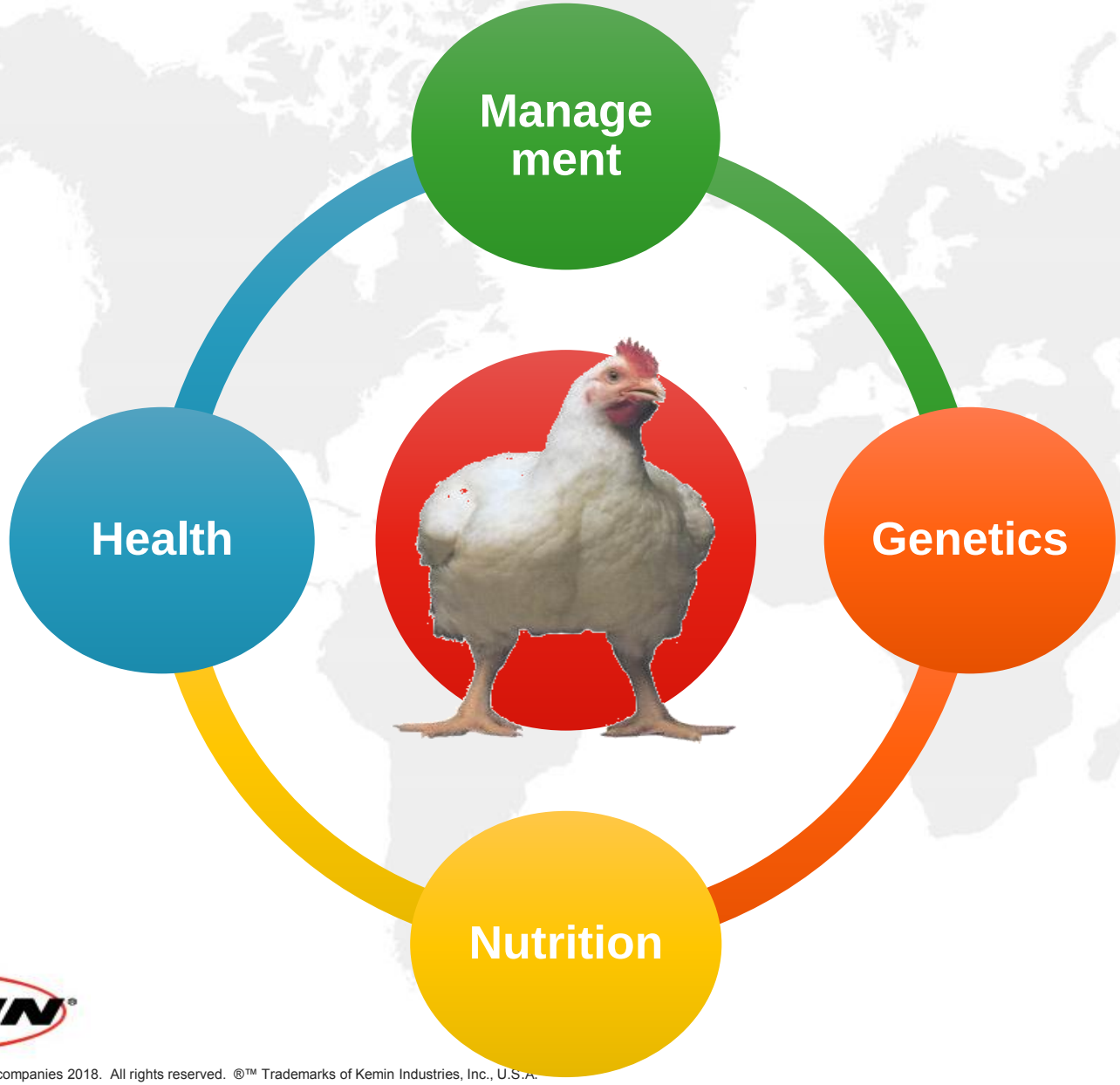
“Managing the stress – Key to successful poultry production”

Dr. Saravanan Sankaran

16.02.18

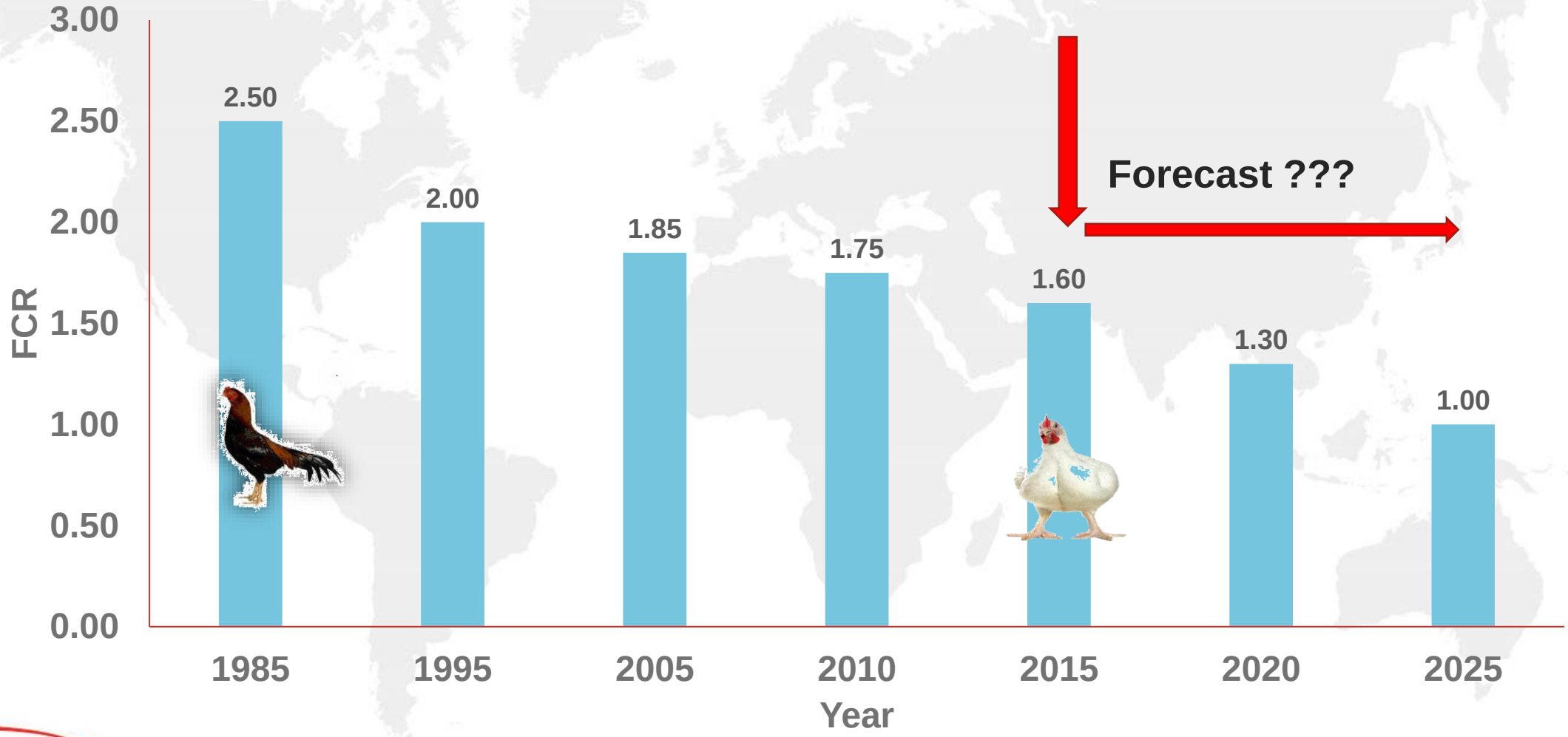
Modern commercial poultry



Objectives:

- Better Feed Conversion
- Higher livability
- Higher meat yield
- Higher quantity and quality eggs

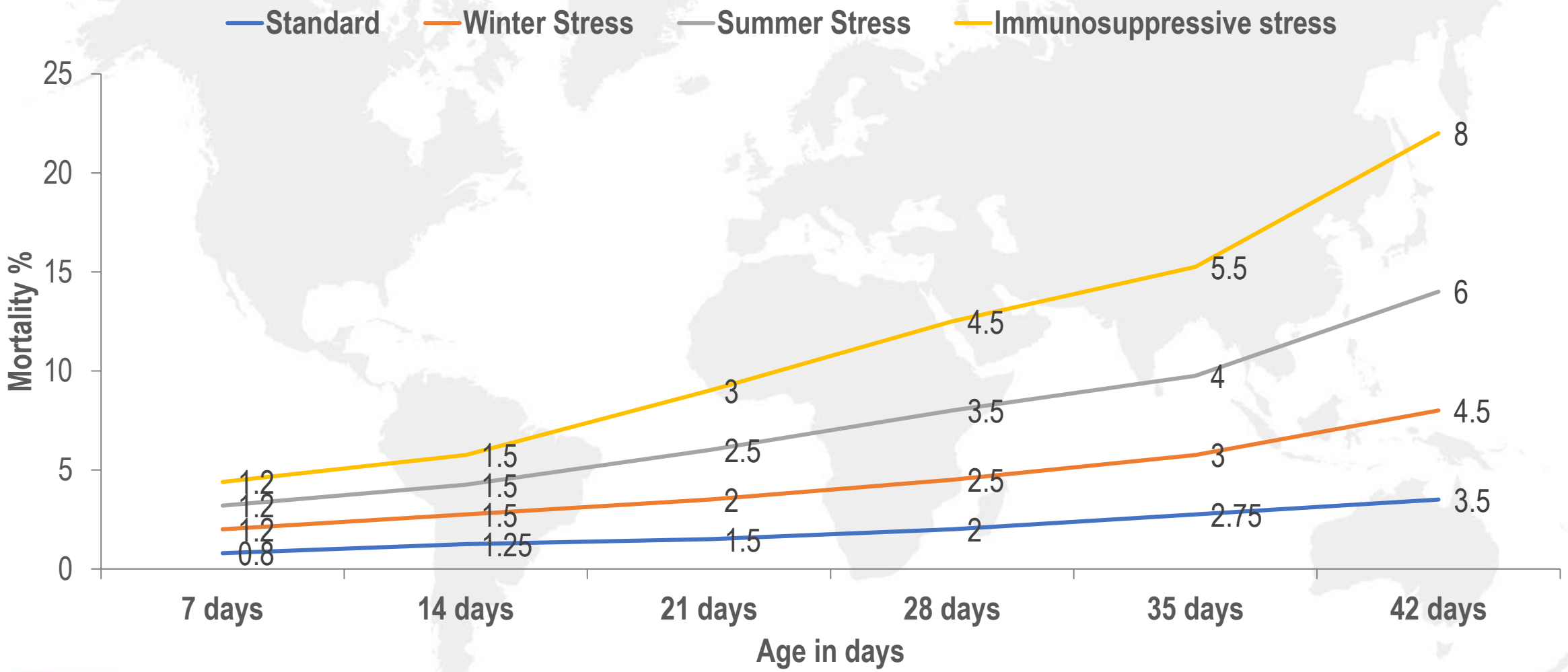
Broiler FCR developments



If we consider year average, FCR will be more than 1.8

Ref: Industry trend

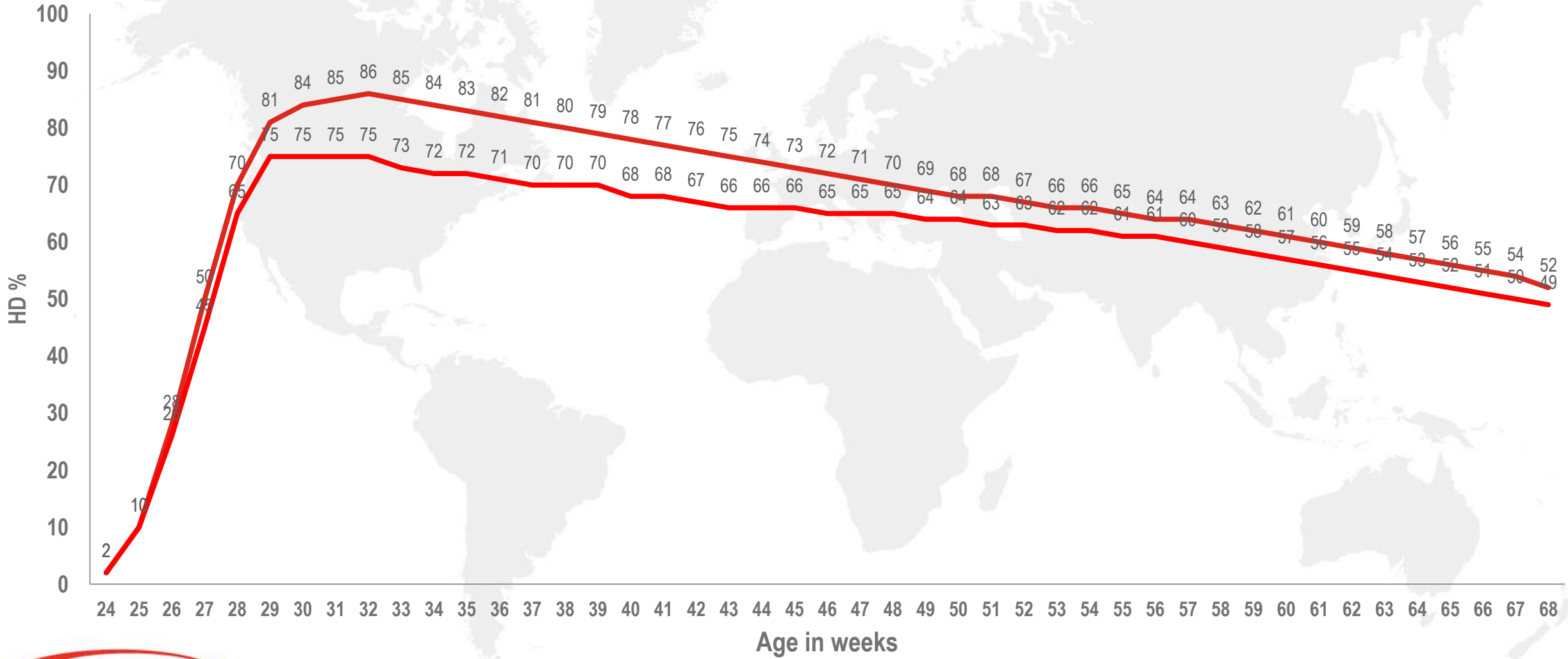
Broiler mortality



More challenge period, mortality goes up to 20% also

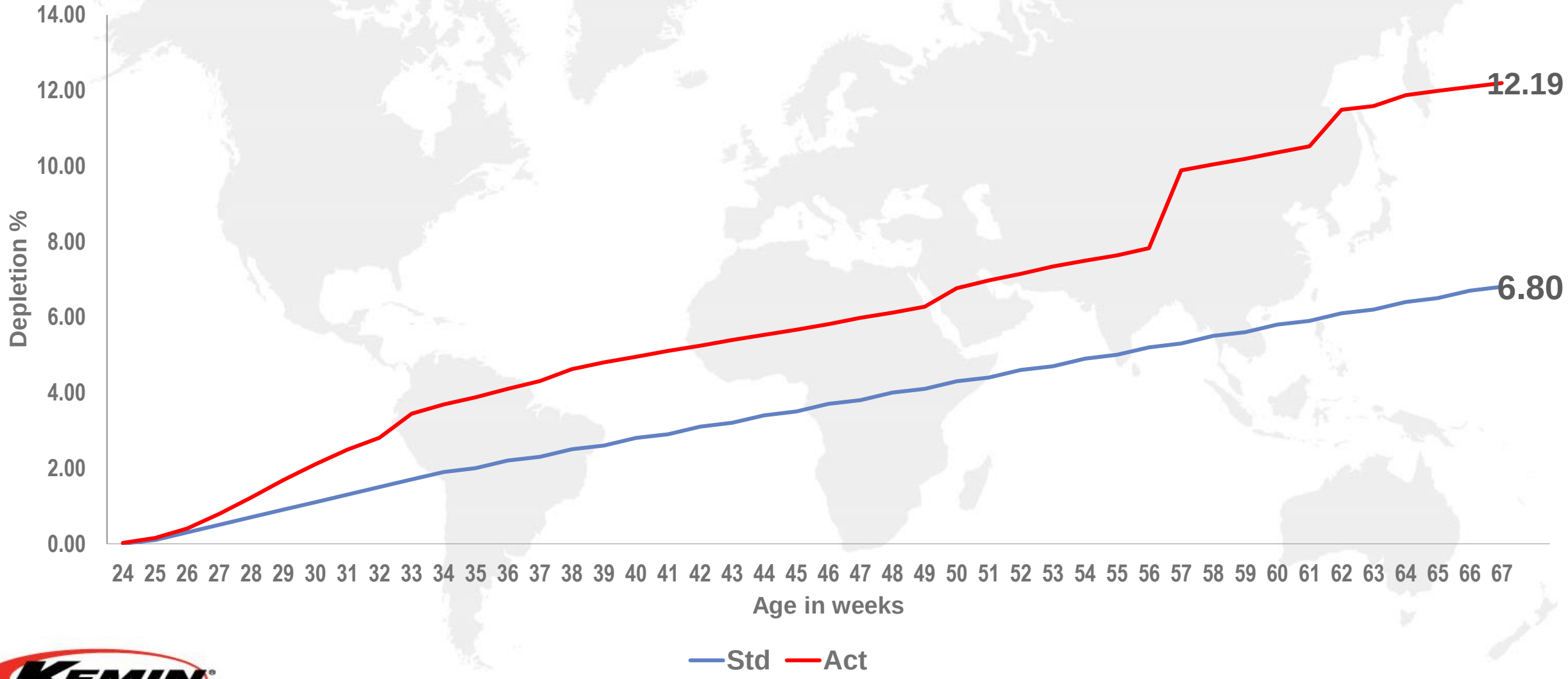
Ref: Industry trend

Breeder productivity- Egg production



Ref: Industry trend

Breeder productivity- Depletion



Courtesy: Dr. DC (Senior Consultant)

The reason for gap…

One of the major reason for the gap- “ STRESS”

Categories of stress in poultry

Climatic stress	• Extreme heat, cold or humidity
Environmental stress	• Bright light, wet litter, poor ventilation
Nutritional stress	• Deficiency, less feed intake
Physiological stress	• Fast growth, sexual maturity, peak production
Physical stress	• Injections, catching, grading, transport
Immunological stress	• Disease causing organisms
Social stress	• Overcrowding, poor uniformity

Ref: A G Rosales, 1994

Stress in poultry operation…

Stress — **Detrimental effects of variety of situations on the health and performance of the poultry**

Stressors — **Factors causing stress**

- Chicken encounter stressors every day of life..
- The adverse effect of stressors are additive !!
- Chicken under stress- extreme functional, structural and behavioral adjustments to cope with adverse effects of its environment
- **Heat stress is the major stressor in summer months**
- **The interrelationship between stress, immunity and nutrition is critical !!**

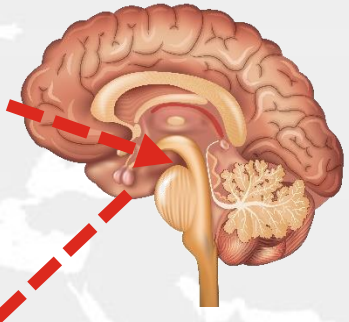
Physiology of stress

What is happening in the system during stress ??

Stressors

Phase 1- Flight or Fight

Phase 2- Adaptive

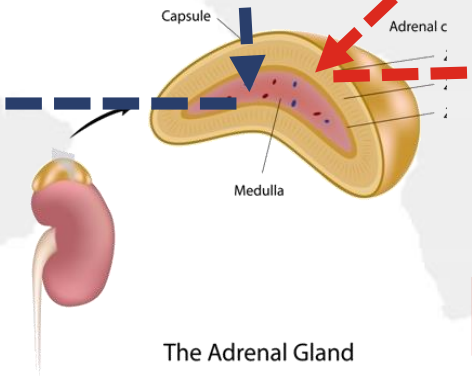


ACTH

Rapid release of glucose

Try to avoid stressor

Epinephrine



The Adrenal Gland

Corticosterone

Mobilization of glucose from reserves

Immuno-suppression

Phase 3- Exhaustion

Fatigue and death

Ref: A G Rosales, 1994

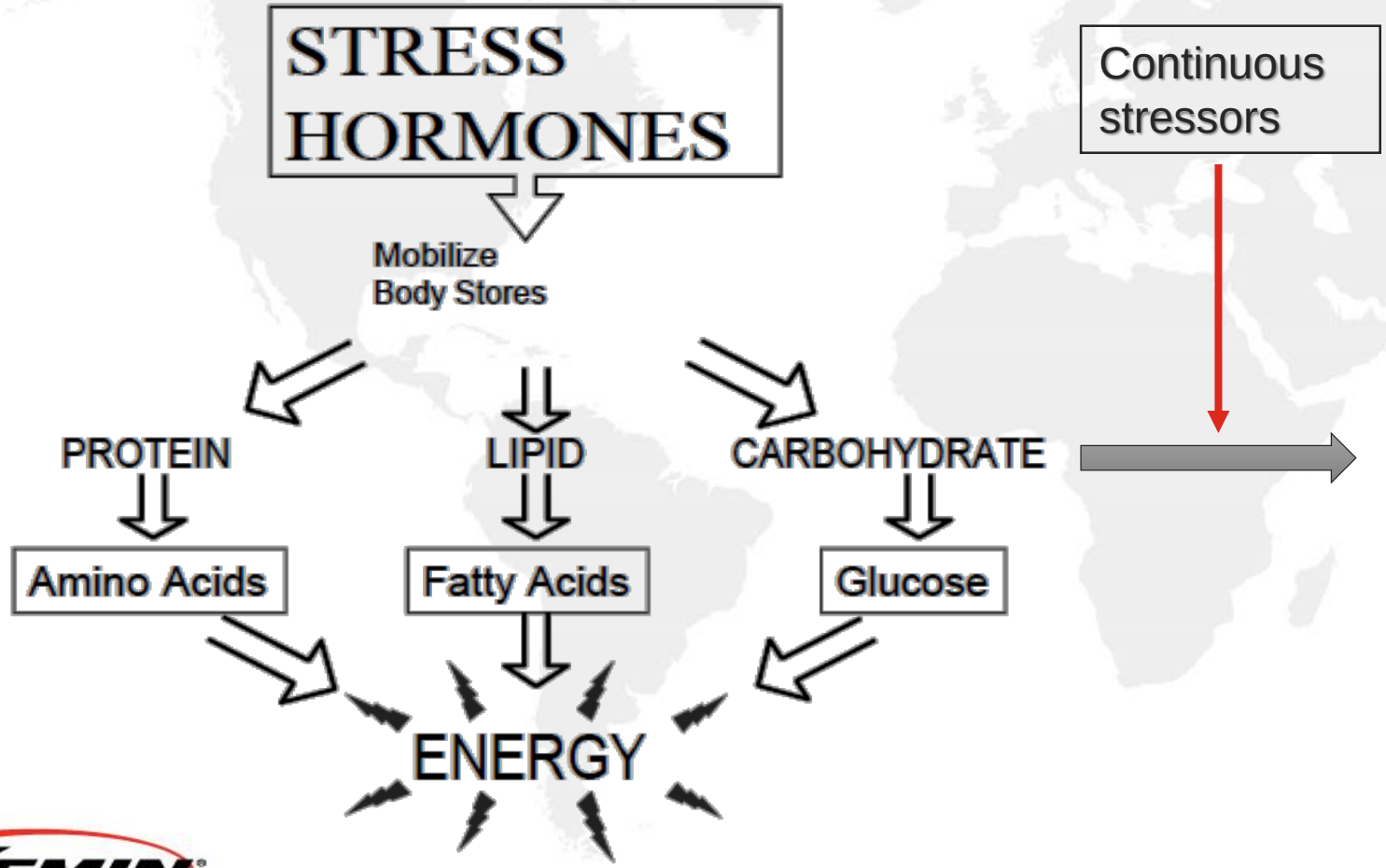
Physiology of stress

Phase 2: General Adaptation Syndrome

- Chicken under stress need adaptation to survive which requires **‘Energy”**
- The adaptation energy yields from carbohydrates, lipids and protein
- These nutrients are available from both feed and body reserves
- The nutrients in feed are not digested and absorbed efficiently during stress conditions
- Hence chicken rely on body reserves for adaptation energy or survive !!
- The vital organ functions like heart, lung, liver, etc will not compromised during stress
- The less important functions like egg production, reproduction, growth and immunity are highly compromised

Physiology of stress

Phase 2: General Adaptation Syndrome



Continuous stressors

Phase 3: Exhaustion

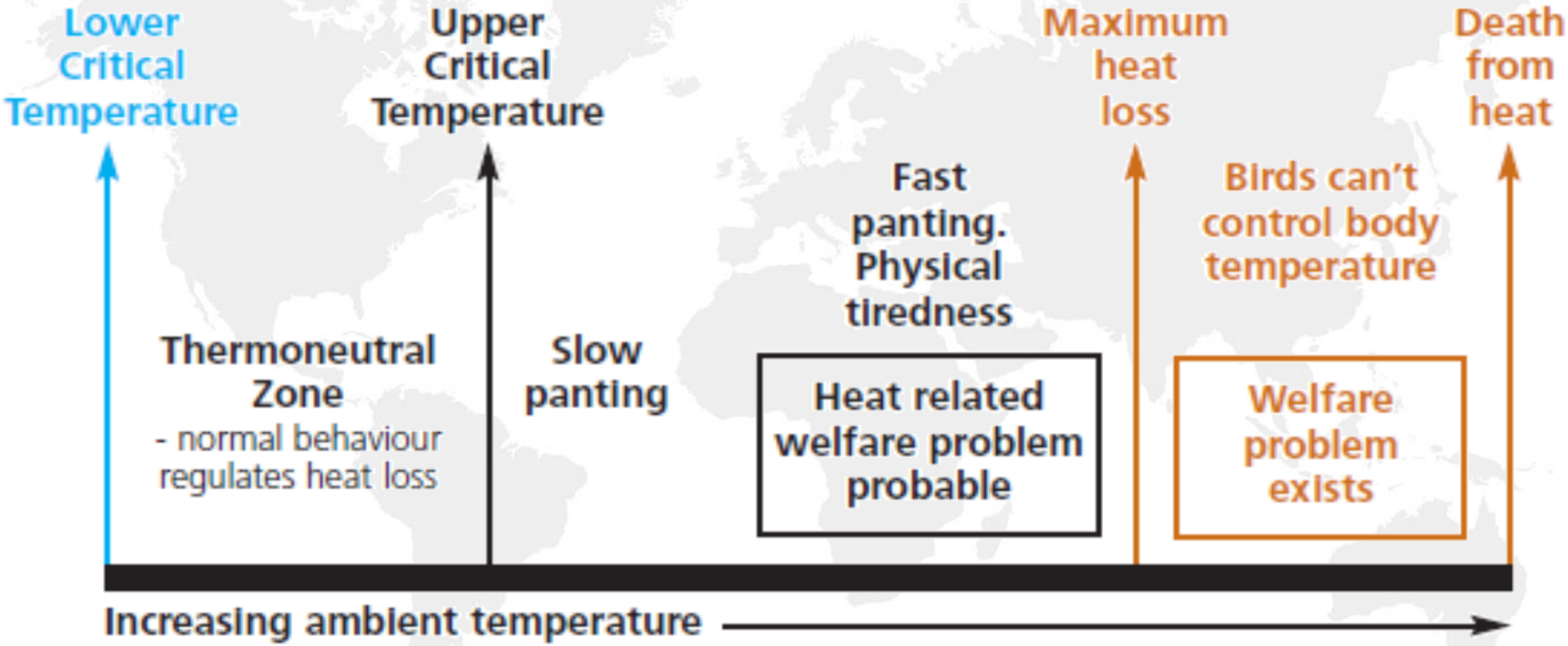
Depletion of body reserves

Inadequate stress hormone

Fatigue and Death

Ref: G D Butcher and R D Miles, 2011

Heat stress in broilers



Ref: Defra, 2005

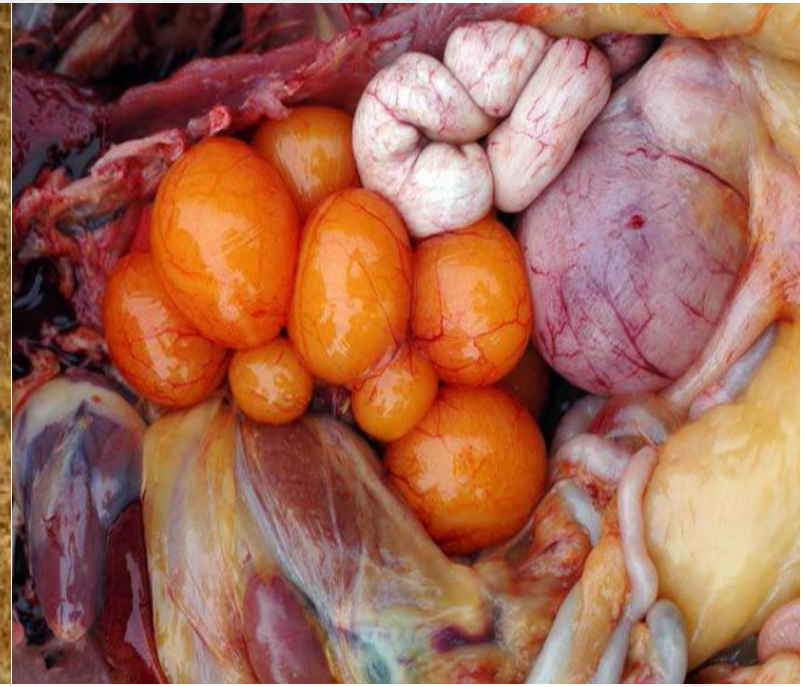
Heat stress in broilers

- Reduced feed consumption
- Less weight gain
- High FCR
- Dehydration
- Immuno-deficiency
- Disease outbreaks
- Increase in energy demands
- Increased culls
- High mortality

Heat stress in breeders and layers

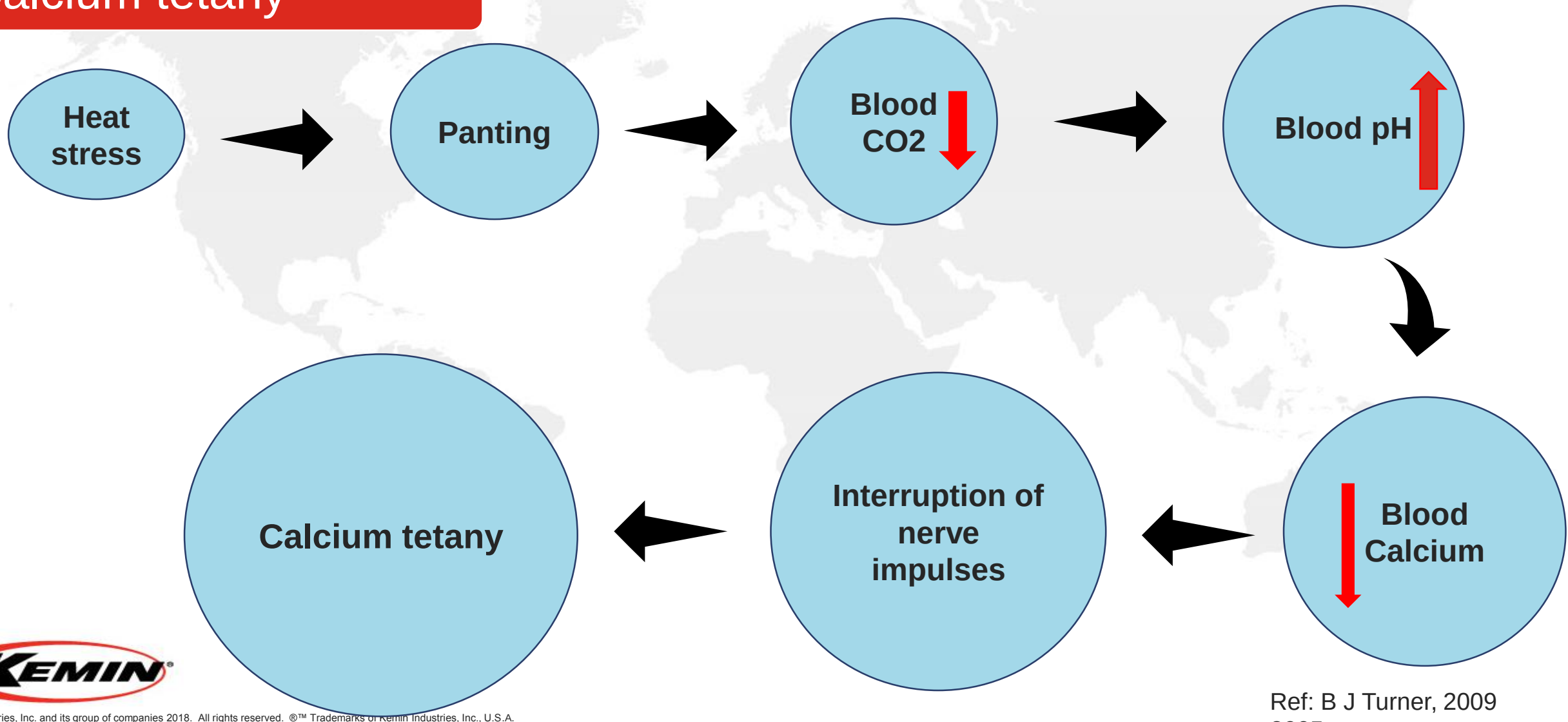
Calcium tetany

Muscle weakness or paralysis, caused by inadequate levels of Calcium in blood especially young flocks in breeders and layers



Heat stress in breeders and layers

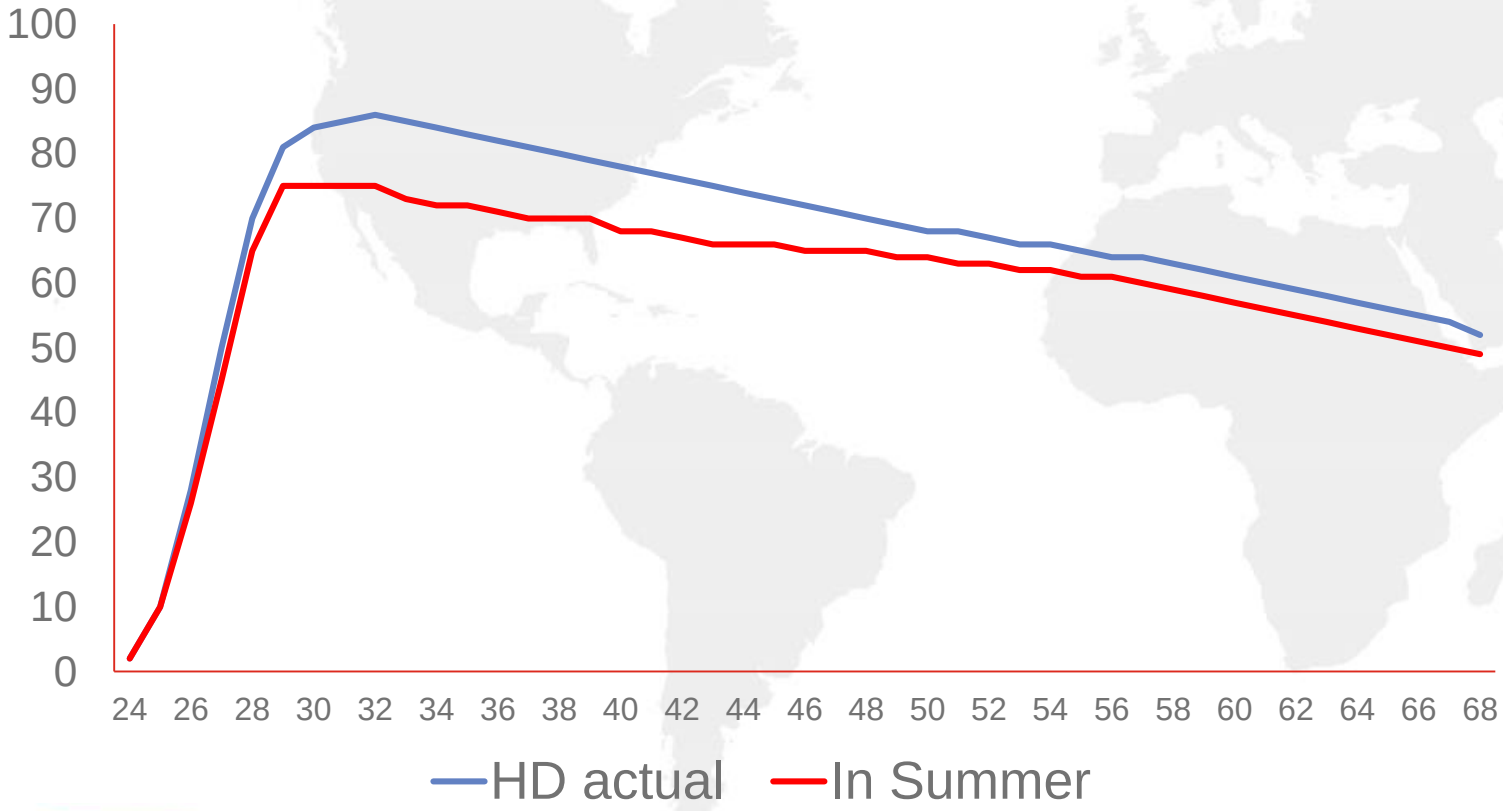
Calcium tetany



Ref: B J Turner, 2009
2005

Heat stress in breeders and layers

Reduction in production



20 % reduction in feed intake

Increased levels of stress hormone

Respiratory alkalosis / Panting

↓

Affecting the reproductive organs

↓

Reduction in egg production

Heat stress in breeders and layers

Reduction in HE selection/ hatchability

Heat Stress

Stress hormone

Reduced feed intake

Cessation of cuticle formation

Reduced absorption of essential minerals

Egg abnormalities

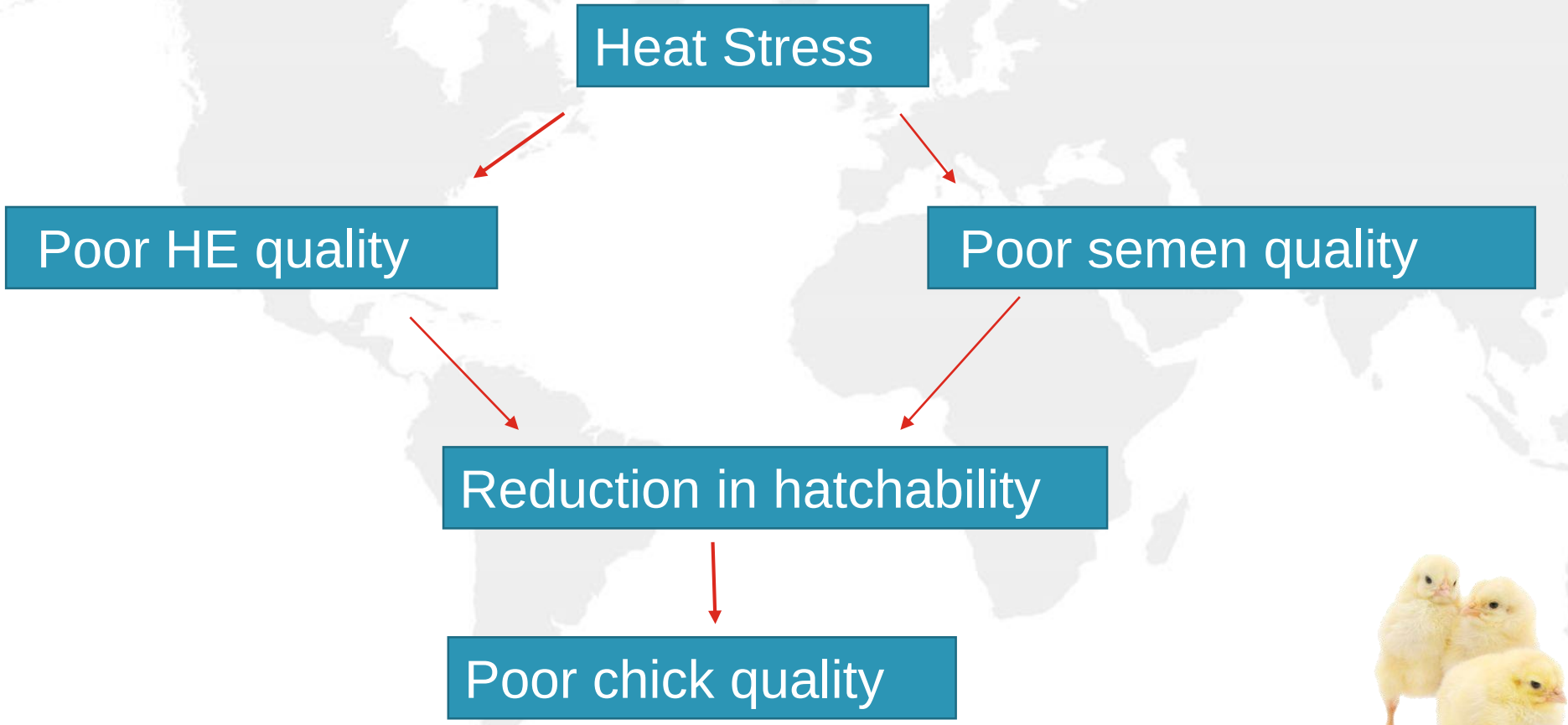
Pale colored eggs

↓ Hatching eggs

Ref: G D Butcher and R D Miles, 1994

Heat stress in breeders and layers

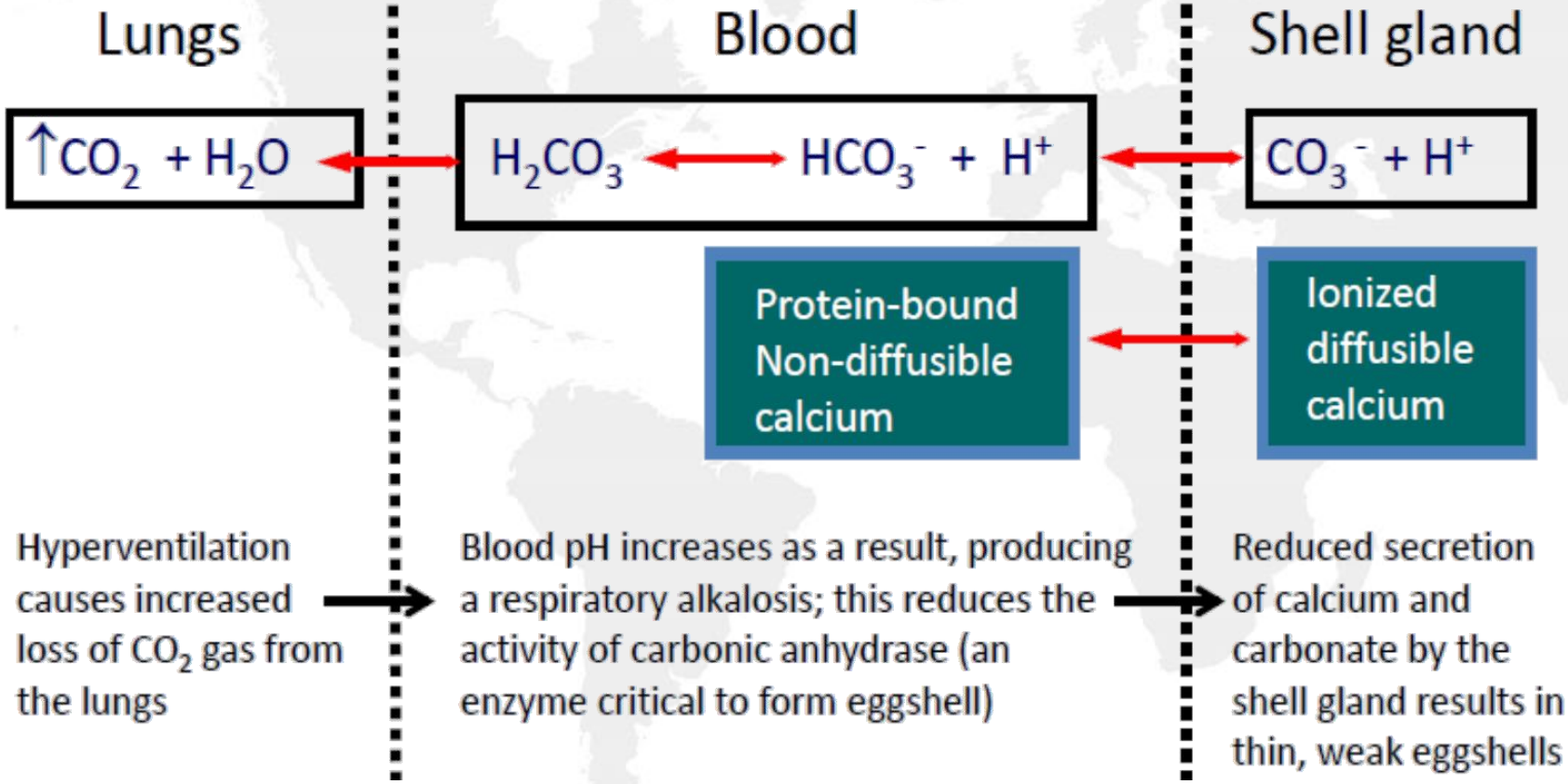
Reduction in HE selection/ hatchability



Ref: J.O.Ayo *et al*, 2011

Heat stress in breeders and layers

Poor egg shell quality in layers



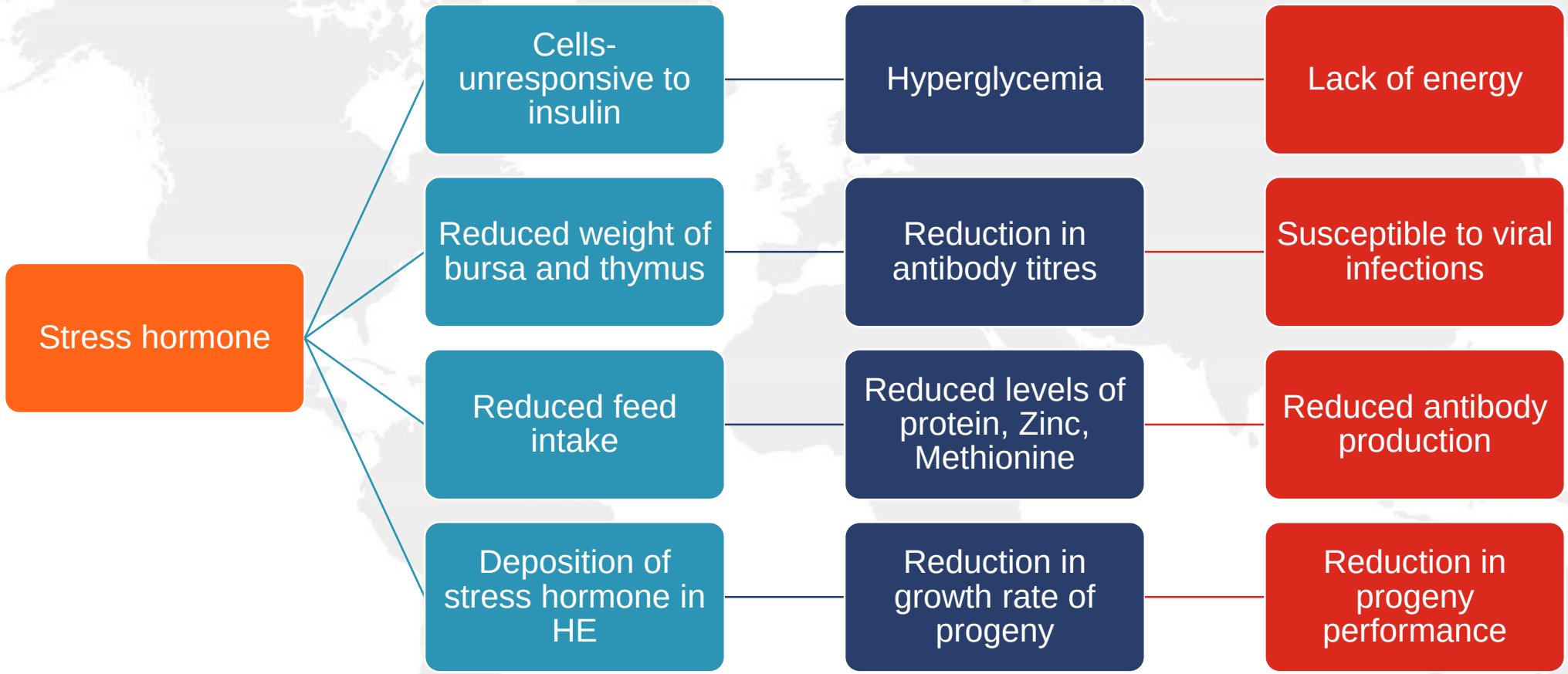
Ref: Hy-Line technical update, 2015

Heat stress on immunity / immunological stress

- Immunological challenge is accompanied with reduced feed intake during heat stress
- Increased levels of stress hormone causes reduction in size of immune organs and antibody production
- Increased susceptibility to coccidiosis / oocyst production
- Reduced levels of biologically active molecules like lymphokines, cytokines, etc
- Reduction in mounting of innate immune response- reduction in phagocytic activity by macrophages and natural killer cells
- The stress in brooding period can result in poor immunity and future performance
- The panting impairs the filtering mechanism of nasal passage and allows the respiratory pathogen bypassing and entering the system

Highest challenge in stress conditions- immunosuppression

Heat stress on immunity / immunological stress



Immunosuppression !!

Ref: Farnell M.B. 2001

Heat stress on immunity / immunological stress

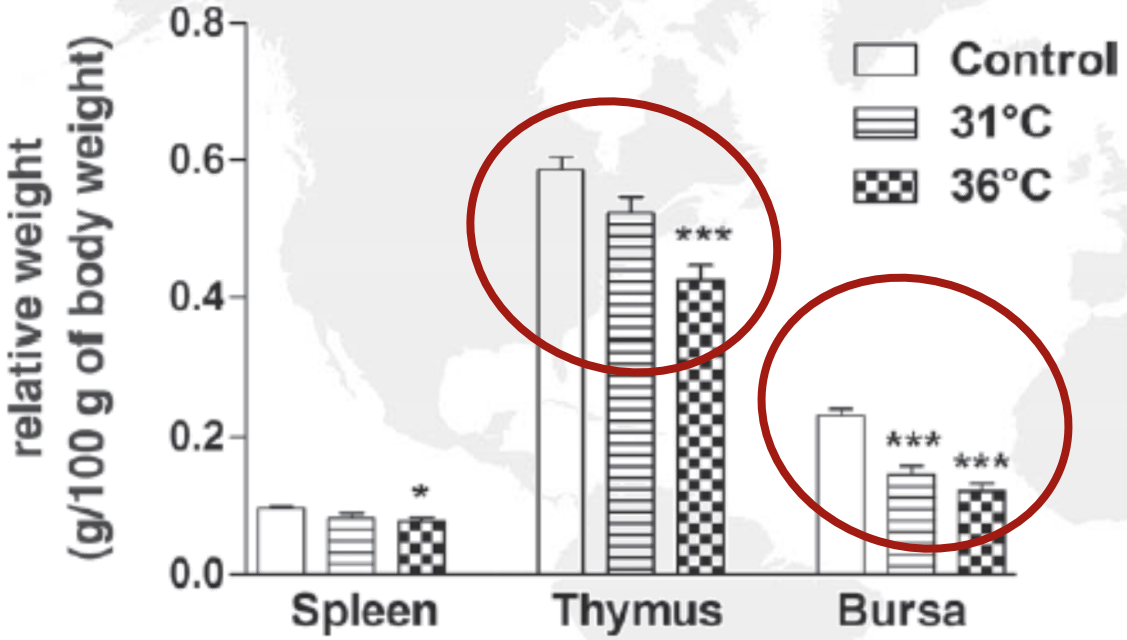


Figure 2. Effects of heat stress (31 ± 1 and 36 ± 1°C) for 10 h per day from experimental d 35 to 42 on the relative weights of lymphoid organs. Data are presented as the means ± SEM (n = 10/group). *P < 0.05 and ***P < 0.001 compared with the control group (1-way ANOVA followed by Dunnett's test).

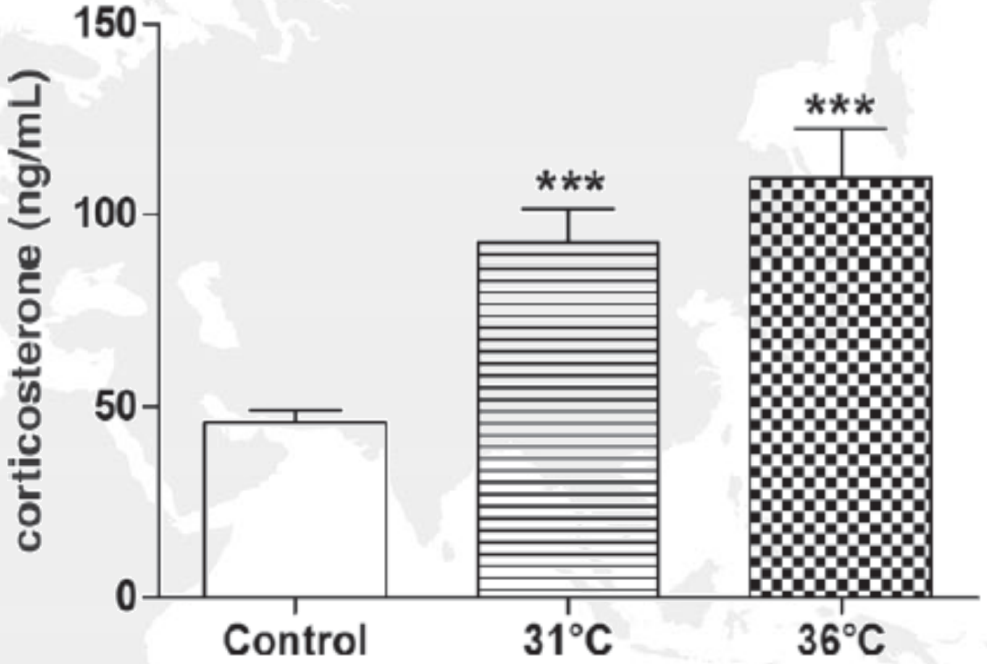


Figure 3. Effects of heat stress (31 ± 1 or 36 ± 1°C) for 10 h per day from experimental d 35 to 42 on the corticosterone serum levels (ng/mL). Data are presented as the means ± SEM (n = 10/group). ***P < 0.001 compared with the control group (Kruskal-Wallis test followed by Dunn's test).

Ref: W.M.Quinteiro-Filho. *et al*, 2010

Immunosuppressive interaction in broilers

Hatch, transport stresses, vaccination reactions

Permanent immunosuppression

Transient immunosuppression

IB, Influenza, ND, ILT, Pneumovirus, GD

Coccidiosis, E coli

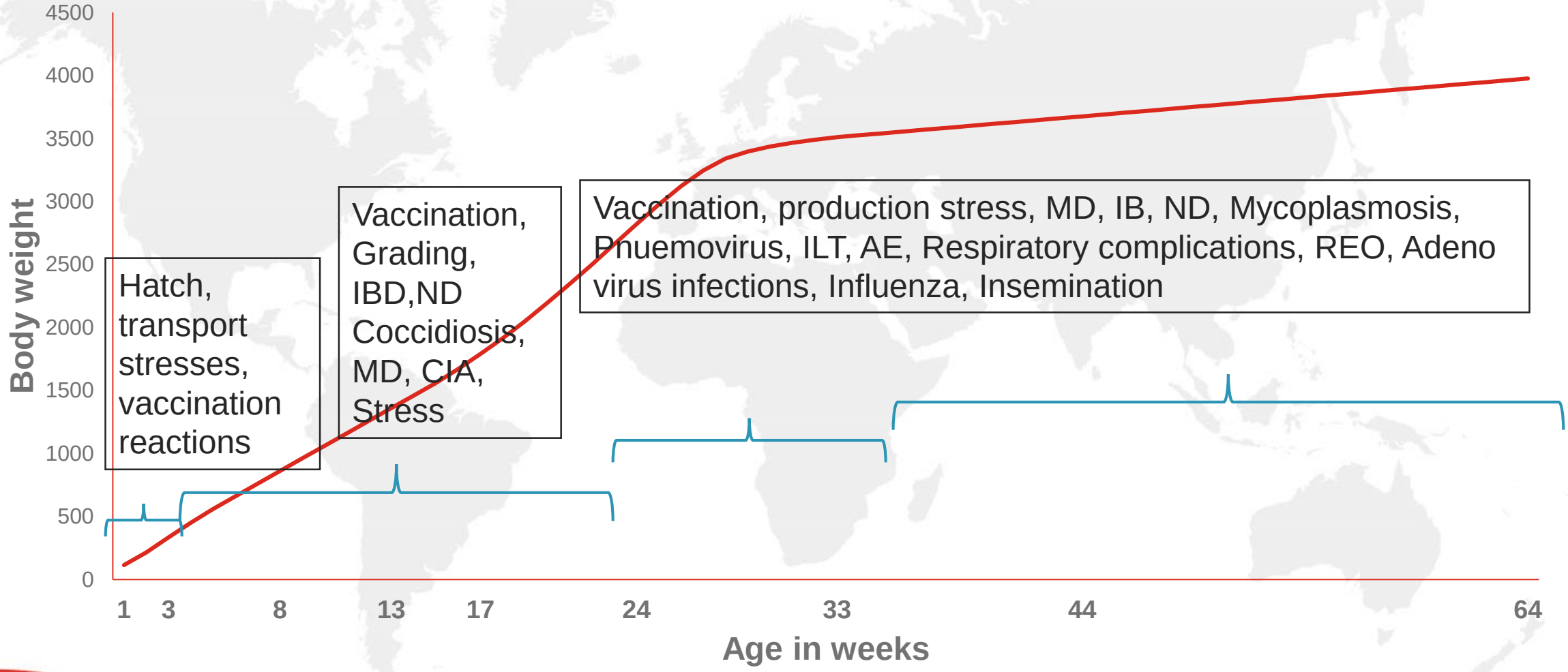
Decline of maternal immunity and infection by IBD and CIA, sequentially or in combination

Environmental stresses (ammonia, temperature), exposure to Marek's disease, chicken anemia and enteric viruses

Influence on Cost, Livability, FCR and Condemnations

Ref: K A Schat and M A Skinner, 2014

Immunosuppressive interaction in breeders/layers



Heat stress on gut health

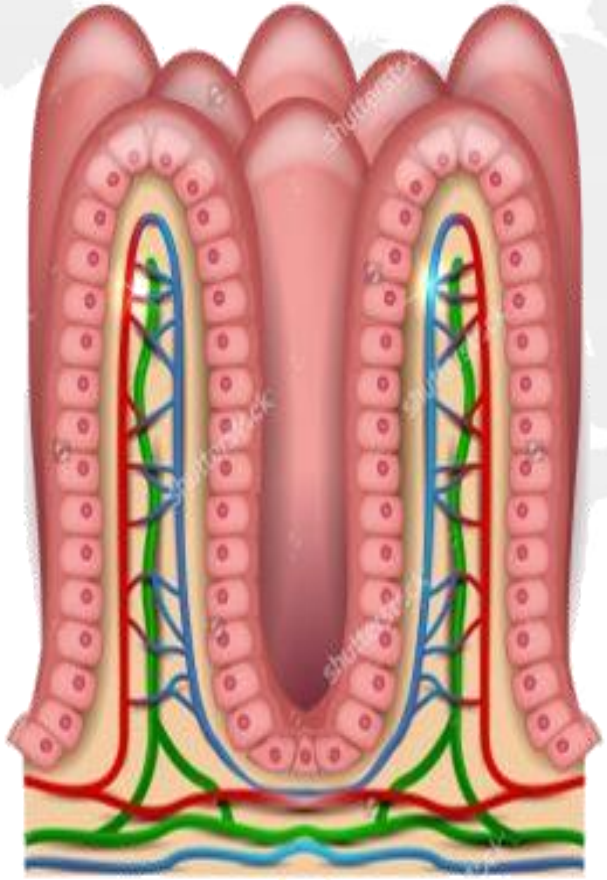
Alteration in gut microbial population

More of Clostridium and Coliform bacteria

Intestinal lesions

Increased villi tips sloughing rate

Loss of microvilli



Damaged intestinal lining

↓

Less nutrient absorption and absorption of endotoxins

↓

Endotoxins go to different organs in the birds

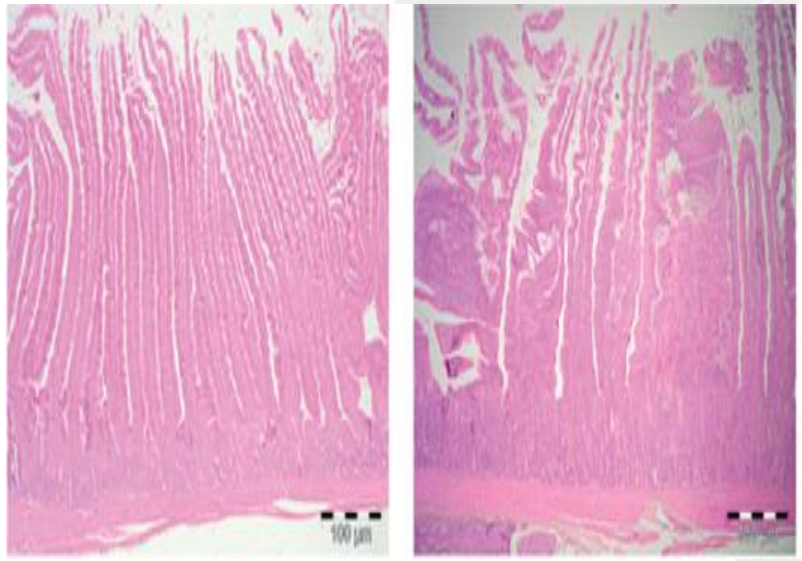
↓

Leads to multi organ dysfunction, poor growth and mortality

Ref: Lambert *et at*.2002, Hall *et al.* 2001

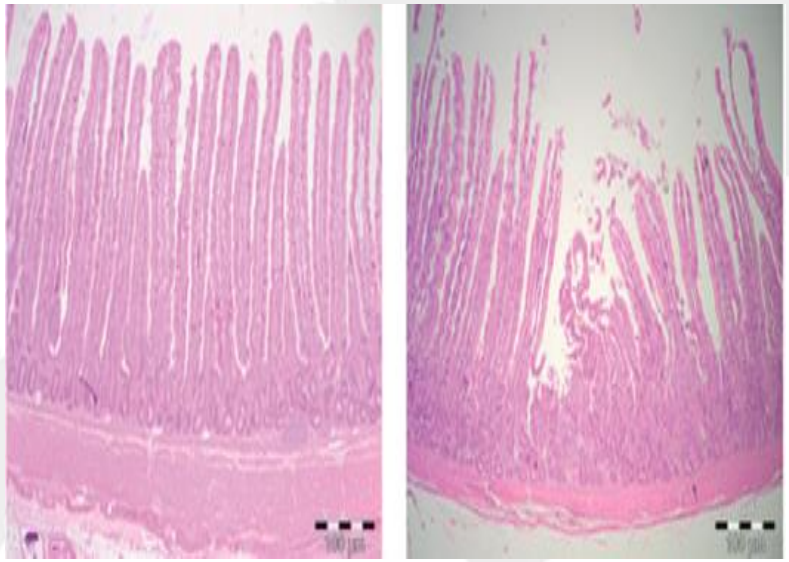
Heat stress on gut health

Intestinal villi morphology in 25^{0}C and 39^{0}C (heat stress for 4 days- 24 to 27 days of age)



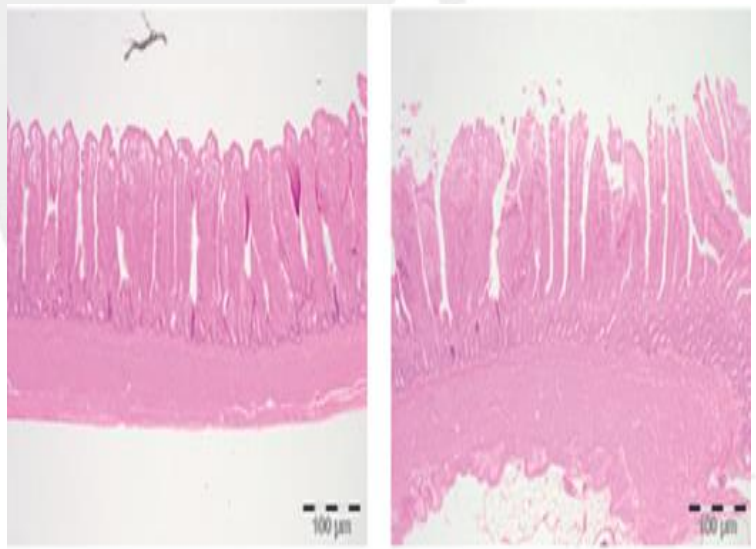
25^{0}C 39^{0}C

Duodenum



25^{0}C 39^{0}C

Jejunum



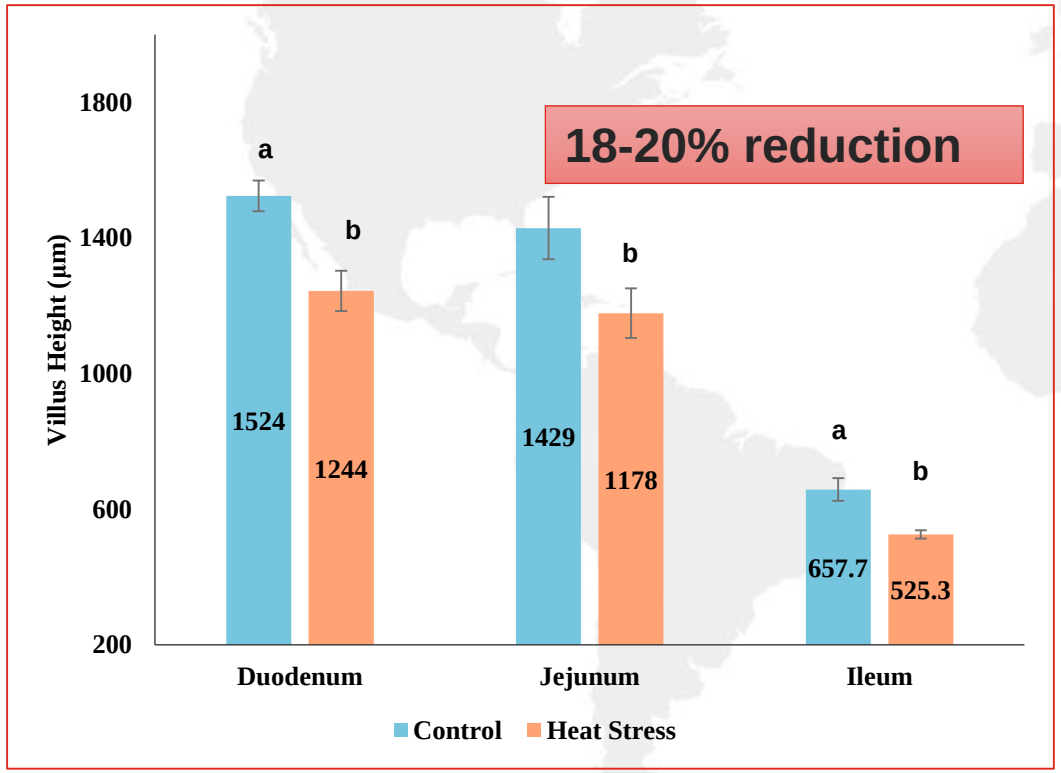
25^{0}C 39^{0}C

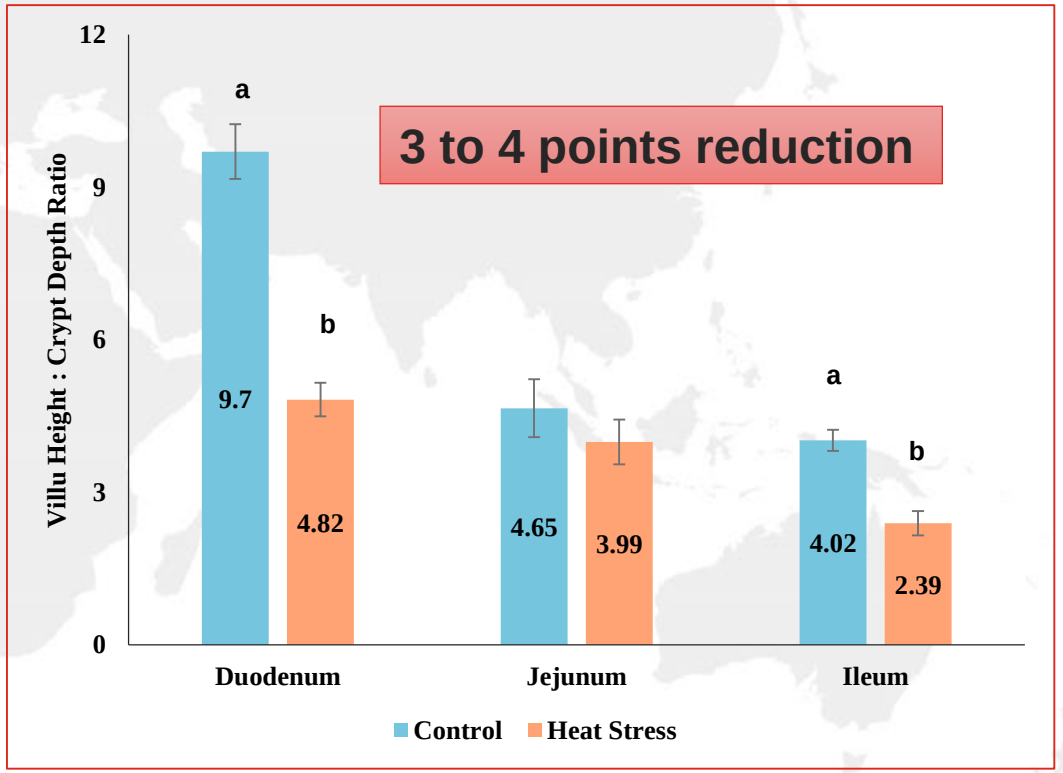
Ileum

Ref: R R Santos *et at*.2015

Heat stress on gut health

Intestinal villi morphology in 25^{0}C and 39^{0}C (heat stress for 4 days)

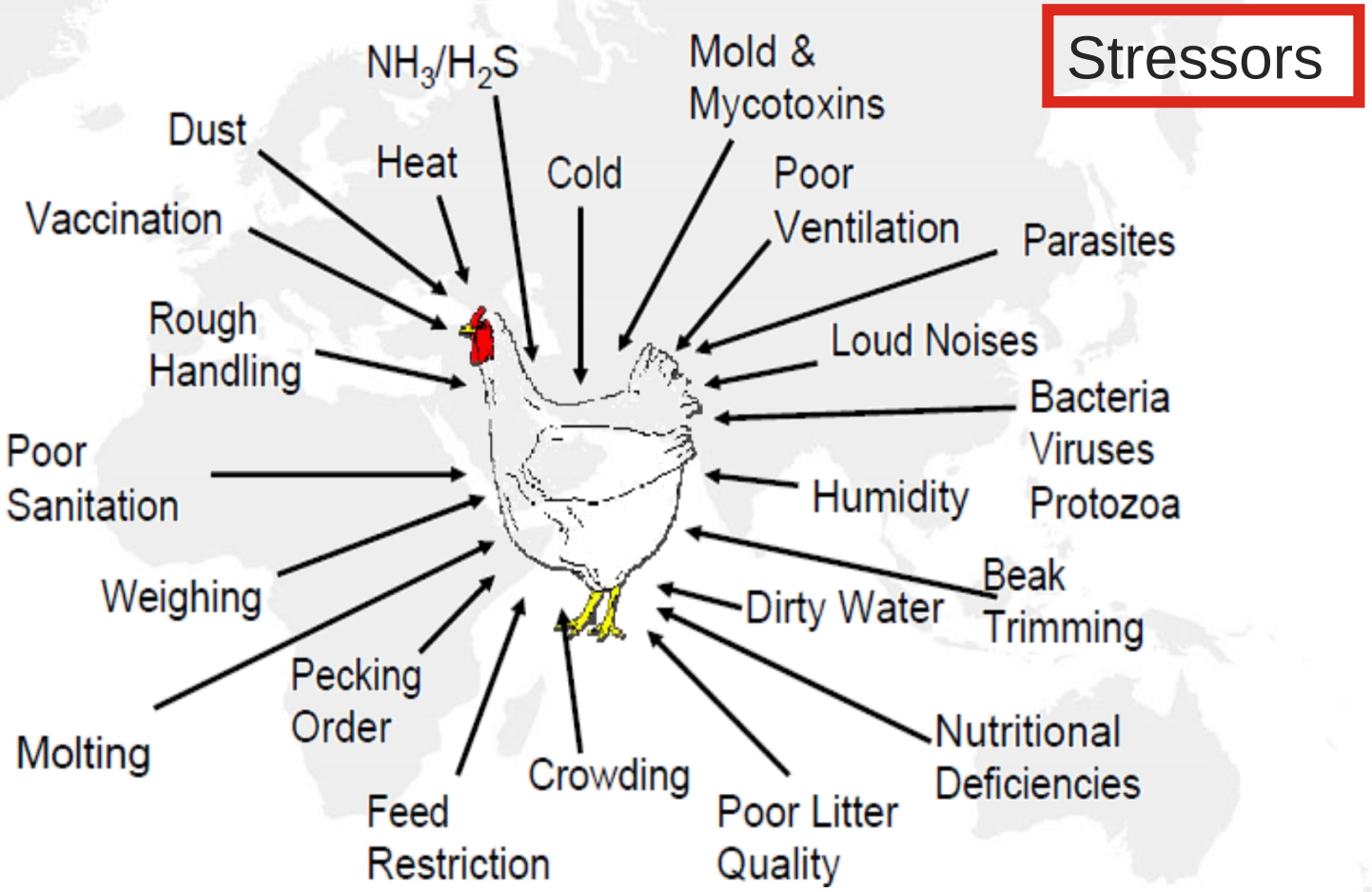




Ref: R R Santos *et at*.2015

The effects of heat stress in poultry…

- **Reduction in egg production**
- **Hatching egg selection**
- **Egg shell quality**
- **Immunosuppression**
- **Higher FCR**
- **Higher mortality**
- **Overall poor performance**



But ….

Ref: G D Butcher and R D Miles, 2011

Stress Management

In nature, *Stress is the rule not the exception*

Complete freedom from stress

Mortality !!

Management of stress is the key to successful poultry production

Heat Stress Management

Three combined approaches

All the three factors are interlinked

Nutritional management of immunity during stress period is important !!

Heat Stress Management

Environmental management

Heat Stress Management

Environment management

Includes poultry house preparation, water, biosecurity and hygiene

Poor management is one of the greatest stress to poultry

Heat Stress Management

Nutritional management

Heat Stress Management

Nutritional Management

Nutritional management during heat stress is very important

Energy

- Optimizing the nutrient composition is the key for nutritional management of heat stress
- Low dietary intake associated with heat stress warrants high density diet
- Optimizing the energy levels through **fat** is major approach to meet the demands
- During heat stress, the intestinal passage time will be increased, in turn non availability of nutrients
- Increase in fat content in the diet will reduce the **passage time** and increase the availability of nutrients
- Also high energy efficiency of fat compared to carbohydrates and protein with less heat increment
- **Fat addition as energy source highly suggested for reducing the heat stress**

Ref: Ghazalah *et al* 2008, Mujahid, 2011

Heat Stress Management

Nutritional Management

Protein

- The protein requirement during heat stress is not clear and different school of thoughts !!
- Increasing protein content during heat stress will increase the heat load by break down
- Supplementing good quality protein with improved amino acid balances is critical
- During heat stress, outflow of amino acid increases due to poor digestibility
- Deficiency of arginine, lysine increases the heat load
- **Improved balance of amino acids- reduction wastage, heat load due to nitrogen excretion and improved digestibility**

Ref: Furlan *et al,* 2004, Gous and Morris, 2005.

Heat Stress Management

Nutritional Management

Vitamins

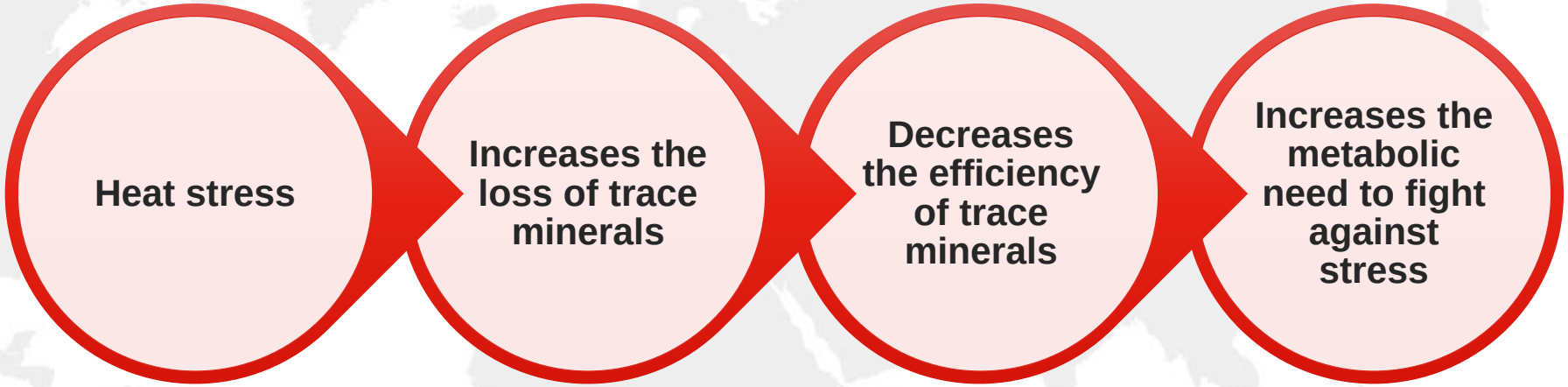
- Supplementation of **Vitamin C** is beneficial in stressful conditions- **Anti-Stress Vitamin**
- Kidney used to synthesize Vitamin C and the ability varies with age, environment, management, disease and stress
- Vitamin C plays major role in regulation of release of corticosterone form adrenal
- **Vitamin E** and **Vitamin C** are important during disease stress or infection
- **Vitamin A** is required for maintaining cellularity of lymphoid organs and immunity
- **In heat stressed conditions, it is advisable to increase all the vitamin levels by 20% since the need and excretion also high**

Ref: G D Butcher and R D Miles, 2011

Heat Stress Management

Nutritional Management

Trace Minerals



- Plasma **Zinc** will be redistributed to vital organs like lungs, liver for synthesis of acute phase proteins
- **Copper** is protective antioxidant in acute phase response
- **Manganese** need will be increased in GI tract and other tissues for immune response
- **Selenium** is essential for immune response

Ref: Klasing *et al*, 1991

Heat Stress Management

Nutritional Management

Trace Minerals

- Interesting defence mechanism- **Removal of circulating Iron- Nutrient for bacteria**
- The injectable or increased supplementation of Iron will increase the mortality / morbidity during immunological stress
- **The increase levels of trace minerals recommended during heat stress conditions (15-20%)**
- **For Calcium tetany-** Calcium can be supplemented as 2-5g shell grit for consecutive 3 days followed by 3 days rest
- **The trace mineral deficiency during heat stress in breeder, not only affects the hen, also affects the progeny chick performance and immunity**
- **Also should be readily available organic form to meet the demand !!**

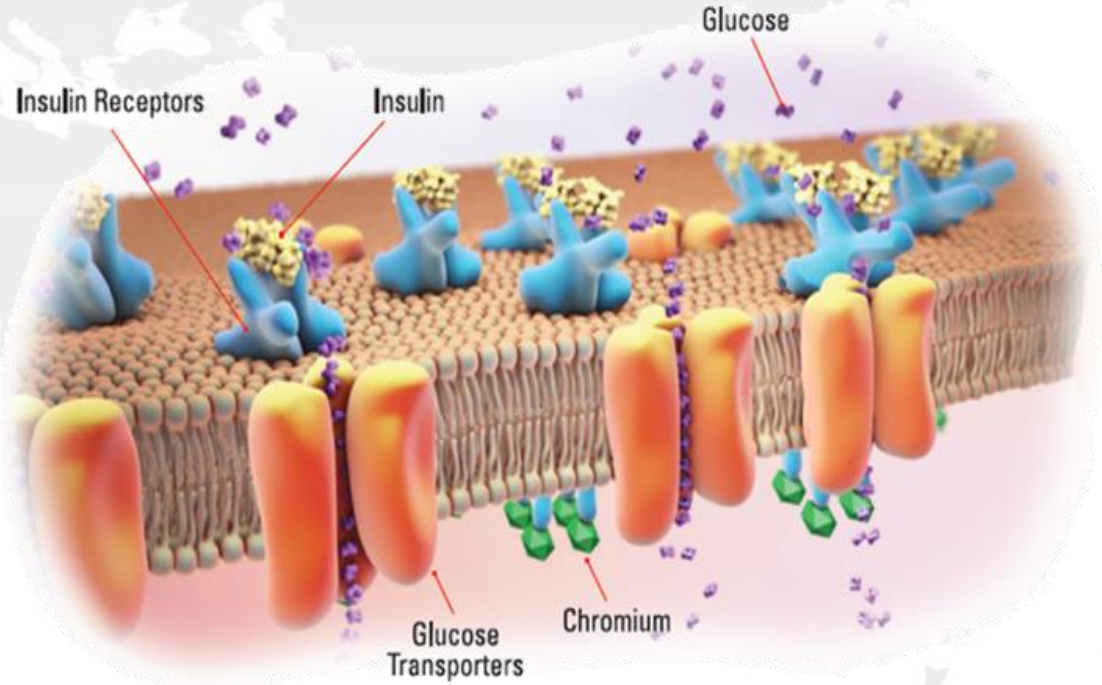
Heat Stress Management

Nutritional Management

Trace Minerals

Recently the role of Chromium is well defined in development of good immunity and reducing the effect of stress

- Chromium is an integral part of GTF which potentiates insulin action
- Improves the immune function in stress condition and in disease challenge conditions
- Reduces the stress hormone levels and nullify the effect of stress

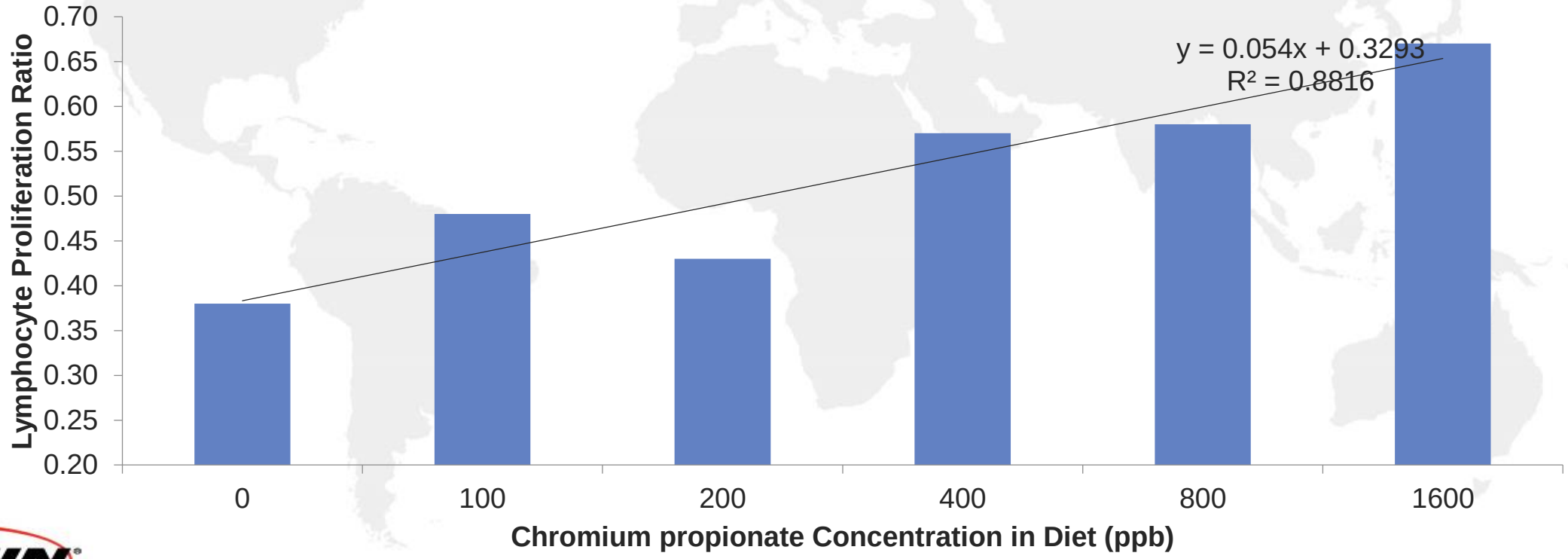


Heat Stress Management

Nutritional Management

Trace Minerals

Organic Chromium propionate in cell mediated immunity



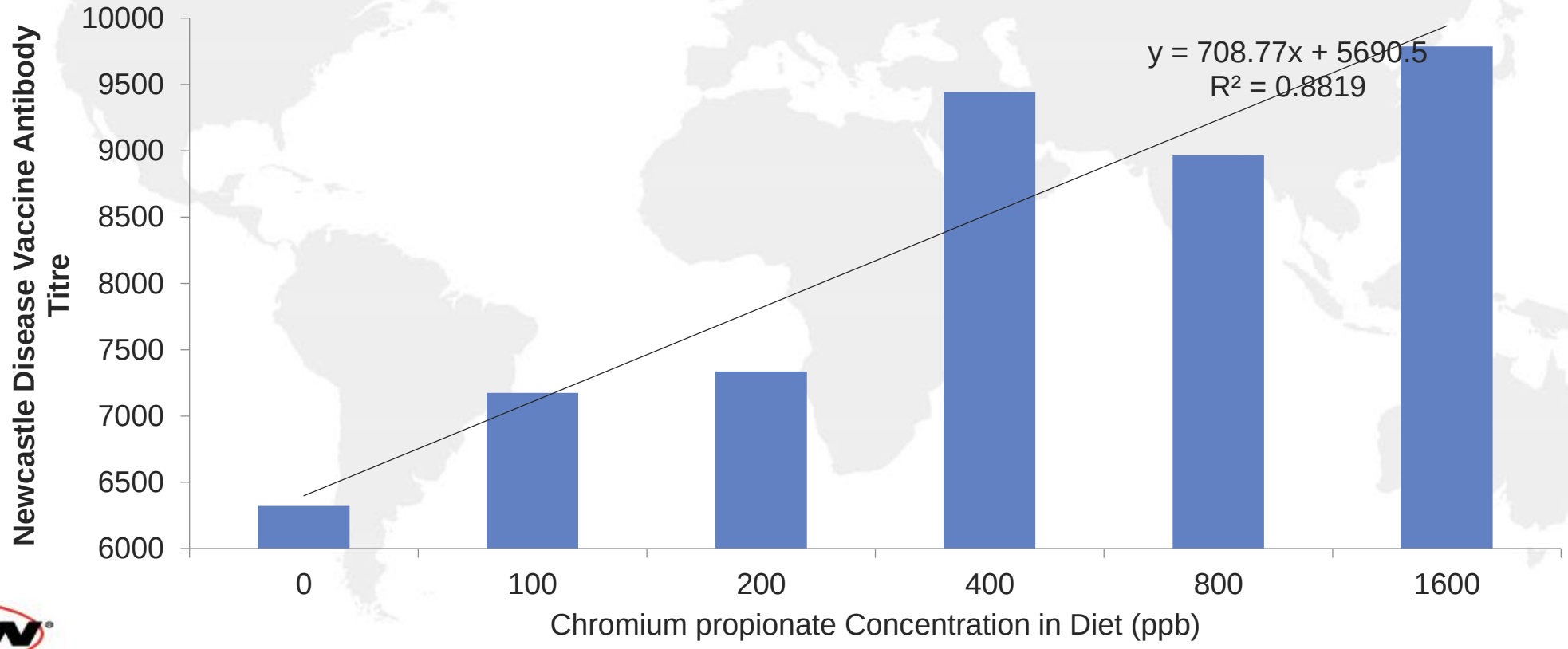
Ref: Rajalekshmi *et al* , 2014

Heat Stress Management

Nutritional Management

Trace Minerals

Organic Chromium propionate in humoral immunity



Ref: Rajalekshmi *et al* , 2014

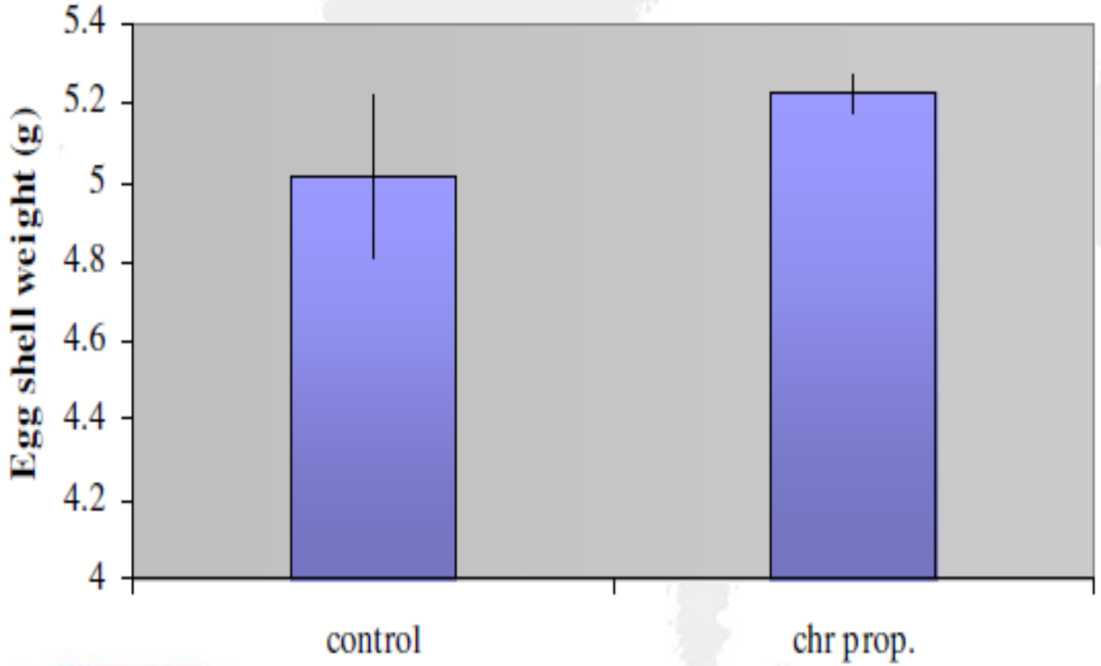
Heat Stress Management

Nutritional Management

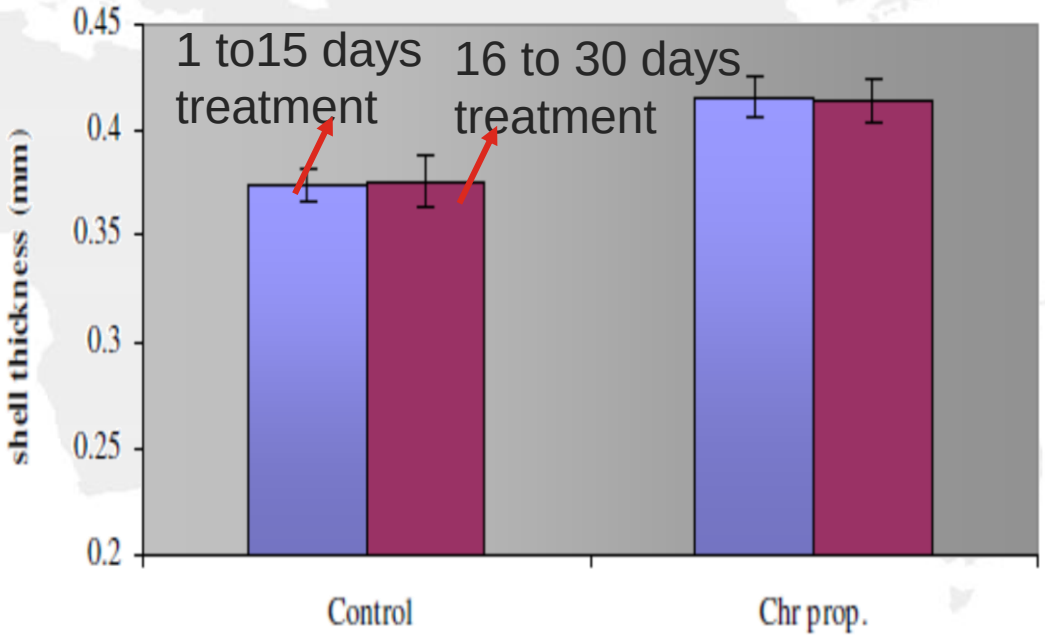
Trace Minerals

Eggs shell weight and thickness in layers

Egg shell weight (g)



Egg shell thickness (mm)



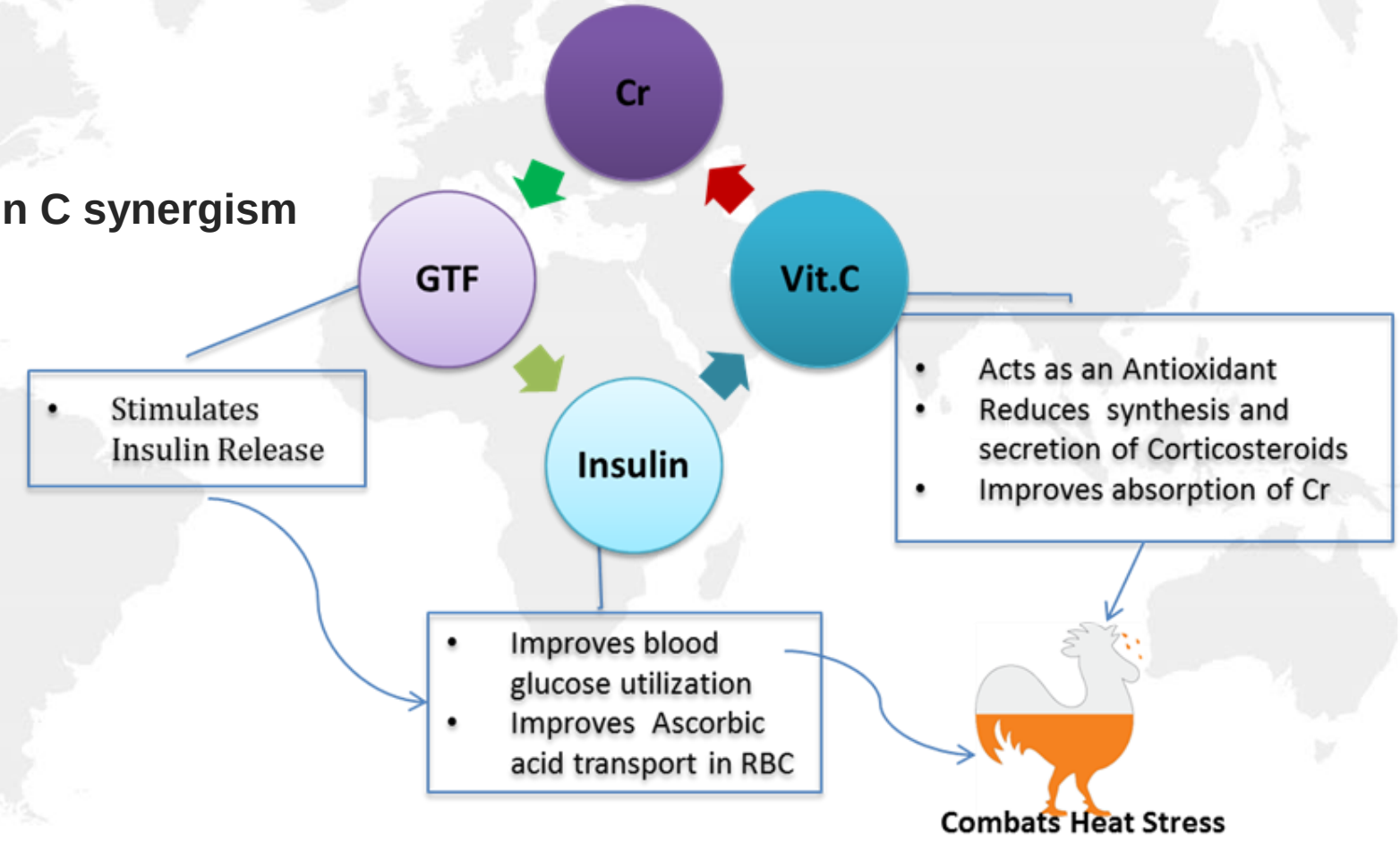
Ref: Rajalekshmi *et al* ,Kemin ID-2008

Heat Stress Management

Nutritional Management

Trace Minerals

Chromium Propionate and Vitamin C synergism



Heat Stress Management

Nutritional Management

Trace Minerals

Chromium propionate and Vitamin C synergism In heat stress conditions

Effects of supplemental chromium and ascorbic acid on some serum hormones and metabolites of b chickens reared under heat stress (32°C) (n = 10)

Item	Treatments*			
	Control	Cr	Vit C	Cr + Vit C
T3, ng/ml	2.75[a]	3.18[b]	3.24[b]	3.95[c]
T4, ng/ml	7.53[a]	8.09[b]	8.16[b]	8.84[c]
Insulin, U/L	29.23[a]	31.50[b]	31.53[b]	33.62[c]
Corticosterone, mol/L	1.95[a]	1.65[b]	1.62[b]	1.44[c]
Glucose, mg/dl	215[a]	198[b]	182[b]	168[c]
Cholesterol, mg/dl	258[a]	249[b]	235[b]	220[c]
Total protein, g/dl	4.30[a]	4.45[b]	4.54[b]	4.66[c]

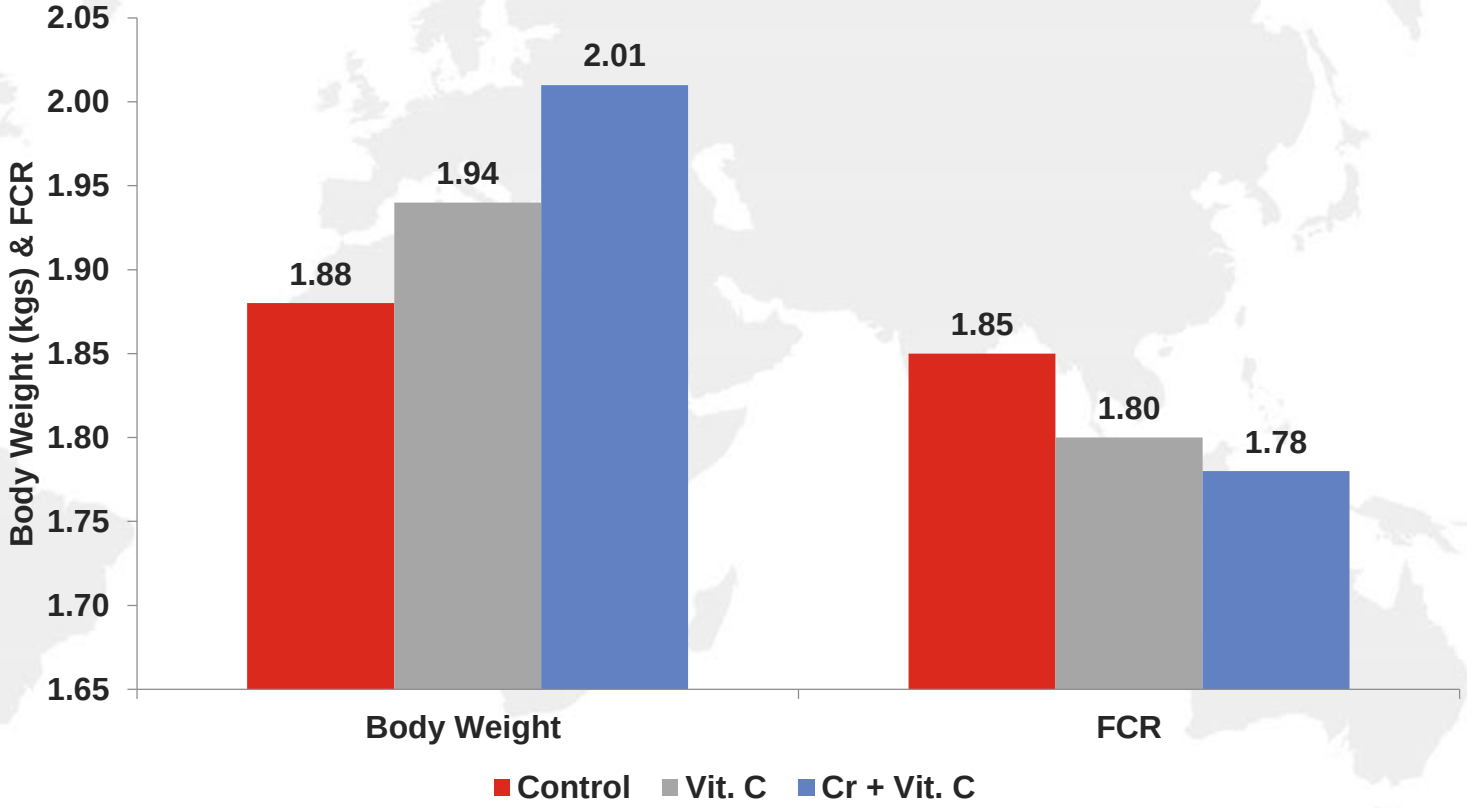
Ref: Sahin *et al* , 2003

Heat Stress Management

Nutritional Management

Trace Minerals

Chromium propionate and Vitamin C synergism In heat stress conditions



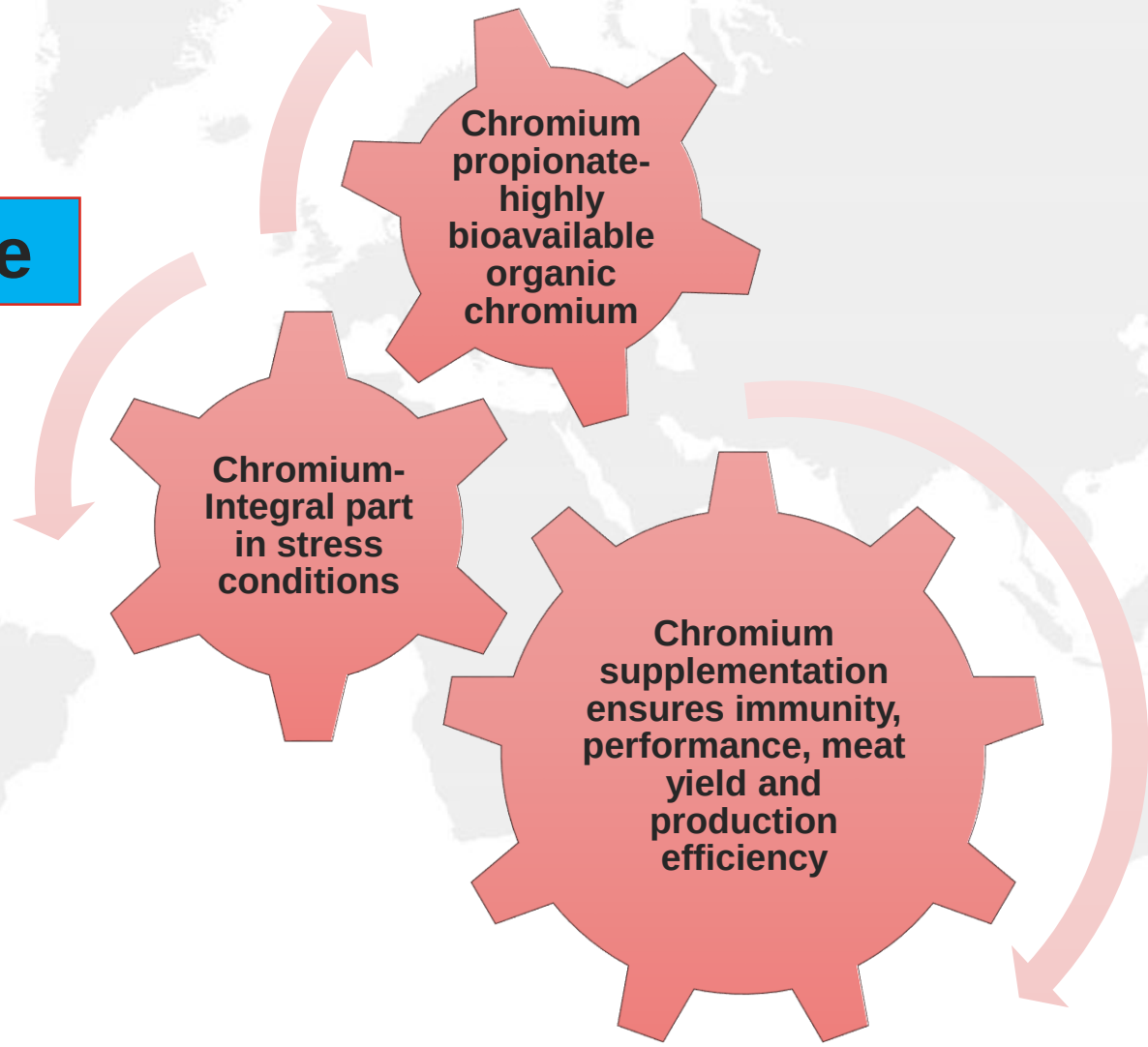
Vitamin C strongly needs Chromium* for a better performance

Vitamin C and Chromium* Compliment each other

Ref: Sahin *et al* , 2003

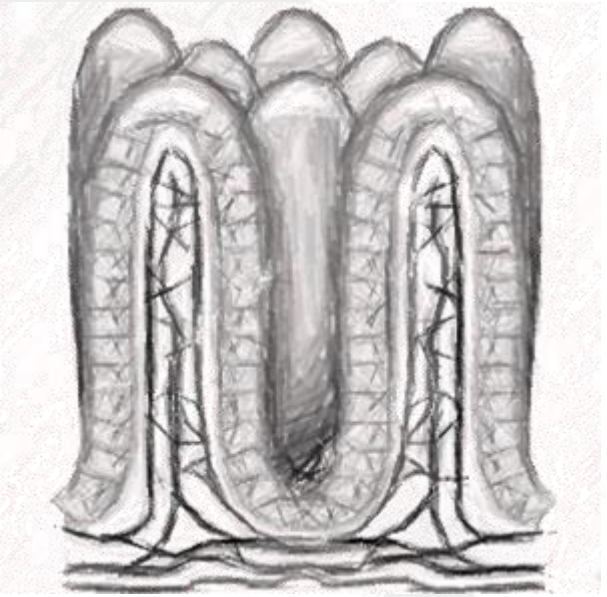
Heat Stress Management

Chromium propionate



Heat Stress Management

Gut health management



Heat Stress Management

Gut health Management

Supplementation of ***Bacillus subtilis*** **PB6** improving the gut health in heat stress conditions

Birds were heat stressed from 21 to 35 days @ 35^{0}C- Broiler performance

Effect of *B. subtilis* PB6 on performance and thermotolerance of broilers.

Parameters	Thermoneutral		Heat stress	
	Basel diet	*B. subtilis*	Basel diet	*B. subtilis*
Initial body weight (g)	870	870	870	870
Final body weight (g)	2030^{xy}	2067^{x}	1642^{z}	1935^{y}
Average daily feed intake (g/day)	152.6^{x}	151.3^{x}	147.1^{y}	142.9^{y}
Average daily gain (g/day)	87.9^{xy}	90.5^{x}	60.1^{z}	81.1^{y}
Feed conversion (kg/kg)	1.73^{y}	1.66^{z}	2.47^{x}	1.78^{y}
Rectal temperature (°C)	41.3^{y}	41.2^{y}	43.2^{x}	43.6^{x}
Rate of increase in rectal temperature (°C/h)	0.11^{y}	0.08^{y}	1.92^{x}	1.94^{x}
Mortality (%)[a]	0.0^{z}	0.0^{z}	12.5^{x}	5.0^{y}

293 g

7 points

Ref: A.R.Al-Fataftah and Anas Abdelqader, 2014

Heat stress management

Gut health Management

Supplementation of ***Bacillus subtilis*** **PB6** improving the gut health in heat stress conditions

Birds were heat stressed from 21 to 35 days @ 35^{0}C- Intestinal microflora

Effect of *B. subtilis* PB6 on the intestinal microflora of broilers (log_{10} CFU/g of fresh digesta).

Parameters	Thermoneutral		Heat stress	
	Basel diet	*B. subtilis*	Basel diet	*B. subtilis*
Lactobacillus	9.04^{y}	10.25^{w}	7.06^{z}	9.68^{x}
Bifidobacterium	7.22^{y}	8.57^{w}	6.14^{z}	8.36^{x}
Clostridium	4.11^{yz}	4.03^{z}	5.78^{x}	4.13^{y}
Coliforms	5.72^{y}	4.74^{z}	6.88^{x}	4.80^{z}

Bacillus Subtilis PB6 improves counts of commensals and reduces pathogenic bacteria in both normal and heat stress conditions.

Please note the increase in the *Clostridium* spp. and *Coliforms* counts in the heat stressed birds compared to normal birds

Ref: A.R.Al-Fataftah and Anas Abdelqader, 2014

Heat stress management

Gut health Management

Supplementation of ***Bacillus subtilis* PB6** improving the gut health in heat stress conditions

Birds were heat stressed from 21 to 35 days @ 35^{0}C- Intestinal villi morphometry

Effect of *B. subtilis* PB6 on the morphology of duodenum and ileum of broilers.

Parameters	Thermoneutral		Heat stress	
	Basel diet	*B. subtilis*	Basel diet	*B. subtilis*
Villus height (µm)				
Duodenum	1552.8^{y}	1823.4^{w}	1289.0^{z}	1713.3^{x}
Ileum	523.0^{y}	658.6^{x}	408.6^{z}	655.8^{x}
Crypt depth (µm)				
Duodenum	315.9^{x}	304.5^{y}	296.0^{z}	320.8^{x}
Ileum	122.1^{x}	108.2^{y}	92.0^{z}	130.3^{x}
Villus surface area (µm^2)				
Duodenum	382.6^{y}	482.1^{x}	271.5^{z}	479.0^{x}
Ileum	110.4^{y}	186.3^{x}	86.0^{z}	184.7^{x}
Absorptive epithelial cell area (µm^2)				
Duodenum	220.5^{y}	248.4^{x}	187.3^{z}	248.7^{x}
Ileum	162.4^{y}	198.2^{x}	127.8^{z}	196.6^{x}

Increase in Villi health by *B Subtilis* PB6

Ref: A.R.Al-Fataftah and Anas Abdelqader, 2014

Heat Stress Management

Bacillus subtilis PB6

Improves counts of commensals and reduces pathogenic bacteria in both normal and heat stress conditions.

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Improved Villi health

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Better Intestinal Health Management and Intestinal integrity during heat stress

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Better Performance of Birds

In conclusion…

Heat stress management

Environment

- Farm preparation
- Biosecurity
- Hygiene
- Feed form
- Feeding time

Nutrition

- Energy
- Amino acids
- Vitamins
- Minerals
- DEB
- Chromium propionate

Gut health

- Hygiene
- Raw material quality
- *Bacillus subtilis* PB6

In conclusion…

In nature, *Stress is the rule not the exception*

Management of stress is the key to successful poultry production

Thank you !!

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