Hy-D®

Optimizing vitamin D levels for enhanced **health** and **performance** in dairy cows

dsm-firmenich

Challenges limiting the productive life and longevity of dairy cows

Extending the productive lifetime of dairy cows is a global challenge:

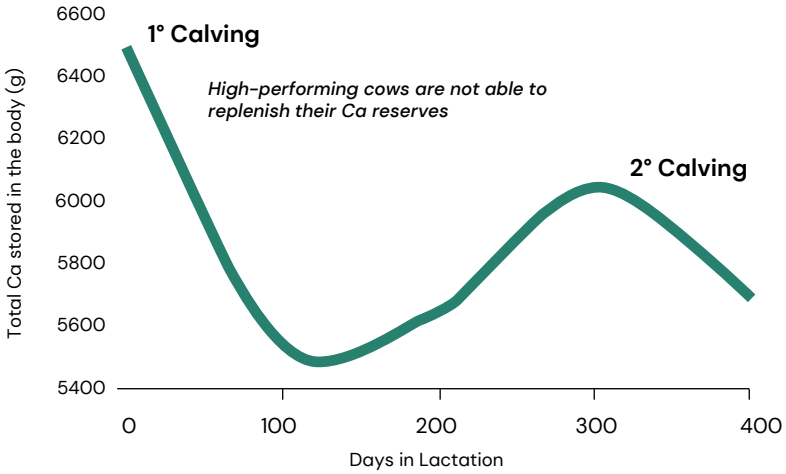
- Raising heifers requires significant time, money, and resources, so longer productive lives improve farm economics and reduce environmental impact
- The primary factors limiting dairy cow productivity and longevity are related to immunity, directly affecting productivity and fertility

Category	Reasons for culling	Reference
Reproductive problems	**~25–30%** of culls are due to reproductive issues such as infertility and failure to conceive	De Vries, A., & Conlin, B. J. (2003).
Mastitis & udder health issues	**~15–25%** of dairy cows are culled due to mastitis and other udder health issues	Hadley, G. L., Wolf, C. A., & Harsh, S. B. (2006)
Lameness & injury	Lameness accounts for **~10–20%** of culling decisions	Huxley, J. N. (2013)
Low milk production	**~15–20%** of cows are culled due to poor milk production performance	Thompson, P. N., Stone, A., & Schultheiss, W. A. (2006)
Metabolic & digestive disorders	Metabolic and digestive issues, such as displaced abomasum and ketosis, contribute **~5–10%** of culls	Guard, C. (2008)
Age	Older age and associated decline in overall health and productivity	

The calcium gap

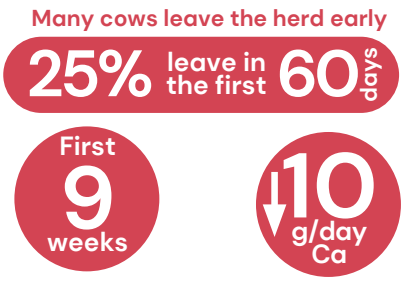
1. A 500 kg cow has about 6 kg calcium (Ca) reserves (SCA, 1990). During the first 9 weeks of lactation, a cow may have a Ca deficit of 10 g/day (Kronfeld, 1976), resulting in a loss of 10% of stored Ca, which will not be surely recovered
2. Every new lactation, the cows arrive with lower Ca levels to calving, which is why older cows are more prone to hypocalcemia
3. The bigger the milk yield, the bigger the calcium gap becomes. Calcium demand has changed with breeding animals for productivity but their capacity to uptake Ca has not changed

What if there was a solution to increase calcium absorption and reduce this gap?



Source: McGrath *et al.*, 2015

Assumptions: Liveweight cow 600 kg, 25 kg milk/d, DMI 20 kg/d in lactation, 11 kg/d in dry period. Dietary Ca content 0,6% (NRC, 2001), absorption efficiency in lactation 0,38 (NRC, 2001) and in dry period 0,25 (Klooster, 1976) and (McGrath *et al.*, 2015).



The key roles of vitamin D

1. Vitamin D's "classic" role: calcium and phosphorus metabolism

In the kidney

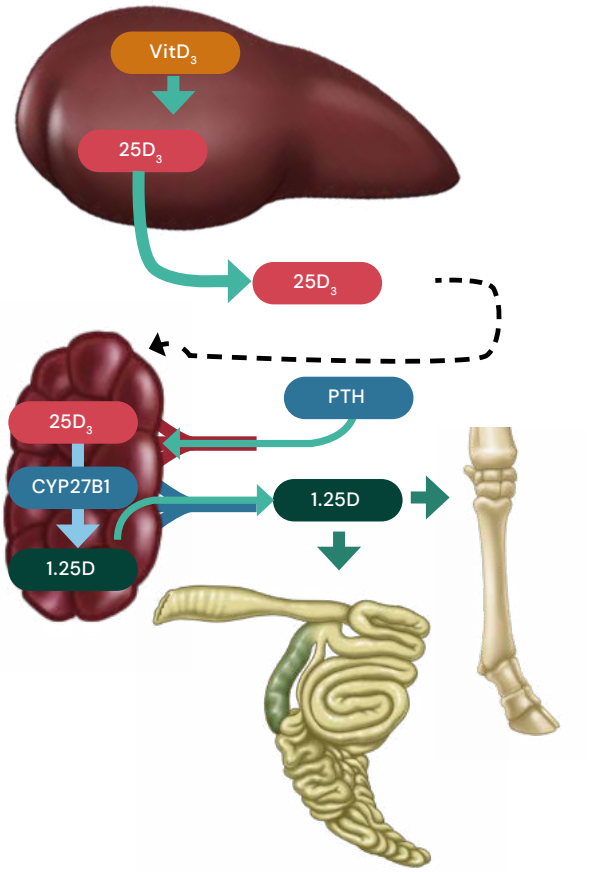
- 1, 25-OH-D_3 enhances the expression of genes for basolateral calcium transporters (resorption from urine to blood)

In the intestine

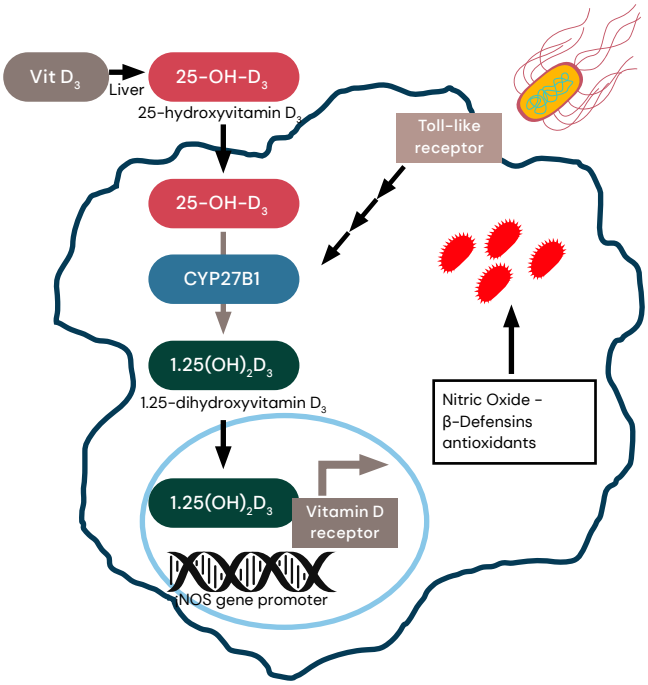
- 1, 25-OH-D_3 stimulates Ca absorption through the epithelium by increasing the permeability of tight junctions
- Enhances the absorption of phosphate by an upregulation of the Na-Pi-transporter

In the bone

- Under hypocalcemia:
  - 1, 25-OH-D_3 + parathyroid hormone (PTH) stimulates mobilization of Ca from bones to increase ionized Ca
- Under positive calcium balance:
  - 1, 25-OH-D_3 stimulates bone growth and mineralization by:
    - Increasing plasma Ca & Phosphorus (P) and
    - Direct effects exerted in osteoblasts



2. Vitamin D's "increasingly popular" role: immune regulation



Toll-like receptors
Source: Poindexter, 2019

1, 25-OH-D_3 stimulates gene expression involved in innate immunity, including toll-like receptors 2 (TLR2) and -4 (TLR4) associated with the defense against infectious agents such as lipopolysaccharides (LPS).

Resulting in:

- Increased bactericidal activity
- Reduction of ROS
- Reduction in inflammation

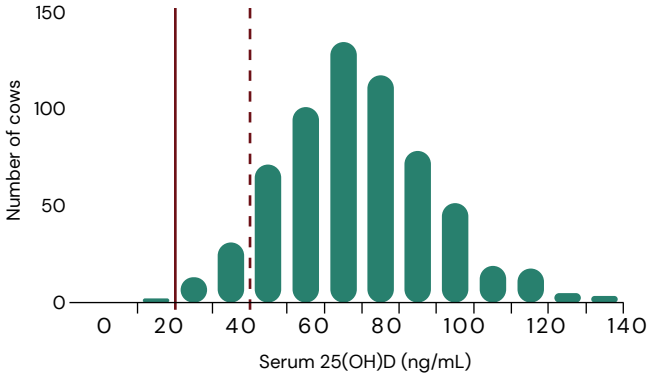
3. The "newest": increased yield of milk in dairy production

- Vitamin D increases carcass yield through protein synthesis and milk yield through increased gene expression for protein synthesis

Most dairy cows have low vitamin D levels

Dairy cows, USA

- 702 samples collected from 12 different herds
- Cows received 30 – 50 K IU vitamin D3 daily

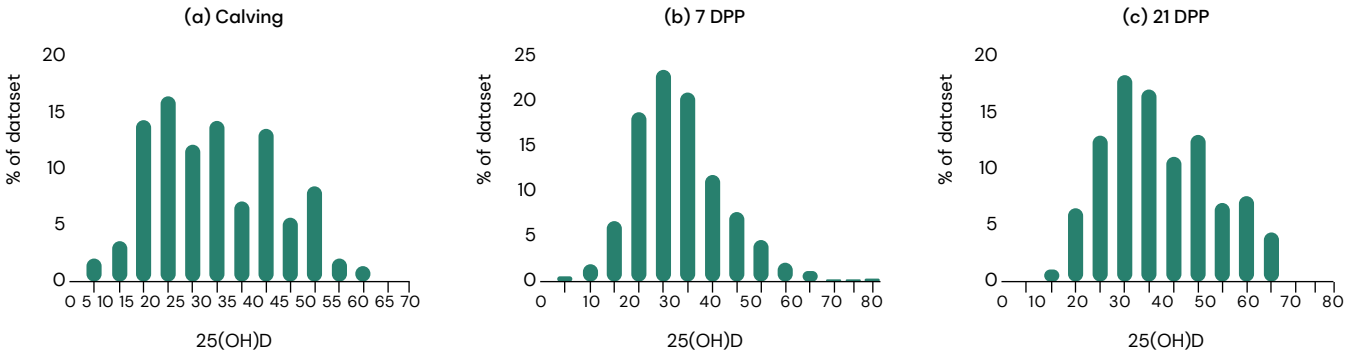


Source: Nelson *et al.*, 2016

Dairy cows during transition, Ireland

- 842 samples from 12 spring-calving farms
- 25-OH-D_3 concentrations correlated positively with immune cell populations

"Current supplementation strategies may not equip cows for optimal immune function"



Source: Ryan *et al.*, 2023

- Serum 25-OH-D_3 is the accepted status indicator
- Levels above 100 ng/ml support optimum immunity (Nelson *et al.*, 2018)

Hy-D®
Say YES to More!

Y

Yield increase of milk and carcass
Increases milk yield during early and late lactation in dairy cows and promotes muscle growth and development through protein synthesis in feedlot cattle and grazing cattle

E

Enhance calcium/phosphorus metabolism
Increases Ca/P concentration in blood, doubles Ca/P retention in the body that leads to bone mineralization

S

Strengthen immunity
Strengthen immunity reducing incidence of diseases during early lactation, improving colostrum quality & quantity, minimizing severity of mammary infection in mid-lactation cows, and improves calves' immunity

Y Yield increase of milk and carcass

Hy-D®'s impact on milk yield of dairy cows

Summary of trials with Hy-D®: Impact on milk yield

The table below summarizes various trials that compared conventional vitamin D3 supplementation with the use of the more available 25-OH-D_3. Hy-D® has been tested in different forms of application, during dry periods (green), during milking periods (purple) and one trial covering both stages (blue).

Table 1. Summary of scientific trials with 25-OH-D_3 supplementation on dairy cows and its impact on milk yield and health outcomes

Source	Period of Supplementation (DIM)	Period of measurement (DIM)	Control Milk Yield (kg/ECM)	25-OH-D_3 (kg/ECM)	Milk Yield Increase (Δ)	Health outcomes (p<0.05)
Martínez et al., 2018	-21 to 0d	0 – 50	35.6	38.6	**3.0***	-92% lower retained placenta -51% lower metritis incidence -52% lower incidence of multiple diseases
Silva et al., 2022	-30 to 0d	0 – 21	29.3	32.4	**3.1***	-14% higher glucose around parturition
Holub, 2023	-28 to 63d	0 – 63	55.3	56.9	**1.6***	
Ribeiro, 2019	Same as period of measurement	230 – 310	27.5	28.8	**1.3***	-20% lower SCC
Rodney, 2016	Same as period of measurement	206 – 236	16.9	20.8	**3.9**	
Xu, 2021	Same as period of measurement	0 – 21	25.1	27.3	**2.2***	
Xu, 2021	Same as period of measurement	114 – 181	29.6	30.5	**0.9***	-19% lower SCC

(SCC: somatic cell count, DIM: days in milk, ECM: energy corrected milk, *: significant difference of energy corrected milk yield, p<0.05)

E Enhance calcium / phosphorus metabolism

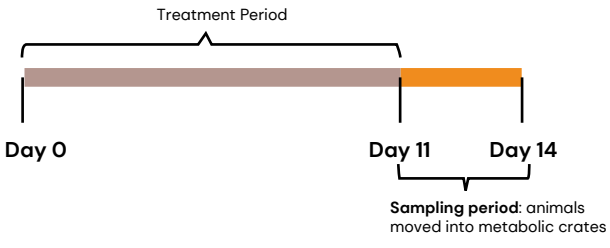
Hy-D® enhances Ca/P metabolism and homeostasis, increasing plasma levels and doubling retention in the body

Hy-D® doubles Ca and P retention within the body

Treatments:

- Control
- Hy-D®

Treatments period:



Unit	Matrix	Control	Hy-D®
Calcium (g/d)	Feed	65.7	66.4
	Feces	60.7	55.8
	Urine	0.9	2.5*
	Retained	**4.1**	**8.1***
Phosphorous (g/d)	Feed	26.1	26.4
	Feces	20.4	17.2*
	Urine	0.9	1.1
	Retained	**4.9**	**8.0***

- Hy-D® reduced fecal Ca and P excretion
- Improved Ca and P balance: retaining more Ca and P into the body
- Eventually leading to bone mineralization

S Strengthen immunity

Hy-D® strengthens and boosts immune defense, reducing the incidence of diseases

Outcomes of improved immunity after Hy-D® Supplementation (when compared to Vitamin D3):

During lactation

- **Somatic cell count** (SCC) reduced by 20% (Ribeiro *et al.*, 2019)
- Lower incidence of clinical diseases like **retained plascenta and metritis** (Martinez *et al.*, 2018)

During transition period

- **Increased colostrum** quantity and **quality** (+20% Immunoglobulin G concentration, Martinez *et al.*, 2018)
- Improved immune response after mastitis challenge (lower mastitis **infection, lower severity of infection**, lower requirement of **antibiotics**) (Poindexter *et al.*, 2019)

Hy-D® dosage recommendations

Dairy cows globally

Adequate D3 supplementation	**Close-up: 3 mg 25-OH-D_3/cow/day**	**20 000 IU D3 +1 mg 25-OH-D_3/cow/day**	
Far-off	Close -up	Lactation	Aim: remain above 100ng/mL

Dairy cows in EU

EU regulation limits vitamin D consumption from any source (D3 or Hy-D® at a maximum of 0.1mg/kg DMI)

1.5 mg 25-OH-D_3 (EU compliant) /cow/day during whole dry period		**20 000 IU D3 +1 mg 25-OH-D_3/cow/day (OVN, EU Compliant)**	
Far-off	Close -up	Lactation	Aim: remain above 100ng/mL

Break-even calculation

How much improvement is necessary to cover Hy-D®'s investment?

Increased milk yield to recover Hy-D®'s investment

- approx. **+30 kg milk/lactation** or **+0.1 kg milk/day** per cow

Lifetime performance to recover Hy-D®'s investment

- **+1 extra day of productive life** per cow

Boosts immune defenses to recover Hy-D®'s investment

- **-3 clinical mastitis cases/year** in a 100 milking cow farm

We bring progress to life

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