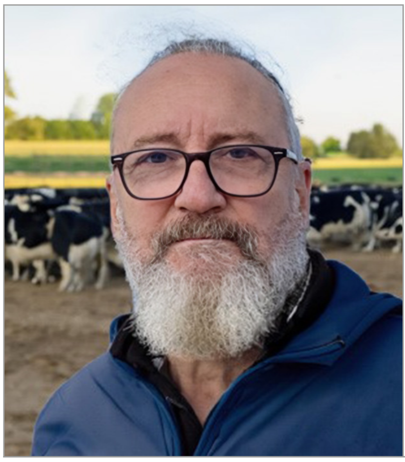

ECONOMICS OF METHANE YIELD AND INTENSITY IN MILK PRODUCTION

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"While methane yield focuses on feed efficiency and methane intensity emphasizes production efficiency, both metrics are essential to create a sustainable and economically viable dairy system. Methane intensity provides a clearer path to balancing environmental goals with profitability, making it a more practical target for breeding and management strategies. However, integrating methane yield into feeding practices can further enhance overall sustainability by reducing methane emissions at their source."

Dairy production faces scrutiny for methane (CH_4) emissions, a potent greenhouse gas primarily produced during ruminant digestion. From a farmer's perspective, these emissions also signify a loss of valuable carbon initially paid for in feed, underscoring inefficiencies in converting feed energy into milk. Two metrics commonly used to evaluate CH_4 emissions in dairy cattle are methane yield (MEY), the methane produced per kilogram of dry matter intake (DMI), and methane intensity (MPM), methane emitted per kilogram of milk produced. These metrics offer insights into emissions efficiency and have significant implications for both environmental sustainability and milk production economics.

METHANE YIELD (MEY)

MEY measures methane emissions per kilogram of feed consumed, providing insight into rumen fermentation efficiency. Lower MEY indicates better feed digestion, benefiting both the environment and farm economics. Factors influencing MEY include:

- **Feed Quality and Composition:** High-energy, low-fiber diets improve fermentation and reduce carbon losses as methane.
- **Rumen Function:** Efficient microbial activity optimizes energy conversion and minimizes methane emissions.
- **Stage of Lactation:** MEY often increases later in lactation as metabolic changes and lower feed intake alter fermentation dynamics.

Although improving MEY can optimize feed utilization and reduce costs, it often requires investing in higher-quality feeds, necessitating strategic ration balancing to ensure profitability.

COW SIZE AND MEY

Larger cows consume more feed, leading to higher methane emissions. However, maximizing their genetic potential for milk production can improve methane intensity (MPM) by diluting emissions across more milk output. Feeding precision diets tailored to support production efficiency can ensure that increased MEY is counterbalanced by improved MPM, demonstrating the importance of balancing cow size, feed quality, and overall health to achieve both economic and environmental benefits.

METHANE INTENSITY (MPM)

MPM links methane emissions directly to milk yield, reflecting the environmental efficiency of milk production. Factors affecting MPM include:

- **Milk Yield:** Higher milk yield spreads emissions across more output, reducing MPM.
- **Feed Utilization:** Efficient feed-to-milk conversion lowers MPM.
- **Animal Productivity:** Multiparous cows tend to have lower MPM due to greater production efficiency.

Reducing MPM aligns with farm profitability by improving income over feed costs (IOFC). Strategies such as genetic improvements, lactation management, and increased milk yields effectively lower MPM while enhancing overall farm sustainability.

ECONOMIC IMPLICATIONS FOR METHANE YIELD AND INTENSITY

- **Reducing MEY** can lead to long-term feed cost savings by improving feed conversion efficiency. However, achieving this often requires investment in higher-quality feed, feed additives like methane inhibitors, or precision feeding systems.
- **Reducing MPM** typically involves strategies that enhance milk yield, such as genetic selection, optimal lactation management, and cow comfort improvements. These strategies are directly linked to economic returns, as they improve profitability per cow.

From an economic standpoint, MPM offers a more direct alignment with profitability, as it ties emissions to milk output. High milk production systems with optimized feed intake often achieve lower MPM, resulting in both environmental benefits and increased income over feed costs. On the other hand, MEY emphasizes feed efficiency and rumen health, which can lower total emissions and reduce feed costs but may not directly correlate with milk yield.

Practical example: Let's suppose a farm with cows that weigh 1,500 pounds, each eating 60 pounds of DM of a total mixed ration. Let's also assume that because of either feed quality or inadequate feed formulation the cows' milk 80 pounds when they have genetic potential to be at 90 pounds per day.

1. **Milk Price**: $20/cwt.
2. **Methane Yield**: 0.35 kg methane/day (average value based on 60 pounds/day of DMI).
3. **Social Cost of Methane ($SC\text{-}CH_4$)**: $1,500 per metric ton (2).

The social cost of methane ($SC\text{-}CH_4$) refers to the estimated monetary value of the harm caused by emitting one metric ton of methane into the atmosphere. In this practical example, the $SC\text{-}CH_4$ is set at $1,500 per metric ton (2). This means that every kilogram of methane a cow emits carries a societal cost of $1.50 (since 1 metric ton equals 1,000 kg). By reducing methane emissions, even slightly, dairy farmers not only improve operational efficiency but also help lower the broader economic and environmental costs associated with methane's contribution to climate change.

1. **Methane Intensity for 80 Pounds of Milk:**

MI_{80} = Methane Yield (kg CH_4/day) / Milk Production (lbs./day)

MI_{80} = 0.35 kg CH_4/day / 80 lbs./day = 0.004375 kg CH_4/lb. milk.

Aspect	Methane Yield	Methane Intensity
Focus	Efficiency of feed utilization	Environmental cost per unit of milk produced
Implications	Encourages feed strategies to improve rumen efficiency	Encourages higher milk yields and overall productivity
Economic Impact	Reduces feed costs but may increase ration costs	Directly tied to milk output and profitability
Measurement Challenges	Requires accurate DMI measurement	Requires both CH_4 and milk yield data

2. Methane Intensity for 90 Pounds of Milk:

MI_{90} = Methane Yield (kg CH_4/day) / Milk Production (lbs./day)

MI_{90} = 0.35 kg CH_4/day / 90 lbs./day = 0.00389 kg CH_4/lb. milk.

3. Methane Intensity Difference (ΔMI):

$\Delta MI = MI_{80} - MI_{90}$

ΔMI = 0.004375 kg CH_4/lb. milk - 0.00389 kg CH_4/lb. milk = 0.000485 kg CH_4/lb. milk.

4. Reduced Methane per Day:

The reduction in methane for an additional 10 pounds of milk per day is then:

Reduced Methane per Day = 10 lbs. milk × 0.000485 kg CH_4/lb. milk = 0.00485 kg CH_4/day.

This shows how increased milk production reduces methane intensity, even if total methane yield remains unchanged.

5. Social Cost of Methane Savings:

The daily savings from reduced methane emissions can be calculated using the social cost of methane. We will use the reduced methane emissions per cow/day due to increased milk production determined above (0.00485 kg CH_4/day) multiplied by the social cost of methane per kg ($1500/1000 = $1.5 per kg of CH_4).

Daily Savings = 0.00485 kg CH_4/day × $1,500/1,000 kg CH_4 = $0.0073 per cow per day.

6. Annual Herd-Level Impact:

So, for 1,000 cows, the annual methane-related savings are:

Annual Savings = 1,000 cows × $0.0073 per cow/day × 365 days = $2,664.50.

While the daily savings per cow might appear small, they scale significantly across large herds, demonstrating the dual environmental and economic benefits of optimizing feed efficiency and reducing methane intensity.

CONCLUSION

While methane yield focuses on feed efficiency and methane intensity emphasizes production efficiency, both metrics are essential to create a sustainable and economically viable dairy system. Methane intensity provides a clearer path to balancing environmental goals with profitability, making it a more practical target for breeding and management strategies. However, integrating methane yield into feeding practices can further enhance overall sustainability by reducing methane emissions at their source. Ultimately, successful methane mitigation will require a comprehensive approach, using innovations in nutrition, genetics, and management to optimize both parameters simultaneously.

References

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About Álvaro García

Álvaro García, DVM, MS, PhD, has extensive experience in academia, research, and industry consulting. Currently working with Dellait – Animal Nutrition & Health, he specializes in dairy cattle nutrition, feed management, and international agricultural trade. Dr. García has held prominent roles, including Director of Agriculture and Natural Resources at South Dakota State University (SDSU), where he led impactful extension programs and contributed to dairy science research. He has published numerous articles, delivered international workshops, and served as a consultant for various agricultural organizations including presently with the US Grains Corn Council. His work focuses on advancing sustainable practices in dairy production and improving animal health and nutrition globally.