laboratories. Although ADF and NDF are good indicators of fibre contents in forages, they do not measure how digestible that fibre is. *In vitro* NDF digestibility gives a more accurate estimate of total digestible nutrients (TDN), net energy (NE), and feed intake potential.

In general, increased NDF digestibility will result in higher digestible energy and forage intakes. By including an NDF digestibility parameter, ration balancing can be more precise, leading to more predictable milk production.

What is NDF digestibility?

Neutral detergent fibre represents the cell-wall components of plants, including cellulose, hemicellulose, and lignin. Neutral detergent fibre digestibility refers to the fraction of this fibre that is fermentable in the rumen, providing energy and supporting microbial protein synthesis, while the indigestible portion passes in the manure.

How is it measured?

There are several methods to determine NDF digestibility:

***In situ* method:** Forage samples are placed in small bags and incubated in the rumen of a cannulated cow. The NDF remaining after incubation is measured to calculate digestibility. This method is accurate but labour-intensive and costly. It also carries a risk that bags can get lost due to incorrect fastening and potential blockages. Additional stress is placed on the animal as the cannula is opened more frequently to retrieve bags at various time periods.

***In vitro* method:** Forage is incubated with buffered rumen fluid in a controlled laboratory environment for a set period (e.g., 12, 30, 120, or 240 hours). The proportion of NDF digested is measured, often expressed as **ivNDFD**. The undigested fraction after long incubation is called **uNDF**. Summed ivNDFD and uNDF equals 100%.

This method is a good prediction of the degree of digestion. Challenges associated with this method are the collection and transfer of rumen fluid, as temperature control and an inert atmosphere are critical. The time between collection and the start of digestion must be kept to a minimum to ensure that rumen fluid activity does not decline.

Predictive models: NDF digestibility can also be estimated using lignin content or near-infrared spectroscopy (NIRS), which predicts digestibility based on chemical composition and reference data. Good prediction models and extended data are critical for accurate predictions.

One reason to measure the ivNDFD of feed ingredients is to predict nutrients absorbed by the cow. When comparing two different NDF digestibility numbers for the same NDF content in two different forage samples that both analysed 21% crude protein, 32% ADF, and 43% NDF, would they be considered equal in terms of their effect on animal performance? However, if one forage sample has 45% NDF digestibility and the second has 60%, it is clear that feeding the latter will result in greater energy gain and feed intake.

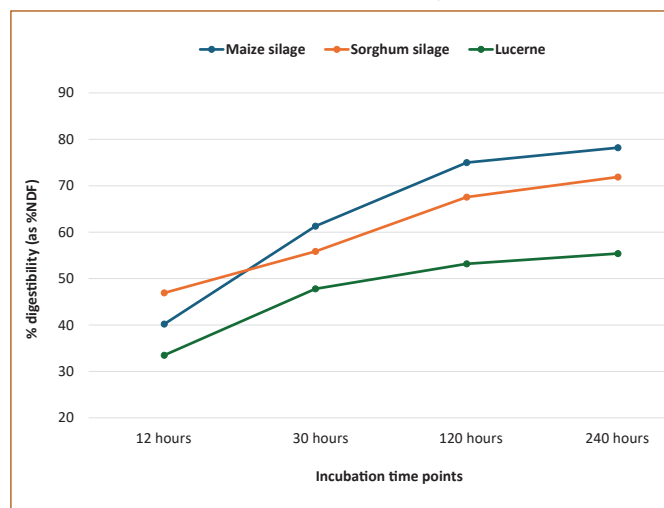
Data points and result evaluations

As ivNDFD indicates the dry matter intake (DMI) and milk production potential of a forage, using the correct time points is critical to predict the best feeding strategy. Control of feed intake is complex. However, one factor affecting feed intake is gut fill.

Forage, a bulky and slowly digested ingredient, is the major contributor to gut fill. If forages are digested relatively quickly, the bulky material disappears, alleviating the feeling of being full. This means that the cow is ready to eat again more quickly if she consumes very digestible forages. Greater forage digestibility results in greater DMI, and, because intake is a key limitation to milk production, it typically also leads to increased milk yield.

Characterising NDF digestibility theoretically allows nutritional models to predict how much NDF may be digested in the rumen, how much microbial protein is produced as a result of that ruminal digestion, and how much energy may be available to the cow from digestion of that fibre. Results from ivNDFD analyses may be

Figure 1: Comparison of NDF digestibility.



used within various ration software. The Cornell Net Carbohydrate and Protein System (CNCPS) nutritional model predicts NDF digestibility of feeds using raw materials at 12, 72, and 120 hours of incubation, while forage NDF digestion rates are predicted using 12, 30, 120, and 240 hours.

Choosing the correct time points depends on the outcome required. If the proven value of measuring *in vitro* NDFD of forages is to predict the impact on DMI, which measure of *in vitro* NDFD has the greatest indicator of gut fill? It has been postulated that cows have a maximum 240-hour undigested NDF (uNDF240) intake and that uNDF240 may be the greatest predictor of gut fill potential of forages.

Whether this measurement is biologically relevant must be considered, as the rumen retention time of forage in a dairy cow is much closer to 30 than to 240 hours, and undigested feed particles would not be retained in the rumen for 240 hours. The measurement, however, does hold value, as all NDF that remains undigested after 240 hours is truly considered indigestible.

Figure 1 illustrates the NDF digestibility of three different forage samples expressed as % NDF. It is important to specify how the results as a digestibility of 42,3% NDF relate to a 13,21% digestibility when expressed as DM. Samples containing high amounts of soil may yield inconsistent results; in such cases, it is better to perform the digestibility assays on an NDFom basis. This way the effect of the higher ash values can be eliminated.

Analysing samples for NDF digestibility is, however, costly, and the results and information obtained from these analyses should

deliver a return on investment. Benefits of knowing the degree and rate of digestibility can be summarised in three points:

- **Forage selection:** Forages with higher NDF digestibility support higher intake and milk production.
- **Ration formulation:** Understanding NDFD helps nutritionists balance fibre levels to maintain rumen health without limiting feed intake. High-quality forages with digestible fibre allow for increased energy density in the diet.
- **Economic impact:** Using NDFD data can improve dairy farm profitability by optimising milk yield and feed efficiency.

In summary

NDF digestibility is a key measure of forage quality, influencing intake, milk production, and dairy cow performance. Accurate measurement or prediction of NDFD allows for better ration formulation and more efficient use of forages in dairy operations.

Labworld provides *in vitro* digestibility assays at time points ranging from two hours to 240 hours for NDF, starch, and protein. Protein digestibility can be broken down to specific amino acid digestibility as well. As the digestibility assays depend on ethical considerations regarding the frequency and volume of rumen fluid that can be collected, it is important to contact Labworld timeously to book a spot. ❖

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Understanding the role of heat stress in poultry physiology

By Caitlin Vosloo, Phileo by Lesaffre

Poultry production has been under increasing pressure due to global warming changes. Poultry products remain the most affordable and among the most widely consumed sources of animal protein globally. Global warming has led to increased prevalence of heat stress in flocks worldwide, which in turn reduces efficiency and increases production costs.

Heat stress affects birds at physiological and behavioural levels. Production parameters such as feed conversion ratio, weight gain, egg production, and egg quality are negatively affected by heat stress, and mortalities tend to increase.

The physiology of heat stress

The mechanism by which heat stress causes health problems within a bird's body is linked to the communication pathway between the peripheral and central nervous systems. When skin sensors detect an increase in temperature, a nerve signal is sent to a specific part of the brain, the hypothalamus. The pre-optic area, a part of the hypothalamus, is triggered – this area is responsible for changes in physiological and behavioural activities – in an effort to maintain homeostasis.

Physiologically, vasodilation in peripheral tissues increases blood volume at the skin surface, facilitating evaporative cooling in this area. Often, behaviourally, birds will be seen lying stretched out with their wings and/or legs extended to increase the skin surface area through which heat may be lost to the surrounding air. This homeostatic mechanism allows the bird to cool its blood and, in turn, its whole body.

Due to peripheral vasodilation, the internal organs and tissues – specifically those of the gut – are not well perfused. Sufficient blood flow to these tissues is vital to their health and integrity. Enterocytes, in particular, have a high demand for nutrients and oxygen delivery, and when blood is directed to the skin rather than the internal organs, these cells begin to die.

Along with this enterocyte death, tight junction integrity and mucus layer thickness may also suffer. Oxidation and production of free radicals also occur in gut tissue, compounding the overall result of intestinal barrier degeneration. This may be seen in post-mortem examinations as sloughing off of epithelial cells in mild cases or bloody lesions in more severe cases of heat stress.

The intestinal barrier is crucial for maintaining the sterility of the body's internal environment. Disintegration of this barrier leads to bacterial translocation from the gut lumen into the endothelial tissues and ultimately into the bloodstream in more severe cases. In severe cases of heat stress, post-mortem findings may show peritoneal sepsis as well as fibrinous pericarditis or hepatitis, a thick white or yellow film covering either the heart or parts of the liver. The infectious agent in most of these extreme cases is *Escherichia coli*.

There is an immediate immune response to pathogen movement across the gut barrier, characterised by localised inflammation and recruitment of immune cells to the site of infection. Certain leukocytes produce cytokines, including interleukin-6 (IL-6). This proinflammatory molecule triggers the hypothalamic-pituitary-adrenal (HPA) axis. Triggering of this axis results in the release of several hormones and signalling molecules into the body.

Glucocorticoids are among these and are classical 'stress' molecules that suppress the immune system to reduce inflammation at the site of infection, namely the gut. The reduction

in immune cell numbers and the production of cytokines at this site allow unchecked bacterial movement from the damaged gut into surrounding tissue and the blood. The immunosuppressive effect of glucocorticoids, however, is not limited to the site of infection; it affects the immune system as a whole, leaving the bird more vulnerable to other maladies such as those caused by viral diseases and other comorbidities.

Stimulation of the HPA axis and the production of glucocorticoids also affect the production of the thyroid hormones T3 and T4, which are directly responsible for growth and the regulation of nutrient partitioning. Since glucocorticoids utilise glucose for their production and since levels of T3 and T4 are reduced, the body's nutrients are repartitioned away from the growth of muscle and fat tissue in broilers and pullets, or from egg production in layers and breeders.

House management

Birds experience heat stress when the air around the body is hot. General feed and house management practices are therefore vital for improving the comfort levels of the birds in the house. Complete climate-controlled houses are very effective at managing temperature and ensuring that birds are in a comfortable temperature-humidity zone.

Ventilation and the use of fans are one way in which houses can be cooled. Air speed management allows the perceived temperature inside the house to be managed according to the birds' age and ambient conditions.

Cooling pads, misters, and foggers may also be used to reduce the perceived indoor temperature. In open-sided houses, opening the curtains allows hot air to escape and be replaced by outside air. This is effective only if the air outside the house is markedly cooler than the air inside. However, in hot climates, the temperature difference between the air inside and outside the house may not be sufficient to reduce stress effects.

For open-sided houses, shade may be provided either by erecting a shade structure over the house or by extending the roof to create shaded areas directly outside the house. This overhang also protects the house's interior from direct sun exposure, helping to maintain a cooler interior.

Roof pitch and reflectivity also influence indoor temperature and help manage heat. Roofs with a higher pitch are beneficial as each face is exposed directly to the sun for fewer hours than on a flatter roof. Highly reflective roofs gain less heat, and insulating the house's roof also helps to lower heat gain in summer.

Feed management

Cool water should always be supplied. Birds that are panting lose more water than non-stressed birds, so water intake will generally be higher when heat stress is a factor. During heat stress conditions, water space per bird should be doubled to ensure easy access for all birds. The quality of the water must also be good; the water should be free from heavy metals and contaminants, and the level of total dissolved solids should be within the prescribed guidelines.

Feeding should be done during the cooler parts of the day. Feeding mid- to late morning results in the highest heat increment in the late afternoon, which is the hottest part of the day. The production of internal heat from feed digestion, coupled with high ambient temperatures, results in lower production and higher mortality. Withdrawing feed eight hours before temperatures peak allows for a higher survival rate than *ad lib* feeding.

During the cooler parts of the day, birds are more likely to be active and exhibit 'normal' feeding behaviour. Thus, feeding late in the afternoon and at night allows birds to achieve a higher feed intake and better calcium metabolism. For laying birds,



extra calcium can be administered through grits provided at night (during shell formation).

The diet's nutrient density should be increased during the hotter months to compensate for lower feed intake. Vitamin and mineral inclusion levels should also be increased for the same reason. Certain raw materials have lower heat increments than others, so including low-heat-increment ingredients in the diet may also allow birds to experience greater levels of digestive comfort, which in turn promotes better feeding and drinking behaviour. This, of course, may be difficult to apply and relies on the availability of raw materials and ration flexibility.

Certain vitamins, such as vitamins C and E, should be added at higher levels in a heat stress diet. This is because the kidneys of heat-stressed birds cannot produce vitamin C in sufficient quantities to meet bird requirements. Vitamin E can help boost immune function and reduce oxidative stress, which is exacerbated by heat stress. Selenium supplementation also helps protect birds against oxidative stress.

Electrolytes are essential in restoring acid-base balance in birds subjected to heat stress. Birds lose minerals such as potassium, sodium, phosphorus, magnesium and zinc during heat stress; this leads to a lack of muscle function and heat exhaustion, as well as other physiological issues. Supplementing the diet with an electrolyte product may also help the body cope with the demands of heat stress.

Selenium supplementation can positively affect heat stress outcomes at the tissue level. Organic sources of selenium are more readily available to the body than inorganic sources – two key molecules are selenomethionine and selenocysteine. Selenocysteine forms part of an enzyme called glutathione peroxidase (GPX), which is the body's first and most efficient line of defence against free radicals.

Since heat stress causes extensive oxidative damage to body tissues, supporting GPX function and renewal by supplementing with organic selenocysteine can positively impact the body's

antioxidant status. Selenomethionine supplementation can also have a positive impact on tissue oxidation status since it is stored as an amino acid in muscle and other tissues, which allows it to become available to form GPX and other selenoproteins used in the body's response to heat stress and oxidative damage.

Feed additives

Feed additives may help birds cope with heat stress, and many have multiple functions. Vasodilators such as niacin and capsaicin allow blood vessels to dilate, directing blood flow to the skin for heat loss. While this helps cool the birds internally by redirecting blood to the skin and away from the gut, leaky gut can still occur, and the negative effects of this cannot be addressed by these products.

Osmolytes such as betaine attract water molecules and help to maintain cell osmolality. They also assist heat shock proteins, which protect cells from heat damage. Products such as sodium zeolite may help by acting as a buffer to reduce alkalosis, and antioxidants can help maintain cellular integrity and protect cells from heat and oxidative stress.

Commercial yeast products, particularly yeast cell wall components such as mannan-oligosaccharides (MOS) and β -glucans, are widely used in animal feeds to improve health and performance. These compounds enhance both innate and adaptive immune responses and support intestinal integrity in poultry. Research shows that yeast-derived products can reduce pathogen load, lower stress indicators such as cortisol levels, and improve immune markers, including antibody titres and immunoglobulin levels. Yeast supplementation helps mitigate heat stress-induced immunosuppression and intestinal damage, improving resilience and productivity in heat-stressed animals.

The mode of action of yeast postbiotics in reducing the effects of heat stress primarily involves maintaining the gut barrier. The product interacts with intestinal cells via mannose receptors and blocks damage caused by pathogens. This allows tight junctions to maintain their integrity and keeps the gut-blood barrier intact. There have been studies on the gene expression of Claudin-5 and ZO-1 tight junction proteins, and both are

upregulated by one such product. Along with this, higher numbers of goblet cells have been observed in the intestinal histology of birds fed the postbiotic. Gene expression of Mucin-2 can also be upregulated by this product. This mechanical prevention of damage is intrinsic to the prevention of the HPA-axis cascade.

In addition to the effect of this product on the gut, yeast postbiotics interact with the immune system, upregulating certain immune pathways to ensure the bird is protected against pathogenic threats. Studies have shown upregulation of certain cellular and cytokinetic pathways. These include upregulation of B-cell and T-cell activity, alteration of the expression of major histocompatibility complex II (increasing MCH_{high} maturation of B-cells) as well as balancing release of pro-inflammatory and anti-inflammatory cytokines such as IL-6 and IL-10, respectively. Interleukin-8, an important cytokine involved in immune-cell signalling, has also been shown to be modulated by such products, resulting in a more responsive immune system that can quickly neutralise a pathogenic threat and return the body to a low state of inflammation.

Yeast postbiotics can also alter bird behaviour. One study found that the internal temperature of birds under severe heat stress was lower for supplemented birds than for non-supplemented birds. This resulted in improved eating behaviour and feed intake, similar to those of the non-challenged control group. Maintaining normal feed intake, coupled with a larger absorptive area and a healthier gut, allowed supplemented birds to grow better than non-supplemented birds under heat-stress conditions.

Regarding hormones, studies have found that levels of T3 and T4 are higher in heat stress challenged birds fed a particular yeast postbiotic versus a challenged control group and, conversely, levels of cortisol are lower. This leads to the conclusion that supplemented birds are able to regulate their metabolism better than non-supplemented birds and the overall stress level experienced by the body is lower.

The primary mechanisms outlined here, as well as the secondary mechanisms of avoiding the HPA axis and the hormonal

cascade that occurs during heat stress, are vital to maintaining a lower stress status in birds, allowing them to perform at an acceptable level in the face of a heat-stress challenge.

A plethora of studies show that yeast fraction postbiotics can benefit birds reared under heat stress. The main benefits observed include maintaining feed intake due to improved bird comfort, resulting in better growth and feed conversion. Mortality is also reduced as the risk of infection is lower and oxidative stress effects are also minimised. Since the body is supported in heat regulation, deaths and morbidity associated with oxidative stress and thermoregulatory failure are reduced.

Conclusion

Heat stress is a costly and widespread issue which erodes performance and profitability. Reducing the body's ability to maintain internal temperature results in stimulation of the HPA axis, which in turn leads to lower immune function. Physiological processes that redirect blood flow away from the gut result in compromised gut integrity and increase the risk of bacterial translocation into the bloodstream.

A wide range of management and nutritional measures exist to mitigate the effects of heat stress. Dietary supplementation with, for instance, vitamins E and C, as well as selenium, can positively impact tissue oxidative status throughout the body, from the cells of the gastrointestinal tract to those of the liver and other organs. Organic sources of these are always preferable over inorganic sources.

Certain feed additives, such as yeast postbiotics, help reduce the effects of heat stress by preserving gut health and function, controlling opportunistic gut bacteria, supporting the bird's immune function, and reducing oxidative stress. These actions result in lower internal body temperature, maintenance of feeding behaviour, modulation of hormone production, and reduction in stimulation of the HPA axis cascade. ♦

For enquiries, contact Caitlin Vosloo at c.vosloo@phileo.lesaffre.com or visit www.phileo-lesaffre.com

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The next frontier: Feeding the biological system

By Judi Rosenstrauch, technical support scientist, Envarto (Pty) Ltd

The next advances in animal nutrition will come less from refining the feed than from understanding the biology that determines how the animal uses it.

One would expect the growth of broilers in the same house, from the same hatch and on the same feed, to be similar. However, a study by Lundberg *et al.* (2021) showed that this was not the case. When 218 broilers were reared together in a single pen for 37 days, the heaviest birds averaged 2 887g and the lightest just 1 836g, a difference of more than 1 000g between birds of the same breed, on the same diet, and in the same pen. What set them apart lay not in the feed but in the gut. The heavier birds carried a more diverse and stable microbiome, richer in the bacteria associated with efficient digestion. The lighter birds carried more of the bacteria linked to inflammation and poor performance.

The implication is worth thinking over. If two birds receive the same well-formulated diet and one converts it far more efficiently than the other, then the feed is no longer the variable that explains the difference. We have spent decades refining that aspect of the equation, through better formulation, sharper ingredient evaluation, tighter amino acid precision and steady genetic progress. The result is a level of efficiency that earlier generations could barely have imagined. Yet the Lundberg birds suggest we are nearing the limit of what feed alone can deliver. The expensive, unexplained gap has moved off the table and into the animal.

Early biology matters

What lies inside the animal is increasingly something we are able to shape. The gap between the broilers traces back to differences in the gut microbiome, most

of it seeded in the first days of life when a chick that established a weaker microbial community ate less, absorbed less, and gradually fell behind. The same window matters in ruminants. Studies at Cornell College of Agriculture and Life Sciences by Soberon and Van Amburgh found that preweaning growth, when the calf's digestive system and metabolism are still developing, accounted for around a fifth of the variation in her eventual first-lactation milk yield. In each case, a biological difference established early, and unnoticed at the time, sets a ceiling on everything that follows.

This changes how we should think about biological feed additives. Enzymes, probiotics and prebiotics, phytogenics, organic and short-chain fatty acids, and emulsifiers have too often been assessed in isolation, each justified by its own claim on a well-performing animal. The more valuable question is not what a single product adds, but what combination of tools builds a more uniform and resilient animal in the first place. The real prize is not squeezing another point or two from the bird that is already thriving, but improving the one beside it that is wasting the very same feed.

Combining tools wisely

That is where the craft lies. These tools are not interchangeable, and their effects are not simply cumulative. Matched to the limitation in front of you and combined with care, they can reinforce one another so that the whole exceeds the sum of its parts. Combined carelessly, they can just as easily blunt or cancel each other out. One plus one does not reliably equal two;

depending on the choice and sequence, it may equal three, or even one. Knowing which additive to reach for, when, and alongside what, is becoming the more meaningful expertise.

Technology belongs in the same frame. The future is unlikely to involve feed mills reformulating diets by the day, because commercial reality will always reward programmes that run consistently and at scale. The genuine opportunity is diagnostic. Artificial intelligence, together with tools such as transcriptomic analysis, is beginning to reveal whether a shortfall in performance arises from gut function, nutrient utilisation, immune load or environmental stress, and does so before the weekly weights make it plain.

Used well, it turns a flock or herd from a number we react to into a biological system we can read early and support with intent.

Managing biology better

The production systems that define the next decade will not be those that post the highest figures under ideal conditions. It will be the ones that maintain their performance when conditions are anything but ideal, whether it is variable raw materials, heat, disease pressure, and the ordinary volatility of a South African production year.

The feed is no longer the limiting factor; the animal is. The next decade belongs to those who learn to manage its biology, not just its diet. ♦

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judi@envarto.co.za for more information.

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- ROUND 2**..... Article submission date: **22 January 2027**
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- ROUND 3**..... Article submission date: **9 April 2027**
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This is not a crisis. It is the condition. Aquafeed formulation has always been the discipline of trading one constraint for another, and the best formulators have always been the ones who learned to read the squeeze before the market announced it.

So, when another ingredient arrives claiming to solve the problem, you are entitled to be sceptical. You have seen ingredients that solved the wrong problem, at the wrong price, with the wrong data behind them.

What if the question is wrong?

QRILL Aqua Total is an Antarctic krill meal that on paper belongs in the protein source column of your formulation matrix. Inclusion rate, amino acid profile, digestibility coefficients – the numbers go where numbers go. But formulators who have worked with it report something that does not fit neatly into that column. Feed intake increases. Fish that were previously difficult to start on pellets adapt faster. Post-stress recovery, after grading, transport, or water quality events,

is noticeably different. The animals behave as if something else is happening.

Something else is. Antarctic krill delivers two classes of protection that no other commercially viable aquafeed ingredient provides in a single matrix. The first is cellular defence: phospholipids, phosphatidylcholine in particular, coat and stabilise cell membranes, reducing permeability under stress and improving the uptake of the nutrients travelling with them.

The second is antioxidant capacity: Naturally esterified astaxanthin from krill is one of the most potent biological antioxidants known, with activity that significantly exceeds both synthetic astaxanthin and vitamin E. It neutralises free radicals at the cellular level, combating oxidative stress before it compounds into poor performance, compromised immunity, or degraded fillet quality.

These are not incidental attributes. They are why Antarctic krill evolved to thrive in one of the most energetically and oxidatively demanding environments on the planet, and why those same mechanisms translate directly into animal resilience under the thermal, handling, and pathogen stresses of commercial aquaculture production.

More than 195 published studies have now evaluated Antarctic krill meal across salmonids, tilapia, marine finfish, abalone, and ornamental species. The pattern that emerges is not simply better growth; it is better animals. Nofima researchers, working with Atlantic salmon, found improvements in health markers and fillet quality that extended beyond what amino acid composition alone could predict. At Jeju National University, olive flounder fed Antarctic krill meal showed enhanced growth performance and disease resistance; outcomes that matter when a health event represents not a setback but a total crop loss.

Not a replacer, a matrix multiplier

What the evidence points towards is straightforward: Antarctic krill meal does

not belong only in the protein column. It belongs in the functional ingredient category. And that requires a different evaluation framework; one that asks not just what it costs per tonne of protein, but what it returns across the full production cycle.

QRILL Aqua Total is positioned as a functional multiplier, an ingredient that improves the performance of the ingredients around it, lifts feed conversion ratios, supports immune function during high-stress production phases, and delivers astaxanthin pigmentation without the instability and bioavailability losses associated with synthetic alternatives. The question is not whether it is expensive relative to fishmeal. The question is whether the return, across growth rate, feed efficiency, animal health, and product quality, justifies the inclusion. That calculation will be different for every operation, but it is the right calculation to be running.

The formulators who will define the next decade of aquafeed production in South Africa are not the ones still asking how to replace fishmeal at the lowest cost. They are the ones asking what an ingredient is actually capable of and building matrices around the answer.

If that question is already on your desk, the data to answer it is one conversation away. Talk to Intofeed.

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A new era of gut technology



By Zané Orffer, technical manager, Nu3enta

Feed has always been the engine of milk and meat production. Today, every kilogram carries more pressure. Raw-material markets remain volatile, margins are tight, and high-performing animals face demanding conditions. Buying well is no longer enough. The defining question is how efficiently the animal converts what has already been purchased.

Feed efficiency is the commercial translation of nutrition, namely milk or liveweight gain relative to dry matter intake. A small improvement, repeated across every animal and feeding day, can change the margin and reduce feed demand per unit of output. Research also links both rumen and lower-gut microbial communities with production efficiency – evidence that the whole digestive system matters (Reis, 2026; Monteiro *et al.*, 2022).

Even a precisely formulated ration cannot deliver its theoretical value if fermentation is unstable, nutrients are incompletely digested, the intestine is

challenged, or immune activity diverts nutrients from production. The rumen is central, but it is not the whole animal.

RumenYeast® is a natural, inactivated *Saccharomyces cerevisiae* solution developed through ICC Animal Nutrition's more than 30 years of yeast-processing expertise. Unlike a conventional live-yeast probiotic, its proposition does not depend on viable cells remaining active. ICC's Four Steps RumenYeast® (4SRY) process preserves and concentrates soluble fermentation metabolites, yeast cell contents, and functional cell-wall fractions, including amino acids, peptides, vitamins, nucleic acids, mannan-oligosaccharides (MOS), and β -glucans (ICC Animal Nutrition, 2026).

One technology, two sites of action

In the rumen, soluble metabolites provide nutrients and growth factors to microbial populations involved in carbohydrate fermentation. The objective is to create a more productive rumen environment:

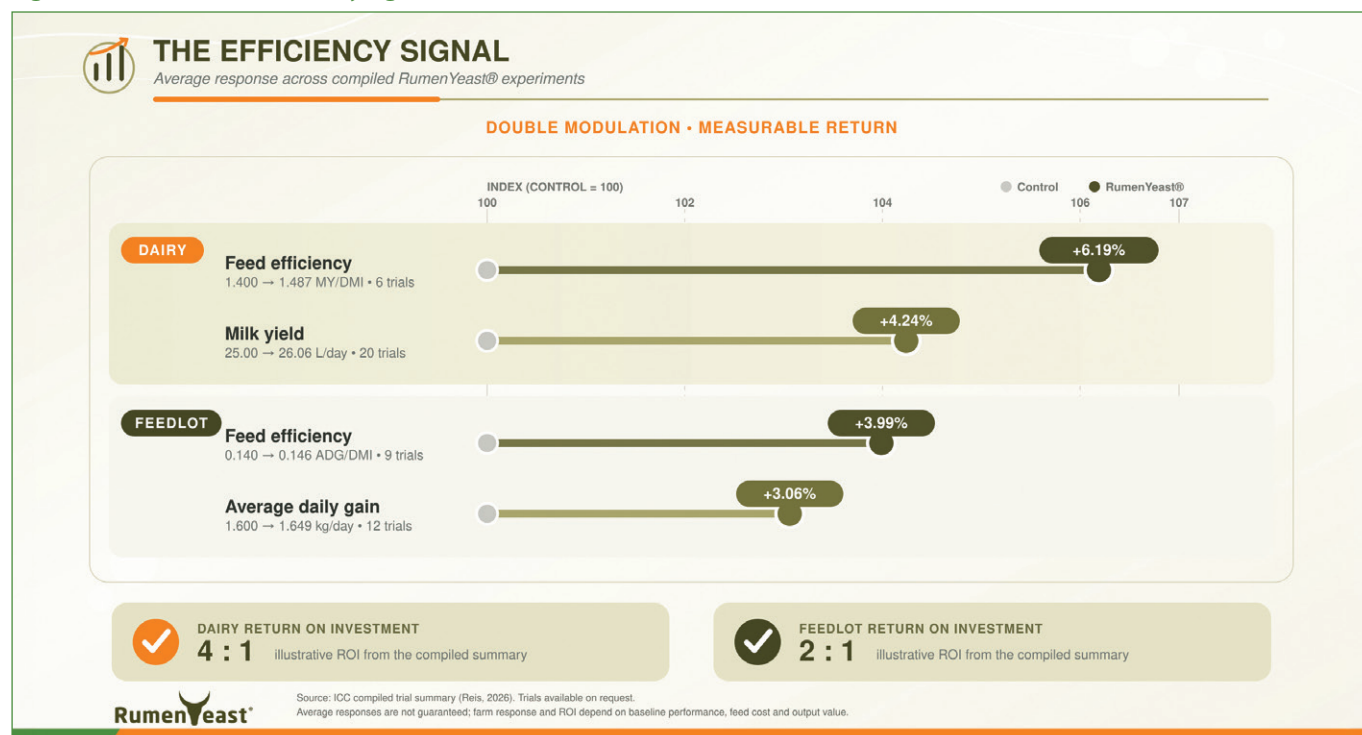
stronger nutrient utilisation, controlled lactate accumulation, and more consistent volatile fatty acid supply. These pathways are supported by *in vivo* and *in vitro* results (Dias *et al.*, 2018b; Halfen *et al.*, 2021; Tun *et al.*, 2020; Jiao *et al.*, 2019).

Beyond the rumen, MOS and β -glucans create the second pathway which supports intestinal microbial balance, gut integrity, and immune readiness. That ruminal-plus-intestinal proposition is the essence of RumenYeast® double modulation (ICC Animal Nutrition, 2026; Carpinelli *et al.*, 2023; Monteiro *et al.*, 2022).

Evidence across systems

Dr William Reis, Technical and R&D Department at ICC Animal Nutrition, evaluated production and intake data from RumenYeast® comparisons to quantify average effects on feed efficiency. The compiled evidence indicates a positive efficiency signal across dairy and finishing systems (Reis, 2026). Peer-reviewed dairy and beef research provides additional

Figure 1: RumenYeast® efficiency signal.



context for improvements in milk yield, rumen stability, digestibility, growth, and feed conversion (Dias *et al.*, 2018a-c; Halfen *et al.*, 2021; Carpinelli *et al.*, 2021; Pontarolo *et al.*, 2021).

Across the ICC trial summary, dairy feed efficiency increased by an average 6,19%, with milk yield up 4,24%. In finishing cattle, feed efficiency increased by an average 3,99%, with average daily gain up 3,06%. These are multi-study averages – not a set response for every farm (Reis, 2026). The direction of response is biologically credible: controlled studies have reported higher milk-component yields, improved rumen pH under a grain challenge, and better digestibility or feed conversion with yeast-culture or autolysed-yeast supplementation (Dias *et al.*, 2018a, 2018b; Pontarolo *et al.*, 2021).

The scientific logic is integration. Ruminal modulation targets digestion and microbial stability; intestinal modulation targets the microbial and immune environment that determines how efficiently absorbed nutrients are retained for production. Research shows that efficiency is connected to microbial

activity across the gastrointestinal tract and not only in the rumen (Dias *et al.*, 2018b; Carpinelli *et al.*, 2021, 2023; Tun *et al.*, 2020; Jiao *et al.*, 2019; Monteiro *et al.*, 2022).

Commercial value will differ with milk price, carcass value, feed cost, and baseline performance. That is why RumenYeast® should be evaluated as an efficiency investment, with return on investment calculated from farm-specific inputs rather than cost per tonne alone (Reis, 2026).

Built for the pressure points

Southern African systems expose animals to heat, variable raw-material quality, grain adaptation, and intense production demands. Heat can change intake and feeding behaviour; high-concentrate diets can destabilise rumen pH; and transition and receiving periods can amplify immune pressure.

Yeast-derived technologies have shown responses under several of these conditions (Dias *et al.*, 2018c; Carpinelli *et al.*, 2021; Tun *et al.*, 2020; Pontarolo *et al.*, 2021). RumenYeast® is therefore most relevant where rumen stability, nutrient utilisation, gut health,

and immune competence intersect: intensive dairy and beef systems, adaptation to grain-rich diets, heat stress, and high-risk production phases.

The opportunity is not to add another product and hope. It is to identify the limiting pressure point, select the right performance measure, and test the response in a technically sound programme. The result may appear as more output, steadier intake, improved conversion, or fewer disruptions (Reis, 2026; Dias *et al.*, 2018a, 2018c; Carpinelli *et al.*, 2021; Pontarolo *et al.*, 2021).

The bottom line: The next gain will not come from feeding more, it will come from unlocking more of what is already available.

For technical discussions, trial summaries and farm-specific return simulations, contact the author at Zane@nu3enta.co.za



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NUTRI FEEDS

At Nutri Feeds, a significant portion of our business consists of independent customers who play a vital role in our continued growth and success. For these customers, good service starts with feeling valued, respected, and in control of their choices. They want honest communication, reliable service, and products that meet their expectations.

Keeping an independent broiler feed customer happy means providing high-quality feed that supports good bird growth, health and feed conversion. Reliable deliveries, fair pricing and practical advice on feeding programmes and flock management are equally important. Building strong relationships through regular communication, quick responses to concerns, and technical support helps earn trust and loyalty. Independent farmers also value flexibility and transparency, as well as having a supplier who understands the challenges of their businesses and works alongside them to improve productivity and profitability.

Delivering excellent results

Chubby Chick has been a loyal and valued customer for many years, and its commitment to good farming practices continues



The Chubby Chick and Nutri Feeds teams with the late Deon and Johnathan Fourie celebrating the first two 500s.



Nutri Feeds and Chubby Chick Free-range Roodekraal staff and management teams.



From the left are Izak Kruger, Chubby Chick Roodekraal assistant manager, Cassie Groenwald, Roodekraal farm manager, Chrisjan Bakker, Nutri Feeds key account technical manager, Willem Kroeze, Chubby Chick Vogelzang farm manager, John Fourie, Chubby Chick management, Dr Franscois Crots, Nutri Feeds group technical manager, Bertus Kirstein, Nutri Feeds feed director, and Jaco Burger, Nutri Feeds technical advisor.

to produce excellent results. Through hands-on management, close attention to bird health, and the use of high-quality feed, Chubby Chick has achieved world-leading production results. This long-standing partnership demonstrates the value of trust, reliability, and teamwork in the poultry industry and makes them an important part of Nutri Feeds' success story.

We currently have nine commercial and five free-range Chubby Chick sites achieving outstanding PEFs of more than 500, reflecting excellent flock performance, sound management practices, and the effective use of quality feeding programmes. These achievements also highlight the strength of our partnership and the commitment to maintaining high-quality production across both commercial and free-range operations.

Water as a critical component

It is also important to remember that broilers consume twice as much water as feed, making clean and safe water a critical part of poultry production. Our biological unit at Earthlab plays an important role in ensuring our producers have access to the best quality water for their broiler units.

Through regular water monitoring and analysis, Earthlab can identify potential bacterial contamination that may affect feed intake, digestion, and flock performance. Access to accurate and timely water analysis enables proactive management decisions and helps producers maintain consistent production standards.

For more information, visit www.nutrifeeds.co.za



HARVESTING ABUNDANCE: Processing a bounty

South Africa has produced its largest soya bean crop on record at 3,044 million tonnes. With a 9% year-on-year increase, this triumph signals a departure from the country's historical dependence on imports mere decades ago. In 2006/07, more than 80% of soya bean meal in South Africa was imported. Today, it is a net exporter. This dramatic shift was described by AFMA's chairperson, Anina Hunter, at AFMA's 78th AGM in September 2025 as one of the greatest agricultural success stories of the past decade.

Taking advantage of opportune circumstances means harvesting the greatest reward at the end of the season. For this reason, Pretoria Protein Trading (PPT) and Pretoria Protein Company (PPC) have developed and refined their collective capacity in response to a fast-growing, feed-hungry market. When global food production needs are estimated to rise by 60% before the turn of 2050, it will take innovative companies to process the bounty.

Turning surplus into value

Feed is the foundation of food security. Now that local soya production has outgrown the country's crushing capacity, it takes thoughtful investment in processing innovation to make the most of a surplus soya bean crop. Pretoria Protein adopts valorisation as a response to increased market fluctuation by using every fraction of a crop as market products rather than lost production costs.

This is what separates a simple crushing plant from a processing agricultural hub, with PPC's plant designed around this very principle.

Employing zero-waste and reducing emissions, PPC's energy-neutral operations in Pretoria West provide the best full-utilisation solution. Closed-loop systems use every part of the soya bean, generating high-value soya products central to a circular economy.

PPT is where that innovation starts. It trades, receives and moves soya and protein products to meet every customer's requirement. Led by CEO and co-founder Mpumi Kekana, PPT maintains a clear vision: affordable, high-protein soya products that increase food security across Africa.

Quality from crop to customer

Fanie Schoeman, CEO of PPC, is no stranger to the knock-on effect of feed and soya sector complexities. His on-the-ground approach to executive management has kept Pretoria Protein's business practices grounded in practical principles.

Speaking in a company interview, Fanie emphasises the importance of understanding market dynamics early versus late in season, and the reasoning behind crush scale and capacity in relation to crop quality. For feed manufacturers, a surplus is only useful if it arrives on spec and on time. Quality is constantly verified on the line: protein, fat, fibre, moisture – all embedded in daily procedures. None of that matters if the plant stops

or can't maximise quality to offset total production costs.

Sander Marais, HOD of maintenance at PPC, understands the need for interlocking logistics to make the most of a season's harvest. A good harvest feeds a season. A processing sector that receives and uses every part of it – oil, meal, hulls, and the protein on our plates – feeds a country sustainably, even in years when a surplus harvest may not be a reality.

Processing capacity meets harvest

The National Agricultural Marketing Council's October 2025 commentary projects soya bean imports falling to roughly 12 300 tonnes, a massive 92% decline, while whole-bean exports are estimated to exceed 300 000 tonnes. South Africa's record 2025/26 crop did not simply happen because farmers planted more, or because La Niña rains fell favourably. It happened because the country built somewhere for the crop to go.

According to the Bureau for Food and Agricultural Policy, South Africa's crushing capacity has grown from roughly 860 000 tonnes in 2012 to 2,9 million tonnes today. For the first time, the harvest has caught up with its processing capability. A record crop and a mature processing sector arrived in the same season. The reward of this timing is being harvested now.

Ultimate outcomes for soya production and food security rely on an agricultural sector set to process its own bounty. Pretoria Protein's AFMA affiliation and its stated dedication to market-resilient trading through PPT and processing capacity through PPC show a strong willingness to invest in feed innovation and market valorisation. By emphasising cohesive cooperation, certainty of a successful harvest is secured, and sector security is collectively ensured. The future of a great harvest depends on it.

Contact Pretoria Protein Trading at 012 004 3166 or info@pptd.co.za and Pretoria Protein Company at 012 004 1120.

Four agricultural labour law myths

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

Misconceptions about labour law are common and often perceived as legally correct. In the agricultural sector, these myths can become deeply entrenched, leading employers and employees alike to believe that certain workplace practices are permissible when they are not. When employers rely on incorrect assumptions rather than the law itself, they unintentionally expose their businesses to unnecessary legal and operational risks.

In this article, we highlight four common labour law myths in the agricultural sector and the legal truths behind them.

Myth #1

An employer and his/her employees can agree on terms and conditions of employment even if they do not comply with labour legislation.

Truth

While employers and employees generally enjoy considerable freedom to enter into contracts, any terms and conditions of employment must at least comply with the minimum requirements set out in the various labour laws in South Africa.

The main laws that regulate the terms and conditions of employment in the agricultural sector are *Sectoral Determination 13 (SD13)*, gazetted under the *Basic Conditions of Employment Act, 1997 (Act 75 of 1997)* or *BCEA*, as amended. Employers are cautioned that any provision in an employment agreement that is inconsistent with or contrary to applicable legislation is unlawful. Employers and employees may, however, agree to terms that are more favourable to the employee than those prescribed by law.

Myth #2

An employee can be dismissed immediately for serious workplace misconduct, such as theft or dishonesty.

Truth

An employee cannot be dismissed before a disciplinary hearing has been conducted. Every employee must be given a fair opportunity to present his/her side of the case during a disciplinary hearing. Labour law requires that an employee's dismissal be both substantively and procedurally fair. Therefore, even if the substantive reason for dismissing an employee is fair, the employer must still follow the correct disciplinary procedure. This means an employee cannot be dismissed without a disciplinary hearing being held in the case of misconduct.

If an employer dismisses an employee without following the proper procedure, the dismissal will be considered unfair. This can have serious consequences for the employer in proceedings before the Commission for Conciliation, Mediation and Arbitration (CCMA).

Myth #3

A farmworker can be fined when he/she has committed an alleged workplace offence.

Truth

This is a very serious yet common misconception in the agriculture sector that puts employers at risk. Currently, fines against farmworkers are strictly prohibited in South African law. Clause 7(3) of *SD 13* clearly states: An employer may not levy a fine against a farmworker.

Myth #4

Domestic workers on the farm are not paid the same wage as general farmworkers.

Truth

Under South African labour law, domestic workers employed on farms are currently classified as farmworkers in accordance with *SD13* and must therefore be remunerated accordingly. This position is further confirmed by the updated schedules to the *National Minimum Wage Act, 2018 (Act 9 of 2018)*. As a result, domestic workers employed on farms must be paid at the same minimum wage rate as other farmworkers, namely R30,23 per ordinary hour worked, effective 1 March 2026.

In today's increasingly regulated labour environment, employers cannot afford to make assumptions when managing employees. Practices that may seem commonplace or widely accepted are not always legally permissible, and mistakes can prove costly when disputes arise.

To mitigate risk and ensure compliance, employers should regularly review their employment contracts, disciplinary codes, workplace policies, and procedures to ensure they align with current labour legislation. Obtaining specialist labour law advice can help protect the business, minimise risk, and foster sound employment relationships in the workplace. ❖

The LWO Employers Organisation assists employers to comply with labour law, and to use it to their advantage to protect their businesses. As a registered employers' organisation with the Department of Employment and Labour, the LWO has the right to represent members at the Commission for Conciliation, Mediation and Arbitration (CCMA).

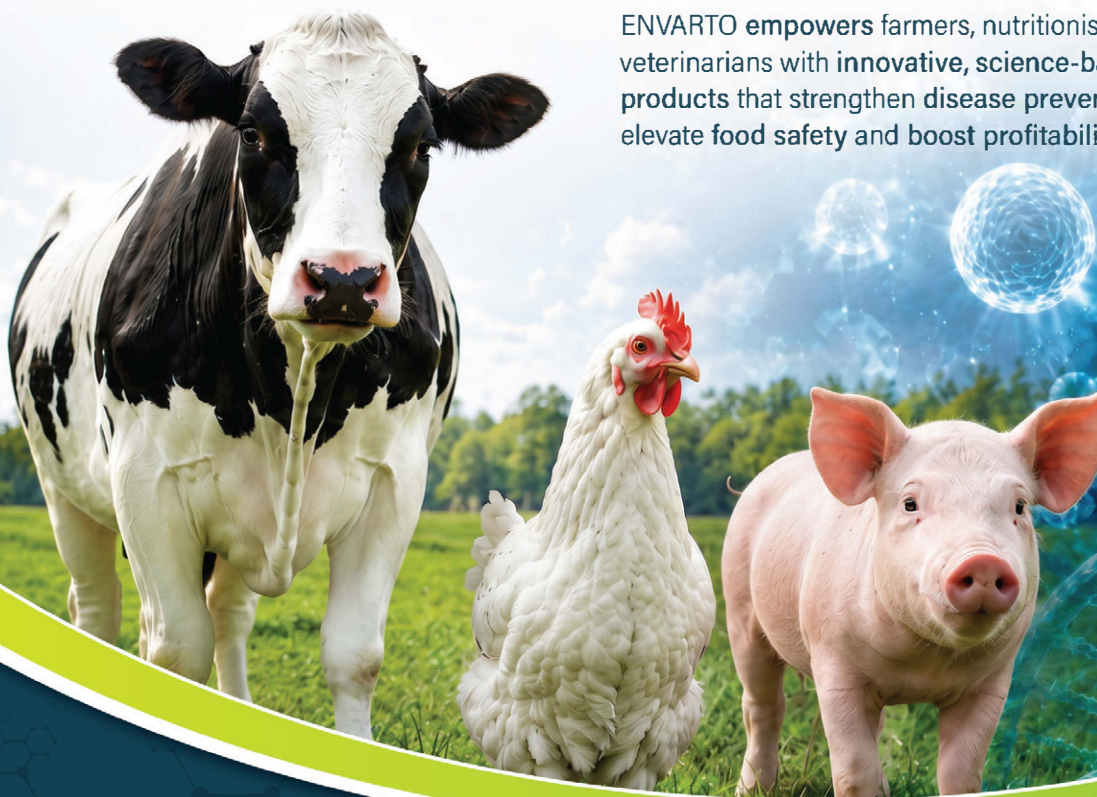
Take note that this article is not legal advice – consult one of our legal advisors about any specific legal problem or matter.

For more information, send an email to info@lwo.co.za or visit www.lwo.co.za



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