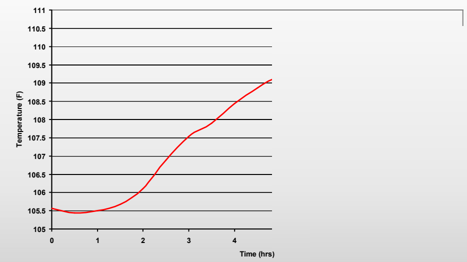
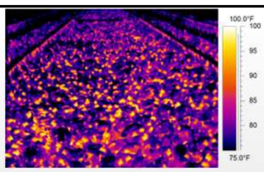
1

Broiler body temperature 86°F (30°C) environment

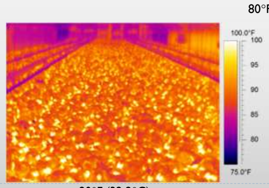


2



70°F (21°C)

80°F (26.7°C)

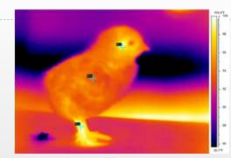


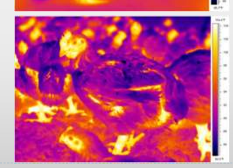
90°F (32.2°C)

3

Broiler body temperature

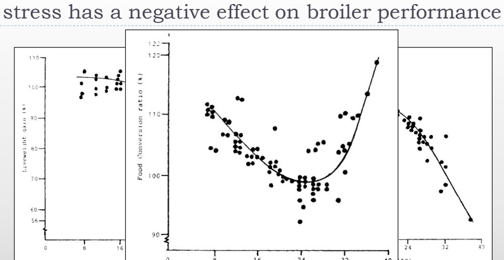
- Hatch
  - 104°F (39.7°C)
- Body temperature increases first week
  - 105-106°F (40.6-41.1°C)





4

Heat stress has a negative effect on broiler performance

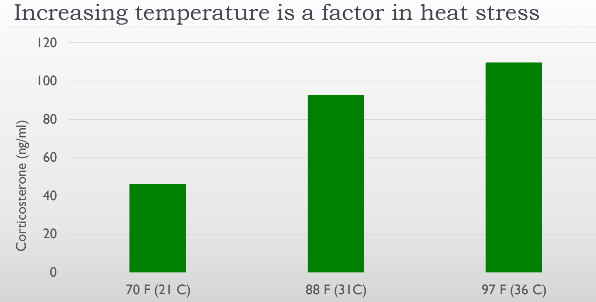


Body Weight Feed Conversion Feed intake

Howlider and Rose, 1987

5

Increasing temperature is a factor in heat stress

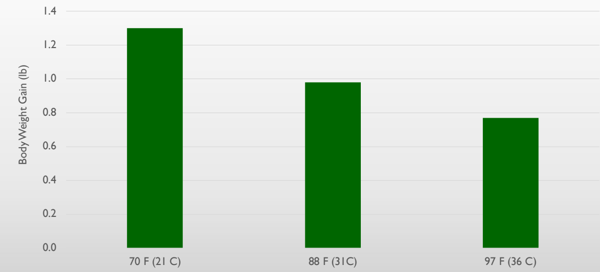


Quinteiro-Filho et. al., 2010

6

Performance

(35-42 days of age)

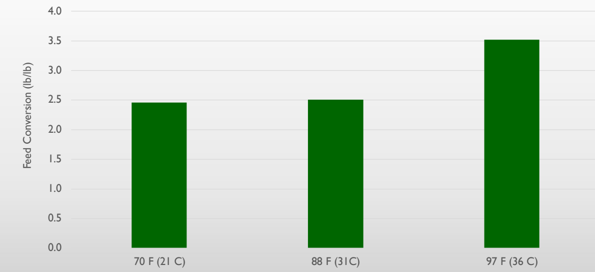


Quinteiro-Filho et. al., 2010

7

Performance

(35-42 days of age)

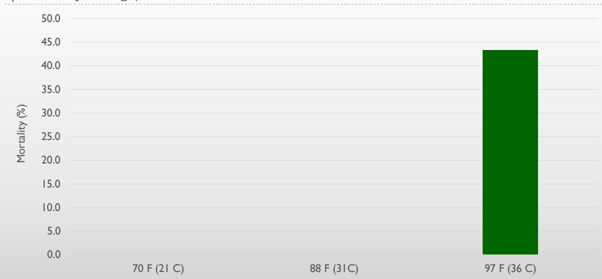


Quinteiro-Filho et. al., 2010

8

Performance

(35-42 days of age)



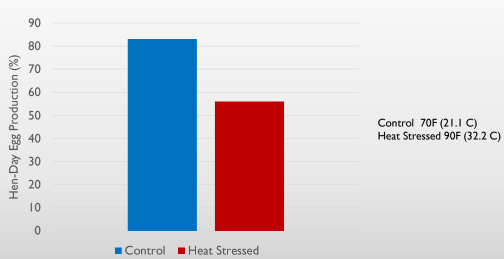
Quinteiro-Filho et. al., 2010

9

Heat stress reduces broiler breeder performance

10

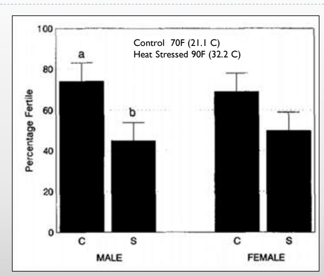
Broiler breeder hen-day egg production



McDaniel et al., 1995

11

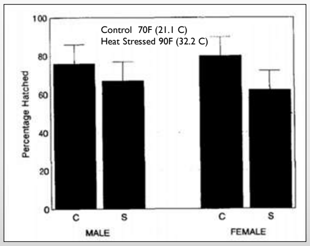
Fertility



McDaniel et al., 1995

12

Hatchability



McDaniel et al., 1995

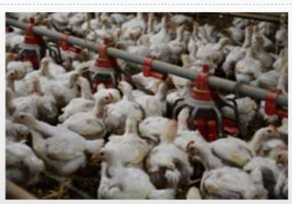
13

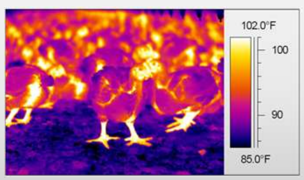
Summary

- Heat Stress has negative effects on:
  - Growth
  - Feed Consumption
  - Feed Conversion
  - Livability
  - Meat yield and quality
  - Egg production
  - Fertility
  - Egg shell quality

14

The primary cause of heat stress is not hot, humid weather but rather…





15

It is the bird’s consumption of feed

16

Feed is a basically a fuel…

- that birds consume/burn feed which has an energy density similar to that of chocolate cake with frosting.

17

How much fuel/energy does a bird consume on a daily basis?

18

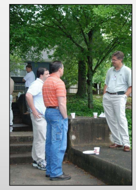
Bird heat

- A 5lb (2.3kg) broiler will eat approx. 0.4lb (0.2kg) of feed
- Digesting 0.4lb (0.2kg) of feed produces approximately 60 Btu's/hr of heat

19

Daily feed/fuel consumption

- Adult human
  - Supposed to consume 20 calories per pound of body weight.
- Broilers (5lb/2.3kg)
  - Consume120 calories per pound of body weight.



20

How does this compare to us?

- Seated at rest the average adult male will produce approximately 340 Btu's of heat each hour…
- 1/7 of the heat per kg produced by a broiler

21

How does a broiler use this feed energy?

- Roughly 35 – 40 % of the energy is used to power the basic functions of life:
- Grow, move around, breath, pumping blood, maintain body temperature, etc.

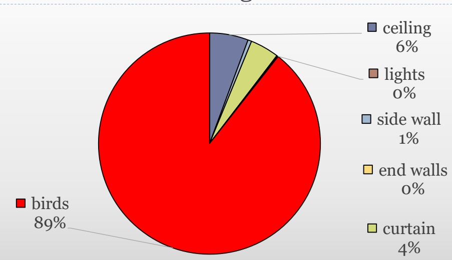
22

How does a broiler use this feed energy?

- The remaining 60 - 65% is essentially put off in the form of heat.
  - Heat a bird must rid itself in order to maintain a proper body temperature and survive.

23

Where is most the heat coming from?



24

How much heat are we talking about?

- At 70°F (21°C) a five pound broiler (consuming approximately 0.4lb (0.2kg) of feed per day) produces approximately 60 Btu's of heat each hour…
  - Same heat as produced by a 25 watt incandescent light bulb
  - Same heat as produced by 60 matches

25

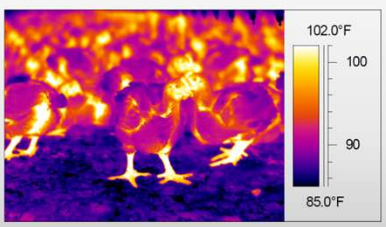
Heat Production: Poultry vs. Humans

	BTU's / lb	BTU's / kg
Human	2	4.4
Broiler	6	13.2
Broiler Breeder	4	8.8
Turkey	3.5	7.7

26

Poultry generate a lot more heat

- Generate a LOT more heat than we do and are MUCH more sensitive to humidity than we are

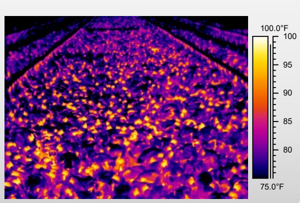


27

Let's see some examples

28

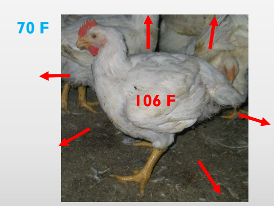
Thermoneutral "ideal" temperature



29

How does a bird rid itself of this excess heat?

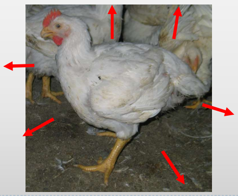
- A bird rids itself of this excess heat primarily in two ways:
  1) To the air around it



30

How does a bird rid itself of this excess heat?

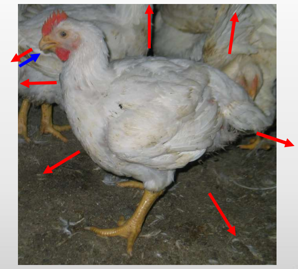
- A bird rids itself of this excess heat primarily in two ways:
  1) To the air around it
  2) Through the evaporation of moisture off of its respiratory system



31

Bird losses heat primarily two ways:

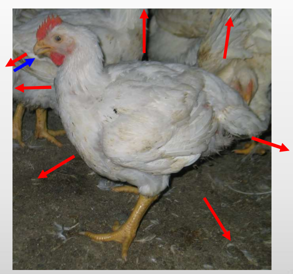
- Digesting 0.4 lb of feed produces approximately 60 Btu's/hr of heat
- 34 Btu's/hr
- 26 Btu's/hr
- 60 Btu's/hr



32

Bird losses heat primarily two ways:

- Digesting 0.4 lbs of feed produces approximately 60 Btu's/hr of heat
- 60% (breathing)
- 40% (to the air)



33

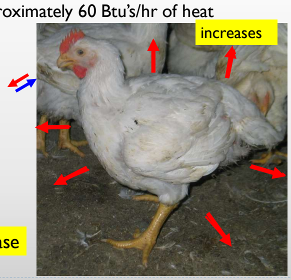
Cooler air temperatures

34

5 lb broiler heat production

- Digesting 0.4 lbs of feed produces approximately 60 Btu's/hr of heat

➔ 34 Btu's/hr lost through respiration
↗ 27 Btu's/hr is lost to the air
❖ 61 Btu's/hr total



Body temperature will decrease

35

If a bird is losing more heat than it is producing…

- Body temperature will decrease
- The birds will eat more feed (fuel) to keep warm
- Feed conversion worse
- Reduced body weight

36

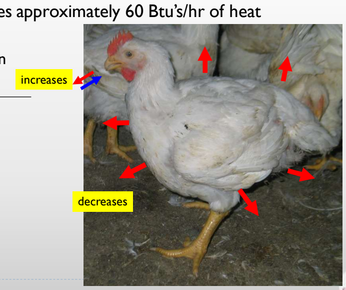
What happens as air temperature increases?

37

Heat loss to the air decreases

- Digesting 0.4 lbs of feed produces approximately 60 Btu's/hr of heat

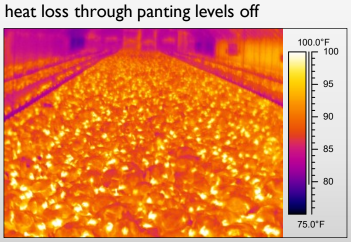
↗36 Btu's/hr is lost through respiration
↘24 Btu's/hr is lost to the air
60 Btu's/hr total



38

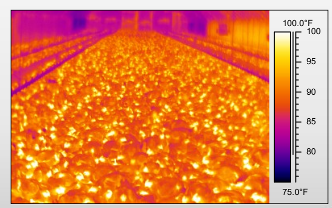
As air temperature increases further…

- Heat loss to the air continues to go down..
- But, eventually heat loss through panting levels off



39

By the time the air temperature reaches ….



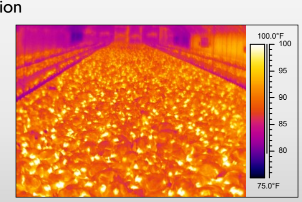
This is definite problem ….

40

Heat loss to the air decreases even more…

- Digesting 0.4 lbs of feed produces approximately 60 Btu's/hr of heat

↗ 39 (72%) Btu's/hr is lost through respiration
↘ 15 (28%) Btu's/hr is lost to the air
54 Btu's/hr total

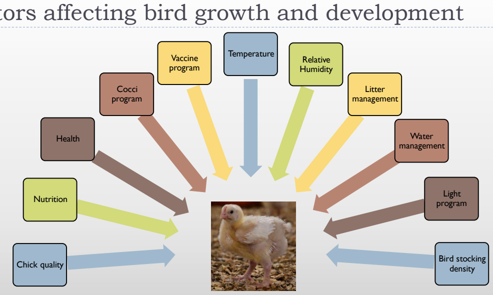


Surplus of 6 or more Btu's/hr

Body temperature will increase!

41

Factors affecting bird growth and development



42

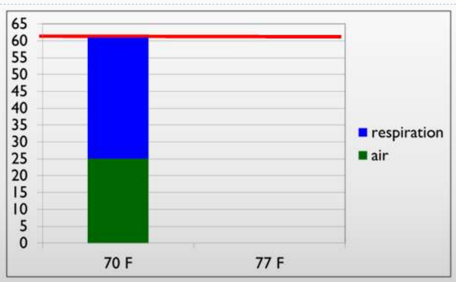
Let’s take a closer look at how air temperature and humidity affect bird heat loss…

43

Poultry vs People

44

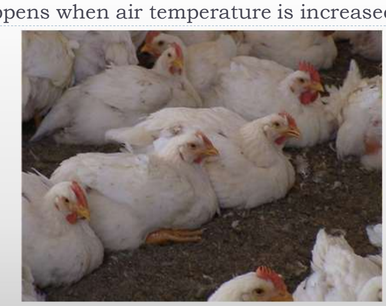
Heat loss from a 5 lb broiler at 70°F and Rh=50%



Levent, & Portier, 2005

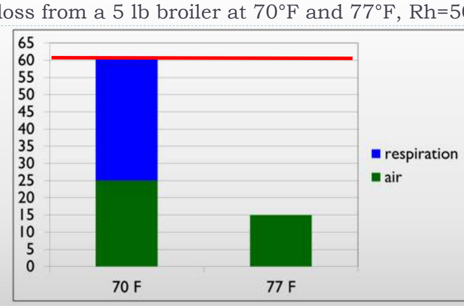
45

What happens when air temperature is increased to 77°F



46

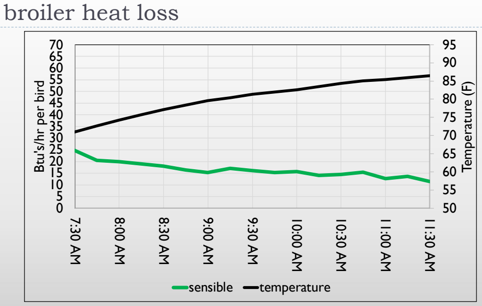
Heat loss from a 5 lb broiler at 70°F and 77°F, Rh=50%



Levent, & Portier, 2005

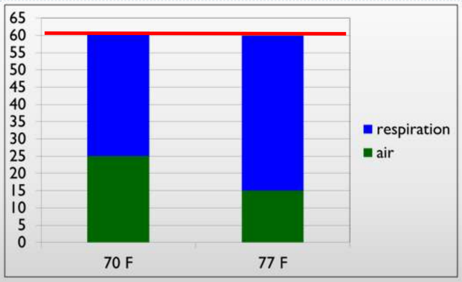
47

4 lb broiler heat loss



48

Heat loss from 5 lb broiler at 70°F (21C) and 77°F (25C), Rh=50%



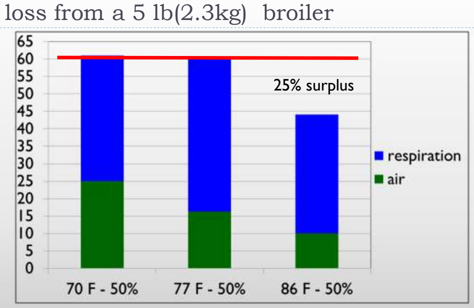
Levent, & Portier, 2005

49

What happens at even higher house temperatures?

50

Heat loss from a 5 lb(2.3kg) broiler



Levent, & Portier, 2005

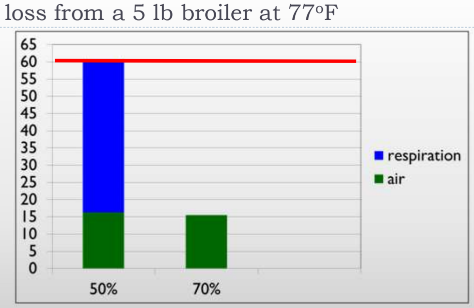
51

How does changing the humidity affect the heat loss from a bird?

- Study at looking at how relative humidity affects heat loss from a five pound bird at 77°F
  - Rh 50%, 70% and 90%

52

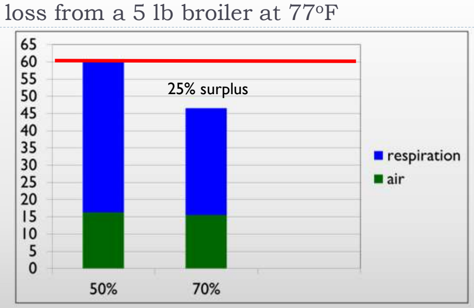
Heat loss from a 5 lb broiler at 77°F



Levent, & Portier, 2005

53

Heat loss from a 5 lb broiler at 77°F



Levent, & Portier, 2005

54

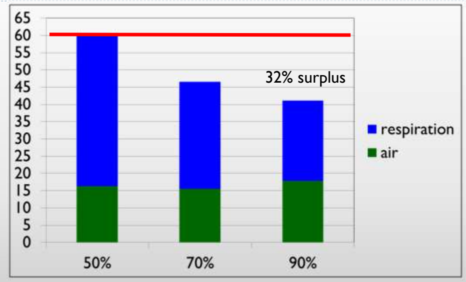
Increasing Rh from 50 to 70 % when it is 77°F

- Feels the same to a bird as raising the air temperature from 77 to 86°F when the Rh is 50%

+20% Rh = Feels 9°F hotter

55

Heat loss from a 5 lb broiler at 77°F



Levent, & Portier, 2005

56

Increasing Rh from 50 to 90% when it is 77°F

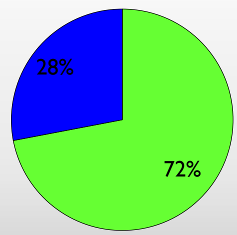
- Feels the same to the bird as raising the air temperature from 77 to 90°F when the Rh is 50%

+40% Rh = Feels 13°F hotter

57

This is a very significant difference…

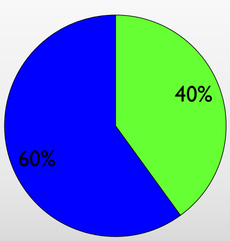
People



58

This is a very significant difference…

Poultry

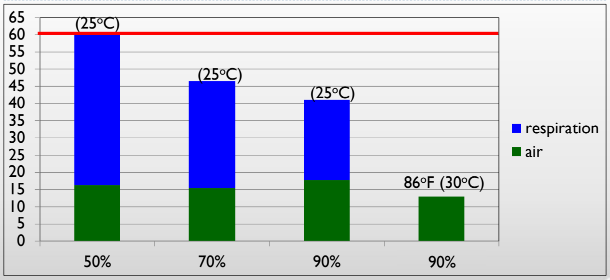


59

What happens at high house temperatures (86°F) with high relative humidity?

60

Heat loss from a 5lb (2.5kg) broiler at 77ºF (25ºC)



Levent, & Portier, 2005

61

If a bird cannot get rid of all the heat it is producing…

- Body temperature will increase
- Feed consumption will decrease
- Growth rate will decrease
- Feed conversions will increase
- Eventually mortality will increase

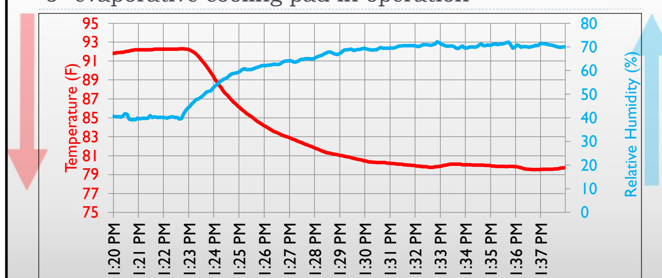
62

Evaporative cooling is often used to decrease house temperature

- Pads/fogging nozzles produce cooling through the evaporation of water into the air which…increases relative humidity of the air

63

6” evaporative cooling pad in operation

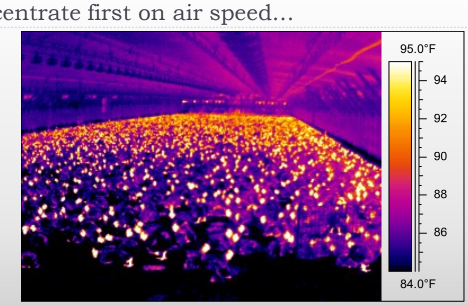


64

Evaporative cooling by itself doesn’t actually increase bird cooling

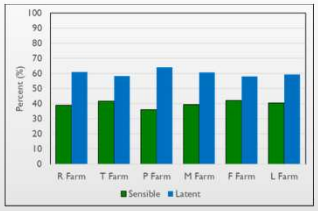
65

Concentrate first on air speed…



66

It is important to keep in mind that…

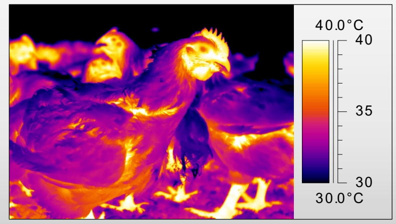


- Roughly 60% of a birds heat loss is through evaporation of water off its respiratory system…primary method of heat loss/cooling

67

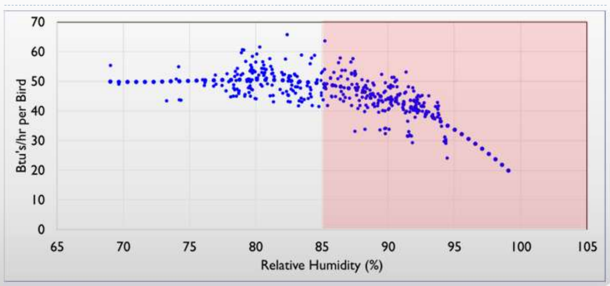
The higher the humidity…

- The lower the amount of water evaporated off the birds respiratory system…
- The hotter the bird will feel



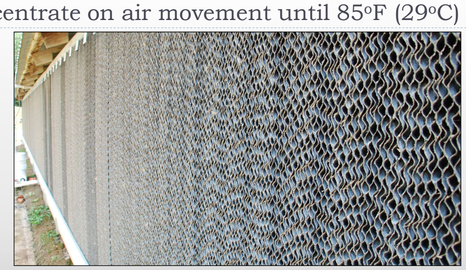
68

Respiratory heat loss decreases rapidly when Rh increases above 85%



69

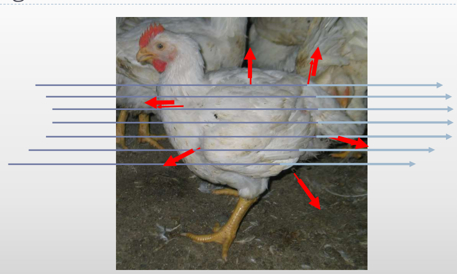
Concentrate on air movement until 85ºF (29ºC)



- Then use the pads

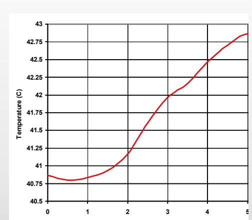
70

Moving air over the bird = heat loss



71

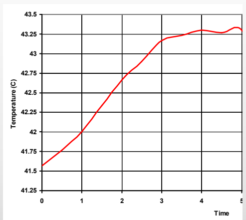
30ºC no air movement….



Body temp rises

72

More air movement over the bird…



73

Increasing air movement

- Lowers body temperature…
- Decreases panting

74

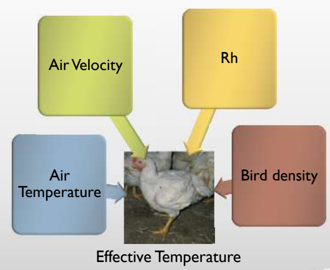
Research on air movement & broiler performance

- USDA Poultry Research Lab
  - Mississippi
  - Explore the relationship between air temperature, relative humidity, wind speed
- Grow birds from three to seven weeks of age at 85°F (29°C)/77(25°C) with different amount of wind speeds
- Monitored bird weights and feed conversion
- Estimate effective temperatures

75

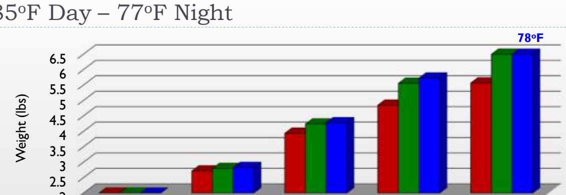
Effective temperature

- What it feels like to the bird
- A combination of several factors



76

85°F Day – 77°F Night



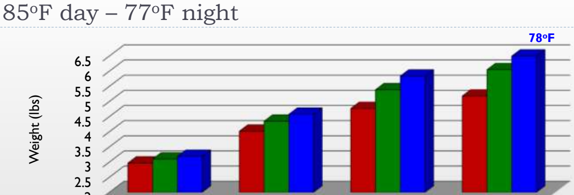
	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks
still air	1.55	2.72	3.94	4.85	5.57
400 fpm	1.55	2.8	4.24	5.56	6.65
600 fpm	1.55	2.83	4.28	5.73	7.07

still air 400 fpm 600 fpm

Simmons et al., 1997

77

85°F day – 77°F night



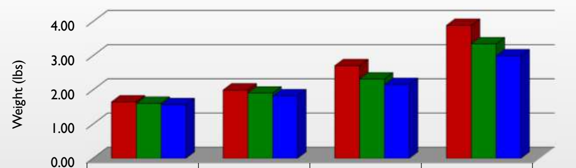
	week 4	week 5	week 6	week 7
still	2.97	4.02	4.77	5.18
400 ft/min	3.1	4.35	5.39	6.05
600 ft/min	3.19	4.58	5.84	6.68

still 400 ft/min 600 ft/min

Dozier et al, 2005

78

85ºF day – 77ºF night (broilers)



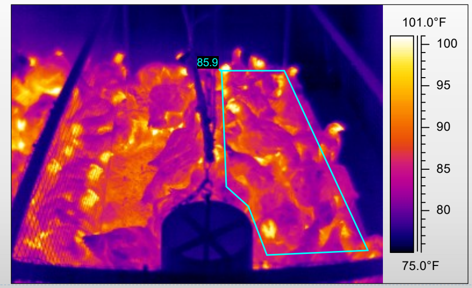
	week 4	week 5	week 6	week 7
still	1.65	2	2.71	3.89
400 ft/min	1.61	1.91	2.32	3.35
600 ft/min	1.57	1.83	2.16	3

still 400 ft/min 600 ft/min

Dozier et al, 2005

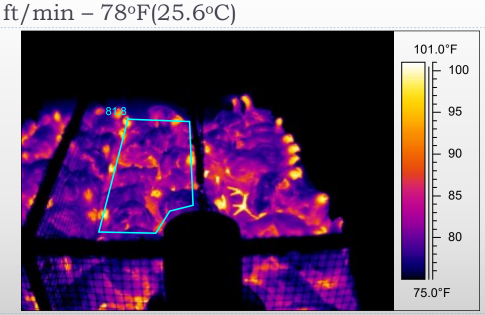
79

Still Air – 78ºF(25.6ºC)



80

300 ft/min – 78ºF(25.6ºC)



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Cooling through air movement

- Dr. Lott - USDA Poultry Research Lab
  - Mississippi State University
- Grew birds from three to seven weeks of age at 85 F with different amount of wind speeds
  - 0 ft/min
  - 400 ft/min
  - 300, 400, 600 ft/min

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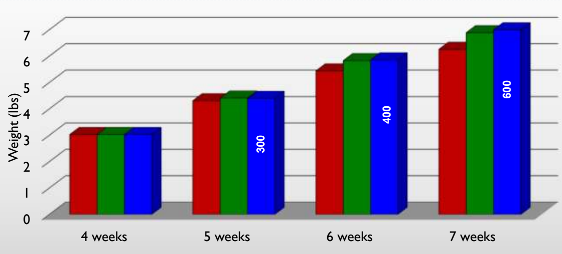
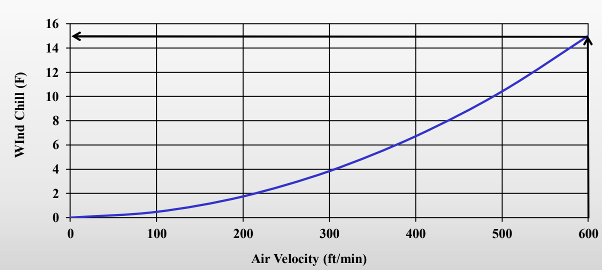
85ºF day – 77ºF night (broilers)



83

Wind-chill effect at 85ºF (29ºC)



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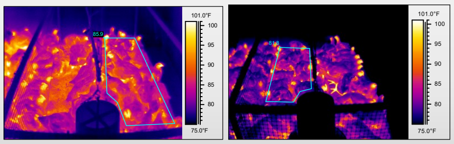
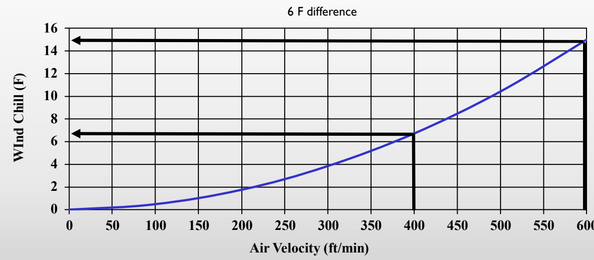
Small changes in wind speed can have a large effect on bird cooling

1) Greater temperature differences
2) More trapped heat between the birds
3) Reduction in wind-chill



85

Wind-chill effect at 85 F



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Poultryventilation.com

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