HEAT STRESS TOOL KIT

How to minimise the impact of heat stressed cows this summer

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VITALCHILL

A supplement pack designed to lessen the impact of heat stress in both dry and lactating cows.

BENEFITS

PROVEN TECHNOLOGY TO NATURALLY COOL COWS DOWN

- Improves cows' tolerance to heat
- Helps to lower internal body temperatures

MINIMISES HEALTH COMPLICATIONS

- Increases water intake to maintain good rumen buffering and rumen fill
- Helps to reduce the risk of acidosis

HELPS TO PROTECT MILK YIELD & QUALITY

- Supports good dry matter intakes
- Helps to maintain feed digestion and feed conversion efficiency
- Supports milk yield and milk constituents in the face of heat stress

HEAT STRESS TOOL KIT
Impact, management & nutrition solutions

Heat stress can be defined as the period when a cow is out of her thermal neutral zone (TNZ) i.e., she is unable to lose sufficient excess heat from her body without excess energy expenditure to reach her homeostatic preference of 38-39˚C because of:

- Higher ambient and environmental temperature
- Increased ambient and environmental humidity
- Reduced/restricted airflow

Whilst we may not consider living in the UK to be a high heat stress risk, by monitoring the temperature and humidity level in our herd's living environment we can begin to understand more fully when risks are high. The Temperature and humidity index (THI) is a measure widely used as an indicator of heat stress risk. Below is a guide which shows when heat stress risk can occur (adapted from Reneau, J. 2012) – Figure 1.

Figure 1: Temperature and humidity index (THI) is used to predict the thermal stress on dairy cows based on the combination of actual temperature and relative humidity

Dairy Cow Temperature Humidity Index (THI)								
	Humidity (%)							
Temp (Celsius)	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00
22	66	67	67	68	69	70	70	71
24	68	69	70	71	72	73	74	75
26	69	70	71	72	74	75	76	77
28	71	73	74	75	77	78	79	81
30	74	75	77	78	80	81	83	84
32	76	78	79	81	83	85	86	88
34	78	80	82	84	86	88	90	92
36	79	81	83	85	88	90	92	94
38	81	84	86	88	91	93	95	98
40	84	86	89	91	94	96	99	101

- (Yellow) Stress threshold for lactating cows. Respiration may exceed 60 BPM. Milk losses begin around 1.13kg/cow/day. Reproductive losses are detectable and rectal temperatures may exceed 39.17˚C.
- (Orange) Mild to moderate stress for lactating cows. Respiration rates may exceed 75 BPM. Milk losses around 2.72kg/cow/day. Rectal temperatures will exceed 39˚C at 72-73 THI and may be closer to 39.72˚C and above at 78-79 THI.
- (Red) Moderate to severe stress for lactating cows. Respiration exceeds 85 BPM. Milk losses around 3.95kg/cow/day. Rectal temperature exceeds 40˚C.
- (Purple) Severe stress! Life threatening conditions for lactating cows. Respiration rates are 120-140 BPM. Rectal temperatures may exceed 40.56˚C.

How does heat stress impact herd performance?

When THI levels reach above or equal to 70, it is widely recognised that herds will see falls in performance from reduced milk production and quality, disrupted fertility and weakening to immune function and response.

Cows can start to reduce their own heat production by reducing dry matter intake (DMI) and therefore heat generating rumen fermentation, and by increasing their heat abatement potential by redirecting blood flow to the skin and by sweating and panting.

Falls in DMI lead to declines in milking performance and potential falls in body weight and condition. Rhoads *et al.,* (2009) shows that heat stressed cows do not break down their own body fat reserves to maintain milk production when DMI falls due to heat stress. However, this only accounts for around 50% of milk yield loss associated with cows experiencing heat stress with the remainder being a consequence of the cow partitioning nutrients away from milk production and towards her own maintenance and heat abatement.

Dry cows are not exempt from heat stress impacts too. Studies have shown that the regeneration of mammary gland tissue during the dry cow period is impaired when dry cows experience periods of heat stress, therefore reducing her milk production potential for future lactations. Additionally, calves born to heat stressed late lactation or dry cows have been seen to have lower birth weights and lower first lactational yield performance – although heat stress periods may appear to be short, there can be multi-generational lasting effects. Karimi *et al.,* 2014 (JDS) shows the effects of THI levels above 69.7 in the last 3 weeks pre-calving - Figure 2.

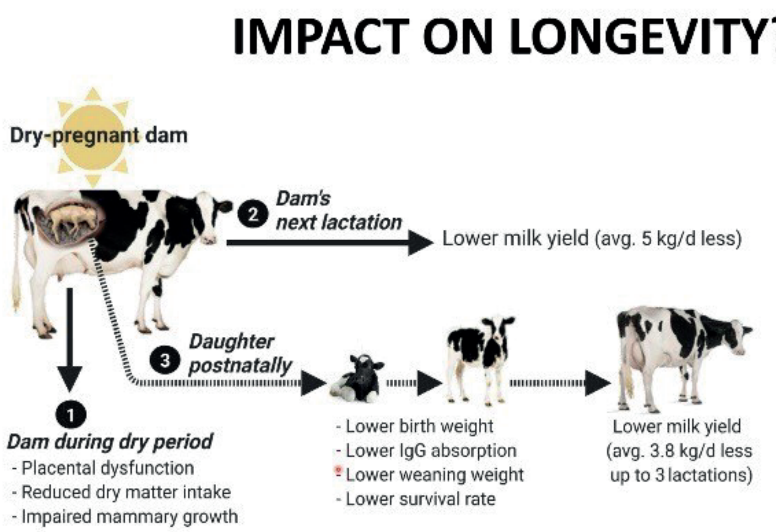
Figure 2: Impact of heat stress in pre calving cows, Karimi *et al.,* 2014

	DRY PERIOD				LACTATION
	Breaths/min	Standing mins	Ruminating mins	DMI kg	Milk yield kg Avg. first 180 days
Cooled	63.3	390.4	282.5	15.5	44.6
Heat stress	70.4	474.0	243.2	13.7	40.5

Karimi *et al.,* 2014 also noted a reduced gestation length (277 v 274 days) and lower calf birth weights (42.6kg v 38.6kg). In addition, heifer calves from heat stressed dry cows produced 2.2kg/day less in the 1st lactation, up to 6.3kg less in the 3rd lactation with more calves born from heat stressed dams culled before the end of the first lactation and overall productive life reduced. Heat stress has the potential to have a significant impact of the longevity, summarised in Figure 3, (G Dahl, 2024).

Fertility performance can also take a downturn when cows experience heat stress periods – for every 1˚C increase in a cow's rectal temperature, there can be a 25% decrease in pregnancy rate (Ulberg and Burfening, 1967 JAS). Increased cow lethargy and reduced mobility can lead to oestrus signs not being expressed as strongly and therefore being missed.

Figure 3: multi-generational impact of heat stress (adapted from G Dahl, 2024)



Hansen (2007) comments that the time of year can have a large effect on the oocyte quality, with higher THI periods showing cows with larger numbers of smaller ovarian follicles and reduced oocyte quality. The oocyte remains susceptible to heat stress before ovulation and if fertilised the developing embryo can be more likely to develop slowly or abnormally. The developing embryo becomes more resilient to maternal heat stress with time, with effects day 3 after fertilisation having little to no effect on embryo development. Hansen continues to explain that heat stress can still cause reductions in foetal and placental growth if experienced during gestation.

It is therefore essential that we support both dry and lactating dairy cows and their environment to reduce the likelihood of THI level climbing to heat stress risk zones. We can increase their heat abatement capability and decrease the negative impact of heat stress on the current dairy herd and future generations.

To reduce the likelihood and the effects of heat stress, we need to take a 2-pronged approach:

1. Manage the herd's environment to reduce the potential for THI to increase to THI 70 and beyond.
2. Support the animal with specialist feed additives to enhance her potential for heat abatement, support dry matter intakes and ruminal function.

Management strategies to decrease likelihood of heat stressed cows
Dairy cows are not known for their excellent ability to lose heat, they have a low surface area to volume ratio and produce a large amount of heat from ruminal feed fermentation, so to support them we must first address the THI potential of their environment.

Below are our on farm management recommendations for reducing heat stress potential:

1. **Measure, measure, measure!**
   Regularly measuring temperature and humidity of a herd's environment helps to understand when THI hits a risk level. One farm set up will not the be the same as another, so focus on each herd individually and use monitoring THI to plan ahead. Bear in mind that what may feel cool to you, will most likely feel a lot warmer to a dairy cow!
   THI calculation:
   THI =0.8 x Temperature (˚C) + Relative Humidity (%) x (Temperature (˚C) -14.4) + 46.4
2. **Monitor, monitor, monitor!**
   There may be tell-tale signs at lower THI levels that cows are beginning to experience heat stress such as:
   - Panting
   - Drooling
   - Periods of prolonged standing
   - Milk leakage
   - Sweating
   - Increased water consumption
   - Decrease feed intake

   Watching the herd for early signs of heat stress is key in heat stress abatement.

3. **Feed and water management** for maintenance of rumen fill and function

	DRY COWS	MILKING COWS
Water	Provide plenty of cool, clean drinking water with minimum 10cm (4-5 in) per cow length of water trough available, and at least two water troughs available per pen to allow unhindered access.	
Feed space	Provide ~92cm (approx 36 in) of feed space	Provide ~60cm (approx 24 in) of feed space

Additional measures around feeding regimes which can reduce the amount of time a cow spends daily at increased risk of heat stress:

- Feed early in the morning and late at night
- Push up feed multiple times during the day
- Remove old feed from the feed fence or troughs
- Clean water trough regularly
- Make sure water feed into troughs is sufficient to meet demand
- Keep effective fibre content in the diet at a high level to avoid rumen acidosis
- Maintain the energy density of the diet
- Review the metabolic base ratio (MBR) of the diet to account for the extra potassium requirement used in sweating

4. **Housing management**

	DRY COWS	MILKING COWS
Housing	Provide housing with good ventilation and shade. For a bedded pack, provide ~10m² (approx. 100 ft²) space per cow, and for cubicles a maximum 80% occupancy, but aim for a lower stocking density where possible.	Provide housing with good ventilation and shade. For cubicles, a maximum 95% occupancy, but aim for a lower stocking density where possible.

Additional measures around housing/daily routine which can reduce the amount of time a cow spends daily at increased risk of heat stress:

- Reduce walking distances where possible
- Reduce time in holding pens and make sure they are well ventilated or cooled
- Provide shade for cows that are grazing
- Avoid vet visits, vaccinations etc in the middle of the day
- Consider installing heat abatement systems in areas of high heat stress risk, e.g., cubicle beds, milking parlours and holding areas

Feeding for improved heat abatement and rumen support

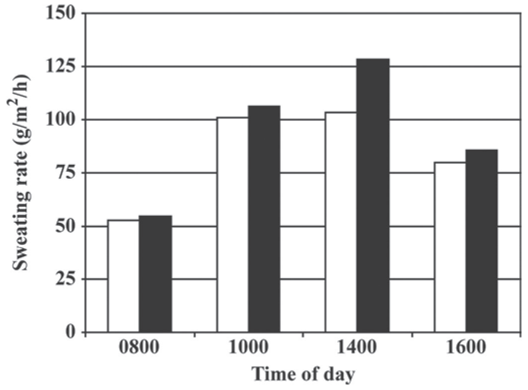
Alongside practical management strategies, there are nutritional aids that can be fed easily to dairy cows to support them with their heat abatement.

Premier Nutrition recommends using VitalChill, as part of both lactating cow and dry cow rations – it contains a combination of feed additive technologies which are both rumen effective and absorbed in the small intestine. When combined, they can help to improve rumen function, increase blood flow to skin, and stimulate water intake.

1. **Niacin**

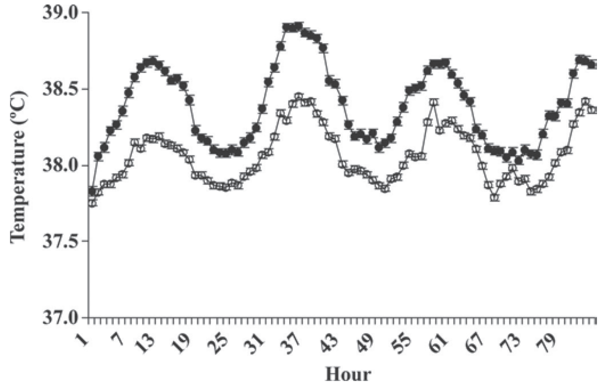
VitalChill contains both rumen degradable and rumen bypass niacin sources. Niacin increases vasodilation (blood vessel widening) at the skin's surface, therefore transferring larger amounts of heat away from the core body to the cow's extremities. Zimbelman *et al.,* 2010 shows the positive effects of feeding encapsulated niacin to heat stressed Holstein cows, increased sweating rates and decreases in vaginal temperatures - Figures 4 and 5.

Figure 4: Effect of THI on mean evaporative heat loss, Zimbelman *et al.,* 2010



Effect of temperature-humidity index (THI) on mean evaporative heat loss in control (white bars) and niacin-fed (black bars) cattle at 0900, 1000, 1400 and 1600 h during heat stress.

Figure 5: Pattern of vaginal temperatures in 1-h intervals of lactating Holstein cows supplemented with 0g or 12g niacin, Zimbelman *et al.,* 2010

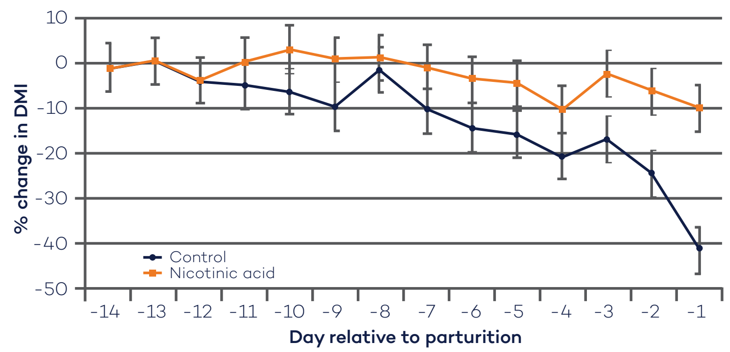


Pattern of vaginal temperatures at 1-h intervals of lactating Holstein cows supplemented with 0g (●) or 12 g (O) of encapsulated niacin per day during d 4 to 7 of heat stress. The SEM derived from the pooled vaginal temperatures was 0.02. Treatments differ at $P < 0.001$.

Heat stress can lead to reductions in rumen gut wall integrity because of lower DMI, decreased saliva production and natural rumen buffering. Heat stressed cattle have been showed to have reduced tight gut junction protein genes expressed, which is alleviated by feeding niacin (Zou *et al.,* 2024) and it also supports the maintenance of rumen papillae length.

Niacin has also been shown in transition cows to support the maintenance of DMI pre-calving, supporting improved performance post-calving, French, 2004 - Figure 6.

Figure 6: Change in DMI for control and nicotinic acid supplemented cows, French, 2004



Change in dry matter intake for control and nicotinic acid (48 g/d) supplemented cows.
Expressed as a percentage change from -15 to -21 day averge.
Interaction for treatment by time was significant at the level of P < 0.01 (SE = 4.5).

2. Essential Oils

The essential oil blend in VitalChill supports the cow in multiple ways. Capsicum has been shown to support in the maintenance of rumen pH which can lead to reduction in DMI and alterations to the rumen microflora and reduction feed fermentation. In a study by Oh *et al.,* 2021, the supplementation of cows -21d pre-partum and into early lactation saw improved dry matter intakes resulting in improved milk yield (P<0.05), Figures 7 and 8.

Figure 7: Weekly DMI of cows fed rumen protected capsicum versus control, Oh *et al.,* 2021

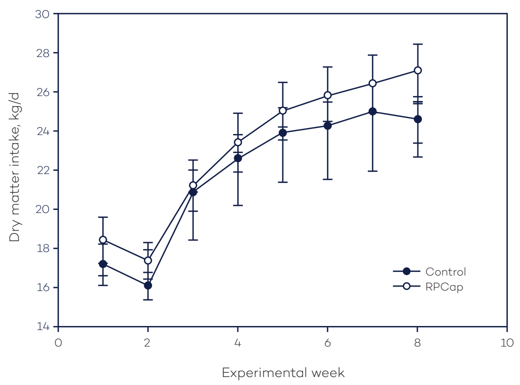
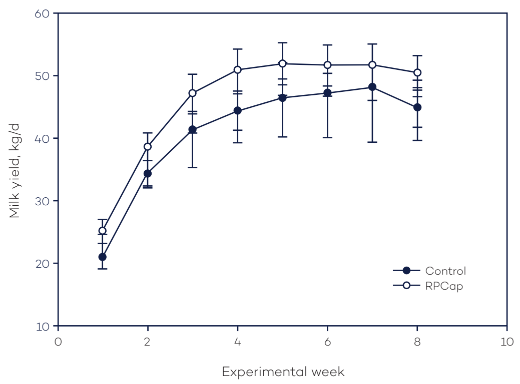
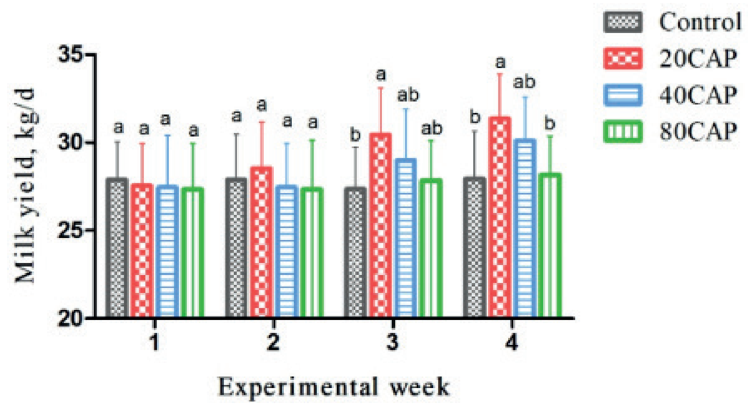


Figure 8: Weekly milk yield of cows fed rumen protected capsicum versus control, Oh *et al.,* 2021



This effect is reflected in cows that are experiencing heat stress, with reduction in DMI and milk production alleviated with feeding capsicum, An *et al.,* 2022 (P<0.05), Figure 9.

Figure 9: Change in milk yield for cows fed a basal diet supplemented with increasing levels of capsicum, An *et al.,* 2022

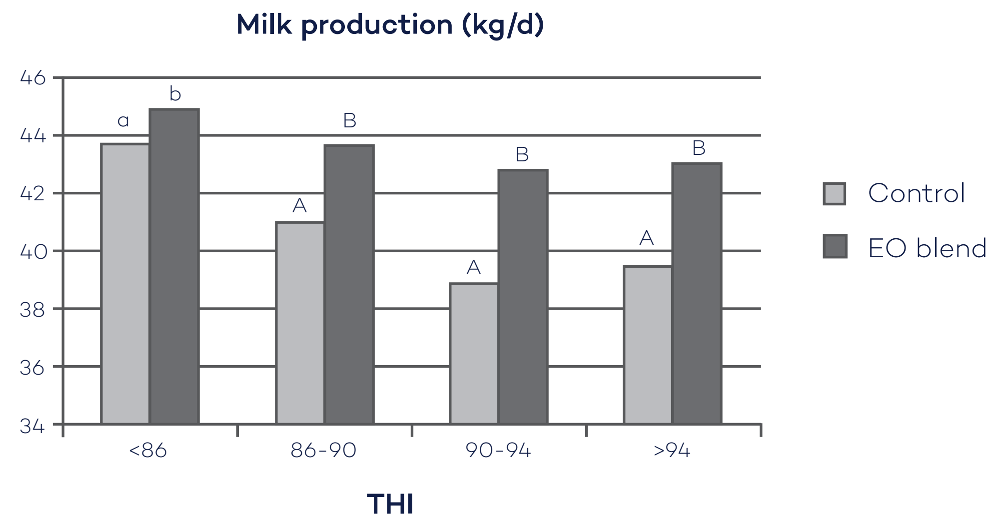


Cows fed capsicum were seen to increase their saliva production, which increases the cow's natural ability to buffer her rumen (Rodriguez-Prado *et al.,* 2006), therefore reducing her risk of rumen pH falling into an acidosis risk level, and reducing DMI and feed fermentation capability further.

Other essential oils included in VitalChill are eugenol and cinnamaldehyde, which *in vivo* studies by Cardozo *et al.,* 2006 have been shown to increase propionate production in the rumen and reduce acetate production. This is advantageous to cows experiencing heat stress as propionate is the preferred energy source for cows during these stress periods as propionate can produce more glucose.

Research has shown that the combination of capsicum, eugenol and cinnamaldehyde support heat stressed cows' milk production even at severe levels of heat stress as shown below - Figure 10.

Figure 10: Milk production from cows in differing levels of heat stress with and without essential oil blend in the diet (Bouraoui *et al.,* 2002)



3. Live Yeast

Probiotics, such as live yeasts, have been shown to support the ruminal environment to aid feed digestion. Live yeasts promote a preferential rumen environment for fibre digesting bacteria, by scavenging oxygen, competing against lactate producing micro-organisms and acting as a nutrient source for the rumen microbiome. This aids the maintenance of a higher rumen pH which is preferential for fibre digestion, supporting higher volatile fatty acid (VFA) production that is essential for the provision of energy to the cow and supporting milk fat production.

VitalChill contains a highly rumen viable live yeast to support a heat stressed cow's ruminal environment and DMI. Moallem *et al.,* 2009 shows us how the introduction of this live yeast to lactating cow diets supports the maintenance of DMI (+2.5%, $P<0.0001$) and milk production (+4.1%, $P<0.007$), both yield and constituents, Figures 11 and 12.

Figure 11: DMI of dairy cows fed either a control diet or supplemented with live yeast (*Saccharomyces cerevisiae*) during the hot season, Moallem *et al.*, 2009

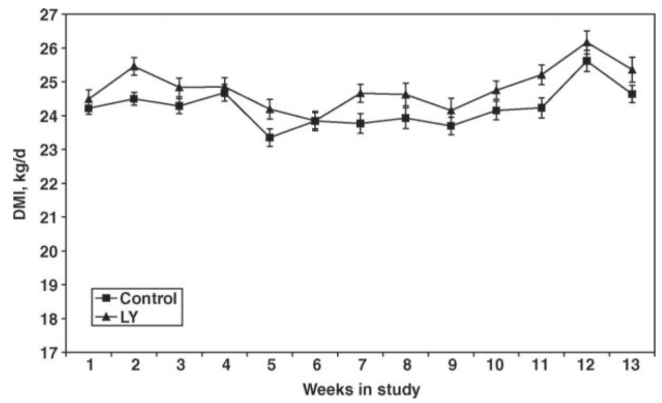
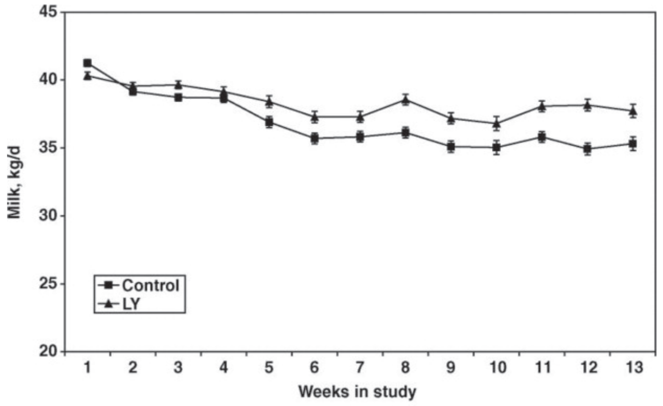


Figure 12: Milk production of dairy cows fed either a control diet or supplemented with live yeast (Saccharomyces cerevisiae) during the hot season, Moallem *et al.,* 2009



The supplementation of live yeast in heat stressed cows has also been seen to increase plasma glucose levels (Salvati *et al.,* 2015), as energy requirements of dairy cows increases during periods of heat stress this may explain not only improved milk production but better health and fertility status of heat stressed cows that are fed live yeast.

All references quoted throughout this document are available upon request.

VitalChill is suitable for feeding to both lactating and dry cows. It should be fed at 25g/head/ day during periods of heat stress (THI >70), and ideally feeding should begin at least 14 days before the predicted heat for optimal effect.

It can be fed as part of the daily TMR as:

- VitalChill Farm Pack
- Included in a Premier Nutrition mineral
- As a component of a blend

Or it can be included in a compound feed.

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Speak to our Ruminant Nutrition Team to see how VitalChill could support your herd's heat abatement strategies:

Donald Lawson: +44 (0)7779 114 078
donald.lawson@premiernutrition.co.uk

Anna Dinsdale: +44 (0)7912 569 934
anna.dinsdale@premiernutrition.co.uk

Ashley Morris: +44 (0)7808 888 533
ashley.morris@premiernutrition.co.uk

Shannon Cunnane: +44 (0)7749 401 310
shannon.cunnane@premiernutrition.co.uk

Lorna Power: +353 (87) 491 4664
lorna.power@premiernutrition.co.uk

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