Vitamins and minerals are crucial for almost all physiological processes in the dairy cow. Therefore, a sufficient and balanced supply of vitamins and minerals is important. Problems with fertility and health, as well as reduced milk production, are often caused by a shortage or imbalance in dietary vitamins and minerals. Provimi has the Rupromin (Ruminant Provimi Minerals) range of minerals specifically designed to meet the requirements of dairy cows.

Our dairy range also contains a number of specialist products, such as long-acting buffering agents and various liver supporting products, to improve the performance of dairy cattle.
Optimise the performance of your dairy herd with the Provimi range.

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Rupromin mineral range
The Rupromin minerals range offers the perfect solution for every situation. It consists of a complete range of vitamins and minerals to ensure that there is a package that offers the optimal mix for your animals.

Rupromin minerals consist of unique microgranulates. The specific choice of ingredients and the unique production process guarantee a uniform and user-friendly product. Unlike minerals in powder form, Rupromin microgranulates are dust free and guarantee a good uptake and mixing in the feed mixer.

We divide the Provimi dairy range into the following four topics:

- **Improved immunity**
  To support the immune system of your cows and prevent health problems, Rupromin products contain a precise combination of antioxidants. These antioxidants eliminate oxidants. Oxidants reduce the immunity of your cows. Apart from the well-known antioxidant vitamin E, Rupromin also contains Grape PP and rumen bypass selenium. Grape PP improves the action of vitamin E. Rumen bypass selenium is better protected against degradation in the rumen, which enhances its antioxidant effect.

- **Transition management:**
  **Combined energy and liver support**
  Early lactation dairy rations are typically deficient in energy content. The energy density is too low to meet the high requirement of the cow in early lactation. The cow experiences a negative energy balance and this is compensated for by mobilising fat from body reserves. Supporting the liver with B vitamins is crucial in this stage of lactation. A shortage of these vitamins reduces liver function and can lead to an accumulation of fat in the liver. Provimi has developed two products to support the liver: LiFT and HyproPower. LiFT contains rumen bypass B vitamins that helps to reduce the risk of fatty liver. HyproPower is a combination of protected B vitamins and a rumen bypass fat, Hyprofat.

- **Healthy rumen, healthy hoofs!**
  Lameness and hoof problems occur regularly in dairy cattle. Proper buffering using Rupromin Balance and adequate addition of vitamins and minerals through Rupromin minerals are essential to tackle these problems. During heat stress, hoof problems may be aggravated, because the forage intake decreases while the concentrate intake is still high. The risk of rumen acidosis is therefore especially high under these circumstances. To reduce the risk of hoof problems and reduced milk production, diets with too much highly fermentable carbohydrates should be avoided, such as concentrates with a high amount of cereals. Rupromin Balance is then essential to buffer the ration.

- **Maximum rumen fermentation for optimal production**
  Rumen degradable protein is largely recycled in the rumen. Not only does this cause unnecessary losses of ammonia in milk and urine, but it also results in unnecessary energy losses. A well-known way to optimise rumen efficiency is to synchronise protein and energy in the diet, using the Provimi ration calculation program PFOS. Another solution is to reduce the protozoa in the rumen.

Ruprolac F has been developed to improve the efficiency of the rumen. This product has a built-in buffering action that provides the optimal environment in the rumen which in turn increases milk production and decreases the urea content.

Rupromin bucket range
The Rupromin range of vitamins and minerals are available in buckets for use in calf rearing systems as well as beef, dairy and dry cow systems such as during the grazing season. The antioxidant complex and the added trace minerals contribute to improved immunity and fertility. The high palatability ensures adequate uptake from the buckets.
The costs of these problems could be as much as €210 a cow a year. (Green and Muelling, 2005). There are, therefore, plenty of reasons to prevent these problems. Nutrition plays an important part in improving lameness and hoof problems. For example, it is important to introduce changes in the ration gradually and avoid high levels of concentrate without adequate fibre and roughage. Addition of vitamins and minerals is often essential to prevent hoof problems.

**Buffering**

Often, hoof problems like laminitis and sole ulcers are caused by sub-clinical rumen acidosis (SARA). Rumen acidosis occurs on many farms. Research by Plaizier et al. (2008) revealed that 19% of cows in early lactation and 26% of cows in mid lactation suffered from SARA. Hoof problems are caused by, among other things, the production of endotoxins from bacteria in the rumen. These endotoxins affect blood vessels in the hoofs and cause infections (Nocek, 1997). Stabilising the rumen pH by using buffering agents may help to solve these problems. Provimi has developed a widely active buffer, **Rupromin Balance**. Rupromin Balance is a mixture of various raw materials, differing in solubility and acid binding capacity. The product is fast and long-acting. It contains live yeasts that promote the conversion of lactate into propionate, improving rumen conditions. The buffering capacity of Rupromin Balance, compared to sodium bicarbonate from saliva, is shown in Figure 1.

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**Healthy rumen, healthy hoofs!**

Hoof problems occur on dairy farms three times more often than the farmer estimates (Espejo et al., 2006; Ward et al., 2008). White line disorder is a particular problem according to research and is estimated to occur on 85% of Dutch farms in an average of 9% of the cows. Between 15% and 20% of cows are culled because of lameness caused by hoof problems. (Ward et al., 2008; USDA, 2007).
Zinc
Zinc strengthens the keratin layer of hoofs (Andrieu, 2008). Also, zinc can repair small hoof injuries. Part of the zinc in Rupromin Hoofguard is supplied in organic form to improve the zinc absorption in the intestinal tract of the cow. Zinc, in combination with biotin, produces strong hoof tissue.

Heat stress
Cow may suffer heat stress in summer and problems are compounded by high humidity. Cows may even suffer heat stress in low temperatures if humidity is high. Heat stress may decrease forage intake while the cow is still consuming concentrates leading to increased risk of rumen acidosis. Rupromin Balance is an excellent solution to this problem. To avoid reduced milk production and quality, and hoof and fertility disorders, high amounts of easily fermentable carbohydrates (concentrates containing a lot of cereal grains) should be avoided. Feeding rumen resistant fat sources is a good solution.

Hyprofat
The energy content of the ration can be improved by feeding rumen resistant fat like Hyprofat. As it is not broken down in the rumen it achieves this without the risk of rumen acidosis. The high energy supply (3400 VEM/kg) ensures that the decrease in dry matter intake is countered when Hyprofat is fed at only 300 to 500 gram. Considerably less heat is produced with the digestion of this by-pass fat compared to the fermentation of cell wall material and starch. Hyprofat may be fed as a topdressing, as it is well-accepted by the animal. Provimi also has HyproPower, which contains Hyprofat, and has B vitamins to support the liver metabolism. The performance and immune status of the animals are maintained by using these products.

Vitamins and minerals
A shortage or imbalance in the uptake of vitamins and minerals will be detrimental to hoof health. This was recognised in studies on Dutch farms, where the locomotion score improved when cows received extra minerals (Amory et al., 2006). Rupromin minerals, like Rupromin Hoofguard, will improve hoof health.

Biotin
The effect of biotin on various hoof disorders was demonstrated in many different trials. Biotin is a B vitamin that is produced in adequate amounts in the rumen under normal conditions (NRC, 2001). If its production is reduced, perhaps by rumen acidosis, additional biotin is required. Many trials show that hoof problems are reduced when biotin is included in the ration. (Green and Muelling, 2005). Biotin decreases the occurrence of sole ulcers, white line infection and digital dermatitis. This decrease results from the effect that biotin has on the fatty acid metabolism, and on the production of keratin, both needed for the formation of strong and hard hoofs.

Daily supplementation of Rupromin Hoofguard provides the cow with sufficient biotin to prevent hoof problems.
Maximum rumen fermentation for optimal production

Many complex processes occur in the rumen of the dairy cow including the release of protein and energy that can be used by the animal. Volatile fatty acids (acetic acid, propionic acid, butyric acid) are formed and microbial protein is produced. Rumen fermentation, however, also produces waste products. Some of these waste products disappear in the form of gases like carbon dioxide ($CO_2$) and methane ($CH_4$). These greenhouse gases harm the environment and also represent losses of dietary energy.

**Improving rumen efficiency**
Rumen degradable protein is eventually broken down into ammonia or incorporated into microbial protein that will be available in the intestine. Ammonia ends up in the bloodstream and is converted into urea in the liver. This urea is excreted in milk or urine, or recycled through the saliva or the rumen wall. It may also serve as a nitrogen source for rumen microbes. Recycling of microbial protein results in considerable loss of protein in the rumen (Figure 1).

This leads not only to increased ammonia in milk and urea, but also to unnecessary energy losses. A well-known method to optimise rumen efficiency is by balancing protein and energy in the ration using Provimi’s ration calculation program, PFOS. Another method is to remove the protozoa from the rumen.

This is called defaunation. Theoretically, up to 40% more microbial protein may become available for the ruminant by suppression of protozoa. Studies in sheep have shown that a substantial improvement in efficiency is obtained where rumen protozoa are reduced as shown in Table 1.

![Image of cows in a field]
Liver function and buffering

A reduction of protozoa in the rumen will decrease the availability of choline. Choline plays a part in preventing fatty liver, but less protozoa also leads to an increase in microbial protein in the rumen. This improves the availability of methionine, an increase that easily counteracts the lower availability of choline. Protozoa also take up starch, thereby postponing the availability of the starch to the intestine to a maximum of 5% of the total available. This results in less buffering of rumen pH.

Ruprolac F

To improve rumen pH buffering, Ruprolac F has been developed. This product improves rumen function and provides a good environment for rumen microbes through built-in buffering. This leads to higher milk production and lower milk urea content. The vitamin levels are high enough to boost the cow’s immune system.

In another study, with cattle, it was shown that milk production increased when rumen protozoa were reduced, and the ratio of fat to protein also increased by 13% as shown in Table 2.

Table 3 shows work carried out by Provimi on high production dairy cattle. Cows were fed a 16% dry matter protein diet based on 50% grass and 50% maize silage. Results showed that by defaunation, the protein in the diet was used more efficiently and there was an increase in milk protein production and a decrease in milk urea. This study confirms the improvement in protein efficiency by defaunation in high production dairy cattle.

In the study 21% more microbial protein reached the small intestine. Daily gain improved by 11% and feed efficiency by 15%.

Table 1. Effect of defaunation in the rumen of sheep

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Defaunated</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumen ammonia, mgN/l</td>
<td>168</td>
<td>117</td>
<td>-30%</td>
</tr>
<tr>
<td>Microbial N flow, % LW</td>
<td>0.023</td>
<td>0.028</td>
<td>+27%</td>
</tr>
<tr>
<td>Microbial protein, g/kg FOM</td>
<td>175</td>
<td>250</td>
<td>+42%</td>
</tr>
<tr>
<td>(Acetate + Butyrate + Propionate)</td>
<td>4.2</td>
<td>3.4</td>
<td>-19%</td>
</tr>
<tr>
<td>Organic Matter digestibility, %</td>
<td>67.5</td>
<td>65.9</td>
<td>-2.6%</td>
</tr>
<tr>
<td>Average daily gain, % LW</td>
<td>0.601</td>
<td>0.644</td>
<td>+11%</td>
</tr>
<tr>
<td>Dry matter intake, % LW</td>
<td>2.51</td>
<td>2.53</td>
<td>+1%</td>
</tr>
<tr>
<td>Feed conversion efficiency, g/kg</td>
<td>10.88</td>
<td>12.85</td>
<td>+15%</td>
</tr>
<tr>
<td>Wool growth, %</td>
<td>5.48</td>
<td>6.23</td>
<td>+14%</td>
</tr>
</tbody>
</table>

Table 2. Effect of reducing rumen protozoa on milk production in cattle

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Defaunated</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protozoa count (10⁴/ml)</td>
<td>28.7</td>
<td>1.2</td>
<td>-95.0%</td>
</tr>
<tr>
<td>Milk yield (kg/d)</td>
<td>20.0</td>
<td>22.3</td>
<td>+13.5%</td>
</tr>
<tr>
<td>Milk fat production (g/kg)</td>
<td>868</td>
<td>912</td>
<td>+5.1%</td>
</tr>
<tr>
<td>Milk protein production (g/kg)</td>
<td>598</td>
<td>713</td>
<td>+19.2%</td>
</tr>
<tr>
<td>Milk fat (g)</td>
<td>45.6</td>
<td>38.8</td>
<td>-14.9%</td>
</tr>
<tr>
<td>Milk protein (g)</td>
<td>30.0</td>
<td>31.5</td>
<td>+5.0%</td>
</tr>
<tr>
<td>Protein/fat ratio</td>
<td>0.66</td>
<td>0.81</td>
<td>+22.7%</td>
</tr>
</tbody>
</table>

Table 3. Effect of defaunation on high production dairy cattle

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Defaunated</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield (kg/d)</td>
<td>41.1</td>
<td>42.0</td>
<td>+0.9%</td>
</tr>
<tr>
<td>Milk fat (g/kg)</td>
<td>41.0</td>
<td>42.4</td>
<td>+1.4%</td>
</tr>
<tr>
<td>Milk protein (g/kg)</td>
<td>30.1</td>
<td>30.5</td>
<td>+0.4%</td>
</tr>
<tr>
<td>Milk fat production (kg/d)</td>
<td>1.70</td>
<td>1.77</td>
<td>+0.07%</td>
</tr>
<tr>
<td>Milk protein production (kg/d)</td>
<td>1.26</td>
<td>1.27</td>
<td>+0.03%</td>
</tr>
<tr>
<td>Milk urea (mg/dl)</td>
<td>20.4</td>
<td>16.8</td>
<td>-3.6%</td>
</tr>
</tbody>
</table>
Rations for dairy cattle immediately post calving often lack energy. This is because the energy density of the ration is not high enough to cover the high requirement of cows at this stage and cows have a negative energy balance.

The cow compensates for this by mobilising body reserves (Figure 1).

**Figure 1. Typical energy requirement and dietary energy provision in the transition phase of dairy cows**

When the cow has a negative energy balance and is mobilising body reserves it is essential to support the liver function with B vitamins. Addition of these vitamins improves liver function and avoids fatty liver. This reduces the incidence of many metabolic problems. Fatty acids are released into the bloodstream to lesser extent and the risk on ketosis is reduced.

**By-pass vitamins**

LiFT is developed to support the liver at the end of the dry period and during the start of the lactation. When adding vitamins to a ruminant diet, they should be resistant to breakdown in the rumen.

A number of vitamins is resistant to rumen breakdown but others, like the liver supporting B vitamins, need to be protected from rumen breakdown. LiFT contains by-pass B vitamins for optimal liver support.
LiFT has been tested on dairy units in England. High yielding cows were divided into two groups of 20 cows each. The experiment started three weeks before calving and ended 90 days into the lactation. In the first 50 days of lactation, average milk yield increased by 3.4 kg a day where LiFT was included in the diet compared with the control. Later in lactation, the difference increased even further (Figure 2).

It is also possible to overcome some of the problems of a negative energy balance by including HyproPower in the diet. In this specific liver supporting product, B vitamins are protected from rumen breakdown by a rumen resistant fat source, Hyprofat. The use of Hyprofat increases the availability of energy to the animal and decreases the negative energy balance. HyproPower is a palatable product that may be used as a topdressing, mixed in concentrates or added to the total mixed ration.

Figure 2. Response in milk yield to LiFT
Free radicals are formed in the metabolic processes in the body and immune activity of white blood cells. These free radicals are released in the body and may destroy body cells. So-called oxidative stress arises when excess free radicals are present which can happen especially around calving and when milk production is high. To enhance the antioxidant status of cows and improve the immune status Provimi has developed Grape PP and bypass selenium for cattle. Grape PP contains a high amount of flavonoids (Figure 1). These flavonoids are much stronger antioxidants than vitamin E or vitamin C.

**Figure 1. Flavonoids**

Grape PP research
Extensive research has shown that Grape PP improves the antioxidant status of the animal. It stabilises the vitamin E (Figure 2) and by doing so it enhances the immune status of the animal. Up to 50% of vitamin E may be replaced by Grape PP in the diet which will reduce feed costs.

Udder health and hoof problems, along with other health disorders, can be costly on dairy units. Poor immunity contributes to these health problems. The immune function of cows is influenced by the supply of vitamins and minerals and by appropriate antioxidant action.
A good solution is a bypass (rumen-undegradable) selenium that is now available from Provimi. This product increases the availability of selenium to the animal and as a result it is more effective as an antioxidant at similar inclusion rates to the inorganic and organic forms. The Rupromin mineral buckets and the complete range of Rupromin minerals now contain Grape PP and by-pass selenium for improved immune status.

**Vitamins and minerals**
Apart from Grape PP and by-pass selenium, the Rupromin mineral products offer a comprehensive supply of minerals and vitamins to improve cattle health.

To support the immunity of your cows best, Provimi has developed **Rupromin ImmunoPlus** and **Rupromin ImmunoBase**. Its high vitamin E and Grape PP content is effective in reducing somatic cell counts and the number of mastitis cases. Biotine and zinc improve the recovery and the firmness of the keratin plug in the teat end which wears off during milking. These minerals therefore enhance the natural barrier function of the udder. Organic zinc is incorporated in enzymes and it is effective in protecting the cell from the inside out against free radicals. Copper is absorbed in the small intestine and is needed in the formation of superoxide dismutase, an important enzyme in the protection of cells against free radicals. A sufficient copper supply also prevents anaemia, thereby maintaining the general health status. To avoid minerals such as sulphur, molybdenum and iron influencing copper uptake Rupromin ImmunoPlus contains organically bound copper to guarantee a good uptake.
Energy demands for milk yield in early lactation are extremely high in modern dairy cows. However, the increase in dry matter intake (DMI) lags behind the increase in energy demands during this period, resulting in a negative energy balance (Figure 1).

Cows can mobilise more than 1kg per day of body fat to compensate for this energy shortage. This body fat needs to be metabolised in the liver in order to supply energy. Extensive mobilisation of body fat in high yielding cows puts a lot of pressure on the liver, which may lead to the development of fatty liver.

Fatty liver is strongly linked with other disorders such as ketosis, displaced abomasum, hoof disorders, mastitis, metritis, retained placenta, reduced fertility and impaired ureagenesis. This means that liver dysfunction is detrimental to animal health and performance and ultimately profitability.

Figure 1. Negative energy balance in dairy cows

LiFT is a feed additive that can help optimise the liver’s natural resources to improve performance in high yielding dairy cows and aid improvements in health, welfare and fertility.

“The role of the liver in transition cow management: The role of LiFT”
Provimi research has shown that LiFT can be effective in improving liver function and dairy performance. Recent improvements in the formulation of CLS Milk, which is now called LiFT, have improved its effectiveness even more. LiFT has been tested against CLS Milk in a trial at a commercial dairy farm in the Netherlands.

Blood sampling results showed that LiFT performed even better than CLS Milk in improving liver function (Figure 2 and 3).

**LiFT benefits**
- Improves fat metabolism in the liver
- Leads to more efficient utilisation of dietary nutrients and reduces the mobilization of body fat
- Improves energy supply to the mammary gland
- Increases yield
- Decreases risk for development of fatty liver and ketosis

<table>
<thead>
<tr>
<th>BCS* 2.75-3.5</th>
<th>BCS* &gt; 3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry period</td>
<td>50 grammes</td>
</tr>
<tr>
<td>Lactation: 0-100 DIM</td>
<td>100 grammes</td>
</tr>
<tr>
<td>100+ DIM</td>
<td>50 - 100 grammes</td>
</tr>
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</table>

* BCS = body condition score
NuStart is a unique combination of essential oils, probiotics, natural antioxidants (Grape PP) and prebiotics. It contains a wel-balanced mix of vitamins and trace elements for young calf development.

In repeated trials carried out at Provimi’s research farms all over the world, growth rates and health in calves fed calf milk replacer containing NuStart consistently out-performed the control groups. A considerable improvement of feed efficiency is also obtained with NuStart.

“**NuStart** - A natural performance enhancer, for the start of a lifetime”
The essential oils in NuStart help to stimulate appetite and kill the non desirable bacteria, while the prebiotic acts as a source of nutrients for the healthy bacteria and therefore aids efficient digestion. The probiotic quickly repopulates the digestive tract with beneficial bacteria. Grape PP is a powerful antioxidant that improves the calf’s natural ability to fight disease.

Provimilk with added NuStart improves the digestive process and increases feed intake, which boosts growth rates and improves feed conversion. In a study, 24 male Holstein calves were divided into two equal groups. A milk replacer containing 20% CP and 18% fat was fed during six weeks, combined with ad libitum Muesli starter feed (19% CP) from two weeks of age. In this trial, the calves receiving milk replacer with NuStart had a 27% improved growth rate (Figure 1) and a 17% higher feed intake than the calves receiving the control treatment without NuStart (Figure 2). These results also show the effect of NuStart on efficient utilisation of nutrients. The positive effect of NuStart on starter feed intake also stimulates rumen development.

NuStart benefits both dairy and beef animals. It contributes to meeting the target calving age of two years at the desired weight of 640kg before calving. In beef cattle, it reduces time to finishing. In both sectors, NuStart has a significant impact on profitability.

**NuStart benefits**
- Promotes an optimal, healthy gut flora
- Stimulates the development of the digestive tract
- Decreases oxidative stress
- Improves the calf’s ability to fight disease

The effects of NuStart result in a clear decrease of digestive disorders and a stimulation of dry matter intake. Besides that, NuStart improves growth and development and it increases feed utilisation and efficiency.
Increased forage efficiency, more milk production

Amaferm is a natural fermentation product of Aspergillus Oryzae. This European authorized zootechnical feed additive stimulates the digestion of fibre by enhancement of fungal growth in the rumen. More nutrients will become available to improve milk production.

**WHAT TO EXPECT:**

- Increased number and activity of rumen fungi and cellulolytic bacteria (*Figure 1*)
- Increased forage efficiency
- Improved profitability
- Increased milk production

*Figure 1.* Animation of fibre penetration by fungi in a control vs. Amaferm diet

Source: derived from Calza et al. 1993; Chang et al. 1999
Technical information

- Species: dairy cows
- Recommended dosage: 3-5 grams /cow/day
- Shelf life: 24 months
- Packaging: 25 kg bags
- Inclusion in TMR, pellet or premix

Product features

- Low inclusion rate
- Safe to handle in the factory
- Well proven unique mode of action
- Tested under research and field conditions

AMAFERM OFFERS:

- More fibre digestion
- Positive effect on milk yield
- Maintained cow productivity under heat stress conditions

Graph 1: Analysis of university performed trials on Amaferm indicate an increase in milk production of nearly 5%

<table>
<thead>
<tr>
<th>Control Kgs</th>
<th>Amaferm Kgs</th>
</tr>
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<tbody>
<tr>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>25</td>
<td>30</td>
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<td>30</td>
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