Flock Management to Optimize Broiler Gut Health Without Antibiotics

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A Chain Is Only As Strong As It's Weakest Link

Feed Quality – Texture, Ingredients

Ambient Conditions

Sanitation

Pest & Rodent Control

Ventilation

Light Programs

Biosecurity

Immune Status

Gut Health

Stocking Density

Nutrition – Formulation

Chick Quality

Feed Space - Availability

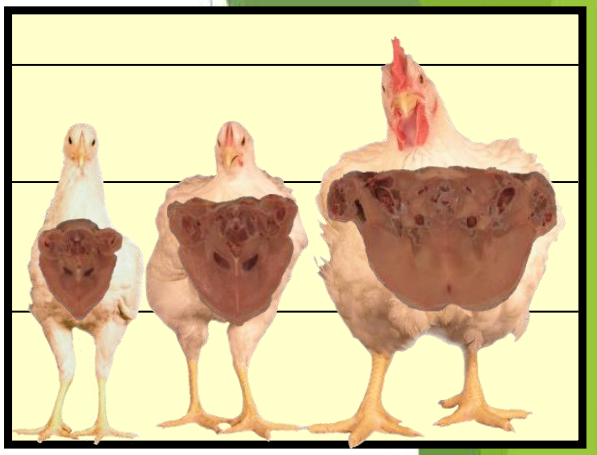
Welfare

Steady State Feed Intake

Litter Conditions

Pathogen Challenges

Water Space - Availability



Broiler 50 years ago Broiler 30 years ago Today's Broiler

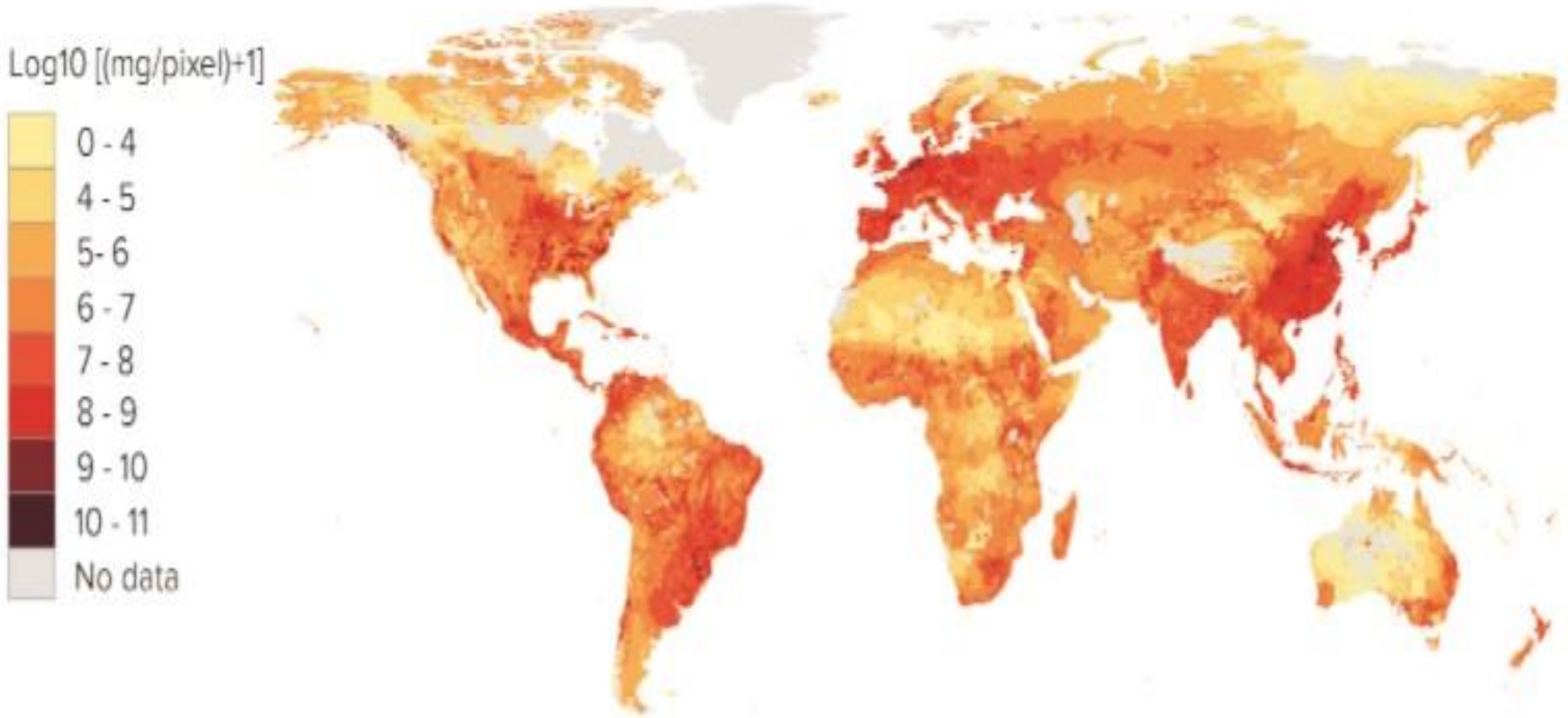


FIGURE 3-1: Global antibiotic consumption in livestock (milligrams per 10 km² pixels) 2010

Source: Van Boeckel et al. 2015

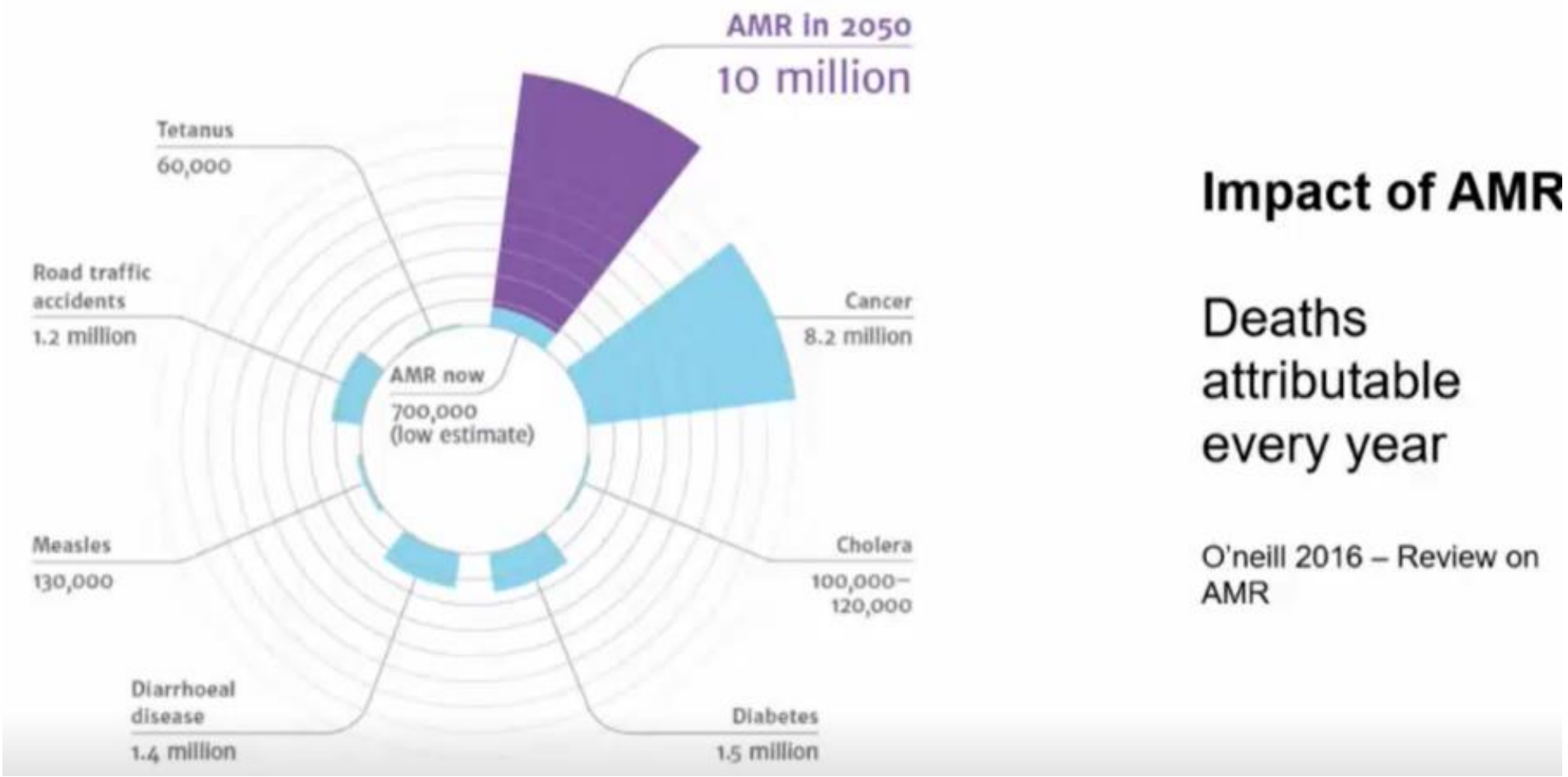
A Brief History of AGP use in Livestock

- Antimicrobial Agents first approved for use as feed additives in livestock without prescription in 1951 (US Food and Drug Administration)

- Practice of feed administration of these Antibiotic Growth Promoters (AGPs) at non-therapeutic concentrations has increased by 10- to 20-fold since the 1950s. Without intervention, could increase 10-fold by 2050.

- World Health Organization (WHO) recommends ban of non-therapeutic use of AGPs, veterinary oversight (prescription-based system) and monitoring of antimicrobial resistance in bacteria.

Deaths due to Antimicrobial Resistance (AMR)



Impact of AMR

Deaths attributable every year

O'neill 2016 – Review on AMR

Do we need AGPs?

Use changed from growth promotion to disease prevention

Viewed as crutch for those not willing or able to focus on management conditions

- Hatchery injection of antibiotics
- Bird density
- Health challenges due to poor brooding, culling, environmental conditions etc.

How does this work in a world of variable poultry housing and feeding conditions?

- Chick Quality, disease, and management challenges?

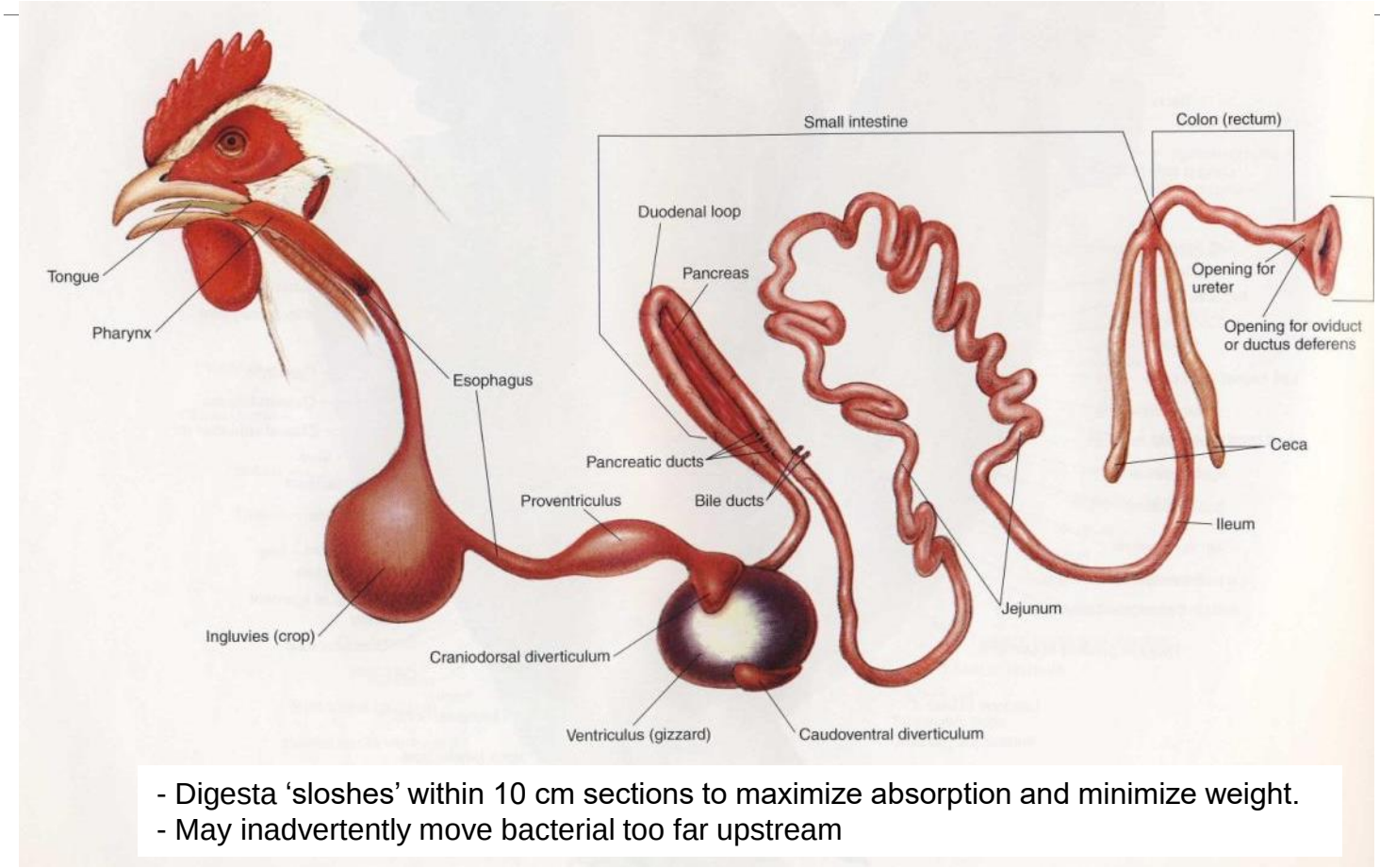
Does global income disparity affect our ability to reduce antibiotic use in poultry diets?

Canada: Most RWA Programs in Newer Barns

What Happens when have Low-tech Facilities?

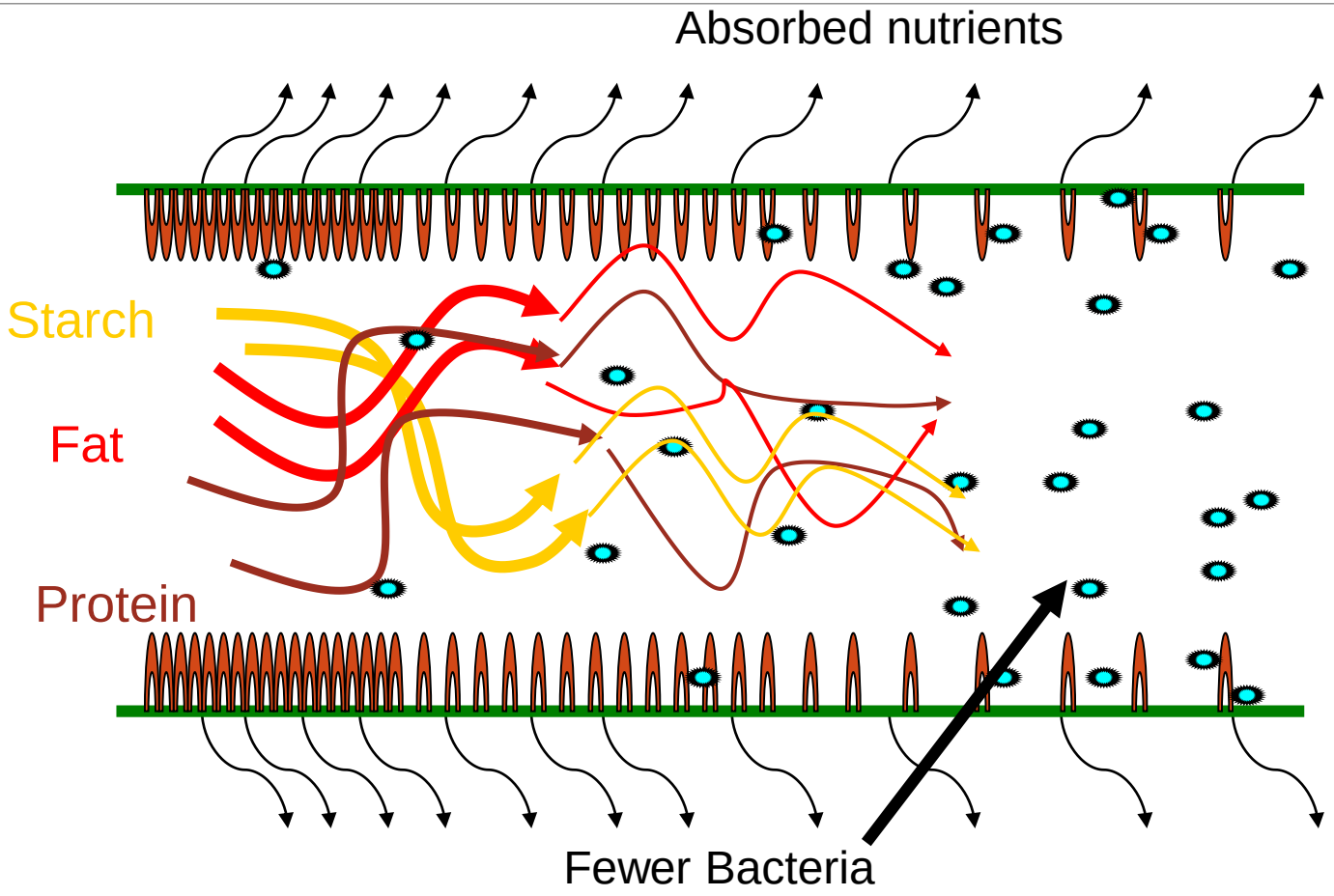
- Can’t control environment or disease vectors
- CO from in-barn combustion heating?
- Antibiotic use bans, but does use go down if keep needing to treat?
- Different standards for local vs. export market?
  - Can’t sell at EU price locally

Normal Poultry Gut Function may Predispose Birds to Diseases Originating from Hindgut Bacteria



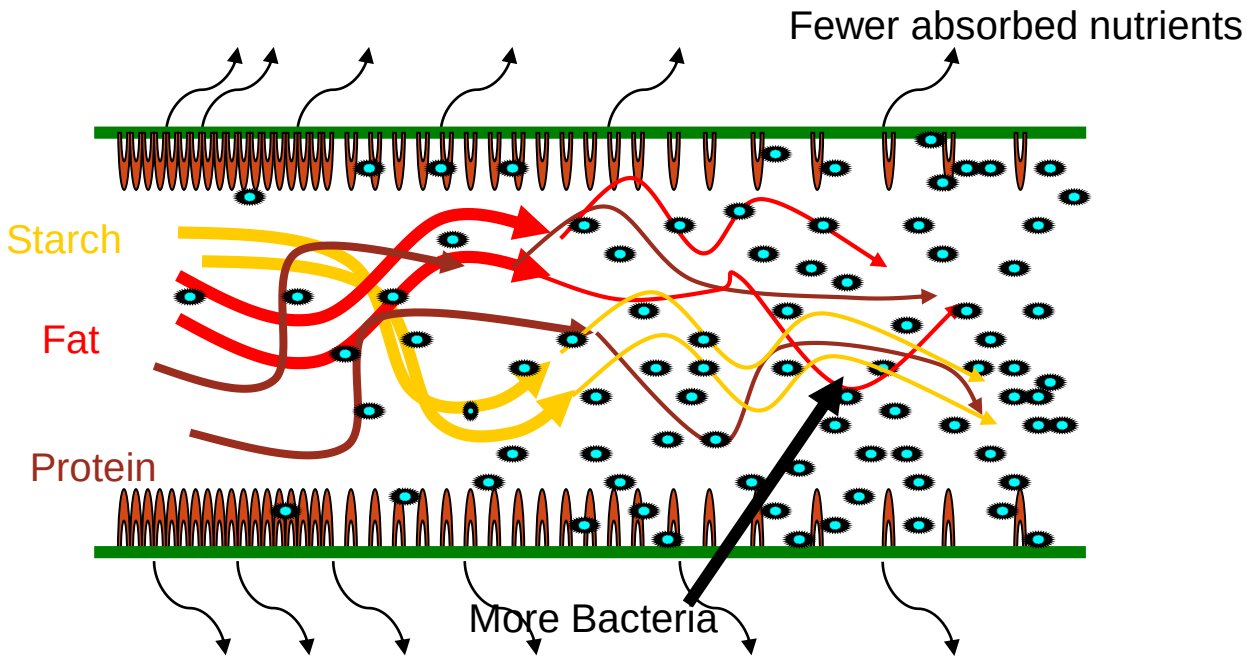
- Digesta ‘sloshes’ within 10 cm sections to maximize absorption and minimize weight.
- May inadvertently move bacterial too far upstream

Optimal rate of digestion results in little substrate for bacteria



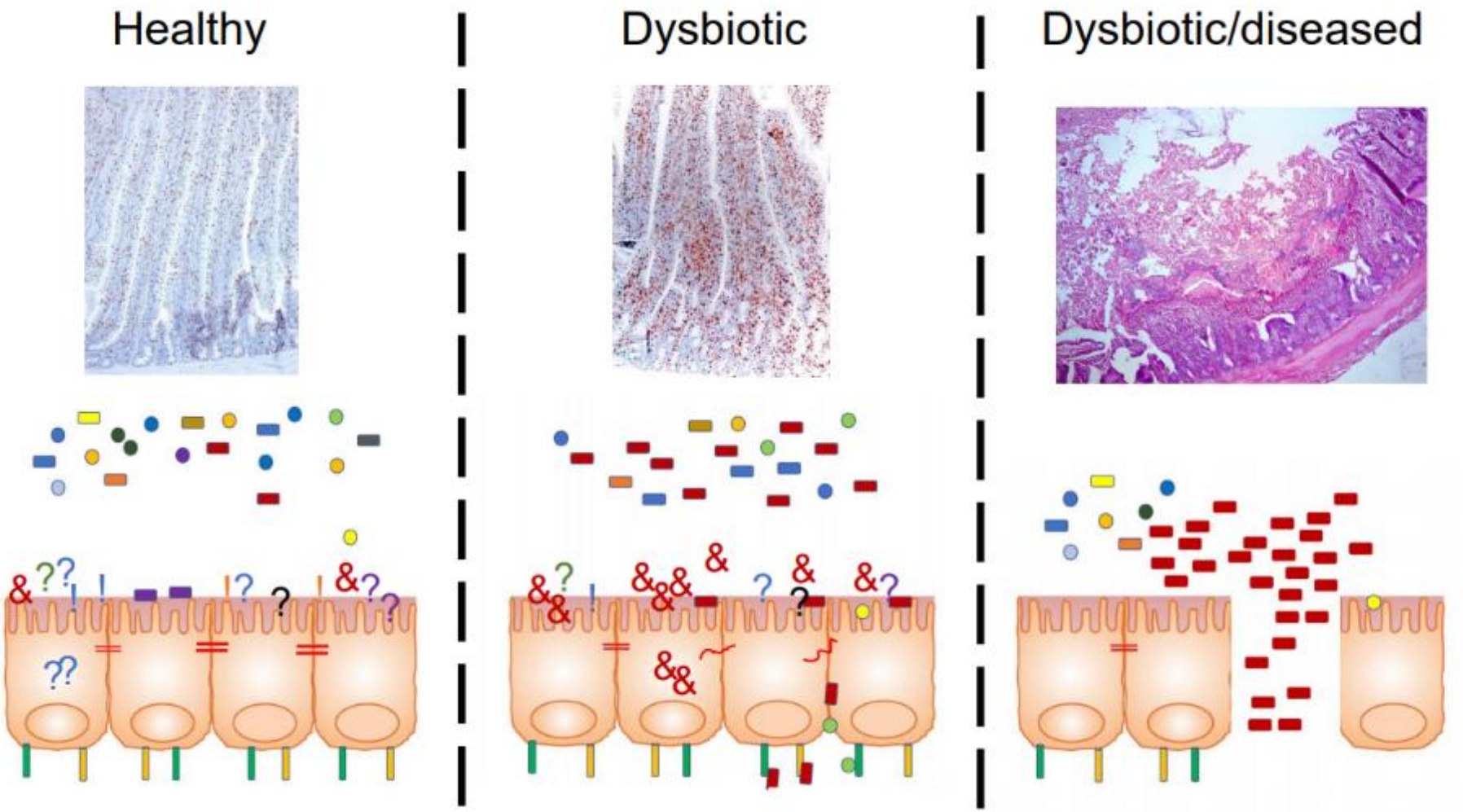
Bedford (2002)

Poor digestion by the bird leads to more substrate for hindgut bacteria



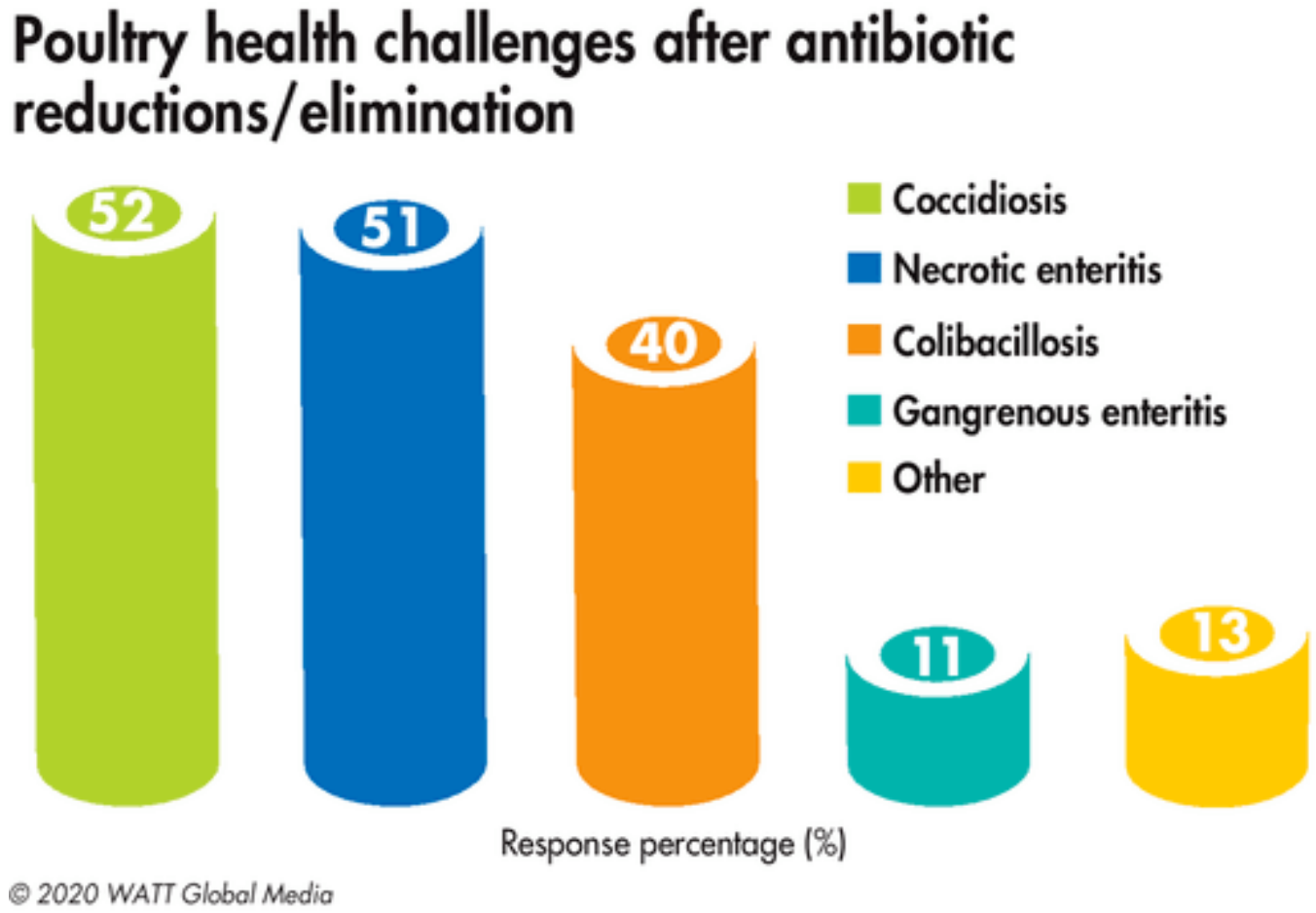
Response is to produce more enzymes and grow a larger intestine. Costly in energy terms.

Bedford (2002)



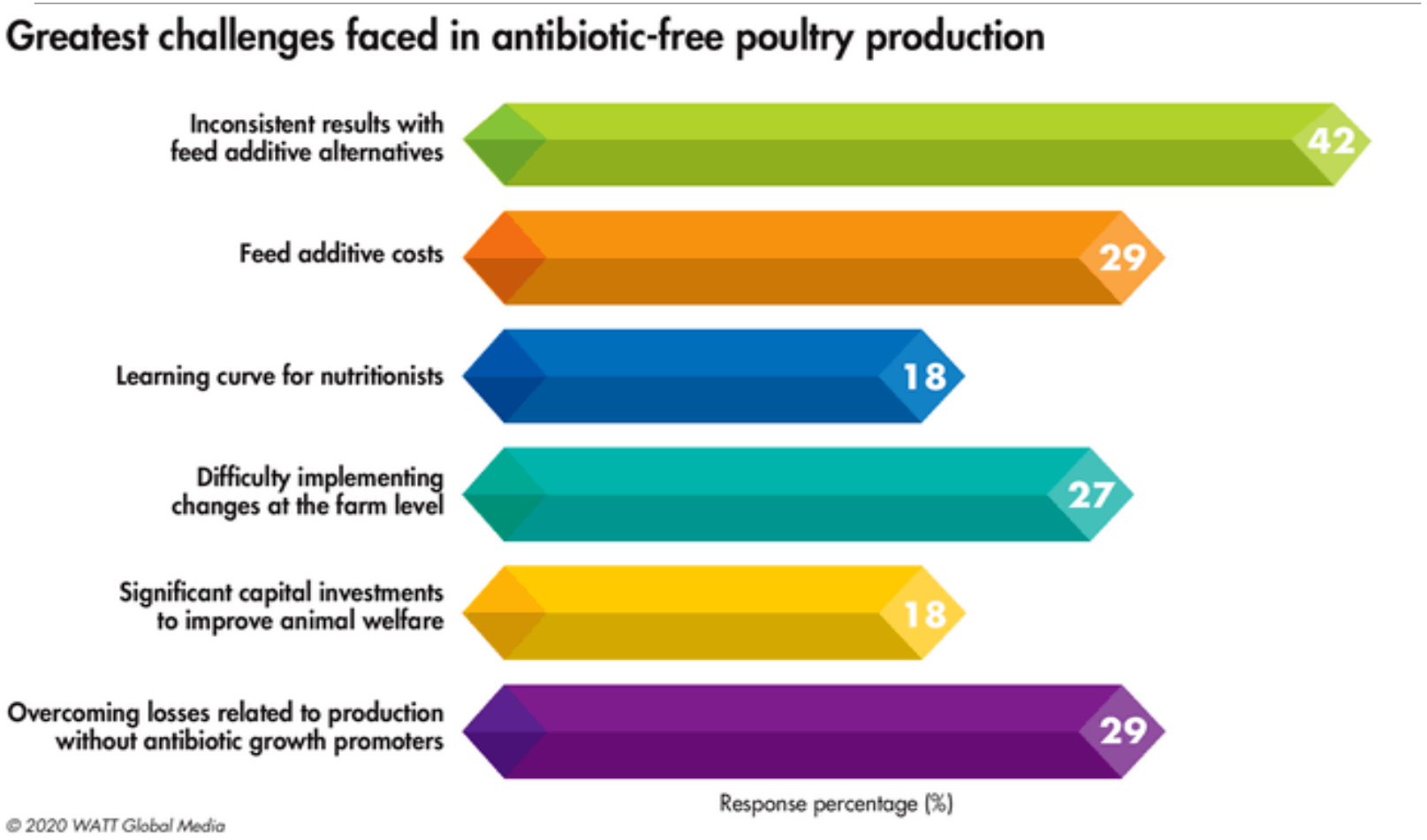
Source: Filip van Immerseel DSM webinar 2020

2020 Poultry Nutrition & Feed Survey



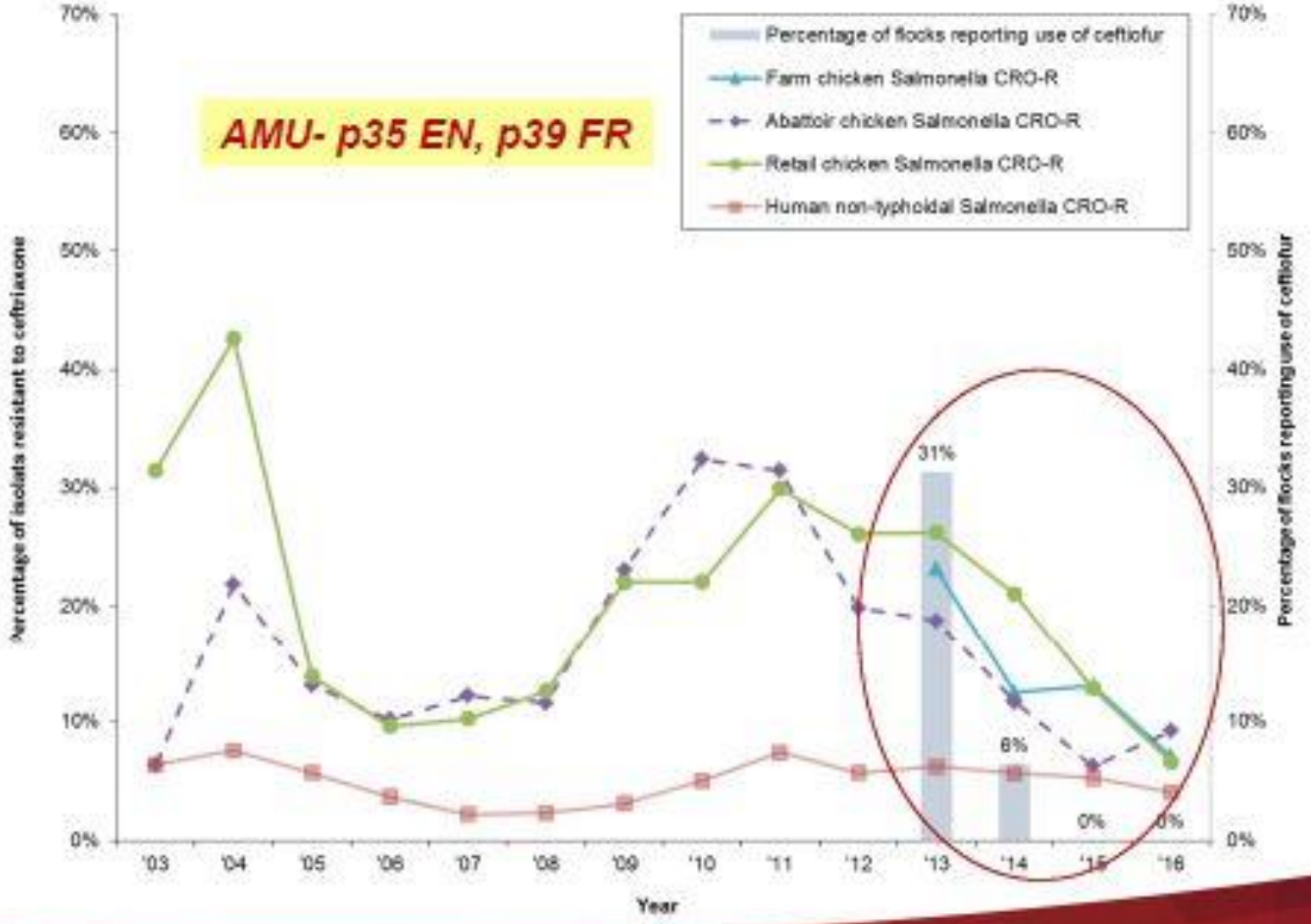
Poultry USA, April 2020

2020 Poultry Nutrition & Feed Survey



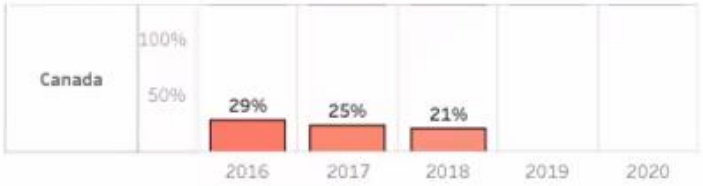
Poultry USA, April 2020

Data integration: resistance of *Salmonella* to ceftriaxone from chickens and humans and farm-level antimicrobial use data

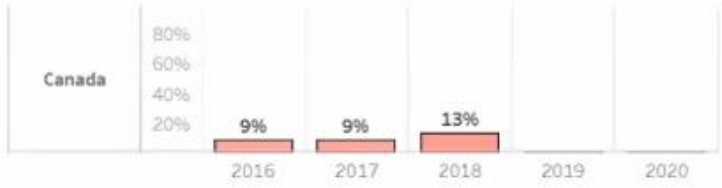


Category II Antimicrobial Use after 2018 Ban

- **Streptogramins (Virginiamycin, Stafac)**

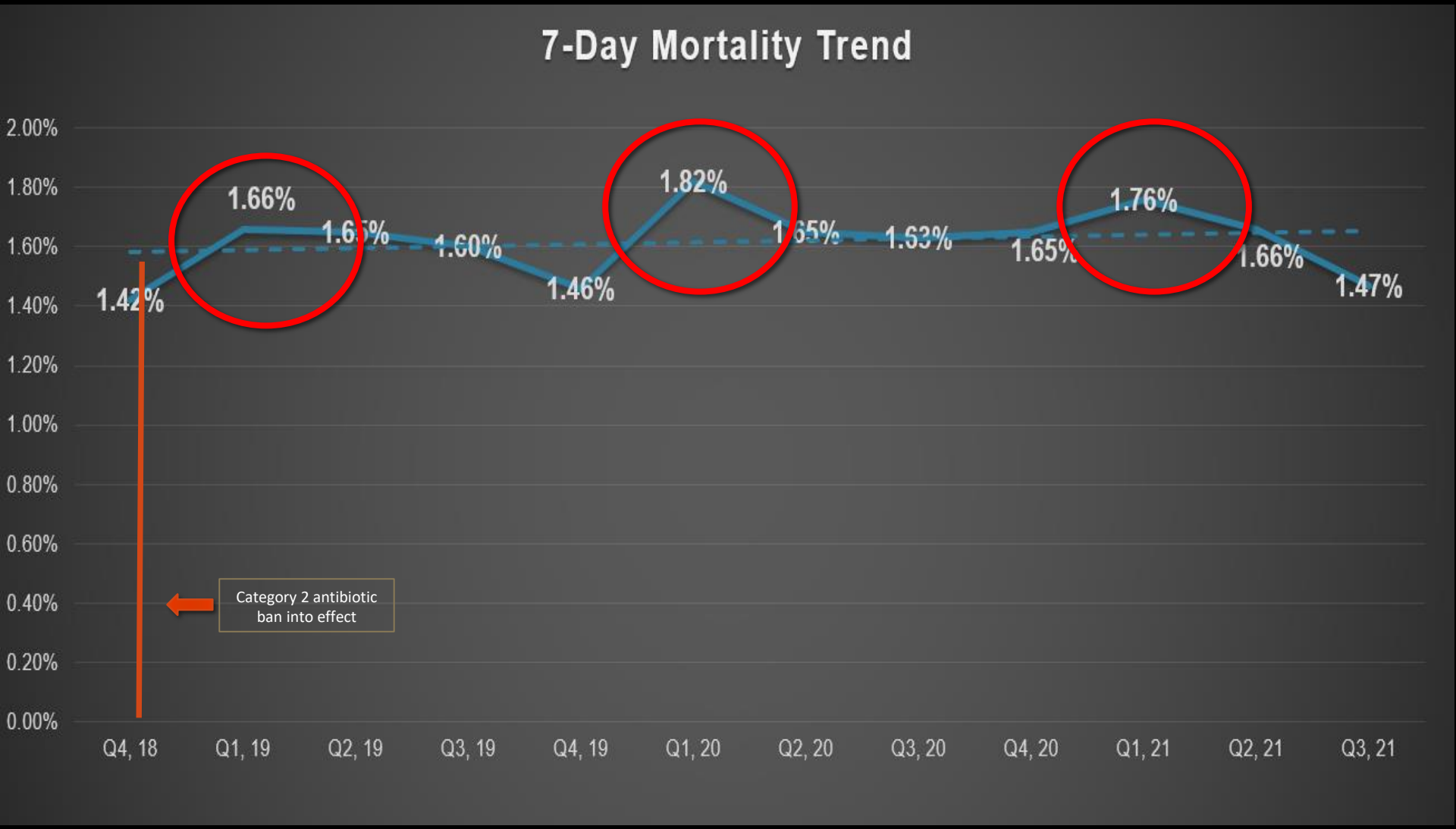


- **Marcolides (Tylan)**



* Concern that Orthosomycin (Surmax) use would increase.
  * Uncategorized antibiotic of human health importance
  * Use dropped between 2019 and 2020.
    * Improvements in flock management?

Based on survey results



*Based on Alberta hatchery survey

Where is the Biggest Impact of Removing AGPs from Animal Production?

Table 6. Species-specific relative average daily growth difference between animals raised with and without antibiotics as growth promoters.

	1980s literature (%)	2000s literature (%)
Cattle	7	3
Chickens	4	0.7
Pigs	9	1

Growth response to AGPs appears to be small in optimised production systems

Loss of income higher in lower income countries with less developed hygiene and production practices

What Tools do we have at Production Level?

- Value-chain vaccination programs
- Additives with antibiotic replacement qualities
  - New combinations for increased impact
- Brooding and environmental management
  - Optimize water system and flock health
- Future / emerging technologies
  - New regulations and consumer pressure may accelerate change and demand more resources into innovation

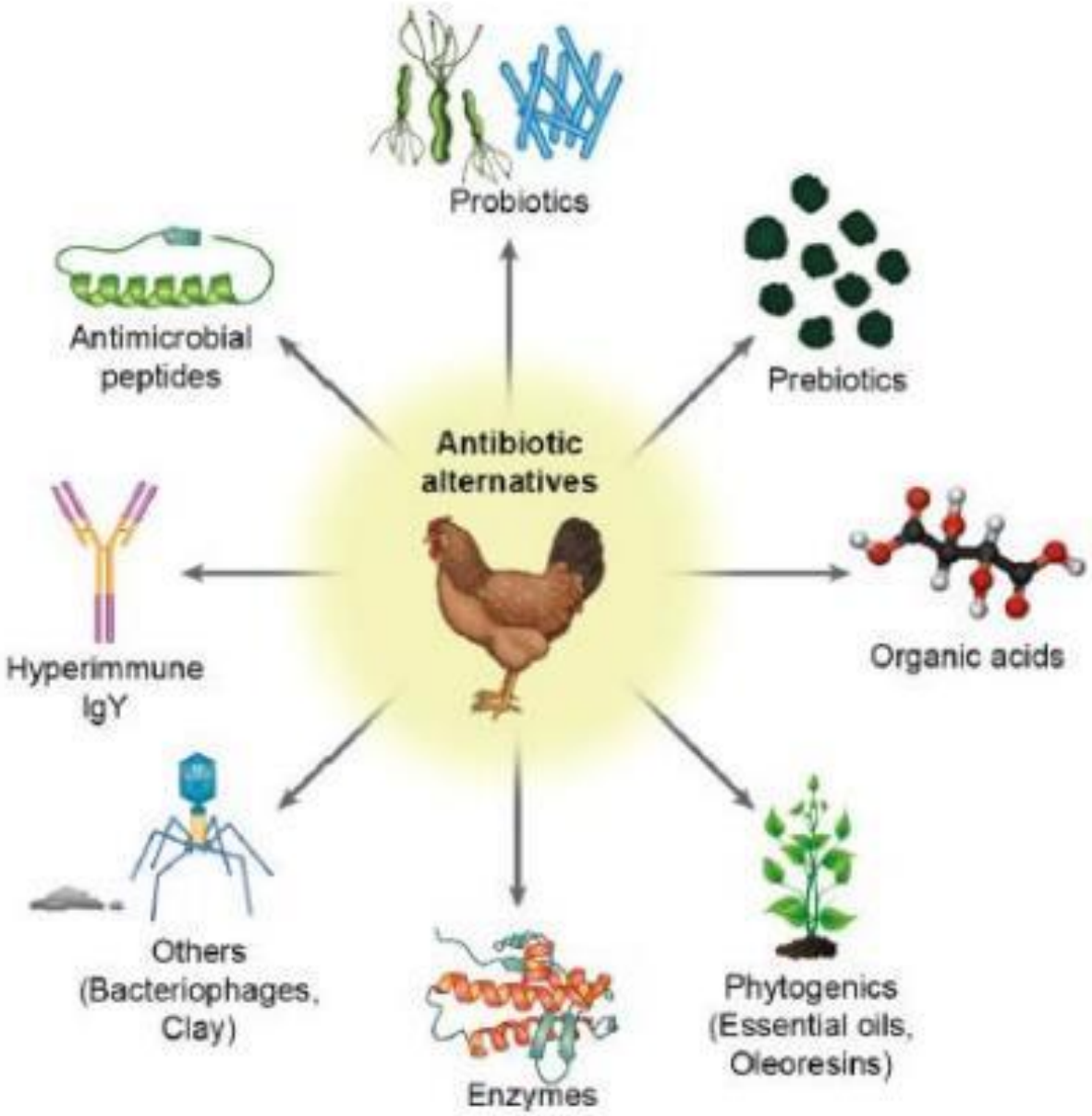


Fig. 1. Various classes of antibiotic alternatives that are available for use in poultry production.

Gadde et al., An. Health. Res. Rev. 2017

Alternatives to AGPs: Confusion over Expectations vs. Advancement

Feed additives vs. other reasons?

- Progress through better genetics, husbandry, health practices, and biosecurity.
- Not through nutritional feed additives alone.

Opportunity for alternative to AGP technologies to continue to improve to meet ongoing challenges of the transition away from antibiotics

- Clear that understanding of host-microbiome interactions is a necessary part of this future

Identify Mechanisms of AGPs and Use This to Identify / Design AGP Replacements

Observational empirical methods that have led to variable results for many products that have the potential to work

- "feed them and weight them" studies

More recently see more work studying mechanisms involved in AGP function and working to identify alternatives that mimic physiological response to AGPs

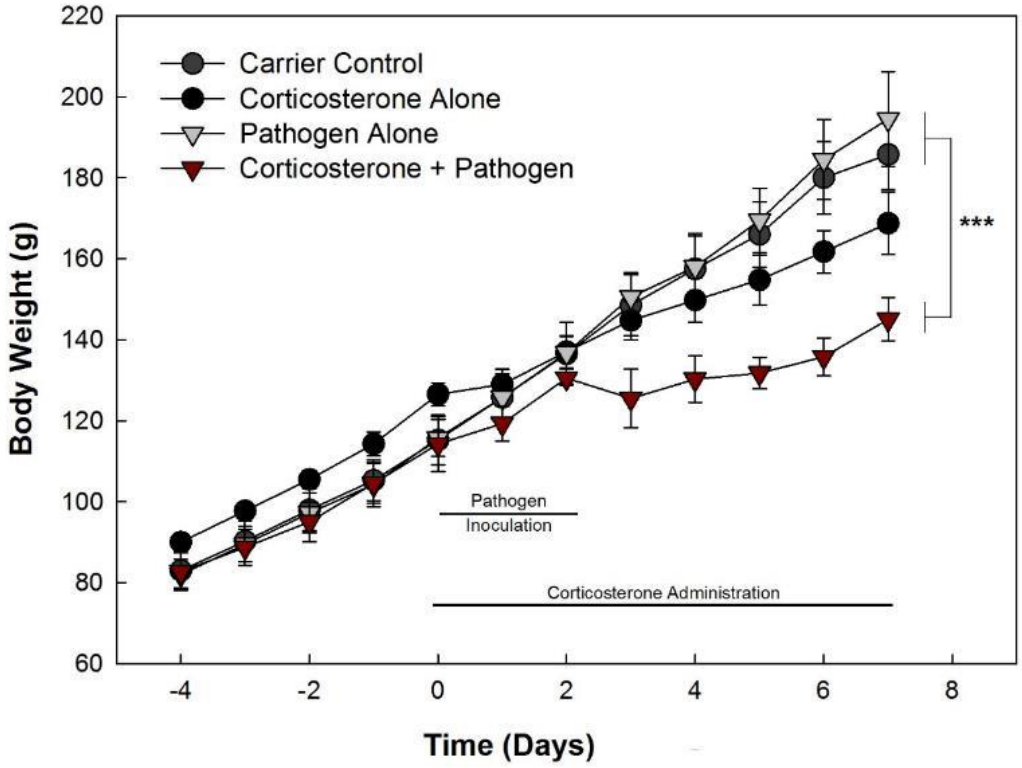
- Do they impact the gut flora, action of the gut, or both?
- How + Why they work (or don't!)

Animal environment (density, stress, activity level, diet, feed form) will influence both gut microbiota and the host.

Complicating Factor of Barn Conditions

Animal environment (density, stress, activity level, diet etc.) will influence both gut microbiota and the host.

- Can negate expected effect of treatment
- Good conditions may also not show protective effect

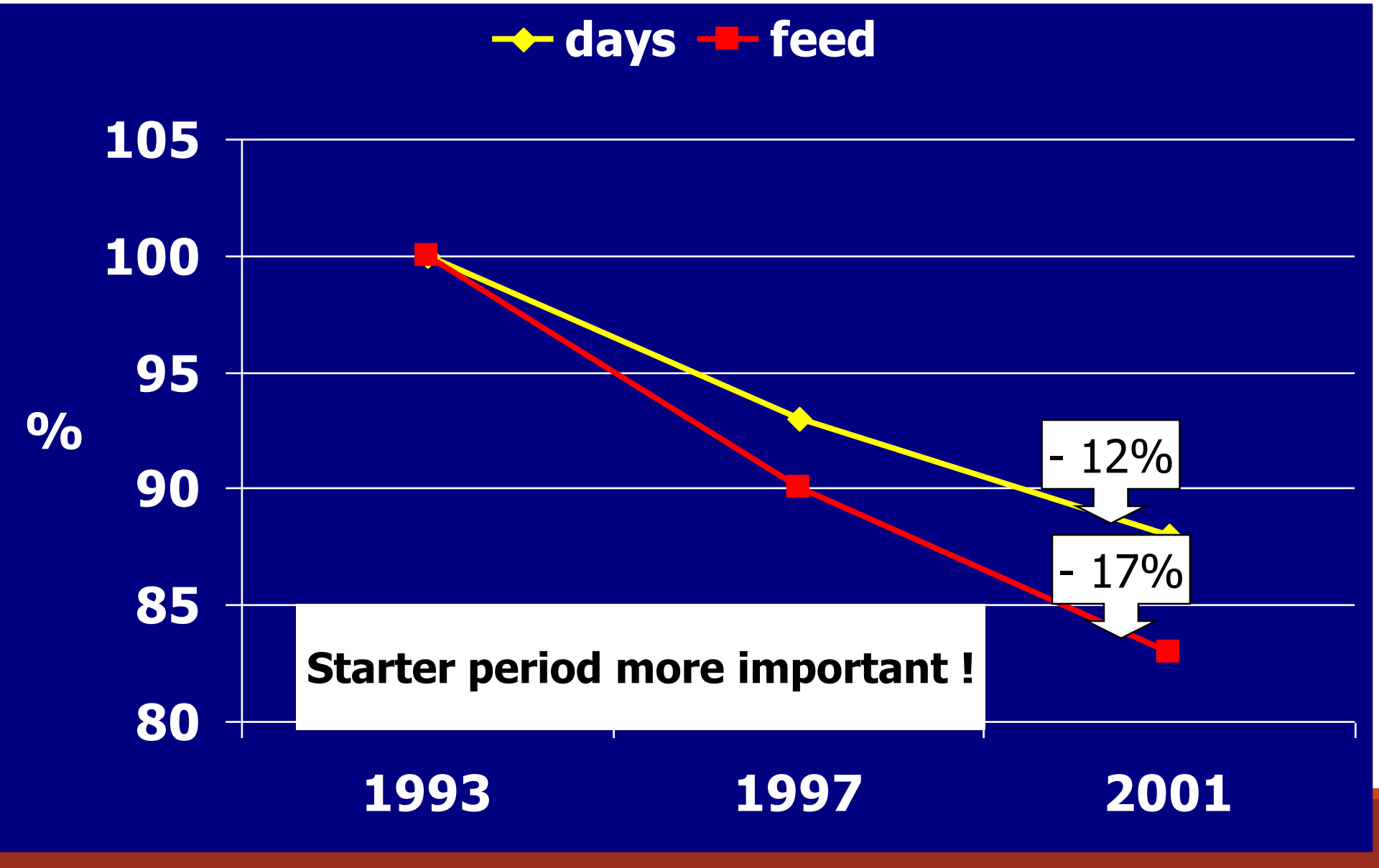


Suggested causes of poor broiler uniformity

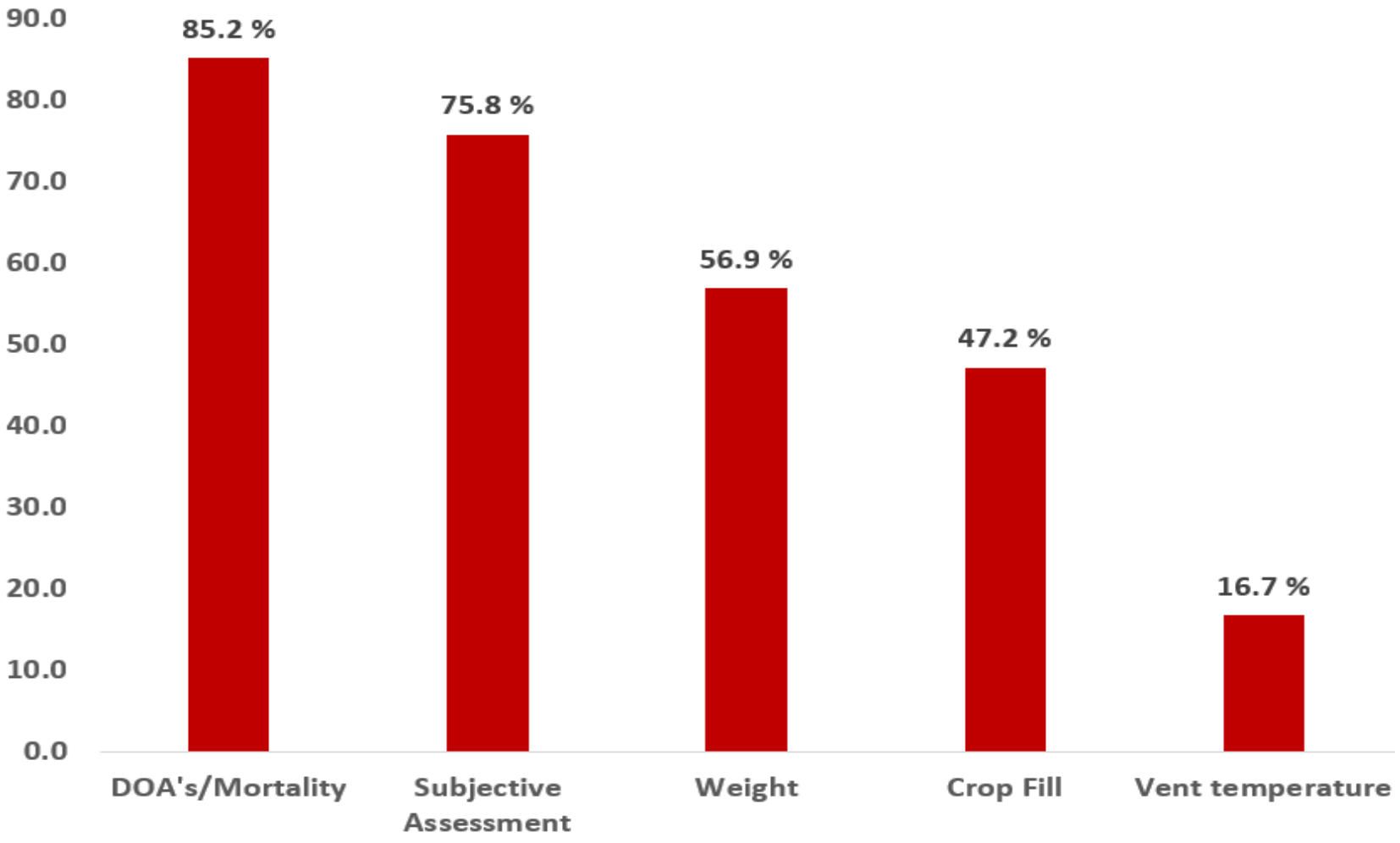
Factor	Effect on uniformity
Breeders with poor uniformity during rearing	X
Absence of pre-warming of stored eggs	X X
Mixing of chicks from different aged breeders	X X X
Poor brooding conditions	X X X X X
Health problems in the 1st week	X X X X X X
Health problems at the end of the growing period	X X X X
Nutritional values (amino acids) poorly digested raw materials	X X X
Insufficient ventilation, ammonia or poor air flow	X X X
Poor adjustment to feeding and drinking equipment	X X

*Note impact of brooding conditions and early exposure to disease on final BW uniformity of broilers (Source = Hubbard)

Age & Feed to Produce a 2040 g Broiler



What Measures Should We Take During Brooding?



Why is early feeding important?

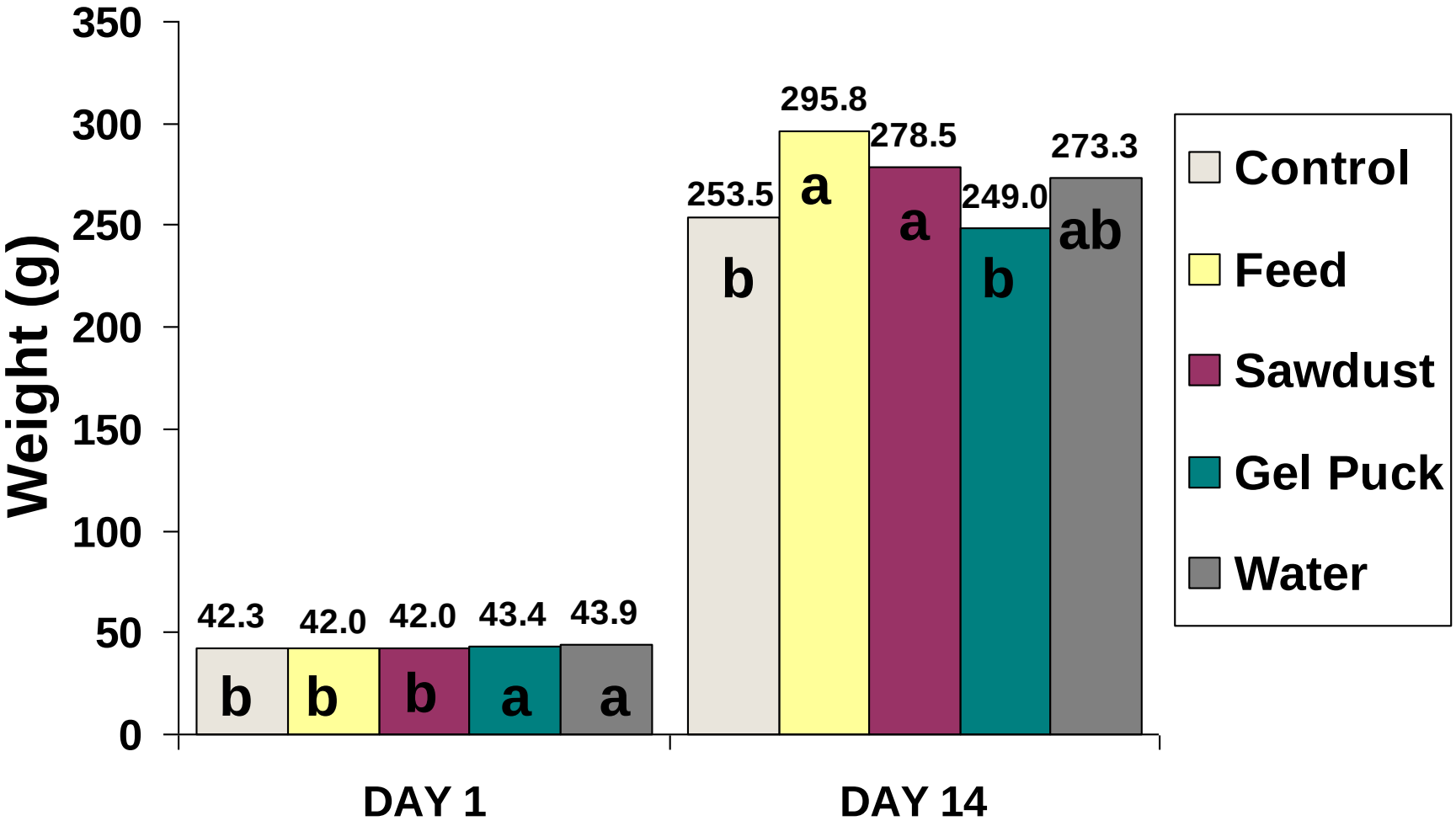
2 to 3 day period of transition after hatch when chick has to absorb residual yolk into both the gut and the circulatory system

Feed in gut stimulates yolk secretion to the small intestines and triggers uptake of fat soluble nutrients

Without feed in the gut, yolk utilisation is slower

- Opposite of what many assume to be true!

The Effects of Dietary Treatment on BW



Getting off to a Fast Start

Presence of ANYTHING in the gut as early as possible provides an early growth advantage.

- Liquid = transient effect; Solid = stimulates growth

Why? Accelerates gut growth and maturation of gut enzyme secretion for digestion of protein, fat, and carbohydrate

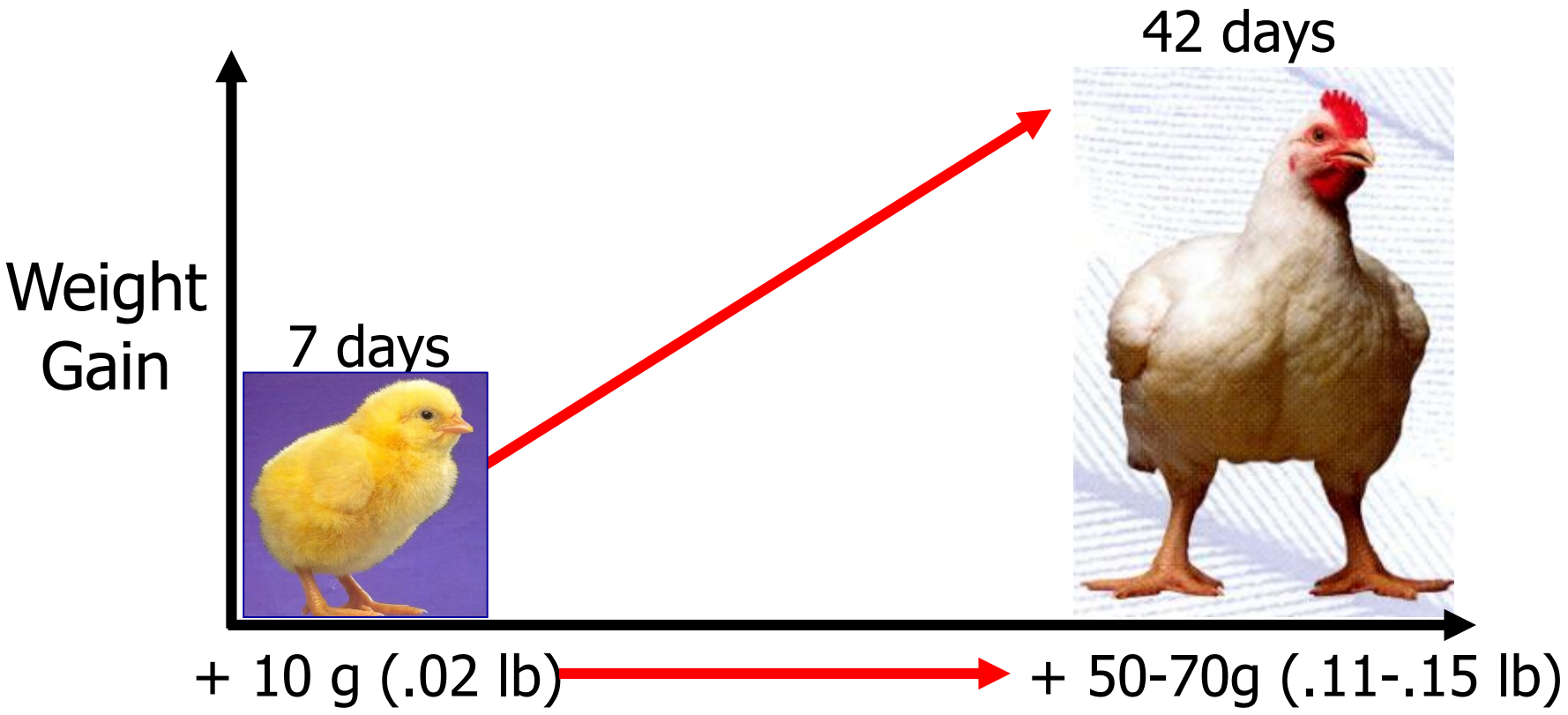
Breast Muscle Development

Early access to feed increases proliferation of satellite cells (breast muscle cell precursors) in the first 1-2 days after hatch

Early feeding can increase breast yield by 4-10% at normal processing ages over birds that were delayed

Even small differences help: Doubling feed on brood paper from 25 to 50g/bird = 50g higher BW at 7 days and 1.6% more breast muscle at processing

Why do we care about 7 d BW?



For every 10 g of extra BW at 7 d, there is an additional 50 to 70 g of BW on the 42 d broiler

Dietary Particle Size

Breeding Company Manuals:

- 0-10 d = sieved crumb
- 11-28 d = 2–3 mm diameter pellet
- 29 d to processing = 3 mm diameter pellet

No optimum particle size for the raw materials of a pellet

- Mill:mill effects
- Final pellet size and quality more important

Measuring Feed Separation

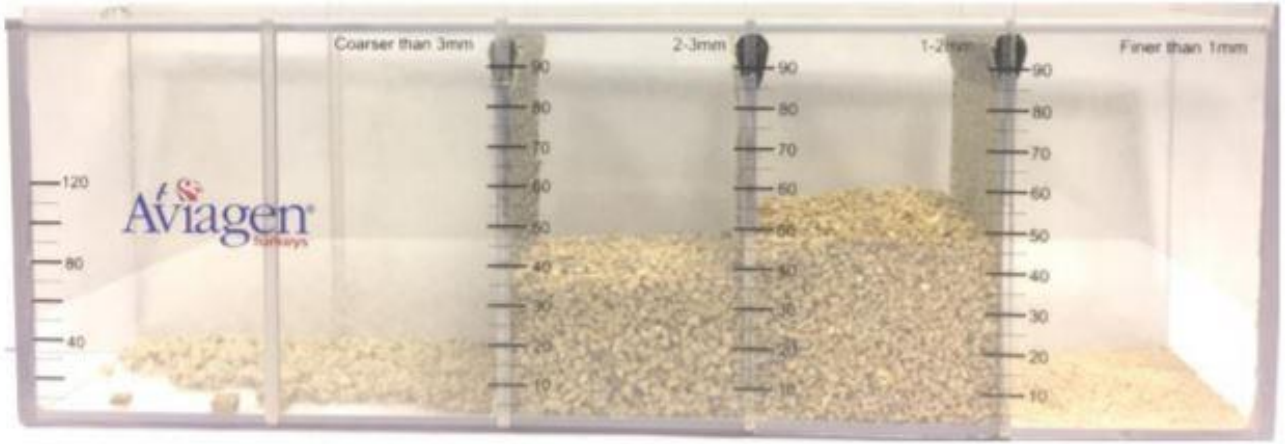


Table 7: Recommended particle size distribution for crumble or pelleted feeds.

Form	Starter	Grower	Finisher
	Crumb	Pellet (3.5 mm)	Pellet (3.5 mm)
> 3 mm	15%	>70%	>70%
> 2 mm	40%	20%	20%
> 1 mm	35%		
< 1 mm	**< 10%**	**< 10%**	**< 10%**

Pre-brooding & Brooding

Receiving and starting chicks

- one of the most difficult yet important stage in growing broilers

Take special care to ensure chicks are started properly

- houses must be ready BEFORE chicks arrive
- exploit genetic potential of chicks

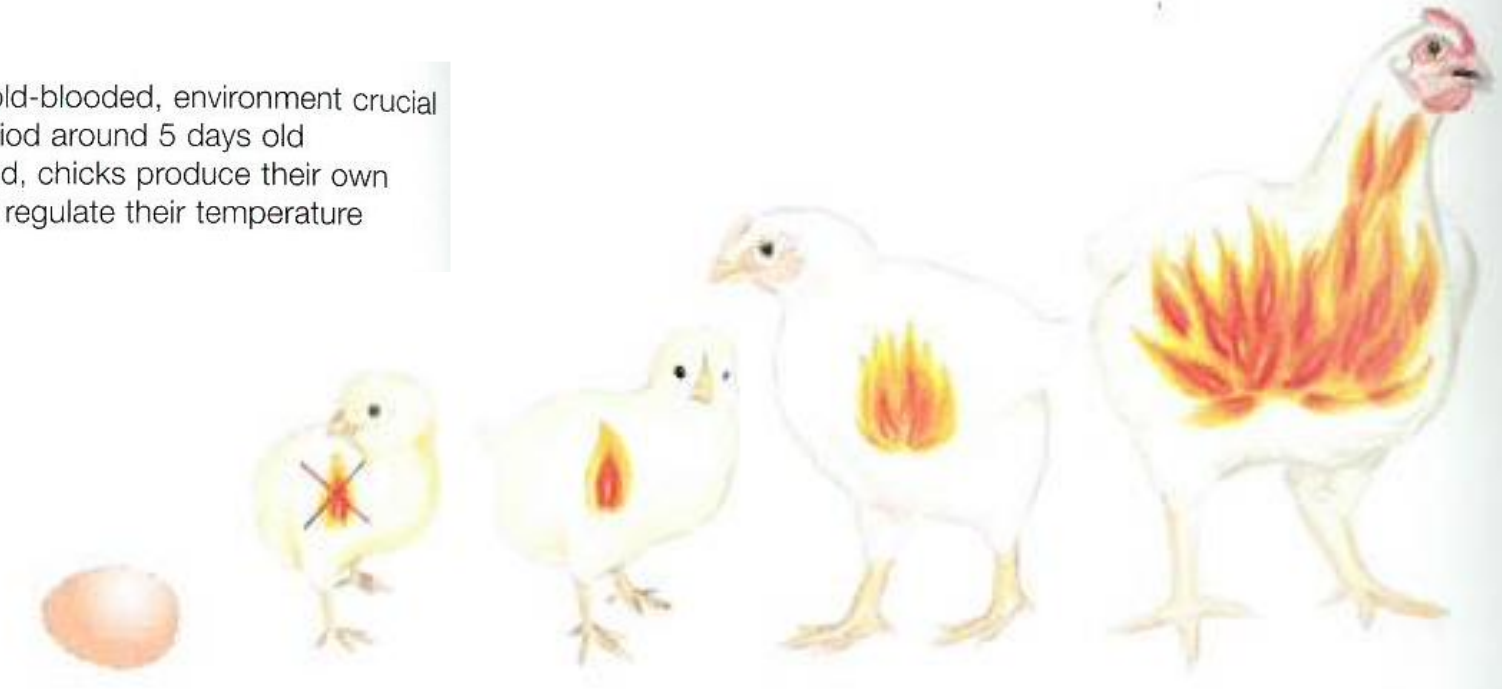
Not properly pre-conditioning barn one of the biggest mistakes we see – especially in cool weather

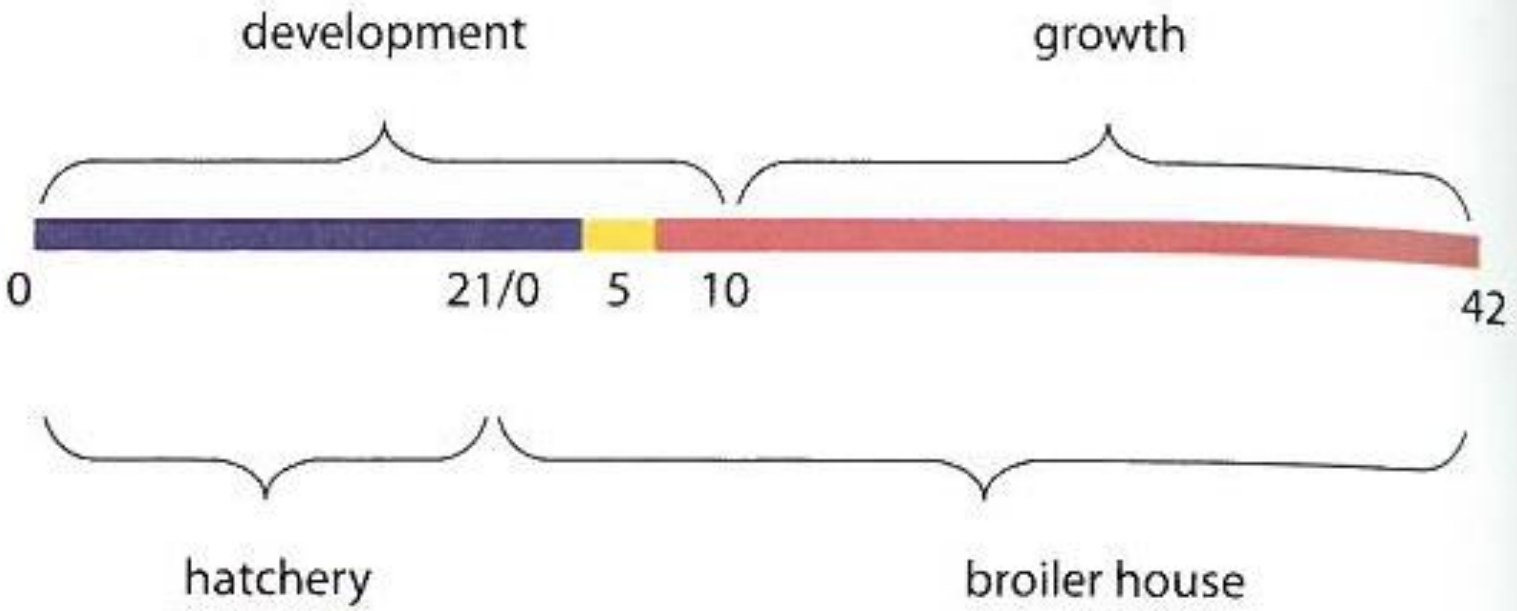
Pre-brooding & Brooding

Why does this matter?

- The chicken is most efficient at 1 day of age
- Performance in terms of growth and FCR seems small in absolute terms, but FCR is most efficient and economical during this period
- Proper temperature control not fully effective until 3 wk of age (but especially problematic in first few days post-hatch)

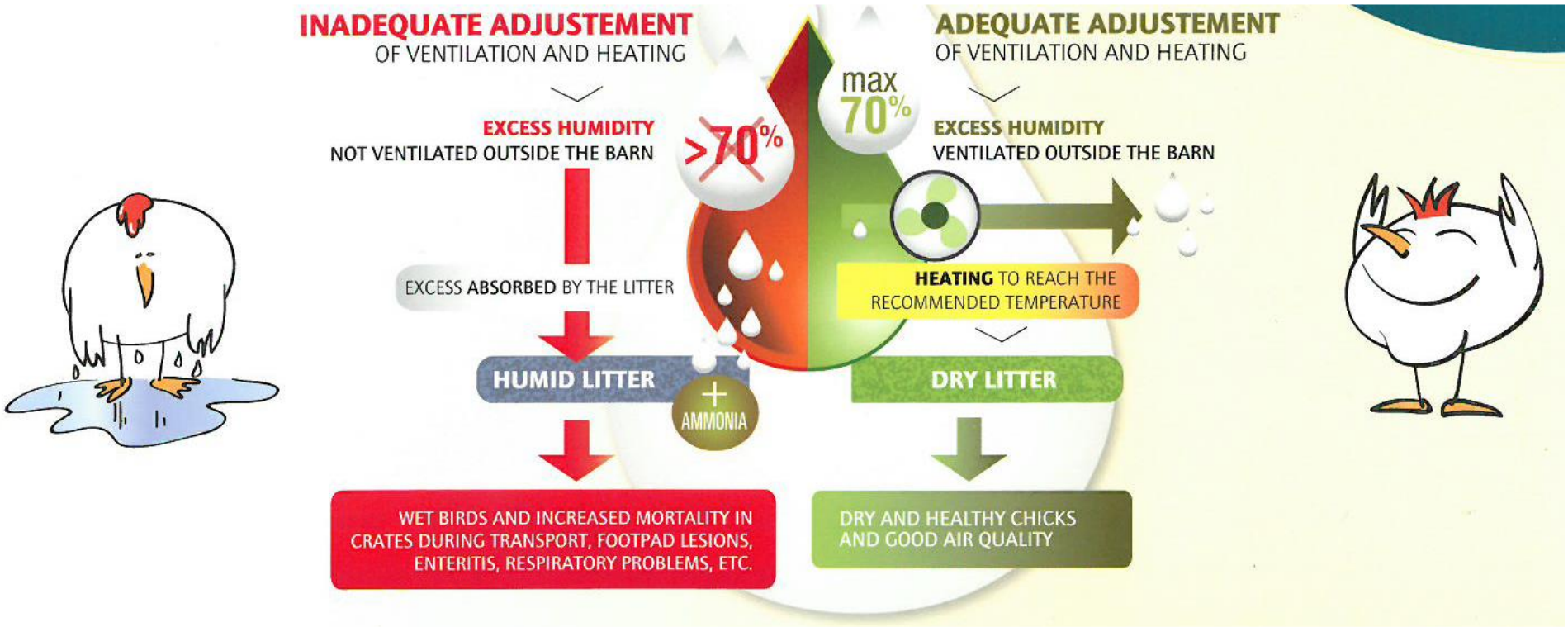
Blue: Chicks are cold-blooded, environment crucial
Orange: Transition period around 5 days old
Red: Warm-blooded, chicks produce their own heat and can regulate their temperature themselves





From "Broiler Signals

Use Humidity Value to Help Decide Ideal Barn Temperature



Effective Temperature

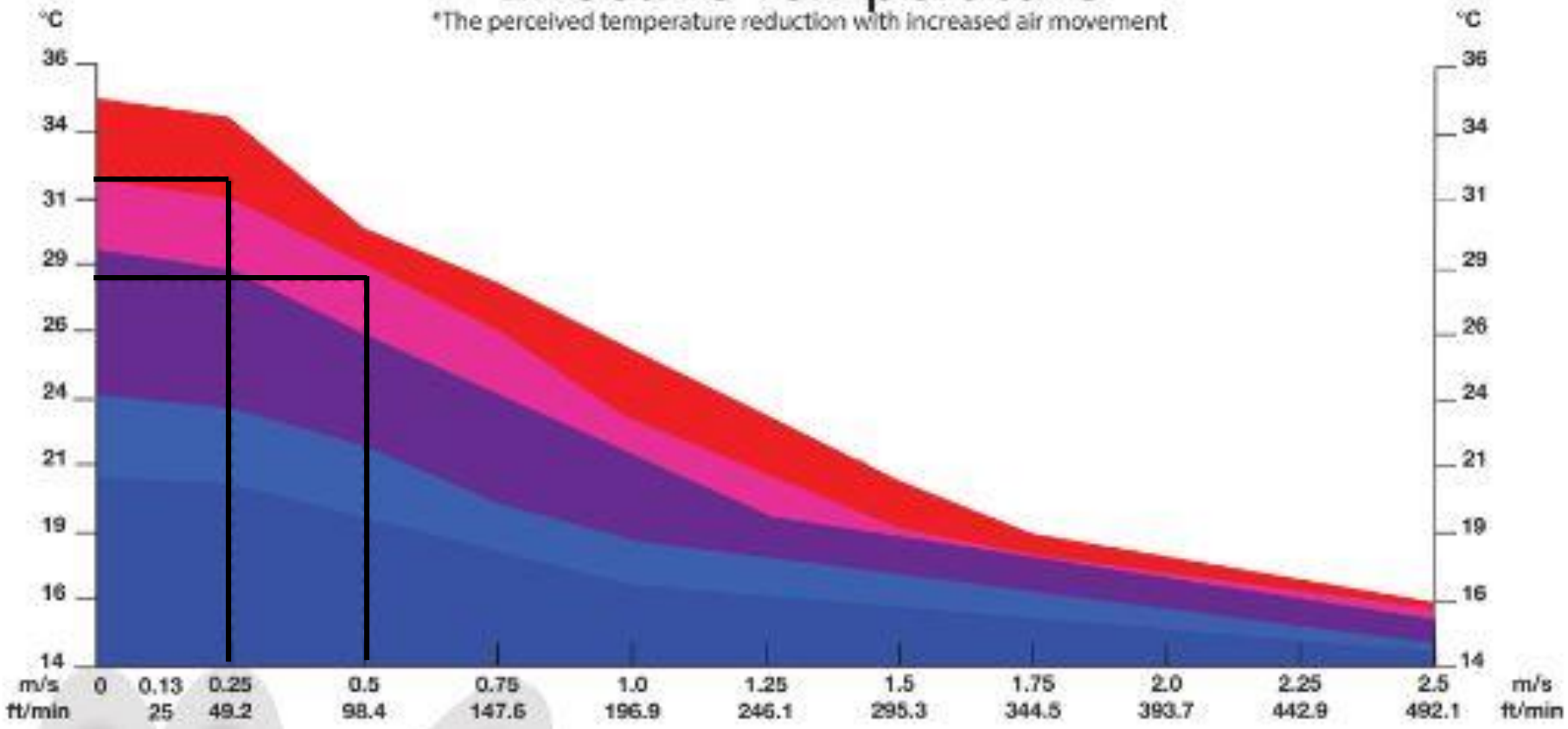
Table 3: Dry bulb temperatures required to achieve equivalent temperatures at varying RH. Dry bulb temperatures, at the ideal RH at an age, are colored red.

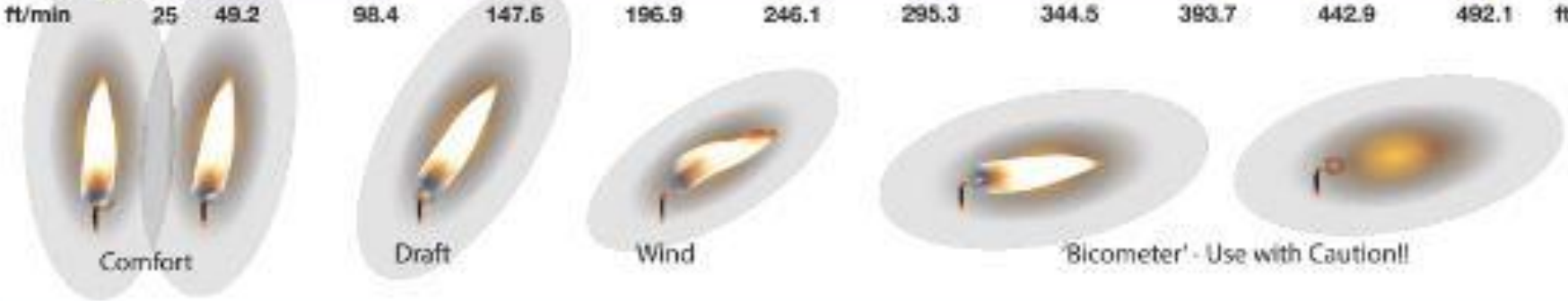
Age (Days)	Dry Bulb Temperature at RH% °C (°F)				
	40	50	60	70	80
Day-old	36.0 (96.8)	33.2 (91.8)	30.8 (84.4)	29.2 (84.6)	27.0 (80.6)
3	33.7 (92.7)	31.2 (88.2)	28.9 (84.0)	27.3 (81.1)	26.0 (78.8)
6	32.5 (90.5)	29.9 (85.8)	27.7 (81.9)	26.0 (78.8)	24.0 (75.2)
9	31.3 (88.3)	28.6 (83.5)	26.7 (80.1)	25.0 (77.0)	23.0 (73.4)
12	30.2 (86.4)	27.8 (82.0)	25.7 (78.3)	24.0 (75.2)	23.0 (73.4)
15	29.0 (84.2)	26.8 (80.2)	24.8 (76.6)	23.0 (73.4)	22.0 (71.6)
18	27.7 (81.9)	25.5 (77.9)	23.6 (74.5)	21.9 (71.4)	21.0 (69.8)
21	26.9 (80.4)	24.7 (76.5)	22.7 (72.9)	21.3 (70.3)	20.0 (68.0)
24	25.7 (78.3)	23.5 (74.3)	21.7 (71.1)	20.2 (68.4)	19.0 (66.2)
27	24.8 (76.6)	22.7 (72.9)	20.7 (69.3)	19.3 (66.7)	18.0 (64.4)

**Temperature calculations based on a formula from Dr. Malcolm Mitchell (Scottish Agricultural College).*

Effective Temperature

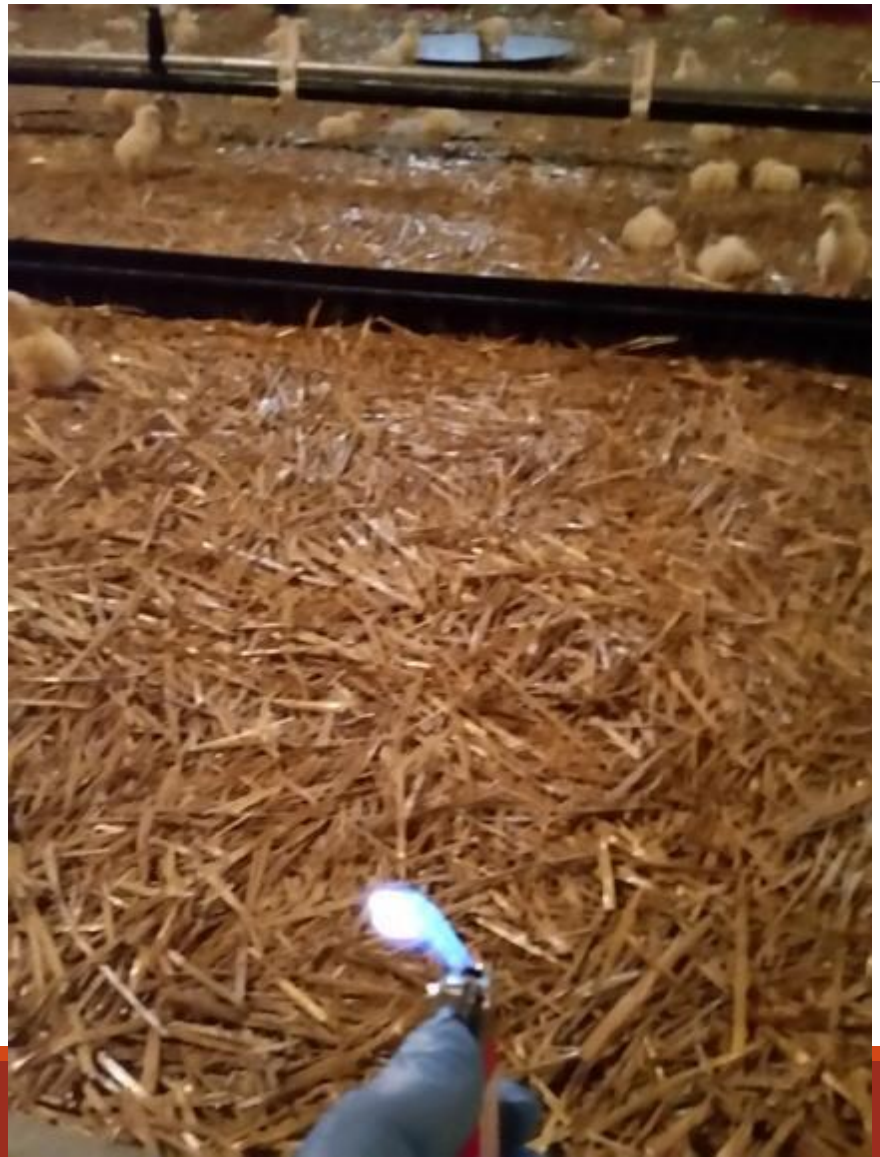
*The perceived temperature reduction with increased air movement





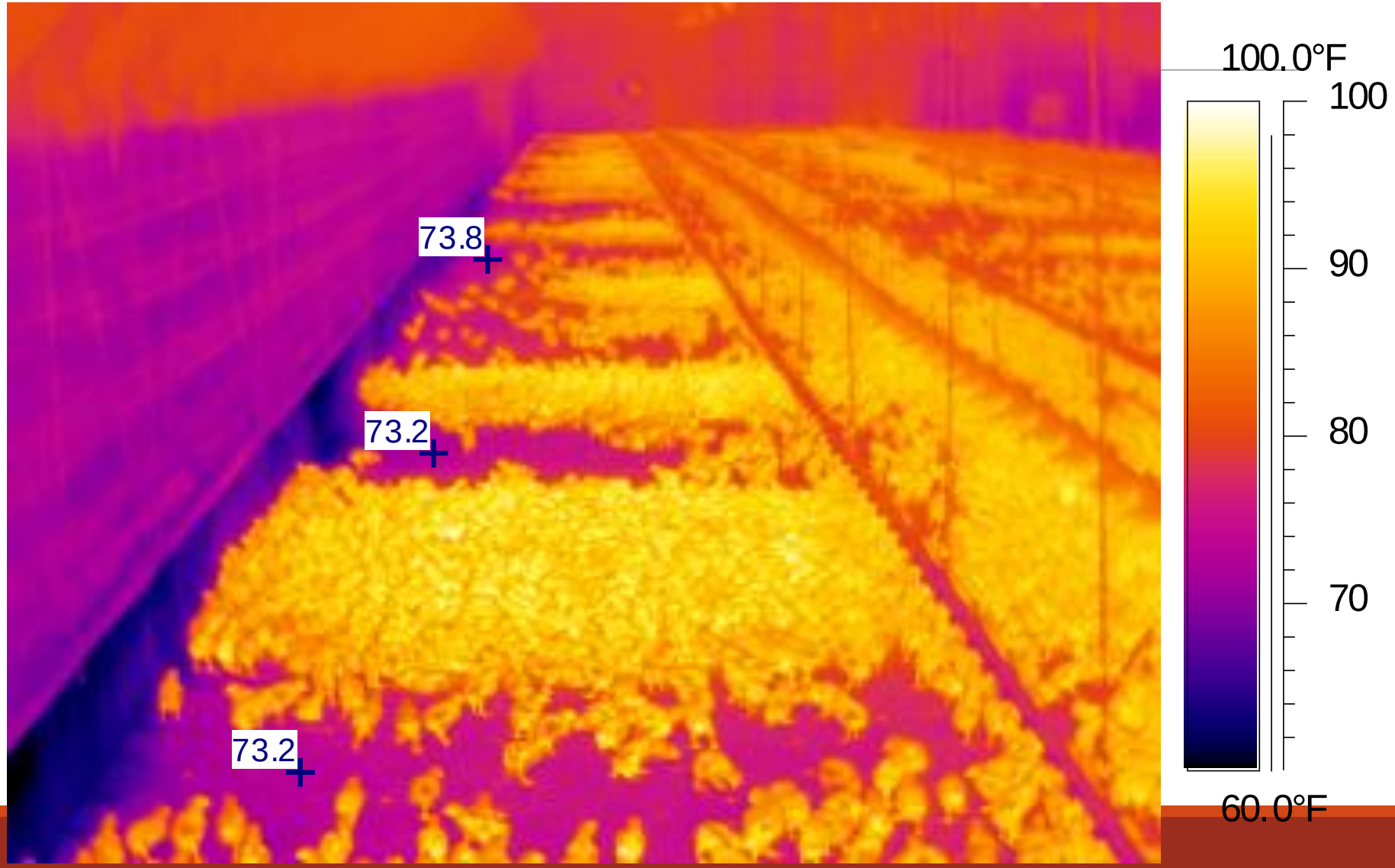
Effective Temperature

~ 150 - 200 Ft/Min



~ 250 - 300 Ft/Min

Chilled chicks due to over ventilation



Supporting Early Growth by Monitoring Crop Fill

Monitor in first 48 hours

- Confirms birds ability to eat and drink.
- 80% - 8 hours after delivery
- 95% - 24 hours after delivery

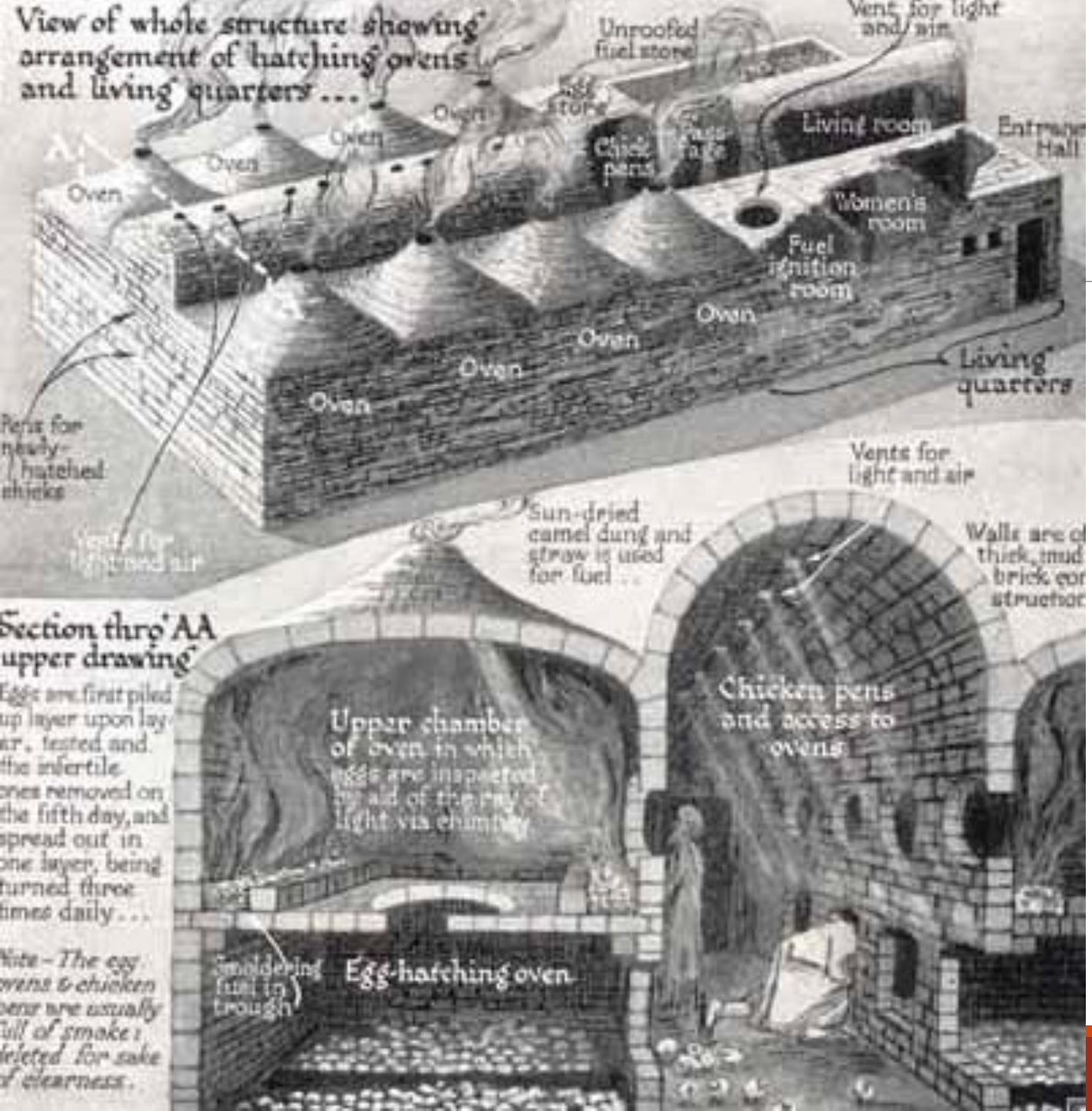
Consider scoring amount of crop fill

- 0 = nothing
- 1 = size of chick pea
- 2 = size of grape

Crop fill can be used at any age as measure of bird comfort

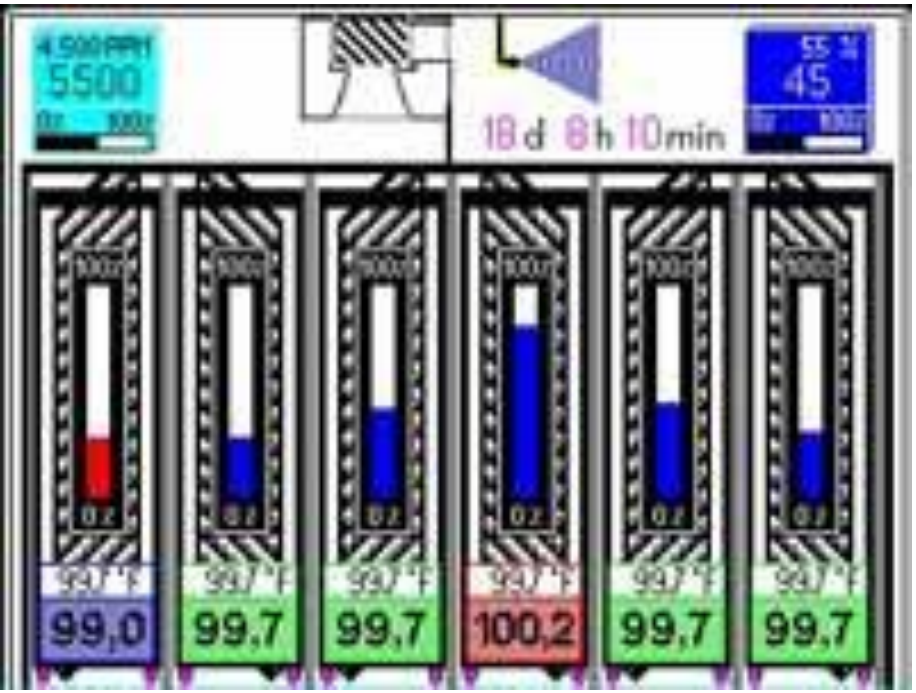
Brooding: Practical Steps

- Feed birds as soon as they arrive on farm
- Target coverage of 50% of floor area with paper
- Put at least 65 gm feed per chick on paper
- Tip the chicks onto feed area, not on litter
- Check crop fill 12 and 24 hrs after placement
- 12 hrs 80% with feed and water in the crop
- 24 hrs, >97% with feed and water in the crop



Origins of centralized hatching: Egyptian egg ovens

Technology and Incubation



Broiler Breeder Farm and Hatchery Effects

Broiler breeder flock fertility and hatch rate
- Male management or male line choice

Incubation / hatch effects
- Incubation temperature (especially in last week)

Clean egg from hatching egg farm?
- Reduced hatchability of floor eggs (82% vs 62.1%) and washing does not help (63.1%) Van den Brand et al., 2016

Egg Handling (bumps, storage temperature etc.)

Traditional vs. In-barn hatching?
- Examples = HatchCare and X-Treck
- In-barn hatching = higher hatch size and early gut growth
- May see better final uniformity due to better growth in early-hatched birds

Role of Egg Handling and Transport

Success or failure of egg transport and storage has strong links back to the hen diet and breeder farm management

-Egg size

-Shell quality

-Lipid stability (antioxidants)

-Barn environment (especially temperature)

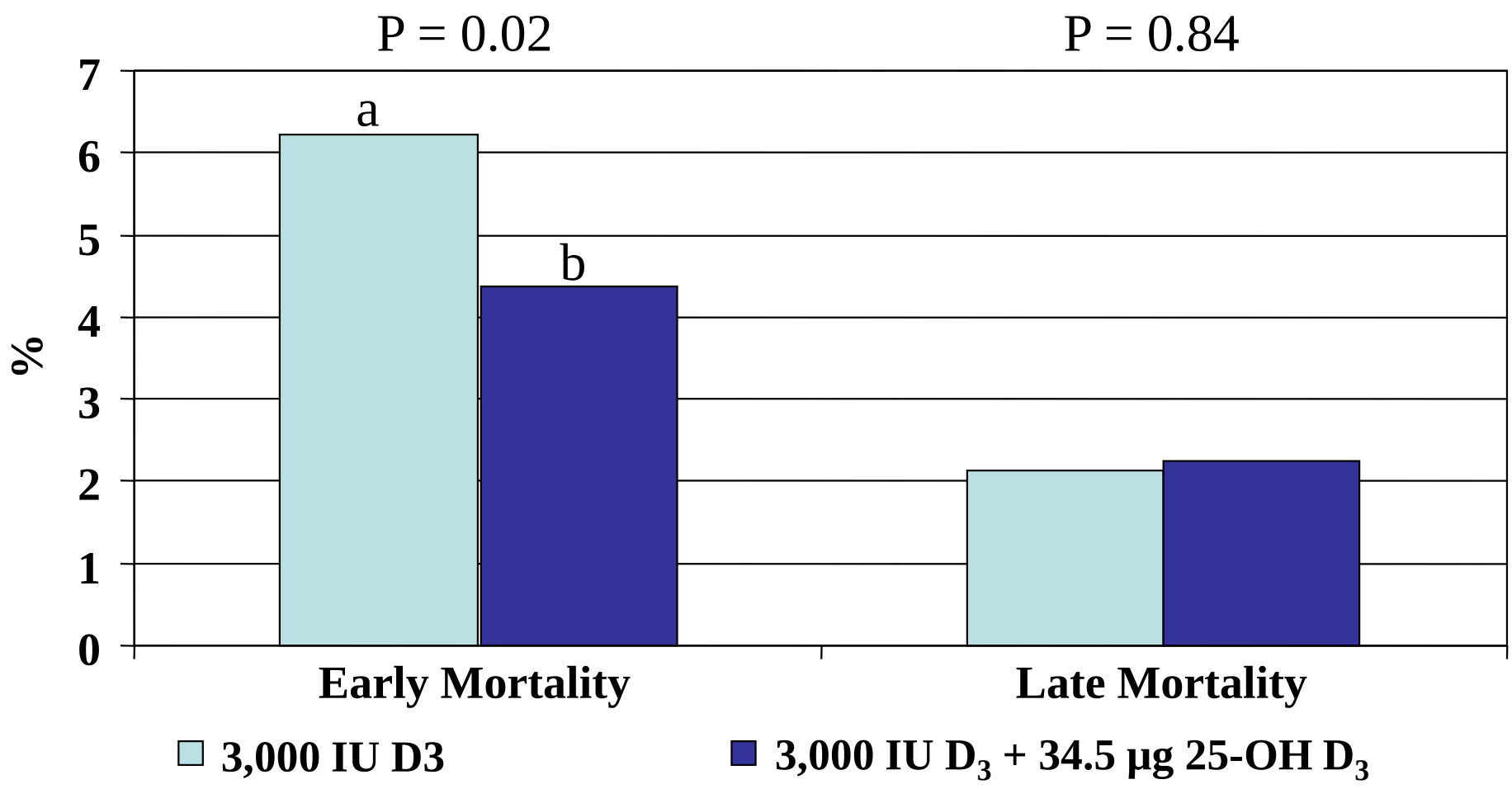
-Barn biosecurity (rodents, insects)

Role of Egg Handling and Transport

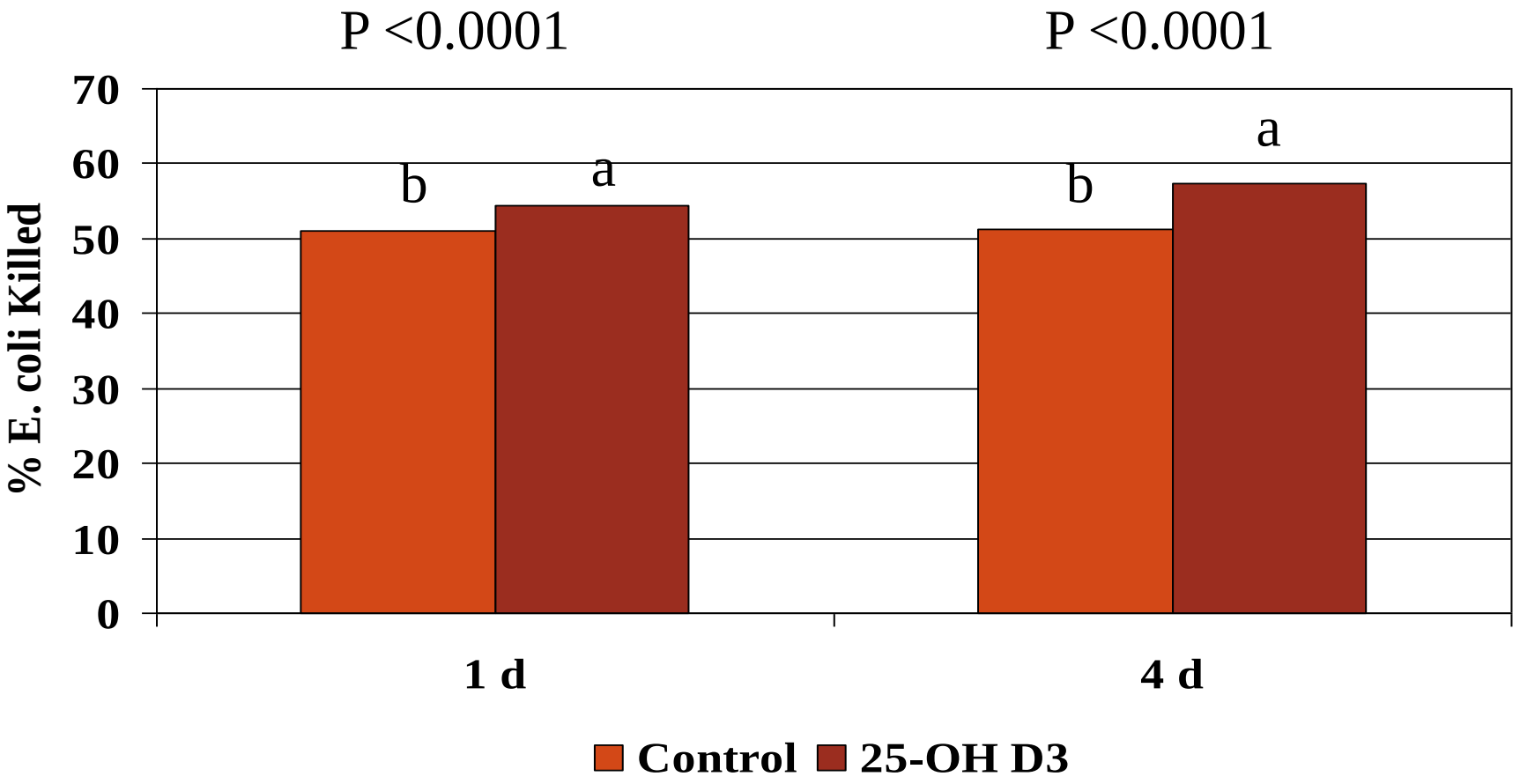
Diagnositics of issues:

- Egg collection
  - Frequency, temperature, equipment issues
- Egg storage at farm
  - Temperature / humidity
- Egg transport to hatchery
  - Equipment, procedure, difference in environment
- Egg transfer to hatchery storage

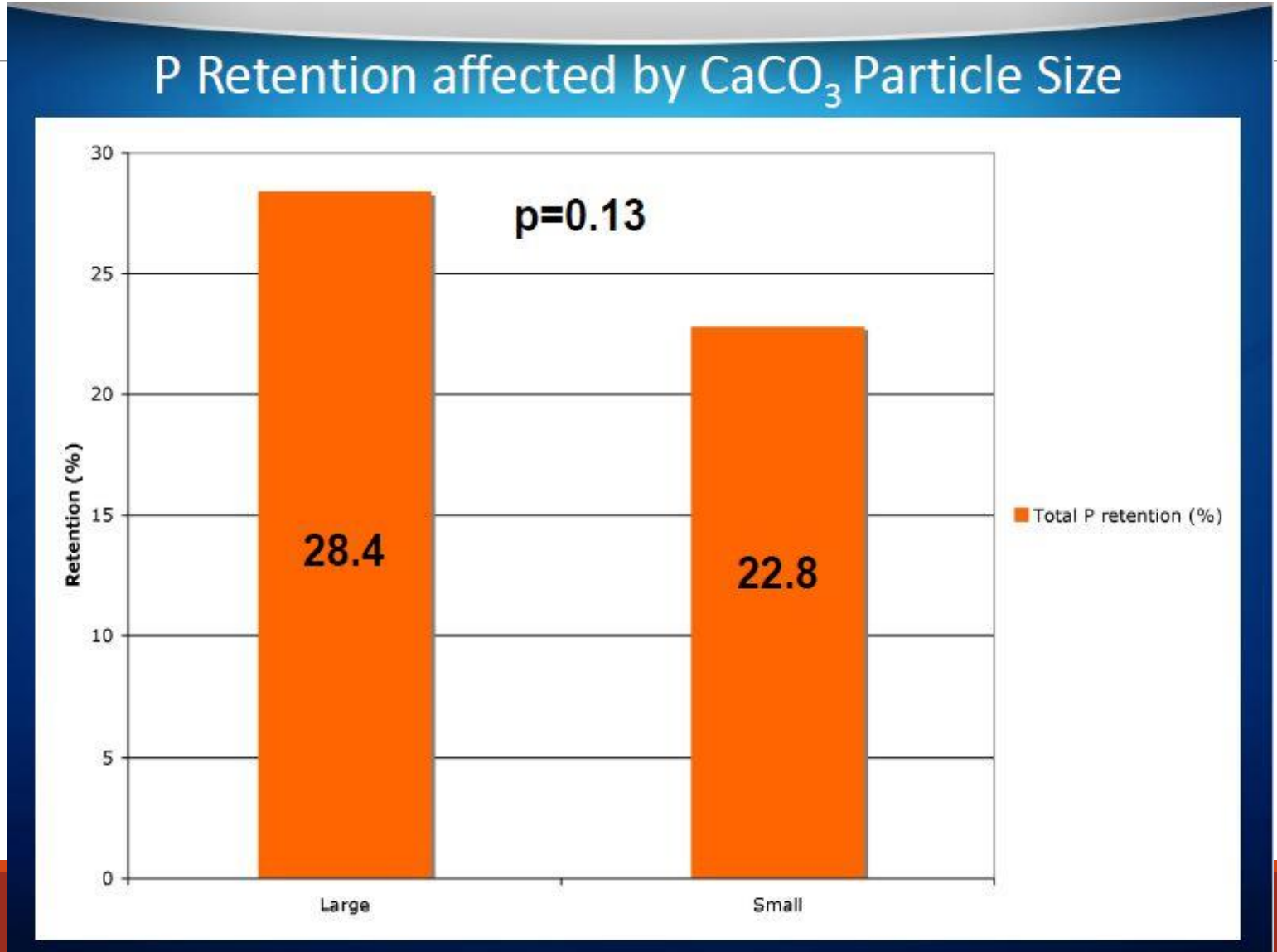
Vitamin D Source Affects Hatchability



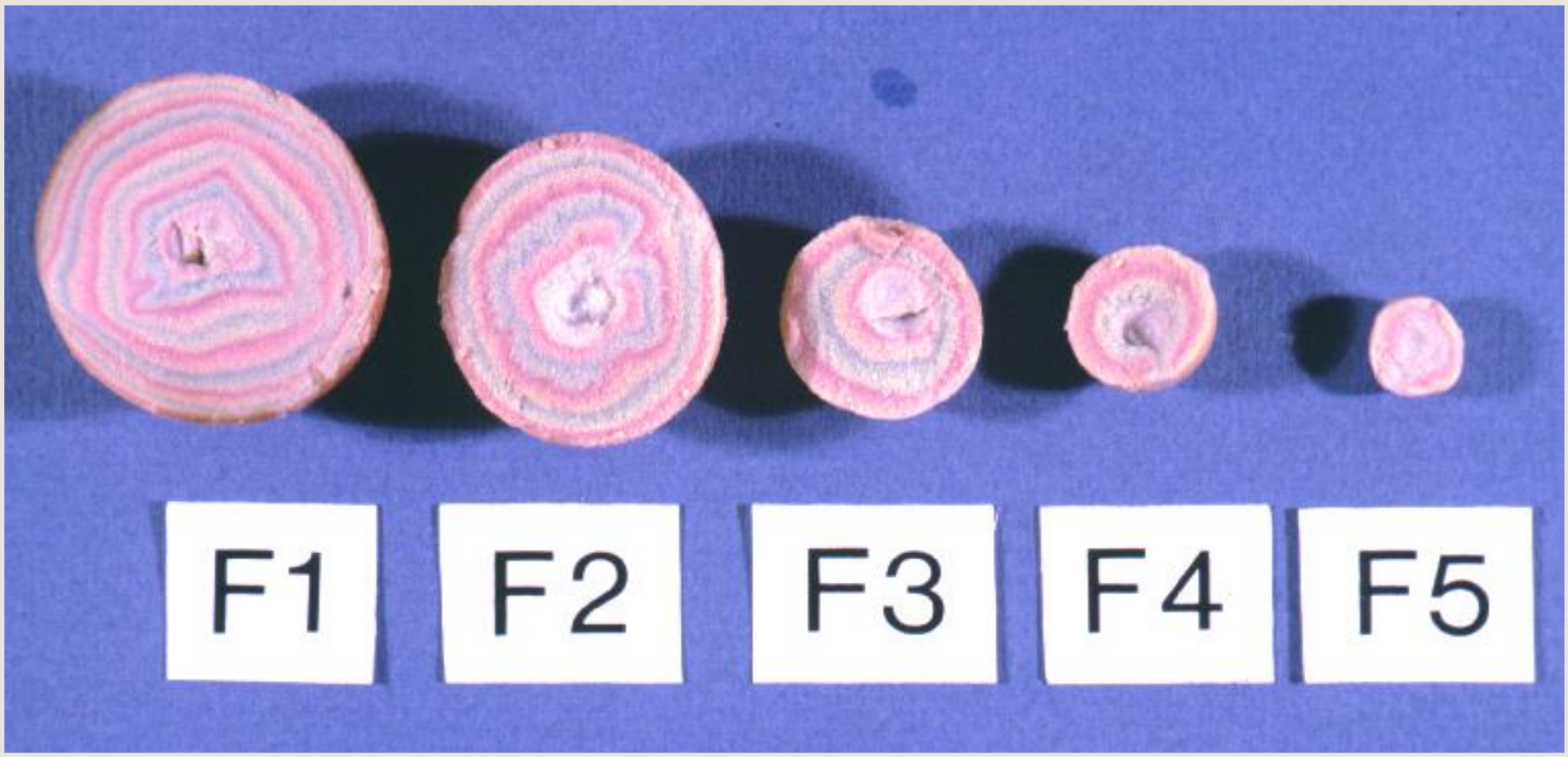
White Blood Cell *E. coli* Killing
Late Production (61 wk)



Shell Quality: Need Large Particle Size Calcium Source



Yolk Deposition



-Each day there is deposition of denser yolk (slower deposition) and less dense yolk (rapid deposition with blood filled with yolk materials in response to feeding)

Egg Transport Issues

Diagnose issues with examination of steps

- Use comercial ‘test-egg’ to record temperature, humidity, and bumps

Upgrade equipment or change procedures as is feasible

- Egg carts with shock-absorbing wheels
- Air-ride suspension trucks (temperature-controlled)

Egg Transport Issues

Alternatives if infrastructure issues:

- Ship eggs at night for cooler temperature
- Avoid rough roads (even if longer drive)
- Fix bad farm accesses
- If applicable: Paper-fiber trays rather than hatchery incubator trays to provide extra protection

Often see a 1-3% increase in hatchability with each of the more serious issues.

Chick Quality Essential: Keeping your broiler production value chain clean

Egg shell contamination and 14 day mortality

Egg condition	Total bacteria	Coliforms	14 day mortality
Clean	600	123	0.9
Soiled	20,000	904	2.3
Dirty	80,000	1,307	4.1

(J. M. Mauldin)

Contaminated eggs increase broiler disease and mortality

Floor Eggs and Egg Sanitation

Floor eggs: As eggs cool in dirty environment, pull bacteria into pores.

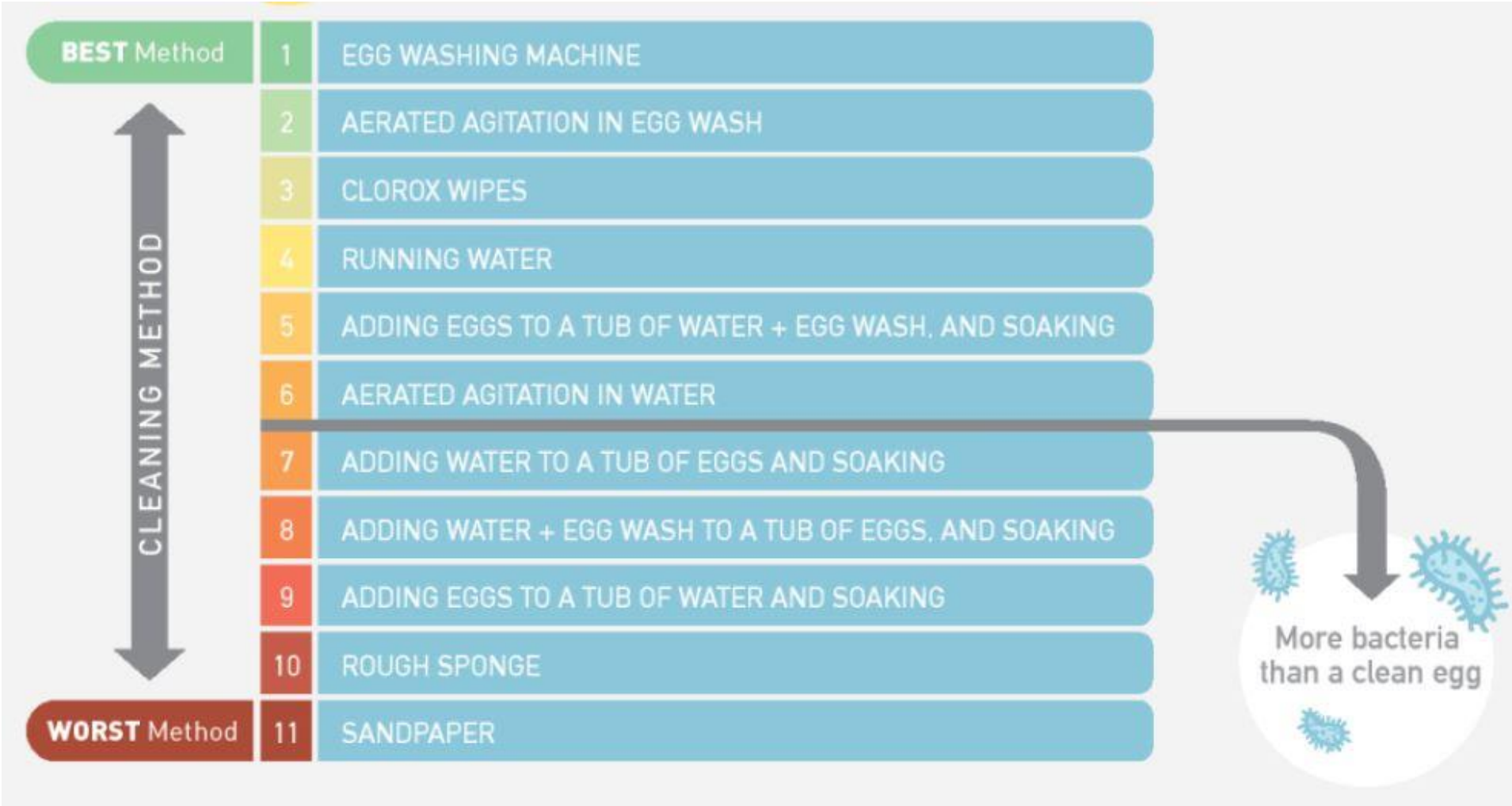
Dirty Eggs: Surface biological contamination

- Breeder guidelines: Size of a dime maximum before discard

Some farms try to ship every egg because it is a potential chick.

- When segregate floor and washed eggs in hatchery, can see 10-20% hatchability

Comparison of Egg Washing Methods



Comparison of Egg Washing Methods

Follow-up hatch project showed bacteria still in pores after any wash method.

Even UV treatment could not resolve high bacterial numbers

Embryo Heat Production

Old genetic lines 0.1 Watt/egg

Hulet and Meijerhof:

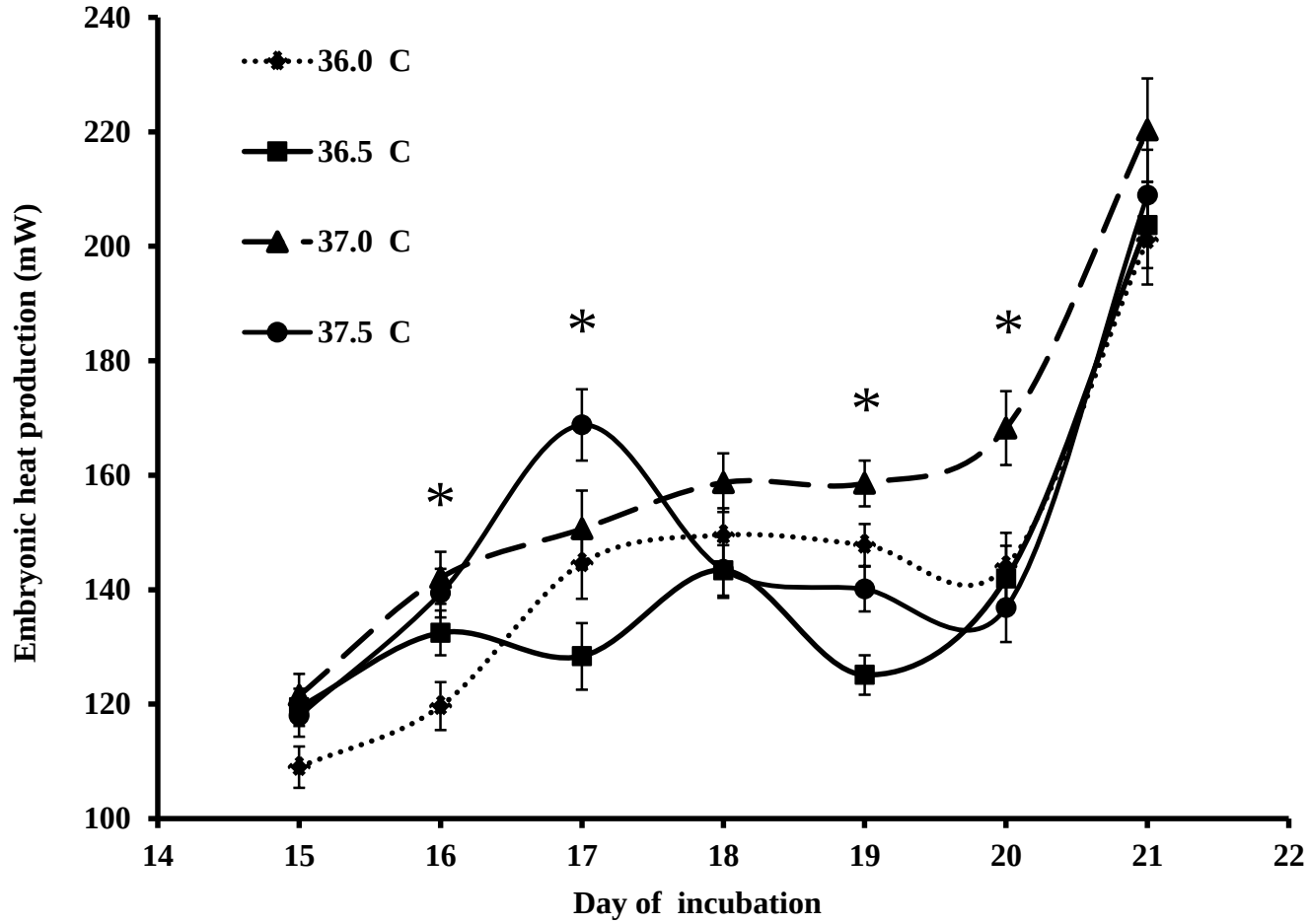
- .14 to .16 Watt/egg
- Later trials: 0.2 to 0.3 Watt/egg
- Based on carbon dioxide production

Lourens: 0.16 Watt/egg at 16 days

27 to 173% Increase in heat production

- More heat to remove with modern genetics

Incubation temperature and embryonic heat production during d 15 to 21 in Ross 708



37.5 C birds “stall” at 17 d. Because it is too hot, growth is stunted.
Late incubation overheating also negatively affects broiler breast muscle yield.

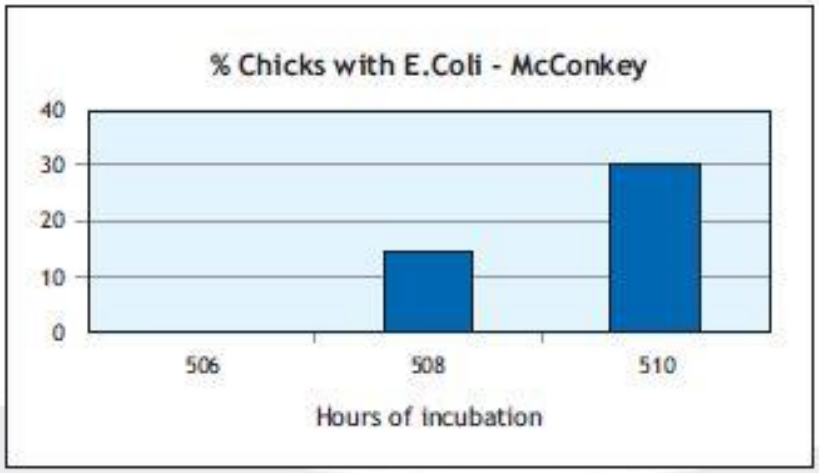
1. Hatchery

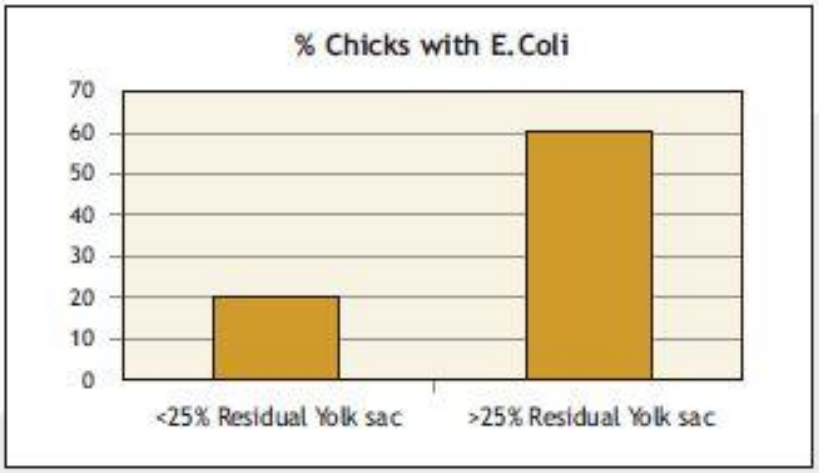
1.24. How to establish good chick quality? - Colibacillosis control

Consequences of overheating embryos
E. Coli susceptibility *(Trial Cobb Spain, 2011)*

It is not clear if overheated embryos are more sensitive because they spend longer in the hatchers (hatch early), but the % of E.Coli isolations seem to increase with:

- Hours of incubation
- Bigger yolk sacs





How do we navigate these changes?

"Technology and data management, regulatory challenges and implementation, and the need to tell our story, justify our decisions and connect meaningfully with consumers alongside making daily decisions regarding the business which I run... It is becoming overwhelming. But as a farmer I feel a lot of pressure to do it all to protect my industry."

Quote from an Alberta farmer, 2021

Thank you

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