Keeping Birds Cool During Hot Weather

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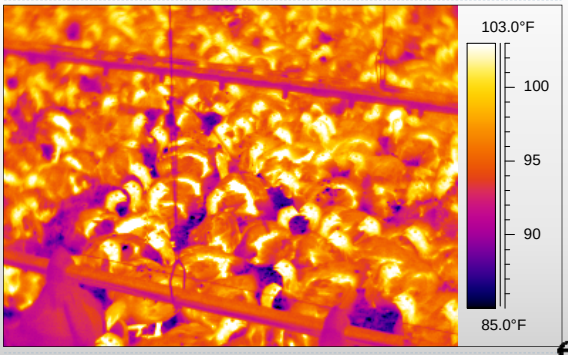
The key to keeping birds cool during hot weather is to realize that…

heat stress is essentially an internal problem,



which is caused by the consumption of feed

This is because feed is a basically a fuel…

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

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

Daily Feed/fuel consumption

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

To put this in perspective…

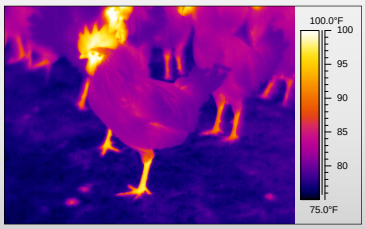
- I would need to eat roughly 20 Big Mac meals each day.
- Or 200 cans of Cone
- Or 227 medium sized apples

How does a broiler use this feed energy?

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

How does a broiler use this feed energy?

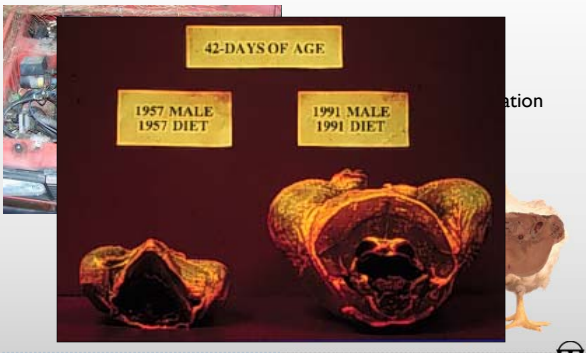
- The remaining 65% is essentially put off in the form of heat.
  - Heat a bird must rid itself in order to maintain a proper body temperature and survive.



How does this compare to your car's engine?

- The typical automobile engine is only about 25% efficient.
- The remaining 75% of the energy goes out the radiator and tail pipe

And like an automobile engine…

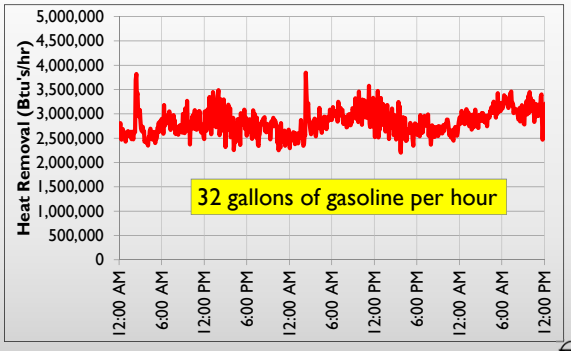


How much heat are we talking about?

- At 70°F a five pound broiler (consuming approximately 0.3 pounds 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


40' X 500' Broiler house

(23,000 – 8 lb birds)

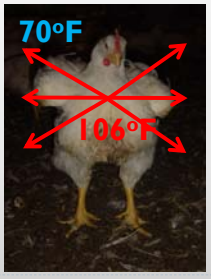


How does this compare to us?

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

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



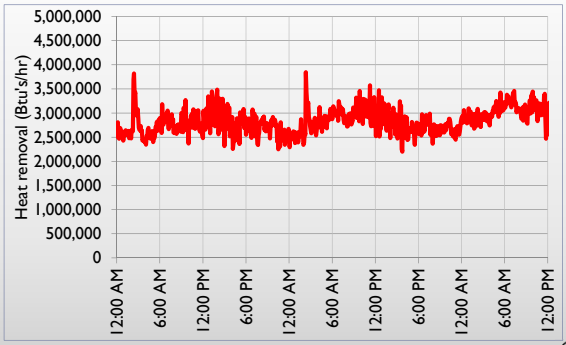
How does a bird rid itself of this excess heat?

- 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

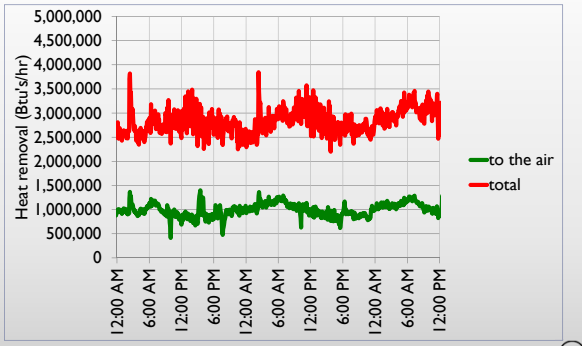
Heat loss breakdown

- Five pound bird at 70°F – 50% Rh
  - 24 Btu's/hr is lost to the air surrounding the bird (40%)
  - 36 Btu's/hr is lost through the evaporation of water off of its respiratory system (60%)

40’ X 500’ Broiler house
(23,000 – 8 lb birds)



40’ X 500’ Broiler house
(23,000 – 8 lb birds)



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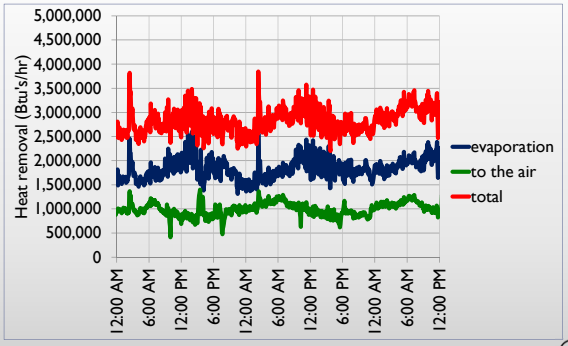
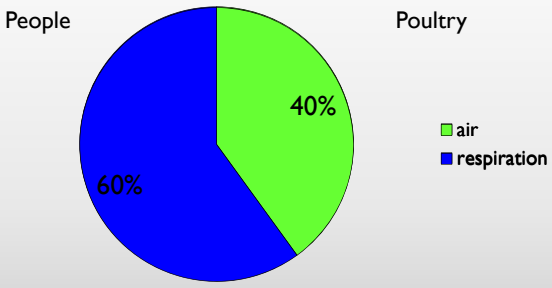


How do we compare?

Seated at rest the average adult male will produce approximately 340 Btu’s/hr

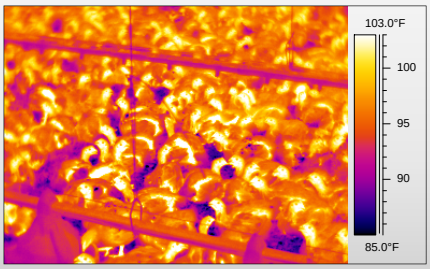
- 28% is lost due to the evaporation of water from our respiratory system and skin (perspiration)
- 72% is lost to the air surrounding us

This is a very significant difference



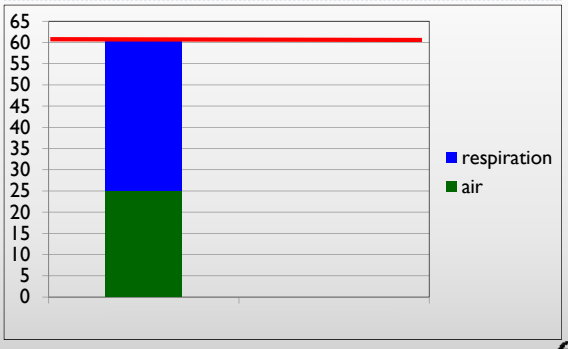
Poultry

- Generate a lot more heat and are MUCH more sensitive by humidity than we are



Let's take a closer look at how air temperature affects a bird's ability to rid itself of excess heat

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



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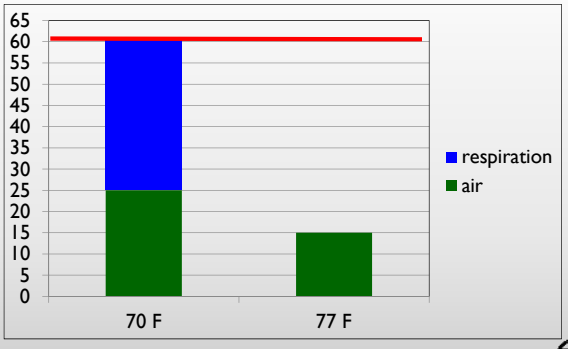
What happens when we increase air temperature to 77°F

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



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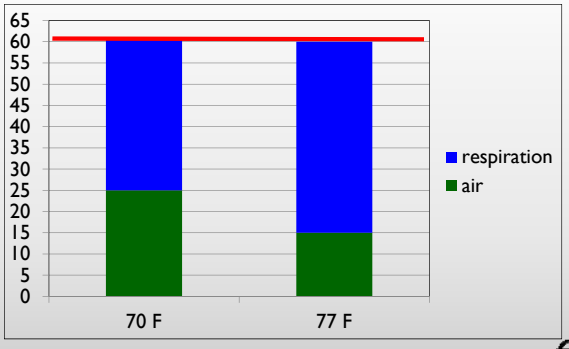
Heat loss from a 5 lb broiler at 70°F and 77°F, Rh=50%



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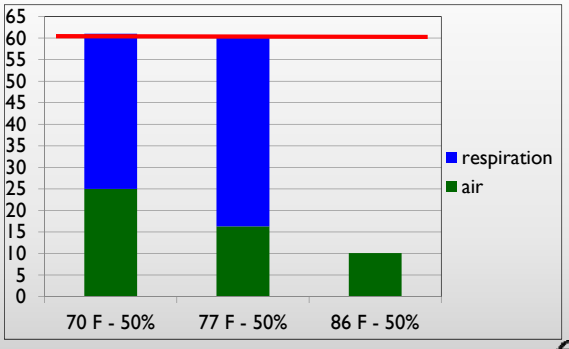
What happens at even higher house temperatures?

Heat loss from a 5 lb broiler



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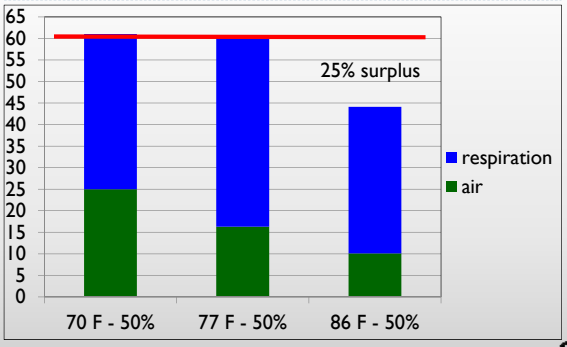
Heat loss from a 5 lb broiler



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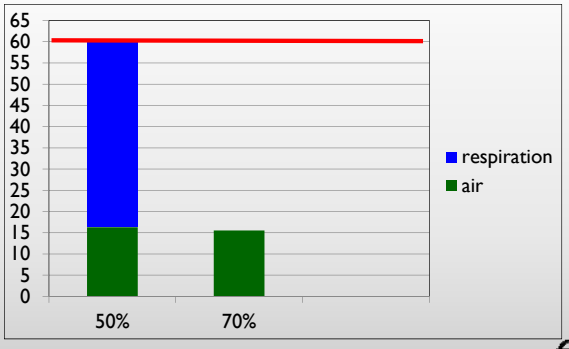
If a bird cannot get rid of all the heat it is producing…

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

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%

Heat loss from a 5 lb broiler at 77°F



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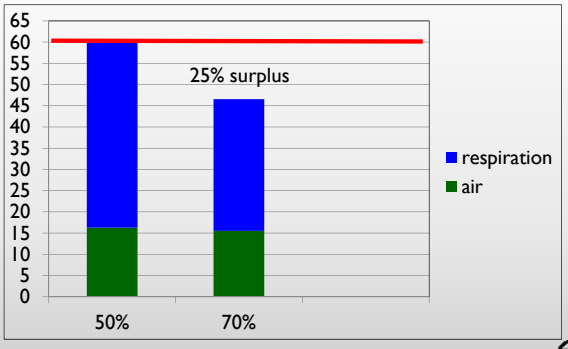
Heat loss from a 5 lb broiler at 77°F



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

- Body temperature will increase,
- Feed consumption will decrease,
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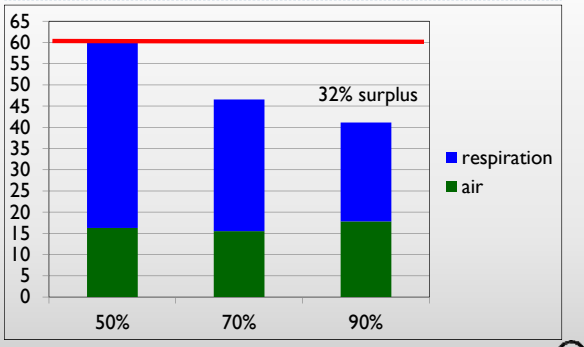
Increasing Rh from 50 to 70 % when it is 77°F

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

Heat loss from a 5 lb broiler at 77°F



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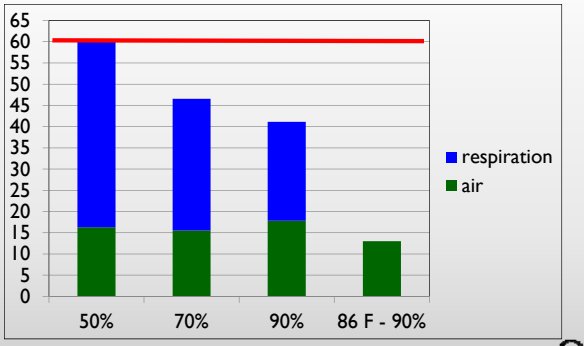
What happens at high house temperatures (86°F) with high relative humidity?

Heat loss from a 5 lb broiler at 77°F



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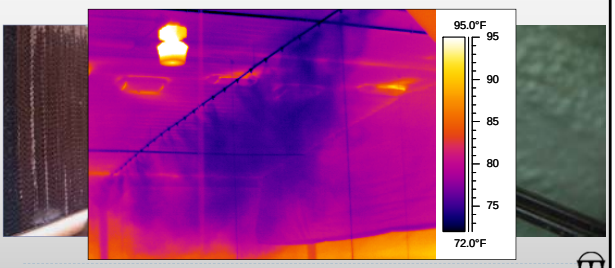
So how do we help remove heat from the birds during hot weather?

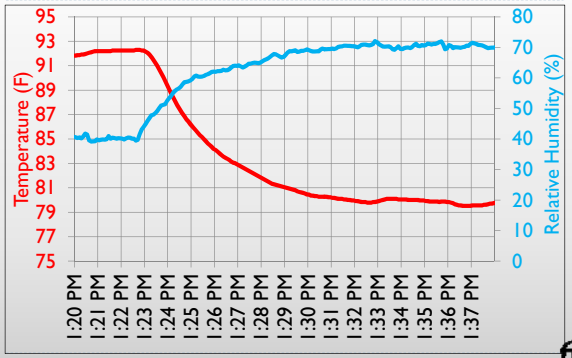
- Lower the air temperature?

Evaporative cooling

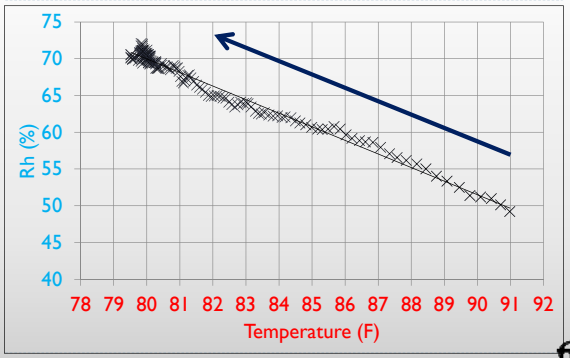
- Pads/fogging nozzles produce cooling through the evaporation of water into the air which increases relative humidity of the air



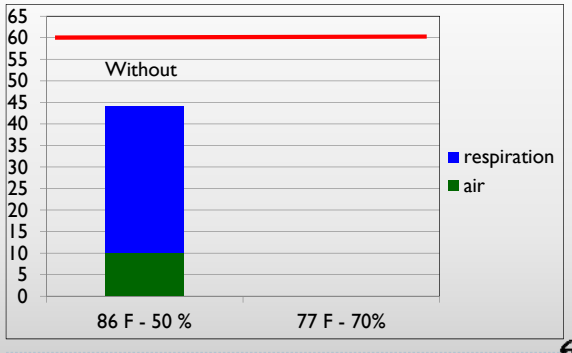
6" evaporative cooling pad in operation



For every 1°F cooling produced by the evaporation of water, the relative humidity will increase approximately 2.5%



So we are left with a choice…



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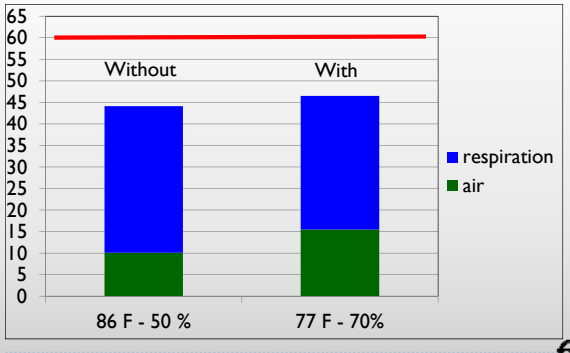

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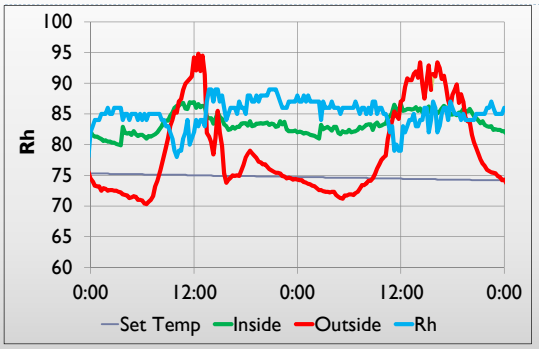
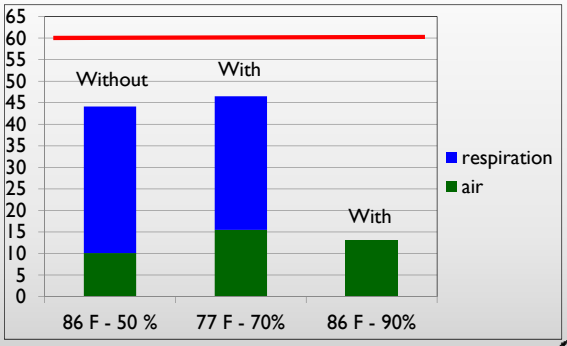
Often conditions in our houses are even hotter and more humid…



Evaporative cooling does not solve our heat surplus problem…



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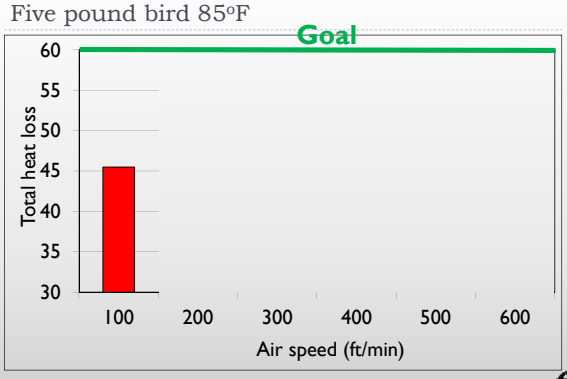
Evaporative cooling

- The PRIMARY reason we can use evaporative cooling pads to keep our birds cool during hot weather is because of the amount of air movement we have in our tunnel houses.

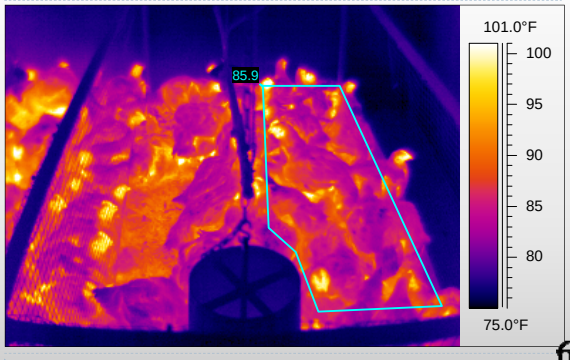
Simmons & Lott 1981

Five pound bird 85ºF

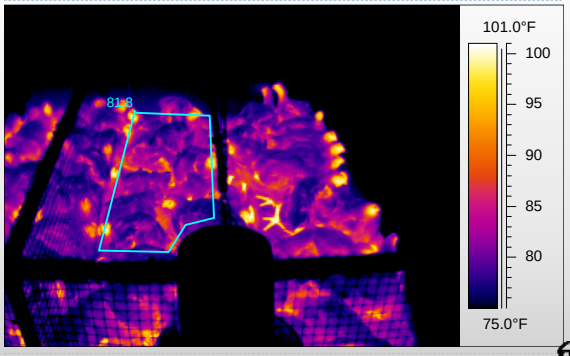


Thermal images of birds with and without air movement

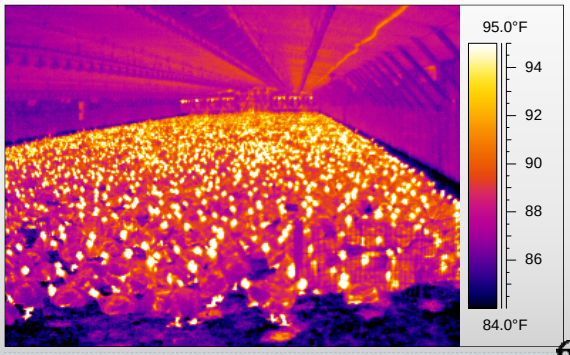
78ºF – no air movement



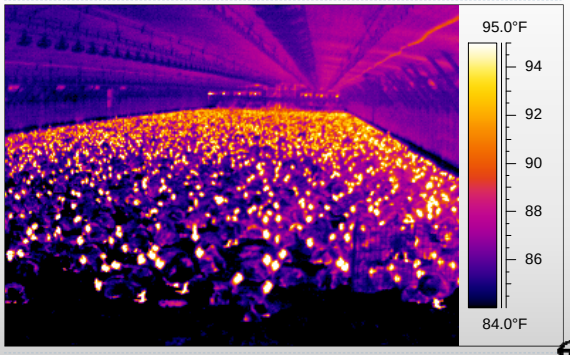
78°F – 300 ft/min



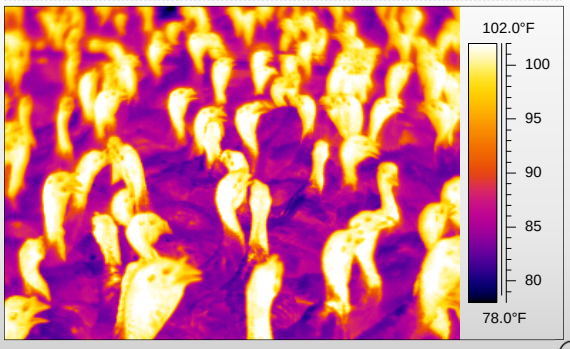
Broilers
(85°F – 250 ft/min)



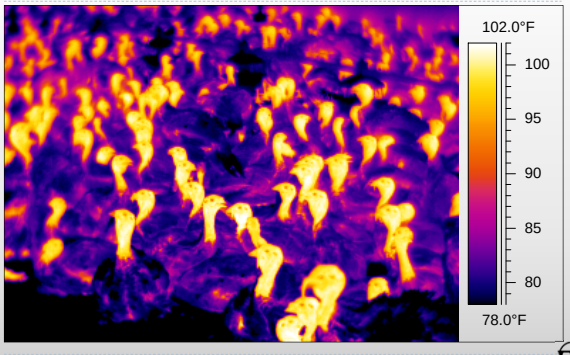
Broilers
(85°F – 550 ft/min)



150 ft/min 80°F



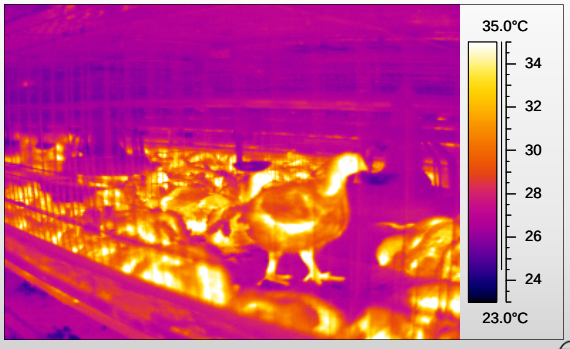
400 ft/min 80°F



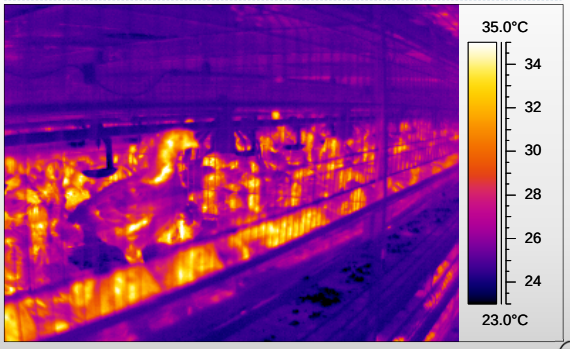
Newest style of broiler house….

Colony broilers

Colony broilers – low air velocity (100 ft/min in cage)

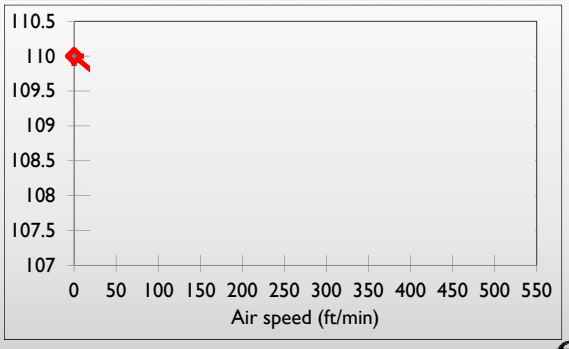


Colony broilers high air velocity (300 ft/min in cage)



Body temperature vs. Air speed

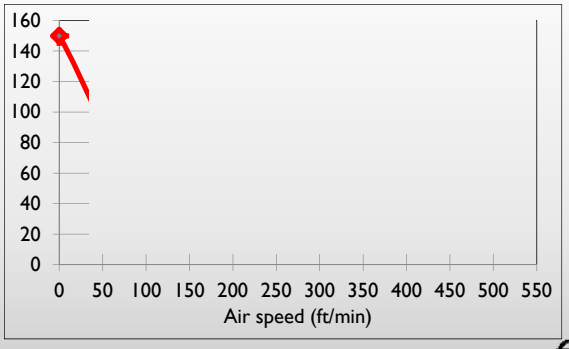
(individual bird at 85°F – Drury Siegel, 1968)



More air movement, more heat removal, panting rate decreases…

Respiration rate vs. Air speed

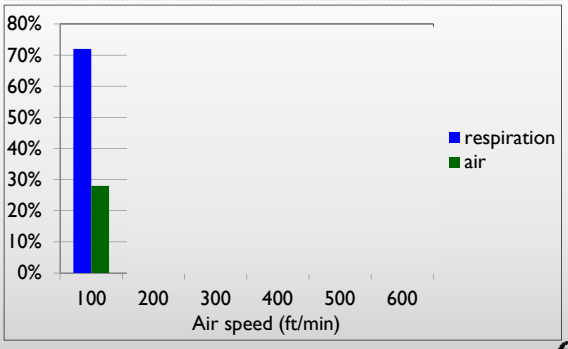
(individual bird at 85°F – Drury Siegel, 1968)



Turkeys (80°F – 150 ft/min)

400 ft/min 80°F

The net result is that air movement lessens the negative effect of high relative humidity



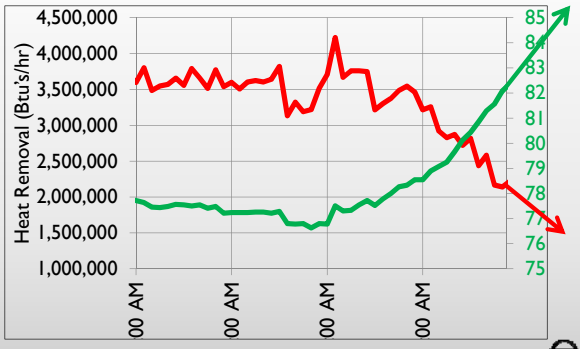
(Simmons & Lott 1981)

This doesn't mean that evaporative cooling is not important

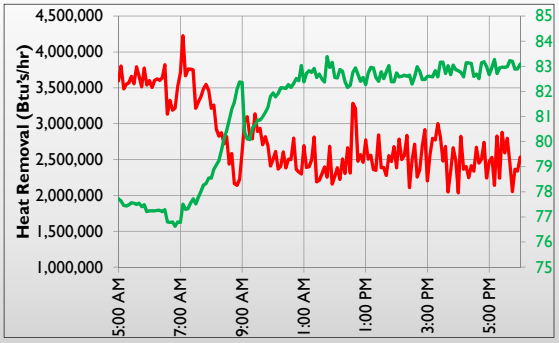
- The closer the air temperature is to the birds body temperature the less heat removed from the birds.

50 X 560' broiler house

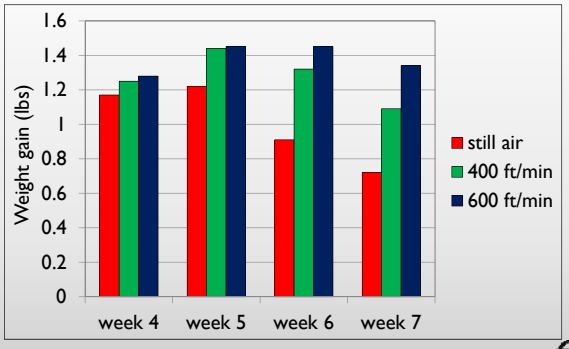
Heat removal and air temperature



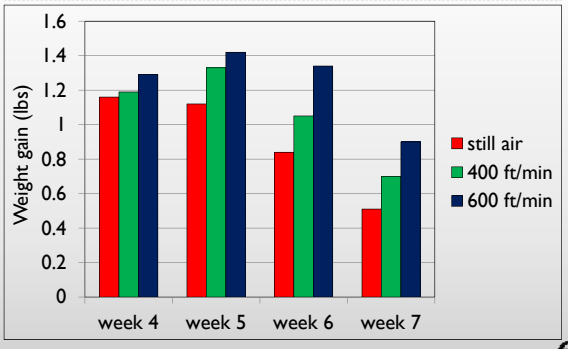
Heat removal and air temperature



Weekly weight gain
86°F Day – 77°F Night



Weekly weight gain
95°F Day – 77°F Night

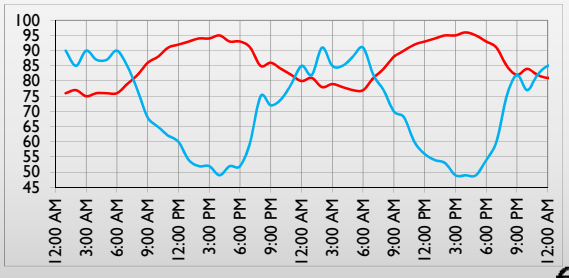


Evaporative cooling keeps our air movement effective at removing heat from our birds

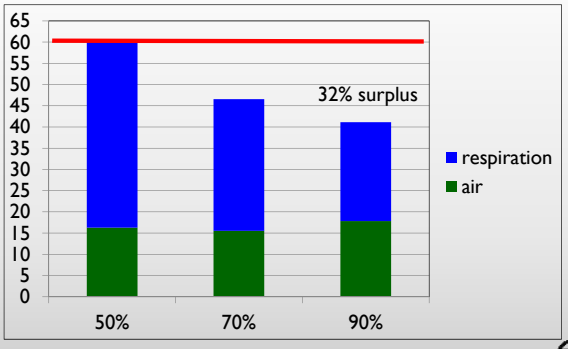
Nighttime bird cooling…

We should not underestimate the importance of nighttime cooling

- Though temperatures are at their lowest…
- Rh is at its highest

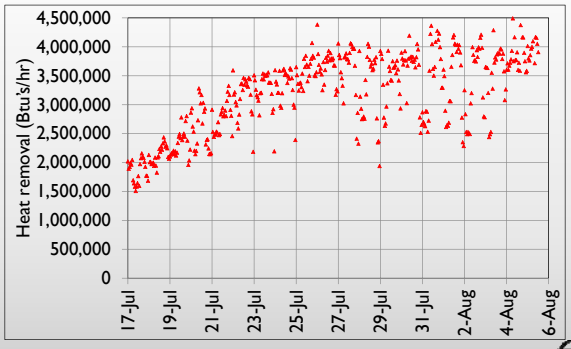


Heat loss from a 5 lb broiler at 77°F

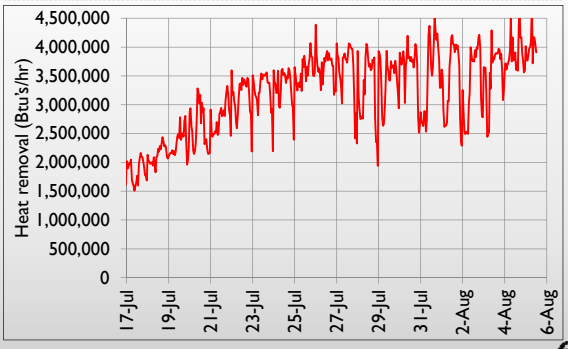


Levent, & Portier, 2005

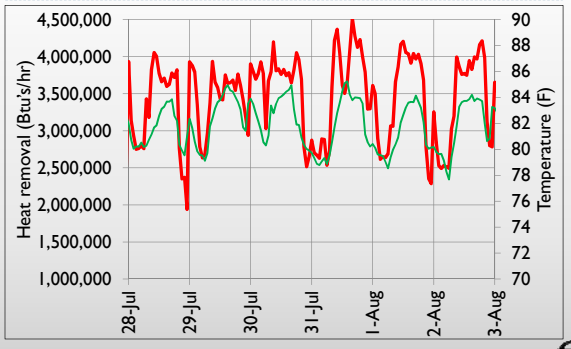
Example of poor nighttime bird cooling



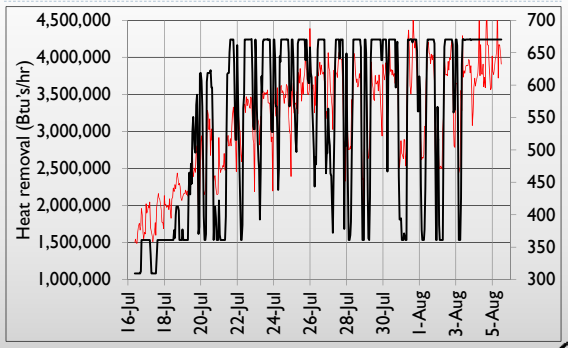
Bird heat removal in 50' X 560' house



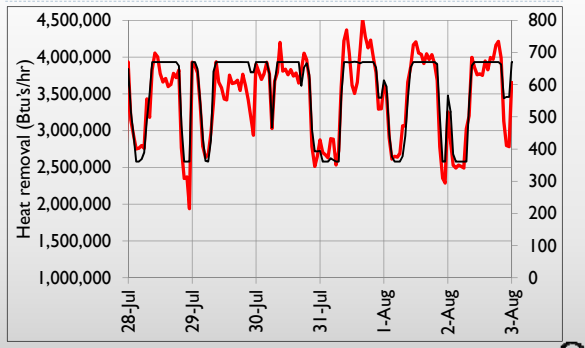
Lowest heat removal occurred when air temperatures were at their lowest



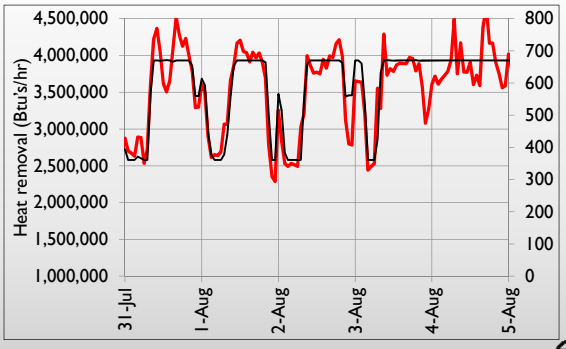
But air speed was not a constant…



It was significantly lower at night because fans were shutting off

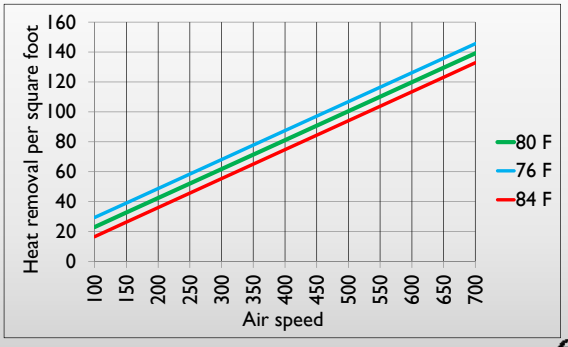


Which resulted in a 20% decrease in daily heat removal

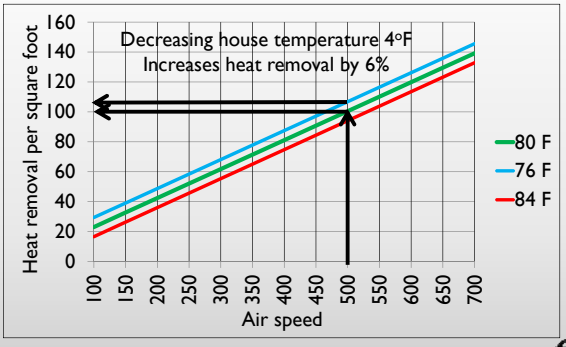


Heat removal chart was developed from data collected from this particular house

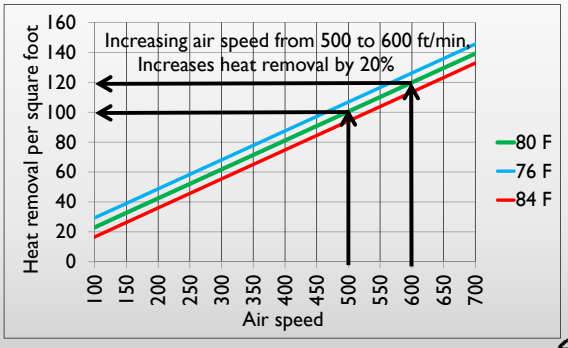
Heat removal as a function of air speed and house temperature



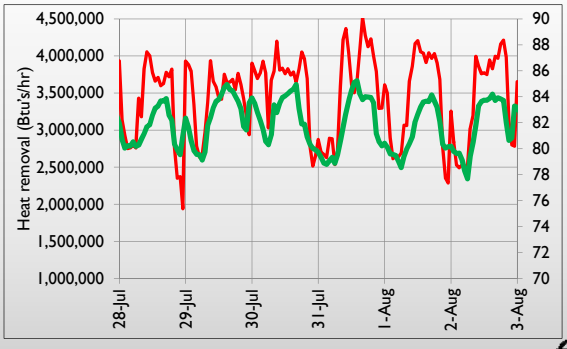
Air temperature and heat removal



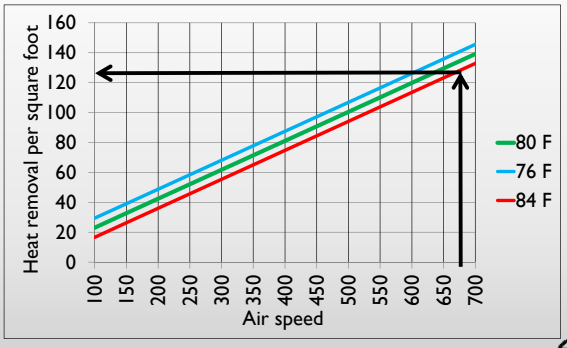
Air speed and heat removal



It is important to realized that inside a house it may only be 4 to 6 degrees cooler at night!

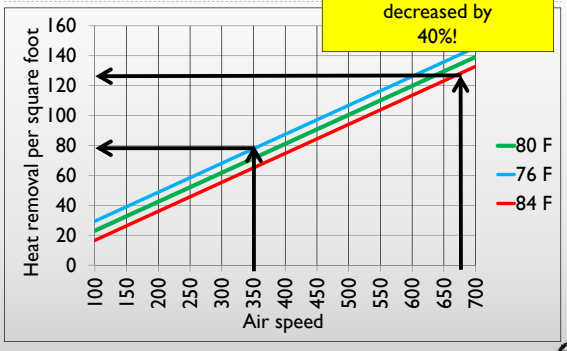


During the day....



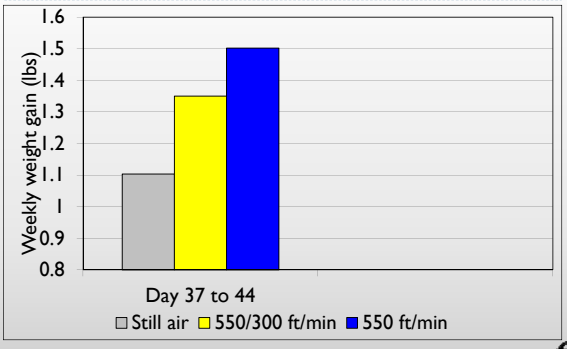
At night...

Heat removal is decreased by 40%!

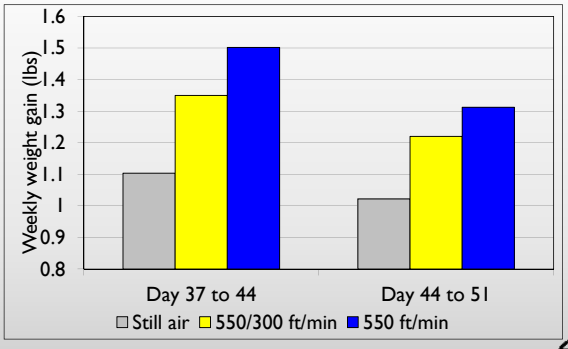


Studies have verified when we don't run all our fans at night we are going to have a loss in performance

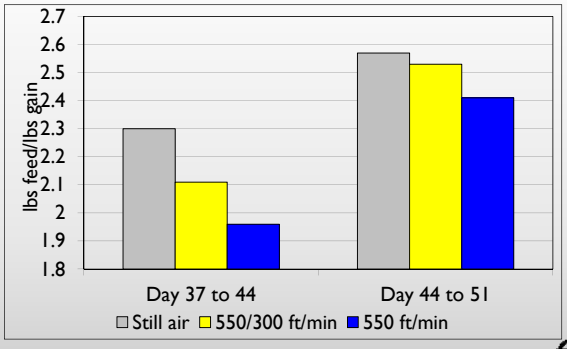
86°F day – 77°F night



86°F day – 77°F night

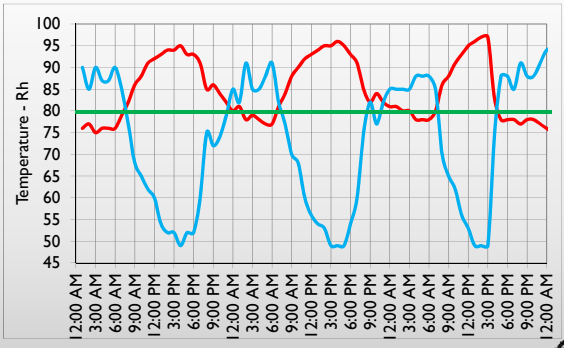


86°F day – 77°F night

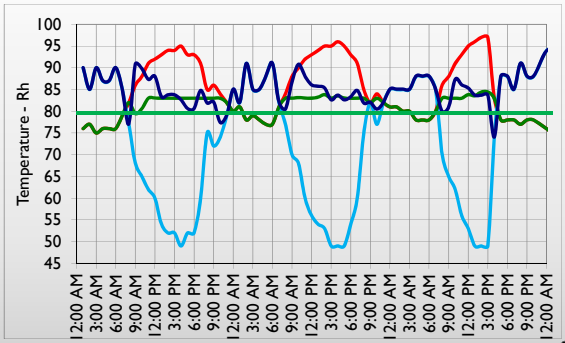


Nighttime evaporative cooling operation?

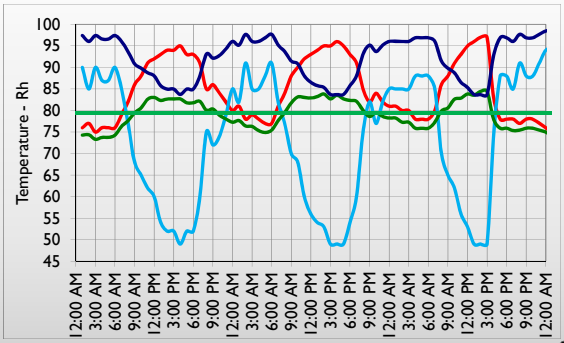
Typical hot weather



Pads only operating during the day



Pads operating 24 hours a day

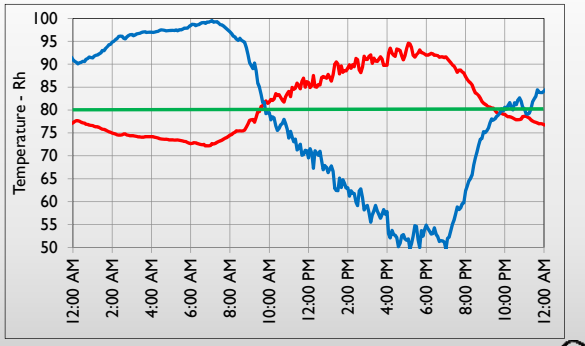


Nighttime pad operation can increase heat stress

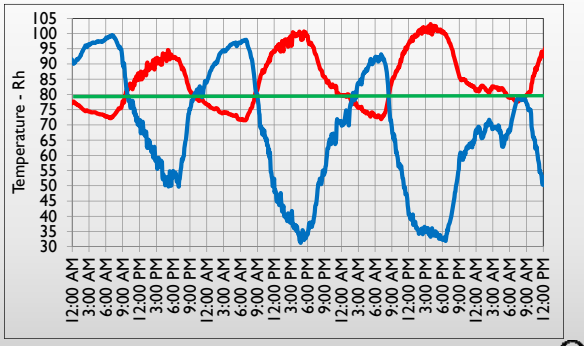
- One way to reduce the possibility of pads operating at night is to simply set a pad operating temperature of approximately 83°F.
- Another way is to set a lower pad operating temperature (i.e., 75°F) AND put them on a time clock so they will not operate between the hours of 10 pm and 9 am.

But during extremely hot weather old rules of thumbs may not hold true…

Outside temperature and Rh

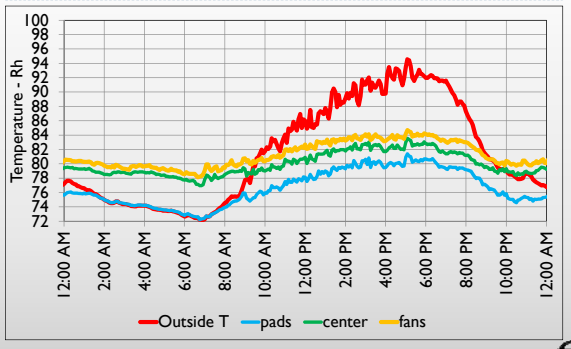


Outside temperature and Rh

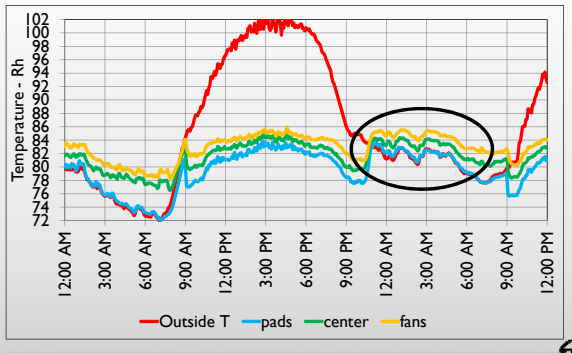


What happens if the pads are not allowed to operate from 10 pm to 9 am?

Normal hot weather



But during extremely hot weather it can be a problem.

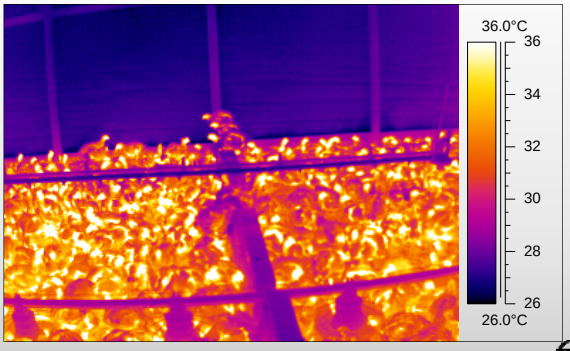


Another critical management factor to keep in mind during hot weather is maintaining uniform bird distribution

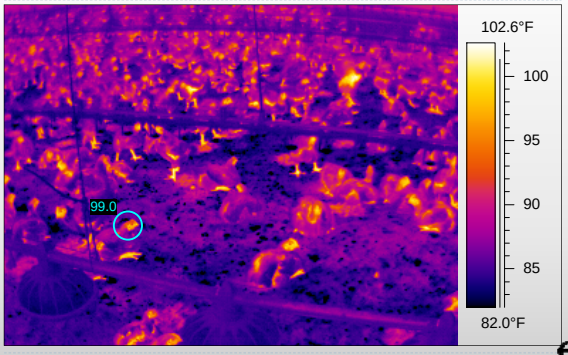
Though high air speeds help to pull heat from between birds…

- In order to maximize bird cooling the birds must be kept spread out as much as possible

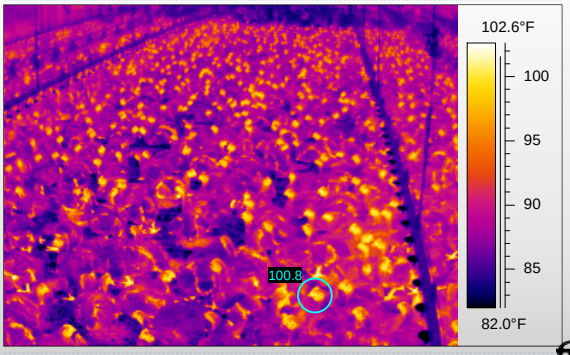
Effect of density on cooling



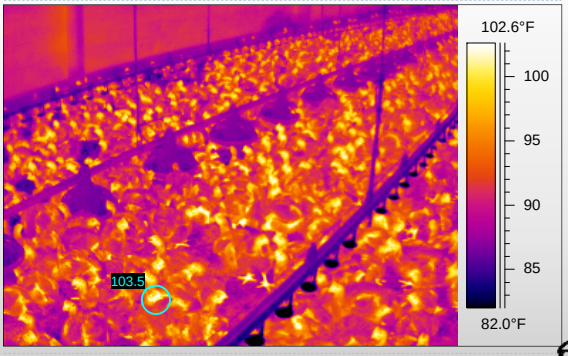
Very low density
(85°F air temperature – 450 ft/min)



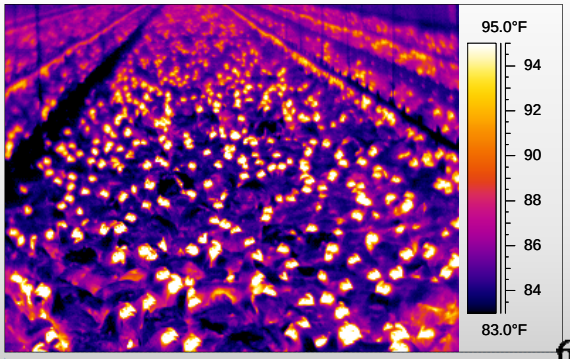
Moderate density – same house
(85°F air temperature – 450 ft/min)



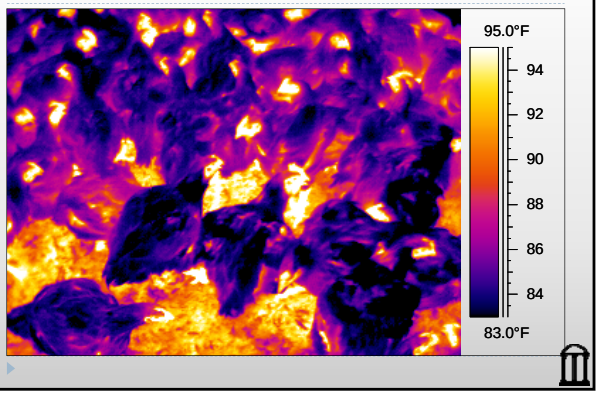
High density – same house
(85°F air temperature – 450 ft/min)



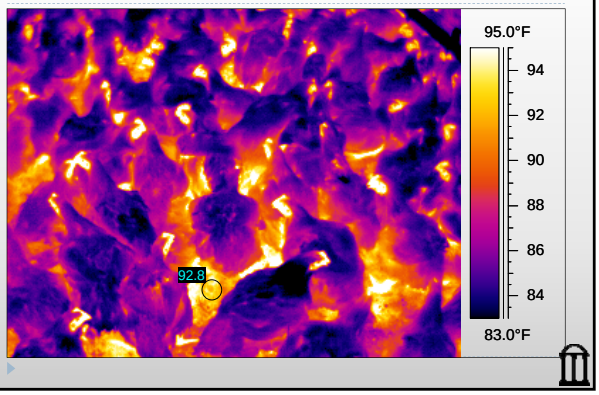
Birds near the cool cells appear to be very cool…



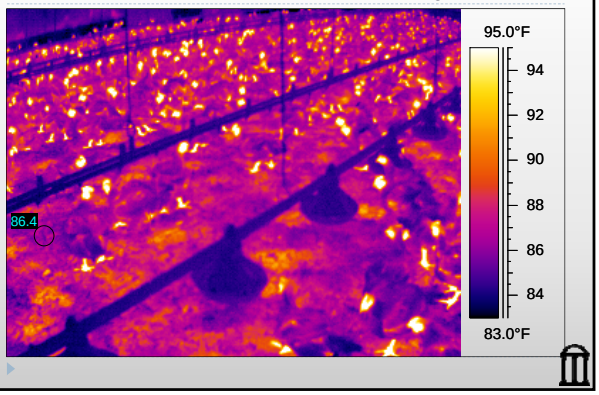
But upon closer examination…



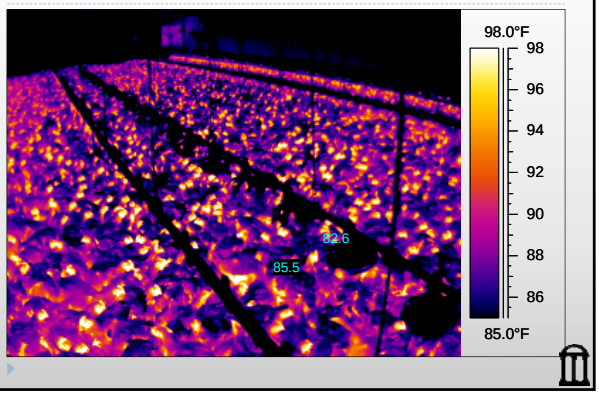
Very little of the birds surface is actually being cooled



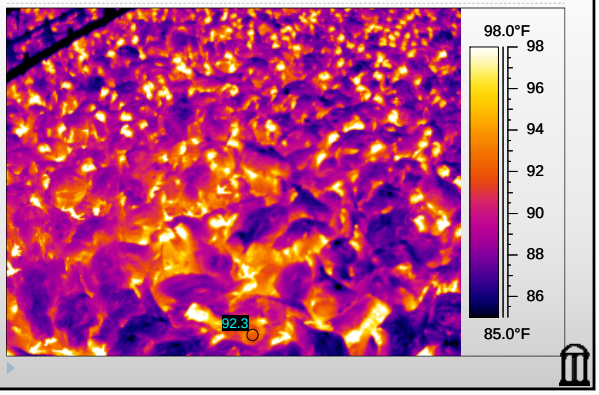
Birds at tunnel fan end are actually cooler…



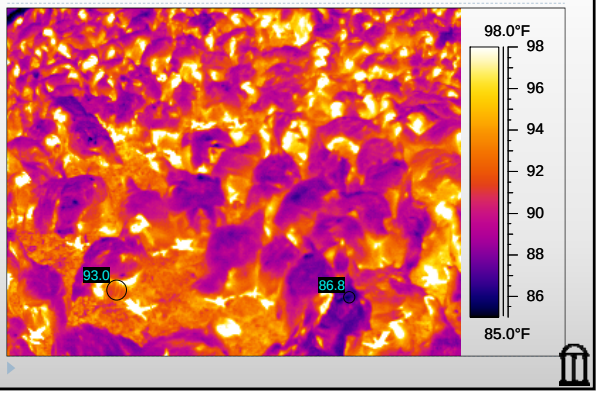
Another farm…



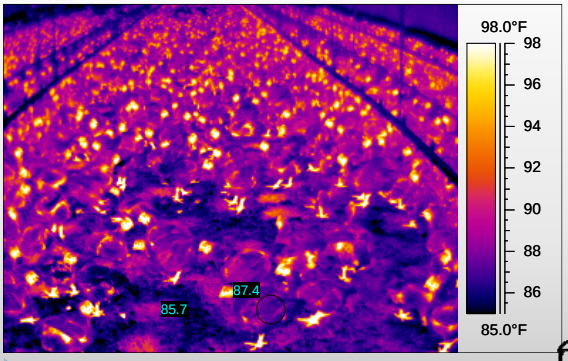
Walking through birds near tunnel opening…



Walking through birds near tunnel opening



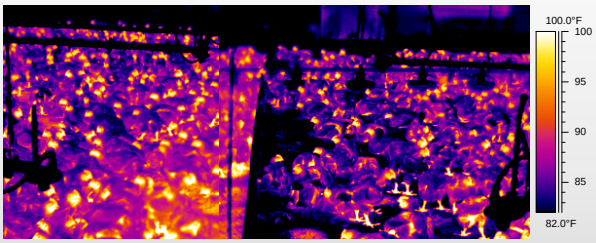
Tunnel fan end of the house.



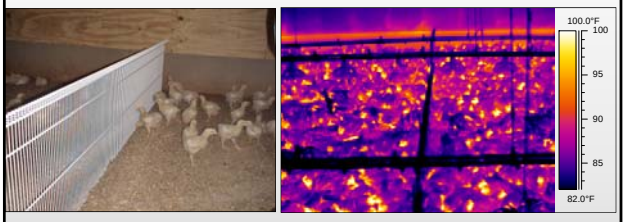
Migration fences are a must…

Plywood fence is not a good idea

Plywood migration fence

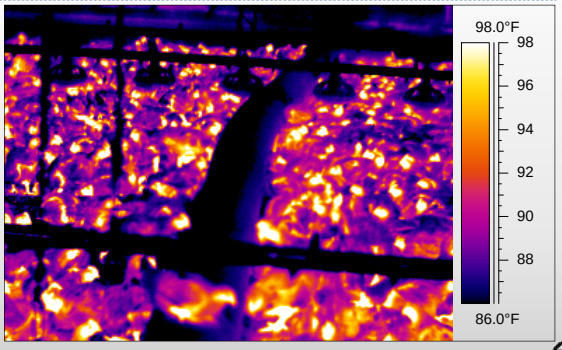


Wire shelving



Plastic pipe

Plastic pipe



Another possible option…

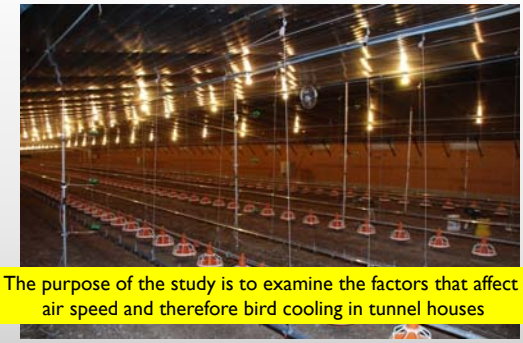
Inverted V fence

Inverted V migration fence

Inverted V fence

What are some of the other factors that affect bird cooling?

Tunnel ventilation system performance study



The purpose of the study is to examine the factors that affect air speed and therefore bird cooling in tunnel houses

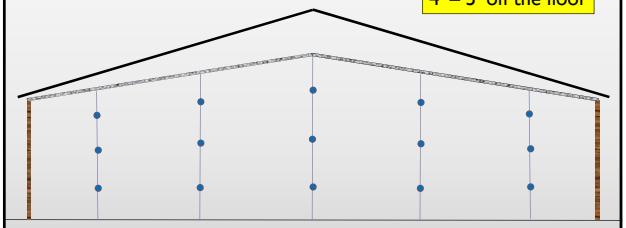
- Funded by USPAE

Measuring house air speed

- 15 anemometers on 5 poles (3 anemometers per pole)

Air speed measurement grid

2' from the floor
2' from the ceiling
4' – 5' off the floor



Measuring house air speed

- Data loggers record average air speed every minute for 10 to 20 minutes under various operating conditions:

The 15 anemometers allows us for the first time to accurately analyze tunnel ventilated houses...

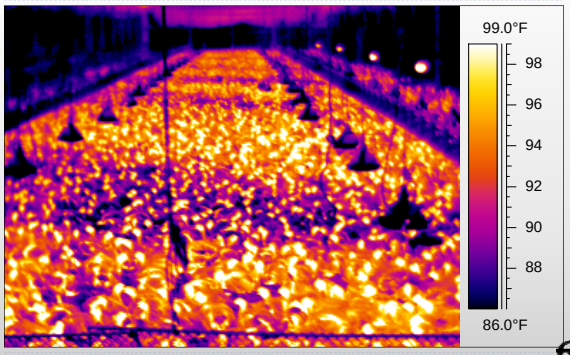
1) Determine how air velocity/bird cooling changes across the profile of a house

To produce maximum bird cooling we need to have as uniform of an air speed as possible throughout a house

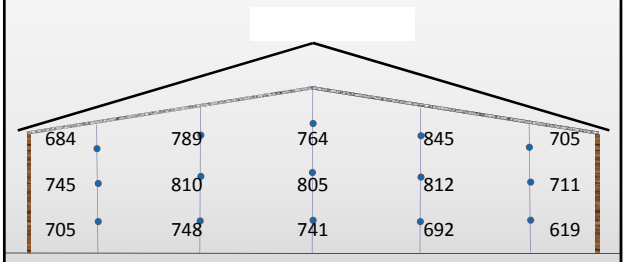
Poor air speed uniformity is a serious problem in naturally-ventilated houses using circulation fans

30' wide naturally-ventilated house with circulation fans

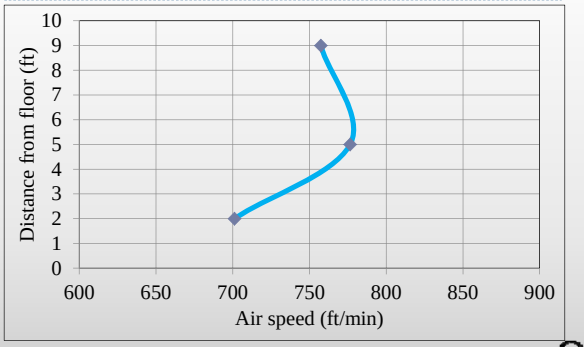
Very localized bird cooling



Air speed measurement grid
(50' X 560' totally enclosed house)

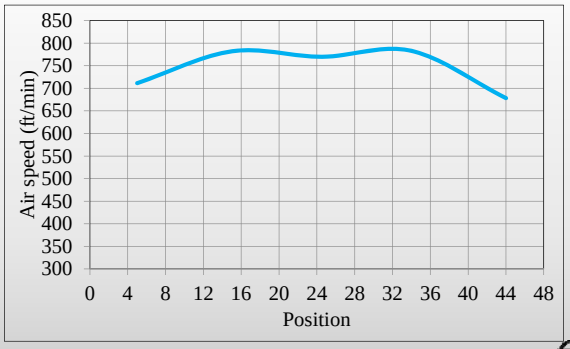


We can determine how air velocity changes from floor to ceiling…



We can determine how bird activity affects air velocity at floor level.

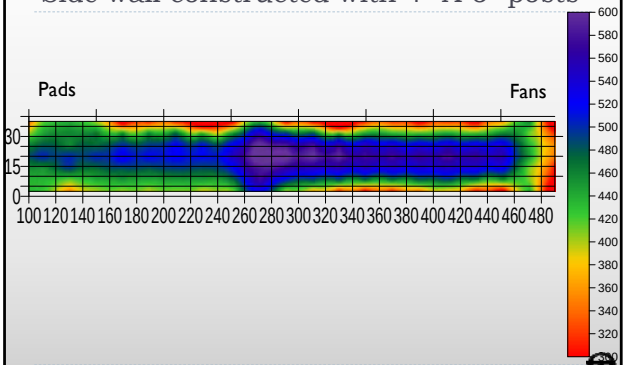
We can accurately determine how air velocity changes from wall to wall



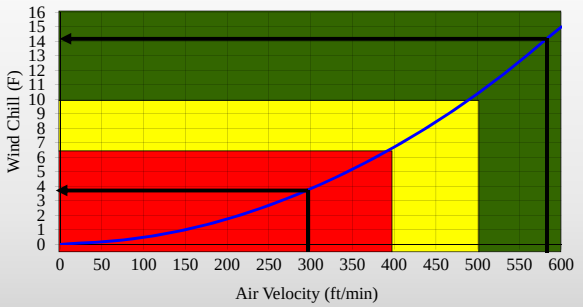
And how the profile changes things such as with type of side wall

- Something as small as exposed side wall posts can affect air speed uniformity

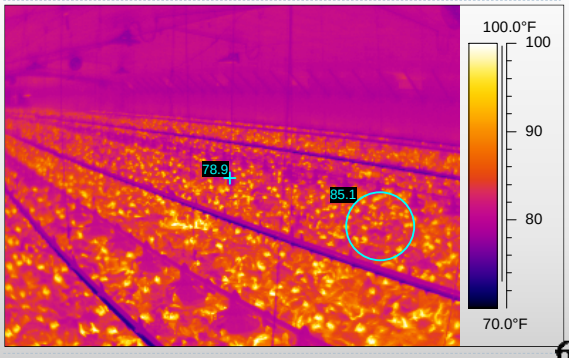
Side wall constructed with 4" X 6" posts



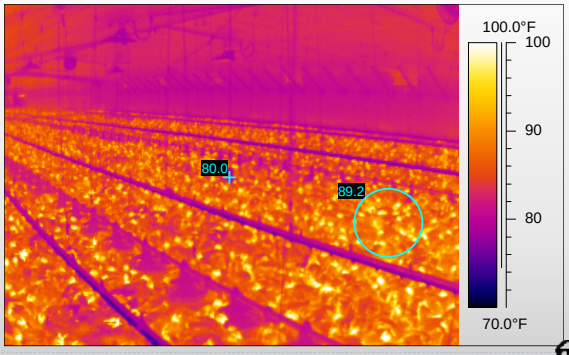
Wind-chill effect at 85°F



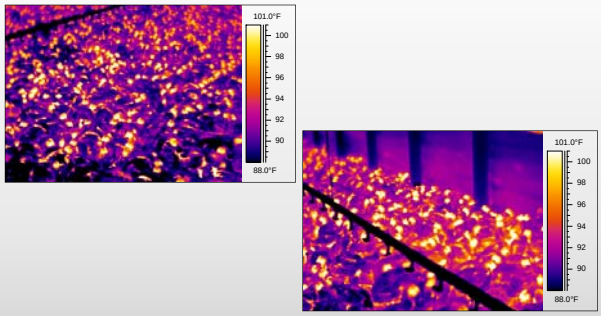
550 ft/min



350 ft/min



Difference in air speed are reflected in bird surface temperatures

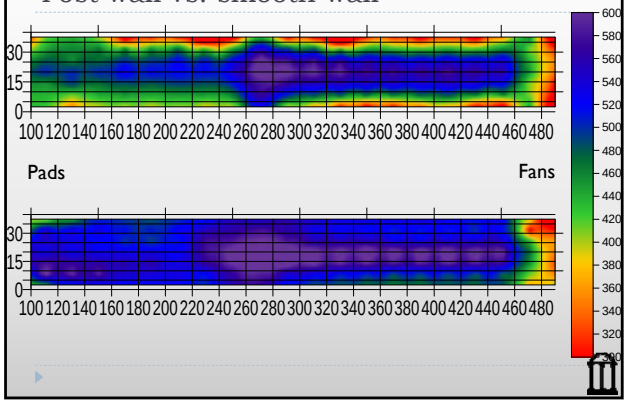


Totally enclosed broiler house with a smooth wall

Side wall air flow
(smooth wall vs. stud wall)

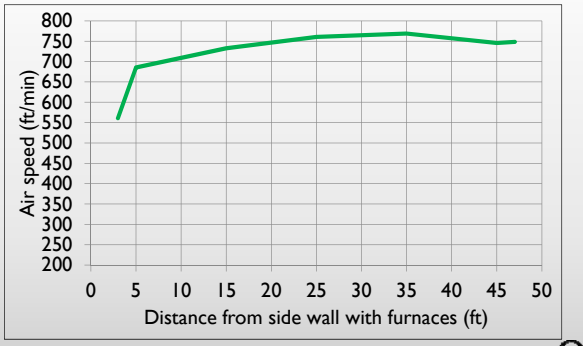
Air flow at floor level
(smooth wall vs. stud wall)

Post wall vs. smooth wall



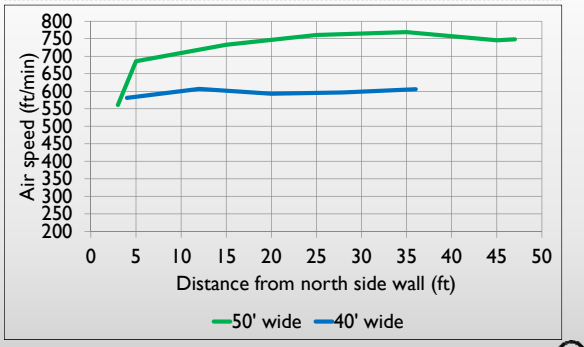
What about forced air furnaces on the side wall?

50’ wide house with furnace along one side wall

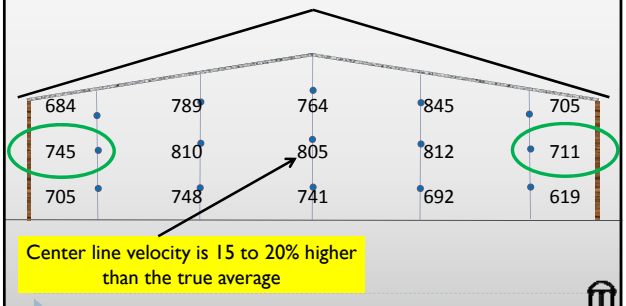


Compare this to 40’ wide house with radiant heaters?

50’ with furnaces vs. 40’ with tube heaters at peak of ceiling



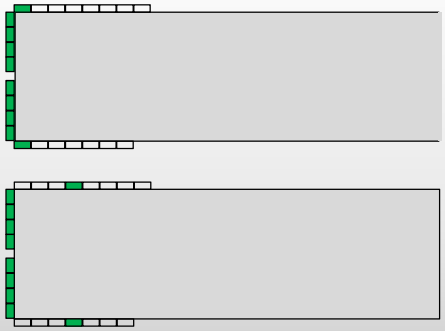
2) The grid helps us to determine where the best place is to measure average air velocity,



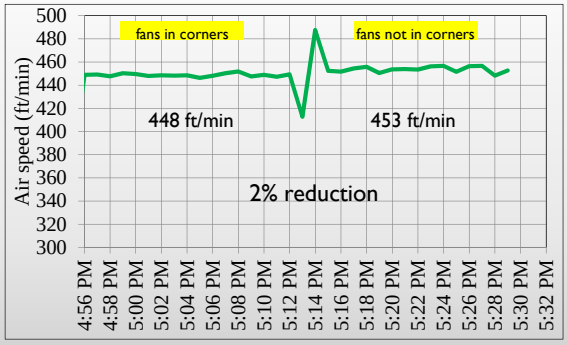
3) Allows us to answer questions about how tunnel fan placement affects fan performance and air distribution

Does placing fans in corners affect their air moving capacity?

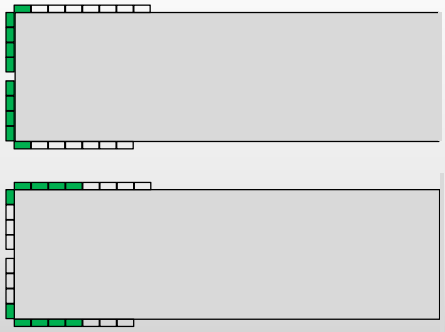
(66' X 600' house with 23, 54" fans)



Fans in corners?

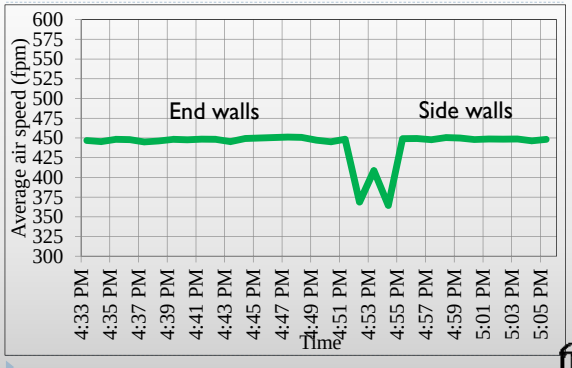


How about fans in end wall vs side walls (66' X 600' house with 23, 54" fans)

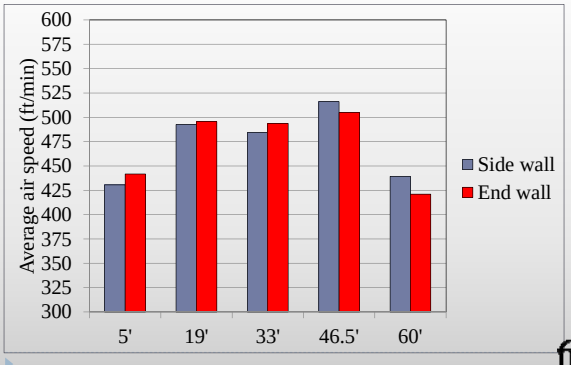


Serious commitment to get all the fans in the end wall

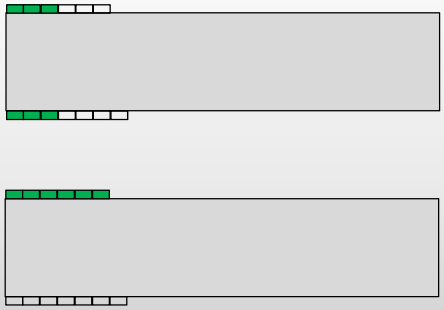
What affect does it have on average air speed (fan capacity)?



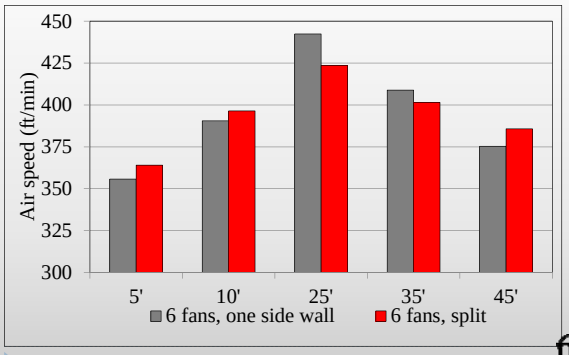
What about air speed uniformity?



How about fans in both side walls vs one side wall (54' X 500 with 13, 52" fans)?

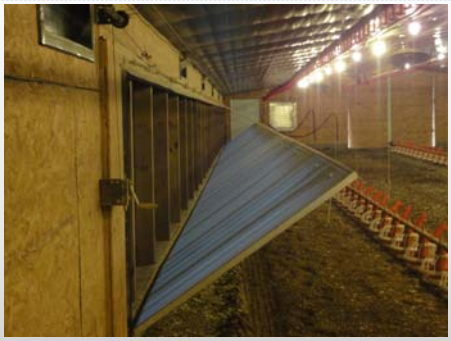


Air speed distribution with six tunnel fans operating



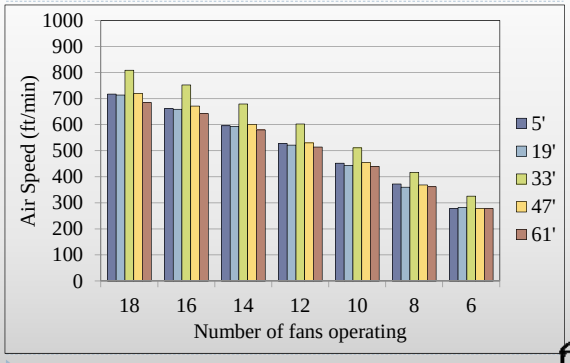
The fact is that air doesn't know where the fans are until it gets to them.

How do tunnel doors affect air speed distribution?



Smooth walled houses with tunnel doors tend to have more uniform air velocities

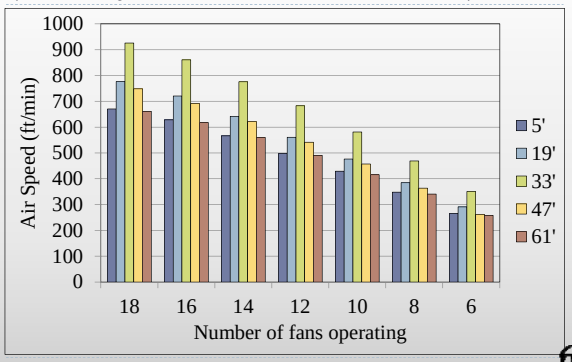
(Air velocity distribution 80' from tunnel fans)



Tunnel shutters offered a valuable insight in to the effectiveness of tunnel doors

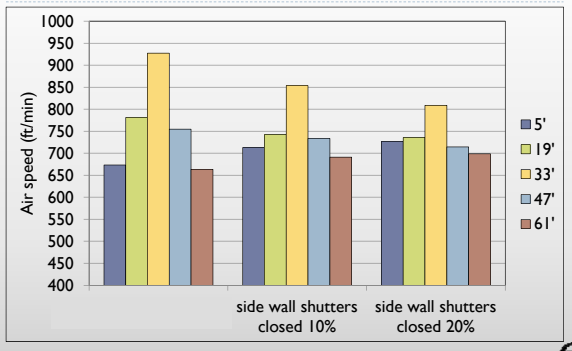
66’ X 500’ with tunnel “shutters”

(Air velocity distribution 80’ from tunnel fans)



Tunnel shutters in partially closed position

Air velocity profile

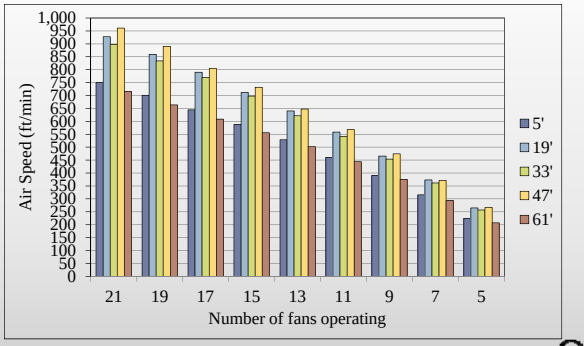


Tunnel door air flow pattern

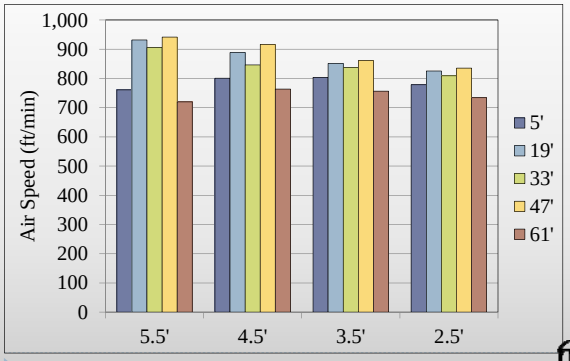
Tunnel curtains have to be closed significantly to have a similar effect

66’ X 600’ with tunnel curtain

(6’ tall pads with 5.5’ tunnel curtain opening)



Closed the tunnel curtain with all fans operating…

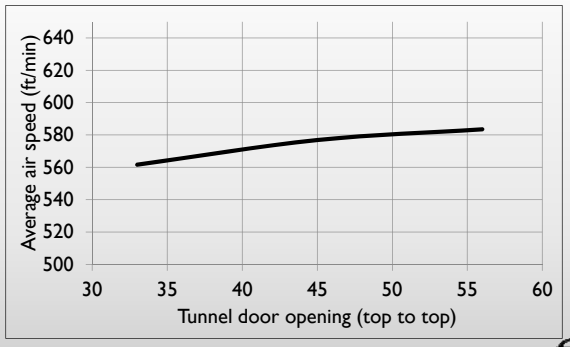


How does tunnel door opening affect the air moving capacity of our fans?

50' X 500' – 600 ft/min

92' of 5' tall pad with a 5' tall tunnel door

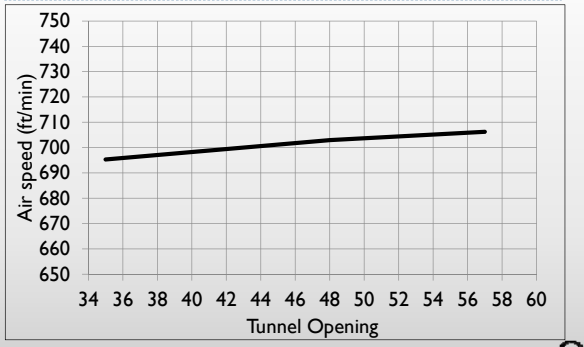
Average air velocity vs. Tunnel door opening



46' X 565' – 700 ft/min

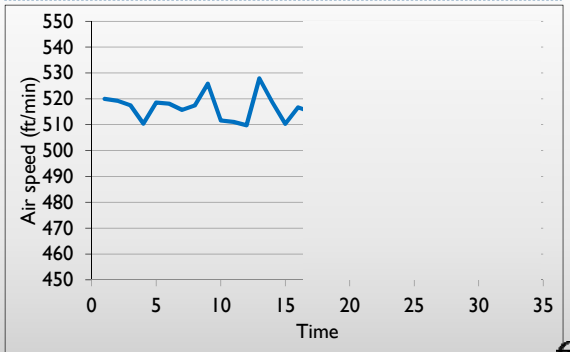
110' of 5' tall pad

46' X 565'



Dry vs. wet pad?

Dry vs. Wet



Water flow over pad

Dirty pads

The University of Georgia

poultryventilation.com