The Path Forward for Changing Milk Composition: Follow the Rules and Play to Win!







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The Path Forward for Changing Milk Composition: Follow the Rules and Play to Win!

Outline

1) Impact on Dairy Product Quality
2) Impact on Dairy Cow Health

How dairy products are made and why milk protein and protein to fat ratio is critical

Changing Milk Composition in New York – Prior to 2010

1) Milk composition has always varied, but the variation was systematic and repeating. Seasonal variation and breed variation were the two main sources of variation but they were known and predictable. They seemed like big variations, but the fat and protein went up and down together and **the average for the year never moved more than a few hundredths of a percent on fat and protein.**

Changing Milk Composition in New York – After 2010

2) Milk composition of milk started to change, slow at first, but then changing at an increasing rate, **but most importantly the fat and protein were not changing at the same rate.** At first, the change seemed like a bump in the trend lines, but after a few years it appeared that composition of the total milk supply was changing in a way we had not seen before at the factory level.

Impacts on Dairy Products and Processes

Pumping (damage to fat and free fatty acids)

Cheese Making (Aged Full-Fat Cheddar Cheese)

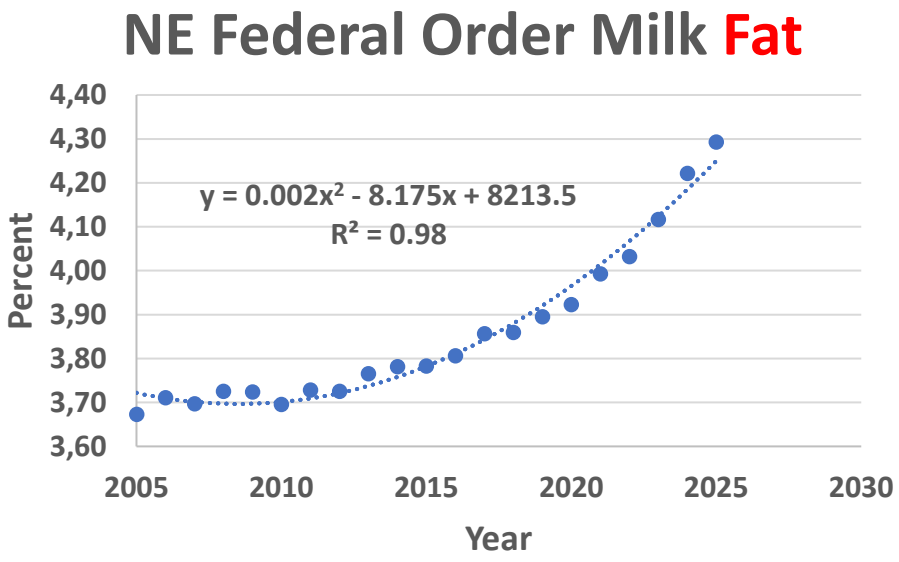
Cream Separation

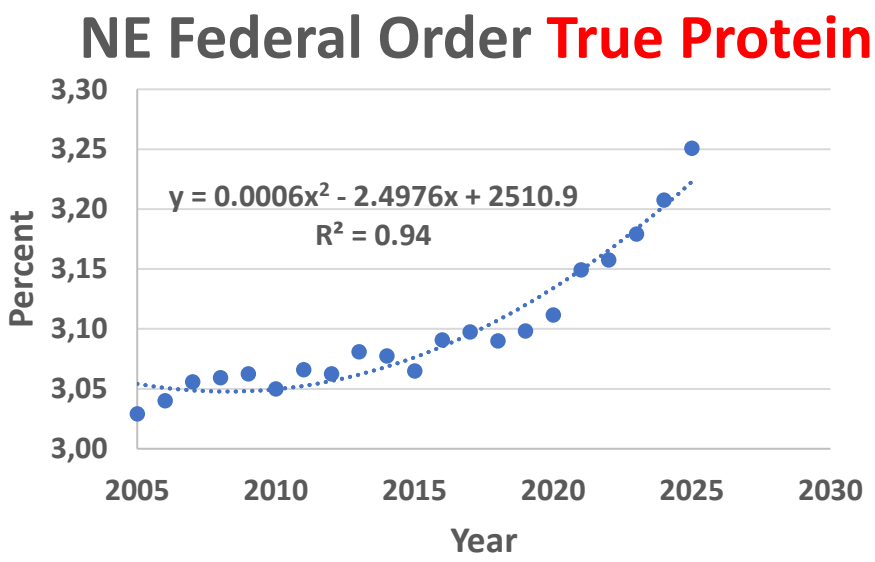
Ultrafiltration and Microfiltration

Spray Drying

Thermal processes - extended shelf-life and shelf-stable beverages

Change in Northeast Federal Milk Market Fat and True Protein Tests 2005 thru 2025





- **Northeast Milk Marketing Area Statistical Handbook**

https://fmmone.com/NE_Statistical_Handbook/NE_Statistical_Handbook_2000-Present.xls

Tables A18 and A19 in the downloadable Excel spreadsheet

Change in Northeast Federal Milk Market
Fat and True Protein Tests
2005 thru 2025

Why are fat and protein increasing?

- **Improved quality of milk composition and milk production data, that allows genetic selection and feeding to be improved.**
- **Improved accuracy and speed of genetic selection of dairy cows**
- **Better understanding and control of feeding to meet the nutrition requirements of high producing dairy cows**

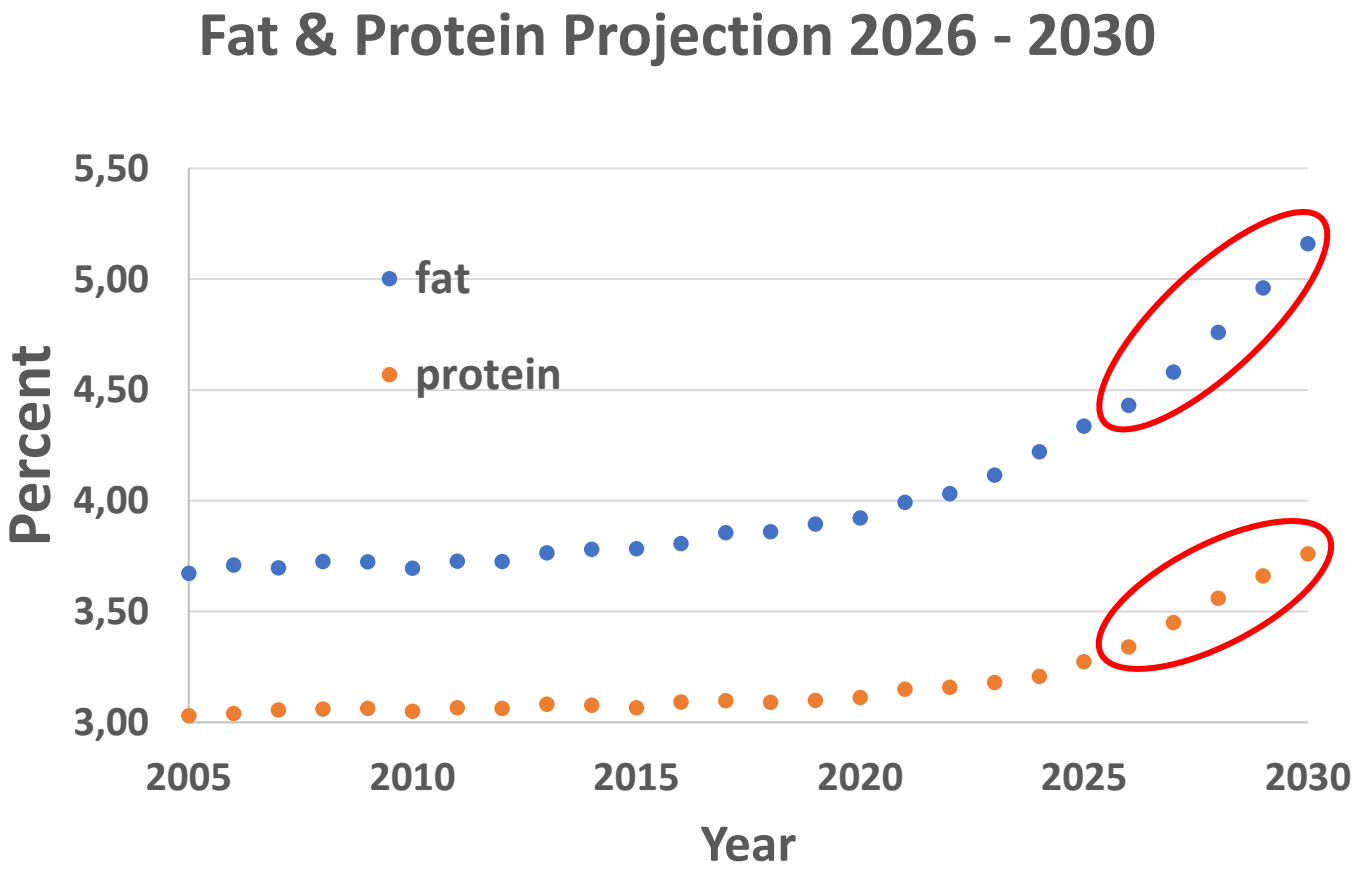
As the composition of milk supply changes in ways that it has not in the past, where are the "pinch-points" in dairy processing and dairy products? - The First pinch-point is full-fat cheeses

The first pinch-point was in full-fat aged Cheddar cheese production. This an important product in the Northeast USA, in general in the USA.

Cheddar cheese and other full-fat cheeses are sensitive to changes in protein (i.e., casein) to fat ratio in the milk in several ways that impact the flavor and physical properties of the cheese.

Why was full-fat Cheddar cheese the first place that we recognized that the CHANGE in average milk composition was causing a problem? Because of the constant overall composition of the milk supply for 50 years, these cheese plants were not designed for, or have the technology to control fat to protein ratio in the milk for cheese making

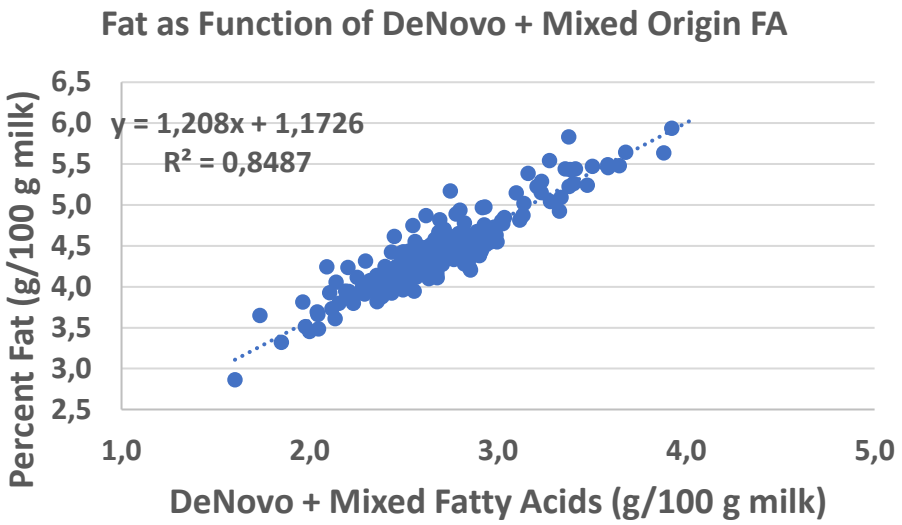
Northeast USA Federal Milk Market Fat and True Protein Projection 2026 thru 2030



Fat concentration is increasing at a faster rate than protein concentration.

As concentration of fat and protein increase, cheese yield increases.

Data from 100 farms in Central NY in 2024



Rules of Thumb in Reviewing Milk Fatty Acid Data

1) De novo, mixed origin and performed fatty acid data should have units of g/100 g milk

2) Fat (in the US) has units of g/100 g of milk. When looking at data in Canada, generally fat test in grams per Liter of milk. On a percentage basis these tests are not the same. Grams/Liter will be a lower fat percentage and the difference between the two gets larger as the fat concentration increases.

3) The sum of de novo + mixed + preformed should be between 93 and 96% of the fat test for bulk tank bovine milk. If this sum is in the 80 percent range there is something wrong with the testing.

Calculation of Theoretical Cheese Yield – VanSlyke Formula

What is the relationship between theoretical Cheddar Cheese Yield and Milk Composition?

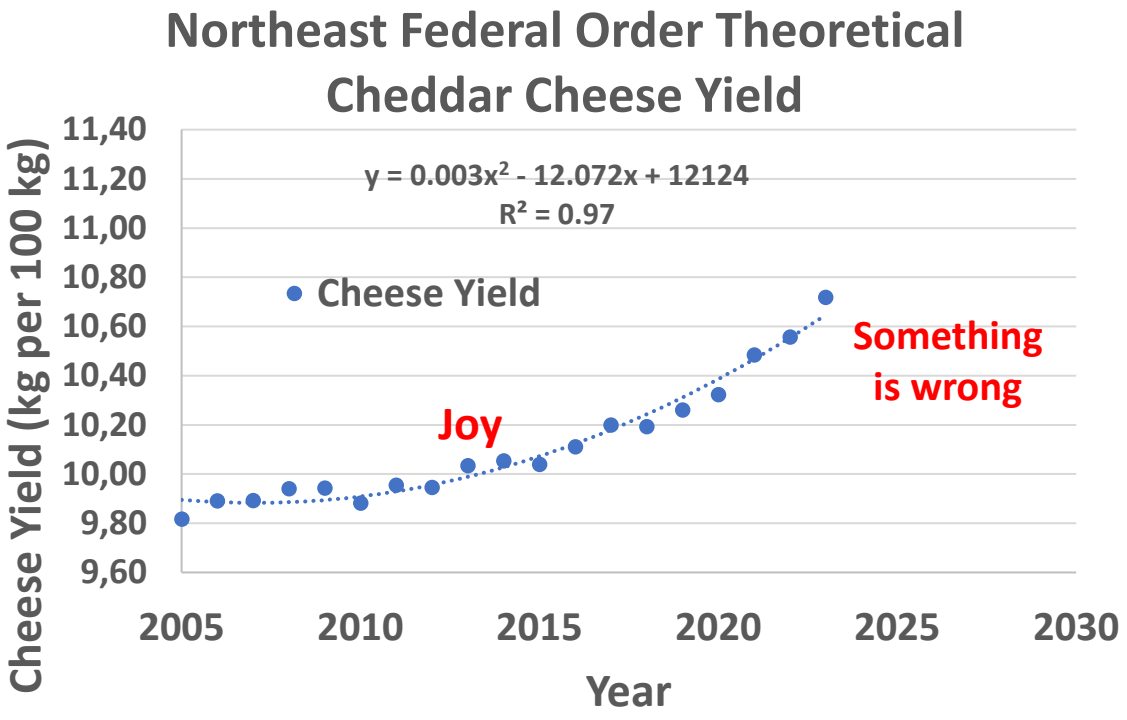
$$\text{Yield} = \frac{[((\%\ \text{Fat recovery in cheese} \times \%\ \text{fat in milk}) + ((\%\ \text{true protein} \times 0.815) - 0.1))] \times 1.09}{1 - (\text{target cheese moisture}/100)}$$

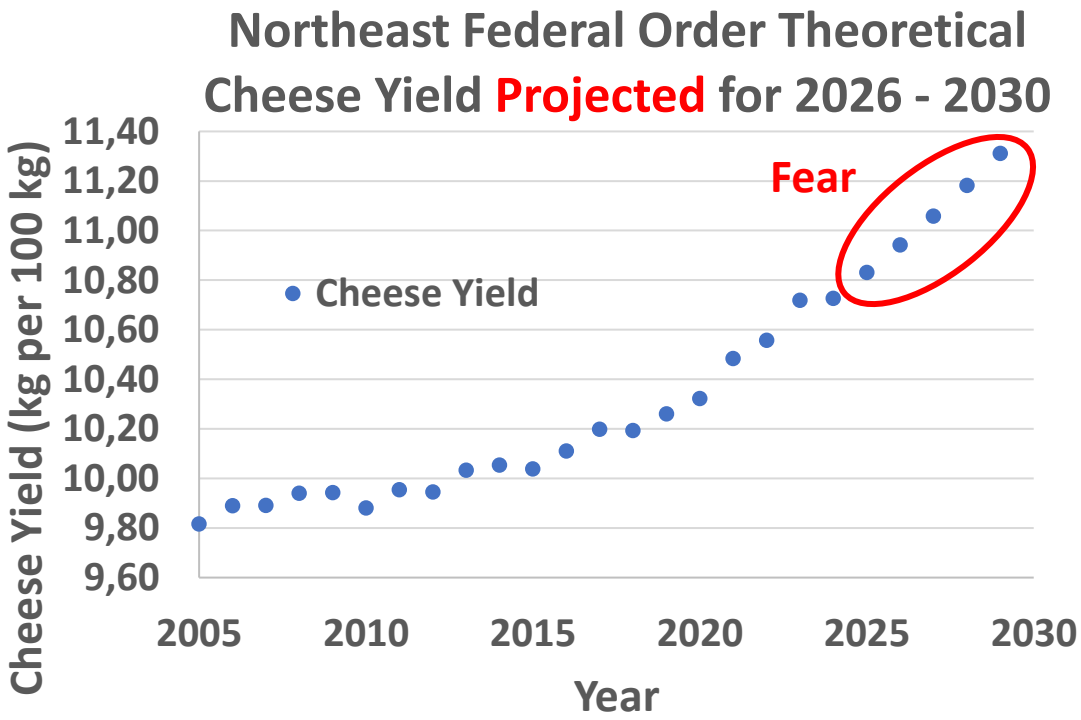
Assume 90% fat recovery in the cheese and a target cheese moisture of 37% and cheese salt of 1.7% and the milk composition in the year 2005

$$\text{Yield} = \frac{[((0.90 \times 3.673) + ((3.029 \times 0.815) - 0.1))] \times 1.09}{1 - (37/100)} = \frac{6.185}{.63} = 9.82 \text{ kilograms per 100 kilogram of milk}$$

Barbano,D.M.,and J.W.Sherbon. 1984.Cheddar cheese yields in New York. J. Dairy Sci. 67:1873-1883.

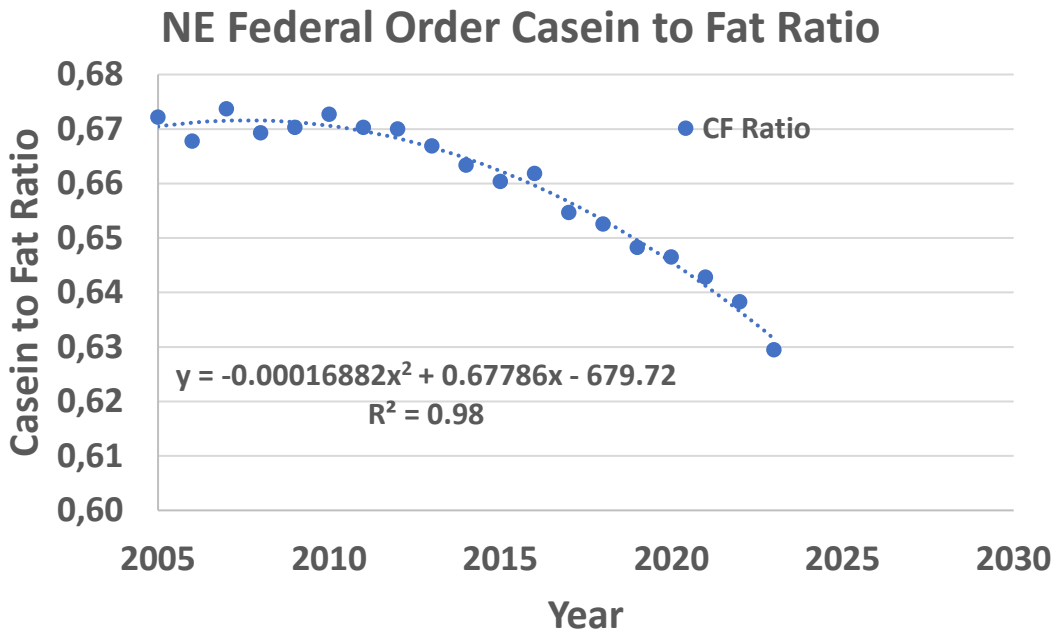
How much is cheese yield increasing?

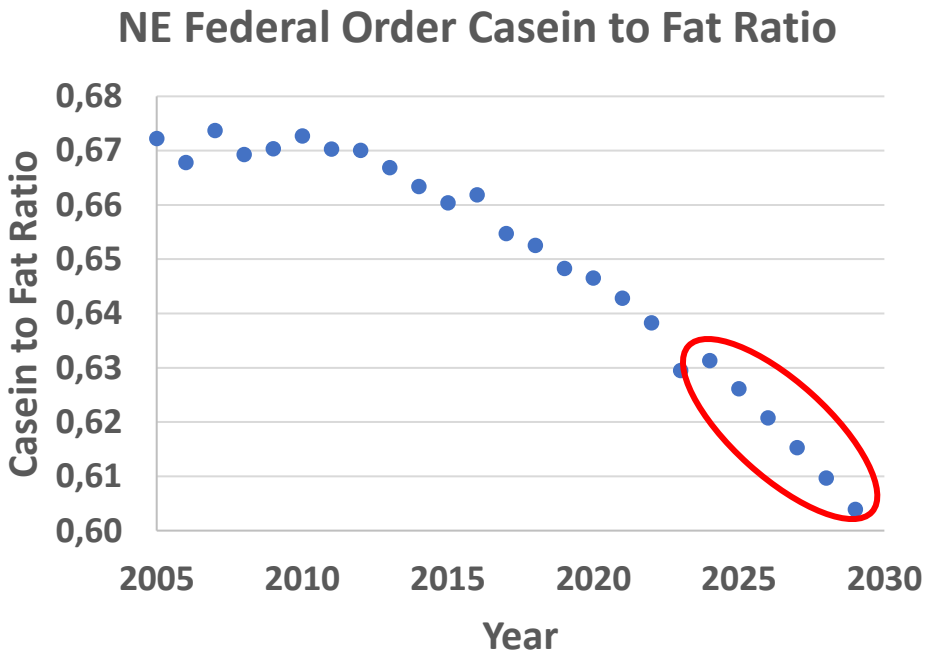




Change – Be careful what you ask for, you might get it.

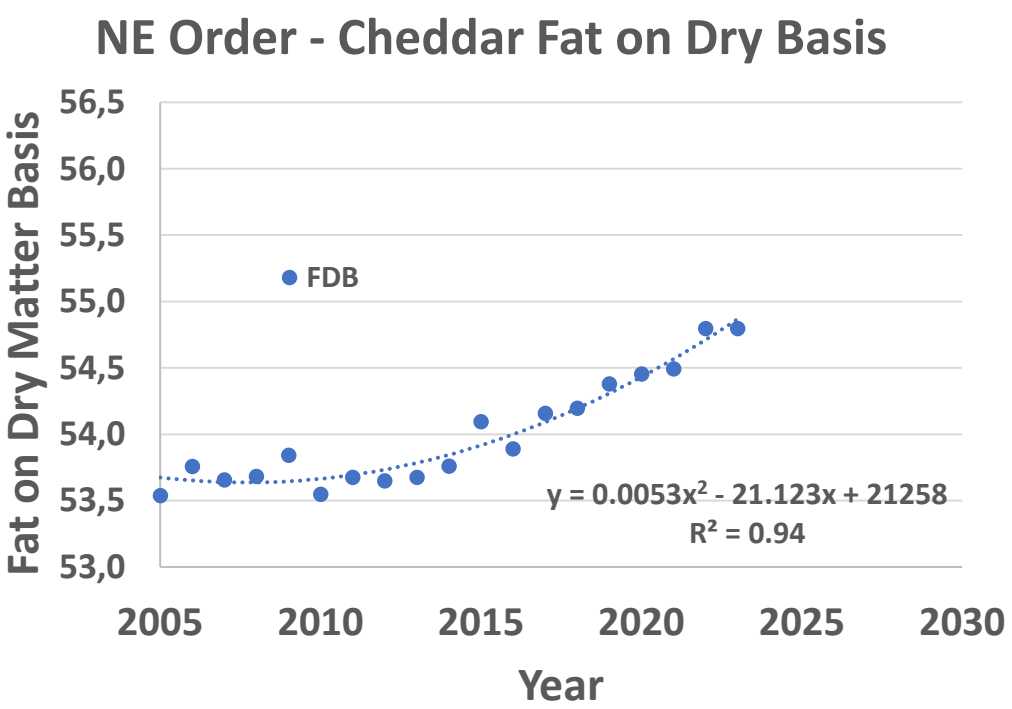
How much is the milk casein to fat ratio decreasing?

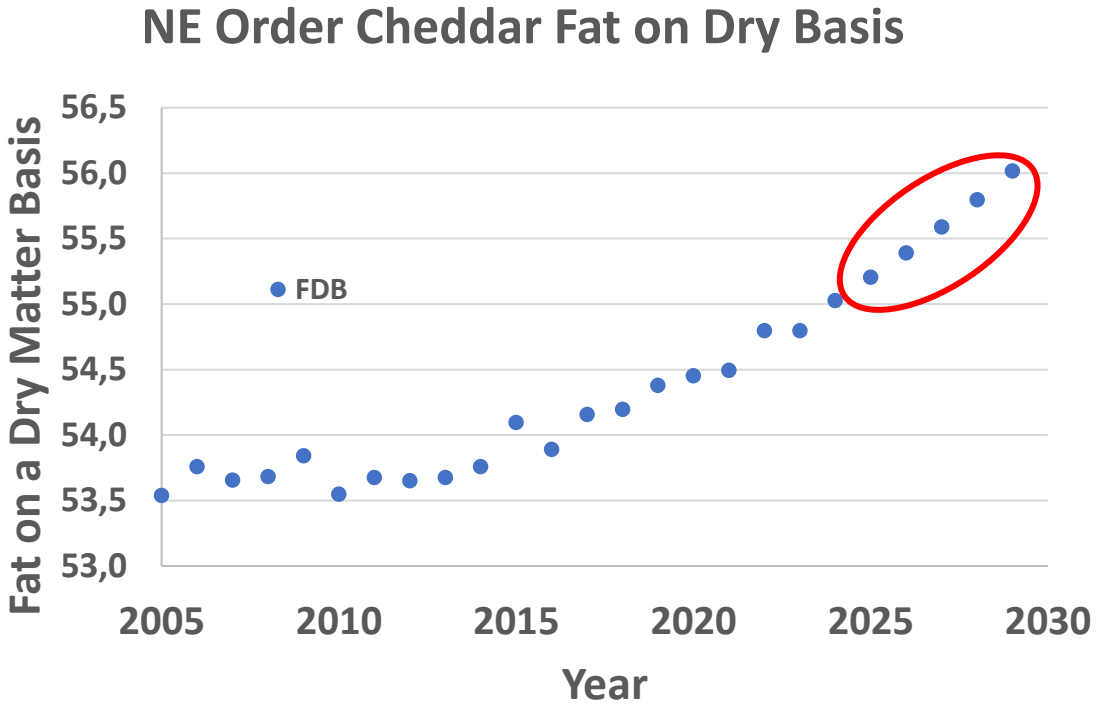




What does the change in casein to fat ratio in the milk do the cheese composition and quality?

How will cheese fat on dry (FDB) basis change?





What is the impact of an increase in Fat on Dry Basis (FDB) on Cheddar cheese quality?

1) As FDB increases, the cheese will get softer and this may impact cheese slicing in automated cheese cutting lines.
2) As FDB increases, it becomes more difficult to keep moisture on target and cheese moisture will gradually decrease lowering cheese yield. Lower moisture will tend to make the cheese firmer.
3) If moisture decreases, then there is less water per kilogram of cheese and if salting rate is not decreased the salt concentration in the water phase of the cheese will increase.
4) An increase in salt concentration in the water phase of the cheese will decrease the rate of Cheddar flavor development during aging.

Operationally what can I do to maintain cheese quality, cheese manufacturing productivity, and control cost?





Higher Fat Content Raw Milk: Options to React as a Cheese Maker



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NYS Cheese Manufacturers' Association Meeting
March 5, 2024

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NORTHEAST DAIRY FOODS RESEARCH CENTER

What can cheesemakers do to maintain cheese quality, cheese manufacturing productivity, and control costs?

1. Read and understand the standard of identity for Cheddar cheese to determine what options are available for dairy ingredients and how to modify the process in your factory to fit your needs.

Cheddar Cheese Standard of Identity – What are the Rules?

Code of Federal Regulations (CFR)

§ 133.113 Cheddar cheese.

(a) *Description.*

(1) Cheddar cheese is the food prepared by the procedure set forth in paragraph (a)(3) of this section, or by any other procedure which produces a finished cheese having the same physical and chemical properties. The minimum milkfat content is 50 percent by weight of the solids, and the maximum moisture content is 39 percent by weight, as determined by the methods described in § 133.5. If the dairy ingredients used are not pasteurized, the cheese is cured at a temperature of not less than 35 °F for at least 60 days.

(b) *Optional ingredients.* The following safe and suitable ingredients may be used:

(1) *Dairy ingredients.* Milk, nonfat milk, or cream, as defined in § 133.3, used alone or in combination.

What can cheese makers do to maintain cheese quality, cheese manufacturing productivity, and control costs?

1. Read and understand the standard of identity for Cheddar cheese to determine what options are available for dairy ingredients and how to modify the process in your factory to fit your needs.

2. **Develop a milk standardization strategy that is achievable for your plant. There are multiple options within the standard of identity. What is the best approach given the scale and structure of your plant?**

Next Step in Milk Production Research

- Increase the protein concentration to bring fat and protein concentration for cheese making

Cheeses and Fluid Milk Based Protein Beverages

- What will be the impact of this on new shelf-stable and extended shelf-life ultrafiltered (UF) milks and milk protein beverages?







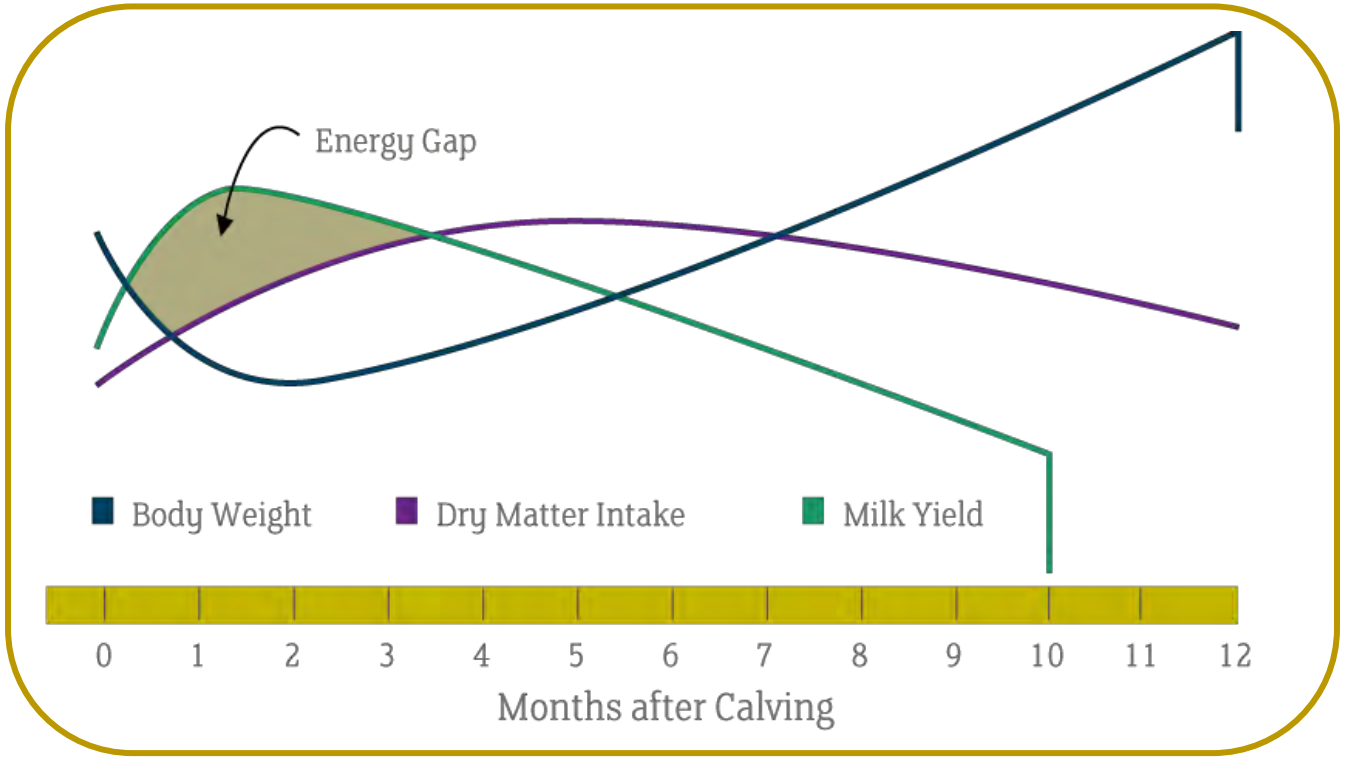
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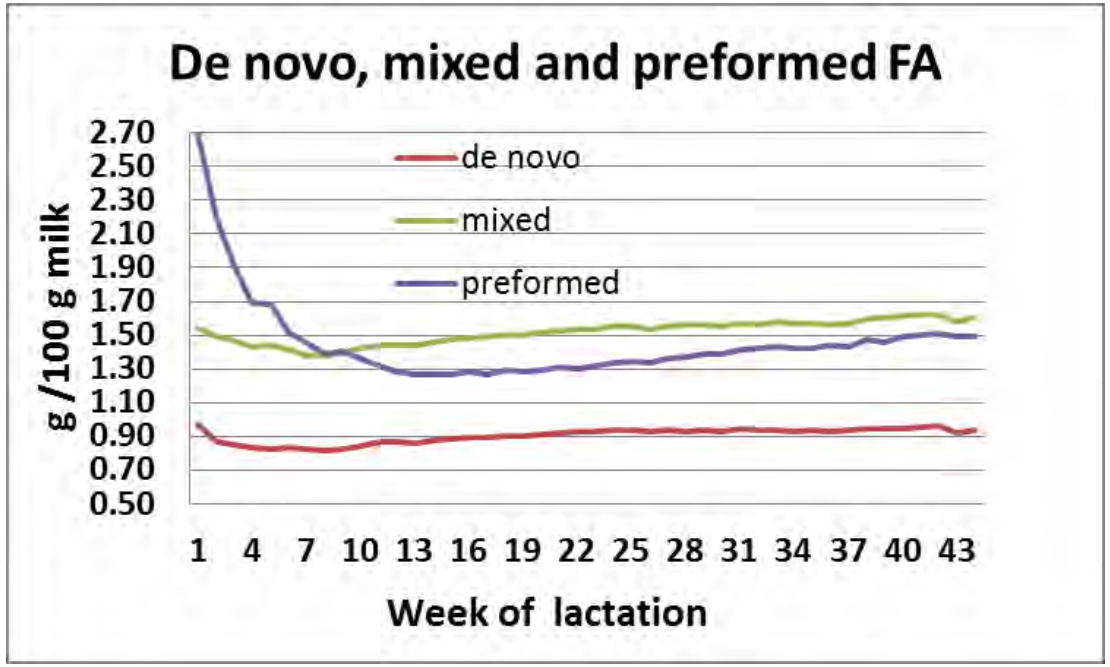
Fat and True Protein Tests - 2005 thru 2025
Impacts on the Health of the Cows

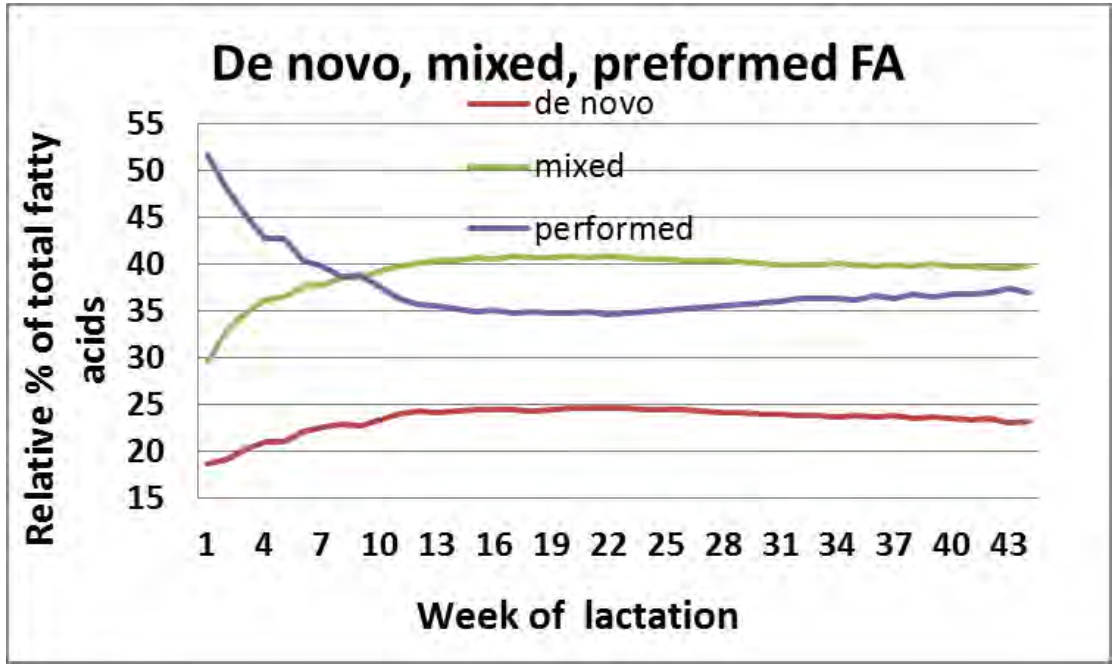
- **Stage of lactation is known to change fatty acid (FA) composition in milk (Lynch et al., 1992; Stoop et al., 2009; Barbano et al., 2017)**



Impact on Milk Fatty Acid Composition

- Stage of lactation is known to change fatty acid (FA) composition in milk (Lynch et al., 1992; Stoop et al., 2009; Barbano et al., 2017, 2019)

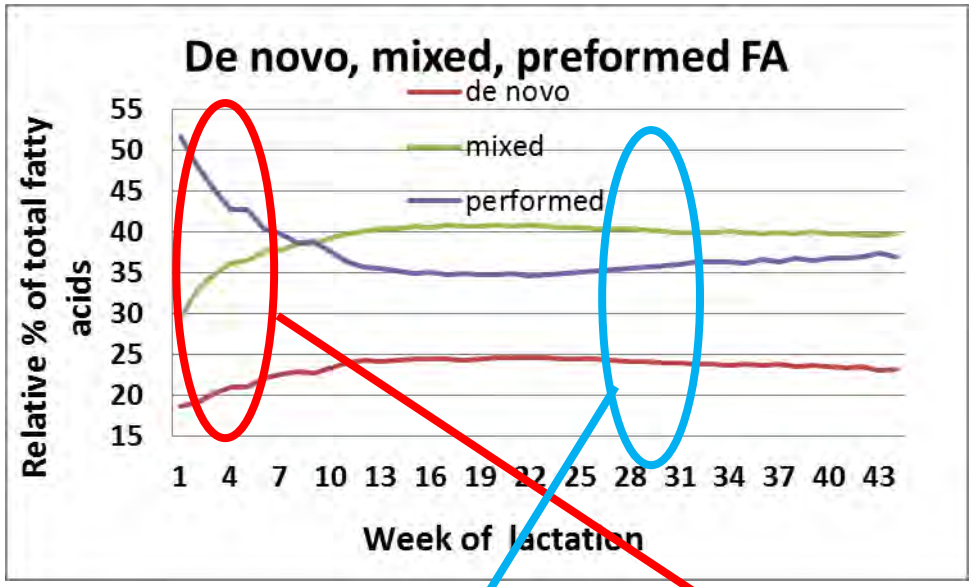




Source: Barbano et al. 2019 Cornell Dairy Nutrition Conference.

Impact on Butter Processing

- Today, on very large farms, the pattern of milking and milk delivery to dairy product manufacturing plants has changed.
- What is different?







Higher Milk Fat and True Protein Impacts on the Health of the Cows
What are we doing right?

Current Status in US

Dairy herd management today is doing of much better job of doing all the correct things we already know to keep cows healthy. We know a lot about this, we just need to do these things right all the time. Bigger farms and the use of higher frequency methods to automate checking for symptoms of problems with faster identification and reaction to problems (e.g. transition cow metabolic issues, mastitis, etc.) has improved over all health of cows.

Higher Milk Fat and True Protein Impacts on the Health of the Cows

Actions for improvement.

- Better transition cow management.
- More aggressive and simple measures to minimize heat stress and crowding in the context of global warming.
- Reduce stress associated with the milking process.
- Focus breeding and feeding research to favor metabolically less use of nutrients to synthesize more lactose per day and use those nutrients to make fat and protein.

Higher Milk Fat and True Protein Impacts on the Health of the Cows

Concerns:

- Meeting the metabolic needs of the cow to maintain reproductive performance.

Actions:

- Ensure bio-availability of long chain unsaturated fatty acids. Long-chain polyunsaturated fatty acids (LC-PUFAs) are important for dairy cow reproductive performance, particularly omega-3 (n-3) and omega-6 (n-6) fatty acids.
- Focus on supporting immune system function to help the cow recover from post-partum metabolic stress.

Next Step in Milk Production Research

- **Increase the protein concentration to bring fat and protein concentration for cheese making**

Conclusions

1. Milk composition is changing and that trend is likely to continue.
2. The impact of the changes in the fat and protein concentration in the milk supply will have impacts on dairy products and manufacturing beyond the most visible impact in cheese industry and as an industry we will need to work together to address these changes *(damage to milk fat during high-speed pumping at milk pick up and unload and cream separator efficiency will be a higher visibility issue going forward in the next 5 years)*
3. To address some issues, there may need to be changes in dairy product regulatory standards of identity to allow the use of other processing technologies, or dairy ingredients, to maintain the sensory and functional properties of traditional dairy foods.