

# Metabolic stress: a comparison of high and low genotypes

C H Knight and A Sorensen

Hannah Research Institute, Ayr KA6 5HL



# High vs Low Merit Cows: Some Simple Energetics

- ☞ HGM produce more milk than LGM
- ☞ HGM are often bigger, but need not be
- ☞ HGM eat more than LGM...
- ☞ ...but the increased intake is typically less than the increased output...
- ☞ ...so HGM partition more to mammary and mobilise reserves to a greater extent

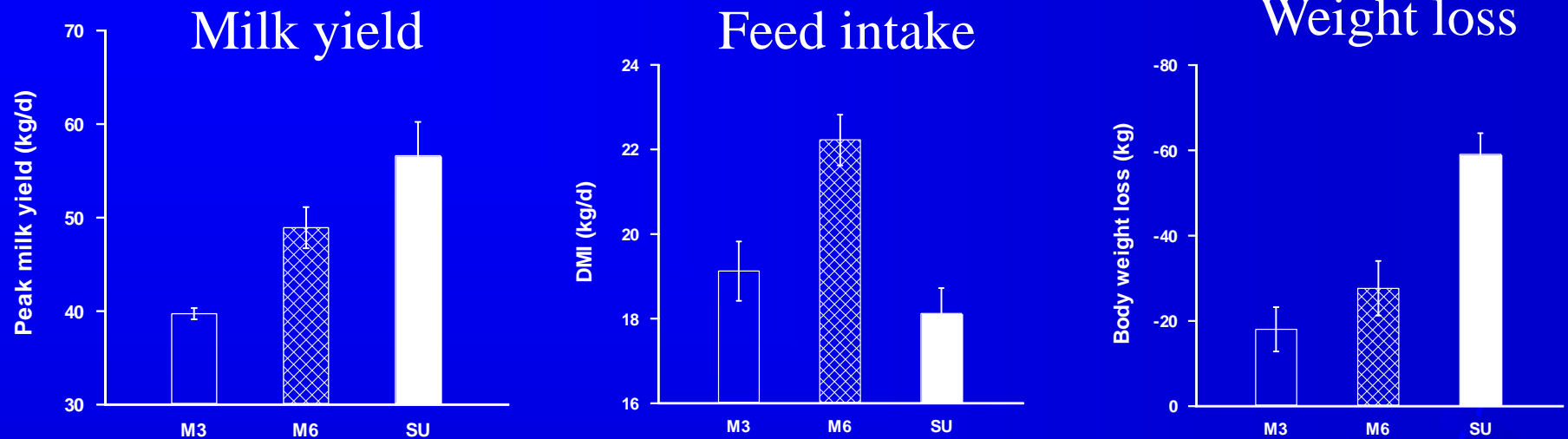
# What is Metabolic Load?

- ☞ Burden imposed by synthesis and secretion of milk
- ☞ Degree of imbalance between input and output
- ☞ Output as a proportion of capacity

# What is Metabolic Stress?

- ☞ That amount of metabolic load which cannot be sustained, such that some energetic processes (which could include those maintaining general health) must be down-regulated

# Extremes of metabolism



Comparison of 3X milked, 6X milked and Suckled (3X + 3X)

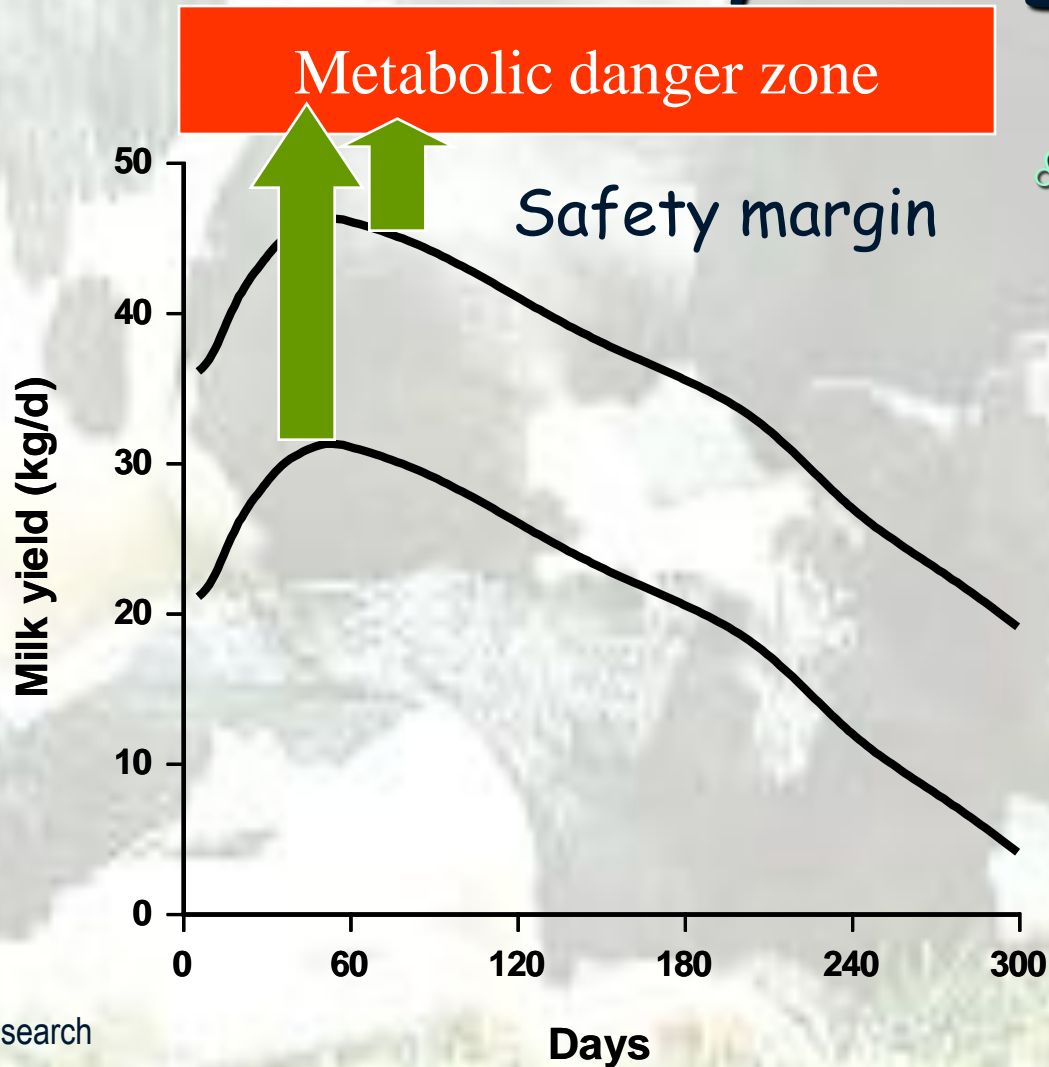
- 👉 Milk yield: Suckled higher than 6X
- 👉 Feed intake: Suckled lower than 6X
- 👉 Body wt loss: Greatest in Suckled

# Questions

- ☞ In peak lactation dairy cows, does excessive energy imbalance rectified by mobilisation:
  - ...cause health problems?
  - ...compromise lactation?
- ☞ Is this a peculiar feature of high genetic merit cows?



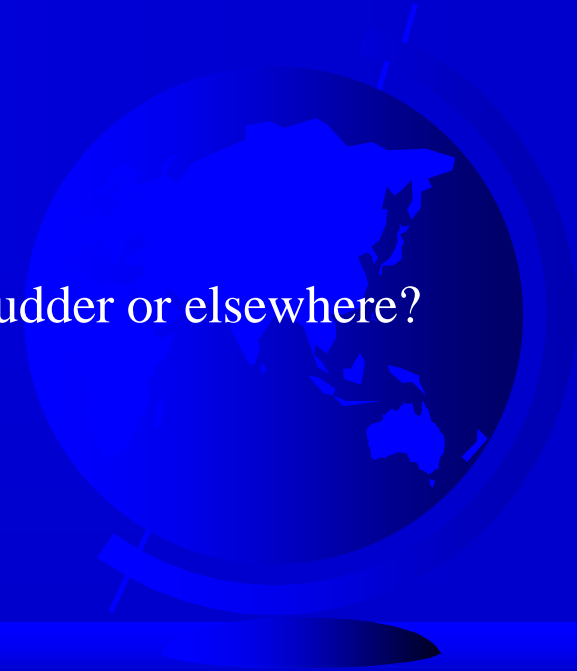
# Metabolic safety margin



Does the high genetic merit (HGM) cow operate closer to her danger zone?

# Objectives

- Are high genetic merit cows operating closer to their metabolic maximum?
- If so, does this expose them to greater risk of metabolic problems?
- Where is maximum output determined: within the udder or elsewhere?





# Design

- 12 HGM and 12 LGM cows
- Half of each group treated (HT, LT), half control (HC, LC)
- Stepwise, additive, multiple stimuli to achieve maximum yield
- Two week treatment periods



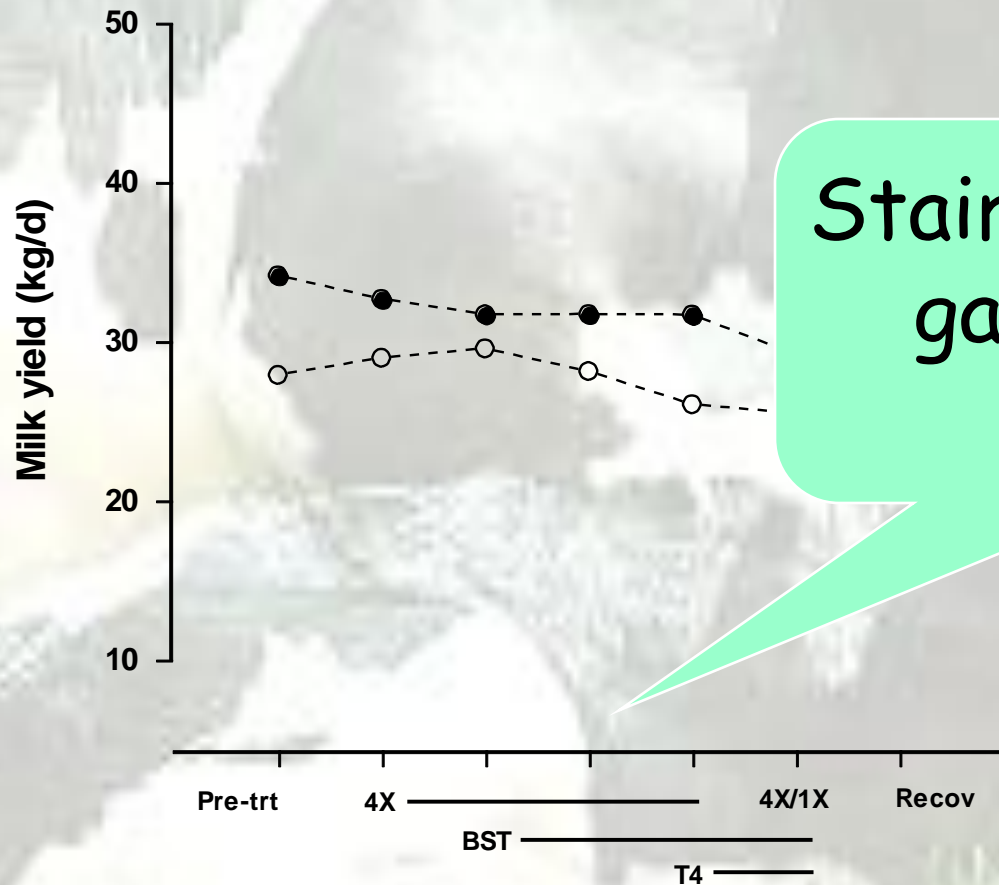
# Periods

- 1: Pre-treatment
- 2: Frequent milking (4X)
- 3: 4X +BST
- 4: repeat of 3
- 5: 4X + BST + thyroxine (T4)
- 6: 4X/1X + BST + T4
- 7: Post-treatment

# Measurements

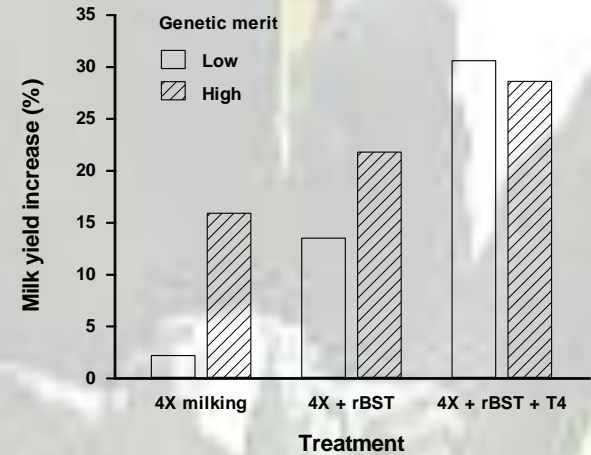
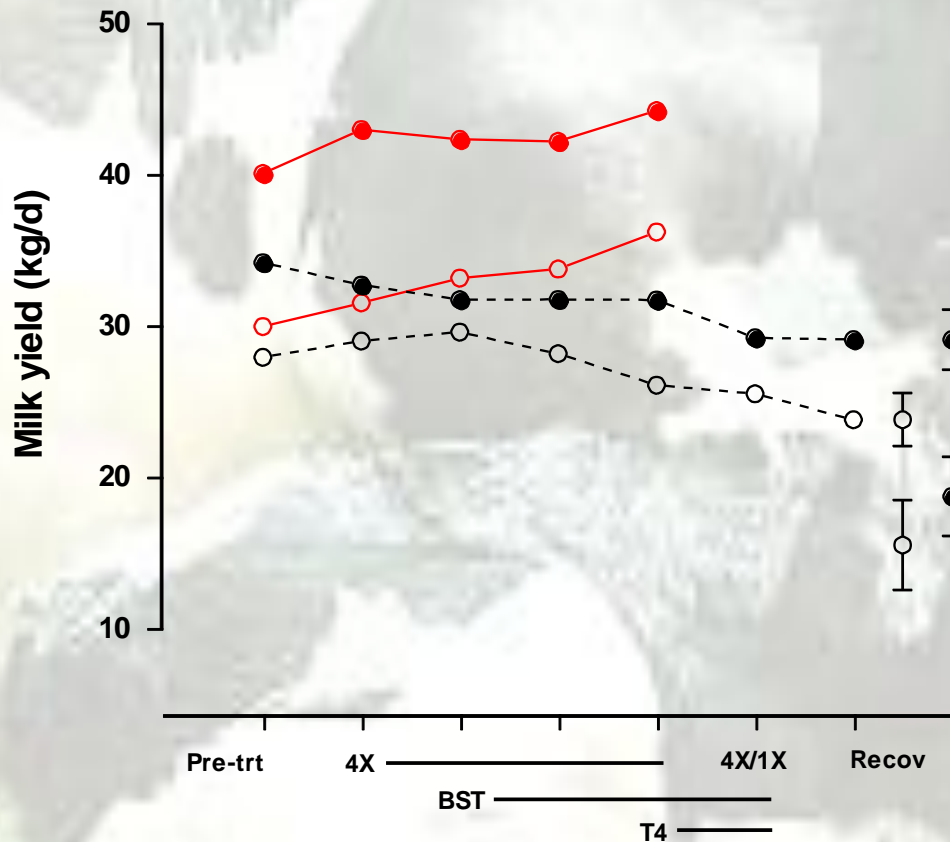
- ☞ Milk yield and composition
- ☞ Body weight and condition score
- ☞ Heart rate
- ☞ Metabolic and stress hormones
- ☞ Plasma metabolites

# Comparing high and low genetic merit cows



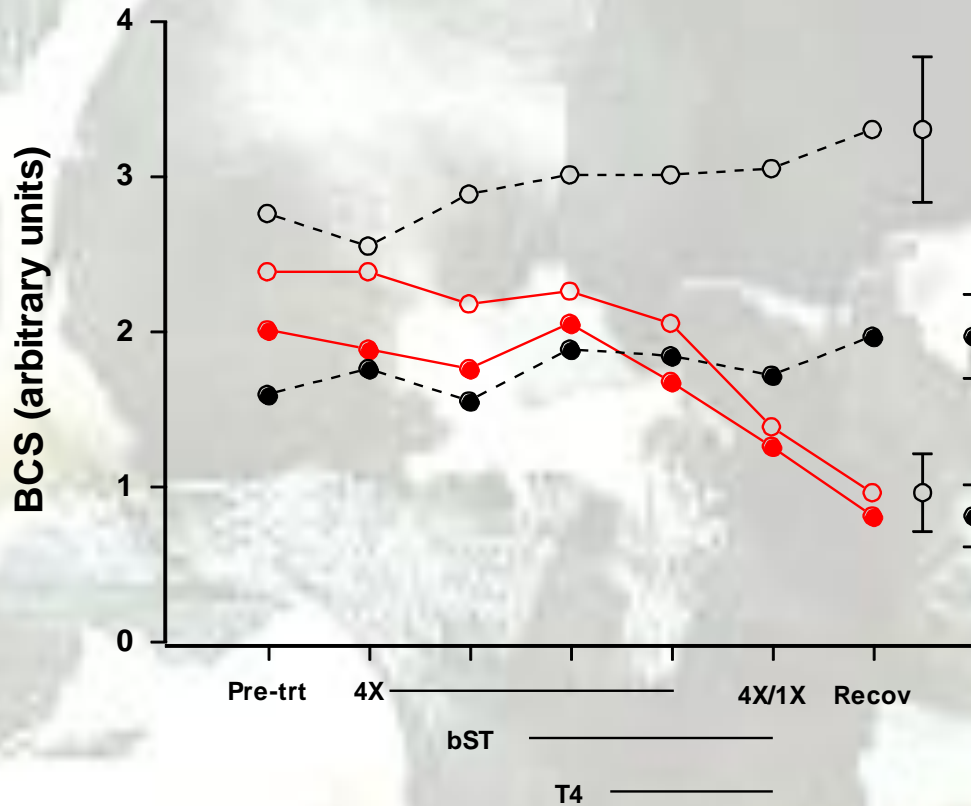
Stair-step additive galactopoietic stimuli

# Effect of galactopoietic stimuli



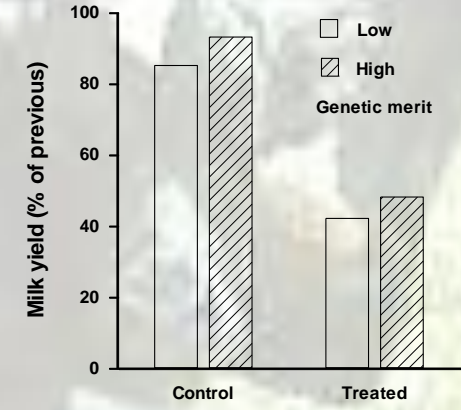
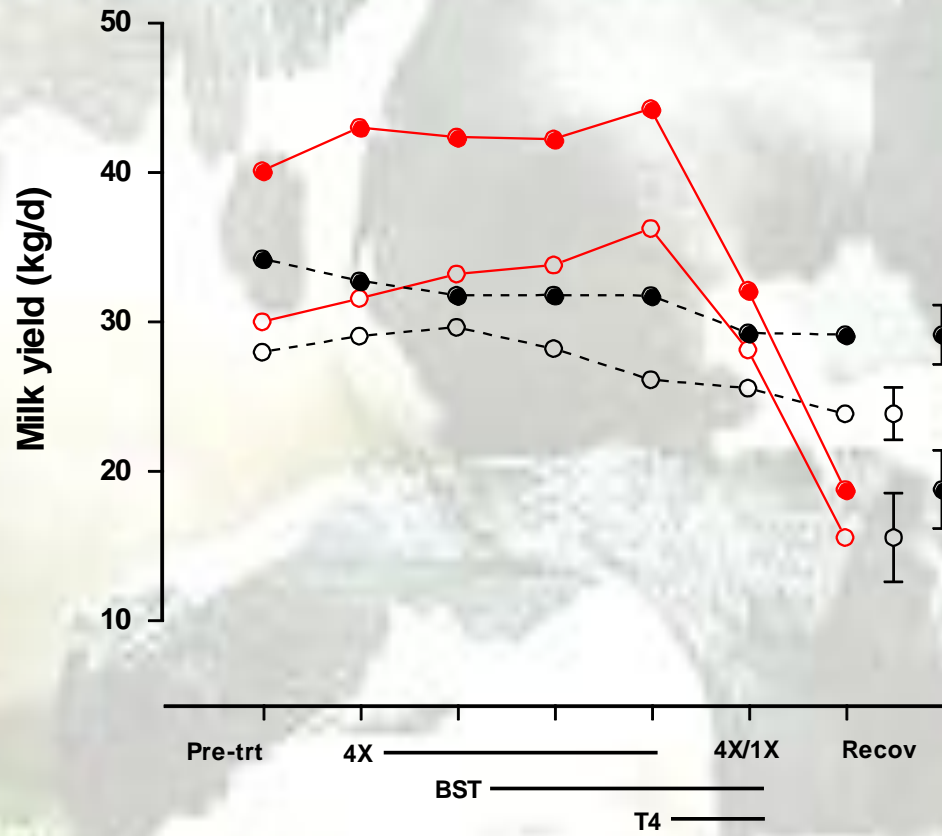
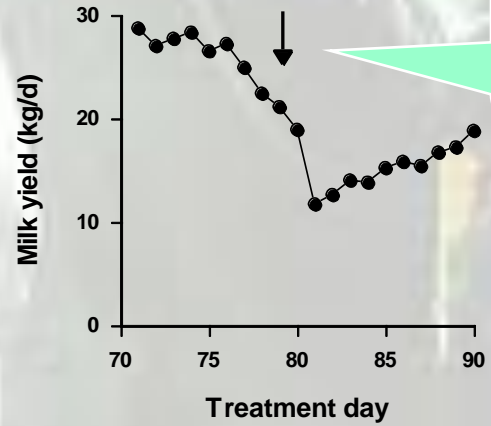
Ω Equivalent responses

# Condition score



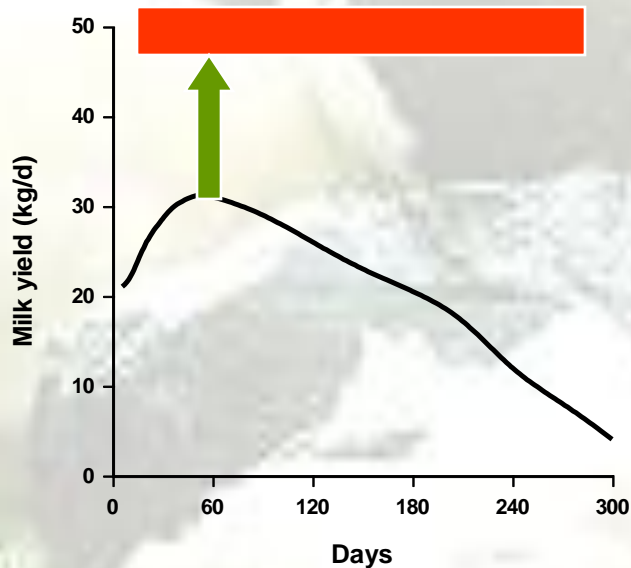
# Lactation fails!

L: 84d  
H: 83d

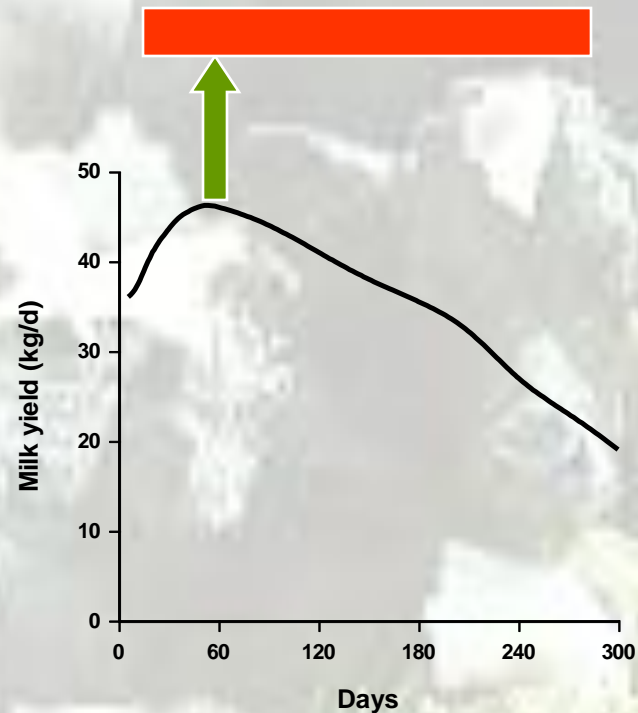


# Safety margin has been maintained

LGM

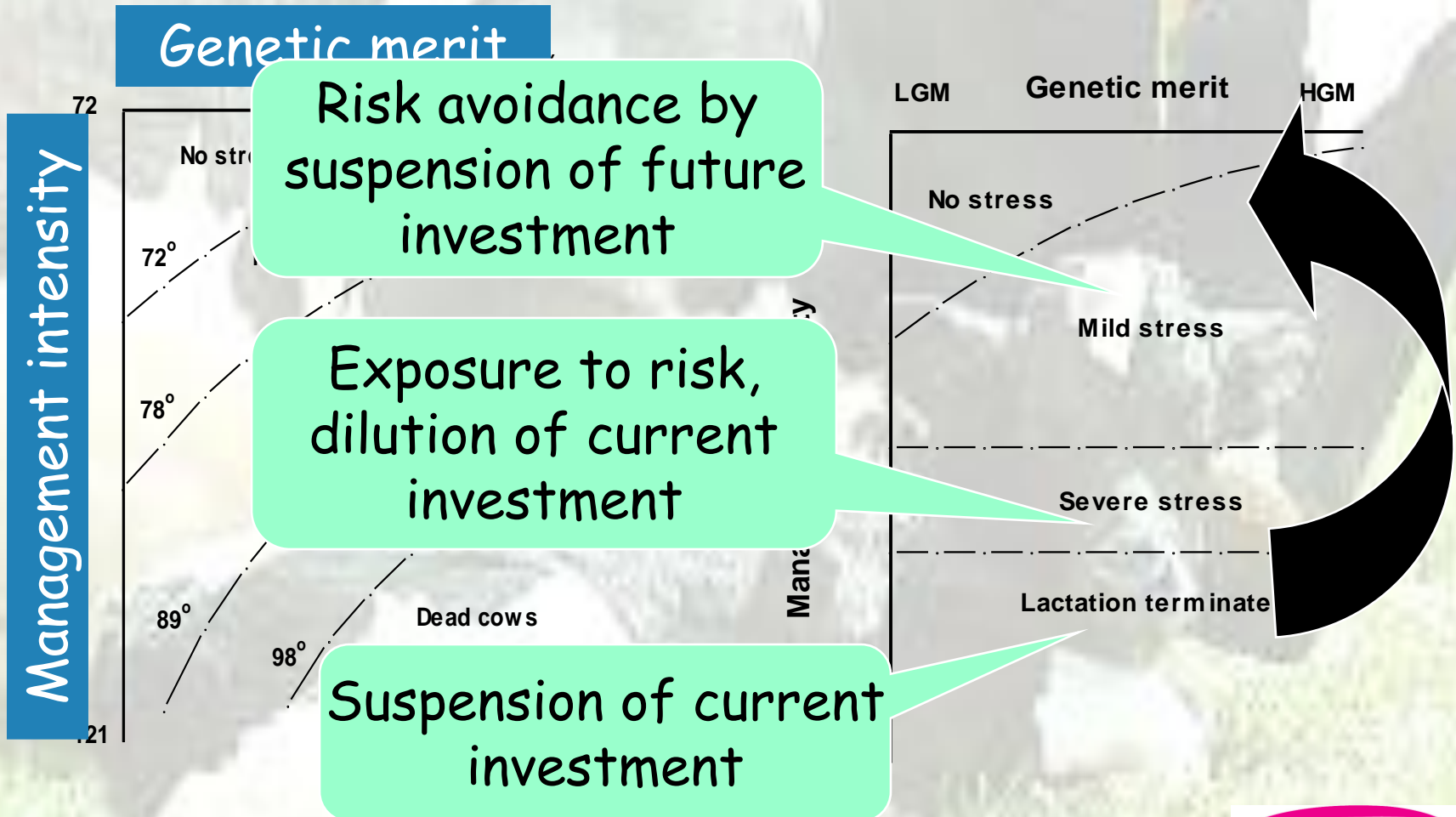


HGM





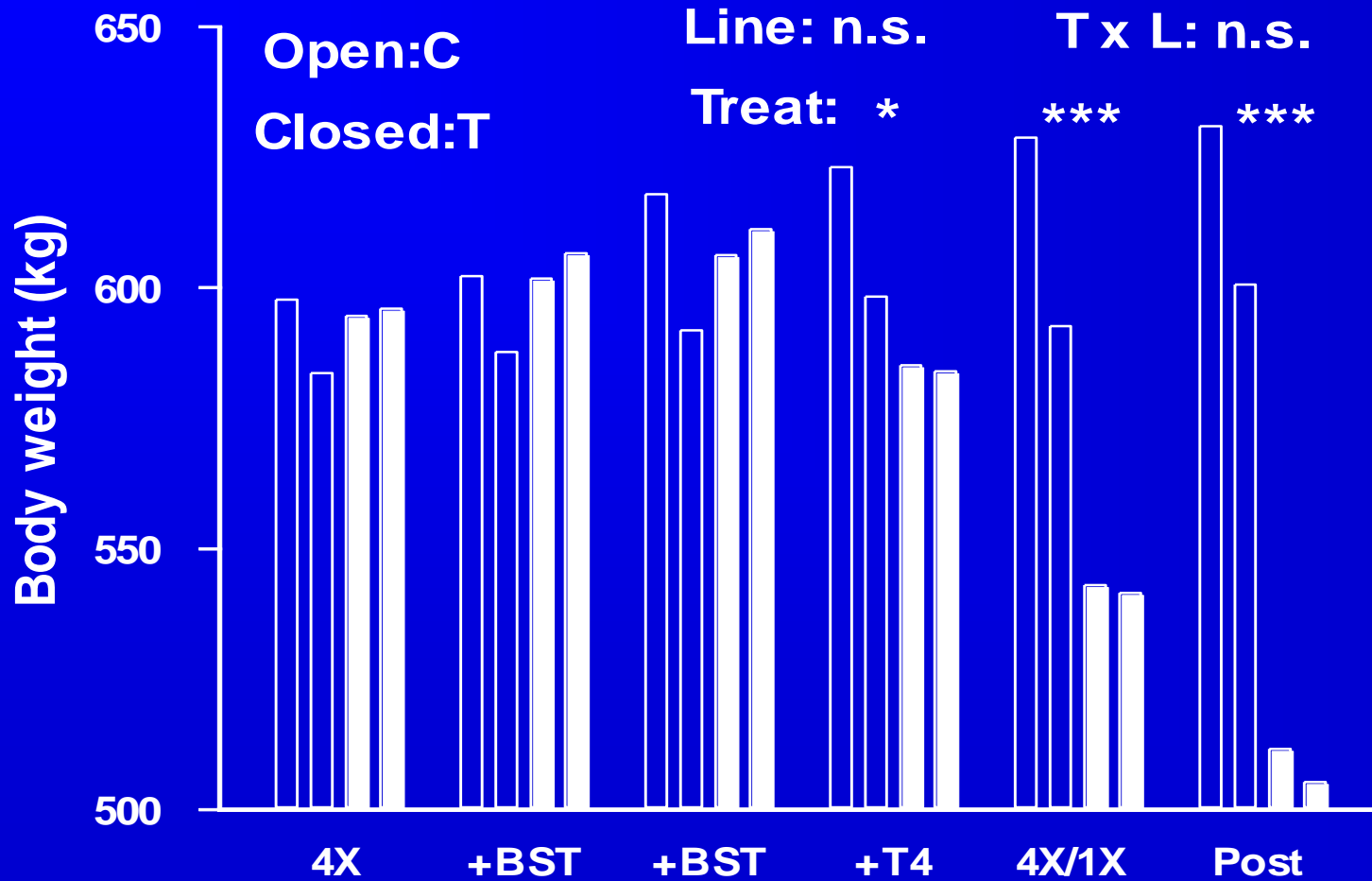
# The cow fails safe



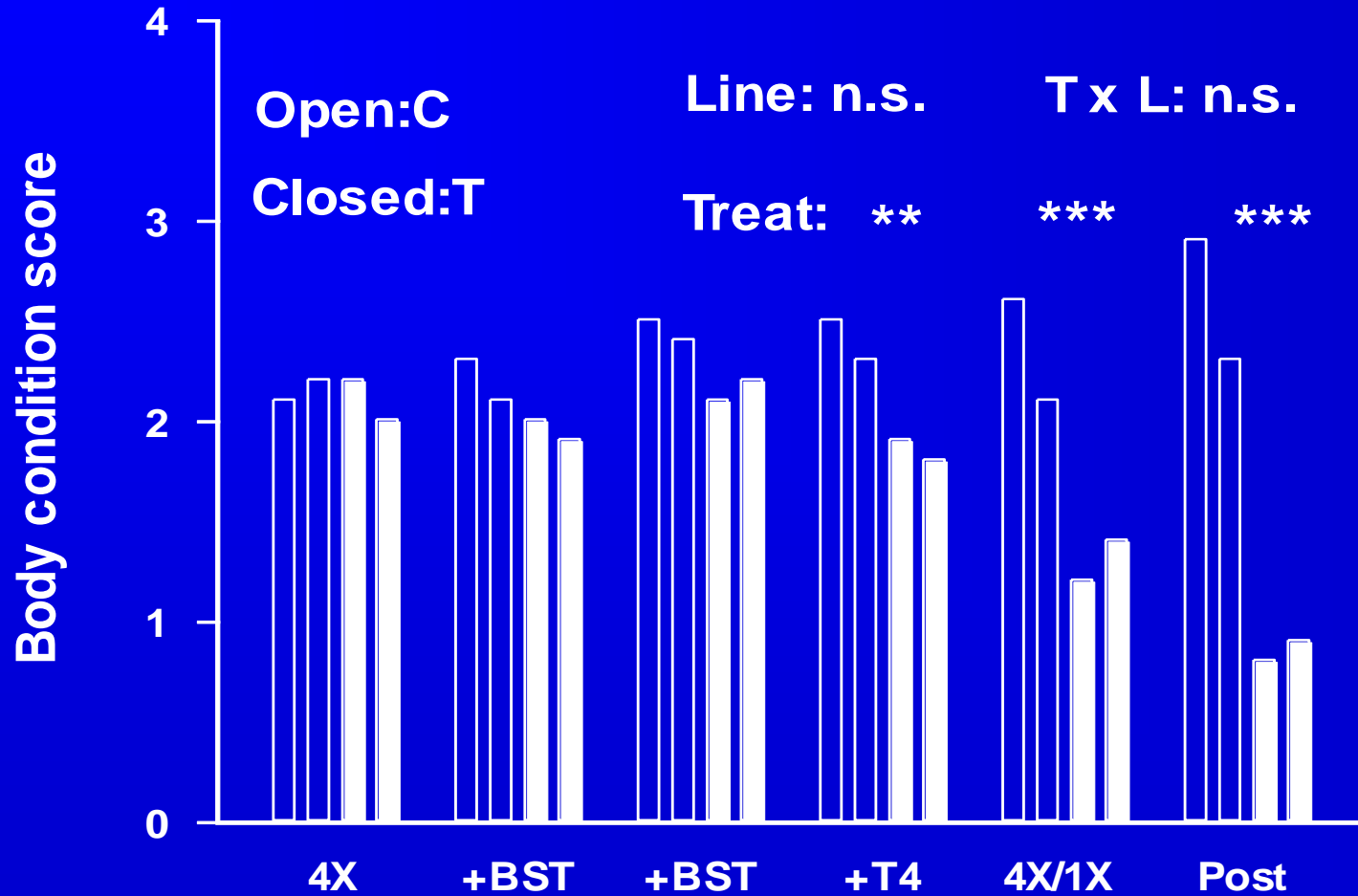
# Milk yield

- ☞ Both lines responded positively and similarly to treatments
- ☞ Maximum response was only achieved with the full combination of 4X + BST + T4
- ☞ Yield dropped markedly during 4X/1X + BST + T4
- ☞ Recovery was slow

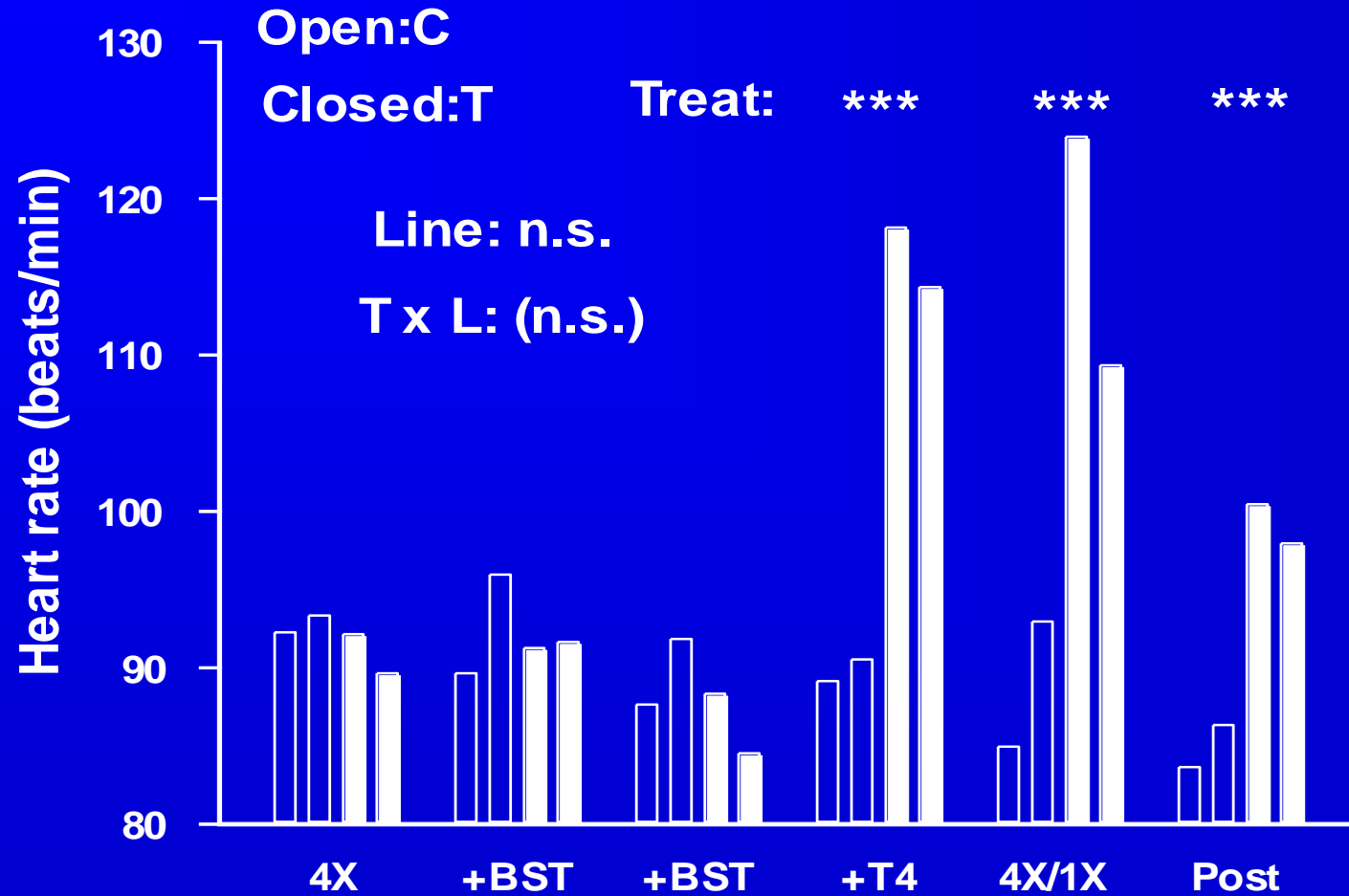
# Body weight responses



# BCS responses



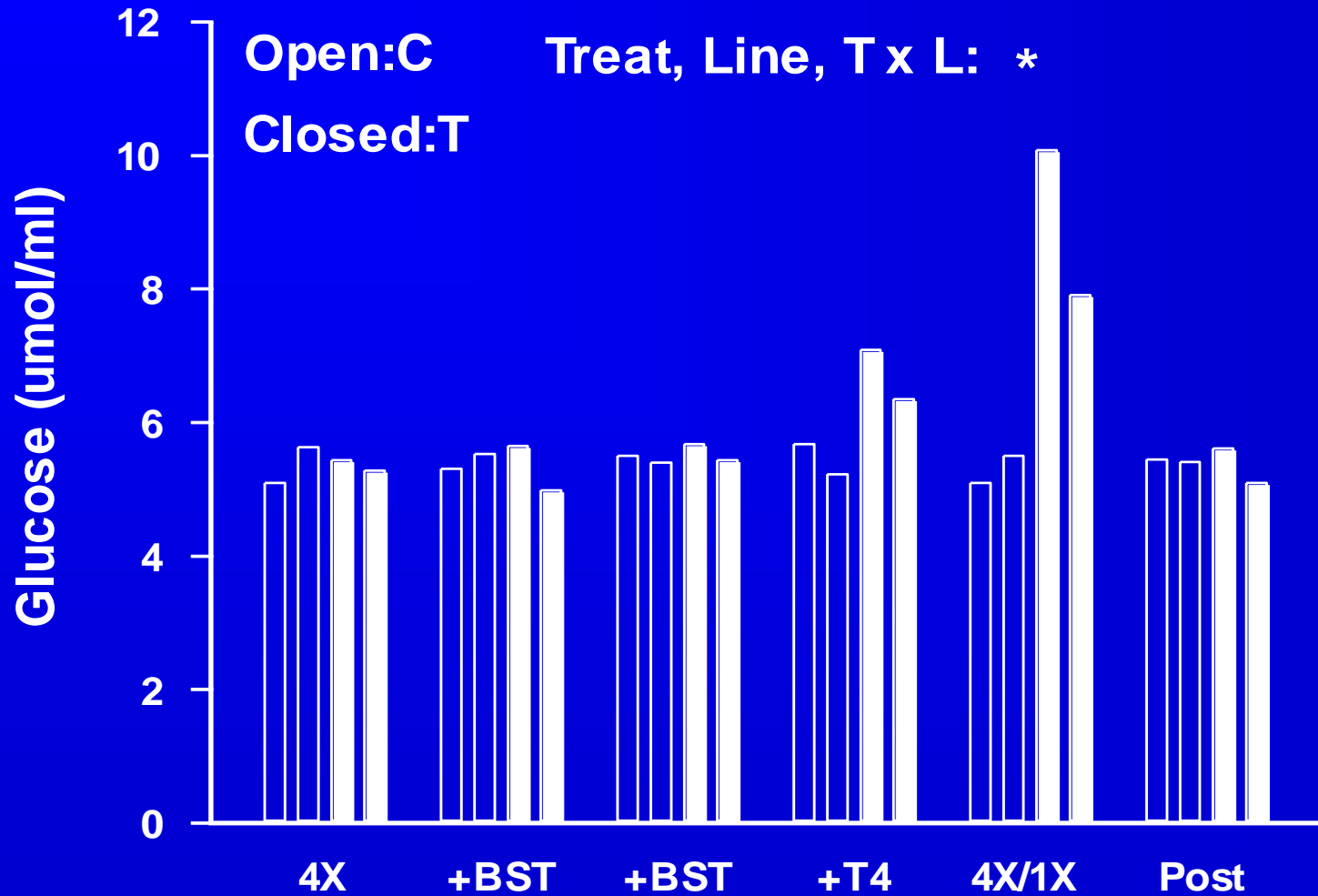
# Heart rate responses



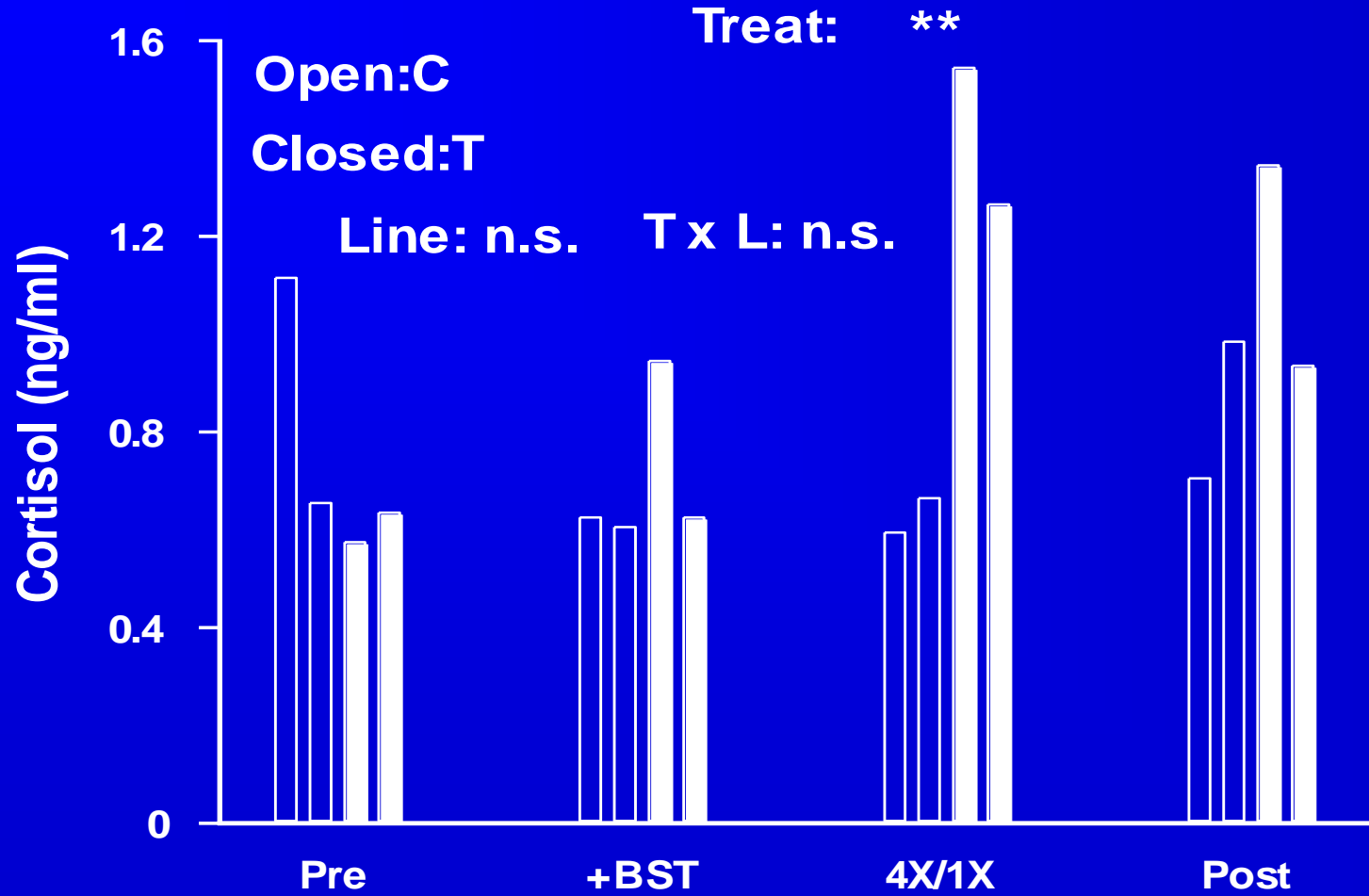
# Metabolism

- ☞ Frequent milking and BST in combination were well tolerated
- ☞ T4 accelerated metabolism markedly
- ☞ Cows lost weight and condition during T4 treatment periods
- ☞ Recovery was slow

# Plasma metabolites



# Cortisol





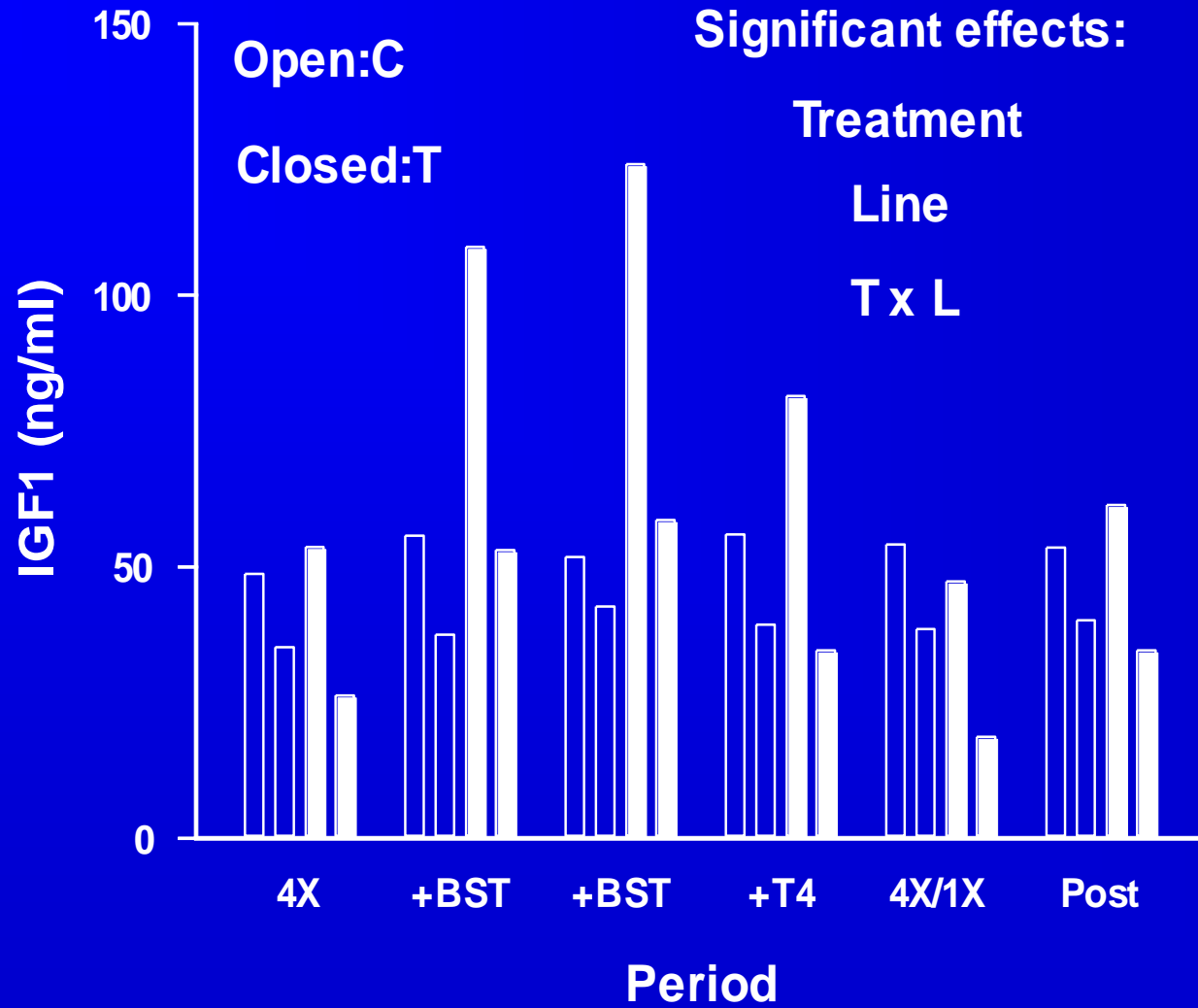
# Evidence of metabolic stress

- ☞ Plasma metabolites were remarkably stable
- ☞ Cortisol rose during maximum treatment phase, coincident with metabolic collapse
- ☞ No differences between HGM and LGM

# Hormones

- ☞ GH (BST) and thyroxine (T4) showed expected elevation during treatment
- ☞ GH response was highest in HGM
- ☞ Baseline prolactin was increased by treatment, milking related release was decreased
- ☞ Insulin increased during the experiment, but not in response to treatment

# IGF1



# Objectives

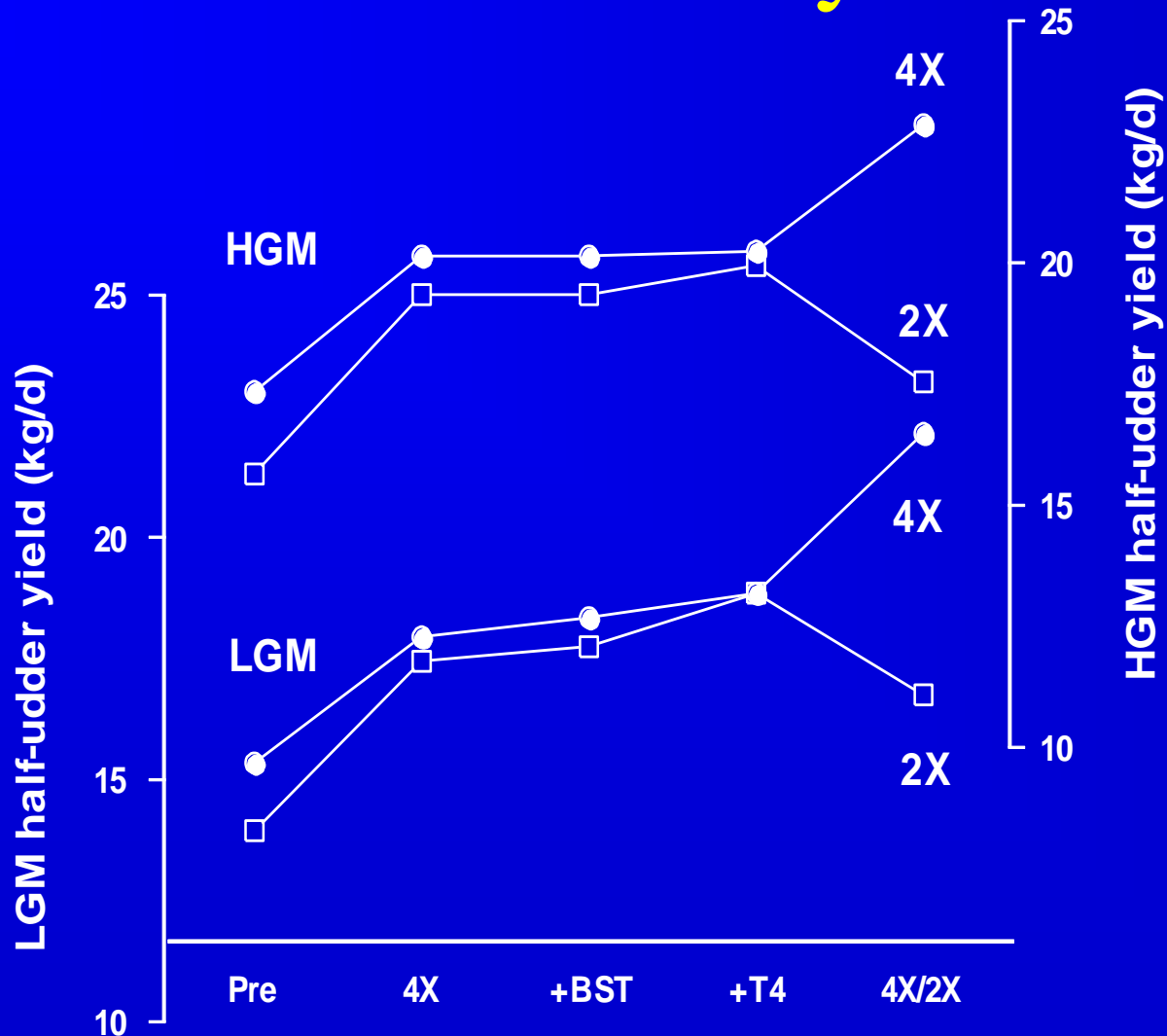
- ☞ Are high genetic merit cows operating closer to their metabolic maximum?
- ☞ If so, does this expose them to greater risk of metabolic problems?
- ☞ Where is maximum output determined: within the udder or elsewhere?



# Localisation of restriction point

- ☞ Experiment was repeated in next lactation
- ☞ 5 day periods rather than 2 week
- ☞ At maximum output, half of the udder was reduced to twice-daily milking
- ☞ Further yield increase in 4X half would be evidence of restriction outwith the udder

# Half-udder milk yields



# Conclusions

- ☞ HGM cows operate no closer to their metabolic maximum than LGM
- ☞ HGM cows are at no greater risk of output-induced metabolic stress than LGM
- ☞ Metabolic capacity is set outwith the mammary gland
- ☞ Extreme stress will result in lactation failure