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Fat Guide



Helping farmers to maximize
efficient and healthy production

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Introduction

A key objective for any livestock farmer is to ensure that animals are productive and healthy to maximize performance efficiency. Fluctuating input costs, a rapidly-growing world population and pressures to reduce emissions to the environment, all focus the attention more and more closely on the need to achieve optimum outputs from agricultural systems. Genetics, management and nutrition all play a role in improving productivity and efficiency on farm.

In all production systems, providing high quality, well-balanced rations to meet the requirements of the animal is key to achieving efficient performance. The first target for ration formulation is to meet the energy requirements of the animal. Fats, as the highest energy ingredients available, play an important role in increasing energy density of rations to improve energy supply.

Volac, a family-owned UK business established in 1970, is a market leader in specialist areas of animal nutrition, feed ingredients, forage systems and animal health. Volac have a long-established reputation for pioneering achievements within the field of specialist fat products for ruminant animal nutrition. Megalac® rumen-protected (bypass) fat was developed in the early 1980s and is now widely used in diets around the world.

All Volac products are supported by our talented technical, marketing and sales teams, who aim to bring you timely husbandry and nutritional information to help improve performance on farm.

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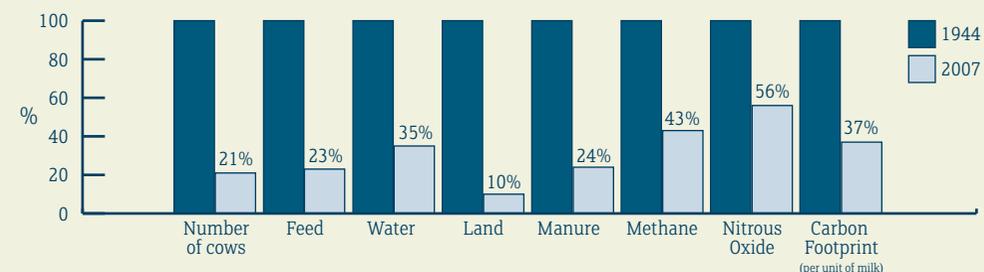
Sustainability

Environmental considerations

Carbon-efficient farming

With a rapidly increasing population that is forecast to reach 9 billion by 2050, our ability to produce sufficient food in a resource-constrained world will become increasingly challenging. Cultivable land and inputs are a finite resource. Legislation continues to reinforce the necessity to significantly reduce the environmental impact of increased food production. Developments within the dairy industry in the past 70 years have resulted in major improvements in agricultural efficiency and greatly reduced the environmental impact of the industry. For example, producing a given volume of milk in the USA in 2007 required only 10 % of the land area compared with that in 1944, with considerably lower greenhouse gas emissions. The industry must continue to focus on producing more from less, using natural resources in an efficient way.

Resources required to produce milk in 2007 as a proportion of 1944 (USA)



Responsible sourcing

Volac uses palm fatty acid distillate (PFAD), a by-product of palm oil refining, in the manufacture of its rumen-protected fats. Our policy is to source PFAD only from members of the Roundtable on Sustainable Palm Oil (RSPO*) and Volac have been members of this organization for several years. Where possible, we source PFAD from segregated and certified sources which are traceable right back to the palm plantation of origin.

Palm oil is a valuable commodity: oil palm yields more oil per hectare than any other crop in the world and palm oil makes up around a third of all the vegetable oil produced worldwide.

Volac is committed to sustainable global food production and believes this can only be achieved by working closely with our customers, suppliers and the industry.

*The RSPO was established in 2004 to promote the growth and use of sustainable palm oil with strict standards for responsible plantations and an independent system for auditing the supply chain.

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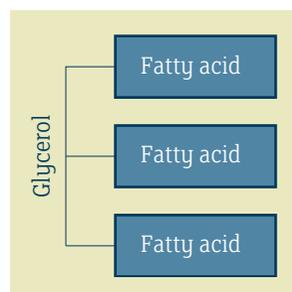
What are fats?

Definition of fats

Fats consist of a group of compounds that are insoluble in water. Although the terms 'fats' or 'oils' are commonly used to refer to these compounds, they simply reflect differences in physical state: at room temperature an 'oil' is a liquid fat and a 'fat' is a solid oil.

All fats are composed of individual fatty acids and it is these which primarily determine the properties of the fat e.g. nutritional value and whether the compound is solid or liquid. A large proportion of fats in nature are present in the form of triglycerides, in which three individual fatty acids are attached to a molecule of glycerol.

Structure of a triglyceride



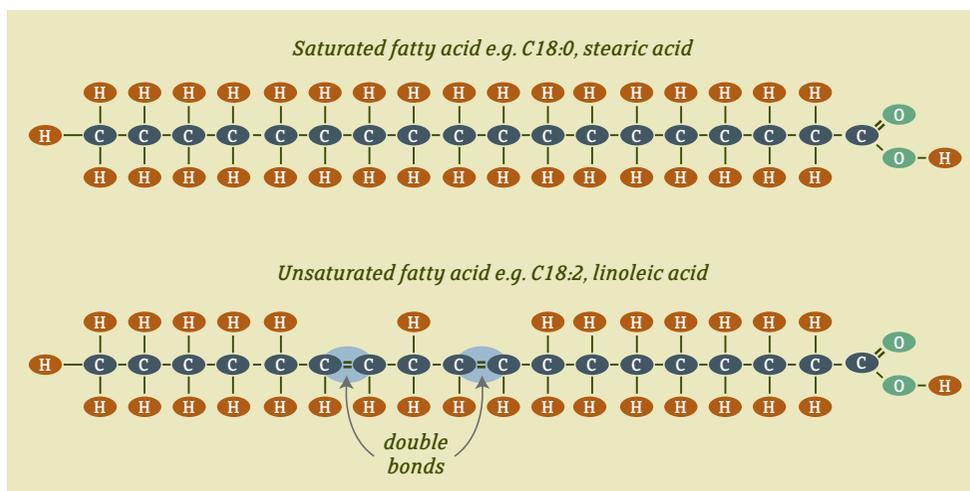
What are fatty acids?

Fatty acids are long chains of carbon (C) atoms which typically range from 4 to over 20 carbons in length. The chains also contain hydrogen (H) and oxygen (O) atoms. There are several distinct categories of fatty acid:

Saturated and unsaturated fatty acids

Fatty acids may be saturated (SFA) or unsaturated (USFA) depending on the number of H atoms in the chain. In SFA, all the carbon atoms in the chain are surrounded by H atoms whereas USFA have some H atoms missing, resulting in 'double bonds' (C=C).

Structure of saturated and unsaturated fatty acids



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What are fats?

Fatty acids are described according to the number of carbons in the chain and the number of double bonds. For example, a SFA with a chain length of 18 carbons and no double bonds is denoted as C18:0, while an USFA with a chain length of 18 carbons and two double bonds can be denoted as C18:2. Unsaturated fatty acids with one double bond are referred to as monounsaturated fatty acids (MUFAs) while those with more than one double bond are referred to as polyunsaturated fatty acids or PUFAs. Individual fatty acids are also given names, the most common ones present in animal feeds are listed below:

Main fatty acids commonly found in feeds

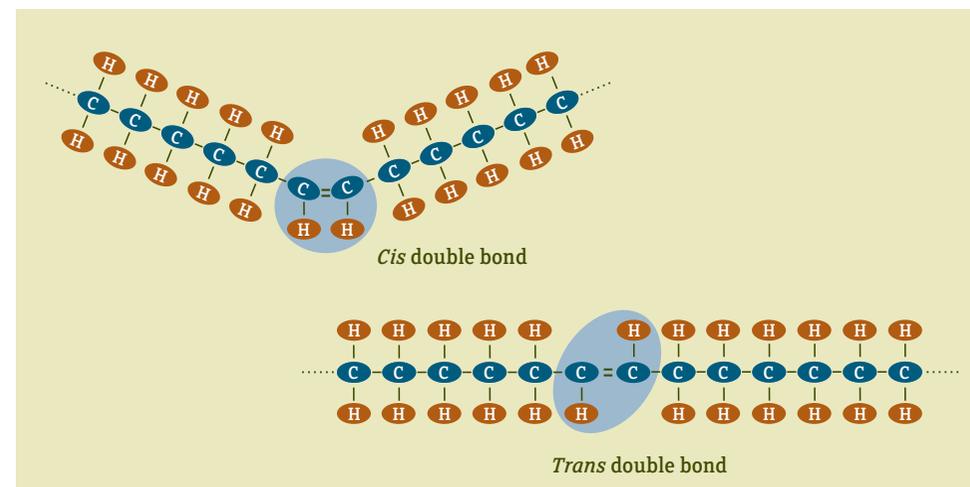
Fatty acid	Name	Classification
C16:0	Palmitic acid	Saturated
C18:0	Stearic acid	Saturated
C18:1	Oleic acid	Monounsaturated
C18:2	Linoleic acid	Polyunsaturated
C18:3	Linolenic acid	Polyunsaturated

* See Appendix for fatty acid profile of some common feed ingredients

Cis and trans fatty acids

Fatty acids can differ in shape (arrangement of the atoms around double bonds in the chain) with the two major categories referred to as 'cis' and 'trans'.

Cis and trans double bonds



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What are fats?

Naturally occurring fats and oils normally only contain *cis* fatty acids. *Trans* fatty acids originate from two main sources, either through alteration of dietary USFA in the rumen by rumen bacteria or from chemical processing of USFA (e.g. vegetable oils).

From a human health perspective, natural *trans* fatty acids (produced in the rumen) are generally considered beneficial, while industrially-produced *trans* are thought to be detrimental to health. It is therefore very important to distinguish between natural and industrially-produced *trans* fats in foods.

Omega-3 and omega-6 fatty acids

These fatty acids are unique due to the position of double bonds in the chain. Animals cannot produce these fatty acids and they must be supplied in the diet. Hence they are described as 'essential' fatty acids and animals not receiving sufficient of these will show deficiency symptoms.

Many vegetable oils contain a high proportion of omega-6 fatty acids but there are only a few sources of omega-3 in nature, the most common being green grass, linseed and fish oil/marine sources.

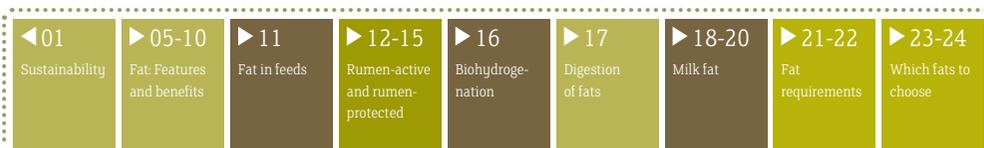
Omega-3 and omega-6 fatty acids are very active in the body, particularly as components of cell membranes to help maintain cell function. However omega-3 and omega-6 fatty acids generally have differing effects in animals. Omega-6s stimulate aspects of the immune system, whereas omega-3s are referred to as 'anti-inflammatory', damping down the immune response while promoting infection-fighting components of immunity. These fatty acids also have a strong influence on fertility.

Why feed fat?

Fat is one of the essential nutrients in diets and, like other nutrients such as protein, fibre, minerals and vitamins, must be balanced in a ration to ensure optimum production. Basal feed ingredients supply some of the fat requirements of the animal but inclusion of high fat supplements is often essential. There are many benefits to increasing diet fat concentration for dairy and other livestock. The major reasons for feeding fat supplements include:

- 1) Increased milk yield
- 2) Improved fertility
- 3) Reduced acidosis
- 4) Improved rumen function
- 5) Formulation of more-balanced rations
- 6) Improved animal health
- 7) Improved feed efficiency
- 8) Reduced environmental emissions

These benefits reflect the unique attributes of fats both as direct energy sources and through other factors not related to energy supply. The major features of fats which contribute to their beneficial effects in diets are summarised in the subsequent section.



Fat: features and benefits

Features and benefits of dietary fat

- Increased energy supply

The primary reason for feeding fat is as an energy source. Fat is a highly concentrated source of energy, containing two and a half to three times the metabolisable energy (ME) concentration of cereals.

Metabolisable energy content of common feeds

Feed	Metabolisable energy	
	MJ/kg fresh	MJ/kg DM
Grass silage	variable	9 - 12
Sugarbeet pulp	11.1	12.5
Wheat	11.7	13.6
Maize	11.9	13.8
Molasses	9.5	12.7
Megalac	31.6	33.3

- 500 g Megalac supplies the same ME as 1.35 kg wheat.

Based on these ME values, replacing 500 g of wheat (5.9 MJ) with 500 g of Megalac rumen-protected fat (15.8 MJ) increases energy supply by 10 MJ, equivalent to approximately 2 litres of milk.

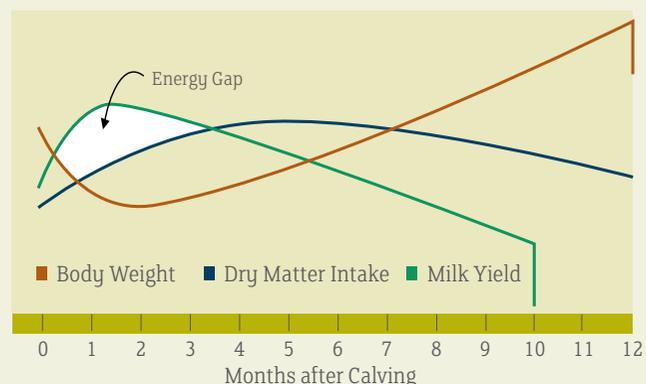


Fat: features and benefits

• Increased energy density

Inclusion of fat increases energy density of diets (more energy per bite). This is particularly beneficial for dairy cows in early lactation when appetite is small and dry matter (DM) intake is low, but milk production is rising rapidly. This leads to an 'energy gap' in early lactation when cows cannot eat sufficient DM (and hence energy) to meet their energy demands for milk production, and they are said to be in negative energy balance.

The energy gap



As a result, cows begin to use their body fat reserves as an energy source (milking off their backs) and hence lose body weight and condition which can lead to health and fertility problems. Given this physical limit to DM intake, a key way to increase energy supply is to increase energy density of the diet such that the animal consumes more energy in every bite of feed consumed.

Effect of including Megalac on ration energy density

	Control (no fat supplement)	Control + 500 g Megalac
DM intake (kg/d)	20	20
ME of diet (MJ/kg DM)	12	12.5
ME intake (MJ/d)	240	250
Additional ME		+10 MJ/d

- 500 g Megalac increases energy density by 0.5 MJ/kg DM.

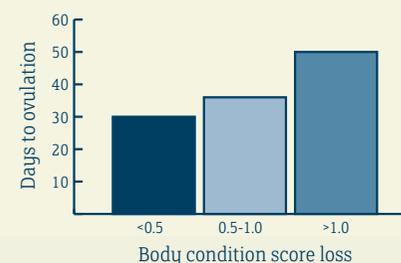


Fat: features and benefits

• Improved fertility - energy balance effects

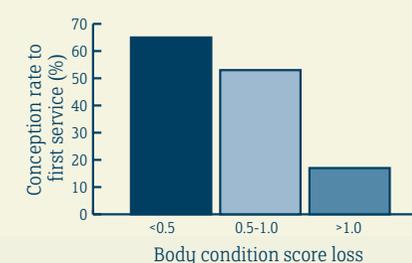
There is a well-proven relationship between cow fertility and body condition score. Cows losing body weight/condition (in negative energy balance) take longer to return to cycling after calving and have lower conception rates. It is well-established that the sooner a cow begins cycling after calving the more likely she is to become pregnant at the subsequent service.

Effect of body condition score loss in early lactation on days to ovulation



(Butler, 2001)

Effect of body condition score loss in early lactation on conception rate to first service



(Butler and Smith, 1989)

- As a guideline, conception rate decreases by 10 % for each 0.5 unit loss of body condition (5-point scale).

Cows losing excessive body fat are also more prone to conditions such as ketosis and fatty liver. Adding fats to the diet aims to increase energy supply and reduce negative energy balance.

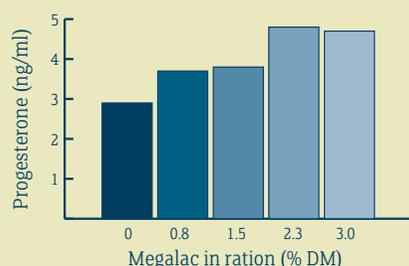


Fat: features and benefits

• Improved fertility – progesterone effects

Fat supplies the building blocks for the production of progesterone (the hormone of pregnancy) which is essential to maintain the developing embryo. Insufficient progesterone results in embryo death and pregnancy failure. Increasing fat concentration in diets is an effective method of increasing progesterone in blood plasma to support pregnancy.

Effect of increasing Megalac in the diet on progesterone in blood plasma

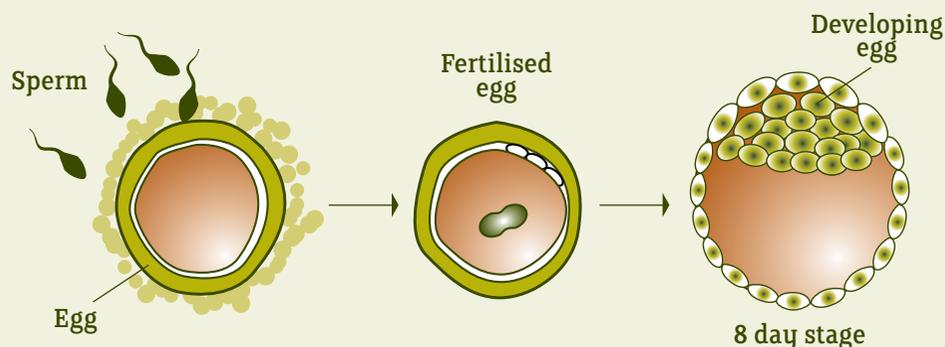


(Garnsworthy et al., 2008)

• Up to 55 % of embryos die in early gestation and inadequate progesterone is a major cause of this loss.

• Improved fertility – egg (oocyte) quality effects

Adding fats to diets can improve development of eggs. This leads to higher quality, more viable eggs, which are more likely to sustain a pregnancy.



Increasing Megalac rumen-protected fat in the diet improves egg development and results in more viable eggs.

(Fouladi-Nashta et al., 2007)



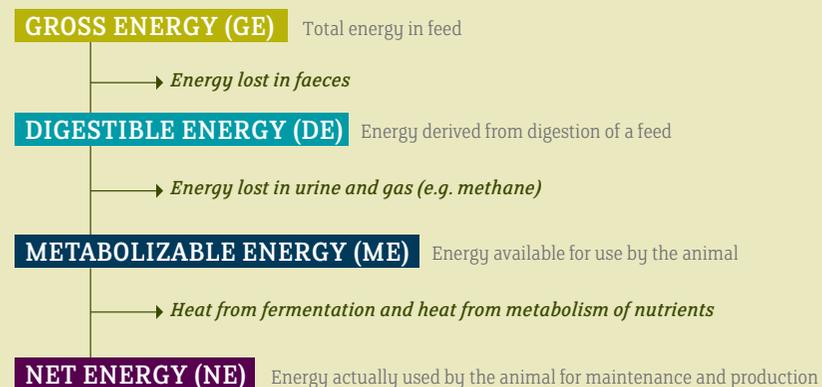
Fat: features and benefits

• Increased efficiency of energy use

Energy from fat can be used very efficiently for milk production, more efficiently than from other ingredients. This is because less energy is wasted converting ME to net energy (NE) actually used by the animal for maintenance and production. While conversion efficiency for typical dairy diets will be around 65 %, ME from fat is converted to NE in milk with an efficiency of approximately 80 %, so reducing energy wastage. Fat therefore has a higher net energy of lactation (NE_L) value than other ingredients.

• Megalac rumen-protected fat has the highest measured NE_L value of any fat supplement (27.3 MJ/kg DM).

How energy is used by ruminant animals



• Reduced acidosis

Fat is not fermented in the rumen and hence unlike cereal (starch) or sugar sources of energy does not add to the acid load in the rumen. As a result, adding fat to diets enables energy density to be increased without increasing risk of acidosis.

• Improved feed efficiency

By supplying increased energy, improving rumen function and use of nutrients, fats can improve feed efficiency. In other words, higher output is achieved (e.g. milk, meat) for a similar level of DM intake.



Fat: features and benefits

- **Reduced methane**

Methane is produced in the rumen as a result of fermentation of feed. Adding fats to diets can lower methane emissions and hence reduce agriculture's contribution of this greenhouse gas. Fats can either act as 'sinks' to mop up the hydrogen atoms produced during fermentation which would otherwise be released as methane gas, or reduce the raw materials for methane production by replacing fermentable feed in the rumen.

Methane also represents a significant loss of feed energy from the animal: up to 12 % of feed energy intake (GE) can be lost as methane from ruminants.

Effect of adding Megalac to a ration on methane production

	Control (no fat supplement)	Control + Megalac	Difference
Milk yield (kg/d)	32.2	34.3	+2.1
Methane (litres/d)	539	498	-41
Litres methane / kg milk	16.7	14.5	-13.3%

(Andrew et al., 1991)

- **Megalac significantly reduces methane production.**

- **Reduced heat stress**

Fat is commonly added to diets to help combat heat stress which can cause major reductions in animal production and fertility. The physical and chemical processes associated with digestion and metabolism of feeds leads to production of heat in the animal. As fats are not fermented in the rumen and are a more efficient source of energy than other nutrients, increasing dietary fat can reduce this internal heat production and help to cool the animal.

Cow suffering heat stress



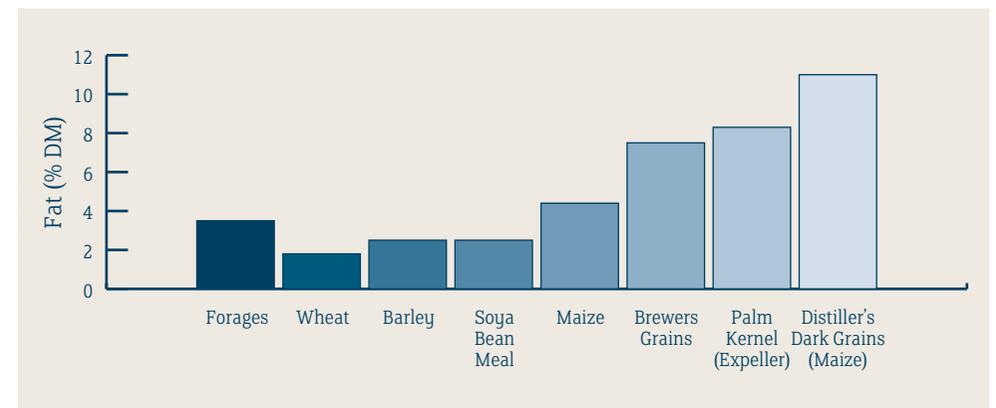
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Fat in feeds

How much fat is in feeds?

Traditional feed ingredients generally have a very low level of fat. Cereal sources such as barley and wheat commonly have less than 2 % fat while forages contain higher amounts. Hence traditional forage/concentrate-based diets will typically have a low fat concentration of around 3 % of diet DM. Higher fat concentrations are found in oilseeds and byproduct ingredients such as distiller's and brewer's grains.

Typical fat contents in common feedstuffs



Increasing fat in diets

Common sources of fat in diets include fish or vegetable oils and higher fat ingredients such as brewer's or distiller's grains. However, fat/oil from these sources is released in the rumen and is described as 'rumen-unprotected', 'free' or 'rumen-active' and can lead to problems in the animal.

Another method of increasing fat in diets is to use rumen-protected fat supplements. Hence, when evaluating fat in diets, it is important to look at both the amount and source of fat.



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Rumen-active and rumen-protected fats

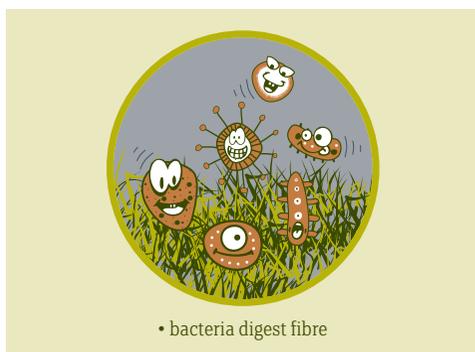
Rumen-active (unprotected) fats

These fats can lead to undesirable effects in the rumen which reduce animal performance. The major issues caused by adding rumen-active (unprotected) fats and oils to rations can be summarised as follows:

- 1. Oil slick**
The oil released in the rumen effectively creates an oil 'slick' which physically coats the fibre particles preventing rumen bacteria from breaking down the fibre, hence decreasing fibre digestion.
- 2. Toxic to rumen bacteria**
Many of the individual fatty acids, particularly the more highly unsaturated fatty acids, are toxic to some rumen bacteria. Bacteria ferment feed in the rumen, so if there are fewer bacteria, this will reduce fibre digestion, rumen function and feed efficiency.
- 3. Trans fats**
Unsaturated fatty acids provide the raw materials for production of particular *trans* fatty acids which are very potent at reducing milk fat %.
- 4. Minerals**
Fatty acids can bind minerals such as calcium and magnesium in the rumen, reducing their availability for bacterial growth and rumen function (muscle contraction).

Only a relatively small concentration of rumen-active fat (around 3 % fat in the ration DM) is tolerated in the rumen before problems can begin to occur. This varies with type of fat, fibre concentration of diet and how the fat is supplied e.g. as rumen-active oils such as fish oil or as a component of oilseeds.

Normal rumen



Unprotected oil in the diet



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Rumen-active and rumen-protected fats

Rumen-protected fats

Adding fats in rumen-protected form avoids the negative effects on rumen bacteria, fibre digestibility and rumen function associated with unprotected sources of fat. Rumen-protected fats pass through the rumen intact but the fat should be released for digestion when it reaches the small intestine.

- To increase the fat concentration of diets 'safely', fats should be added in rumen-protected form.

Other benefits of rumen-protected fats

Unsaturated fatty acids in standard feed ingredients are not rumen-protected and are converted to SFA by rumen bacteria by the process of biohydrogenation. Rumen-protection of fatty acids is essential to help ensure that USFA pass through the rumen unchanged and are then available for uptake into milk fat and other tissues and organs in the body. Rumen-protected fats containing USFA can greatly reduce the SFA concentration of milk fat.

Offering USFA in rumen-protected form also avoids the potential for production of those *trans* fatty acids which reduce milk fat % (see section: Biohydrogenation, p18).

Effect of Megalac rumen-protected fat on SFA concentration in milk fat

Fatty acid	Milk fatty acids (% total fatty acids)	
	Control (no fat supplement)	Control + Megalac
C4:0 – C10:0	12.1	11.6
C12:0	4.5	3.6
C14:0	12.1	10.6
C16:0	30.9	30.5
Total SFA	70.4	66.9
C18:1	13.7	16.2

(Kliem et al., 2012)

- Megalac significantly reduces saturated fatty acids in milk.

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Rumen-active and rumen-protected fats

Commercially available rumen-protected fats

There are a limited number of rumen-protected fats available for use in diets and these can be grouped into three main categories.

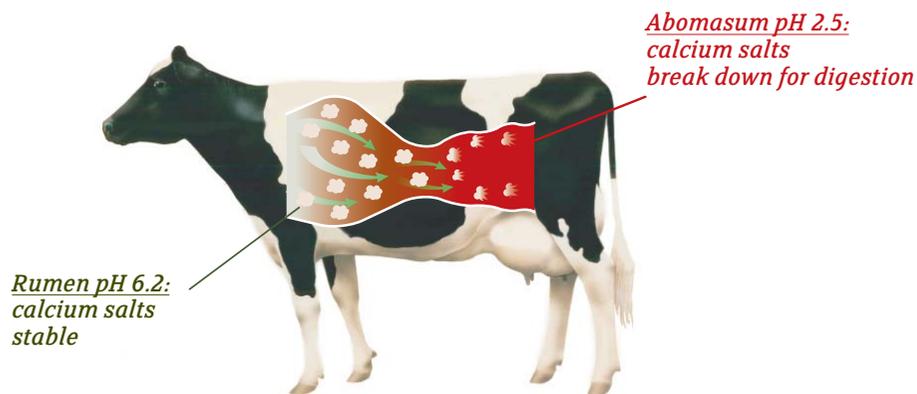
Calcium salts of fatty acids

Calcium salts can be manufactured from any fatty acids but the most common are based on palm fatty acids. These supplements are produced by reacting fatty acids with calcium to produce a rumen-insoluble fat source which passes unchanged through the rumen to the small intestine for digestion.

These products are stable at the high pH values found in a healthy rumen (pH above 6.0), but break down (dissociate) in the acid conditions of the abomasum (fourth stomach) (pH 2.5). Both the fat and calcium components are then available for absorption by the animal.

However not all calcium salts are the same:

- Products with larger granules are more stable and provide improved rumen protection compared with those composed of finer particles.
- Individual fatty acids differ in their degree of rumen stability as calcium salts.
- The blend of fatty acids present will influence the animal's response to the supplement.



- Volac's Megalac is the original calcium salt product and was developed in conjunction with Prof. Don Palmquist at Ohio State University in the USA and Dr Eric Miller from the University of Cambridge in the UK.

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Rumen-active and rumen-protected fats

Hardened fats

These products contain mostly SFA and are designed to pass through the rumen without being broken down due to their high melting point (around 60°C) compared to rumen temperature (approximately 37°C). These fats will typically contain high concentrations of C16:0 (palmitic) and C18:0 (stearic) fatty acids. A common method of producing 'hardened' fats is by a process called hydrogenation (hydrogenated fats).

Whole oil seeds

Although not a source of rumen-protected fat *per se*, whole oilseeds (e.g. rapeseed, linseed) are a source of slow-release oil due to their hard seed coat. However, animals can have difficulty digesting the seed coats and if they remain intact, whole seeds will pass out in the faeces, providing no nutritional value to the animal.



Calcium salts of fatty acids (Megalac)



Rapeseed



Linseed



Hardened fat

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Biohydrogenation

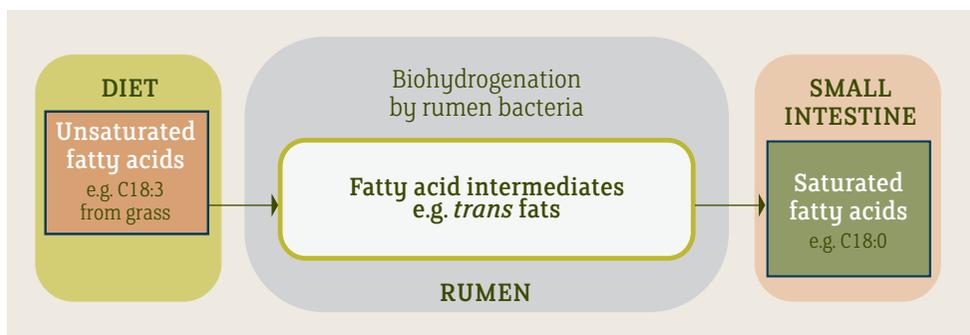
What is Biohydrogenation?

This is a process that occurs in the rumen in which bacteria convert USFA to SFA. As a result of biohydrogenation, the fatty acids leaving the rumen are highly saturated. So, although animals can consume large quantities of USFA from standard feed ingredients, most of these will 'disappear' in the rumen and so are not available for uptake into milk fat, meat or tissues.

- Only a small proportion of diet USFA escape biohydrogenation to SFA.

The process of biohydrogenation of USFA to SFA involves several steps, resulting in production of many unique fatty acids some of which will leave the rumen and be taken up in milk fat. However, some of the fatty acids formed by biohydrogenation can lead to a major reduction in milk fat production (see section: Milk fat depression, p22).

Biohydrogenation of USFA in the rumen



Though only five main fatty acids are found naturally in the diet of ruminant animals (C16:0, C18:0, C18:1, C18:2 and C18:3), ruminant products contain a considerable number of different fatty acids which have been produced either as intermediates in the biohydrogenation process or from other processes in the animal. Milk fat, for example, contains around 400 different fatty acids.

However, feeding fats in rumen-protected form enables USFA to pass through the rumen intact for use in the body e.g. to increase USFA in milk fat thereby reducing SFA in milk (see section: Other benefits of rumen-protected fats, p15).

- Rumen-protected fats help reduce conversion of diet USFA to SFA.

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Digestion of fats

How are fats digested ?

Nutrients are only useful to an animal if they can be digested and absorbed, otherwise they pass through the digestive tract and are lost in the faeces. The energy value of a fat supplement is dependent primarily on the digestibility of the fatty acids, which can vary dramatically between different types or sources of fat.

Most fats in animal feedstuffs are present as triglycerides or, in the case of forages, as glycolipids where one of the fatty acids is replaced by sugar. The first stage of fat digestion occurs in the rumen where the bacteria split off the individual fatty acids (and sugars) from glycerol by the process of hydrolysis.

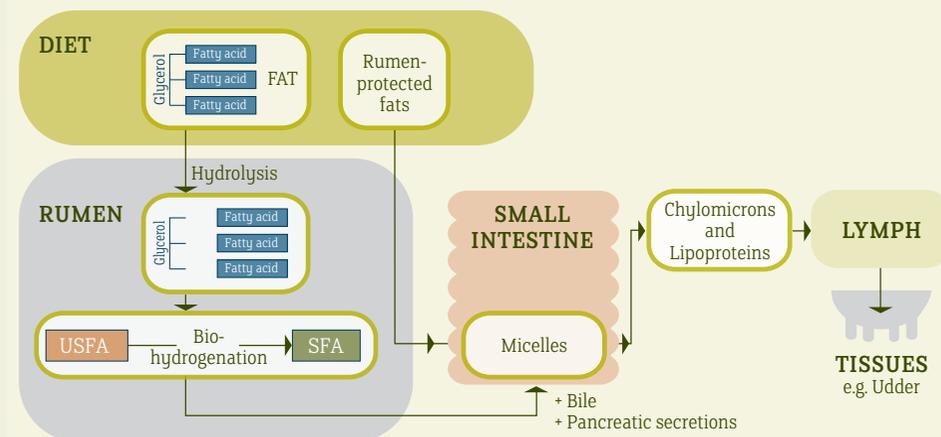
Most USFAs released are converted to SFA by the process of biohydrogenation.

The fatty acids then pass out of the rumen attached to feed particles and enter the small intestine where, with the addition of bile and pancreatic secretions, they form structures called micelles. Formation of micelles is the key to fat digestion as this is the form in which the water-insoluble fatty acids are absorbed through the gut wall. Here they are converted back to triglycerides and packaged into structures called chylomicrons and lipoproteins, before entering the lymphatic system for delivery to tissues such as the mammary gland for use.

Rumen-protected fats pass through the rumen unaltered for digestion in the small intestine.

- Dietary fats do not pass through the liver during digestion and so do not contribute directly to issues such as ketosis or fatty liver.

How fats are digested



◀01 Sustainability	◀02-04 Where are fats	◀05-10 Fat Features and benefits	◀11 Fat in feeds	◀12-15 Rumen-active and rumen-protected	◀16 Biohydrogenation	▶18-20 Milk fat	▶21-22 Fat requirements	▶23-24 Which fats to choose
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Milk fat synthesis

In general, fatty acid digestibility decreases with saturation i.e. USFA tend to have higher digestibility than SFA. Individual fatty acids such as oleic acid can help formation of micelles and improve digestibility of fat.

Highly-saturated triglycerides can have poor digestibility due to their high melting points and low solubility preventing digestive enzymes from breaking them down.

Milk fat

The mammary gland is one of the major sites of fat production in the dairy cow and synthesis of milk fat accounts for around half of the energy requirements for milk production. Milk fat % varies between breeds and with factors such as stage of lactation and diet.

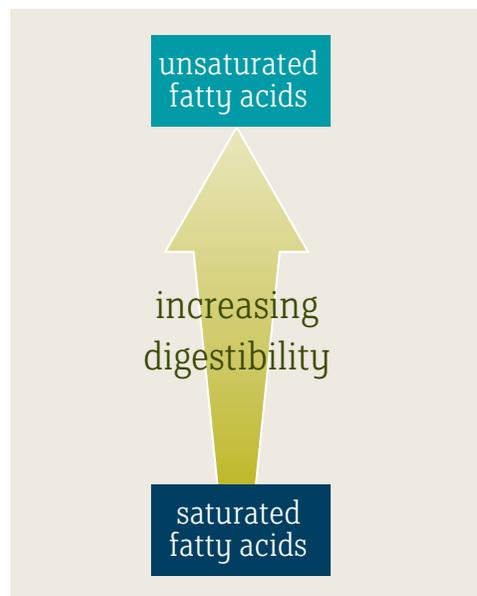
Milk fat synthesis

Milk fat is produced within the mammary gland and originates from three sources:

1. Direct (*de novo*) synthesis in the mammary gland from acetate and butyrate produced by fermentation in the rumen (contributes 40-50 % of total milk fat).
2. Fat supplied from the diet.
3. Mobilization of body fat/loss of body condition.

De novo synthesis results in the formation of all the short- and medium-chain (C4:0 to C14:0) fatty acids and approximately half of the C16:0 fatty acids found in milk. The remainder of the C16:0 and the longer chain fatty acids (C18 and above) are from lipids circulating in the blood plasma which arise in turn from dietary fatty acids and from fat mobilized from body reserves (body fat).

Digestibility of fatty acids



Milk fat manipulation

Altering milk fat %

Milk fat is the easiest of the milk components to manipulate and altering either the ingredients in the diet or the physical form of the diet can induce marked changes in milk fat %. A summary of some of the major dietary factors influencing milk fat % is given below.

Dietary factors affecting milk fat %

Increase milk fat %	Decrease milk fat %
Increase fibre	Reduce fibre
Low grain / Low starch	High grain / High starch
Long fibre	Finely-chopped forages
Cracked or coarse-rolled grains	Ground cereals
Small, frequent concentrate feeding (e.g. TMR or out-of-parlour feeders)	Large, infrequent concentrate feeds (e.g. twice per day in parlour)
Megalac rumen-protected fat	Rumen-active fat supplements, vegetable oil, fish oil, high-oil byproduct feeds (e.g. brewers grains)

In simple terms, high starch, low fibre rations generally induce low milk fat %, while adding rumen-active oils can lead to the production of particular *trans* fatty acids which are a major cause of milk fat depression.



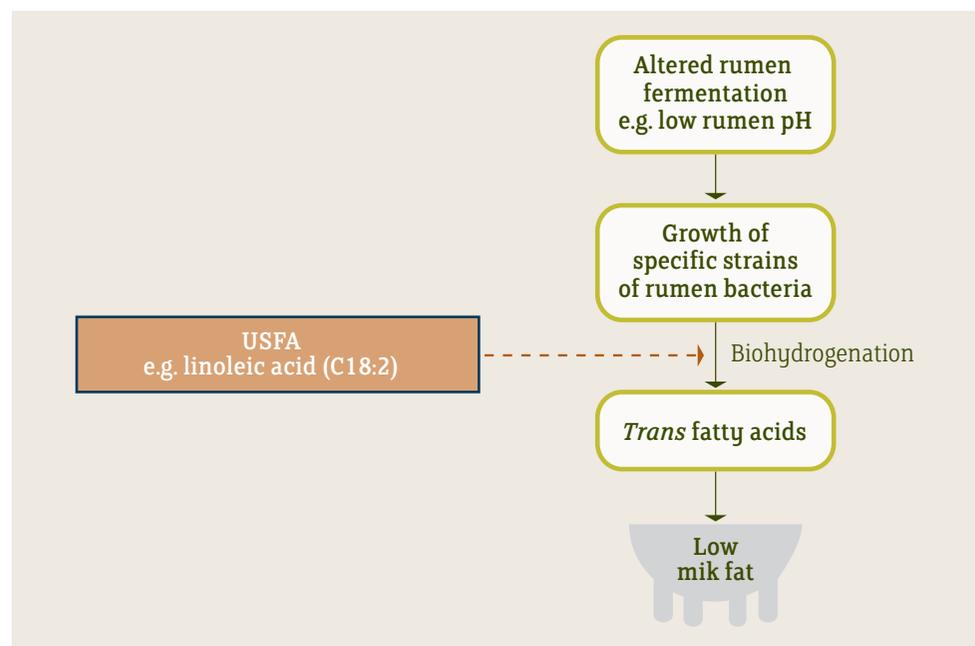
Milk fat depression

What causes milk fat depression?

Milk fat production is strongly influenced by nutrition, with milk fat depression being one of the primary examples. Diet-induced milk fat depression occurs when the diet contains rumen-active oils comprising USFA and where there is also an alteration in rumen fermentation. For example, high cereal/low fibre diets drive down rumen pH (more acidic) resulting in growth of particular strains of bacteria in the rumen. These bacteria modify the USFA in the diet (biohydrogenation process) to produce specific *trans* fatty acids (e.g. *trans*-10, *cis*-12 conjugated linoleic acid (CLA)) which are very potent at reducing milk fat production.

- As little as 2 g of *trans*-10, *cis*-12 CLA can reduce milk fat production by 20 %.

Biohydrogenation pathway leading to milk fat depression



This process is also active following turnout to pasture in spring. Animals grazing lush spring grass often have a slump in milk fat % over this period due to the low fibre and high oil concentrations in pasture compared with winter diets.

◀01	◀02-04	◀05-10	◀11	◀12-15	◀16	◀17	▶21-22	▶23-24
Sustainability	Where are fats	Fat Features and benefits	Fat in feeds	Rumen-active and rumen-protected	Biohydrogenation	Digestion of fats	Fat requirements	Which fats to choose

Animals requiring fat supplements

Which animals need rumen-protected fat ?

The greatest need for dietary fat supplementation is typically for lactating dairy cows. These animals are under the greatest nutritional stress due to their genetic potential for high milk production. However, all ruminant animals can benefit from rumen-protected fats and rations for sheep, goats and beef cattle are commonly supplemented with fat. Similarly, less-traditional farmed species such as buffalo and camels are also often offered fat supplements to improve performance.



◀01	◀02-04	◀05-10	◀11	◀12-15	◀16	◀17	◀18-20	▶23-24
Sustainability	Where are fats	Fat Features and benefits	Fat in feeds	Rumen-active and rumen-protected	Biohydrogenation	Digestion of fats	Milk fat	Which fats to choose

How much fat?

How much fat to feed

Fat requirements for dairy cows have been widely researched and general 'rules of thumb' developed to determine the adequacy of fat in rations for particular levels of production. For most other species there are no definitive guidelines as to the most beneficial level of fat to include in a ration.

It is well-established that the optimal level of fat in a ration for maximum efficiency of milk production occurs when 15 to 20% of the ME in the diet comes from fat. For high-producing cows, this could be equivalent to around 6 to 8% of ration DM.

A further approach is to work out the balance between fat consumed in feed and fat output in milk per day. A good approximation for cows in energy balance (not gaining or losing body condition) is to feed as much fat as is secreted in milk, as shown in the table below.

Guideline fat requirements for dairy cows in energy balance

	Value
DM intake	20 kg/d
Diet fat	3.5 % DM
Fat Consumed	700 g/d
Milk yield	30 kg/d
Milk fat	4.0 %
Fat output in milk	1200 g/d
Fat balance	-500 g/d

Recommendation: supplement the diet with 500 g of rumen-protected fat to make up the shortfall.

Fat released from body stores during periods of negative energy balance can also contribute to the fat requirements of the cow. This will be more pronounced in higher yielding cows where milk fat output is high yet diet supplies from the basal ingredients are limited. Hence, in this situation the cows' requirements can be met from additional rumen-protected fat supplementation taking into account the contribution from mobilised body fat.

Fat supply from particular rations and requirements of cows at particular production levels can be assessed using Volac's Fat Calculator: accessed online at www.volac.com/fat-calculator.



Which fat to choose?

How to compare fat products

With so many fat supplements available it is important to be confident that you know exactly how the different types of product work, what you are expecting them to do and whether they are providing value for money. Some questions you should be asking are:

1. How much fat/oil is in the product?
2. What is the fatty acid content of the fat and is this guaranteed to be consistent from batch to batch?
3. Is the fat rumen-active or is it rumen-protected?
4. What other ingredients are used and are they of any nutritional value?
5. How much moisture is in the product?
6. How digestible is the product?
7. What is the ME content?
8. What is the measured NE_L?
9. Is the supplement proven i.e. are the energy values measured and is there scientific evidence to support any claims?



- Megalac rumen-protected fat. The original calcium salt and the most proven product on the market.



Which fat to choose?

It may help to fill out the following table – remember to make sure everything is compared on the same basis i.e. as % DM or as % fresh weight. This can make a big difference: a product with 12 % moisture (88 % DM), with an ME of 27 MJ/kg DM will only contain 23.8 MJ/kg fresh weight.

	Megalac	Other Fat
Fat/Oil (%)	84	
Fatty acid profile (% total fatty acids)	C16:0 48 C18:0 5 C18:1 36 C18:2 9	
Rumen-protected or not?	Rumen-protected fat	
Formulation	Constant and balanced fatty acid profile and composition	
Moisture (%)	5	
Digestibility (%)	96 Measured	
ME (MJ/kg DM)	33.3 Measured	
ME (MJ/kg)	31.6	
Net energy for lactation (NE _L) (MJ/kg DM)	27.3 Measured	
Cost/tonne (£)	630*	
Cost/kg (£)	0.63	
Cost/% of oil (per tonne) (£/%)	7.5	
Cost/unit of ME (p/MJ/kg)	2.0	
Cost/unit of NE _L (p/MJ/kg)	2.3	
Protein (%)	0	
Fibre (%)	0	
Benefits/Proof	Over 30 years of independent and published trials showing production and fertility benefits.	

* Example cost only to show calculation

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Appendix: Ingredient fat profile

Fatty acid profile of some common feed ingredients

Fatty acid	% of total fatty acids											
	Canola	Corn oil	Soya oil	Wheat	Palm Kernel	Fish oil	Canola	Corn oil	Soya oil	Wheat	Palm Kernel	Fish oil
<C10					8							
Lauric acid		-	-	-	50							3.7
Myristic acid		-	-	-	16							-
Palmitic acid	3	12	11	18	8							10.2
Stearic acid	1.5	2.2	4	1	2.5							4.7
Oleic acid	63	27	25	15	12							18.6
Linolenic acid (omega-6)	19	57	50	56	3							1.2
Linoleic acid (omega-6)	10	1	8	6	-							0.6
EPA (n-3)												12.0
DHA (n-3)												13.8

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The information provided in this booklet is accurate at the date of publication so far as Volac is aware. Any changes to a farm animal ration should be approved by your nutritional advisor. Volac cannot take responsibility for problems, damages or losses caused either directly or indirectly by the use of information provided herein.

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