

The Stonyfield Farm Greener Cow Project

Executive Summary

Stonyfield Farm has launched the first program in North America to decrease global warming gases from cow digestion, while improving the nutritional value of the milk. Enteric emissions, the “burps” released from the natural digestion process of cattle and other ruminants, are responsible for 5-10% of human induced greenhouse gas emissions¹.

The program works by feeding cows a diet high in natural omega-3 sources, such as alfalfa, flax, hemp and of course grasses, which naturally re-balance the milk fatty acids, resulting in an increase in the important omega-3 content and decrease in saturated fats. The omega-3 rich feed rebalances the cow’s rumen to reduce the waste by-product methane.

Stonyfield Farm has been able to reduce the enteric emissions from the cows by as much as 18% (average of 12%), while naturally increasing the omega-3s in the milk by 29% without adding anything, such as fish oil, to the milk. These findings hold great promise for a healthier future.

Overview

In recent years, there has been much news devoted to dairy cows and their link to global warming. With headlines claiming cow emissions to be more damaging to the planet than cars, and the E.P.A. exploring the idea of a “cow tax” on methane, (the potent greenhouse gas emitted by livestock), dairy is an industry at risk.

For Stonyfield Farm, the world’s largest organic yogurt manufacturer, the recent news about cow emissions is not *new* at all. We have been working to reduce our carbon footprint for over two decades. In 1997 we were the first manufacturer to offset our CO₂ emissions from our facility energy use - more than a decade before most people had ever heard of a “carbon offset”. In the late 1990’s we began exploring other ways the business impacted climate change. The results of our carbon footprint in 2000 sent a shock through the company. While facility energy use is a large emitter of global warming gases, it ranks only 4th – behind distribution, packaging and the number one source of our GHG emissions, milk production! Work began immediately to address these contributors to climate change.

Our research revealed that there are multiple factors contributing to the GHG emissions in milk: methane and nitrous oxides (N₂O) from manure, feed production (energy used

¹ IPCC 4th Assessment, Agriculture is responsible for 17-32% of human-induced GHG emissions (including land use changes), Methane from cattle enteric emissions is 32% of ag emissions

in producing fertilizers and pesticides as well as N₂O emissions from nitrogen fertilizer use), on-farm energy use (tractors, milk equipment, etc.), milk transport, and the largest contributor, the natural by-product from ruminant digestion - methane “burps” from cows or “enteric” emissions. We found the results varied by farm practice and region, but as an example, they approximated the results from a sample Wisconsin dairy: enteric, 38%; feed production, 34%; manure, 23%; farm electricity, 3%; and milk and feed transport, 2%.

Stonyfield developed programs to reduce emissions in each of the global warming impact areas of milk production except for one. We had no idea what to do about enteric emissions, the methane emissions (95% burps) from the cows’ normal digestion.

We learned that Danone had a pilot program in France to reduce enteric emissions which they developed with the French nutrition company Valorex. We went to France to learn more, and fell in love with the project. Danone plans to roll the project out globally.

The Stonyfield Solution

While this journey began as a way to address an environmental issue, to our surprise and delight, it has evolved into far more. What began as an environmental project is now also a health and nutrition project - potentially a watershed moment for the dairy industry.

The program has the potential to improve our bodies’ omega-6/omega-3 balance. When this ratio is in a state of imbalance, cancer, heart disease, obesity, diabetes and other ill health can result.

What the Stonyfield Farm Greener Cow Project offers is a solution that creates an important environmental benefit and improves human and animal health as well.

The Opportunity: Omega-3

The great human physiological functions are regulated by the balance between omega-6 and omega-3. There is a wealth of research on the positive effects of omega-3 in the prevention of chronic diseases, such as cardiovascular disease, cancer, inflammatory and autoimmune diseases.

For the science behind the omega-3 and omega-6 See Section One below.

Only plants can synthesize omega-6 and omega-3. By eating animals that have consumed plants high in omega-3, humans get this important nutrient into our bodies.

Over the past 50 years, however, we have changed our way of eating so we now eat more vegetable oils, such as corn, palm and soy oil, which are high in omega-6. We’ve

also changed what livestock eat by increasing the amount of corn and soy in their feed, and decreasing grass, which is high in omega-3.

This has resulted in animal products, such as eggs, meat and dairy, with reduced omega-3. The omega-6 /omega-3 ratio in the human diet – which used to be about 1 or two to 1 – is now out of balance with about 20 times more omega-6 than omega-3. These changes in the nutritive value of the animal products we consume, coupled with the increase in the use of oils high in omega-6, are contributing to the obesity epidemic, rise in diabetes and a host of other nutrition-related chronic diseases.

In addition to the human health impacts, there is an environmental cost to these changes. Clearing forests for palm and soy has caused ecological devastation. For every piece of forest or prairie that is destroyed to grow soybean or palm, our bodies will pay the price with an imbalance in the omega-6 to omega-3 ratio.

Put simply, our health and nutrition is tied to what animals eat. We are what they eat!

For the science behind omega-3 and omega-6 see Section One below.

Omega-3 and GHG Emissions

When cows are given feed rich in omega-3, such as grass, alfalfa, flax and hemp, to re-balance their diet, methane emissions from their enteric emissions can be reduced by as much as 30-40%.

Methane emissions from the cow are linked to SFA (Saturated Fatty Acid) synthesis. With more omega-3 in the diet, the cows reduce both SFA production and methane emissions.

In other words, by feeding a high omega-3 diet to cows, the nutritional value of their milk can be increased and the enteric GHG emissions can be decreased. By having a properly balanced rumen, the methane waste by-product is greatly reduced.

For the science behind the link between omega-3 and omega-6 see Section Two below

Stonyfield Farm's Pilot Project

Fifteen organic farms in Vermont are participating in the Stonyfield Greener Cow Project. The farms are members of CROPP/Organic Valley, the cooperative that supplies the milk for our yogurt. The cows' diets have been rebalanced to increase the omega 3 level and lower the omega-6/omega-3 ratio. The milk is tested at the University

of Vermont using gas chromatography, an analytics technique for determining chemical composition.

Results show that we've been able to naturally increase omega-3 by 29%, achieve an omega-6 to omega-3 ratio of 1.45 to 1 and increase CLA by 26%. Enteric GHG emissions have been decreased by as much as 18% (average of 12%). Regarding animal welfare, it is too early to draw any conclusions. Improvements in the cows' fertility and body condition are expected, but they must be observed over the entire term of the pilot to be meaningful.

Conclusion

Stonyfield Farm's Greener Cow Project changes the diet of cows to naturally increase omega-3 and move the omega-6/omega-3 ratio to a healthier level. In so doing, we have been able to rebalance the fatty acid composition of the milk improving its nutritional quality. By having a properly balanced rumen, the waste by-product of methane is greatly reduced.

The Stonyfield Farm Greener Cow Program has been able to reduce the enteric emissions from the cow by as much as 18% (12% average) while increasing the Omega 3s in the milk by 29%, naturally, without adding anything (like fish oil) to the milk.

The Stonyfield Farm Greener Cow Project holds enormous potential to reduce enteric GHG emissions from livestock and improve human health. Stonyfield Farm is the first dairy processor in North America to have a program to reduce enteric GHG emissions in their milk supply. This fundamental change holds great promise for healthier food, healthier animals, healthier people and a healthier planet.

THE STONYFIELD FARM GREENER COW

The Science Behind The Project

1. **Omega-3 and Omega-6**
 - 1.1 In human nutrition
 - ✓ *The evolution*
 - ✓ *The reasons of such an evolution*
 - 1.2 Environment
 - ✓ *Where omegas come from?*
 - ✓ *Ecological impact of omega sources*

2. **Omega-3 and cow's methane emission**
 - 2.1 The Mechanics of cow methane emissions
 - 2.2 Omega-3 in cow's diet and methane emission reduction
 - 2.3 Milk fatty acids and methane emission
 - ✓ *Milk fatty acids and methane production in the rumen*
 - ✓ *Milk fatty acids are markers of methane emission*

3. **Milk fatty acids quality and human nutrition: All fats are not created equal**
 - 3.1 All the quality of milk fat is re-balanced

1. Omega-3 and Omega-6

1.1 In human nutrition

The first evidence of the important role of dietary intake of omega-3 in human health was published in the 1980's (Kromann *et al.* 1980). Since then, there have been a tremendous number of scientific articles published that provide an impressive amount of data on the necessity of omega-3 in human diets. To get a sense of the scope, go to a scientific database such as "PUBMED" (<http://www.ncbi.nlm.nih.gov/pubmed/>) and enter "Omega-3 and stroke", "Omega-3 and depression", "Omega-3 and diabetes", "Omega-3 and obesity", or any disease related to Omega3, and you will find thousands of articles on the benefits of Omega-3 to human health and nutrition. Research on omega-3 has occurred from animal studies, epidemiological studies, and double blind randomized clinical studies.

✓ *The evolution*

Numerous studies have documented the positive effect of omega-3 on preventing cardiovascular disease, cancer, inflammatory and autoimmune diseases. (Simopoulos, 2008; Kris-Etherton *et al.*, 2002).

Nutritional guidelines across the globe recommend an increase in Omega-3 consumption (Kris-Etherton *et al.*, 2002). The World Health Organization recommends an omega-6 fatty acid intake of 5-8% of energy and an omega-3 fatty acid intake of 1-2% of energy to reach a ratio of 5 to 1 between Omega-6 and Omega-3 (McLean *et al.* 2004). Consumption studies in western countries have found this ratio to commonly be at a level of 15 to 25 to 1 (Eaton *et al.* 1998 ; Ailhaud *et al.* 2006 ; Simopoulos. 2008). Studies focused on breast milk composition (Ailhaud *et al.* 2004; Cunanne *et al.* 1999) or on adipose (fat) tissue fatty acids composition (Ailhaud *et al.* 2005; Dubnov *et al.* 2008) reveal a dramatic increase of this ratio which is now four to five times higher than it was 50 years earlier.

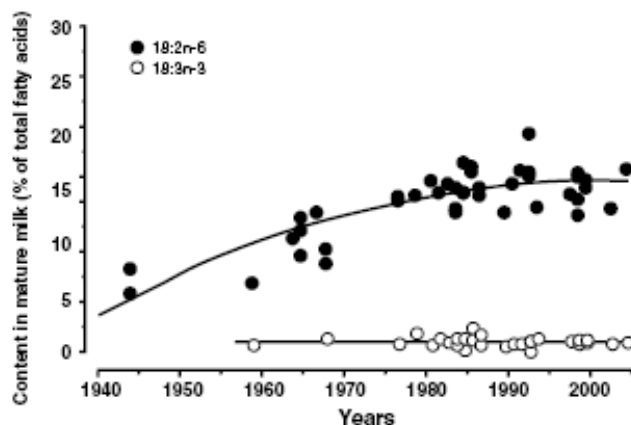


Fig 1 Breast milk composition of US women from 1944 to 2005.
(Ailhaud *et al.* 2006)

✓ **The reasons for such an evolution**

Omega-6 and Omega-3 are essential for synthesizing hormone-like molecules (Prostaglandins, Thromboxanes, Leucotrienes) that control the main physiological functions in humans such as aggregation (which impacts cardiovascular health), immunity, fertility, inflammation and lipogenesis. All animals, including humans, are completely dependent on the Omega-6 / Omega-3 ratio in food to create the right balance of these molecules in our bodies. Since omega-6 and omega-3 compete, if there is a large amount of either omega-6 or omega-3, it will displace the other and cause a physiological imbalance.

Our body ratio between Omega-6 and Omega-3 depends on our diet ratio. Changes in the composition of the fats we consume (Ailhaud *et al.* 2006) have an important impact on our diet fatty acids composition.

For the last 50 years soybean (51% omega-6) and corn (58% omega-6) have become the predominant sources of lipids, with palm oil (0.2% omega-3, and 9.1% of omega-6; National Research Council, 2001) in both human and animal diets. These diet changes have serious consequences for human health (Simopoulos, 2008).

The predominant Corn/Soybean feed system provides a high ratio of omega-6/omega-3 (Table 1) which generates:

- Animal fat with a very high omega-6/omega-3 ratio (Chilliard *et al.* 2004)
- Problems of health and infertility for animals (Kruse *et al.* 1977 ; Perez *et al.* 1995 ; Sattar *et al.* 1998 ; Boone *et al.* 2000 ; Petit *et al.* 2002 ; Weibel *et al.* 2004 ; Ambroise *et al.* 2006 ; Bazinet *et al.* 2004).
- A high omega-6/omega-3 ratio in humans (Eaton *et al.* 1998 ; Ailhaud *et al.* 2006 ; Simopoulos. 2008).

A natural, balanced food chain should bring to our plates a balanced supply of omega-6 and omega-3. Instead of looking to drugs for the solution, agriculture can play an important role by returning the proper balance to the animal products- milk, meat, eggs- that we consume.

1.1 Environment

✓ **Where omegas come from?**

Most of our dietary lipids come from animal products: dairy products, eggs, meat and fish. The composition of the animal lipids that humans consume is related to the animal diet lipids composition. (Chilliard *et al.* 2000 ; Weill *et al.* 2002 ; Bourre *et al.* 2005 ; Couvreur *et al.* 2006 ; Kouba *et al.* 2003; Leskanich *et al.*, 1997). For instance, if a wild salmon eats other fish that have eaten shrimp that have eaten algae (high omega-3 source), the salmon will concentrate Omega-3 from the algae in its fat. A bred catfish fed with corn and soybean will be very rich in Omega-6 (Van Vliet *et al.* 1990 ; Regost *et al.* 2003 ; Shapira *et al.* 2009).

Omega-3 enters our bodies through animal products as a result of the food chain and what animals eat. There is an undeniable link between human nutrition and animal nutrition.

In spring, Omega-3 as alpha-linolenic acid (ALA) (C18:3 n-3) is the predominant source of fat on the earth. In fact omega-3 is a major component of plant membranes especially in chloroplast. In grass leaves and in algae about 60 to 70% of the total fat is omega-3 fat (Siegenthaler *et al.* 1998). Omega-6 as linoleic acid (C18:2 n-6) is the predominant source of fat on the earth in late summer because Omega-6 is the major fatty acids of seeds reserves (Table 1). Some seeds are the exception because they have a very high level of Omega-3. Flaxseed is the seed (and thus oil which is derived from the seed) richest in Omega-3.

<i>(g/100g *100) of total fatty acids</i>	<u>OMEGA-6 - C18:2 n-6</u>	<u>OMEGA-3 - C18:3 n-3</u>
Canola	22.1	11.1
Corn	58	0.7
Cottonseed	51.5	0.2
Flaxseed	12.7	53.3
Palm	9.1	0.2
Peanut	32	-
Safflower	74.1	0.4
Sesame	41.3	0.3
Soybean	51	6.8
Sunflower	39.8	0.2

Table 1 Omega-6 and Omega-3 composition of seeds.
(National Research Council, 2001)

✓ ***Ecological impact of omega sources***

Grass, alfalfa, hemp and flax are some of the plants with the highest levels of omega-3. These plants are grown with significantly less agricultural inputs such as fertilizer and pesticides than omega-6 rich corn and soybeans (Slots et al, 2009). Thus, by determining the levels of Omega-3 and Omega-6 in eggs, meats and milk reveals information about the agricultural inputs. The lower the ratio is (meaning higher Omega-3), the fewer inputs were used and the better the ecological footprint will be.

2. Omega-3 and cow methane emissions

2.1 The mechanics of cow methane emissions

Methane is the second most important global warming or greenhouse gas (GHG). Methane production in the cow rumen is a natural part of the metabolic process of bovine digestion (Fig 2).

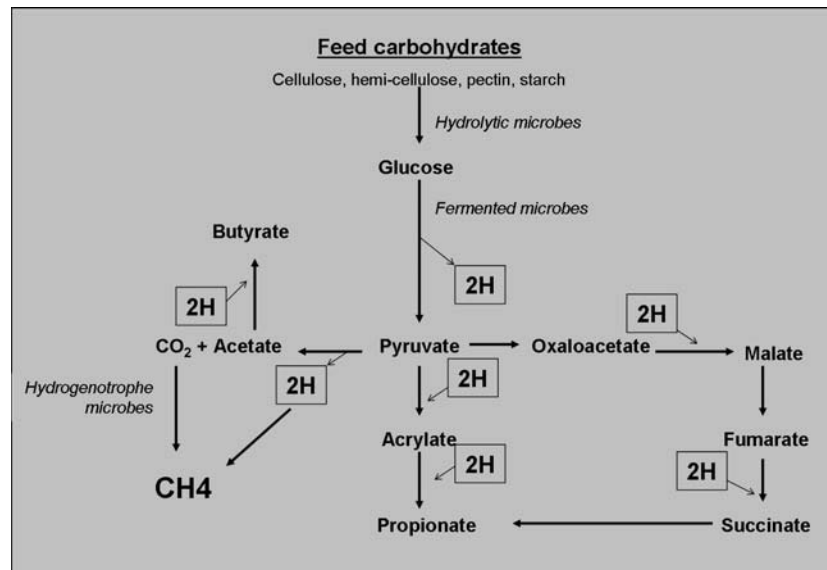


Fig 2 The fermentation process of feed carbohydrates in the rumen leading to the production of methane. (Martin *et al.* 2006)

The amount of cow methane emissions are related to:

- Cows productivity: more milk per cow = less methane per pound of milk. (Casey *et al.*, 2005 ; McCrabb.. 2002)
- Number of lactations per cow: more lactations = less non-milk producing periods for heifers when methane is being produced without milk (Johnson *et al.* 2002)
- Additives like antibiotics (Bogaert *et al.* 1989), organic diacides (Callaway *et al.* 1996)
- Quality of the diet: the cow's diet changes the digestion pathways (and so microbes' population) in the rumen and can generate more or less methane with the same production of milk depending on the feed. (Giger-Reverdin *et al.* 2003; Martin *et al.* 2008b)

2.2 Omega-3 in cow's diet and methane emission reductions

The impact of omega-3 on the ruminant microbial ecosystem, and in particular on the methane and propionate pathways has been studied for many years (Czerkawski *et al.* 1966). Thus ruminant methanogenesis has been well documented in numerous works. The increase of polyunsaturated fatty acids is a well-founded solution to decrease methane production (Giger-Riverdin *et al.* 2003) and particularly omega-3 supplementation (Martin *et al.* 2006). More

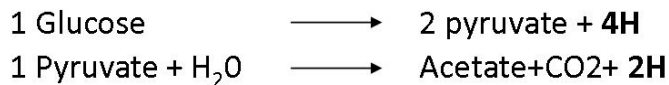
recently, new studies have measured the effect of flax supplementation on multiple factors including enteric methane output, diet digestibility and milk production (Eugene *et al.* 2008 ; Martin *et al.* 2008). The Martin trial concluded that it is possible to decrease enteric methane emissions by 40% with cooked flaxseed with no negative impact on production.

2.3 Milk fatty acids and methane emissions

✓ *Milk fatty acids and methane production in the rumen*

Rumen microbial digestion produces Volatile Fatty Acids (VFA) from dietary carbohydrates fermentation. Most important VFA are acetate (C2), propionate (C3) and butyrate (C4). As shown in figures 2 & 3, CH₄ emissions are related to C2 and C4 production in the rumen ($CH_4 = 0.45C_2 - 0.275C_3 + 0.4C_4$; Moss *et al.* 2000).

Hydrogen producing reactions



Hydrogen using reactions

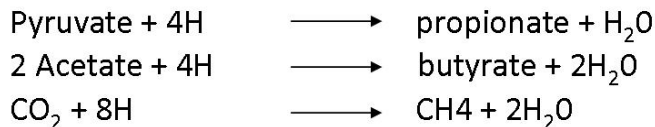


Fig 3 Fermentation pathways in the rumen.

(Moss *et al.* 2000)

Milk fat comes from blood fat (60%) and from *de novo* synthesized (40%). *De novo* milk fats are synthesized from acetate and butyrate and most of them are short and medium chain fatty acids (C_{4:0} to C_{16:0}; Chilliard *et al.* 2000). As a consequence, C₂ and C₄ are also the precursors of Saturated Fatty Acids synthesis in the rumen (Fig 4).

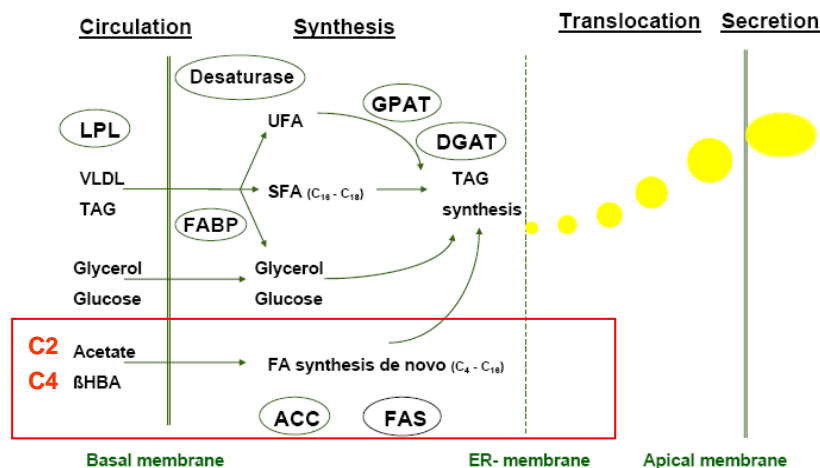


Fig 4 Milk fat synthesis
(Figure adapted from McGuire *et al.* 2002)

C2 and C4 synthesis produces CH₄ in the rumen (Fig 2 & 3) and are the basis material for SFA synthesis in the udder (Fig 4). There is a strong biological correlation between methane (CH₄) emissions in the rumen and Saturated Fatty Acids (SFA) production in the udder. That what was measured in the trial below. This correlation is true without *exogenous* fat sources like animal fat and palm oil.

✓ ***Milk fatty acids are markers of methane emissions***

The strong relationship between milk fatty acids- specifically SFA's and methane emissions (described above), has been measured in a trial run by VALOREX, DANONE and INRA (French National Research Institute for Agriculture). In this trial methane emissions were determined using the sulphur hexafluoride tracer technique (Johnson *et al.* 1994), and milk fatty acids compositions were measured by gas chromatography. The first part of that trial was published in 2008 and presents the impact of flaxseed on methane emission reductions (Part 2.2; Martin *et al.* 2008; Table 2). The second part of the trial demonstrated the strong correlation between milk fatty acids composition and methane emission. The results of this trial will be published by the end of 2009. From these results an equation of prediction of methane output was created (Patent : 08 54230, June 2008).

% of flaxseed oil in cow's diet from extruded flax	2%	4%	6%
Decrease of CH ₄ / kg of milk ¹	-6%	-20%	-37%
Increase of C18:3 n-3 (% of TFA) ²	+70%	+180%	+280%
Decrease of C16:0 (% of TFA) ²	-13%	-32%	-49%
Decrease of short FA C4+ C6+ C8+ C10 (% of TFA) ²	-5%	-18%	-42%

TFA = Total Fatty Acids ; FA = Fatty Acids

Table 2 Methane reduction and milk fatty acids composition
(¹ Martin *et al.* 2008 ; ² Weill *et al.* 2008)

3. Milk fatty acids quality and human nutrition: All fats are not created equal

In recent years fat has earned a reputation among the general public as being “bad”. But in reality, of the more than 400 fatty acids contained in milk, some are essential to health. Since the 1990's it has been known that Unsaturated Fatty Acids (UFA) decrease the risk of atherosclerosis (Mensik *et al.* 1990). In contrast, a number of studies make the correlation between Saturated Fatty Acids (SFA) and cardiovascular diseases. An abundance of SFA increases cholesterol in the blood particularly in the presence of C16:0 (Palmitic acid) (Billett *et al.* 2000). Nevertheless short and medium SFA can have a positive impact on human health including weight loss and hypercholesterolemia (Tsuji *et al.* 2001; Rock. 2004). Milk contains some *trans* fatty acids (such as *trans* 11) which are healthy, in contrast to industrial *trans* fats (*trans* 10) from hydrogenated vegetal oil (Mozzafarian *et al.* 2006 , Lock *et al.* 2005) which contributes to artherosclerosis. In addition, a well balanced milk fat can have a low ratio between omega-6 and omega-3 which supports cerebral function, mental, cardio-vascular and insulinoreistance (Voigt *et al.* 2002 ; Mozzafarian *et al.* 2006 ; Schmitt *et al.* 2006). Dairy

products can also be an important source of Conjugated Linoleic Acid (CLA), which may inhibit human cancer development (Parodi. 1999).

3.1 All the quality of milk fat is re-balanced

Milk fatty acids composition depends on cow genetics and days in lactation (Delaby *et al.* 2002) but can be controlled by cow's diet (Agabriel *et al.* 2004 ; Martin *et al.* 2002 ; Chilliard *et al.* 2007). Table 3 shows the impact of cow's diet on milk fatty acid quality.

Diet	SFA	UFA	C16:0	C18:2	C18:3	C18:2/C18:3
Corn silage	71.8	28.2	31	2.28	0.22	10.3
Pasture	64.7	335.3	24.1	3.12	0.7	4.45

Table 3 Effects of diet composition on milk fatty acids quality.
(Couvreur *et al.* 2006)

During winter, grass can be replaced by omega-3 sources in order to rebalance the milk fat quality (see 1.2).

Cow's diet	SFA	UFA	C18:1/C16:0	C18:3
Corn silage + cereals	74.1	24.73	0.43	0.23
Plus 3.1% of extruded flax	69.4	29.23	0.61	0.43
Plus 6.2% of extruded flax	65	32.99	0.73	0.67
Plus 3% of grounded flax	72.6	26.12	0.51	0.32
Plus 6.2% of extruded canola	68.7	29.8	0.68	0.27

Table 4 Milk composition depending on winter supplementation.
(Hurtaud *et al.* 2006)

Adding omega-3 sources in the cow's diet doesn't only increase the omega-3 level in milk but totally rebalances the milk fat quality (Table 3 & 4 and Kerhoas *et al.* 2008) to be healthier for humans.

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