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Smart Nutrition, Stronger Herds: A Holistic Approach to NZ Dairy Excellence

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I wish to thank the Kellogg Programme Investing Partners
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Executive summary

This report explores the critical yet underutilised role of nutrition in New Zealand's pasture-based dairy systems. Despite its foundational importance to animal health, productivity, and environmental sustainability, dairy cow nutrition remains inconsistently applied and poorly integrated into broader farm decision-making. The project investigates the current state of dairy nutrition through a combination of semi-structured interviews with 18 key stakeholders—including nutritionists, educators, industry professionals, and rural advisors, and a comprehensive literature review.

The research identifies six core themes that represent both challenges and opportunities for the sector: (1) education and training, (2) young stock rearing, (3) precision feeding and technology integration, (4) holistic farm management, (5) financial and economic analysis, and (6) the development of new initiatives and programs. Across these themes, the report highlights significant gaps in practical training, credentialing, and the translation of scientific knowledge into on-farm practice.

Key findings include the need for standardised, modular training programs that blend theoretical and practical knowledge; the critical importance of early-life nutrition for long-term productivity of livestock; the underutilisation of wearable technologies and data tools in decision-making around nutrition; and the lack of integration between financial and nutritional advice. The report also emphasises the need for a systems-thinking approach that aligns nutrition with environmental goals, farm infrastructure, and economic viability.

Recommendations are targeted at multiple stakeholder groups. Farmers are encouraged to build foundational nutrition knowledge and adopt data-informed practices. Rural professionals should pursue micro-credentials and collaborate across disciplines. Education providers are urged to revise curricula to include more applied, pasture-based nutrition content. Industry bodies are called upon to revive and modernise the FeedRight equivalent programs, support credentialing pathways, and foster collaboration to unify messaging and improve knowledge transfer.

Ultimately, this report calls for a cultural and structural shift in how nutrition is valued and applied within the dairy sector. By investing in capability, collaboration, and evidence-based practice, New Zealand can build a more resilient, productive, and sustainable dairy industry, one where smart nutrition is not just a technical input, but a strategic cornerstone of success.

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Throughout this report I have used the help of Microsoft Copilot to summarise and simply writing. I researched the literature and directed Copilot to group information as required.

This project is the result of many voices, shared experiences, and collective wisdom. I am grateful to have had the opportunity to learn from and alongside you all.

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Prologue

In the heart of New Zealand's dairy sector lies a paradox: while nutrition is universally acknowledged as a cornerstone of animal health, productivity, and sustainability, it remains one of the most inconsistently understood and applied elements of farm management. As a rural professional and passionate advocate for evidence-based practice, I have often found myself asking: *Why is something so fundamental so often overlooked?*

This project began with a simple curiosity, how can we do better? But as I engaged with farmers, nutritionists, educators, and industry leaders, it became clear that the question was not just about feed or formulas. It was about systems, education, trust, and the way we value knowledge in our sector. It was about the disconnects between science and practice, between data and decision-making, and between short-term costs and long-term gains.

Through the Kellogg Programme, I have been privileged to explore these questions deeply, guided by a commitment to improving outcomes not just for cows, but for the people and environments that support them. This report is the culmination of that journey, a synthesis of research, interviews, and reflection. It is both a critique and a call to action: to elevate the role of nutrition in our national conversation, to invest in capability and collaboration, and to build a dairy industry that is not only productive, but principled and prepared for the future.

Introduction

New Zealand's dairy industry is globally renowned for its pasture-based systems, which have long been celebrated for their efficiency, cost-effectiveness, and alignment with the country's natural environment. However, as the sector faces increasing pressure from environmental regulations, evolving consumer expectations, and the need for greater productivity from less, the role of nutrition has emerged as a critical lever for transformation. Despite its foundational importance, dairy cow nutrition in New Zealand remains underexplored, inconsistently applied, and often misunderstood—particularly in the context of modern farm systems that demand both economic and ecological sustainability.

This report investigates the current state of dairy nutrition in New Zealand, with a focus on identifying gaps, challenges, and opportunities across the sector. It explores how nutrition intersects with animal health, farm profitability, environmental outcomes, and the broader agricultural ecosystem. Drawing on insights from semi-structured interviews with nutritionists, educators, industry professionals, and rural advisors, as well as a comprehensive literature review, the report highlights the need for a more integrated, evidence-based, and future-focused approach to nutrition.

By examining themes such as young stock rearing, precision feeding, holistic farm management, and the integration of technology and financial analysis, this project aims to inform the development of practical, scalable solutions that empower farmers and advisors alike. Ultimately, it seeks to contribute to a more resilient, productive, and sustainable dairy industry—one where smart nutrition is not just a technical input, but a strategic cornerstone of success.

Aims and objectives of this report

Aims

1. To investigate the current challenges and opportunities in dairy cow nutrition within New Zealand's pasture-based systems, with a focus on improving productivity, sustainability, and animal welfare.
2. To explore the integration of education, technology, and holistic farm management in enhancing nutritional decision-making across the dairy sector.
3. To identify and recommend strategies for strengthening the capability and consistency of nutrition advice delivered to farmers and rural professionals.

Objectives

1. Conduct qualitative research through semi-structured interviews with key stakeholders including New Zealand Animal Ruminant Nutrition (NZARN) members, tertiary educators, industry professionals, and rural advisors to gather insights on gaps, innovations, and educational needs in dairy nutrition.
2. Review and synthesise current literature on dairy nutrition, focusing on young stock rearing, precision feeding, environmental impacts, and economic returns.
3. Evaluate the role of wearable technologies and data-driven tools in supporting precision nutrition and farm decision-making.
4. Assess the effectiveness and accessibility of current education and training programs for farmers, rural professionals, and tertiary students in the field of ruminant nutrition.
5. Explore the feasibility of developing standardised, modular training and credentialing systems to improve the quality and consistency of nutrition advice across the sector.
6. Develop recommendations for industry collaboration, program development, and policy support to enhance the adoption of evidence-based nutritional practices and improve long-term farm resilience.

Literature Review

Nutrition is a cornerstone of productivity and sustainability in New Zealand's pasture-based dairy systems. Traditionally, these systems have relied on grazed pasture, primarily perennial ryegrass and white clover, as the main feed source due to its cost-effectiveness and alignment with seasonal calving (Clark et al., 2007). However, the seasonal variability in pasture quality and availability presents a significant challenge, particularly in meeting the high energy demands of modern, high-genetic merit cows during early lactation (Clark et al., 2001). This variability contributes to fluctuations in milk composition, especially in fat, protein, and lactose levels, which are not fully mitigated even when cows are fed a consistent total mixed ration (TMR) (Auldist et al., 2000). Compounding this issue is the pasture-centric education and advisory framework within New Zealand's dairy industry, which can limit the exploration of more flexible and innovative nutritional strategies. Recognising where these systems can adapt opens opportunities for collaboration and innovation that benefit not only animal health and production but also farm profitability and environmental outcomes.

The limitations of pasture-based diets are further compounded by their nutrient imbalances. Pasture often contains excess crude protein relative to energy, leading to inefficient nitrogen utilisation and increased nitrogen excretion in urine, which contributes to environmental pollution (Clark et al., 2007; Foote et al., 2015). This inefficiency not only reduces feed conversion efficiency (FCE) but also exacerbates nitrate leaching and greenhouse gas emissions. While supplementary feeds such as maize silage and palm kernel extract (PKE) can help balance the diet and support higher milk yields, their use introduces new complexities, including increased feed costs, potential substitution effects that reduce pasture intake, and heightened environmental concerns (Clark et al., 2007).

To address challenges, a range of nutritional solutions has been proposed and trialled. Strategic supplementation remains a key tool, particularly when used to complement rather than replace pasture. Formulated grain mixes and partial mixed rations (PMRs) have shown promise in improving milk production and stabilising rumen pH when compared to traditional grain feeding at milking (Wales & Kolver, 2017). Additionally, the inclusion of high-fibre forages such as straw or hay can help maintain rumen health during periods of lush pasture growth. Rumen modifiers like monensin and buffers such as sodium bicarbonate or magnesium oxide have also been used to mitigate the risk of acidosis, although their effectiveness can vary depending on diet composition and feeding practices (Westwood et al., 2003).

Improving pasture quality itself is another avenue for nutritional enhancement. The integration of diverse forage species, such as plantain, chicory, and legumes with condensed tannins, can improve the balance of nutrients, increase dry matter intake, and reduce nitrogen losses (Wales & Kolver, 2017). These species not only enhance the nutritional profile of the sward but also contribute to better environmental outcomes by reducing urinary nitrogen concentrations and nitrate leaching (Beukes et al., 2014). Furthermore, precision feeding technologies and mechanistic nutrition models offer the potential to tailor supplementation strategies to individual cows, optimising nutrient use efficiency and supporting animal welfare.

In both New Zealand and Australia, evolving feed systems have introduced new challenges and opportunities. While New Zealand has traditionally emphasised low-cost, pasture-dominant systems, there has been a shift toward higher-input systems incorporating more supplements to meet production demands (Wales & Kolver, 2017). However, these systems must now operate within tighter environmental constraints, particularly regarding nitrogen leaching.

The future of dairy nutrition lies in achieving a balance between high-quality, consistent nutrition, economic viability, and ecological sustainability. This vision demands a multifaceted approach that integrates improved pasture management, targeted supplementation, genetic selection, and innovative feed technologies. These strategies must be guided by a flexible and informed understanding of nutrition to adapt to evolving challenges and opportunities.

While nutrition is not the sole factor influencing seasonal variations in milk composition or cow health, it remains a cornerstone of dairy system performance. It plays a critical role in improving feed efficiency, supporting animal welfare, and minimising environmental impact. Tackling these interconnected challenges requires a holistic approach, one that not only optimises nutritional strategies but also aligns with the broader goals of sustainability and profitability in dairy farming.

Moreover, nutrition is integral to the success of New Zealand's farm systems. As farmers shift in mentality by leaning into per cow performance rather than per hectare which in turn has led to less cows per hectare but more efficient animals the focus on ruminant nutrition becomes key. Building

knowledge and confidence in understanding the return on investment from sound nutritional practices is essential. Empowering farmers with the right tools and insights to make informed nutritional decisions will be key to driving long-term resilience and productivity across the sector.

Methodology

Semi-structured interviews

1. Research Design

This study employed a qualitative research design using semi-structured interviews to explore the perspectives, experiences, and practices of stakeholders involved in dairy cow nutrition. The aim was to gain in-depth insights into nutritional decision-making, challenges, and innovations at farm level all the way through to industry bodies and ultimately our sector. Interviews from specifically NZARN Members & Nutrition Extension Specialists formed the foundation and focus areas of this report.

2. Participant Selection

Participants were selected using purposive sampling to ensure a diverse representation of roles and experiences. The sample included:

- NZARN members & nutrition extension specialists
- Industry professionals
- Industry bodies
- Tertiary educators

NZARN Members & Nutrition Extension Specialists were targeted due to the nature of their work, knowledge and expertise in dairy nutrition in New Zealand & globally. Industry professionals were selected to understand if they felt they had similar viewpoints around nutrition and how that influences their thinking and job. Industry bodies and tertiary educators gave an insight into processes, how they can help, along with their limitations or suggestions.

A total of 18 participants were interviewed.

3. Interview Protocol

A semi-structured interview guide was developed based foundation questions addressing key factors in dairy nutrition in agriculture.

Key themes for NZARN members & nutrition extension specialists included:

- Gaps and complexity in nutrition
- Education, training & credentialing
- Systems thinking & farm success
- Technology, data & AI
- Farmer support & practical advice

Key themes for tertiary educators included:

- Gaps and complexity in nutrition
- Education, training & credentialing

Key themes for tertiary educators included:

- Gaps in nutrition in industry
- Education, training & development
- Their role and impact
- Collaboration & industry support
- Standardisation, system thinking & decision-making
- Credentialing and pathways
- Technology, data & AI

- Emissions & environmental impact
- Farmer support, education & practical advice
- Advice and general reflections

Interviews were conducted in person or via a Microsoft Teams call, depending on participant availability and location. Each interview lasted approximately 45–60 minutes and was audio-recorded with the participant's consent.

4. Ethical considerations

Participants were provided with background information and signed a consent form prior to the interview. All information has been anonymised and stored securely.

5. Data analysis

Interviews were transcribed accurately and analysed using thematic analysis. The process involved:

1. Familiarisation with the data
2. Coding of transcripts using Microsoft Co Pilot
3. Identification of themes and subthemes
4. Cross-comparison of themes across participant groups

Themes were reviewed and refined to ensure they accurately reflected the data and addressed the research objectives.

Literature Review

The literature review was conducted following the themes and insights that arose from the semi-structured interviews. This formed the basis of the literature review to demonstrate the current state of play with regards to dairy nutrition and the problems in our industry.

1. Research design

This literature review adopts a systematic approach to explore the multifaceted domain of dairy cow nutrition, with a particular emphasis on:

- Nutritional strategies for young stock (calves and heifers)
- Education and training of farmers and advisors
- Precision feeding technologies and digital innovations
- Holistic farm management practices
- Financial and economic analyses of nutritional interventions
- The development and implementation of new initiatives in dairy nutrition

The aim is to synthesise current knowledge, identify best practices, and highlight gaps and opportunities for innovation and development.

2. Search strategy

A comprehensive search was conducted across the following databases via Lincoln University database:

- Scopus
- Web of Science
- PubMed
- MDPI
- BioMed Central (BMC)
- NZARN Articles
- New Zealand Rural Leadership Trust website

3. Inclusion and exclusion criteria

Inclusion criteria:

- Studies focusing on nutritional management of dairy cows and young stock
- Research involving precision feeding technologies, training programs, or economic evaluations
- Articles addressing sustainability, farm systems, or policy initiatives
- Studies with empirical data or comprehensive reviews

Exclusion criteria:

- Studies unrelated to dairy cattle or nutrition
- Articles not available in full text
- Publications not peer-reviewed (unless grey literature was relevant to policy or education)

4. Data extraction and analysis

A structured data extraction form was used to collect the following information:

- Author(s), year, country
- Study design and sample characteristics
- Nutritional focus (e.g., young stock, precision feeding, economic analysis)
- Intervention or technology used
- Outcomes measured (e.g., growth, milk yield, cost-benefit, training impact)
- Key findings, limitations, and recommendations

A thematic synthesis was conducted, organising findings back into six core themes:

1. Young stock nutrition
2. Education and training
3. Precision feeding and technology
4. Holistic farm management
5. Financial and economic analysis
6. Development of new initiatives

This thematic structure enabled a comprehensive understanding of how nutrition intersects with broader aspects of dairy farm performance and sustainability.

Limitations

Limitations of the Study

While this study provides valuable insights into dairy nutrition practices and perceptions, several limitations should be acknowledged:

1. Sample size and representativeness
   The study involved a relatively small number of participants, which may limit the generalisability of the findings. Although purposive sampling ensured diversity in roles and experience, the sample may not fully represent the broader population of dairy farmers and industry professionals.
2. Geographic scope
   Participants were primarily drawn from within the New Zealand agricultural industry, which may influence the applicability of findings to other countries with different climatic, economic, or regulatory conditions.
3. Self-Reported Data
   The study relies on self-reported information, which may be subject to recall bias, social

desirability bias, or selective reporting. Participants may have presented their practices or knowledge in a more favourable light.

4. Interviewer Influence
   Despite efforts to maintain neutrality, the presence and style of the interviewer may have influenced participant responses, particularly in a semi-structured format where probing and follow-up questions are used.
5. Focus on Perceptions Over Outcomes
   The qualitative nature of the study emphasises perceptions, experiences, and attitudes rather than measurable outcomes. As such, the findings provide depth but not statistical evidence of effectiveness or impact.
6. Technology and Innovation Bias
   Participants with a greater interest in or access to precision feeding technologies or innovative practices may have been more likely to participate, potentially skewing the findings toward more progressive viewpoints.

Limitations of the Literature Review

While the literature review aimed to provide a comprehensive overview of current research on dairy cow nutrition, several limitations should be acknowledged:

1. Publication and Language Bias
   The review was limited to studies published in English, which may have excluded relevant research published in other languages. Additionally, there may be a publication bias toward studies with positive or significant findings, potentially overlooking valuable insights from unpublished or negative-result studies.
2. Database Coverage
   Although multiple academic databases were searched (e.g., Scopus, Web of Science, PubMed), some relevant studies may have been missed due to limited indexing or restricted access to certain journals, particularly regional or industry-specific publications.
3. Time Frame Constraints
   The report focused on literature published between 1990 and 2025, which may have excluded foundational or earlier studies that still hold relevance. Conversely, very recent studies may not yet have been indexed or widely cited.
4. Scope and Thematic Breadth
   Given the broad scope—including young stock nutrition, precision feeding, education, economics, and farm systems—some areas may have been covered more extensively than others. This may have led to uneven depth across themes.
5. Variability in Study Quality
   The report included a mix of study designs (e.g. observational, reviews), which varied in methodological rigor. While efforts were made to assess relevance and quality, a formal critical appraisal of each study was not conducted.
6. Interpretation and Synthesis Bias
   Thematic synthesis involves a degree of subjective interpretation, which may influence how findings were categorised and emphasised. While care was taken to ensure accuracy and balance, researcher bias cannot be eliminated.

Results & Findings

Analysis of interviews

Based on the findings and themes from the interviews, this directed the focus of research on nutrition in the New Zealand dairy industry to be on the following areas:

NZARN Members & Nutrition Extension Specialists – Foundation of Report Themes

1. Comprehensive Education and Training Programs

Development of Standardised Training Modules: Create comprehensive training programs that cover all aspects of dairy nutrition, from basic principles to advanced practices. These should be targeted at tertiary education, farmers, and rural professionals.

Integration of Practical and Theoretical Knowledge: Ensure that training programs combine practical on-farm experiences with theoretical knowledge to provide a holistic understanding of nutrition.

2. Young Stock Rearing

Focus on the First Year of Life: Conduct research on the best practices for rearing young stock, particularly in the critical six to nine months following the initial three months. This research should aim to develop guidelines and standards for optimal growth and development.

Impact of Early Nutrition on Long-Term Productivity: Investigate how early nutrition affects long-term productivity and health of dairy cows, including milk yield and reproductive performance.

3. Precision Feeding and Technology Integration

Utilisation of Wearable Technologies: Research how wearable technologies can be better integrated into farm management practices to provide real-time data on cow health and behaviour. Focus on developing tools and methods for interpreting this data effectively.

Data-Driven Nutrition Decisions: Study the impact of data-driven nutrition decisions on farm productivity and profitability. Develop models and algorithms that can help farmers make informed decisions based on real-time data.

4. Holistic Farm Management

Interdisciplinary Approaches: Promote research that integrates agronomy, animal health, and nutrition to develop holistic farm management practices. This should include the development of decision-making frameworks that consider all aspects of farm management.

Impact of Nutrition on Environmental Sustainability: Investigate how improved nutrition practices can contribute to environmental sustainability, including reducing greenhouse gas emissions and improving soil health.

5. Financial and Economic Analysis

Return on Investment in Nutrition: Conduct research to quantify the return on investment in quality nutrition products and practices. This should include case studies and economic models that demonstrate the financial benefits of good nutrition.

Integration of Financial and Nutritional Advice: Study how financial advisors and nutritionists can work together to provide integrated advice that balances cost-cutting with maintaining or improving animal health and productivity.

6. Development of New Initiatives and Programs

Revival and Improvement of FeedRight Program: Consider reviving and improving the FeedRight program to provide a standardised approach to nutrition education. This program should be updated to include the latest research and best practices.

New Roadshows and Workshops: Develop new roadshows and workshops focused on various aspects of dairy nutrition, such as transition cow management, setting cows up for mating, and integrating technology with nutrition advice.

Conclusion

Focusing research on these areas will help address the significant gaps in knowledge and practices identified in the interviews. By improving education and training, integrating technology, and promoting holistic farm management, the New Zealand dairy industry can enhance productivity, profitability, and sustainability.

NZIPIM (NZ Institute of Primary Industry Management) Insights and Themes

1. NZIPIM's role and scope

- NZIPIM focuses on building the capability of rural professionals, not farmers or vocational learners.
- It acts as a conduit for credible information, not a provider of education or training.
- The institute shares knowledge through newsletters, webinars, and journals, but does not validate or endorse specific systems or practices.

2. Information sharing and neutrality

- NZIPIM does not take a stance on controversial topics (e.g., GMOs, feed systems) but ensures shared content is from credible sources.
- The goal is to enable professionals to make informed decisions by accessing a range of perspectives.
- They avoid sharing content that is conspiratorial or lacks scientific credibility.

3. Nutrition as an underserved topic

- Nutrition is under-represented in professional development and industry discourse.
- There is a lack of consistent, evidence-based information being shared across the sector.
- Decisions around nutrition are often made based on sales advice rather than science, leading to inconsistent or poor outcomes.

4. Need for professional accreditation

- There is growing interest in professional accreditation for rural advisors, including nutritionists.
- NZIPIM is exploring a modular accreditation system that could include:
    - Nutrient management
    - Ruminant nutrition
    - Freshwater planning
    - Greenhouse gas mitigation
- However, such a system is costly and complex, and would require industry-wide collaboration and farmer buy-in.

5. Challenges in implementation

- Accreditation systems require critical mass and financial backing to be sustainable.
- Previous attempts failed due to lack of farmer demand.
- A new survey (Survey of Rural Decision Makers) will assess whether farmers now see value in accredited advisors.

6. Openness to collaboration

- NZIPIM is open to supporting initiatives that bridge education gaps, including:
    - Hosting webinars
    - Sharing reports and articles
    - Promoting credible research

- They are also working on digitising and podcasting their journal content to improve accessibility.

7. Integration of nutrition and economics

- There is a disconnect between financial advisors and nutrition knowledge.
- A modular approach could allow professionals to be endorsed in specific areas, such as nutrition, without requiring full accreditation in all domains.
- The goal is to encourage cross-disciplinary understanding, especially around return on investment in nutrition.

Summary of recommendations and ideas

- Develop a modular accreditation system for rural professionals, including a nutrition module.
- Collaborate across industry (e.g., Dairy NZ, Farmlands, AgResearch) to co-fund and co-develop education tools.
- Improve access to credible nutrition information through open-source platforms and podcasts.
- Encourage farmer buy-in by demonstrating the value of accredited advice.
- Use data and research (e.g., from wearables, pasture growth tools) to support evidence-based decision-making.
- Bridge the gap between science and practice by translating research into practical tools and language.

University Insights & Themes

1. Applied learning in agricultural education

- Emphasis was placed on the value of hands-on, practical experience in agricultural education.
- There is a notable difference between students who are regularly on-farm and those who are not, with the former gaining more meaningful, applicable knowledge.
- The current academic structure often lacks sufficient repetition and real-world application, which are essential for developing critical thinking and problem-solving skills.

2. Gaps in nutrition education

- A significant gap exists in how nutrition is taught, particularly in relation to basic feeding principles and feed budgeting.
- Many students struggle with numeracy and data interpretation, which are crucial for understanding animal nutrition.
- There is a need for simplified, foundational courses that demystify nutrition and make it more accessible to learners and professionals alike.

3. Industry decision-making and system pressures

- Decision-making in the dairy industry is often driven by milk price fluctuations, leading to reactive strategies like overuse of supplements.
- There is a tendency to focus on production numbers rather than what animals actually require, which can compromise animal health and efficiency.
- Tools like decision trees and calculators were suggested as effective ways to help farmers visualise and evaluate the impact of their choices.

4. Young stock rearing and calf care

- The importance of early animal care was highlighted, particularly in calf rearing, which is often undervalued despite being critical to long-term herd performance.
- There is a call for industry standards and training in this area, as well as recognition of the specific skill set required for effective calf management.

5. Short courses and micro credentials

- A proposal was made for short, modular courses that could be tailored to different roles (e.g., farmers, consultants, accountants).
- These would focus on basic nutrition, feed budgeting, and interpreting farm data, and could be completed alongside regular work.
- Such courses could help bridge the knowledge gap and improve cross-disciplinary understanding in the industry.

6. Credentialing and professional standards

- Currently, there is no formal credentialing system for animal nutritionists in the country.
- A certification or exam, similar to those used in other countries, was suggested to ensure science-based, consistent advice is being delivered.
- The need for extension skills, the ability to translate scientific knowledge into practical advice, was emphasised as a critical gap.

7. Structural and systemic challenges

- The structure of current degree programs may not adequately prepare students for industry roles, especially in animal science and agri-business.
- There is a shortage of skilled professionals in nutrition and consultancy, and a need to attract and train younger talent.
- A more integrated, systems-based approach to education and industry training was recommended.

NZARN (New Zealand Association of Ruminant Nutritionists) Insights & themes

1. Gaps in dairy nutrition knowledge in NZ

- There were six recurring themes from interviews with 13–15 nutritionists:
    1. Education and training
    2. Young stock rearing
    3. Precision feeding and technology
    4. Holistic farm management (including emissions and soil health)
    5. Financial and economic analysis
    6. Development of new initiatives and programmes

2. Role of NZARN (New Zealand Association of Ruminant Nutritionists)

- NZARN's core mission is education for its members.
- It operates as a volunteer-based, member-driven organisation.
- While it has done farmer education days in the past, resource constraints limit outreach.
- There is interest in expanding educational efforts to rural professionals and farmers, but capacity is a challenge.

3. Need for standardised education and language

- There's a call for a universal or standardised system (e.g., an updated version of FeedRight) to align language and understanding across the industry.

- NZARN supports the idea but notes differences in philosophy between NZARN and Dairy NZ, which may complicate collaboration. While interviewees show there is a want for this collaboration, it would need to be outcome focussed with particular interest on the best and most efficient producers and how to replicate the best and advocate to continue to be better.

4. Credentialing and career pathways

- Currently, no formal credential exists in NZ for ruminant nutritionists.
- NZARN membership is one form of recognition, but it's limited in size (~40 full members).
- The Australian ARN course is a pathway some have taken.
- There's strong support for creating a New Zealand-based credential or micro-credential, possibly through universities or NZARN, to:
    - Attract new talent
    - Provide a clear career pathway
    - Ensure quality and consistency in advice

5. Industry collaboration and integration

- There's potential for greater collaboration between nutritionists, vets, and farm advisors.
- A "governance board" model on farms, involving these three roles, could improve decision-making.
- Integration with data and wearable tech companies is seen as a future opportunity for nutritionists.

6. Challenges in knowledge transfer

- There's a disconnect between research, professionals, and farmers.
- Many farmers still ask basic questions, indicating poor knowledge cycling.
- The limited number of qualified nutritionists and lack of accessible, up-to-date resources are major barriers.

7. Cultural and structural barriers

- Nutrition is often undervalued in NZ's pasture-based systems.
- Unlike poultry nutrition (which is highly specialised), ruminant nutrition lacks professional gatekeeping.
- There's a need to make the role more appealing and distinguished to attract talent.

Recommendations and ideas discussed

- Develop a micro-credential or junior nutritionist programme through NZARN.
- Create a standardised educational platform with modules and in-person training.
- Increase collaboration with Dairy NZ, vets, and rural professionals.
- Improve access to evidence-based resources for both professionals and farmers.
- Explore funding or investment to support NZARN's outreach and training efforts

Dairy NZ Insights & themes

1. Systems thinking in nutrition

- Nutrition must be understood within the context of the whole farm system, not in isolation.
- What's optimal for animal efficiency may not be optimal for system profitability or sustainability.

- There's a need to balance production, infrastructure, labour, and farmer goals when making nutrition decisions.

2. Gaps in education and training

- There are significant gaps in nutrition education at all levels:
    - Tertiary education lacks practical, pasture-based nutrition training.
    - Vets and rural professionals often lack systems-level understanding.
    - Sales reps may promote products without evidence-based reasoning.
- There's a call for standardised, independent, and practical training modules that integrate theory and real-world application.

3. FeedRight and the need for independent tools

- The FeedRight programme was developed to fill the gap between research and practical application.
- It was valued for being independent, systems-focused, and evidence-based, but is now outdated.
- There is strong support for reviving and updating FeedRight, potentially through a collaborative, multi-stakeholder approach.

4. Decision-making frameworks and tools

- Farmers need help developing "decision rules"—frameworks for making consistent, informed choices.
- Tools like the Feed Checker and Supplement Price Calculator are useful but need to be digitised and simplified for broader use.
- There's a need for accessible, real-time data (e.g., pasture growth, feed quality) to support on-farm decisions.

5. Technology and data use

- Wearables and data tools (e.g., rumination monitors) are promising but risk misinterpretation.
- Data should be used as part of a broader decision-making process, not in isolation.
- More research is needed to validate metrics like rumination and link them to outcomes like reproduction and production.

6. Greenhouse gas emissions and sustainability

- Nutrition plays a key role in emissions intensity, but the relationship is complex.
- Only ~10% of emissions intensity is explained by production per cow, system-level factors matter more.
- There's a need for targeted feeding strategies based on season, pasture quality, and supplement type to reduce emissions.
- Palm kernel, while controversial, may still have a role depending on context and performance outcomes.

7. Integration of nutrition and economics

- There is a disconnect between financial advisors and nutritionists.
- Few professionals can integrate both perspectives, leading to fragmented advice.
- Larger entities (e.g., Southern Pastures) are better positioned to bring in specialist teams, but smaller farms lack this support.

8. Communication and peer learning

- Farmers benefit from peer-to-peer learning and practical, timely updates.

- There's a desire for more structured, farmer-focused communication, such as:
    - Podcasts (e.g., Ireland's Grass10)
    - Local pasture growth signage
    - Practical roadshows and workshops

9. Accreditation and professional standards

- There's growing interest in accreditation for feed reps and nutrition advisors.
- A modular credentialing system could help ensure consistent, evidence-based advice.
- Any accreditation must be relevant to New Zealand's pasture-based systems and avoid being overly commercial or prescriptive.

10. Collaboration over competition

- There's a need to move beyond silos and egos in the advisory space.
- A collaborative approach involving Dairy NZ, independent experts, and industry bodies could help unify messaging and improve outcomes.
- The goal is to support farmers with credible, practical, and adaptable tools and advice.

Summary of recommendations

1. Revive and update FeedRight with a collaborative, independent, and modular structure.
2. Develop standardised training modules for tertiary students, rural professionals, and sales reps.
3. Digitise and simplify tools like Feed Checker and Supplement Price Calculator.
4. Promote systems-thinking in all nutrition education and advisory services.
5. Use data tools alongside human expertise, not as replacements.
6. Support research into emissions and supplement strategies tailored to NZ systems.
7. Create a modular accreditation system for nutrition and advisory professionals.
8. Encourage peer learning and practical communication (e.g., podcasts, pasture updates).
9. Bridge the gap between nutrition and economics through integrated advisory models.
10. Foster a culture of collaboration to reduce misinformation and improve farmer outcomes.

Industry Professionals

1. Back to basics: fundamentals still matter

- Industry professionals emphasised that many farms are missing foundational practices:
    - Measuring feed quality and quantity
    - Understanding pasture variability
    - Matching feed supply to cow requirements
- There's a tendency to chase silver bullets (e.g., supplements, additives) without addressing basic nutritional needs or system limitations.

2. Complexity vs. simplicity in nutrition

- Nutrition is inherently complex, but the industry often overcomplicates or oversimplifies it.
- There's a disconnect between scientific knowledge and practical application, especially when advice is based on averages or assumptions.

- A middle ground is needed: accessible, evidence-based guidance that is contextualised to each farm system.

3. Decision-making and system fit

- Nutrition decisions must align with:
    - Farm goals and drivers
    - Infrastructure and labour capacity
    - Economic constraints
- The concept of "decision rules", frameworks for making consistent, informed choices, was highlighted as a valuable tool for farmers.

4. Data and technology: game changers with caveats

- Wearables and AI are transforming how we:
    - Monitor cow health and behaviour
    - Track reproduction and rumination
    - Identify inefficiencies and opportunities
- However, data is only valuable if interpreted correctly. There's a steep learning curve, and trust in data varies among farmers.
- AI is seen as a powerful enabler, turning raw data into actionable insights and reducing time burdens on farmers.

5. Partnerships and advisory models

- No single advisor can do it all. The future lies in collaborative partnerships between:
    - Vets
    - Nutritionists
    - Consultants
    - Data providers
- These partnerships must be goal-aligned, ego-free, and farmer-focused.
- There's a need to redefine advisory roles to reflect the integrated nature of modern farming.

6. Farmer learning and peer influence

- Farmers learn best from other farmers, especially those who are top performers.
- Practical, peer-led learning (e.g., farm discussion groups, field days) is more effective than top-down instruction.
- There's a call to revive and modernise extension models, focusing on real-world examples and relatable language.

7. Emissions and efficiency

- Emissions intensity is closely tied to feed efficiency and system design.
- Homegrown feed and feed conversion efficiency are key levers.
- However, emissions accounting is complex, especially when considering embedded emissions and system variability.
- The industry needs clearer metrics and communication to help farmers make informed decisions.

8. The role of AI in the future

- AI is expected to:

    - Streamline data interpretation
    - Support decision-making
    - Highlight research gaps
- It will likely disrupt traditional advisory roles, especially those based on outdated or anecdotal advice.
- There's a need to train advisors and farmers to work with AI and understand its outputs.

9. Credentialing and standardisation

- There's strong support for micro-credentials or base-level training in nutrition and data literacy.
- These would help unify messaging, reduce misinformation, and lift the industry baseline.
- Programmes like FeedRight are seen as valuable but need updating and broader collaboration.

Summary of recommendations

1. Reinforce the basics: Prioritise foundational nutrition knowledge and measurement.
2. Develop decision-making frameworks: Help farmers create consistent, goal-aligned strategies.
3. Promote collaborative advisory models: Encourage integrated teams over siloed specialists.
4. Leverage AI and data tools: Use them to enhance, not replace, human expertise.
5. Revive peer-led learning: Focus on top performers and practical, relatable communication.
6. Clarify emissions metrics: Provide tools that connect nutrition, efficiency, and emissions.
7. Create micro-credentials: Establish base-level training for nutrition and data interpretation.
8. Encourage open data sharing: Build trust and competitiveness through transparency.
9. Support adaptive extension models: Blend science, tech, and farmer experience in delivery.

Discussions

Comprehensive Education and Training Programs

As agricultural systems grow more complex and environmental challenges intensify, the need for effective, adaptable farmer education becomes increasingly urgent. In both New Zealand and globally, the success of agricultural innovation depends on training that is grounded in scientific theory while remaining deeply connected to practical realities.

This section begins with a breakdown of our current state of play in New Zealand with regards to education and then explores how standardised, yet flexible training modules can be designed to align with farmer learning preferences, integrate intuitive and evidence-based knowledge, and foster participatory, trust-based learning environments.

Overview of animal nutrition education in New Zealand

New Zealand offers a broad spectrum of educational opportunities in animal nutrition, ranging from academic degrees and vocational training to online courses and professional development. These programs are designed to support students, industry professionals, and practitioners working across the livestock sector. However, while the range is diverse, there are notable gaps in depth, particularly in practical and ruminant-specific nutrition training.

At the academic level, Lincoln University provides foundational training through it's *Bachelor of Science (Animal Science)*. A key component of this degree is the third-year paper; *ANSC 327: Animal Nutrition, Biochemistry and Metabolism*. This paper introduces students to core principles of nutrition and metabolism. Massey University stands out as the only institution in New Zealand offering a full undergraduate major specifically focused on animal nutrition. It's *Bachelor of Animal Science (Animal Nutrition and Growth)* explores how nutrition influences the performance and health of both livestock and companion animals. In addition to the degree, Massey offers specialised papers such as *117303: Ruminant Animal Nutrition* and *117226: Performance Animal Nutrition*. These papers delve into feed composition, digestion, and diet evaluation. However, despite their targeted focus, they still fall short in delivering hands-on, practical training, particularly in areas like ration formulation, feed conversion efficiency, and real-world application in dairy systems. While these course offers valuable theoretical grounding, it lacks a strong emphasis on applied or ruminant-specific nutrition, and practical assessment components are limited.

Unitec Institute of Technology incorporates nutrition into its *Bachelor of Applied Science (Animal Management, Welfare, Biodiversity & Veterinary Nursing)*. The program includes a compulsory Level 6 paper: *Animal Breeding and Nutrition*. While this course provides applied knowledge in breeding and feeding systems, it does not explore ruminant nutrition in depth. Key concepts such as the relationship between animal husbandry practices and feed efficiency, or the impact of nutrition on animal health and productivity, are not comprehensively addressed.

For those seeking flexible, industry-oriented learning, Learning Cloud offers an online course titled '*Animal Feed and Nutrition' (Animal Husbandry III)*. This 100-hour course is well-suited for individuals working in animal care, farming, or breeding. However, its content remains broad and introductory, with limited focus on dairy nutrition or the specific needs of ruminant animals. It serves more as a general overview than a targeted training solution for those in the dairy sector.

Beyond formal education, a range of professional development opportunities are available but often lack independence. The results pointed out that people are often trained in product knowledge but lack a deeper understanding of farm systems and nutrition. This gap leads to over-reliance on informal or potentially biased training sources, underscoring the need for formal, structured learning pathways. However, the overall lack of education throughout the sector has meant that independent programs have some forward as means to help.

Agvance Nutrition regularly hosts expert-led webinars on ruminant nutrition, such as recent sessions on colostrum cow care. Nutritech is another provider that hosts online webinars in the ruminant space. LWT Animal Nutrition and the New Zealand Veterinary Association (NZVA) offer tailored short courses and webinars for veterinarians, feed professionals, and animal health practitioners. These include CPD accredited sessions on gut health, nutrition, and disease management.

The New Zealand Veterinary Nursing Association (NZVNA) also provides webinars for vet nurses, such as the upcoming session on gastrointestinal protocols. Meanwhile, Fonterra and NZ Farm Source deliver webinars for rural professionals, covering topics like feed efficiency and herd health.

Several professional bodies support ongoing learning and knowledge exchange in animal nutrition. The New Zealand Association of Ruminant Nutritionists (NZARN) host regular seminars and conferences, however requirements restrict information to only those associated. The New Zealand Society of Animal Production (NZSAP) and AgResearch contribute through research dissemination and workshops on sustainable feeding practices.

Results show New Zealand's education system has historically focused too heavily on pasture management, often neglecting the nutritional needs of the animal. The requirement for balanced training that integrates both pasture and animal nutrition, helping farmers understand the trade-offs between feed management and cow health remains of huge importance. Furthermore, it was emphasised about the need for practical, on-farm training. It was said that many farmers misunderstand nutrition, often equating it solely to supplements. This resulted in a recommendation for more hands-on education, including interpreting on-farm data and balancing rations, highlights the importance of contextual, experience-based learning.

Enhancing farmer learning: standardised training modules and the integration of practical and theoretical knowledge

Identified gaps in animal nutrition education

Despite the offerings, there are notable gaps in New Zealand's animal nutrition education landscape. While undergraduate programs are well-established, they lack applied education and still feature gaps around how this pathway educates people and where this will take you within the industry. There are few advanced qualifications specifically focused on animal nutrition. Postgraduate options tend to combine nutrition with broader topics like genetics or physiology, and there is no formal certification pathway for becoming a professional "Animal Nutritionist."

Practical short courses tailored to farmers and farm staff are also limited. Although webinars exist, many farmers still rely on consultants or company representatives for advice, rather than structured, accessible training. There is a lack of micro-credentials or online modules focused on practical skills such as ration formulation, pasture management, or supplement economics, particularly within New Zealand's pasture-based systems.

For working professionals, there is no consistent CPD pathway. While webinars are available, they are often isolated sessions rather than part of a structured learning journey. Emerging areas like sustainable feeding, precision nutrition, and climate-resilient diets are under-represented.

Standardised yet adaptive training modules & learning preferences

Research highlights the importance of balancing consistency with adaptability in agricultural training. Payne et al. (2016) propose a typology of nine extension approaches, emphasising that no single model suits all contexts. Instead, training should offer a modular framework that can be tailored to the complexity of the issue, farmers' readiness, compatibility with existing systems, and available resources. Sewell et al. (2014) supports this view, advocating for participatory learning communities where farmers and scientists co-develop knowledge. Effective training modules should therefore include core theoretical content such as pasture physiology and grazing systems alongside customisable practical components like region-specific case studies and decision-making tools for both farmers and extension agents.

Farmers often rely more on intuition and experiential learning than on formal planning tools. Nuthall (2012) found that most farmers do not use feed budgeting software, instead developing personalised systems based on observation and experience. While expert systems have been proposed, their effectiveness is limited by the uniqueness of each farm. Training programs should aim to enhance intuitive decision-making through structured reflection, real-world scenarios, and case studies that contextualise theory. By also encouraging pattern recognition and mental modelling, to identify the key traits of expert farmers, we can help bridge the gap between theory and practice. Sewell et al. (2014) emphasise that farmers learn best when they can connect evidence-based ideas to their own systems, revisit key concepts, and engage in hands-on, multi-sensory activities.

Farmer learning is shaped by both cognitive processes and social dynamics. Corkran (2023) and Sewell et al. (2014) identify two key pillars: the cognitive aspects of awareness, information gathering, and decision-making; and the social aspects of trust, networks, and peer validation. Farmers prefer learning that is practical, relevant to their systems, and delivered through trusted networks or advisors. They value scientific support, but not overly technical content, and benefit from repetition and real-world application. Nuthall (2012) further notes that successful farmers

exhibit strong observational, anticipatory, and risk management skills and traits that can be nurtured through targeted training.

Building trust and networks through extension to create adoption

Trust is foundational to effective farmer engagement. Farmers are more likely to adopt new practices when they trust the source of information, particularly when it comes from peers or empathetic advisors. Rust et al. (2022) and Sewell et al. (2014) highlight the importance of embedding training within existing farmer networks, using facilitators with local credibility, and avoiding hard-sell tactics. Instead, training should focus on co-learning and mutual respect, creating safe, inclusive spaces for dialogue and experimentation. The Red Meat Profit Partnership (RMPP) Action Network exemplifies this approach, using small, farmer-led groups to foster peer learning and collaborative problem-solving.

Education plays a critical role in shifting farmer attitudes and encouraging the adoption of new practices. Bharani Baanu et al. (2022) demonstrates this in their study on treated wastewater reuse in agriculture. Initially, farmers showed low willingness to pay, but targeted education on the economic and agronomic benefits significantly increased acceptance. This underscores the importance of training modules that clearly articulate the benefits of new practices, use data and demonstrations to build confidence, and address psychological and cultural barriers to change.

The roles of farmers, rural professionals, and education providers

Farmers are not passive recipients of information. They are active learners and co-creators of innovation. Participatory learning environments, such as communities of practice or facilitated groups, allow farmers to contribute local knowledge, co-construct new understandings, and develop the confidence to question, adapt, and innovate (Sewell et al., 2014). Training programs should respect and build upon farmers' existing knowledge, provide opportunities for reflection and peer exchange, and encourage experimentation and feedback loops. Corkran (2023) emphasises that relevance, trust, and practical application are key to farmer engagement.

Rural professionals including farm advisors, consultants, agronomists, and veterinarians play a vital role as facilitators and knowledge brokers. Often the most trusted sources of information, they are most effective when they demonstrate empathy, communicate clearly, and focus on shared goals rather than sales. Sewell et al. (2014) describe how these professionals can support learning communities by creating inclusive spaces, bringing in expert knowledge, and encouraging ongoing reflection. To fulfil this role, rural professionals themselves need training in facilitation, adult learning principles, and systems thinking, along with institutional support to maintain long-term relationships with farming communities.

Universities, polytechnics, and training organisations play a crucial role in designing and delivering standardised agricultural training. However, traditional top-down, lecture-based approaches have often proven ineffective in the context of farming. As Sewell et al. (2014) and Nuthall (2012) argue, these conventional methods fail to engage farmers meaningfully, particularly when they overlook the importance of practical relevance, dialogue, and co-construction of knowledge.

To address these shortcomings, education providers must evolve their role from content deliverers to learning system designers. This involves collaborating closely with farmers and rural professionals in curriculum development to ensure that training is grounded in real-world needs. Blended learning approaches, combining theoretical instruction with hands-on practice, are essential. Additionally, incorporating sociocultural learning theories can enhance engagement by emphasising dialogue, contextual relevance, and shared meaning-making.

Sewell et al. 2014 study on herb pastures illustrates the potential of university-led, farmer-partnered learning programs. These initiatives were successful because they built trust and mutual respect, allowed farmers to shape the learning agenda, and used real-world trials and multi-sensory experiences to reinforce learning. Such programs demonstrate that when farmers are treated as partners rather than passive recipients, the outcomes are more impactful and enduring.

Education providers must also recognise the diversity of learners in the agricultural sector. Differences in age, literacy levels, digital access, and learning styles require thoughtful, inclusive design. Training must be accessible and adaptable, ensuring that all farmers, regardless of background, can engage meaningfully with the content.

The most effective agricultural training systems are those that integrate the unique strengths of farmers, rural professionals, and education providers. Each group brings essential contributions to the table: farmers offer local knowledge, practical experience, and peer networks; rural professionals provide facilitation, technical advice, and trusted relationships; and education providers contribute research, curriculum design, and pedagogical expertise.

Programs like the RMPP Action Network exemplify this collaborative model. These initiatives use farmer-led groups facilitated by trained professionals and supported by research institutions, creating a dynamic learning environment that is both grounded and innovative. This integration ensures that training is not only scientifically sound but also socially and practically relevant.

Recommendations for training module development

Based on the synthesis of research and practice, several key recommendations emerge for the development of effective training modules:

1. **Modular design**
   Develop standardised modules that include core theoretical content alongside customisable practical applications tailored to local contexts.
2. **Contextual relevance**
   Ensure that content reflects regional and sector-specific realities, incorporating local case studies and farmer experiences.
3. **Blended learning**
   Combine classroom-style instruction with on-farm demonstrations, digital tools, and peer-led sessions to enhance engagement and retention.
4. **Facilitation and trust**
   Employ trained facilitators to guide learning groups, fostering inclusive, trust-based environments that encourage open dialogue and experimentation.
5. **Feedback and reflection**
   Integrate mechanisms for continuous feedback, self-assessment, and structured reflection to support the development of intuitive decision-making skills.
6. **Participatory co-development**
   Involve farmers directly in the design and delivery of training to ensure relevance, ownership, and long-term impact.

Conclusion

New Zealand provides an offering in animal nutrition education through its universities, training institutions, and professional bodies. Programs at institutions like Massey and Lincoln Universities offer valuable theoretical grounding, while industry-led webinars and short courses provide ongoing professional development. However, there is a need for these courses to incorporate more ruminant and animal husbandry focus to allow our industry to learn how these components interact with each and their impact on productivity, animal health, efficiency and environment. There remains a clear and pressing need for more applied, flexible, and advanced training options, particularly for non-veterinary professionals, farm advisors, and dairy farmers who require practical, context-specific knowledge.

To meet the evolving demands of modern agriculture, the integration of standardised training modules with practical, trust-based learning environments is essential. Aligning educational content with farmer learning preferences, by blending scientific theory with intuitive, experience-based knowledge, can make agricultural extension more effective, inclusive, and sustainable. Collaborative models that bring together the strengths of farmers, rural professionals, and education providers are key to building resilient, adaptive farming systems. Addressing current gaps in training and creating more accessible, hands-on learning opportunities will not only enhance individual capability but also strengthen New Zealand's broader capacity for innovation and sustainability in animal nutrition.

Young Stock Rearing

In New Zealand young stock rearing is an important part of the dairy system. Results highlighted that focusing on the first year of life and understanding its impact on long-term productivity are essential for a successful dairy system, particularly when examining young stock rearing. Nutrition in the first year is foundational for calf health, immune development, skeletal growth, and future productivity. This is a core pillar that, from the results, indicates how crucial this period of a dairy animal's life is on the future of our efficiency, sustainability and profitability. It can have the potential to become a limitation in our dairy systems going forward. Early-life nutrition influences not only immediate growth but also long-term outcomes such as age at first calving, milk yield, reproductive efficiency, and skeletal health.

Results emphasised a significant gap in young stock rearing, particularly in the six to nine months following the initial three-month period. These stages are critical for the development of dairy replacements yet are often overlooked. These insights reinforce the need for sustained nutritional and management support beyond the early calf phase to ensure long-term herd productivity.

Colostrum and passive immunity

Newborn calves rely entirely on colostrum for passive immunity. Studies in New Zealand (Cuttance et al., 2017; Lawrence et al., 2017) found that 25–33% of calves experienced failure of passive transfer (FPT), which was associated with increased disease risk. Key practices to reduce FPT include:

- Feeding colostrum within the first 6 hours of life.
- Continuing colostrum feeding for at least four days post-birth.
- Managing calving workloads to ensure timely calf care.

Monitoring serum total protein (e.g., via Brix refractometry) is a practical tool to assess colostrum success and identify at-risk calves (Dam Otten et al., 2023).

Pre-weaning and post-weaning nutrition

Milk or milk replacer intake during the first 6–8 weeks of life is a key driver of early growth in dairy calves. Higher milk intake, combined with early access to starter grain, has been shown to enhance average daily gain (ADG) and support earlier onset of puberty (Heinrichs et al., 2005; Le Cozler et al., 2008). Building on this, Gibson et al. (2025) demonstrated that while calves reach approximately 89–90% of their mature height by one year of age, they achieve only 60–62% of their mature weight at one year of age, underscoring the need for sustained nutritional support beyond weaning to ensure balanced development. The importance of early-life nutrition extends beyond growth alone. Gelsinger et al. (2016) conducted a meta-analysis showing that preweaning nutrition, specifically milk and starter intake, along with ADG has a measurable, though modest, impact on first-lactation milk, fat, and protein yields. Notably, calves that achieved an ADG above 0.5 kg/day and consumed both liquid and solid feeds preweaning experienced synergistic gains in first-lactation performance, suggesting that early nutritional strategies can influence mammary development and metabolic efficiency, thereby enhancing long-term productivity.

The type and timing of forage introduction also play a critical role in shaping outcomes. Zhang et al. (2024) investigated the effects of different forage types supplemented during the preweaning phase and found that including hay alongside concentrate improved rumen pH, nutrient digestibility, and reduced fecal scores. Although these benefits were not immediately reflected in early growth metrics, they translated into significantly higher milk production during the first lactation. This aligns with industry observations that early-life forage strategies can influence rumen development and microbial colonisation, with lasting effects on health and productivity.

Strategic early-life nutrition not only supports growth but also enhances resource efficiency. Franco et al. (2021) demonstrated that supplementing milk replacer with isoenergetic levels of starch or lipid significantly improved feed efficiency in nursing Holstein calves. Both supplemented groups exhibited lower residual feed intake (RFI), indicating more efficient nutrient utilisation, without compromising growth performance. Notably, the study also highlighted that synchronising non-fibrous carbohydrate and crude protein intake can influence water metabolism through increased metabolic water production. These findings reinforce the idea that precision diet formulation during the preweaning phase can optimise both feed and water efficiency, laying the foundation for improved lifetime productivity and sustainability.

As findings highlighted, the period from six to nine months post-birth is often neglected in New Zealand dairy systems. It was emphasised the importance of physical observations, such as manure consistency and rumination data to better understand and manage nutrition during this phase. It was also touched on for comprehensive training programs that address practical aspects of young stock nutrition.

Second Winter Nutrition

In pasture-based systems like New Zealand's, the second winter (around 18–24 months of age) is a critical period. Nutritional deficits during this time can impair bone development, particularly in the humerus, which continues to grow after other bones have matured (Gibson et al., 2025). Wehrle-Martinez et al. (2025) identified inadequate protein-energy intake during this period as a key risk factor for spontaneous humeral fractures in first-lactation heifers.

Macdonald et al. (2014) showed how energy use shifts from growth to milk production as animals mature. During lactation, a higher proportion of dietary energy is directed toward milk rather than body weight gain, which explains the reduced divergence in Residual Feed Intake compared to the calf phase. This follows on from results around the importance on the first year of life and how this period remains just as important and the first 6 months. In results it was clear this period is often a dairy farmers hardest time of year for feed, due to time, season and environment, often leaving young animals compromised.

Growth and Development

Heinrichs et al. (2005) found that early-life nutrition and health events influenced age, body weight, and body condition score at first calving. Calves with higher early-life milk and grain intake reached breeding targets sooner and calved earlier. Gibson et al. (2025) showed that early growth in stature (e.g., leg length, wither height) is highly heritable and less influenced by environment, while capacity traits (e.g., girth, live weight) are more responsive to nutrition and continue developing until 810 days of age.

Pre-pubertal overfeeding, particularly with high-energy diets, has been shown to impair mammary gland development due to increased fat deposition, potentially reducing first-lactation milk yield (Le Cozler et al., 2008). However, more recent evidence suggests that modern Holstein heifers may tolerate higher growth rates without compromising future milk production (Heinrichs et al., 2005). Gelsinger et al. (2016) further support this by highlighting the link between early-life nutrition and mammary development. Drawing on Brown et al. (2005), they note that calves fed a high-protein, low-fat milk replacer along with a high-protein starter during the preweaning period exhibited greater mammary gland mass and increased parenchymal tissue, key indicators of functional mammary development. In contrast, high-protein starter feeding postweaning increased fat deposition without enhancing parenchymal growth. These findings suggest that the timing and composition of early nutrition are critical for optimal mammary development. Further to this, Gibson et al. (2025) emphasise the importance of thoracic growth and structural capacity, particularly the development of the humerus and heart girth, which continues into the second year of life and supports mammary tissue. Their work underscores that while height is largely genetically determined and less responsive to nutrition, thoracic development is highly plastic and sensitive to nutritional input, offering a key opportunity to influence future lactational performance through targeted management during this critical growth window.

The study by Gibson et al. (2025) highlights the critical role of structural development in dairy heifers, particularly the growth of thoracic capacity and bone maturation, in supporting future productivity. While height and leg length are largely determined early in life and less influenced by environmental factors, measures such as heart girth and live weight, which are closely tied to thoracic development, continue to grow into the second year and are highly sensitive to nutritional input. This is especially relevant for bones like the humerus, which matures later than distal limb bones and contributes significantly to thoracic capacity. Findings aligned with information from Gibson et al. (2025), particularly around the emphasis of management during the early stages of our young stock.

Wehrle-Martinez et al. (2025) identified osteoporosis as the underlying pathology in spontaneous humeral fractures observed in first-lactation cows, linking these fractures to inadequate protein-energy nutrition during the second winter, increased bone resorption in early lactation, and failure to reach peak bone mass due to interrupted growth. These findings underscore the importance of sustained, high-quality nutrition beyond weaning, not only to support skeletal integrity and prevent structural failure but also to maximise the development of capacity that underpins future lactational performance. Together, these studies emphasise that the second year of life is a nutritionally

sensitive period for bone development, with long-term implications for both productivity and animal welfare.

Effective Monitoring and Management of Youngstock

Effective monitoring and management are essential to ensure that nutritional and health goals are met throughout the first year of life and beyond. Early-life growth and health not only influence immediate outcomes but also have long-term implications for structural development, productivity, and welfare.

Dam Otten et al. (2023) introduced a dashboard-based monitoring tool that integrates key indicators such as colostrum quality (via Brix scores), clinical health scores (e.g., for respiratory and gastrointestinal disease), growth tracking (via heart girth and weight estimates), and pathogen detection (via PCR diagnostics). This integrated approach enables farmers to visualise calf progress, detect early signs of disease or poor growth, and evaluate the effectiveness of interventions in real time. Such tools are particularly valuable for ensuring calves meet developmental milestones and for tailoring management to individual needs.

Management strategies must also account for breed, environment, and system-specific risks. Wehrle-Martinez et al. (2024) found that early access to pasture and crossbred genetics (Holstein-Friesian × Jersey) were associated with increased risk of spontaneous humeral fractures in first-lactation heifers. Delaying pasture access post-weaning and ensuring adequate winter nutrition, especially during the second winter, may reduce this risk by supporting continued bone development. This aligns with findings from Gibson et al. (2025), who emphasised that thoracic growth and bone maturation, particularly in the humerus, continue into the second year of life and are highly sensitive to nutritional input.

Le Cozler et al. (2008) emphasised that rearing strategies must be tailored to breed, calving system (seasonal vs. year-round), and growth potential. Monitoring tools, such as those described by Dam Otten et al., can help ensure that calves meet key targets for weight, height, and condition at each stage. These tools also support proactive management, allowing for timely adjustments in feeding, housing, and health protocols to optimise outcomes.

The findings emphasise the value of on-farm observations and data collection, such as rumination monitoring and manure analysis, as practical tools for managing young stock nutrition. These approaches support a more responsive and individualised method of calf care. Additionally, hands-on field days that combine scientific knowledge with practical advice have proven effective in delivering valuable, non-product-focused insights to farmers, particularly in calf rearing. Another initiative, focused on simplifying body condition scoring, has significantly improved farmers' understanding and application of this important management tool, which is crucial for both calf and cow health.

Together, these studies along with results from interviews underscore the importance of a holistic, data-informed approach to youngstock management; one that integrates real-time monitoring, breed-specific strategies, and nutritional planning to support healthy development and long-term productivity.

Precision Feeding and Technology Integration

Wearable Technology and Data-Driven Nutrition in Dairy Cows

The global dairy industry is undergoing a digital transformation, driven by the need to enhance productivity, animal welfare, and environmental sustainability. At the heart of this evolution is Smart Dairy Farming (SDF), which integrates Internet of Things (IoT), Artificial Intelligence (AI), and Computer Vision (CV) technologies to address challenges such as low milk yield, inefficient resource use, and health management (Akbar et al., 2020; Liu et al., 2023). Wearable technologies, particularly collar-mounted and ear-tag sensors are central to this shift, enabling real-time monitoring of cow behaviour, health, and nutrition. This is conceptualised in Figure 1. These tools support precision livestock farming (PLF), a data-driven approach that optimises individual animal care and farm-level decision-making (Lamanna et al., 2025).

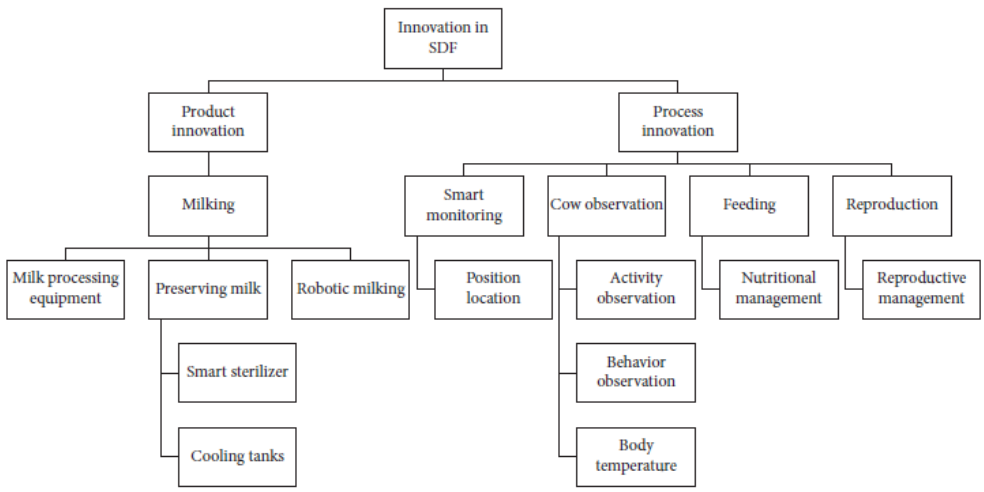

Figure 1: Innovation in Smart Dairy Farming, From Akbar et al., 2020

Monitoring, Detection and Precision Nutrition

Behavioural monitoring is a cornerstone of SDF, leveraging wearable sensors, machine vision, and deep learning to detect feeding, rumination, walking, and estrus behaviours (Liu et al., 2023). Collars equipped with accelerometers, gyroscopes, magnetometers, microphones, GPS, and RFID tags can detect nuanced behaviours such as grazing, biting, chewing, and rumination, activities directly linked to nutritional status (Lamanna et al., 2025). For example, acoustic sensors can classify jaw movements to estimate food intake, offering a non-invasive method to assess whether cows meet their dietary needs. Devices like AfiCollar™ and MooMonitor+ have shown strong correlations between rumination time and milk yield, making them valuable tools for assessing digestive efficiency and nutritional adequacy (Iqbal et al., 2023; Werner et al., 2019).

However, as results emphasised, while our farmers often collect this data, they tend to focus more on reproduction or labour-saving features, underutilising the nutrition modules. It was stressed the need for better interpretation and integration of data into nutrition decisions to unlock the full potential of these technologies.

Chewing and rumination are not only behavioural indicators but also physiological necessities. Dairy cows typically spend around 4.5 hours eating and 7 hours ruminating daily, with chewing playing a vital role in reducing feed particle size, stimulating saliva production, and maintaining rumen pH (Beauchemin, 2018). These processes support microbial digestion, nutrient absorption, and rumen motility. Diet composition, particularly forage neutral detergent fibre (FNDF) and particle size, significantly influences chewing time. High-fibre diets increase rumination, while finely ground feeds may reduce it and elevate the risk of subacute ruminal acidosis (SARA). Sensor technologies now allow real-time monitoring of these behaviours, enabling early detection of nutritional imbalances and digestive disorders.

Automated heat detection systems are replacing traditional visual observation methods, offering greater accuracy and efficiency. Technologies such as pedometers, accelerometers, and pressure sensors detect behavioural changes associated with estrus, enabling timely insemination and improved conception rates. Devices like Cow Manager ear tags and MooMonitor+ collars have demonstrated high sensitivity and specificity, reducing the need for hormonal synchronisation protocols and aligning with consumer preferences for natural production systems

(Santos et al., 2022; Werner et al., 2019). These systems are often integrated into broader SDF platforms, which also support fertility tracking and calving alerts through real-time analytics (Taneja et al., 2019).

Wearable sensors are also proving invaluable for early disease detection. Gusterer et al. (2020) found that changes in rumination, activity, and lying behaviour could be detected up to five days before clinical signs of disease appeared. These behavioural changes, such as reduced rumination and increased lying time, are often linked to nutritional imbalances and metabolic disorders like ketosis. Health monitoring technologies now include thermal imaging, automated milking systems, and machine learning models (e.g., CNNs, RNNs) to detect conditions such as mastitis, lameness, and diarrhoea (Liu et al., 2023). Platforms like SmartHerd enhance this capability by using fog computing to process behavioural data locally, ensuring resilience even in areas with limited internet connectivity (Taneja et al., 2019). As the result noted, while tools like Allflex collars offer great potential, many farmers don't fully utilise the data they provide, highlighting the need for better training in interpreting and applying this information.

Data-Driven Nutrition Management

Nutrition is a cornerstone of dairy productivity, and SDF places a strong emphasis on precision feeding. Essential minerals such as calcium, phosphorus, and magnesium are critical for optimal milk yield and cow health. IoT-enabled systems automate the monitoring of feed intake and water consumption, ensuring cows receive balanced diets and adequate hydration (Akbar et al., 2020). Technologies like the Keenan MechFiber (KMF) system, combined with digital platforms like PACE, support real-time adjustments to rations based on individual cow needs. These systems not only improve feed conversion efficiency (FCE) and reduce greenhouse gas emissions but also help prevent underfeeding and overfeeding (Colman et al., 2011). Near-infrared spectroscopy (NIRS) is also widely used for feed analysis, offering accurate assessments of dry matter and nutrient content (Liu et al., 2023).

Some findings emphasised that the more data available, the better nutrition can be managed but also noting that tools like automatic calf feeders and wearables are often underutilised. It was stressed about the importance of integrating technology with consultant advice to help farmers interpret and act on data effectively. It was also highlighted the value of data-driven decisions in validating and fine-tuning nutrition plans in New Zealand dairy farms.

GPS-enabled collars offer new possibilities for pasture management by providing insights into cow movement patterns. Hendriks et al. (2025) demonstrated that metrics such as standardised distance travelled, mean distance to herd mates, and rumination time can be used to estimate pasture mass. These indicators are particularly useful in rotational grazing systems, where pasture quality and availability vary. Notably, rumination time was positively correlated with pasture mass, suggesting its utility as a proxy for dry matter intake (DMI) and nutritional adequacy. While current models are not yet accurate enough for real-time decision-making, they offer valuable insights for long-term pasture planning and nutritional strategy development.

Some nutritionists praised technologies like Halter for their ability to integrate live data on pasture, rumination, and milk production, allowing farmers to see the impact of nutrition decisions in real time. It was also highlighted that the use of GPS and collar data to track cow movement and energy expenditure, which can help optimise feeding strategies and improve efficiency.

Technological Limitations and Future Directions

Despite their promise, wearable technologies and SDF systems face several challenges. Current collar technologies cannot directly measure feed intake in kilograms or time spent at the feed bunk, limiting their precision in nutritional monitoring (Lamanna et al., 2025). High initial costs, infrastructure demands, and the need for technical expertise can also hinder adoption, particularly in underdeveloped regions (Akbar et al., 2020; Liu et al., 2023). Additionally, data integration across platforms and the complexity of interpreting large data streams remains a significant barrier. Future innovations should focus on multi-sensor integration, energy-efficient and solar-powered designs, and user-friendly interfaces tailored to different farm sizes.

Future innovations should focus on multi-sensor integration, energy-efficient and solar-powered designs, and user-friendly interfaces tailored to different farm sizes. Integrating ethical considerations around data privacy and ownership must also be addressed to build trust and encourage widespread adoption.

Wearable technologies and smart dairy farming systems are reshaping how nutrition, health, and reproduction are managed in dairy herds. By leveraging IoT, AI, CV, and behavioural analytics,

these tools enable more precise, proactive, and sustainable farming practices. From optimising feed efficiency to detecting disease and improving reproductive outcomes, the integration of wearable sensors and cloud-based analytics is paving the way for a more intelligent and responsive dairy industry. As technological barriers are overcome and sensor accuracy improves, these innovations will become indispensable in meeting the growing global demand for dairy products while ensuring animal welfare and environmental stewardship.

Holistic Farm Management

Holistic farm management emphasises the interconnectedness of all components within a farming system, recognising that sustainable outcomes depend on integrated, system-wide thinking. Two key pillars of this approach are interdisciplinary collaboration and the environmental impact of nutrition. First, promoting interdisciplinary research that bridges agronomy, animal health, and nutrition enables the development of comprehensive decision-making frameworks. These frameworks support farmers in managing their operations more effectively by considering the full spectrum of biological, environmental, and economic factors. Second, improved nutritional strategies play a critical role in environmental sustainability. By optimising feed efficiency and nutrient balance, farms can reduce greenhouse gas emissions, enhance soil health through better manure quality, and contribute to more resilient agroecosystems. Together, these elements illustrate how holistic farm management not only improves productivity but also supports long-term environmental stewardship.

Farm Systems

The evolution of New Zealand's dairy farm systems reflects a complex interplay of global trends, economic pressures, regulatory shifts, and changing consumer expectations. As outlined by Shadbolt et al. (2015), the future of dairy farming in New Zealand is likely to unfold across a spectrum of plausible scenarios, each demanding a high degree of adaptability and strategic foresight. These scenarios, ranging from diversified hybrid systems to regulation-driven compliance models, underscore the need for farm systems to move beyond traditional, pasture-based approaches. Instead, they must embrace technological innovation, sustainability, and market alignment to remain resilient in an increasingly volatile global environment.

In the base scenario, farms evolve into hybrid systems that integrate supplementary feeds and automation to maintain competitiveness. Scenario 1, "Consumer is King," envisions farms becoming highly specialised and aligned with niche markets, leveraging precision technologies and traceable supply chains. Scenario 2, "Governments Dictate," presents a more constrained future dominated by cost-efficiency and consolidation, while Scenario 3, "Regulation Rules," emphasises compliance with stringent environmental and welfare standards. Across all scenarios, the adaptability of farm systems, particularly their ability to align with societal values and technological advancements, is portrayed as essential for long-term viability.

This strategic adaptability is echoed in Greig's (2012) analysis of the economic drivers behind the transformation of New Zealand's dairy systems over the past decade. Greig highlights how fluctuating input and output prices such as those for feed, fertiliser, and milk have prompted farmers to shift from low-input, pasture-based models to more intensive systems. Using production economics, he explains that profitability hinges on the dynamic relationship between biophysical production functions and market prices. As these variables shift, so too must the structure and management of farm systems. The rise of high-input models like System 5 illustrates how farmers respond not only to economic signals but also to broader factors such as climate variability, land values, and societal expectations around sustainability and animal welfare.

Results from New Zealand expert perspectives further reinforce the need for holistic, systems-based thinking in the design and management of farm systems. For instance, many emphasised the importance of considering all aspects of animal health and behaviour in nutrition decisions, advocating for a collaborative approach that includes agronomists, vets, and consultants. She warns that substandard practices have become normalised and calls for a more integrated, higher-standard approach. Similarly, it was highlighted the need for financial advisors to understand the value of nutrition, promoting interdisciplinary collaboration to align dietary strategies with financial goals.

It was also stressed in results around the importance of breaking down silos in training and decision-making, advocating for structured learning that connects nutrition, pasture management, and business strategy. Some results included an environmental lens, urging farmers to consider feed conversion efficiency and emissions intensity as part of a broader strategy to enhance both productivity and sustainability. Finally, it was discussed about the importance of aligning nutrition decisions with the specific goals and regional contexts of each farm, rejecting one-size-fits-all solutions in favour of tailored, goal-oriented advice.

Furthermore, looking at the industry through to individuals, Dedieu (2019) presented a comprehensive overview of the evolving nature of agricultural work, emphasising the need for interdisciplinary and systemic approaches to understand its complexity. The article categorises

research into two main perspectives: the worker's standpoint, focusing on employment, health, and skills and work as a component of farming systems. It highlights the diversification of employment types, the rise of salaried and migrant labour, and the precarious conditions many agricultural workers face. Health concerns such as musculoskeletal disorders, pesticide exposure, and mental health issues like stress and suicide are also discussed. The paper underscores the importance of both formal knowledge and experiential learning in developing the skills needed to adapt to technological and agroecological transitions. From a systems perspective, Dedieu (2019) explores how different farm models, industrial, entrepreneurial, family-based, and subsistence, shape labour organisation, identity, and task distribution. The article concludes by advocating for a more inclusive and integrated understanding of agricultural work that considers local contexts, systemic interactions, and the diversity of farm models to better support the future of work in agriculture.

Together, these insights emphasise that New Zealand's dairy farm systems are no longer static production units but dynamic, strategic platforms. Their success depends on the ability to integrate precision technologies, respond to regulatory and market signals, and invest in human capital and innovation. Whether navigating a consumer-driven market, a regulation-heavy environment, or economic uncertainty, the future of dairy farming in New Zealand will be shaped by the agility, collaboration, and systems thinking embedded within its farm systems.

Emissions:

Environmental concerns related to nitrogen (N) excretion are increasingly relevant in dairy nutrition, though they are not yet the primary driver of dietary decisions among U.S. dairy nutritionists. According to Prestegaard-Wilson et al. (2021), U.S. dairy cattle excrete approximately 1.36 million tonnes of reactive nitrogen annually, much of which contributes to environmental degradation through nitrate, ammonia, and nitrous oxide emissions. These emissions are linked to water pollution and eutrophication in sensitive ecosystems such as the Chesapeake Bay Basin and the Great Lakes. Despite this, only 9% of surveyed nutritionists cited environmental concerns as a primary reason for reducing crude protein (CP) in lactating cow diets. Instead, the dominant motivation was economic, specifically, the high and volatile cost of metabolisable protein (MP) sources. While 58% of respondents believed that nitrogen regulations would become more stringent within the next 3 to 5 years, most reported that their current efforts to reduce CP were aimed at improving feed cost efficiency rather than mitigating environmental impact. Nonetheless, the study highlights that balancing diets for amino acids (AA) rather than total CP can improve nitrogen use efficiency and reduce waste, offering a potential pathway to align economic and environmental goals in dairy nutrition (Prestegaard-Wilson et al., 2021).

Enteric methane (CH_4) emissions from ruminant livestock are a significant contributor to agricultural greenhouse gases. As emphasised by Beauchemin et al. (2022) and Hristov et al. (2022), effective mitigation requires a holistic, systems-based approach that balances environmental goals with animal productivity, economic feasibility, and practical implementation across diverse production systems. Nutrition is central to this strategy, influencing rumen fermentation, feed efficiency, and microbial dynamics, key drivers of methane production.

Recent expert insights from New Zealand reinforce the importance of integrating nutritional strategies with broader farm system design:

- It was highlighted the critical link between feed conversion efficiency and emissions intensity, noting that middle-tier farmers often struggle to dilute emissions due to suboptimal milk output. Emphasising that improving nutrition is a direct pathway to reducing emissions per unit of milk, and the systems view implicitly includes pasture and soil management as part of the efficiency equation.
- It was identified that the energy cost of grazing, suggesting that system design and nutrition must work together to improve cow efficiency and reduce environmental impact. This also pointed to the trade-offs between pasture management and animal nutrition, advocating for a balance that supports both soil health and animal performance.
- It was reinforced that efficient feed conversion is not only economically beneficial but also environmentally responsible. The emphasis on balanced rations and forage quality reflects an understanding of the soil-pasture-animal interface, even if not explicitly stated.

The perspectives align with the broader scientific consensus that nutritional interventions must be embedded within a whole-farm context, one that considers emissions, productivity, animal welfare, and environmental stewardship.

Beauchemin et al. (2022) categorise CH_4 mitigation into three main pathways, production intensification, dietary reformulation, and rumen manipulation, which align with the following practical strategies:

1. Improving Forage Quality and Fiber Digestibility
   High-NDFD forages and lower uNDF improve DMI and milk yield while reducing CH_4 intensity (Oba & Allen, 1999). Replacing grass silage with corn or legumes enhances energy utilisation and reduces emissions (Hristov et al., 2022).
2. Optimising Carbohydrates
   Starch and NFC promote propionate production; a hydrogen sink that competes with methanogenesis. Sugars can enhance microbial protein synthesis, though their CH_4 impact is context-dependent (Boerman et al., 2015; Hall, 2017b).
3. Maintaining Physically Effective Fiber (peNDF)
   Adequate peNDF supports rumen health and buffering, improving efficiency and potentially lowering CH_4 emissions (Grant et al., 2018).
4. Lipid Supplementation
   Vegetable oils and oilseeds reduce CH_4 by ~19.5% but must be managed to avoid negative effects on fiber digestibility (Palmquist & Jenkins, 2017).
5. Methane Inhibitors and Electron Sinks
   - 3-NOP reduces CH_4 by 28–32% without affecting DMI or milk yield (Melgar et al., 2021).
   - Nitrates and fumarates offer ~17% reduction but require careful handling (Feng et al., 2020).
   - Macroalgae like Asparagopsis can reduce CH_4 by over 50%, though practical challenges remain (Li et al., 2018).
6. Bioactive Compounds
   Tannins and essential oils show variable results and may affect digestibility (Jayanegara et al., 2012).
7. Integrated Approaches
   Combining strategies (e.g., 3-NOP + canola oil) can yield additive effects, with reductions up to 51% (Zhang et al., 2021). Modelling tools like CNCPS support data-driven decision-making (Van Amburgh et al., 2015).

Mitigating enteric methane emissions through nutrition is not a standalone solution, it must be part of a broader, integrated farm system. As alluded to in the results it emphasises nutrition, efficiency, emissions, and soil-pasture-animal interactions are deeply interconnected. Aligning nutritional strategies with system design, environmental goals, and economic realities is essential for building resilient, low-emissions dairy systems.

Integrated Modelling Systems

Modern dairy systems face the dual challenge of optimising productivity while reducing environmental impact. Two powerful modelling tools CNCPS v6.5 and the Ruminant Farm Systems (RuFaS) Animal Module, offer complementary approaches to achieving this balance through precision nutrition, emissions modelling, and whole-farm systems integration.

The Cornell Net Carbohydrate and Protein System (CNCPS) version 6.5 introduces significant advancements in modelling nutrient supply, amino acid requirements, and environmental outputs for dairy cattle. Key updates include revised degradation rates for protein and carbohydrate fractions, updated amino acid profiles, and improved efficiencies of amino acid utilisation, particularly for methionine and lysine, which enhance the model's accuracy in predicting metabolisable protein (MP) supply and milk yield (Van Amburgh et al., 2015).

Importantly, CNCPS v6.5 integrates greenhouse gas (GHG) emission prediction capabilities. Methane (CH_4) emissions are estimated using equations from Mills et al. (2003) and Ellis et al. (2007), which account for metabolisable energy intake and fibre composition. Carbon dioxide (CO_2) emissions are modelled using the approach developed by Casper and Mertens (2010), incorporating dry matter intake and milk yield. Validation against respiration chamber data showed no significant differences between predicted and observed emissions, confirming the model's reliability (Van Amburgh et al., 2015). These enhancements make CNCPS v6.5 a robust, field-usable tool for formulating diets that optimise productivity while addressing environmental sustainability.

While CNCPS focuses on nutrient metabolism and emissions at the animal level, the RuFaS Animal Module expands this scope to simulate entire farm systems. Developed by Hansen et al. (2021),

RuFaS is a next-generation, modular platform that integrates four interconnected biophysical systems: animals, manure, crops and soil, and feed storage which is displayed in figure 2.

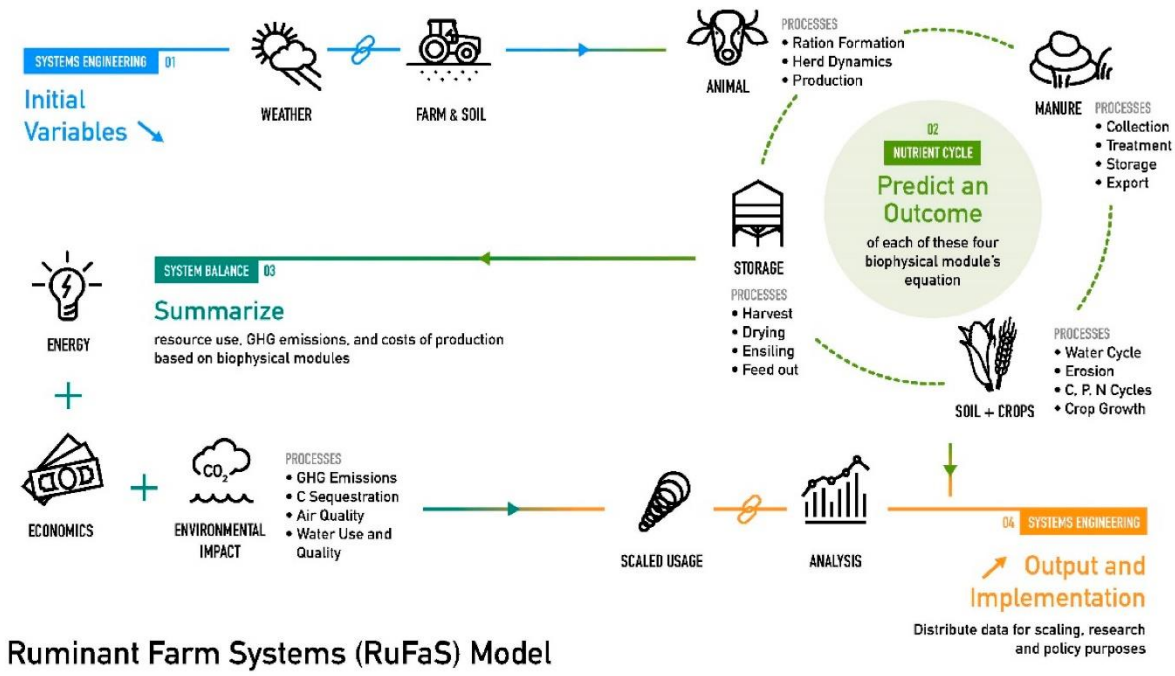

Figure 22: Ruminant Farm Systems (RuFaS) Model Conceptual Diagram

Operating on a daily time step, RuFaS simulates individual dairy cows from birth to culling, capturing dynamic interactions between nutrition, reproduction, housing, and environmental conditions. A standout feature is its modelling of residual feed intake (RFI), a trait that quantifies feed efficiency relative to production. In a case study, Hansen et al. modelled three RFI-based scenarios (Baseline, High Efficiency, Very High Efficiency), demonstrating that improving feed efficiency can reduce:

- Feed use by 6–12%
- Enteric methane emissions by 6–12%
- Manure output by 6–12%
- Total CO_2-equivalent emissions by 4.6–9.3% (Hansen et al., 2021)

These results underscore the power of genetic and nutritional strategies to enhance sustainability without compromising productivity.

Together, CNCPS and RuFaS offer a multi-scale modelling ecosystem:

- CNCPS provides detailed, diet-level insights into nutrient flows and emissions.
- RuFaS contextualises these insights within broader farm dynamics, including pasture quality, manure handling, and economic trade-offs.

Both systems emphasise dynamic ration formulation, least-cost optimisation, and environmental modelling, enabling producers to simulate and evaluate:

- Seasonal shifts in pasture and supplement use
- Emissions trade-offs from different feeding strategies
- Economic impacts of feed prices, milk returns, and input costs

By tightly coupling nutrition, physiology, environment, and economics, these tools empower farmers, advisors, and policymakers to make data-driven, sustainable decisions.

Financial and Economic Analysis

In the evolving landscape of dairy farming, the integration of financial and nutritional decision-making is increasingly recognised as a critical driver of both profitability and sustainability. Despite this, a disconnect often persists between financial advisors and farm nutrition strategies, with cost-cutting pressures sometimes leading to underfeeding and compromised animal performance (Freitas & Cabrera, 2025). This gap underscores the need for a more holistic approach that acknowledges the substantial return on investment (ROI) that can be achieved through optimised nutrition. Tools like the Dairy Victory Platform (DVP) exemplify this integration by linking feed efficiency (FE) and milk income over feed cost (IOFC) to real-time economic outcomes, enabling farmers to make data-driven decisions that enhance both productivity and profitability (Freitas & Cabrera, 2025). Complementary research by Azmi (2023) and Adamie et al. (2023) further reinforces the economic value of strategic feed management, showing that regions and farms with superior nutritional practices consistently outperform their peers in technical efficiency and total factor productivity. As industry experts advocate, improving feed conversion not only boosts economic returns but also reduces emissions intensity, aligning financial goals with environmental stewardship. Together, these insights highlight the imperative of integrating financial and nutritional expertise to support resilient, high-performing dairy systems.

Accountants and bankers play a pivotal role in shaping the financial strategies of dairy farms, yet many lack a nuanced understanding of how nutritional decisions directly influence farm profitability. As findings pointed out, financial professionals often advise farmers to reduce costs without fully appreciating the return on investment (ROI) that comes from optimal feeding strategies. This disconnect can lead to underfeeding, reduced animal performance, and ultimately lower economic returns—outcomes that contradict the very financial goals these advisors aim to support. Currently, financial assessments tend to focus on static cost structures and overlook dynamic variables like feed efficiency (FE) and milk income over feed cost (IOFC), which are critical indicators of profitability (Freitas & Cabrera, 2025). By integrating nutritional metrics into financial evaluations, accountants and bankers could provide more informed, strategic guidance that aligns short-term budgeting with long-term productivity and sustainability. Educating financial professionals on the economic value of nutrition would not only improve farm-level decision-making but also enhance the quality of financial products and services tailored to the agricultural sector.

Freitas and Cabrera (2025) introduce the Dairy Victory Platform (DVP), a cloud-based benchmarking system designed to enhance economic decision-making in dairy farming. The platform addresses a critical gap in standardised economic performance data by automating the calculation and benchmarking of key performance indicators (KPIs), including feed efficiency (FE), milk income over feed cost (IOFC), and net income margin. By integrating test-day data from Dairy Herd Improvement (DHI) centres with market prices and farm-specific characteristics, DVP delivers real-time, actionable insights that support both operational and strategic decisions.

The DVP comprises five interconnected modules: Data Integration (DVP-DI), which processes large datasets from DHI and market sources; Benchmarking (DVP-B), which compares farm performance using constrained K-means clustering; Analytics (DVP-A), which visualises KPIs through data envelopment analysis (DEA); Simulation (DVP-S), which models the economic impact of strategic changes; and Recommendations (DVP-R), which sets progressive, achievable goals based on peer performance (Freitas & Cabrera, 2025). A case study involving 712 farms and over 265,000 cows demonstrated the platform's potential to improve IOFC by up to 35%, with specific gains from increasing milk fat percentage and improving FE.

Nutrition and feed management are central to DVP's benchmarking framework. FE, defined as the ratio of energy-corrected milk (ECM) to dry matter intake (DMI), is calculated at the cow level and aggregated to the farm level. IOFC, another critical KPI, is derived by subtracting feed cost from milk income. Because test-day records often lack detailed diet composition, DVP estimates feed costs using spot market prices and cow performance metrics, validated through pilot farms and DHI associations (Freitas & Cabrera, 2025). The DVP-S module allows users to simulate the economic impact of changes in diet cost and composition, while DVP-R sets incremental goals for improving FE and reducing feed costs, supporting both profitability and sustainability.

These insights align with industry perspectives emphasising the integration of financial and nutritional decision-making., for instance. Findings, highlighted the disconnect between financial advisors and farm nutrition strategies, noting that cost-cutting pressures can lead to underfeeding and reduced animal performance. They advocate for educating financial professionals on the return on investment (ROI) of good nutrition and promoting integrated advisory services to support better

farm decisions. This reinforces the DVP's approach of linking economic and nutritional data to guide strategic planning.

Similarly, interviewees underscored the challenges faced by mid-input farms, which often struggle with emissions intensity and economic efficiency. It was emphasised that improving feed conversion not only enhances profitability but also reduces environmental impact. The recommendation to use feed budgeting as a foundation for both economic and nutritional planning echoes the DVP's simulation and benchmarking capabilities.

Interviewees further stress the importance of efficient feed conversion for economic sustainability. They note that better conversion reduces both production costs and environmental footprint, while it is warned against over-reliance on cheap feeds like palm kernel, which can limit flexibility and long-term viability. These insights support the DVP's emphasis on feed-related KPIs and its ability to model the economic consequences of feed strategy changes.

Findings in results added another layer to the discussion by critiquing the high cost and limited accessibility of advanced nutrition education. This calls for more affordable, structured learning opportunities to improve farm profitability through better nutrition. This aligns with the DVP's goal of democratising access to performance data and decision-support tools, making advanced analytics more accessible to a broader range of farmers.

Complementing these practical insights, Azmi's (2023) doctoral research provides a macroeconomic and regional perspective on dairy productivity in New Zealand. The study identifies key drivers of total factor productivity (TFP), technical efficiency (TE), and technological gap ratios (TGR) across three regions. Region 3 (Marlborough-Canterbury and Otago-Southland) exhibited the highest TFP growth and TE scores, attributed to superior feed management and larger herd sizes. In contrast, Regions 1 and 2 lagged, suggesting a need for targeted support to enhance managerial capacity and technology adoption.

The policy implications are clear. Azmi (2023) recommends that Region 3 focus on sustaining innovation and R&D, while Regions 1 and 2 require interventions to improve management practices and technology uptake. Farm expansion strategies must be economically justified, and policies should consider herd size thresholds, recognising that productivity gains vary across different scales. Future research should incorporate input and output price data to assess allocative efficiency, address potential endogeneity in input use, and expand the dataset to include unbalanced panel data for a more comprehensive analysis.

Adding another dimension, Adamie et al. (2023) explore the relationship between dairy cow longevity and economic performance in Swedish dairy farms. Their study finds an inverted U-shaped relationship between longevity and three economic indicators: technical efficiency, profitability (gross margin), and productivity (milk yield per cow). Optimal longevity was estimated at approximately 950–1,000 days for efficiency and profitability, and around 800 days for milk yield. These findings suggest that while extending cow longevity can be beneficial, there is a threshold beyond which economic returns diminish.

Although feed and nutrition were not directly analysed, they were implicitly included in the cost structure, and the authors suggest that future research should incorporate more detailed cow-level feeding data to better understand the drivers of longevity and performance. This recommendation aligns with the broader call for integrating nutritional data into economic analysis, as emphasised by interviewees.

The development of tools like Diet Check further illustrates the value of integrating nutritional insights into financial decision-making on dairy farms. Designed as a tactical decision support tool, Diet Check enables farmers to assess whether their cows are receiving sufficient metabolisable energy (ME), crude protein (CP), and neutral detergent fibre (NDF) to meet production targets, particularly in pasture-based systems (Heard et al., 2004). By estimating pasture intake, substitution effects from supplements, and marginal milk responses, the tool provides a practical framework for evaluating the cost-benefit of feeding strategies. This kind of analysis is precisely what financial advisors and bankers often overlook. As results noted, financial professionals frequently advise cost-cutting without understanding the economic returns that can result from well-informed nutritional investments. Diet Check is used throughout New Zealand and bridges this gap by translating complex nutritional dynamics into economic outcomes, offering a shared language for both financial and farm management advisors. When used alongside platforms like the Dairy Victory Platform (Freitas & Cabrera, 2025), such tools can empower more holistic, data-driven decisions that align nutritional strategies with financial sustainability.

Some companies/ individuals in New Zealand run similar programs to Diet Check that help to measure and breakdown some of the complexities to feed cows. An example is a dairy calculator as seen in Figure 3. By looking at outputs vs inputs calculations, you can work through to breakdown efficiency of production and ground expectations. This allows farmers to get a gauge around how they operate and where the shortfalls are. However, this is only a snapshot of what is happening on farm and can be only as accurate as the information put in.

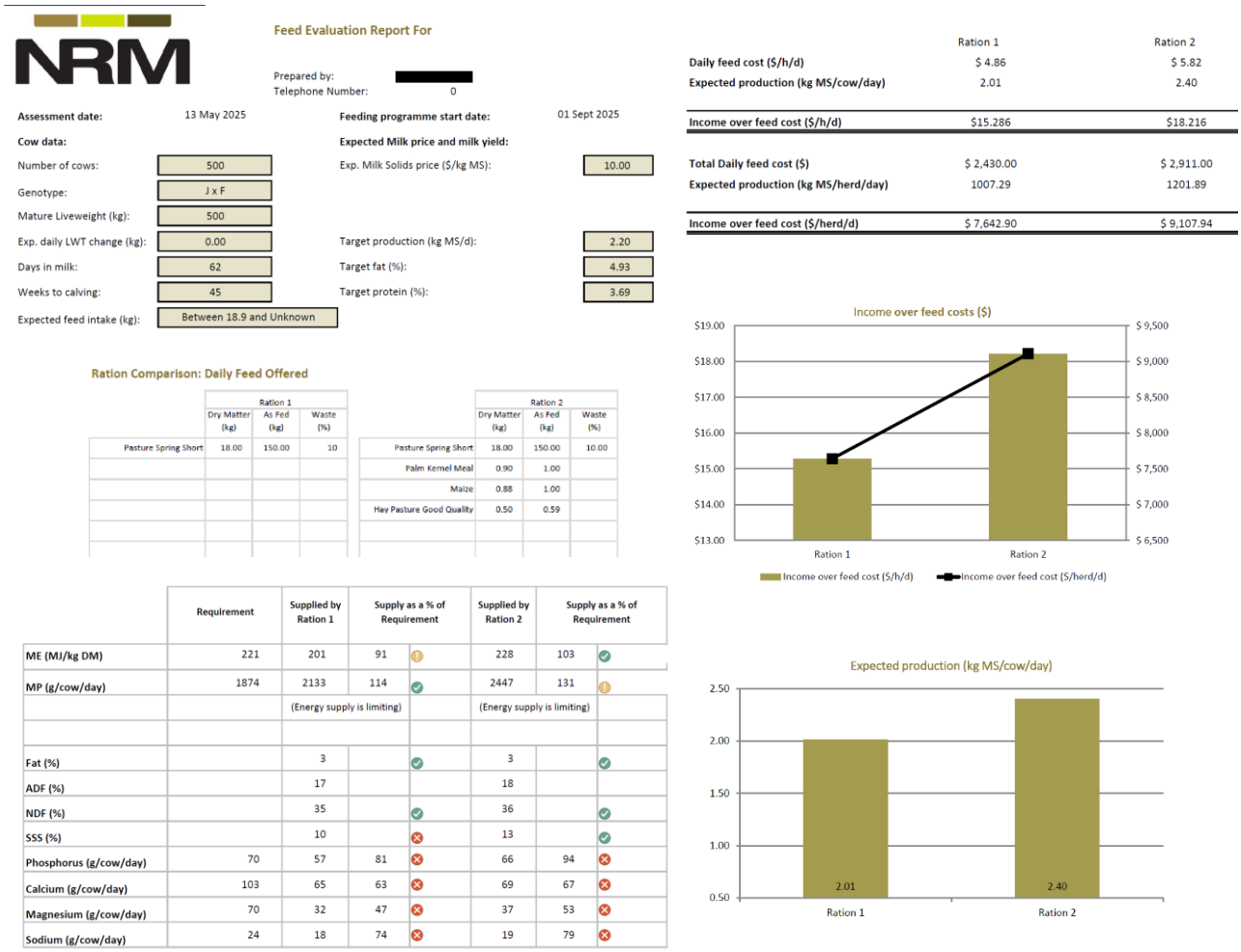

Figure 3 3: NRM Dairy Calculator - Return on Investment and Comparison of Different Systems

In conclusion, the convergence of academic research, industry insights, and technological innovation highlights the central role of feed efficiency, nutrition, and integrated decision-making in driving sustainable dairy farm performance. The Dairy Victory Platform offers a powerful tool for real-time, data-driven management, while the work of Azmi (2023) and Adamie et al. (2023) provides critical context for understanding regional dynamics and biological-economic trade-offs. Complementing these strategic and analytical tools, Diet Check serves as a practical, on-farm decision support system that helps farmers assess whether their cows are receiving adequate metabolisable energy, crude protein, and fibre for targeted milk production (Heard et al., 2004). By estimating pasture intake, supplement substitution, and marginal milk responses, Diet Check enables tactical feeding decisions that directly impact profitability and animal performance. Together, these perspectives and tools advocate for a holistic approach to dairy farm management, one that balances profitability, sustainability, and resilience through the integration of nutritional science, financial insight, and user-friendly technology.

Development of New Initiatives and Programs

As the dairy industry continues to evolve in response to changing environmental, economic, and consumer demands, the need for robust, science-based nutrition education has never been greater. Two key opportunities for advancing on-farm nutritional outcomes in New Zealand are the revival and enhancement of the FeedRight program or similar and the development of targeted roadshows and workshops. FeedRight, once a cornerstone of standardised nutrition training, holds significant potential if revitalised with updated content reflecting the latest research in pasture-based systems, transition cow management, and precision feeding technologies.

To ensure future initiatives are both innovative and impactful, it is essential to look beyond our agricultural sector or national borders. An example of this is New Zealand's vocational education system, which is undergoing a major shift with the introduction of an industry-led model from January 2026. This change responds to concerns that the current system, managed by Te Pūkenga, has become too centralised and disconnected from industry needs (Tertiary Education Commission, 2025a). The new model will empower Industry Skills Boards (ISBs) to lead training design and quality assurance, while approved providers will gain more autonomy in delivering work-based learning.

This reform aligns with international trends carried out in other dairy countries. Examples extend to countries like Ireland and Sweden that offer valuable models and education through organisations such as Teagasc and LRF Mjölk, which integrate cutting-edge research with farmer-focused advisory services (Teagasc, 2024a), (LRF, 2024). Teagasc's work on spring transition nutrition and feed efficiency, and LRF's emphasis on sustainable feed practices and milk quality, demonstrate how structured education and regional adaptation can drive meaningful improvements in dairy cow nutrition. By drawing on these international examples, New Zealand can reinvigorate its own programs, ensuring they are not only scientifically rigorous but also practical, accessible, and aligned with the future of sustainable dairying.

Learning from New Zealand's Shift to Industry-Led Vocational Education

The new industry-led model for work-based learning in New Zealand, set to begin on 1 January 2026, represents a significant transformation in the delivery of vocational education and training (VET). This change is a response to long-standing concerns that the current system, largely managed by Te Pūkenga, has become overly centralised and disconnected from the practical needs of industry. Employers and industry leaders have voiced that apprentices and trainees were not consistently acquiring the skills necessary for their roles, prompting a shift toward a more responsive and industry-aligned framework (Tertiary Education Commission, 2025a).

At the heart of the new model is the establishment of Industry Skills Boards (ISBs), which will serve as statutory bodies governed primarily by industry representatives. These boards will be responsible for setting training standards, endorsing programmes, moderating assessments, and conducting workforce analysis. They will also provide investment advice to the Tertiary Education Commission (TEC), ensuring that training provision aligns with both current and emerging industry needs (Tertiary Education Commission, 2025a). This structural change reflects a broader desire for stronger industry leadership in shaping the VET system, ensuring that qualifications and delivery models are relevant and future-focused.

In addition to the creation of ISBs, the model grants greater autonomy to training providers. Any provider including Polytechnics, Private Training Establishments (PTEs), or Wānanga, that meets the government's quality and funding requirements will be eligible to deliver work-based learning. These providers will manage all aspects of apprenticeships and traineeships, including the critical area of pastoral care. This decentralisation is intended to foster innovation and responsiveness in programme delivery, allowing providers to tailor their offerings to meet specific sector needs (Tertiary Education Commission, 2025a).

A transitional phase will occur from 2026 to 2027, during which Te Pūkenga's existing work-based learning divisions, including their apprentices and trainees, will be temporarily transferred to ISBs. This arrangement ensures continuity of training while allowing time for new industry-led training enterprises to be established. During this period, learners and employers will continue working with their current providers, minimising disruption and maintaining stability in the system (Tertiary Education Commission, 2025a).

The funding model underpinning this new system is designed to support both ISBs and providers. ISBs will receive public funding for their core functions and may charge quality assurance fees to providers. Meanwhile, approved providers will receive tuition subsidies and may charge enrolment fees, provided they meet TEC's funding and quality standards. This structure aims to ensure

sustainability while promoting flexibility and responsiveness in training delivery (Tertiary Education Commission, 2025b).

The rationale for this transformation is rooted in several systemic challenges. One of the primary drivers was the growing disconnect between training programmes and the actual needs of industry. The centralised model was often slow to adapt, and employers reported that learners were not consistently gaining the skills required for their roles (Tertiary Education Commission, 2025a). Additionally, the system lacked the flexibility needed to respond to emerging technologies, evolving job roles, and the diverse needs of learners. The 21st Century Delivery and Assessment report emphasised that future training systems must be more adaptable, incorporating a variety of delivery methods and assessment approaches to remain relevant (Murray & Koopmanschap, 2024).

Another significant issue was the underutilisation and complexity of the Recognition of Prior Learning (RPL) system. The report noted that the current RPL framework was not only underfunded but also difficult for learners and providers to navigate, resulting in missed opportunities to acknowledge existing skills and reduce redundant training (Murray & Koopmanschap, 2024). Addressing this gap is seen as essential for creating a more efficient and learner-centered system.

Ultimately, the new model promises several benefits for learners and employers. Training will become more tailored and practical, with qualifications more closely aligned to real-world job requirements. The increased involvement of industry in shaping training content and delivery is expected to enhance the relevance and effectiveness of vocational education. Furthermore, the system's flexibility will make it easier to adapt to emerging technologies and evolving job roles, ensuring that New Zealand's workforce remains competitive and future-ready (Tertiary Education Commission, 2025a).

Dairy Industry Associations Across the World Address Dairy Nutrition

Dairy Australia plays a pivotal role in advancing dairy cow nutrition through a suite of educational programs and practical resources designed to enhance on-farm feeding practices. A flagship initiative is the Nutrition Fundamentals program, a nationally delivered, evidence-based workshop that equips farmers and farm staff with foundational knowledge in dairy cow nutrition. This two-day course covers critical topics such as rumen function, nutrient requirements, including energy, protein, and fibre, feed selection, and body condition monitoring. The program is designed to be practical and adaptable, enabling participants to make informed feeding decisions that support both animal health and farm profitability (Dairy Australia, 2024a).

Throughout its resources, Dairy Australia emphasises the importance of maintaining a balanced and consistent diet for dairy cows. Proper nutrition is not only essential for optimal milk production but also for sustaining rumen health and overall animal welfare. Farmers are encouraged to consider variables such as feed quality, seasonal fluctuations, and environmental stressors like heat when developing feeding strategies. Understanding the nutrient composition of various feeds and their impact on milk yield and composition is highlighted as a key component of effective feed management (Dairy Australia, 2024a).

Beyond foundational education, Dairy Australia supports farmers with tools for feed and water budgeting, aligning feeding practices with herd nutritional needs. These efforts are part of a broader strategy to improve Feedbase management and promote sustainable, profitable dairy farming across the country. The organisation also offers platforms like DairyFeedbase, which focuses on optimising nutrition during the critical first 100 days of lactation (Dairy Australia, 2024a).

Internationally, similar organisations contribute significantly to dairy cow nutrition through research, education, and on-farm support. In the United States, the National Dairy Council (NDC) leads efforts in science-based nutrition education, promoting sustainable feeding practices and collaborating with dietitians and researchers to develop guidelines that support both cow health and environmental stewardship (National Dairy Council, 2024).

In Canada, Dairy Farmers of Canada (DFC) advocate for feeding strategies tailored to lactation stages, climate, and feed availability. Canadian farmers often work with nutritionists to assess feed quality and incorporate sustainable by-products like brewery grains, aiming to boost productivity while minimising environmental impact (Dairy Farmers of Canada, 2024).

The United Kingdom's AHDB Dairy supports farmers with tools such as the Feed into Milk (FiM) model, which predicts energy and protein supply in rations. AHDB also provides extensive resources on

transition cow nutrition, body condition scoring, and feed efficiency, enabling data-driven decisions to enhance herd health and performance (AHDB Dairy, 2024).

In Ireland, Teagasc, the National Agriculture and Food Development Authority, plays a central role in promoting efficient pasture-based systems, especially during the spring transition. Their guidance focuses on managing energy, protein, and fibre intake during early lactation to prevent negative energy balance and support milk solids production. Tools like the Spring Rotation Planner and nutritional benchmarks help optimise feed quality and cow performance (Teagasc, 2024a). Teagasc also leads research into innovative nutritional strategies aimed at reducing environmental impacts while maintaining productivity. This includes adapting the Cornell Net Carbohydrate and Protein System (CNCPS) for Irish pasture systems and exploring advanced feed chemistry techniques to improve nutrient efficiency and reduce nitrogen emissions (Teagasc, 2024b).

In Sweden, the Federation of Swedish Farmers (LRF), particularly through its dairy division LRF Mjölk, supports farmers with nutritional education and sustainability-focused feeding practices. LRF promotes feed hygiene, quality assurance, and regionally adapted feed strategies to enhance milk quality and animal welfare. Their initiatives align with broader EU goals to reduce fossil-based feed inputs and improve biodiversity through pasture management (LRF, 2024).

These international examples underscore the importance of structured, regionally relevant, and science-based nutrition education. As results pointed out, New Zealand's current offerings are often too system-focused or generalist. There is a clear call for more specialist knowledge, practical training, and better use of our tools including new ones coming through. It was further emphasised the need to integrate financial literacy with nutrition education and to raise awareness of what "good" nutrition looks like through peer-reviewed science and practical roadshows or field days.

New Zealand's dairy sector has a timely opportunity to strengthen its nutrition education by aligning with industry needs and learning from global best practices. The shift to an industry-led vocational model, combined with insights from countries like Australia and Ireland, highlights the value of structured, practical, and regionally relevant training. Revitalising programs like FeedRight and adopting proven international approaches can ensure that future education is both impactful and sustainable, supporting healthier herds, more profitable farms, and a more resilient dairy industry.

Conclusion

This report has highlighted the critical role of nutrition in shaping the future of New Zealand's dairy industry. Despite its foundational importance, nutrition remains inconsistently applied and undervalued across many farm systems. Through a combination of stakeholder interviews, literature review, and sector analysis, it is clear that improving nutritional understanding and practice is not just a technical challenge, it is a strategic opportunity.

The findings underscore the need for a more integrated, evidence-based approach to dairy nutrition, one that connects science with practice, and short-term decisions with long-term outcomes. From young stock rearing to precision feeding, from financial analysis to environmental sustainability, nutrition intersects with every aspect of farm performance. Yet, gaps in education, training, and credentialing continue to limit the sector's ability to fully realise these benefits.

To address these challenges, it calls for a collaborative, multi-stakeholder response. Farmers, rural professionals, educators, and industry bodies must work together to build capability, standardise knowledge, and foster innovation. Revitalising initiatives like FeedRight, developing modular training pathways, and integrating financial and environmental metrics into nutrition planning are all essential steps forward.

Ultimately, smart nutrition is not just about what we feed our cows, it's about how we feed our future. By investing in knowledge, tools, and people, New Zealand's dairy sector can lead the way in building a more resilient, productive, and sustainable agricultural system.

Recommendations

To strengthen the future of dairy nutrition in New Zealand, a multi-stakeholder approach is essential. Farmers, rural professionals, educators, and industry bodies each have a critical role to play in improving the consistency, quality, and impact of nutritional practices across the sector.

For farmers, the foundation lies in building a stronger understanding of nutrition fundamentals. This includes engaging in short courses or workshops that cover feed budgeting, pasture variability, and young stock nutrition. Farmers are encouraged to make use of decision-support tools such as Diet Check and wearable technologies to monitor feed efficiency and cow health. Particular attention should be paid to young stock rearing, especially during the often-overlooked six to nine-month period and the second winter. These stages are critical for skeletal development and long-term productivity. Farmers should also integrate nutrition into broader farm planning by aligning feeding strategies with financial goals, labour capacity, and environmental outcomes.

Rural professionals and advisors are encouraged to pursue micro-credentials in ruminant nutrition to ensure they are delivering evidence-based, system-aware advice. These credentials should be modular and tailored to different roles, such as consultants, vets, and financial advisors. Advisors should also work to bridge the gap between financial and nutritional decision-making by understanding and communicating the return on investment (ROI) of quality nutrition. This includes using tools like the Dairy Victory Platform to benchmark performance and simulate the economic impact of feeding strategies. Promoting systems thinking and interdisciplinary collaboration, particularly between vets, agronomists, and financial advisors, will help ensure that nutrition advice is both practical and strategic.

Education providers, including universities and training institutions, should revise and expand their curriculum to include more applied, pasture-based nutrition training. This includes integrating modules on ration formulation, feed conversion efficiency, and the interpretation of wearable tech data. Institutions should also develop stackable learning pathways, such as micro-credentials and short courses, that are accessible to farmers, students, and professionals. These programs should emphasise observational learning through case studies, decision trees, and on-farm simulations to build critical thinking and real-world problem-solving skills.

Industry bodies such as DairyNZ, NZARN, and NZIPIM have a pivotal role in coordinating and supporting sector-wide improvements. A key recommendation is to revive and modernise the FeedRight program as a collaborative, modular training platform that reflects current science and technology. This platform should include content on transition cow management, emissions reduction, and financial integration.

Industry bodies should also support the development of a national credentialing framework for ruminant nutritionists, with clear pathways from entry-level to advanced certification. Improving knowledge transfer is equally important, this includes funding peer-led learning initiatives, translating research into farmer-friendly tools, and promoting open access to credible resources. Finally, fostering collaboration across advisory roles and reducing siloed thinking will be essential to delivering consistent, high-quality nutrition advice that supports both farm profitability and environmental stewardship.

Together, these recommendations aim to create a more resilient, informed, and future-ready dairy sector, one where smart nutrition is not just a technical input, but a strategic pillar of success.

In summary, I recommend;

For Farmers:

- Build a stronger understanding of nutrition fundamentals to make better decisions on evidence-based information
- Participate in short courses/workshops on:
    - Feed budgeting
    - Pasture variability
    - Young stock nutrition
- Use decision-support tools like:

    - Diet Check
    - Wearable technologies for feed efficiency and cow health
    - Ruminant nutritionists in accordance with NZARN full membership.
- Integrate nutrition into broader farm planning:
    - Align feeding strategies with financial goals, labour capacity, and environmental outcomes

For Rural Professionals and Advisors:

- Pursue micro-credentials in ruminant nutrition
    - Modular and role-specific (consultants, vets, financial advisors)
- Bridge financial and nutritional decision-making:
    - Communicate ROI of quality nutrition
    - Use tools like Dairy Victory Platform for benchmarking and simulations
- Promote systems thinking and interdisciplinary collaboration:
    - Encourage cooperation between vets, agronomists, and financial advisors

For Education Providers:

- Revise and expand curriculum to include:
    - Applied, pasture-based nutrition training
    - Include modules on ration formulation, feed-conversion efficiency, wearable technology and data interpretation
    - Have more applied practical training
- Develop stackable learning pathways:
    - Micro-credentials and short courses for farmers, students, and professionals
- Emphasise observational learning:
    - Case studies, decision trees, on-farm simulations

For Industry Bodies (e.g., DairyNZ, NZARN, NZIPIM):

- Revive and modernise the FeedRight or equivalent program:
    - Collaborative, modular training platform
    - Include content on transition cow management, emissions reduction, financial integration
- Support a national credentialing framework for ruminant nutritionists:
    - Clear pathways from entry-level to advanced certification (perhaps through NZIPIM's work with consultant certification)
- Set up apprenticeship-type programmes within industry bodies such as NZARN to attract young or nutritionally motivated people to be involved. This in conjunction with mentorship would allow for guidance through to become a full NZARN member or nutritionist.
- Improve knowledge transfer by:
    - Fund peer-led learning initiatives
    - Translating research into farmer-friendly tools
    - Promoting open-access to credible resources

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13.0 Appendix

Appendix – Semi structured interviews questions

NZARN Members & Nutrition Extension Specialists

1. Gaps and Complexity in Nutrition

- In regards to animal nutrition, where do you see the biggest gaps in the New Zealand dairy industry?

2. Education, Training & Credentialing

- What programs or resources have you seen or done that have been integral to your and farmers' understanding of animal nutrition and requirements?
- Are there any initiatives that have been done well that you would like to see come back or be started?
- Do you think how we train and educate people in the industry has gaps at these levels:
    - a) Tertiary education
    - b) Farmer
    - c) Rural professional (e.g., sales reps)

3. Systems Thinking & Farm Success

- a) How do you think animal nutrition can influence the success of a farm business?
- b) Do you think we apply this understanding consistently across the NZ dairy industry?

4. Technology, Data & AI

- With technology developments coming and people having more access to data, how do you as a nutritionist stay applicable to our industry?

5. Farmer Support & Practical Advice

- Do you have any advice that you would give to a farmer revising their system or nutrition plan?

Tertiary Educators

Tertiary Educators Interview Questions

1. Gaps and Complexity in Nutrition

- With regards to your position as an industry educator, where do you see gaps in nutrition in New Zealand dairy, and why do you think these have arisen?

2. Education, Training & Credentialing

- If you could change or influence change in the programs offered at tertiary level, how would you do that with nutrition as the main subject?
- Do you think we include the practical nature of nutrition enough in the current papers or courses for students?
- Do you think there is a requirement or opportunity to educate better in the nutrition space for rural professionals and farmers to bridge the knowledge gaps?
    - Does this look like a certificate or an option for other levels of study to put knowledge into the industry and allow correct information cycling?
- Currently there is no credential in New Zealand for animal nutritionists—do you think we need to provide something in this space, such as the Australian nutrition exam, to ensure people are advocating from a scientific and educational background?

Industry Bodies

NZIPIM

1. Education, Training & Credentialing

- What opportunities do you see in the food and fibre industry for education and training on behalf of NZIPIM?
- Do you think the work NZIPIM is doing on consultant credentials could include education or requirements for understanding of nutrition?
- Leaning into some of the work that you are doing around credentials for farm consultants, do you think there could be something similar for nutritionists in New Zealand—acknowledging the need for an evidence-based approach and formal education, especially given the number of unqualified individuals providing advice?

2. Collaboration & Industry Support

- How are decisions made on where NZIPIM focuses its efforts and involvement?
- With acknowledgement from NZARN interviewees addressing the importance of nutrition within the dairy industry, do you think NZIPIM would be open to helping bridge some of the education gaps in New Zealand?

NZARN

1. **NZARN's Role and Impact**
   - As the Chair in NZARN, how do you feel you guys are contributing to the nutrition space in New Zealand?
   - Do you think that what you guys are doing could be pushed out further to allow more education for rural professionals and farmers?
   - Do you think there is a duty or inclination to put more information out to help raise the industry's knowledge level?
2. **Farmer Education and Outreach**
   - Do you think farmer days would help with education, or are there other options?
3. **Standardisation and Systems**
   - Do you think there could be a standardised system or education piece to familiarise language and nutrition fundamentals?
   - Would NZARN help with creating a fundamental system or programme like FeedRight?
4. **Credentialing and Pathways**
   - Do you think there should be a credential or learning piece to grow the group and industry knowledge?
   - What would be the perfect pathway for someone like me to become a full member or nutritionist in New Zealand?
   - Do you think New Zealand should have a credential to that standard, and should it be at a university level?
5. **Industry Collaboration**
   - Do you think NZARN would support putting out a continual flow of accurate, evidence-based articles?
   - Do you think data companies will hire nutritionists to interpret data for better outcomes?
   - Do you think there's space for NZARN to connect with vets to bring them along on the ruminant nutrition journey?
6. **Advice and Gaps**

- Do you have any advice for a farmer revising their system/nutrition plan? Where should they go and who should they use?
- Do you think we have enough people in this space?

7. **Training and Development**
   - Would a junior nutritionist programme be a good idea to help bring people into the field?
   - Would a micro-credential help correct misinformation and build associate-level knowledge?
   - Do you think farmers would benefit from and require such a programme?
8. **General Reflections**
   - Why do we allow such a loose approach to nutrition in our biggest export market?

Dairy NZ

1. Gaps and Complexity in Nutrition

- Where do you see the biggest gaps in the New Zealand dairy industry regarding animal nutrition?
- Are we turning over enough of the right research to ensure the market has accurate, up-to-date information?
- How do we stop misinformation and non-scientific decision-making in nutrition?

2. Education, Training & Credentialing

- Do you think how we are training and educating people in the industry has gaps—at tertiary, farmer, rural professional, and sales rep levels?
- Should there be a standardised programme or credential for feed reps or aspiring nutritionists?
- What would a pathway look like for someone who wants to become a nutritionist in New Zealand?
- Is there a need to bring back or reinvent something like FeedRight to support education and consistency?

3. Systems Thinking & Decision-Making

- How do we better integrate animal nutrition with system-level thinking (e.g., infrastructure, labour, profitability)?
- How do we help farmers understand and define their decision-making rules?
- Do we understand our system needs well enough to make the right nutrition decisions?

4. Technology, Data & AI

- How do we use technology and data (e.g., wearables, pasture growth apps) to support better nutrition decisions?
- How do we ensure data is interpreted correctly and not used in isolation?
- How do you, as a nutritionist, stay applicable in an industry increasingly driven by data and AI?

5. Emissions & Environmental Impact

- How does nutrition influence greenhouse gas emissions and environmental sustainability?
- How do we educate farmers about the relationship between nutrition, emissions, and efficiency?
- Should we be tailoring supplement strategies to seasonal emissions profiles?

6. Collaboration & Industry Support

- Could a collaborative approach (e.g., involving DairyNZ, NZARN, independent experts) help develop a unified nutrition education programme?
- Should DairyNZ lead or support the redevelopment of FeedRight or similar initiatives?
- How do we ensure independent, evidence-based advice is accessible and trusted?

7. Farmer Support & Practical Advice

- How do we get more independent, evidence-based advice to farmers?
- Do you have any advice for a farmer revising their system or nutrition plan—where should they go, who should they use, and what should they do?

Industry Professionals

1. Gaps and Complexity in Nutrition

- Where do you see the biggest gaps in our dairy industry regarding nutrition?
- Are we missing the basics while chasing incremental gains?
- Do we make too many assumptions about feed without measuring it?
- How do we better understand and manage the variability in pasture and feed quality?

2. Data, Technology & AI

- How can wearable tech and AI help solve problems in nutrition and farm management?
- Will AI replace or support nutritionists and consultants?
- How do we use data to make better, evidence-based decisions?
- How do we ensure farmers understand and trust the data they're collecting?
- Who should own and interpret farm data—tech companies, farmers, or advisors?

3. Decision-Making & Farm Systems

- How do we balance technically correct nutrition advice with practical, cost-effective solutions?
- How do we align nutrition strategies with farm infrastructure, labour, and goals?
- Should we rethink traditional practices like mating frequency or replacement rates?
- How do we define success on-farm, and how does nutrition contribute to that?

4. Emissions & Efficiency

- How does nutrition influence emissions—especially emissions intensity?
- Should we focus more on feed conversion efficiency and homegrown feed?
- How do we educate farmers about the link between nutrition and emissions?
- Can we use data to identify and replicate what low-emission farms are doing?

5. Education, Communication & Collaboration

- Should there be a credential or micro-credential to help professionals navigate nutrition better?
- How do we foster better collaboration between vets, nutritionists, consultants, and farmers?
- How do we improve communication so that technical advice is more relatable and actionable?
- Should we bring back structured farmer learning groups or on-farm days?
- How do we ensure farmers learn from each other without copying systems blindly?