The Power of Stakeholder Engagement to Establish a Social Licence to Operate

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Perspectives from Dairy Technologies

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Executive Summary

The New Zealand dairy sector constantly researches new products and technology for improved efficiency to sustainably meet growing production demands with fewer resources. The assessment of the value of innovation is no longer determined by monetary gains alone; the public perception of the innovation and its impact on the sector's social licence to operate (SLO) are paramount in the current climate.

This project aims to bring attention to the importance of stakeholder engagement during the research and development phases of a dairy technology or product. The focus is twofold: first, what can we learn from the commercialisation of wearable technologies, and second, what perspectives and opinions do stakeholders have on genetic dairy technologies? The research question guiding this study is: How do we ensure that current and future genetic dairy technologies and products establish and maintain their social licence to deliver to their full potential?

A literature review was conducted to gain insights into the "What": social licence to operate, by the "How": stakeholder engagement, for the "Why": genetic dairy technologies. The literature review also defines the background of cow wearables to demonstrate this technology's use as a case study. Nineteen semi-structured interviews were carried out, four of which were conducted with wearable company representatives, aiming to gather qualitative data regarding companies' product commercialisation and stakeholder engagement. The other fifteen interviews were with stakeholders investigating the SLO of four genetic dairy technologies.

The findings from the literature review and interviews showed that concerns and priorities of the New Zealand dairy industry are representative of all stakeholders in the supply chain, but awareness and perspectives on genetic dairy technologies vary widely. Stakeholders have shown a genuine interest in genetic dairy technologies and the desire to be more actively involved. The Responsible Innovation (RI) framework could be utilised to involve stakeholders in the research of genetic dairy technologies, while acknowledging the future uncertainty and risks associated with genetic research. Additionally, an independent party to promote genetic dairy technology and its SLO must be considered.

Recommendations for Research Institutes:

- Share research projects and questions with the wider NZ sector early to create the potential for feedback. Options to do this could be as simple as a quarterly newsletter.
- Review current stakeholder engagement practices during product development and investigate ways to build stage-gates to include reflection and opportunities to improve.
- Build an open and responsible research platform by taking stakeholders along on the research journey - create promoters.
- Create a governance structure that balances the legal, economic, and social licence of genetic dairy technology post-commercialisation to ensure a desirable long-term impact on the NZ dairy sector.

Recommendations for Stakeholders:

- Support the research and development of dairy technologies, through building networks and seeking active involvement in those technologies that have the potential to influence the SLO of your core business.
- Build capabilities, like stakeholder groups or committees, to tackle wider SLO questions as a group of stakeholders by sharing responsibilities and perspectives.
- Facilitate open and unbiased conversations to capture perspectives and beliefs and create collaboration opportunities.

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Abbreviations

Abbreviation	Full Form
GDP	Gross Domestic Product
JIVET	Juvenile In Vitro Embryo Transfer
MPI	Ministry of Primary Industries
N&N	Narratives and Networks
NZ	New Zealand
RI	Responsible Innovation
SGL	Short Gestation Length
SLO	Social Licence to Operate

1. Introduction

New Zealand (NZ) is a large exporter of whole milk powder and the NZ dairy sector is a major contributor to the NZ economy. The dairy industry contributed an estimated twenty-six billion dollars ($26B NZ dollars) of export revenue in 2023 (MPI, 2023). One in four export dollars NZ earns comes from exporting dairy products, making dairy NZ's largest goods export (Sense Partners, 2023). Business undertakings in the agri-food sector have a significant flow-on effect. Dairy contributes another half a billion ($0.5B NZ dollars) to the Gross Domestic Product (GDP) by utilising outputs from a wide range of service industries (MPI, 2023). Furthermore, dairy farming has been identified as a shock absorber for rural economies regardless of the peaks and troughs in the milk price (Sense Partners, 2023).

The New Zealand dairy sector constantly researches new products and technology for improved efficiency to sustainably meet growing production demands with fewer resources. The assessment of the value of innovation is no longer determined by monetary gains alone; the public perception of the innovation and its impact on the sector's social licence to operate (SLO) are paramount in dairy's demanding climate.

The social acceptance, and resulting support, of inventions are fluid, dependent on stakeholders' perspectives and narrative. One example of pressure of SLO on the legal licence is the use of induction of labour in cows. Inducing cows had been common practice since the 1970's (SunLive, 2010). Farmers started to proactively reduce the practice due to the ethical image since the 1990s (TheCattleSite News Desk, 2010) and it was banned as a routine, non-veterinarian treatment in 2015 (Rural News Group, 2015).

Genetic dairy technologies and products have an essential role to play due to the accumulative and permanent nature of genetic gain. For example, selection and introgression of specific genes (such as the "Slick" gene) enables enhanced adaptation to the ever-changing environment. Genetic gain is defined as the improvement in average genetic value in a population or the improvement in average phenotype, relating to the observable characteristics of an individual value due to selection within a population over cycles of breeding (Hazel & Lush, 1942). Genetic gain in Breeding Worth, the national measure of an animal's ability to breed profitable replacement heifers, translates into an extra eleven NZ dollars profit per five tonnes of dry matter consumed each year (Bryant, 2017).

This research investigates the current social licence to operate (SLO) of genetic dairy technologies by interviewing stakeholders on their perspectives and beliefs of the technology or product and their desired involvement during development and commercialisation. Additionally, this research aims to identify learnings from the product commercialisation processes of wearable technologies, focusing on the stakeholder engagement processes.

In a broader context, this research project aims to increase awareness of the importance of stakeholder engagement prior to the release of a new dairy technology or product. A dairy technology or product's success is measured by financial value and SLO from the industry and wider community. This report is intended to ensure, through the creation of a stakeholder engagement framework, that genetic dairy technologies establish their SLO before commercialisation. The achievement and maintenance of an SLO will enable the full potential utilisation of genetic dairy technology.

2. Objectives

The main research question is:

How do we ensure that current and future genetic dairy technologies and products establish and maintain their social licence to deliver to their full potential?

With a focus on genetic dairy technologies, the objectives of this research project are to:

- Define the importance of having and maintaining a social licence to operate.
- Understand who our stakeholders are during product commercialisation and delivery.
- Identify learnings from the product commercialisation of other dairy technologies focusing on wearables/cow monitoring devices.
- Investigate the current social licence to operate for a range of genetic dairy products by interviewing stakeholders, structured around four recurring themes identified from literature and by measuring the responses using the Likert scale.
- Increase understanding of drivers that underpin stakeholders' perspectives of genetic dairy technologies and products.
- Create stakeholder engagement guidelines that can be used during the development and commercialisation of dairy technologies and products.

3. Literature Review

3.1 Introduction

The literature review provides the context for the study by summarising and synthesising previous research findings of others. A wide range of literature is available on social licence to operate (SLO), stakeholder engagement, and genetic technologies in general. Simon Sinek's Golden Circle is utilised to focus the scope of the literature review (Sinek, 2009). Sinek's Golden Circle is shown in Figure 1, with "Why" representing the innermost circle or bullseye. The "Why" inspires people with a purpose, whereas the next ring, the "How", describes processes or methods. The outer circle is labelled "What" and represents the result or outcome of the "Why" and the "How". The literature review will work from the outside circle to the core of the Golden Circle.

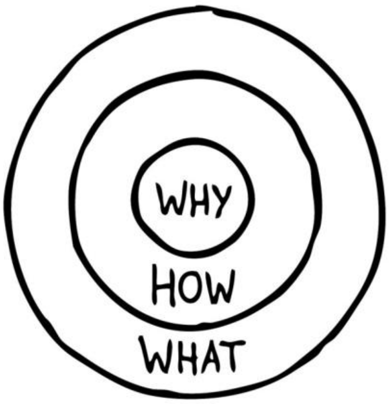

***Figure 1**: Simon Sinek's Golden Circle* (Sinek, 2009)

Section 3.2 defines SLO, discusses key components of influence, explains the complexity of an SLO through a conceptualisation model, highlights the importance of the SLO of the NZ dairy industry and identifies themes that could impact the SLO of our "Why", genetic dairy technologies and products. Section 3.3 focuses on the "How"; stakeholder engagement, by defining stakeholders and investigating the Responsible Innovation paradigm as a tool to create our "What", the SLO, for our "Why", genetic dairy technologies. Section 3.4 explains why genetic technologies and products are essential to the NZ dairy sector and reviews four genetic dairy technologies and processes. Section 3.5 defines the background of cow wearables to demonstrate this technology's use as a case study.

3.2 The What - Social Licence to Operate

3.2.1 Definition of Social Licence to Operate

Social licence to operate (SLO) is a commonly used but unclearly defined term used frequently in NZ over the last 12 years (Edwards & Trafford, 2016). Sometimes called "licence to operate" or "social licence", the term "SLO" emerged from the mining industry in the mid-90s. The term "SLO" originally referred to the mining industry's need to recover its reputation and acceptability with the community after several environmental disasters (Thomson & Boutilier, 2011).

Since the SLO's first mention in literature, it has been defined in many ways, which can be broadly categorised as either binary and tangible or a more complex, staged approach. The binary definition of SLO is whether a product, project or technology has a 'licence' or community support. Most literature indicates that SLO can be lost and has a potential tangible side, but this definition does not capture the dynamics involved in establishing and maintaining an SLO. Consequently, the general definition of SLO used throughout this report is the one by Thomson and Boutilier (2011): 'A social licence to operate is the level of approval that an industry, organisation, or project realises from its stakeholders'.

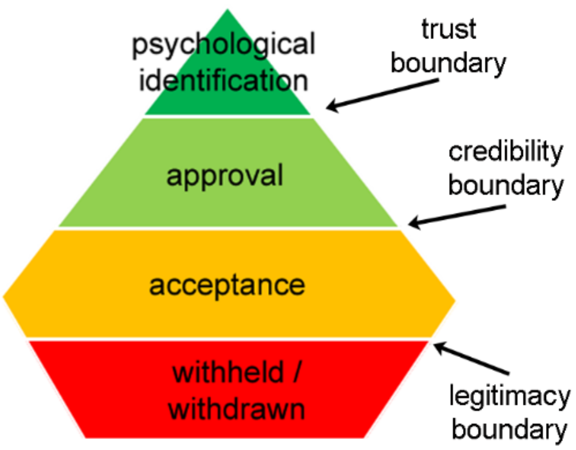

***Figure 2**: The pyramid model of SLO proposed by Thomson & Boutilier (2011)*

The pyramid model by Thomson and Boutilier, shown in Figure 2, describes the levels of approval that can make up the SLO. The lowest level describes the loss of an SLO, often associated with regulatory actions. The next level is acceptance of the project or company's actions; this layer covers the greatest area to indicate that it is the common level of social licence granted (Boutilier & Thomson, 2011). The SLO rises from acceptance to approval if the company or project establishes and maintains its credibility. Over time, if trust is established and maintained, the social licence could rise to the level of "psychological identification", where the level of socio-political risk is very low. Psychological identification is defined by: 'Stakeholders believe that the company will always act in the community's best interest and share responsibility for a project's success.' (Thomson & Boutilier, 2011).

3.2.2 Key Components of the Social Licence to Operate

There is an abundance of literature describing key components to establish a positive SLO. Common themes found throughout literature, in alphabetical order, are:

- Accountability
- Credibility
- Fairness
- Integrity
- Legitimacy
- Respect
- Transparency
- Trust

Stuart et al. (2023) conclude that the importance of the SLO is in the explicit recognition and consideration of the financial, reputational, and community risks associated with failing to meet stakeholder needs and expectations. Additionally, a review of the literature supports the theory that the creation of the SLO is dynamic and non-permanent (Boutilier, 2020; Boutilier & Thomson, 2011; Dare et al., 2014; Delborne et al., 2020; Edwards & Trafford, 2016; Moffat & Zhang, 2014; Prno & Scott Slocombe, 2012; Stuart et al., 2023; Thomson & Boutilier, 2011).

3.2.3 Social Licence to Operate Conceptualisation

To develop a "psychological identification" of the stakeholders with the project or company, the ultimate positive SLO, (Figure 2), some authors have conceptualised the creation of an SLO.

In 2020, Boutilier proposed the narratives and networks (N&N) model as an approach to clarify the SLO and place it in a political context that frames the processes by which stakeholders influence the SLO. The N&N model, shown in Figure 3, focusses on the dynamic interactions between networks of narratives and networks of stakeholders, a process called 'socio-political churn'.

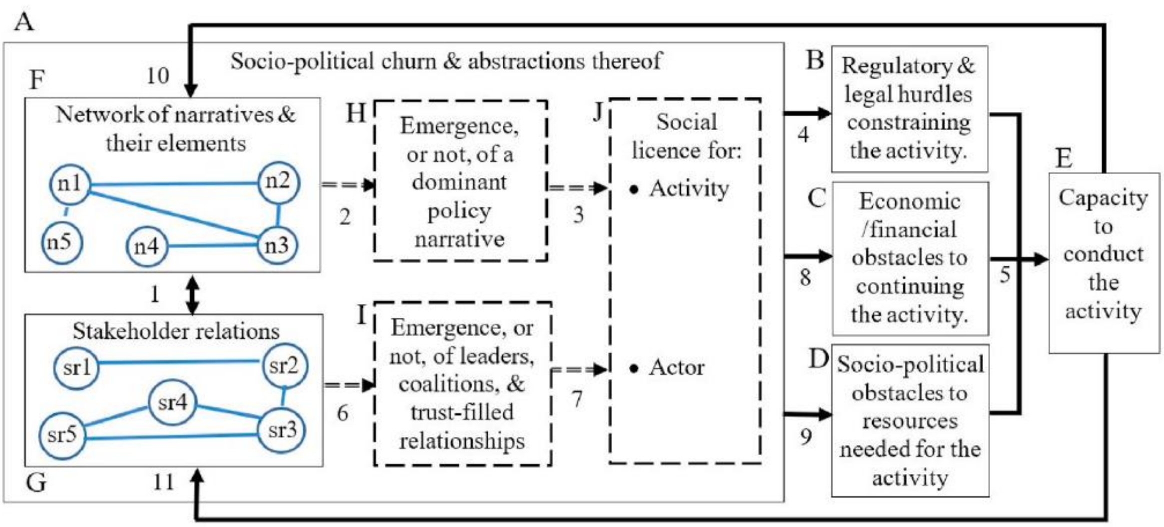

Figure 3: The narratives and networks model of the SLO proposed by Boutilier (2020)

In theoretical terms, the N&N model portrays the SLO as both cause and effect (Boutilier, 2020), again emphasising the dynamics of the process. Additionally, the N&N model displays the interactions between the SLO, legal licence, and economic licence, distinguishing between these and the activity's continuation. In Figure 3, the inclusion of both actors and activities in rectangle J reflects the correspondence between coalitions of stakeholders, rectangle G, and the narratives they believe and promote, rectangle F. For example, if the legal licence of an activity were lost because of the loss of the SLO, the N&N model would apply more weight to the activity aspect of the SLO in rectangle J, because of rectangles F and H, than the actor, because of rectangles G and I (Figure 3).

In 2023, (Stuart et al.) combined existing SLO literature in a meta-conceptualisation displayed in Figure 4. Even though Stuart et al.'s model appears to be a flowchart explaining how individual stakeholders arrive at SLO judgements, the authors emphasise that dynamics between individuals, and power disparities, occur to form organisational, or group, judgement and that this impacts the SLO. The authors exclude group dynamics in their model and argue that understanding the process of SLO formation through an individual, displayed in this meta-conceptualisation, is a necessary first step (Stuart et al., 2023).

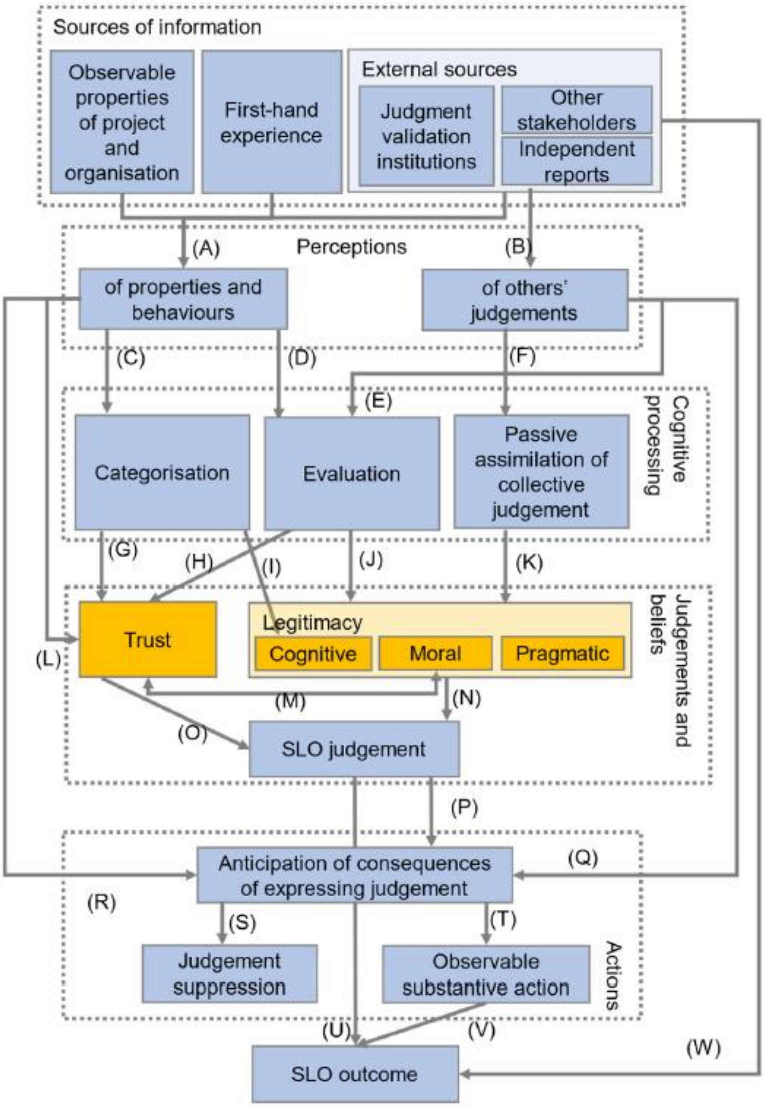

__Figure 4__: The meta-conceptualisation model determining SLO outcomes from an individual gaining information about operations to their actions impacting the overall SLO, proposed by Stuart et al. (2023)

The meta-conceptualisation model proposed by Stuart et al. (2023) highlights four key stages in the formation of an SLO judgement by an individual:

1) The assimilation of information
2) The formation of perceptions
3) The application of cognitive processes to these perceptions
4) The formation of trust, legitimacy and the SLO judgement

The individual SLO judgement and the role of actions, made up of either judgement suppression or observable substantive action, will create the final SLO outcome. This SLO outcome is equivalent to rectangle J in the N&N model shown in Figure 3.

Both the N&N and the meta-conceptualisation models serve the purpose of visualising the establishment of the SLO. The N&N model focuses on the dynamics of stakeholder groups while the meta-conceptualisation model highlights the complexity of an individual SLO judgement.

3.2.4 Social Licence to Operate in the New Zealand Dairy Industry

In recent history the SLO of the NZ dairy industry has been pressured by environmental concerns like nitrate leaching in freshwater streams (Joy, 2022) and greenhouse gas emissions (DairyNZ, 2023). Additionally, negative publicity around bobby calves, winter cropping and animal welfare cases, have been detrimental to the rural sector. In 2017, Woodward investigated the SLO of the NZ dairy sector and advised the sector to invest more into promoting its story (Woodward, 2017). Latest reports show that while New Zealanders feel that farming provides strong benefits to the country, recognising the sector's benefits does not equate to greater trust in farming (Beban et al., 2023). The NZ dairy sector must continue to earn its SLO through its actions on a range of environmental and social issues (DairyNZ, n.d.).

3.2.5 Perspectives and Learnings from Social Licence to Operate Literature

3.2.5.1 Overview

A literature review was conducted to form the context of the stakeholder interviews and their perspectives of our "Why", described in section 3.4. The review focused on scientific articles and publications published in the past decade relevant to our "Why" by using combinations of keywords comprising social licence, agriculture, dairy, farming, genetics and dairy technologies.

3.2.5.2 Animal Welfare

Animal welfare in dairy farming, including the impact technologies and products have on animal welfare, is an ever-present topic in literature. Animal welfare implications reach further than our legal licence; literature discusses animal welfare implications for surplus male dairy calves (Balzani et al., 2021; Bolton & von Keyserlingk, 2021), dairy calf management (Thomas & Jordaan, 2013), cow-calf separation (Flower & Weary, 2001), lameness management and disbudding or dehorning of calves (McConnachie et al., 2019).

Douglas et al. (2022) point out that science has increased public interest in animal welfare. They state that the growth of animal science as an established science includes the growing recognition of animals as sentient beings whose physical, mental, and social well-being is important. A report from MPI (2017) highlights that a high standard of animal welfare on NZ farms was important to all their NZ public respondents. However, the conclusion from this study stated that NZ is generally considered to be a world leader in animal welfare.

3.2.5.3 Community Impact

In NZ, the primary sector is identified as a significant supplier of employment to the NZ public, and this is one of the main factors that enables it to maintain its social licence to operate (MPI, 2017). The impact of the "Why", described in section 3.4, on the opportunities for the community is important to the SLO. Additionally, any impacts of the "Why" on health & safety in general or the quality of life of the personnel working on farms, need to be considered (Kelly, 2024).

3.2.5.4 Cultural Values and Beliefs

The culture of the community also plays a vital role in the establishment of the SLO. A recent study by Clark et al. (2024), empirically identified the perspectives of indigenous Māori communities of NZ on the gene editing technology. The study highlighted the importance of individualised stakeholder engagement and suggests the utility of Māori values to inform broader ethical considerations in technology-based debates.

3.2.5.5 Environmental Impact

A recent study by Beban et al. (2023) illustrated that most significant concern identified by the NZ public regarding the NZ farming sector is environmental impact. Conversely, when this same study asked their respondents about their biggest hope for the future, the most common answer was that farming practices would be environmentally sustainable. To build trust, two major courses of action stood out: implement sustainable farming practices to address environmental harms and reduce the amount of public relations spin by being open and using facts and science (Beban et al., 2023).

3.3 The How - Stakeholder Engagement

3.3.1 Overview

The SLO is granted by the stakeholders and is dynamic and transitory. Beliefs, perceptions, and opinions can change as time passes, events occur, or new information is acquired (Quigley & Baines, 2014). Stakeholders, in a direct sense, can be defined by: 'a person, group, or organisation with a stake (interest) in the subject activity, whose interest is not solely political or legal in nature (Stuart et al., 2023).

The stakeholders involved in the SLO of large, socially diverse projects are often a combination of the following categories:

- **Internal stakeholders** - governance structure, employees and shareholders
- **External stakeholders -** suppliers, competitors, customers, and consumers
- **Wider public perception/community**
- **Public/government**

SLO is an outcome of engagement with all four stakeholders identified above. Nevertheless, the literature demonstrates that categorising stakeholders to establish SLO may be unsuitable as it assumes equal contribution by all stakeholder groups to the SLO formation. It is stakeholders together as a group, including their internal dynamics and potential power disparities (Rodolaki & Barakos, 2023), that will define the level of the SLO as outlined in Figure 2. Consequently, the stakeholder engagement process, whether issue focused or creating SLO during commercialisation, needs to consider the interplay between public opinion narratives and views from more traditionally defined stakeholders (Boutilier, 2020; Dare et al., 2014). The N&N model shown in Figure 3 and discussed in section 3.2.3 also emphasises the engagement within and between stakeholder groups.

3.3.2 Skillset

Looking at the key components of the SLO, as described in section 3.2.2, we identify the requirements of a specific skillset enabling attributes such as transparency for our "Why", science driven dairy technologies. In a speech by Sir Peter Gluckman in 2017, he acknowledges that to be able to engage with the science community, you need to have a certain skillset (Gluckman, 2017).Additionally, Delborne et al. (2020) emphasises the fact that novel biological interventions are inherently plagued by uncertainty about outcomes.

When identifying and engaging stakeholders, their skillset plays an essential role in determining engagement with them to create an SLO. This concept is illustrated in the cognitive processing rectangle in Figure 4, the meta-conceptualisation SLO model.

3.3.3 Responsible Innovation Framework

Stakeholder engagement is a broad topic well-covered in the literature. Methods and approaches that can contribute towards an SLO as published by Ministry of Primary Industries (MPI) are (Quigley & Baines, 2014):

- Social impact management plans
- Certification schemes
- Equator principles
- Community engagement
- Corporate social responsibility
- Monitoring and reporting (e.g. sustainability criteria)

Nevertheless, none of these approaches are closely related to our "Why", described in section 3.4. From the literature review, the Responsible Innovation (RI) framework is identified as a good stakeholder engagement framework for genetic dairy technologies by Delborne et al. (2020). Delborne et al. (2020) argue that an SLO-derived model of engagement is inadequate for synthetic biology due to the uncertain nature of science, the inability to stop or retract the technology when it has been commercialised, the potential for the community to shape the technology during development, and the lack of problem framing from the front foot.

Stilgoe et al. (2013) defines RI as taking care of the future through collective stewardship of science and innovation in the present. In conjunction, Stilgoe et al. proposed an RI framework to understand and support efforts of RI. The RI framework consisted originally of four dimensions (Stilgoe et al., 2013), but was expended to six by (Lubberink et al., 2017):

- Anticipation - systematic thinking aimed at increasing resilience, while revealing new opportunities for innovation and the shaping of agendas for socially-robust risk research
- Reflexivity - critically thinking about one's own actions and responsibilities, values and motivations, knowledge and perceived realities, and how each of these influence the management of the innovation process for the desired outcome
- Inclusion - the possibility of including new voices in discussions of the ends as well as the means of innovation
- Deliberation - a commonly agreed two-way exchange of views and opinions between stakeholders based on shared information and evaluation criteria that could support decision-making regarding the innovation that is under consideration
- Responsiveness - the capacity to change shape or direction in response to stakeholder and public values and changing circumstances
- Knowledge management - creating or obtaining knowledge to solve knowledge gaps that come with the processes and outcomes of the innovation, to subsequently integrate it into the innovation process

One way to utilise the RI framework is through stage-gating, splitting the research and development into discrete stages. Stilgoe et al. (2013) discuss a case study in which they utilised the RI framework to create stage-gate criteria governed by an independent committee. The social scientists were part of the committee and used the RI framework dimensions to question the milestones and direction of the project at every stage-gate. It is important to note that the stage-gate itself was a process of responsiveness; the project team got the opportunity to identify what inputs they should consider in order to respond.

In a recent article, Taylor et al. (2023) presented a case study of the implementation and practice of RI in a UK-based synthetic biology project. In this research project, RI was developed as a concept in which biological scientists were encouraged to consider the social consequences of their work. Social scientists were part of the project team to establish RI discussion in routine project meetings. As a result of the diverse project team, the design of a key product of the project was altered in ways that went beyond standard institutional requirements. The authors recognised that, especially in the field of synthetic biology, where project results are uncertain and timeframes are long, the sustainability of the inclusion of social science collaborations can be difficult. A culture of RI in all science areas would overcome this issue.

3.4 The Why – Genetic Dairy Technologies and Products

3.4.1 Overview

Stakeholder engagement has always been critical, but the increased focus on environmental impact due to NZ's emission targets, affecting everyone in the dairy and associated meat sector, seems to have increased the importance of the NZ dairy industry meeting the SLO. Additionally, the emission targets set rely on current and new technologies, including breeding and genetics, to reduce the emission intensities of our dairy products (NZAGRC, n.d.).

Genetics increases efficiency and performance gains on-farm by breeding better animals. Genetic gain is defined as the improvement in average genetic value in a population or the improvement in average phenotype, relating to the observable characteristics of an individual value due to selection within a population over cycles of breeding (Hazel & Lush, 1942). The introgression or removal of specific genes through breeding techniques like gene editing can lead to additional benefits for the animal and its offspring.

In this report, the term "genetic dairy technologies" will be used to describe a range of technologies and products that will either:

- impact the genetics of dairy cows themselves; or
- impact the genetic gain of a group of dairy cows

An SLO, through stakeholder engagement, is required to deliver genetic dairy technologies and products to their full potential. The success of a dairy technology or product does not rely solely on the technology's financial or environmental outcomes but also on its acceptance by the community, consumer, and broader industry: the SLO.

Four potential SLO outcomes are illustrated by uncoupling the operational and SLO status below, in Figure 5 (Stuart et al., 2023). Where operations go ahead with a positive SLO, it is good for the organisation (Figure 5, top right quadrant). Where operations go ahead with a negative SLO (Figure 5, top left quadrant) it is less clear what the financial repercussions are. Negative SLO can bring with it considerable costs and operational risk (Hall, 2014; Jijelava & Vanclay, 2018; Miller, 2014), so is likely to be worse for the organisation than operating with a positive SLO.

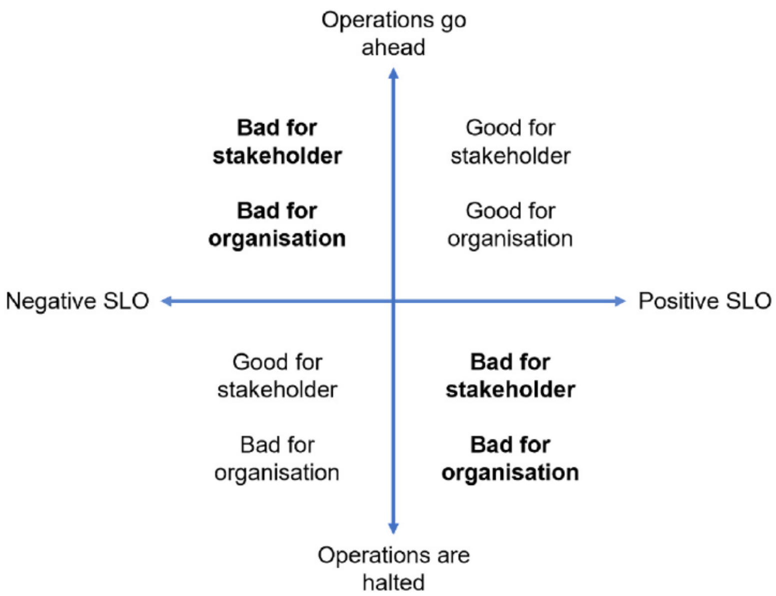

***Figure 5**: The four potential SLO outcomes by Stuart et al. (2023)*

3.4.2 Short Gestation Length Products

Short gestation length (SGL) semen is a genetic dairy product from LIC that aims to allow dairy farmers to have a condensed calving period, more days in milk and more recovery time (LIC, n.d.). Dairy production in NZ is a seasonal pasture-based system, where one of the major challenges is the achievement of a condensed calving pattern. A condensed calving pattern extends the cow's lactation period and gives the cow more time to recover before she is inseminated again. Each day a cow calves later in the calving period increases the odds of the cow failing to conceive early in the mating season and of effectively failing to conceive at all, often leading to her removal from the herd.

To enable farmers to maintain a tight calving interval, LIC created the SGL breeding programme, which aims to produce sires solely for use at the end of the mating season to effectively align calving dates. LIC has two types of SGL bull teams: SGL beef and SGL dairy. The SGL beef product has a longer gestation length but creates an easily recognisable dairy beef calf, through the white face indicator, which is potentially be more valuable. The calf from the SGL dairy product has a shorter gestation length, but no value as a dairy replacement, and therefore is often deemed to be a terminal calf. The SGL products are a cost-effective alternative to get cows in-calf in late mating and reduce the gestation length by 8 to 12 days (LIC, n.d.).

3.4.3 Slick Gene – Traditional Breeding and Embryo Transfer Work

The slick gene is a term used to describe a major, dominant gene associated with higher heat tolerance in cattle. The slick gene is found in Senepol and other Criollo beef and dual-purpose breeds, and is associated with a short, slick hair coat (Olson et al., 2003). Cattle carrying the slick gene have shown higher heat tolerance (Dikmen et al., 2014; Olson et al., 2003) and higher tick resistance (Hüe et al., 2014; Ibelli et al., 2012). In 2014, LIC started a breeding programme to integrate the slick variant into a NZ dairy background by crossbreeding NZ dairy cattle with Senepol sires. In subsequent generations, a variation of embryo transfer work was utilised, including embryo biopsy techniques, to reduce the Senepol breed while maintaining the slick gene (Davis et al., 2017). Chief Scientist Richard Spelman from LIC says: "Assuming progress continues as planned, Kiwi farmers will be able to breed heat tolerant cows by 2029." (LIC, 2023)

3.4.4 Gene Editing – Transgenesis

3.4.4.1 Overview

The terms "gene editing", genetic modification and genetic technologies encompass a wide variety of methods that modify the DNA of an animal or plant. The most commonly accepted type of gene editing (from a regulatory perspective) is either the transfer of a gene (cisgenesis) or a combination of genes (intragenesis); both will be referred to as gene editing from here onwards. Neither technique uses foreign DNA and both are, therefore, often exempt from falling under Genetically Modified Organism (GMO) regulations or food safety protocols in most countries (Te Puna Whakaaronui, 2023).

To date, gene editing is not allowed in NZ, but the scientific community, government, and NZ public are having discussions about how this technology should be used and governed (Office of the Prime Minister's Chief Science Advisor, 2023).

3.4.4.2 Slick Gene – Gene Editing Approach

Gene editing the slick gene through cisgenesis techniques into the NZ dairy population is much faster than introgression through traditional breeding and is potentially much more flexible (Donkersloot et al., 2023). Gene editing slick into NZ dairy cattle will allow us to capture the desired trait, while optimising genetic gain in our NZ dairy population. Additionally, opportunities exist to incorporate other desired genes. Achieving such "gene stacking" through introgression is feasible but would be an expensive and lengthy process, demanding considerable animal resources (Donkersloot et al., 2023).

The ability to edit the slick gene into non-carrying animals has been demonstrated in beef cattle in Brazil (Erickson, 2022).

3.4.5 Juvenile In-Vitro Embryo Transfer

Reproductive technologies such as juvenile in vitro embryo transfer (JIVET) can be used to obtain oocytes before sexual maturity (Raadsma & Tammen, 2005), thus accelerating the rate of genetic gain. Embryo transfer describes a process that allows the cattle industry to increase the number of calves that a single donor cow can produce in a year by implanting her eggs or embryos into recipient cows.

Common practice in NZ dairy cattle is to either (Animal Breeding Services (2007) Ltd, n.d.):

1) collect oocytes from the ovaries of donor cows which are then fertilised and grown in a laboratory before being implanted into a recipient cow. This procedure is called trans-vaginal recovery followed by in-vitro embryo production.
2) use follicle stimulating hormones to get the donor cow to release more eggs, which will then be fertilised inside the cow and collected non-surgically to be implanted in a recipient cow. This procedure is called multiple ovulation and embryo transfer.

Both these techniques require post puberty heifers.

JIVET utilises the procedure of laparoscopic ovum pick-up followed by in-vitro embryo production, allowing the recovery of oocytes from animals as young as two months of age (Currin et al., 2021). JIVET allows offspring of donor animals to be born well ahead of the typical calving age, using recipient cows. JIVET has been performed in prepubertal animals following hormonal stimulation protocols adapted from those used for adult animals (Currin et al., 2021). Several large biotechnology companies internationally have implemented JIVET, presumably to breed superior animals at the youngest age possible to maximise genetic gain.

3.5 Case Study - Wearables

DairyNZ's technology and workplace practices survey report (2023) concludes that as herd sizes increase, labour pressures persist and more farming technologies emerge, NZ dairy farmers have been investing more on herd and milking management technology. One of these technologies is individual cow monitoring technologies, also called cow wearables. Wearables in the form of ear sensors, leg tags, collars, and rumen boluses, have been in development and commercial application for over 40 years (Burton, 2022).

Wearables have seen a large increase in uptake since 2018, led by large farms with rotary dairies. In 2023, 16% of farms reported using wearable technology compared to just 3% in 2018. Collars are most popular (13%) followed by ear tags (4%). Most farmers are using wearables to automate heat detection, but there is interest in health monitoring and virtual herding (DairyNZ, 2023).

Cow wearables are easy to implement because they are often not reliant on other infrastructure (DairyNZ, 2023). The wearable package often supplies the wearable item with hardware and software installations.

The fast uptake of this innovative technology makes it an interesting case study to understand stakeholder engagement as part of establishing the SLO. Nevertheless, Burton (2022) stated that the public perception is less of a commercial viability issue, and more of a public education hurdle.

Different perspectives on wearable technology continue to make headlines in the media, with one example being the virtual fencing concerns of dairy farmer Tim Rhodes. Virtual fencing removes the need for physical fences by using audio, vibrations and potentially an electric pulse to guide the individual cow through her collar. Rhodes, together with another 3000 parties, has made a submission against virtual fencing to the National Animal Welfare Advisory Committee which has been reviewing the welfare code for dairy cattle. Rhodes says that with the move to virtual fencing, he is embarrassed people may think farmers are control freaks who are "robotising" animals by compromising or virtually eliminating their freedom (Round, 2023).

4. Method

4.1 Data Collection

4.1.1 Case Study Interviews - Wearables

Four semi-structured interviews were conducted with wearable company representatives, aiming to gather qualitative data regarding companies' product commercialisation and stakeholder engagement. The questions, provided in Appendix 1, were structured first to understand the company's background, strategy, and stakeholders. The focus of the second set of questions was on product development and commercialisation. Lastly, questions were asked regarding stakeholder engagement, feedback, building trust and social licence to operate the product, and how it impacts the sector's social licence. Interviews were conducted via Microsoft Teams or in person and took approximately one hour each.

4.1.2 Stakeholder Interviews

To investigate the current SLO of genetic technologies, fifteen semi-structured interviews were conducted with stakeholders. The objective was to capture a range of perspectives from direct stakeholders and peers through a strategically structured interview including Likert scale questions (Joshi et al., 2015). The data gathered was both quantitative and qualitative in nature, using the questions provided in Appendix Two and descriptions of exemplary genetic dairy technologies provided in Appendix Three.

The questions were structured first to understand the stakeholder's background and company strategy. Second, it was deemed important to understand the stakeholder's general concerns and priorities regarding the NZ dairy sector. The focus of the third set of questions was to understand the stakeholder's perspective on the four genetic dairy technologies. The interview ended with three questions to capture the stakeholder's perception on the SLO of genetic dairy technologies as well as any other final statements.

A total of 15 interviews were conducted targeting 14 different companies. In Table 1, the 15 stakeholders are categorised into various groups to preserve anonymity and highlight potential patterns between groups. Interviews were conducted via Microsoft Teams or in person and lasted approximately one hour.

4.2 Data Analysis

The collected data was a combination of qualitative and quantitative results. The Likert scale questions were analysed quantitatively, while the qualitative questions were examined using thematic analysis. Thematic analysis is a method for identifying, analysing, and reporting patterns within data (Braun & Clarke, 2006). ChatGPT was used to summarise key themes and examples for each interview question (OpenAI chatbot, 2024) and Miro software (Miro, 2024) was used to visualise the thematic analysis results.

Table 1: Summary of stakeholder interview participants by category

Category	Stakeholders	# interviews	Total
Farmer			3
	Family-owned farm	2	
	Iwi owned farm	1	
Other Stakeholder			2
	Government	1	
	Rural Professional	1	
Dairy Processor			4
	Dairy Processor	3	
	Food Manufacturer	1	
Meat Processor			3
Research Institute			3
	Non-Governmental Organisation	1	
	Crown Research Institute	1	
	AB Company	1	

4.3 Limitations of Research

The findings from the case study interviews are limited to one representative from each of four wearable companies. Three of these four companies conduct product development activities mainly internationally, influencing their stakeholder engagement and product commercialisation in NZ. The interviews were solely focused on the domestic aspect of these businesses; however, the interviews included frameworks of product development and commercialisation.

This project is limited by the stakeholders interviewed to gain an understanding of their perspectives on genetic dairy technologies. By virtue of the research project size, it was decided to limit the study to direct stakeholders of the genetic dairy technologies' customers, including customers themselves, the farmers. Additionally, due to the nature of qualitative interviews, the results are limited to the experience and knowledge of the stakeholders questioned. The questions and topics were not shared beforehand, ensuring the perspectives and thoughts were captured based on their experience and/or the descriptions provided.

The report encompasses multiple objectives regarding the importance of stakeholder engagement in establishing and maintaining an SLO. Both stakeholder engagement and the SLO are extensive and well-researched topics. However, this report aims to investigate this using four genetic dairy technologies as examples. Hence, limitations apply.

The sociopolitical impacts on the NZ dairy sector during the period of this study will have unavoidably affected the outcome. For example, during this research report, Fonterra announced a strategic step-change by exploring the divestment of some or all of its global consumer businesses (Norman, 2024). Publications touching on any themes related to the contents, including animal welfare concerns and gene editing, will undoubtedly impact the perspectives captured in the interviews.

5. Analysis and Results

5.1 Thematic Analysis of Case Study Interviews

5.1.1 Overview

Wearable company representatives were asked a series of questions to determine stakeholder definition, product development and commercialisation practices, and characterisation of success regarding SLO. The responses provided insights into stakeholder engagement practices throughout their businesses, from the product creation to the end delivery and services on-farm. Ultimately, these stakeholder engagement practices would constitute their SLO. Figure 6 on the following page outlines the key themes identified from the case study interviews.

5.1.2 Stakeholders

All representatives identified the need to include all relevant stakeholders during customer engagement. There was unanimity the sales process needed to be solution-driven for the customer - the farmer - and the product implementation needed to include all other relevant farm advisors, e.g., veterinarians and nutritionists. Multiple representatives described customer engagement as a journey in which the product needs to fill a gap. The service from the wearable would be tailored, and the wearable would need to add value for the customer.

When the representatives were explicitly asked to define the external stakeholders in their companies, all four responses included relevant inputs to the customer, such as veterinarians and nutritionists. Additionally, all mentioned the dairy processor as a stakeholder, but only one also noted the role of the meat processor. Only one interviewee included the government as a stakeholder in a regulatory and a facilitating role.

5.1.3 Product Development and Commercialisation

The discussion around product development and commercialisation varied depending on whether the company was NZ-based or international. Nevertheless, all four wearable company representatives noted that they are actively creating products for NZ; often, this was more focused on the algorithm sitting in the background used to convert the data into tools or simply the display of data customised for NZ.

All four representatives stressed the importance of stakeholder engagement and involvement into the product development process. Multiple representatives stressed that the stakeholders involved would be selected to meet the specific requirements of the work or project. Two wearable companies used a product development framework whereby stakeholder engagement was included numerous times during commercialisation. One wearable company created an independent stakeholder governance group to guarantee independent, unbiased advice during product development and commercialisation. Additionally, three out of four representatives mentioned the value in having relationships with research institutions for the purpose of trials and expert, independent advice.

> "At every stage of product development, we require stakeholder feedback. This works reciprocally since it will help us create the best product possible, while taking the stakeholder on the journey with us." — Wearable company representative

Stakeholder feedback was identified as essential for the product development process. Some wearable companies used application groups and community groups to capture feedback regularly. Others stated that actively listening and asking questions was a more natural process of integrating stakeholder feedback. One company stood out by stressing the importance of partnering with customers to sell the product. Employing the word "partnering" demonstrates a more connected viewpoint to customer relationships, presumably impacting the engagement and feedback quality captured.

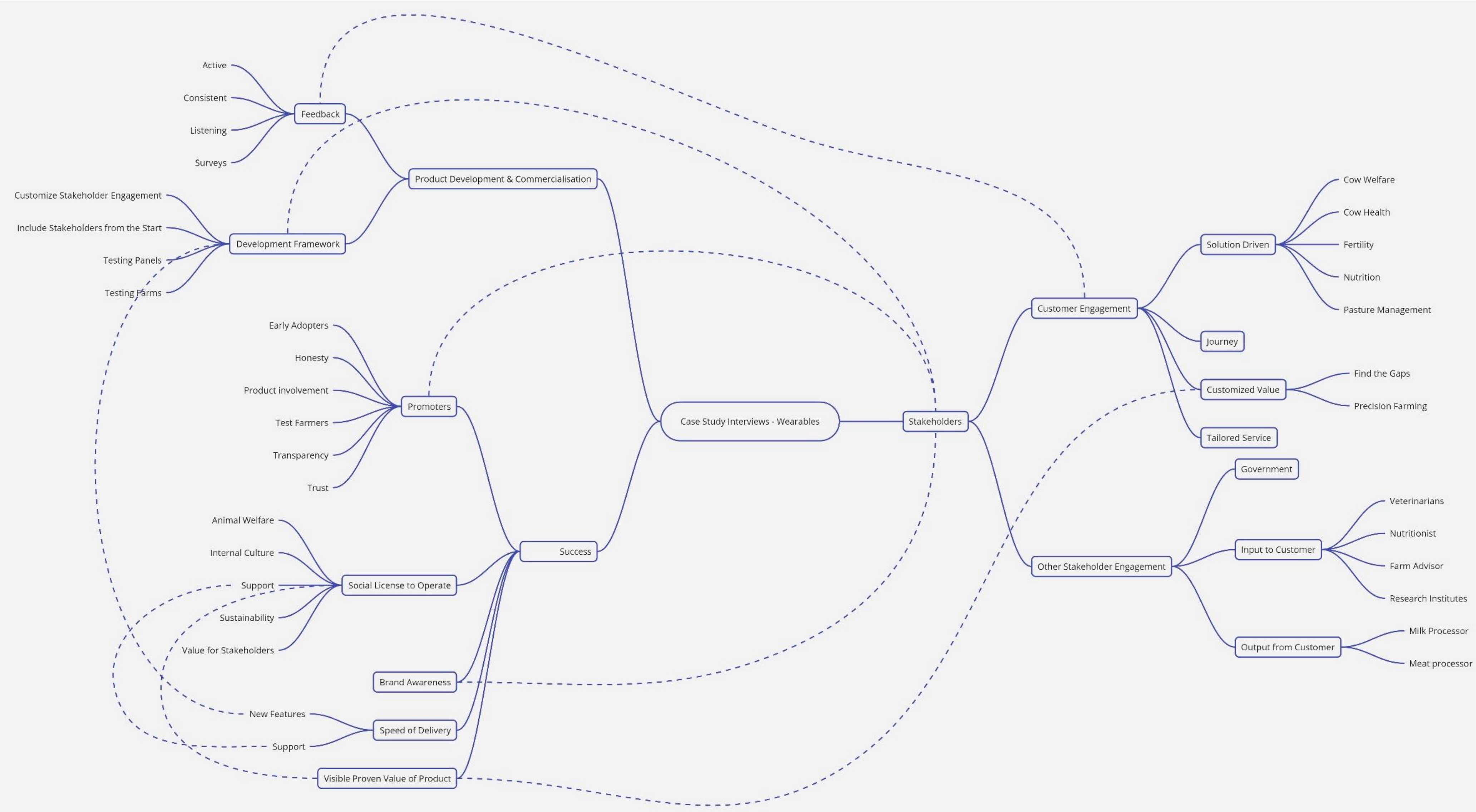

Figure 6: *Thematic analysis results on case study interviews with wearable companies*

5.1.4 Success

Initially, wearable company representatives described the product's success regarding stakeholders as the visible proven value, happy customers, brand awareness, and speed of delivery. The follow-up questions delved into the concept of promoters, and the responses started to vary. Some responded that a happy customer is a promoter. In contrast, others stated that it is often the stakeholders that have either had issues with the product or those involved actively in developing the product that become the best promoters. Key components to create promoters were building trust, transparency, and honesty.

One wearable company representative stated that success is all in the hands of the stakeholder:

> "You create the momentum, but stakeholders drive the change." — Wearable company representative

All wearable company representatives stated their positive SLO had enhanced individual dairy farms SLO by adding efficiencies and addressing critical concerns of workplace safety, animal welfare and environmental impact. Three out of four wearable company representatives indicated they did not see the need to directly engage public perception or communities. However, these three acknowledged that any form of automation often has an adverse reputation of replacing good stockmanship. None were concerned about this adverse reputation since the value for stakeholders would outweigh the potential adverse public perception. Two wearable company representatives noted that having wearables on farm has added to the attractiveness of the farm as an employer, presumably a positive influence on the SLO of the farm.

> "Invasiveness or non-invasiveness from an animal welfare point of view will significantly impact the social licence's ability to operate." — Wearable company representative

> "Animal welfare is very emotive for farmers and if it adds to the sustainability and the profitability piece, it's a win-win." — Wearable company representative

According to all four representatives, the competitive market in which the wearable companies operate has influenced the construction of their SLO. One representative stated that there needed to be more collaboration between the wearable companies to improve the SLO of various products. According to this representative, these silos are slowly breaking down due to the push for data transparency to capture the emission intensity profile of NZ dairy farms. Presumably, this strong push on the SLO of dairy farms is starting to impact the SLO of wearables now they are becoming a more common sight on farms.

5.2 Analysis of Stakeholder Interviews

5.2.1 Overview

Fifteen stakeholders were asked a series of questions to understand concerns and priorities regarding the NZ dairy sector, preferred ways of staying up to date on new dairy technologies, perspective on the four genetic dairy technologies used as examples, appetite for engagement during the development of genetic dairy technologies, and thoughts on the SLO of genetic dairy technologies. The responses provided insights into stakeholders' varying perceptions on the general SLO of the NZ dairy sector and the SLO of genetic dairy technologies. Additionally, the responses provided suggestions on stakeholder engagement during development and commercialisation.

Due to the mix of qualitative and quantitative data gathered throughout the different sections of the interview, the findings below are structured according to the context of the questions, and the results are a mixture of thematic and quantitative analysis.

5.2.2 NZ Dairy Sector Perspectives

All fifteen stakeholders were asked to prioritise five key concerns identified from the literature. The results are shown in Figure 7. Environmental impact was prioritised as a concern for the majority interviewed, and New Zealand's economic dependency on the dairy industry was generally a lower concern. Animal welfare and public perception typically ranked as the third or fourth priority, however, there was a lot of variety. Broken down to the stakeholder categories in Table 1, the results remain varied within the categories, except for research institutes. Research institute stakeholders all agree that environmental impact is the highest concern and economic dependency is the lowest concern of the options given.

"Environmental impact is a key priority due to the fact that we still don't have clear solutions." — Other Stakeholder

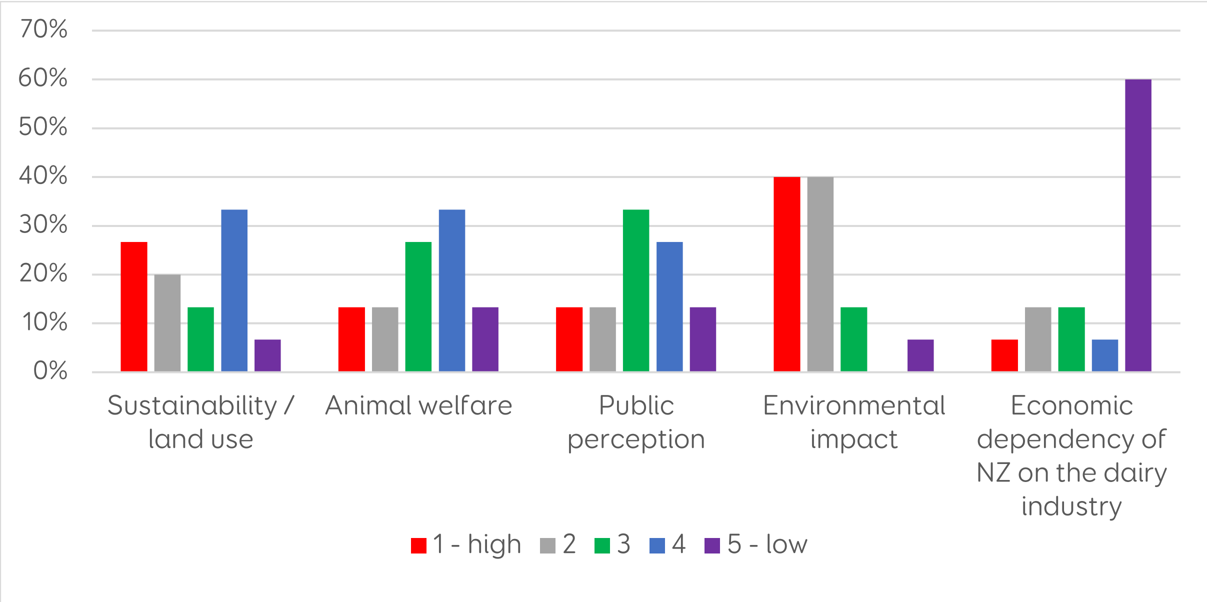

Figure 7: Summary of priority rank given by stakeholders on key concerns impacting the NZ dairy sector

The stakeholders also identified a list of other concerns facing the NZ dairy industry that was not captured in the five themes shown in Figure 7. The following concerns were mentioned more than once:

- Lab based foods
- Human resources
- SLO / market access due to negative media

Figure 8 displays the stakeholders' responses to prioritising key themes in the NZ dairy sector. The responses are less varied, with a clear focus on farm-level sustainability, closely followed by environmental footprint and animal welfare. Once more, the three stakeholders in the research institute category responded almost unanimously, while the other stakeholder categories displayed more variation.

"You got to be in the green to be green." — Farmer

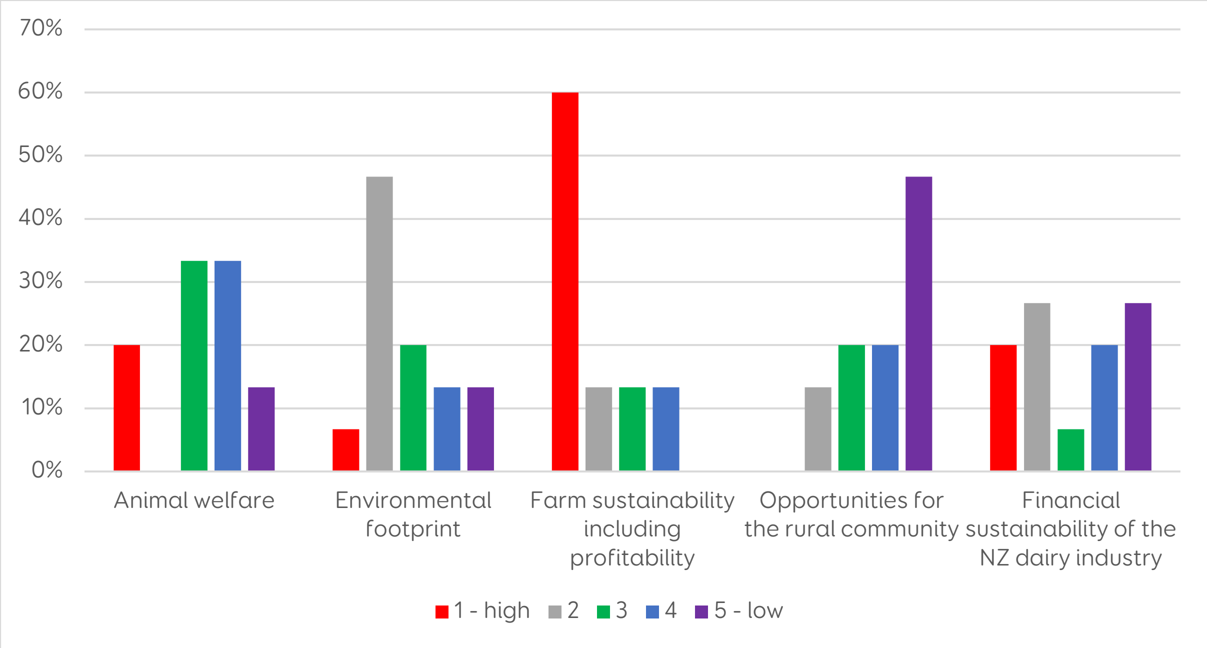

Figure 8: *Summary of priority rank given by stakeholders on key themes impacting the NZ dairy sector*

Stakeholders were asked their perspective on what has the most significant influence on the New Zealand dairy sector; their responses, as a result of thematic analysis, are displayed in Figure 9.

The theme of adaptation crosses multiple levels of the NZ dairy sector, from grassroots to diversification in our final dairy product mix. Adaptation of the respondent was also pointed out by the influence the stakeholders' international exposure had on their perspective of NZ dairy. The theme of community is self-explanatory and includes the media highlighting extreme perspectives designed to trigger an emotional reaction that could influence a stakeholder's perspective. The sustainability theme is coupled with economic variability, external pressures like regulations, and cultural values like environmental stewardship.

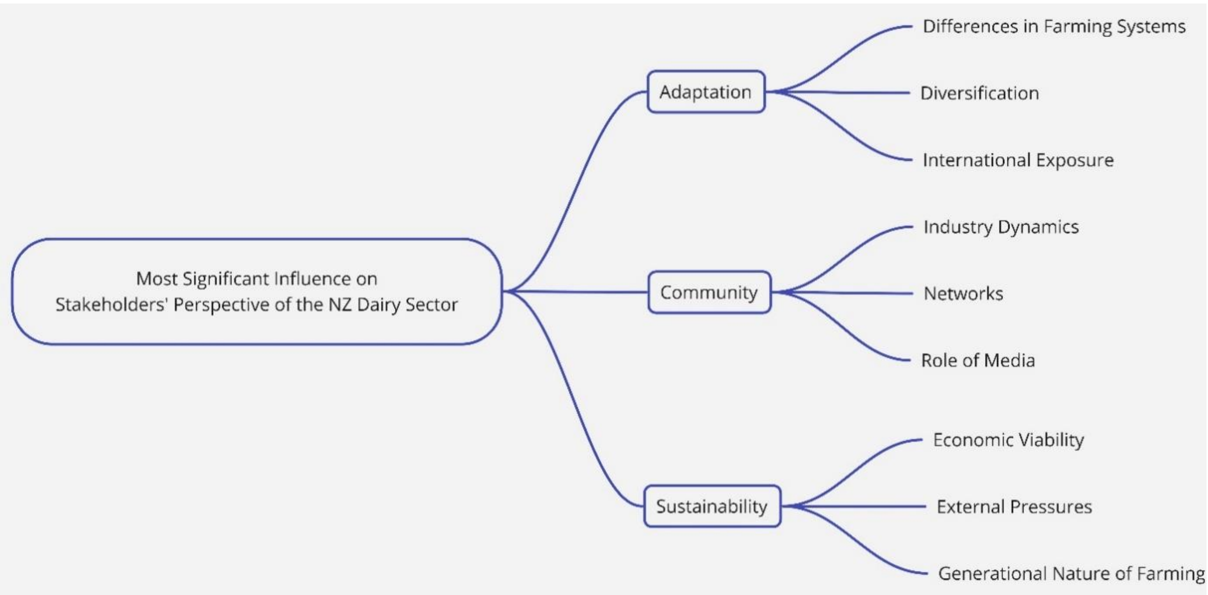

Figure 9: *Key themes generated from stakeholders' responses to the question: "What has been the biggest influence on your opinion of the NZ dairy industry?"*

5.2.3 Genetic Dairy Technology Perspectives

Figure 10 shows the thematic analysis results of stakeholders' perspectives on the four genetic dairy technologies used as examples, categorised as positives, negatives, and stakeholder involvement.

Fourteen out of fifteen stakeholders interviewed were interested in understanding each genetic dairy technology discussed; levels of awareness before the interviews varied widely between the four genetic dairy technologies. When asked if they could describe their areas of interest in the technology itself, the answers unanimously emphasized the benefit assessment, including the economic viability, the risk evaluation, and the transparency of process. Transparency of process interests could be summarised by asking questions starting with "How": How does the slick gene work? How does JIVET impact the donor's welfare? How does the SGL beef offsprings' growth rates compare with other dairy beef crosses?

On average, the fifteen stakeholders interviewed perceived the slick gene technology through traditional breeding as relatively positive. Their responses demonstrated few negatives other than the probable public perception, potential gene trade-offs, compromised breeding focus on other traits of interest, and speed of delivery for the market. Research institutes and dairy processors were interested in active involvement during the product development. At the same time, farmers and other stakeholders were happy to follow from the sidelines, provided the opportunity to participate remained, should they desire. Meat processors were interested but did not feel this would impact them directly.

"If we can quantify the impact of the slick gene, there is a huge opportunity to socialise it wider." —Other Stakeholder

"Would the public really care about something like the slick gene? Do they truly understand enough of genetics to interpret it?" — Meat Processor

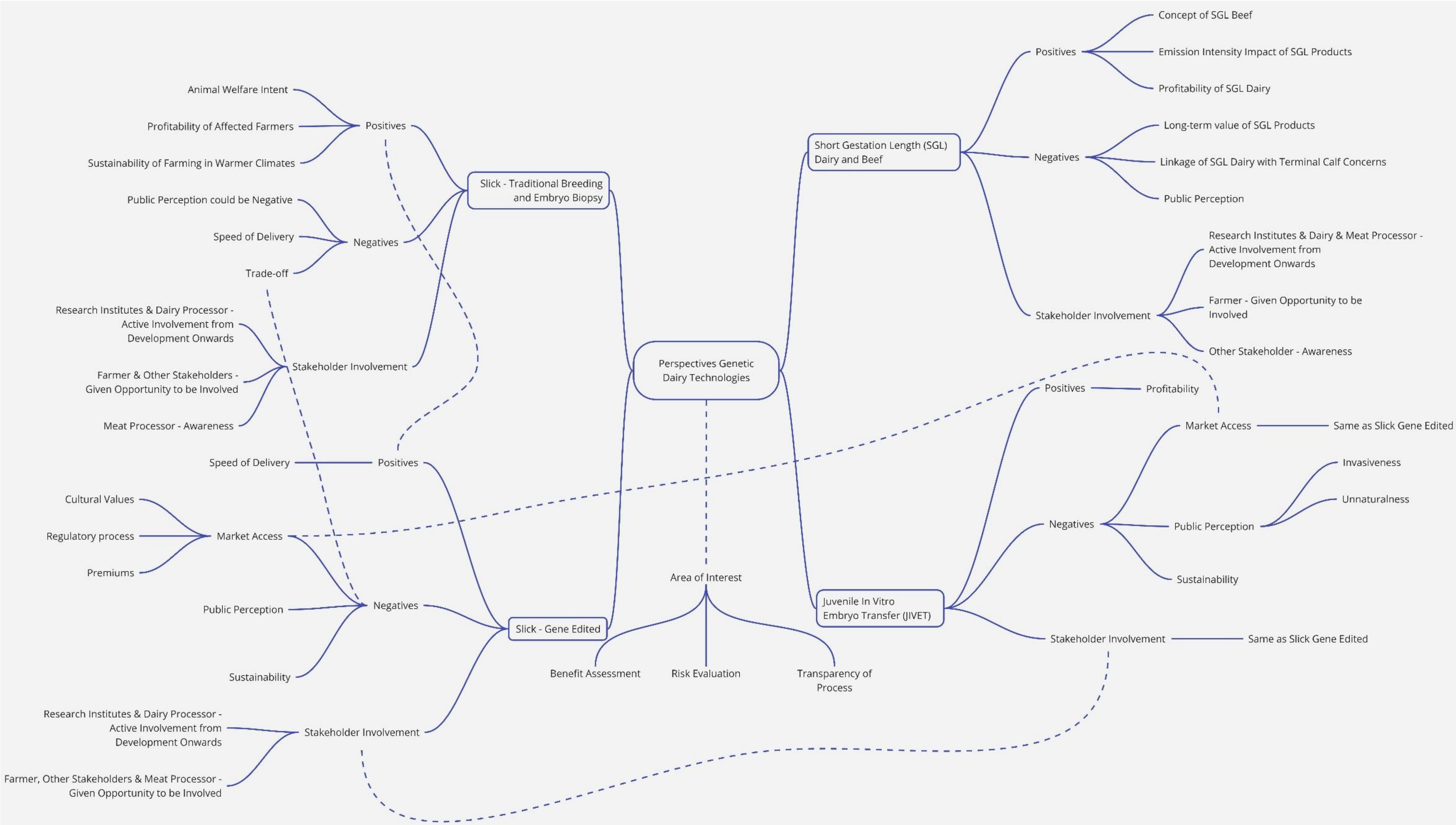

Figure 10: *Thematic analysis results on stakeholders' perspectives and involvement interest in genetic dairy technologies*

When the discussion moved to editing this specific gene into our NZ dairy cattle population, the level of concern increased rapidly. The concerns were directed to market access, public perception, and sustainability of the NZ dairy industry. In the first instance, the farmers' and consumers' cultural values influence the perceived market acceptance of gene-edited animal. Additionally, the stakeholder's concern around market access of final product was discussed from a regulatory and binary point of view, e.g. some markets will simply not purchase this meat or dairy, and a premium angle, e.g. milk or meat from gene-edited animals cannot go into their regular premium stream any longer.

Principally, 60% of the stakeholders still felt slightly positive about gene editing the slick gene. However, all participants acknowledged the need for the sector to tackle this implementation collectively. Multiple stakeholders cited large companies, based on market share, like Fonterra, to resource the gene editing conversation for the dairy industry. It was recognised that the supply structure is very different in the meat industry, and discussions on who would take responsibility for gene editing will need to be addressed.

The perspectives gathered from the SGL products displayed the most variation regarding the potential sustainability impact this product has on the NZ dairy sector. Respondents' concerns regarding the direct link from SGL dairy to terminal calves ranged from stating it was simply a better terminal calf and beneficial to the cow to concerns around public perception of adding to the terminal calf pool. 69% of the stakeholders were "slightly positive" to "positive" about the technology. The stakeholder involvement interest moved to include meat processors in active involvement, while other stakeholders would like to be aware.

Half of the stakeholders interviewed were unaware of the potential use of specialised embryo transfer technology to harvest oocytes from juvenile animals. All stakeholders acknowledged the technology's financial benefit, but public perception concerns were like gene editing technology's. The invasiveness and unnaturalness underpinned the public perception concerns. Some stakeholders stated that this is potentially a technology you would share with direct stakeholders but not communicate with end-product consumers or the general public. In general, 67% of the stakeholders felt positive about JIVET, 13% neutral and 13% negative.

"Public perception of JIVET is expected to be negative since it is a form of biological modification, you are going against Mother Nature's rules." — Meat Processor

"Market access for both JIVET and gene editing will be very black and white." — Meat Processor

5.2.4 Social Licence to Operate of Genetic Dairy Technologies

The SLO of genetic dairy technologies has a direct impact on the end-products, dairy and meat. The fifteen stakeholders were asked to define SLO of the NZ dairy sector and their responses are summarised in three categories:

- Social acceptability and responsibility
- Consumer perception and market access
- Community engagement and dialogue.

Examples of social acceptability and responsibility include maintaining transparency, uniformity, honesty, and kindness in operations, and demonstrating consciousness of environmental and social concerns. Consumer perception and market acceptance includes regulatory, financial and social hurdles. Community engagement and dialogue stresses the importance of conversations, education, and varied narratives. The stakeholders emphasised the need for collective efforts in shaping societal perspectives and maintaining SLO.

"We get bombarded with media and see the extreme sides of the spectrum. The noise is bigger than the proportion of the population. SLO starts with a conversation. Educate yourself with other people's viewpoints." — Other Stakeholder

"What is considered acceptable by the consumer is based on the knowledge they have. So, let's educate them!" — Other Stakeholder

The role of diversity and the need for choice was mentioned multiple times in relation to SLO. Not every genetic dairy technology is going to fit every farmer, like not every dairy product fits every customer. Two stakeholders stressed that choice gives people freedom and allows them to shape perspectives.

There was agreement that the research institute was responsible for proving the science and building the value of genetic dairy technology; stakeholders must be identified and involved from the early stages. One of the stakeholders commented that "the identification of suitable stakeholders to engage is a lot easier in dairy than in meat due to the market share distribution." Nevertheless, another stakeholder identified the use of trade associations, e.g., the Meat Industry Association of New Zealand (MIA), as a first point of call.

More than 80% of the stakeholders felt that the SLO of genetic dairy technologies should be constructed in conjunction with the government or another independent consultant. Suggestions about the origin of this consultant ranged from non-governmental organizations (NGOs) to MPI, Primary Industry Committees or animal welfare committees.

6. Findings and Discussion

This project aims to bring attention to the importance of stakeholder engagement during the research and development phases of a dairy technology or product. The focus is twofold: first, what can we learn from the commercialisation of wearable technologies, and second, what perspectives and opinions do stakeholders have on genetic dairy technologies?

The findings and discussion section amalgamates the insights obtained from the literature review and those perspectives, beliefs, and experiences captured during the semi-structured interviews.

6.1 Stakeholder Engagement

The literature review and the case study interviews highlighted that stakeholder engagement is a process impacted by many different variables. The definition of stakeholders in the context of SLO varied widely; the interviewees perceived it differently from each other, and the literature also contained a wide range of definitions. The word 'stakeholders' traditionally indicates that the identified party needs to have a direct stake in the business; however, looking at the term from an SLO perspective, the entire dairy industry, including the community and end consumer, could be seen as a stakeholder. The case study interviews demonstrated that most wearable representatives identify stakeholders as those involved in either a governing body, an input role, e.g. input to the customer or input to the company itself, or an output role, e.g. dairy or meat processor. The stakeholder definition has a crucial impact on the engagement process.

During the case study interviews, which focused on identifying learnings from the engagement wearables companies have with stakeholders, the concept of stakeholder motivation emerged: understanding the motivation or the value for both parties involved to maximise the engagement. The sales process of wearables, as outlined by the wearable representatives, applies this by creating customised values and services for the farmers. However, working with other stakeholders who contribute to the farm in ways other than directly with the product, like veterinarians, makes this less transparent. In this case, the value for the veterinarian sits in the socially responsible and animal health realm, where the veterinarian's role moves from reactive to proactive animal care.

The theme of motivation, or the resulting value for the stakeholder, is well discussed in the literature. The value for the indirect stakeholder, as with the veterinarian example mentioned above, is heavily weighted towards the SLO of the veterinarian in this case, but arguably, the financial licence will also be impacted. If a veterinarian were to advise a farmer against the wearable in question, and the farmer consequently chooses to switch to another rural professional, it could carry a negative economic result for the veterinarian. However, they might endure a short-term negative financial licence if they support the wearable purchase. Still, they would increase their social relationship with the farmer, likely leading to a long-term economic benefit. The N&N model, shown in Figure 3 (Boutilier, 2020), supports the impact dynamic interactions between networks of narratives and networks of stakeholders can have on the SLO of a dairy technology, in this case, wearables. Simultaneously, this example and the supporting literature stress the importance of including all stakeholders while considering their motivation.

A key finding from the case study interviews was the importance of feedback during product development and commercialisation. Even though the literature did not single out the use of feedback, we can connect the underlying objective with some of the dimensions that make up the Responsible Innovation (RI) framework. The feedback process, which includes utilising the outcomes during product development, captures the RI components of inclusion, deliberation, responsiveness, and knowledge management.

The interviews and literature review findings highlight the need for customisation at every level of stakeholder engagement. The literature review focused on the requirements of a specific skillset to create SLO attributes like transparency during stakeholder engagement. The findings from the interviews focused on the customisation of stakeholder groups required during product development, engagement with different stakeholders, and governance for various aspects of the business. This customisation aims to create key components of the SLO as mentioned in the literature, e.g. trust, transparency, and credibility.

The case study interviews found that success in stakeholder engagement lies in the stakeholder becoming a promoter. Key components to create promoters were building trust, transparency, and honesty. The key elements of promoters are closely associated to the highest level of the SLO in the pyramid model by Thomson and Boutilier, Figure 2. The "psychological identification" level is defined by: 'Stakeholders believe that the company will always act in the community's best interest and share responsibility for a project's success.' (Thomson & Boutilier, 2011). Promoters are an important part of maintaining and establishing the SLO of a dairy technology.

6.2 Perspectives on and Beliefs about Genetic Dairy Technologies

The key findings from the stakeholder interviews on critical concerns and priorities for the NZ dairy industry aligned with the literature review results. Environmental impact and land use remain top priorities, but the findings clarified that stakeholders prefer to consider sustainability, including economic viability. Both literature and stakeholders confirmed the importance of animal welfare, and both agree that NZ farms have a high standard of animal welfare. Media stories displaying bad animal welfare cases are the exception and do not represent most farmers or the trust of NZ public in farmers doing the right thing for their animals.

Crucially, it appears that all stakeholders were interested in the genetic dairy technologies discussed, although stakeholders do not want to be forced into an active involvement with every technology. Imagine a scenario where the genetic dairy technology could potentially harm the SLO of the dairy or meat industry. In that case, the stakeholders would want to be given the opportunity to be involved during the product development stage. Potential negatives of genetic dairy technologies were captured in the three key themes: market acceptance, public perception and sustainability or other trade-offs. Market acceptance was identified as more comprehensive than the economic impact of the genetic dairy technology; it also includes the alignment of the product with cultural values and beliefs. This comprehensive classification of market acceptance corresponds with findings from the literature and serves as an example of the entanglement between legal licence, economic licence and social licence as described by (Boutilier, 2020) in the N&N model, shown in Figure 3.

To a certain extent, the perceptions and opinions captured through the stakeholder interviews followed the SLO meta-conceptualisation from Stuart et al. (2023), displayed in Figure 4. The description of the genetic dairy technology amalgamated the information, and the stakeholder applied cognitive processes to form an SLO judgement. However, the perceptions and opinions captured in the interviews excluded the dynamics between individuals and power disparities that could impact individual perspectives and organisational or group judgement. Consequently, it indicates the expected variety of perspectives on genetic dairy technologies for this specific group of stakeholders but does not represent the complete picture. Hence, further work is required.

As acknowledged in Section 4.3, the stakeholder group was narrow, and knowledge gaps exist regarding perceptions from communities, international customers, and end-consumers. It is heartening to see that research institutes like AgResearch and MPI are using events like the Fieldays to capture perspectives from stakeholders and enable conversations around genetic dairy technologies (AgResearch, 2024; On Farm Support team MPI, 2024).

6.3 Social Licence to Operate of Genetic Dairy Technologies

One deduction drawn from the interview is that the term and boundaries of "social licence to operate" is highly variable between stakeholders. Nevertheless, the thematic analysis findings from the responses were in line with the conclusion of Stuart et al. (2023). Namely: the importance of the SLO is in the explicit recognition and consideration of the financial, reputational and community risks associated with failing to meet stakeholder needs and expectations.

The need for open, unbiased conversations around the impact of genetic dairy technologies to create the SLO became clear in the findings from the JIVET discussion, using juvenile animals as donors to create high genetic merit embryos, with stakeholders. All stakeholders acknowledged that profitability is the only direct positive of this technology and identified several negatives, including significant concerns about the unnatural and invasiveness of the technique. However, 67% of the stakeholders felt positive about JIVET, indicating the SLO isn't necessarily negative.

The Responsible Innovation (RI) framework was identified through the literature as a potential tool to ensure stakeholder engagement to create SLO. The RI framework would have most value if it were adopted as an integral part of the product development of genetic dairy technologies. Additionally, the RI framework is more suitable to the nature of animal science and biology. The requirement for stakeholder engagement during product development, resulting from the stakeholder interviews, combined with the focus on feedback and the need for promoters from the case study interviews, indicates a need for research institutes to investigate tools like the RI framework to ensure appropriate stakeholder engagement to establish and maintain the SLO.

The ownership of the SLO of genetic dairy technologies is a knowledge gap for the NZ dairy and meat industry. Most stakeholders stated that the research institute should be responsible for the SLO, but the role of government, NGOs, other stakeholders, and dairy and meat processors seems unclear. Often, Fonterra is assumed to represent the customer view simply due to their market share. However, current dynamics in the market, including Fonterra's divestment of customer-facing brands, could significantly impact their role on the SLO of the NZ dairy sector.

Additionally, the involvement of the meat industry seems often forgotten when discussing the SLO of elements of the dairy sector. Potentially, this lack of involvement is due to more complex engagement requirements to get a majority customer voice, as well as the meat industry's governing financial structure, whereby meat levy goes to a separate NGO. Nevertheless, there is a need for the SLO to encompass all stakeholders and for its validation and promotion to be performed by an unbiased, independent consultant or committee.

7. Conclusions

Genetic dairy technologies and products play an essential role in the NZ dairy sector's quest to sustainably meet growing production demands with fewer resources. The success of a genetic dairy technology is not just reliant on its economic and legal licence; the social licence to operate (SLO) is arguably playing a more significant role than ever. Consequently, stakeholder engagement should be incorporated into research, ensuring the SLO is well understood and established before commercialisation.

To adequately combine all narratives and perspectives relevant to the SLO of dairy technologies, the meat and dairy sector needs to collaborate and take ownership of all practices in the supply chain. Research institutes need to lead the construction of an SLO, having open and unbiased conversations with stakeholders including capturing perspectives from the community and end consumers. A balance must be struck between key components of the SLO and future uncertainty and risks associated with genetic research. Tools like the Responsible Innovation (RI) framework could be utilised to enable this balance; an independent party to promote genetic dairy technology must also be considered.

Stakeholders have shown a genuine interest in genetic dairy technologies and the desire to be more actively involved. Concerns and priorities of the New Zealand dairy industry are representative of all stakeholders in the supply chain, but awareness and perspectives on genetic dairy technologies vary widely. The entanglement of legal, economic and social licence will remain complicated. Still, trust and networks need to be built to advance and implement the best outcome from research for the entire sector.

8. Recommendations

Recommendations for Research Institutes:

- Share research projects and questions with the wider NZ sector early to create the potential for feedback. Options to do this could be as simple as a quarterly newsletter.
- Review current stakeholder engagement practices during product development and investigate ways to build stage-gates to include reflection and opportunities to improve.
- Build an open and responsible research platform by taking stakeholders along on the research journey - create promoters.
- Create a governance structure that balances the legal, economic, and social licence of genetic dairy technology post-commercialisation to ensure a desirable long-term impact on the NZ dairy sector.

Recommendations for Stakeholders:

- Support the research and development of dairy technologies, through building networks and seeking active involvement in those technologies that have the potential to influence the SLO of your core business.
- Build capabilities, like stakeholder groups or committees, to tackle wider SLO questions as a group of stakeholders by sharing responsibilities and perspectives.
- Facilitate open and unbiased conversations to capture perspectives and beliefs, and create collaboration opportunities.

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10. Appendices

10.1 Appendix 1 – Interview Questions for Wearable Technologies

Introductory questions

1. What is the company's background in a couple of sentences?
2. What does success look like for your company?
3.
    a. What are the critical responsibilities of your role?
    b. How does your role fit into the company's strategy?
4. Who are the key stakeholders in your company, outside farmers as your direct customers?

Delving into the products

5. What does your current product portfolio look like?
6. How do regulatory requirements influence your product portfolio?
7. Can you please talk me through the commercialisation of your latest product?
8.
    a. At what time during product development would you seek feedback from outside the company?
    b. Do you utilise a specific roadmap or framework to seek feedback during the product development?
    c. Please explain why or why not?
9. What is your definition of a finished product or service?

Relationships and communication

10. What key performance indicators do you communicate to your stakeholders?
11. How would you define the social licence to operate of your corporation and product?
12. What actions do you take to maintain your social licence to operate or serve the community you operate in?
13. Do you believe you have a group of promoters in the industry?
    a. If so, what is the size of this group?
    b. Do they have any common attributes?
    c. How do you believe they have become promoters?
14.
    a. If a product or service gets negative feedback, how do you rebuild trust?
    b. Would you be willing to share an example of when this might have happened?
15. How do you get promoters for your product?
16. How do you think your product or brand adds to the social licence of the NZ dairy industry?
17. How do you think your stakeholders would experience your product for below themes?
    a. Animal welfare
        1) Poor
        2) Fair
        3) Good
        4) Very good
        5) Excellent
    b. Environmental footprint
        1) Poor
        2) Fair
        3) Good
        4) Very good
        5) Excellent

c. Farm sustainability including profitability
    1) Poor
    2) Fair
    3) Good
    4) Very good
    5) Excellent
d. Opportunities for the rural community
    1) Poor
    2) Fair
    3) Good
    4) Very good
    5) Excellent
e. Financial sustainability of the dairy industry
    1) Poor
    2) Fair
    3) Good
    4) Very good
    5) Excellent
f. Can you please explain why you gave them the above scores?

18. How might different stakeholder groups have answered the above question differently on the 5 themes?

Final remarks

19. After talking a little bit about your strategy and products, who, in your eyes, is responsible or should lead the social licence to operate for wearables?
20. Are there any questions you think I should have asked around the product commercialisation and social licence to operate?
21. Do you have any other comments you wish to make around stakeholder engagement and social licence to operate?

10.2 Appendix 2 - Interview Questions for Stakeholders

Introductory questions

1. What is your current occupation?
2. Who is your employer?
3. What is your employer's, company's, or organisation's strategy?
4. Who do you see as being the key stakeholders in your company / employer?
5. How would you describe your affiliation with the New Zealand (NZ) dairy industry?
6. How would you define the social licence to operate?

NZ Dairy industry

7.
    a. What is your biggest concern in the NZ dairy industry, from high to low please:
        - Sustainability / land use
        - Animal welfare
        - Public perception
        - Environmental impact
        - Economic dependency of NZ on the dairy industry

    b. Do you have any other concerns, if so, please describe
8. What has been the biggest influence on your opinion of the dairy industry?
9. Who would you talk to about NZ genetic dairy technologies or products?
10. How do you stay up to date with new dairy technologies or products?
11. Can you please rank the below themes from high to low priority for you:
    - Animal welfare
    - Environmental footprint
    - Farm sustainability including profitability
    - Opportunities for the rural community
    - Financial sustainability of the NZ dairy industry

Genetic dairy technologies (these questions were repeated for the following four technologies after reading out the description shown in Appendix 3: 1. Slick - Traditional breeding and embryo biopsy, 2. SGL Dairy & Beef, 3. Slick - Gene edited, 4 - Juvenile In Vitro Embryo Transfer)

12. Can you please describe your understanding of this genetic dairy technology or product?
    1) Unaware / never heard of it
    2) Aware but not confident to talk to others about it
    3) Aware and confident to talk to others about the basics
    4) Aware and very confident to talk about it
13. If you would review this genetic dairy technology or product, what would you like to know about it?
14. How do you feel this technology impacts animal welfare?
    1) Positive impact
    2) Slightly positive impact
    3) Neutral
    4) Slightly negative impact
    5) Negative impact
15. How do you feel this technology impacts the profitability of the NZ dairy industry?
    1) Positive impact
    2) Slightly positive impact
    3) Neutral

4) Slightly negative impact
5) Negative impact

16. How do you feel this technology impacts public perception of the NZ dairy industry?
    1) Positive impact
    2) Slightly positive impact
    3) Neutral
    4) Slightly negative impact
    5) Negative impact
17. How do you feel this technology impacts the sustainability of the NZ dairy industry?
    1) Positive impact
    2) Slightly positive impact
    3) Neutral
    4) Slightly negative impact
    5) Negative impact
18. Can you please explain why you gave this technology the previous scores?
19. What are your concerns about this technology?
20. In general, how do you feel about this technology:
    1) Positive impact
    2) Slightly positive impact
    3) Neutral
    4) Slightly negative impact
    5) Negative impact
    6) Other:
21.
    a. During the development of this technology, at what stage would you like to be given the opportunity to be involved, if at all?
    b. Why have you indicated you want to be involved at this specific stage in the product development process?

Final remarks

22. After talking a little bit about genetic dairy technologies and products, who, in your eyes, is responsible or should lead the social licence to operate for the genetic technologies like discussed?
23. Are there any questions you think I should have asked?
24. Do you have any other comments you wish to make in the general sense related to genetic dairy technologies?

10.3 Appendix 3 – Descriptions of Genetic Dairy Technologies Utilised as Examples in Interviews

Slick – Traditional breeding and embryo biopsy

The slick gene is a term used to describe a major, dominant, gene associated with higher heat tolerance in cattle. Cattle like Senepol carrying the slick gene display a short, slick hair coat. In 2014, LIC started a breeding programme to integrate the slick variant into a NZ dairy background by crossbreeding NZ dairy cattle with Senepol sires. In subsequent generations, a variation of embryo transfer work was utilised, including embryo biopsy techniques, to reduce the Senepol breed while maintaining the slick gene.

Short Gestation Length (SGL) genetic products

Short gestation length (SGL) semen is a genetic dairy product from LIC that aims to allow dairy farmers to have a condensed calving period, more days in milk and more recovery time. LIC has two types of SGL bull teams, SGL beef and SGL dairy. The SGL beef product has a longer gestation length but creates an easy recognisable dairy beef calf, through the white face indicator, and the calf has the potential to be more valuable. The calf from the SGL dairy product has a shorter gestation length, but no value as a dairy replacement, and is therefore often deemed to be a terminal calf.

Slick - gene editing

Gene editing the slick gene into the NZ dairy population is much faster than introgression through traditional breeding. Gene editing the slick gene into NZ dairy cattle will allow us to capture the desired trait, in this case the slick gene, while optimising genetic gain in our NZ dairy cattle, the difference in genetic value between parent and offspring. The ability to edit the slick gene into non-carrying animals has been demonstrated in beef cattle in Brazil.

Juvenile In Vitro Embryo Transfer

Juvenile in vitro embryo transfer (JIVET) can be used to obtain oocytes before sexual maturity, therefore accelerating the rate of genetic gain. JIVET utilises the procedure of laparoscopic ovum pick-up followed by in vitro embryo production, allowing the recovery of oocytes from animals as young as two months of age. Several large biotechnology companies internationally are using JIVET, presumably to breed superior animals at the youngest age possible to maximise genetic gain. In NZ, embryo work is solely performed on post puberty heifers.