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Net Zero by 2050: U.S. Dairy's Climate Pledge and Lessons from Idaho

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The agriculture and food sector, including dairy farming, is a substantial contributor to greenhouse gas (GHG) emissions in the United States. Recognizing the increasing concerns about the role of the dairy sector in climate change, the Innovation Center for U.S. Dairy launched the Net Zero Initiative (NZI) in 2021. This industry-wide effort aims to achieve carbon neutrality by 2050 (U.S. Dairy, 2023). However, attaining net-zero emissions across the entire dairy industry is a complex and multifaceted goal that cannot be accomplished without effective participation and substantial investment from stakeholders including dairy producers, consumers, and processors (Flysjö, 2012).

This article explores the attitudes and perceptions of Idaho dairy producers toward the NZI through focus group discussions involving a diverse sample of producers from Idaho. Our objectives were to examine the current adoption status of carbon reduction projects, identify potential barriers and opportunities for broader adoption, and pinpoint areas where future research could most effectively support dairy producers' transition toward net zero.

Idaho provides a valuable case study for these inquiries. Although mostly recognized for its potato production, Idaho is also a major player in the U.S. dairy industry, ranking third in milk production behind California and Wisconsin. In 2022, Idaho accounted for 7.35% of the country's total milk output, producing 16.6 billion pounds from 410 licensed dairy herds (USDA-NASS, 2023). While the average herd size of Idaho dairy producers is large, with around 1,600 cows per operation (USDA-NASS, 2023), it is important to also consider the many smaller operations with fewer than 1,000 cows per herd in pursuit of the NZI. The Idaho Dairymen's Association, a member of the Innovation Center of U.S. Dairy, has committed to achieving net-zero emissions by 2050 (Naerebout, 2021). If the U.S. dairy industry targets net zero by 2050, any solutions must consider Idaho.

What Is Currently in the Industry's Toolbox?

According to Berry (2013), dairy farm emissions primarily originate from four sources: about 35% from enteric emissions, which result from the digestion of ruminant animals; about 26% from feed production; about 33% from manure-related emissions; and about 6% from on-farm energy use. While strategies exist to reduce the environmental impact of each emission source (Berry, 2013), implementing them may be costly and complex. Common mitigation strategies for enteric methane emissions include diet management, genetic improvement, better herd management, enhanced cow comfort, and the use of feed additives. Manure management practices often focus on using digesters, renewable fertilizers, water recycling, and improved manure storage techniques. In feed production, strategies such as no-till farming, cover crops, nutrient management, and precision agriculture are becoming more widespread. For energy use, renewable energy sources and increasing energy efficiency are being explored, along with the replacement of fossil fuel engines with electric motors.

Biogas Anaerobic Digesters

Anaerobic digesters are enclosed systems in which microorganisms break down organic matter—such as manure—in an oxygen-free environment. This process produces renewable natural gas, which can be used in place of conventional natural gas for on-farm energy needs/electricity generation or sold and injected into pipelines for additional revenue (EPA, 2023).

While anaerobic digesters are an effective tool for reducing GHG emissions, they come with significant upfront costs. Their overall profitability depends on the price of gas and electricity generated, per unit operating costs, and the value of carbon reduction (Key and Sneeringer, 2011; Massé, Talbot, and Gilbert, 2011). However, dairy farmers can tap into significant revenue

streams through programs like California's Low Carbon Fuel Standard (LCFS) and the federal Renewable Fuel Standard (RFS), which offer credits for reducing emissions (Smith, 2024). Sellers of dairy biogas earn LCFS credits, and if the biogas is used for transportation, they can generate D3 RINs, a highly valuable form of credit under the RFS. D3 RINs are designated for biofuels that achieve a 60% reduction in lifecycle greenhouse gas emissions, making them an important component of renewable energy profitability (EPA, 2024).

For instance, between mid-2018 and the end of 2021, revenues from selling biogas and the associated RIN and LCFS credits were roughly double the costs of installing and operating a typical digester (Smith, 2024). However, recent declines in LCFS credit prices have made operating digesters closer to merely break even. Lauer et al. (2018) argue that these investments could be profitable in Idaho, but the high capital outlay discourages broader adoption, especially among smaller diaries, where the scale may not justify the expense. Adding to these challenges are the regulatory uncertainties. For instance, the potential introduction of eRINs (Electronic Renewable Identification Numbers) could enable biogas to generate credits for renewable electricity production under the RFS. The EPA's rulemaking process for eRINs is still pending at the time of publication.

Opportunities in the Sale of Carbon Offsets and Participation in Insets

Many large corporations are setting ambitious goals to reduce GHG emissions or achieve net zero in coming decades. To achieve these targets, they often resort to two primary strategies: purchasing carbon offsets and investing in carbon insets. Carbon offsets involve paying third parties for verified emission reductions outside their supply chain, while carbon insets focus on supporting projects within the company's own supply chain.

Leading dairy companies such as Nestle and Danone are actively investing in carbon insets by funding farm-level initiatives like regenerative agriculture to reduce their carbon footprints (Nestle, 2023; Danone North America, 2022). In addition, several dairy producers have been selling offset credits to firms participating in California's Low Carbon Fuel Standard program to fulfill the latter's carbon emission reduction targets (Smith, 2024). The growing demand for carbon offsets and insets allows producers to exploit a new revenue stream while mitigating their environmental impacts.

Changes in Feed Purchasing and Cropping Practices

One effective strategy to lessen the environmental impact of dairy operations is to revisit feed sourcing and forage production techniques. Dairies relying on external feed supplies can significantly reduce emissions by decreasing transportation distances. Partnering with suppliers who prioritize sustainable agriculture can further reduce the carbon footprint associated with feed. For dairies managing their own forage production, adopting sustainable farming methods can directly decrease environmental impacts. Practices such as no-till or low-till cultivation, precision nutrient management based on soil testing, strategic use of cover crops like legumes to fix nitrogen, and efficient irrigation methods can all substantially reduce emissions. (USDA Climate Change Program, 2013)

Feed Additives and Genetic Improvement

Ongoing research is developing innovative tools to reduce methane emissions from enteric fermentation. Feed additives, such as methane inhibitor supplements, show the potential to lower emissions by targeting the digestive processes that produce methane. Further, ongoing breeding programs are seeking to develop cattle that naturally produce lower levels of enteric emissions, offering a long-term biological solution (Sikiru et al., 2024). These advancements, while still under development, could complement existing measures and provide new avenues for emissions reduction in the dairy sector.

Improved Manure Management Techniques

Effective manure management is a key strategy for reducing GHG emissions (Chadwick et al., 2011). Producers can reduce methane emissions by shortening waste storage time, composting, managing lagoons, and using solid separation technologies (Leytem et al., 2017). These strategies, while environmentally beneficial, often have uncertain cost savings, especially for smaller farms. Methane digesters, particularly those supported by subsidies in California, have been more viable for large farms. However, smaller farms face higher per unit costs due to limited economies of scale, and alternative practices often require more labor and capital, further straining their resources (Valdes-Donoso and Sumner, 2019).

Carbon-Based Product Marketing

Growing consumer interest in sustainability is driving the dairy industry toward climate-based marketing strategies, with studies indicating a willingness to pay more for products deemed sustainable (Zander and Feucht, 2018; Canavari and Coderoni, 2020). However, the widespread adoption of carbon footprint (CF) labeling faces challenges due to the lack of standardized definitions, potentially leading to ambiguous messaging. The potential impacts of CF labels on producers are twofold: (1) producers meeting defined benchmarks could receive a price premium for their products or (2) it can establish a new standard, with producers falling short of benchmarks receiving discounted quotes from processors. Currently, the empirical effects of such a shift remain unclear, highlighting the need for further research.

Methods and Procedures

In March 2023, we conducted a focus group discussion with eight Idaho dairy producers, following the protocol outlined in Krueger and Casey (2009). The session began with participants completing a brief demographic and operational survey, followed by a 90-minute moderated discussion. Topics explored in the discussion include current tools and practices for reducing GHG emissions, perceptions of the NZI, drivers and barriers to adopting specific emission reduction practices, and areas of research that could accelerate their implementation. Procedures and questions regarding this focus group were approved by the Institutional Review Board at the University of Idaho.

Participants were reasonably representative of Idaho's milk production industry. Operation sizes ranged from approximately 1,000 to 12,000 cows, with some producers managing multiple smaller operations under one entity. The size of operations largely aligns with the U.S. and Idaho dairy production—the 2022 Census of Agriculture notes that farms with 1,000 or more cows accounted for over two-thirds and 85% of all U.S. and Idaho milk sales, respectively. All participants were male, with education backgrounds varying from high school to college graduates. Most had at least 5 years of industry experience, and milk sales were their primary source of revenue. While many participants sold compost, this served mainly as a manure management measure, not a significant source of additional income or a primary environmental focus.

The 2022 Census of Agriculture demographic information for dairy producers in certain areas of Idaho lacks details (e.g., dairy production counties with incomplete or no demographic data). While such comparisons would be valuable, the operational diversity in terms of size among the producers involved in this study offers useful insights into their views regarding the NZI. As our discussion suggests, operation size is generally one of the most relevant factors affecting dairymen's challenges.

Results

Producer Perceptions Toward Net Zero

While recognizing the importance of addressing emissions, many producers expressed skepticism about achieving net zero due to concerns about measurement, verification, and fairness. This uncertainty resonates with broader debates about the transparency and practicality of net-zero goals (Zickfeld et al., 2023; Fankhauser et al., 2022).

Producers were particularly unclear about the inclusion and exclusion of emissions in the net-zero calculation and questioned the clarity of scope definitions. Typically, emissions are categorized into three scopes: Scopes 1 and 2 refer to direct and indirect emissions associated with company facilities and processes, respectively, while Scope 3 refers to all other indirect emissions within the company's value chain not directly linked to its operations. The ambiguous nature of Scope 3 emissions and the evolving technologies for estimating and accounting for these emissions add to the producers' concerns. Without transparent and standardized measurement techniques, participants felt the feasibility of achieving net zero remained uncertain.

Concerns also extend to the fairness of net-zero policies in the dairy sector. For example, a blanket percentage reduction in GHG emissions could unfairly penalize early adopters who may have already invested in strategies like improved manure management or renewable energy sources. These producers would have fewer options for further reductions and face a higher marginal abatement cost than their peers who have yet to implement such measures. Another area of concern is ensuring "additionality"—verifying that new initiatives and mandates deliver actual environmental benefit while fairly crediting those with previously existing involvement with net zero. An example might be a new program offering a stipend for a certain practice that many producers have already implemented. In such a case, the program would not incentivize new adoption but rather subsidize existing behavior.

Current State of Adoption of Various Strategies Among Participants

Most focus group participants had limited experience with carbon reduction or sustainability projects. Three had some experience with a digester or were in the process of implementing one. One producer noted that he was in talks with a company about an inset project that involved using a feed additive to reduce belching. In terms of feed, while some producers growing their own forage had heard about carbon contracts for crops, none were part of these programs.

Composting emerged as the preferred method for manure management, particularly in open lot setups, while dairies with vented barns typically used traditional manure lagoon systems. One producer was exploring the potential to grow mushrooms on compost to generate additional operational revenue while reducing carbon footprints. Finally, none of the producers had significant experience with carbon-based marketing but were aware of the consumer trends on CF labels.

Ease of Implementing Sustainable Projects

When ranking various areas or projects regarding the ease and feasibility of changes, participants emphasized the interconnectedness of various aspects and the need for a holistic approach. They expressed openness to a wide variety of alternatives, provided the economics worked. Several participants produced their own forage, which they identified as the most manageable area for implementing changes to meet neutrality goals. While changes to forage practices had the shortest timeline,

changes could be made in any area as part of longer-term plans to upgrade their systems. For instance, a few producers noted that upgrades to manure management systems are inevitable, and integrating a digester with appropriate planning may be possible.

Barriers and Opportunities

Producers were asked about the barriers and opportunities for adopting future emission mitigation strategies under the NZI. Table 1 outlines these factors, categorized as positive, negative, or both. We observed a significant willingness among producers to participate in emission-reduction projects, granted the "economics of the project worked." With a few minor exceptions, no significant resistance toward the NZI itself was observed within our focus group. This positive attitude suggests that transitioning to net zero may be less about overcoming resistance to change and more about ensuring the long-term financial viability of emission reduction projects. This contrasts with situations where broader political, societal, or cultural resistance can pose significant challenges to the net-zero transition (Fankhauser et al., 2022).

Economics Is a Primary Driver

Consistent with previous literature (Trujillo-Barrera, Pennings, and Hofenk, 2016), economics was viewed as both the primary barrier and opportunity for the adoption of mitigation strategies. Producers emphasized that their operational margins are often narrow; thus, any additions must generate meaningful revenue to be considered. Additionally, the substantial capital outlay required for adopting certain projects poses a disproportionate challenge for medium and small dairies. This raises a critical question: If a certain degree of carbon reduction or even complete net zero were mandated for produced milk, could these operations afford the necessary upgrades to meet a hypothetical carbon intensity benchmark?

Project Ownership Structure Matters

Ownership structures become crucial when considering projects requiring substantial investment, particularly anaerobic digesters. Currently, dairy producers can either own and operate their own digester or contract with a service provider, in which case a third party is responsible for the capital expenditure, operation of the digester, and payment to the dairy farmer(s) in exchange for the farmer providing an agreed-upon amount of manure.

Many focus group participants favored the service provider model, especially for smaller operations. Although relying on a third party raises concerns about potential changes in ownership or management decisions that could impact the farmer, it offers several advantages. First, it eliminates the substantial upfront cost for farmers by having the company finance and construct the digester. Second, the service provider handles the day-to-day operations and maintenance, reducing the operational burden on the farmer. Finally, this model allows for risk sharing, as the company bears some or all of the financial risks associated with the project. In particular, some participants were worried about being locked into full ownership if the technology became obsolete. The consensus among the group is that the service provider model might become more popular in the future, with providers targeting large dairy operations first and gradually expanding to smaller operations as the anaerobic digester market becomes more saturated. Participants believed that growth in this space could very well be the key to wider adoption.

Middlemen Have a Place

Producers view intermediaries, often referred to as "middlemen," as crucial partners in achieving NZI. These individuals can act as information brokers, providing essential guidance and knowledge to navigate the evolving landscape of NZI technologies and implementation strategies. In some instances, they might even assume certain inherent risks associated with

Table 1. Summary of Discussed Factors Impacting NZI-Related Projects

Factors Impacting Adoption	Impact
Capital outlay	(-)
Revenue potential	(+)
Potential (future) supply chain requirements	(+) / (-)
Emergence of middlemen	(+)
Corporate insets	(+)
Uncertainty regarding the future of carbon markets	(-)
Information sharing	(-)
Experiences of other dairymen	(+) / (-)
Long-term contracts	(-)
Lack of familiarity with nzi-related projects	(-)

adopting new technologies. These individuals come with a cost, which farmers seem happy to incur due to the perceived benefits.

Participants also expressed a need for a reliable and trusted platform similar to “Angie’s List” but specifically focused on NZI projects. Such a platform could offer valuable information and recommendations for selecting qualified service providers in the net-zero space. This highlights a gap that can be filled by organizations designed to support agriculture, including extensions and trade groups, in assisting producers in navigating this new space.

Attitudes Toward Information Sharing

Information sharing with external parties emerged repeatedly during discussions, often met with hesitation and negative perceptions. Participants acknowledged the inevitability of sharing some data but expressed concerns about potential harm to their businesses. The hesitation was primarily fueled by the uncertainties in the evolving carbon markets, particularly the potential implementation of low-carbon standards by private milk buyers. For example, producers raised hypothetical scenarios where early adopters of emission reduction strategies might be penalized more heavily than those with initially higher emissions who had not invested in mitigation efforts. In such a scenario, producers who withheld information would be in a more favorable position. While hypothetical, these examples underscore how ambiguity in potential enforcement policies can discourage information sharing.

On the other hand, producers recognized the benefits of information sharing. They understood the importance of establishing baselines for emission reductions and directing resources and services based on actual needs. While there may be other reasons for resistance to sharing data, it is crucial to develop straightforward data handling and privacy policies that promote the fairer implementation of emission reduction enforcement. Such policies are essential for enabling effective collaboration between dairy farmers and partners aiming to achieve net zero.

Experiences of Other Dairy Farmers May Assist Adoption

Witnessing successful implementations of sustainable practices elsewhere is a significant motivator for dairy farmers considering similar approaches. Some small operators noted that while they are not actively considering making large investments, they are keen to observe the results achieved by their peers. It was acknowledged that while academic research provides valuable data on the viability of certain projects, the real-world applicability of these studies is often limited by their assumptions. Therefore, learning from the experiences of others could bridge this gap. For example, economic models suggest that anaerobic digesters could be financially viable (Lauer et al., 2018; Benavidez, Thayer, and Anderson, 2019), yet practical, operation-specific “how-to” guides are scarce. This scarcity underscores the importance of peer experiences in making operational decisions, aligning with findings that indicate a “cluster effect” among producers within the same region (Villamayor-Tomas, Sagebiel, and Olschewski, 2019).

Long-Term Contracts Are a Negative

Producers view long-term contracts as a major deterrent for carbon-reduction projects. Many projects, like anaerobic digesters with decades-long agreements, require significant upfront investments and lock producers into extended commitments. Contracts for carbon offsets typically last 5–10 years (Ando et al., 2022), and inset projects are likely to have a similar timeframe.

These lengthy contracts elevate investment risk. Producers are concerned about being locked into unfavorable agreements and missing out on potentially more lucrative opportunities. The nascent carbon market and uncertainties surrounding the long-term viability of emerging technologies further amplify these concerns. There appears to be no immediate cure beyond waiting for the market to mature and stabilize. As carbon markets evolve and the effectiveness of carbon-reduction technologies becomes clearer, the perceived risk of long-term contracts should decrease. In the meantime, the best approach may be to equip producers with resources to reduce the information asymmetry between them and potential counterparties.

Future Efforts and Research Directions

As the sessions concluded, participants identified several crucial areas for future research and outreach. A key concern was bridging the knowledge gap. Producers expressed a strong desire for readily available resources to guide their decision making when choosing partners and selecting projects most beneficial to their operations. For instance, what common structures are emerging for inset/offset programs, and what are the cons and pros of their operations? Second, while recognizing the value of existing academic research, producers emphasized the need for practical “how-to” guides that translate theoretical knowledge into actionable steps. A top priority is to provide detailed analyses of the economic viability of various projects tailored to their unique circumstances, as farmers are primarily motivated by what makes financial sense for their operations while meeting environmental and societal obligations as defined by regulations (Varma et al., 2021). Third, producers were eager to learn more unbiased information on NZI-related projects backed by science and research. While intermediaries can provide dairy farmers with important information and guidance, they cannot be completely relied upon since they are often biased toward the products they sell.

Conclusion

Idaho dairy farmers currently lack experience with carbon-reduction projects and are skeptical of the NZI, but they are open to adopting sustainable practices. Key challenges include economic concerns, hesitancy about information sharing, and the constraints of long-term contracts. However, there's a strong interest in learning from peers, recognizing the potential value of intermediaries, and utilizing practical resources. Overcoming these challenges and investing in targeted research areas will be crucial for Idaho's dairy industry to transition to a more sustainable future.

While the adoption of a service provider model, where an external entity installs and manages carbon-reduction technologies like digesters, could reduce some of the immediate financial and operational risks for Idaho's dairy farmers, the aversion to long-term contracts remains a significant barrier. Long-term commitments are essential for ensuring the sustained operation of these technologies, which deliver the most substantial GHG mitigation benefits over time. A short-term approach would undermine these benefits. Therefore, future strategies must not only address economic feasibility but also find ways to foster confidence in long-term engagement, a key factor for the long-run success of the projects.

The evolving nature of carbon markets adds uncertainty to capital-intensive projects. As these markets mature, along with technology advancements to reduce emissions and a growing network of intermediaries to facilitate knowledge transfer, "green" projects will become increasingly feasible. Future research should focus on how to make these projects financially viable for dairies of all sizes. For successful implementation, Extension services should prioritize the development of practical, actional guides that assist in the pursuit of net-zero goals.

For More Information

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