Poultry House Environmental Control
Past, Present and Future

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The level of environmental control in poultry houses in the U.S. has increased dramatically over the last 20 years...

20 year ago producers had very few tools to help them control the environment in their houses

During cold weather

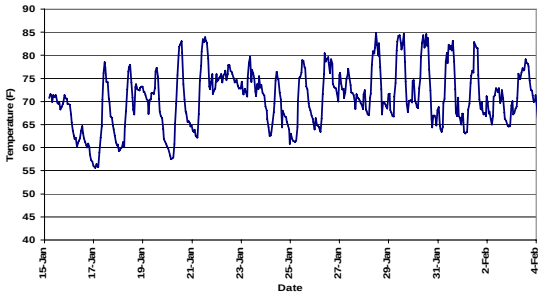
Natural ventilation

- Difficult to control:

Natural ventilation

- Difficult to control:
  1) You can't control house how much air enters the house because you cannot control the wind
     - Little control over temperature

Cold weather temperature control



Relied on natural ventilation to control the environment

- Difficult to control:
  1) You can't control house how much air enters the house because you cannot control the wind
     - Little control over temperature
     - Little control over air quality

Cyclic air quality

Natural ventilation

- Difficult to control
  1) You can't control house how much air enters the house because you cannot control the wind
  2) How it moves once it enters the house.

Cold air falling to floor

Cold air falling to floor

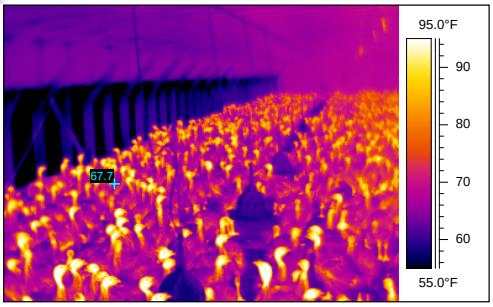
1) Displaces warm air near the floor toward the ceiling.
2) Chills the birds
3) Does not remove water from litter
4) Excessive fuel usage

Cold air blanketing floor

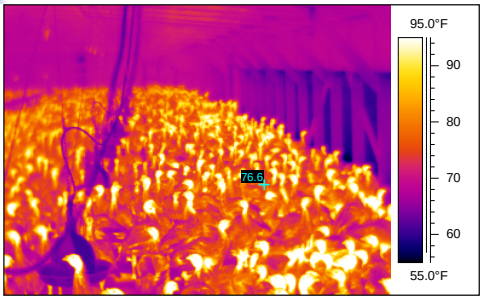
Cold air falling to floor

1) Displaces warm air near the floor toward the ceiling.
2) Chills the birds
3) Does not remove water from litter
4) Excessive fuel usage
5) Poor temperature uniformity

Upwind side of house



Downwind side of house



Natural ventilation was used during hot weather as well

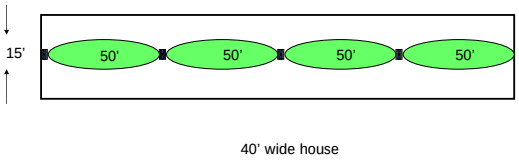
and was equally problematic

- For the same basic reasons...
  - Little control over air exchange
  - Little control over air movement within the house.

36” fans were used to produce some bird cooling

But there effect was limited

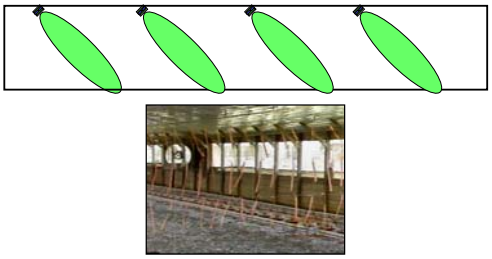
- Due to the relative limited area each fan covered.



Air movement only in the center of the house

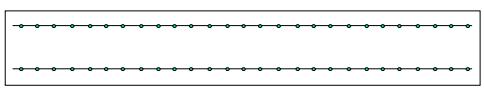
Circulation fans on the side wall

- Really didn’t improve conditions

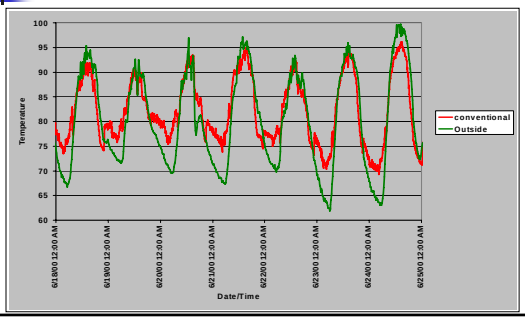


Houses had very limited ability to reduce air temperature through evaporative cooling

- Fogging system
  - Couple rows of 1 – 2 gal/hr fogging nozzles (120 psi) capable of producing a few degrees cooling



Inside conditions pretty much followed outside conditions



Modern poultry house is very different…

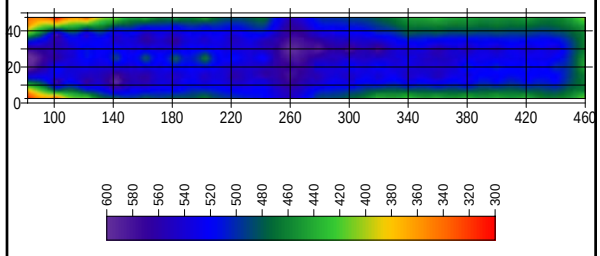
- It is all about gaining environmental control

Tunnel ventilation

Total air exchange in 60 seconds or less

Relatively uniform air velocity

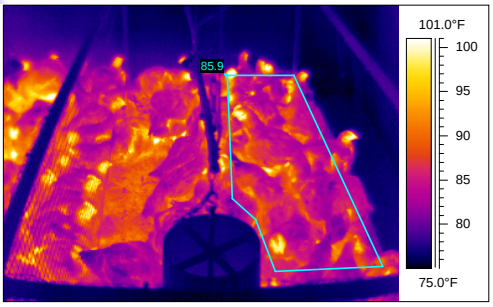
Air velocity profile in tunnel house



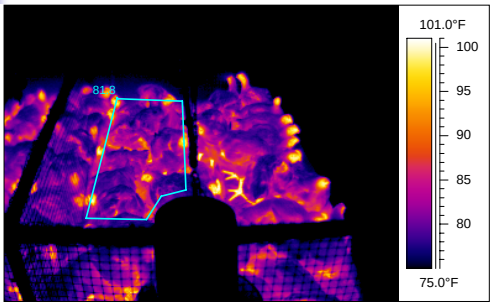
These houses have taught us the importance of air movement during hot weather

More air speed…
more cooling

78ºF – no air movement



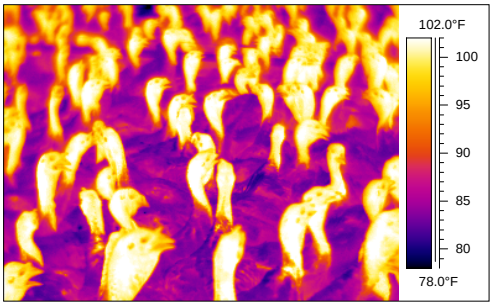
78ºF – 300 ft/min



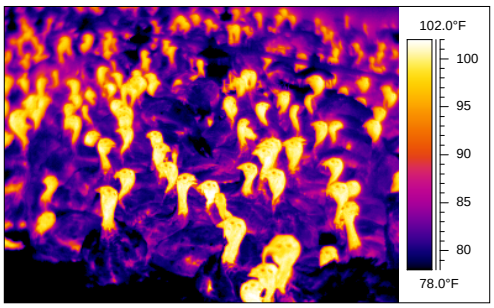
Turkeys

(80ºF – 150 ft/min)

80ºF – 150 ft/min

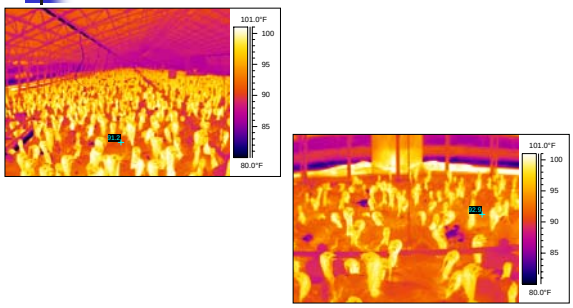


80ºF – 400 ft/min

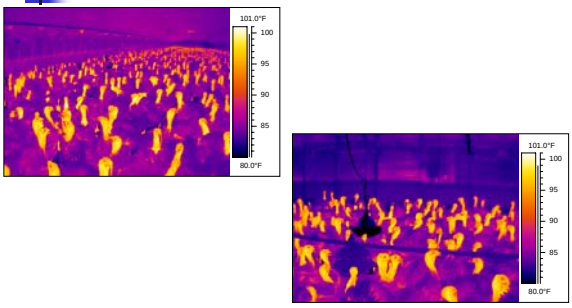


400 ft/min 80ºF

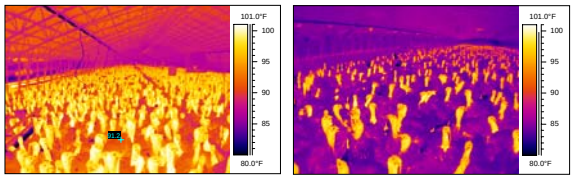
Naturally-ventilated house during hot weather



Tunnel-ventilated house during hot weather

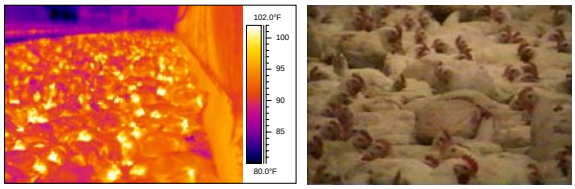


Natural vs. Tunnel

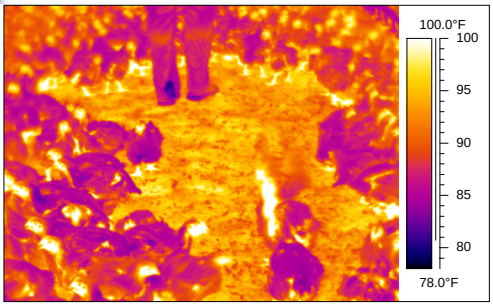


Tunnel Houses

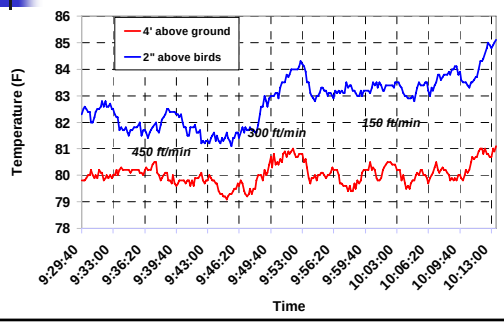
- Improved heat removal from the bird
- Improved heat removal from between the birds.



Hot Floors



Air movement and bird heat removal

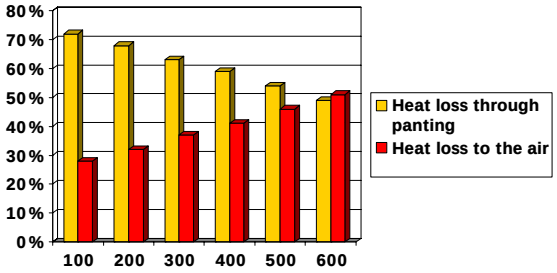


Tunnel Houses

- Improved heat removal from the bird
- Improved heat removal from between the birds.
- Reduce the adverse effect of high humidity

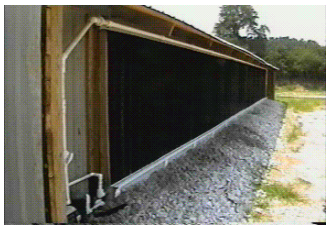
Simmons & Lott 1981

Five pound birds 85ºF



Evaporative cooling pads

- "Cool cells"



Decrease incoming air temperature 2 – 25ºF

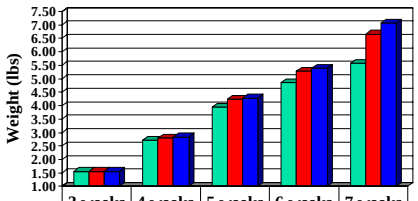
Combination of air movement and evaporative cooling

- Dramatic effect on our ability to cool our birds

Performance has increased dramatically

Broiler weekly weights

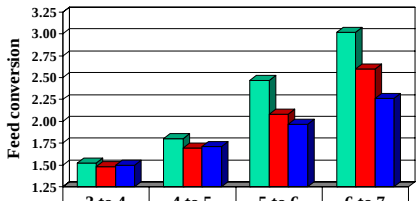
(77ºF night – 85ºF day)



	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	5.28	6.65
600 fpm	1.55	2.83	4.28	5.38	7.07

Weekly feed conversions

(77ºF night – 85ºF day)

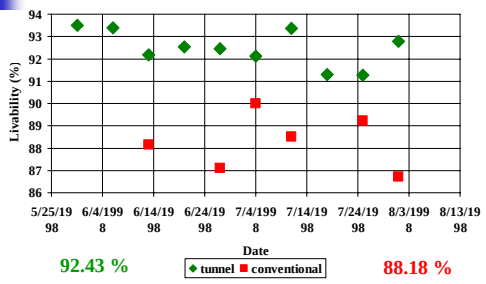


	3 to 4	4 to 5	5 to 6	6 to 7
still air	1.52	1.80	2.47	3.02
400 fpm	1.48	1.70	2.08	2.60
600 fpm	1.50	1.71	1.97	2.27

Broiler Performance in Tunnel-Ventilated Houses

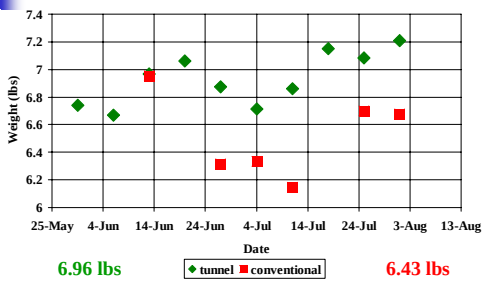
- Conventional - circulation fans & foggers
  - males
  - 0.90 ft²/bird
- Modern house
  - males
  - 0.85 ft²/bird

Average livability



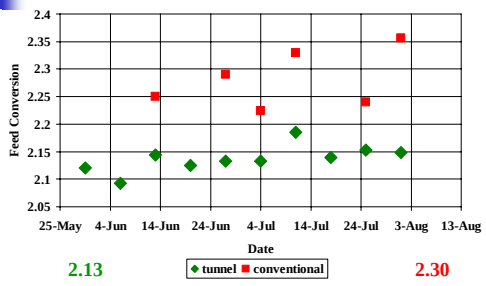
92.43 % 88.18 %

Average weight



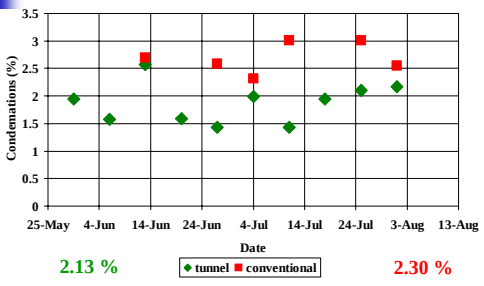
6.96 lbs 6.43 lbs

Feed conversion



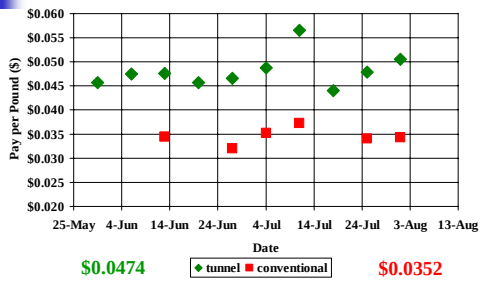
2.13 2.30

Condemnations



2.13 % 2.30 %

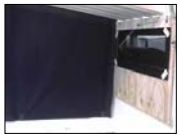
Pay per Pound



$0.0474 $0.0352

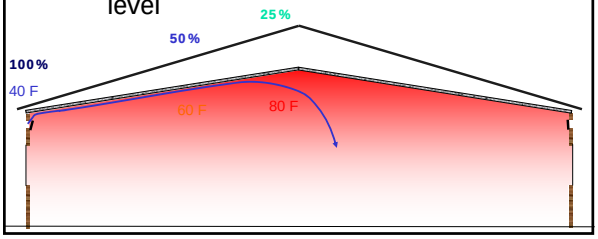
For cooler times of the year houses are equipped with a negative pressure ventilation system

- Small volumes during cold weather
  - Air quality control
  - Minimize drafts
  - Minimize fuel usage
- Large volumes during mild weather
  - Air temperature control



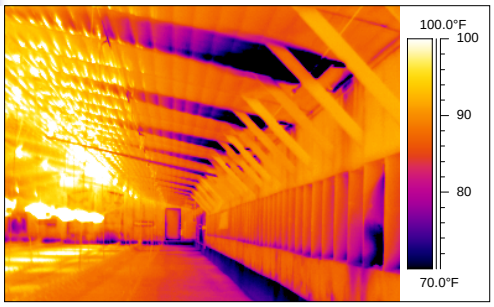
Air inlets

- Direct the air along the ceiling to heat up and "dry out" before moving to floor level



Air flow in house with side wall inlets

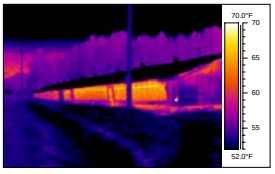
Ceiling inlet air flow

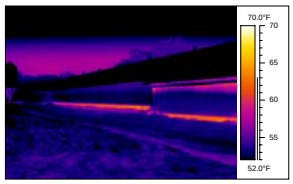


Modern houses are totally enclosed…to increase control

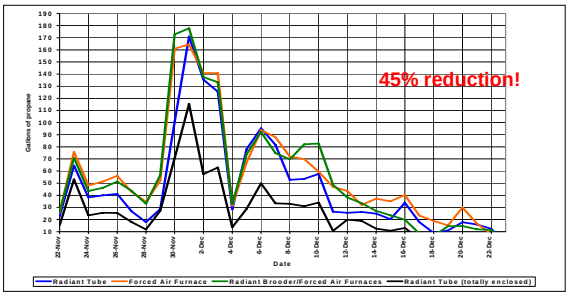
Curtain-sided vs. Solid sided

- Significantly lower heat loss

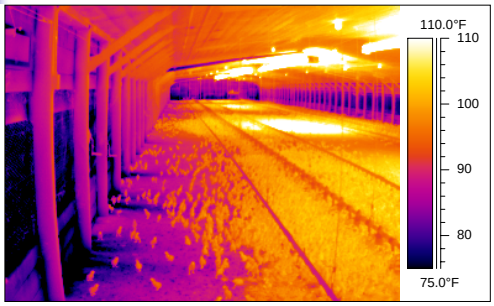




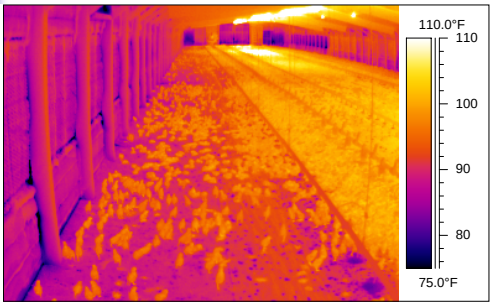
Daily fuel usage



Curtain-sided house



Totally enclosed house



Modern houses give us control over the light environment

- Intensity

Modern houses give us control over the light environment

- Intensity
- Duration

Operation using restricted lighting program field study

Lighting Programs	Age (days)	Weight (lbs)	Gain per day	Adjusted Feed Conv.	Percent Livability	Percent Condems	Cost (cents)
Restricted	48.7	4.73	0.097	1.86	99.2	1.42	25.93
Constant	48.7	4.64	0.095	1.88	97.8	1.93	26.19

Since the houses are power ventilated:

- Side wall inlet (spring-winter-fall)
- Tunnel in the summer
- The industry has discover they can now proper ventilate wider buildings

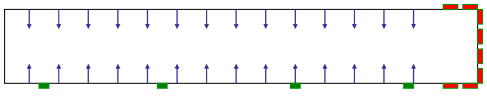
50’ x 500’ Broiler houses

60 and 67’ X 600’ Broiler houses

Electronic environmental controllers

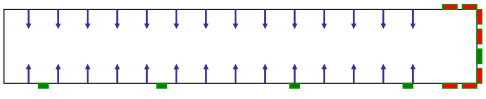
- Coordinate the operation of:
  - Fans
  - Heaters
  - Evaporative cooling
  - Tunnel curtains
  - Side wall inlets
  - Lights
- To precisely maintain the desired conditions.

Minimum ventilation



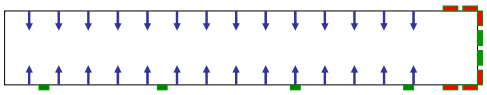
+1ºF

Moderate ventilation



+3ºF

Moderate ventilation



+4ºF

Low level tunnel ventilation

+7ºF

Med. level tunnel ventilation

+8ºF

High level tunnel ventilation

+9ºF

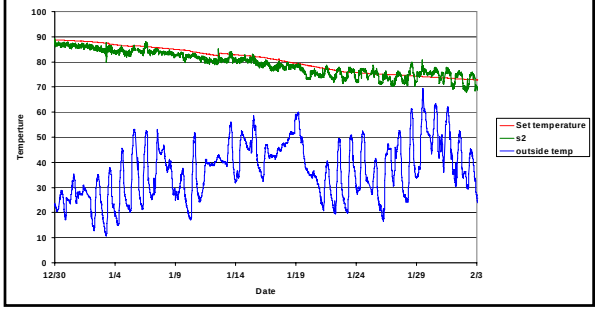
Evaporative cooling pads

+11ºF

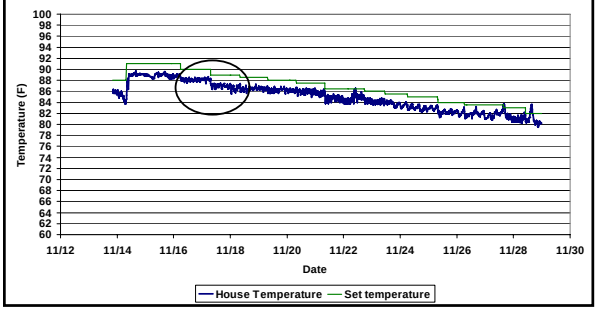
Modern broiler house

- Excellent level of control over a wide range of outside conditions

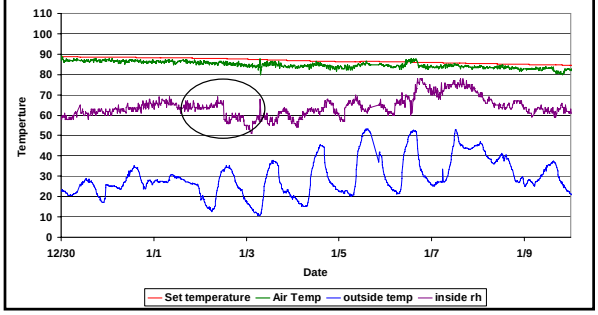
Cold weather temp control



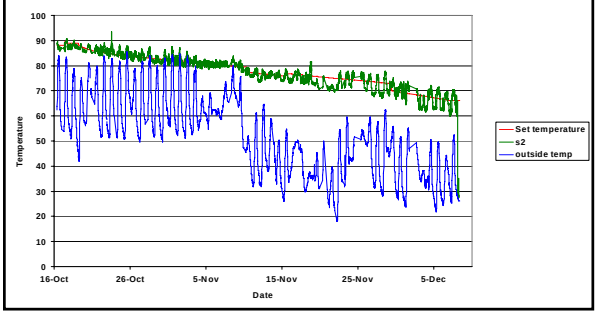
High level of temperature control



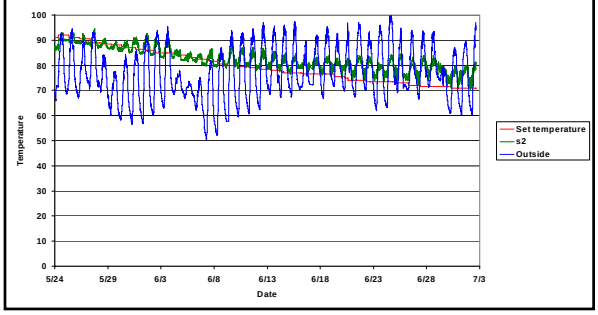
Air quality control



Spring – Fall temperature control



Summer temperature control



What has driven the change...

"1950's Bird"

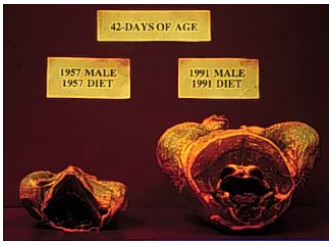
Birds have changed...

Modern broiler

- Do well in older style houses...
- But, in order to get the most out of the bird it is crucial to have the proper growing environment.
  - Air temperature
  - Air quality
  - Air movement
  - etc.
- The bird is "fine tuned" for performance not hardiness.

Potential performance problems

- Heat stress



Potential performance problems

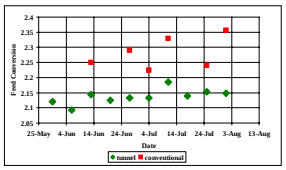
- Health stress issues:
  - heart problems
  - leg problems
  - respiratory problems

What has driven the change..

- Genetics
- Bird size

What has driven the change..

- Genetics
- Bird size
- Consistency



What has driven the change..

- Genetics
- Bird size
- Consistency
- Production cost
- The fact is it is hard to compete without a modern broiler house

Not just broiler producers are moving towards this new housing style

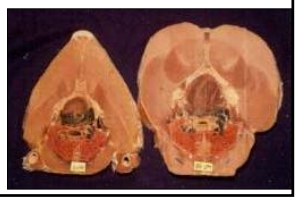
Broiler Breeder Pullets

Broiler Breeders

Commercial Layers

Turkeys

Broilers...Turkeys



and not just in the Southeast

Pennsylvania

Oregon

Washington

Basically everywhere in the U.S.

- Minnesota
- Ohio
- California
- South Dakota
- Etc.

Worldwide trend

- Mexico
- Jamaica
- Canada
- Australia
- Russia
- Spain
- South America
- Etc....

What's next?

- No major changing to housing on the horizon.

What's next?

- Information age…
- Farm data collection, reporting, data mining

Today…

- The process of growing birds is not truly being evaluated.
- We basically wait until the end of the flock to see how we did.
  - If a producer does well, we really don't know why
  - If a producer does poorly, we really don't know why

Today…

- Basically, a broiler complex has 300 to 500 undocumented studies going on at any one time.

Today...

- If we could monitor the process of growing chickens on a continuous basis we could learn a lot about growing chickens in a very short time.


The good news is that...

- That with modern poultry house environmental controllers data collection is fairly easy.



Modern environmental controllers

- Monitor:
  - House temperatures
  - House relative humidity
  - Static pressure
  - Water consumption
  - Heat status
  - Fan status
  - Alarm status
  - Mortality (grower input)

For a little additional expense

- Monitor:
  - Bird weights
  - Feed consumption

Farm performance

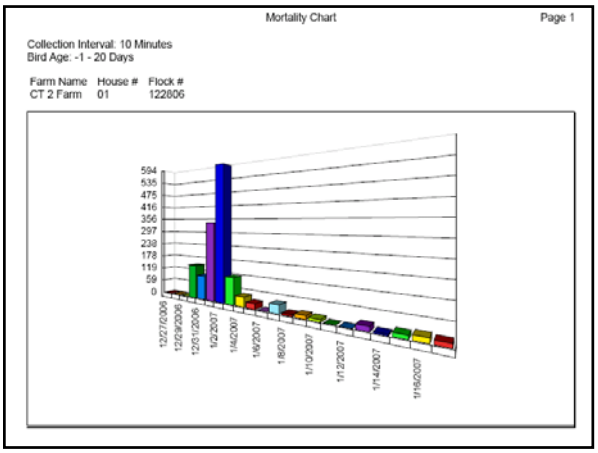
- The problem is this ability is not being fully utilized.

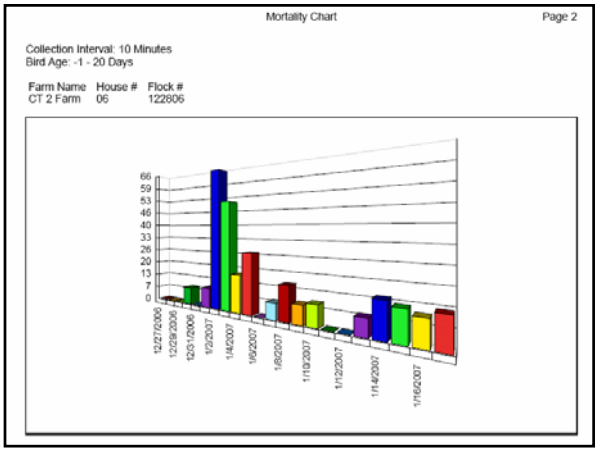

The real good news is

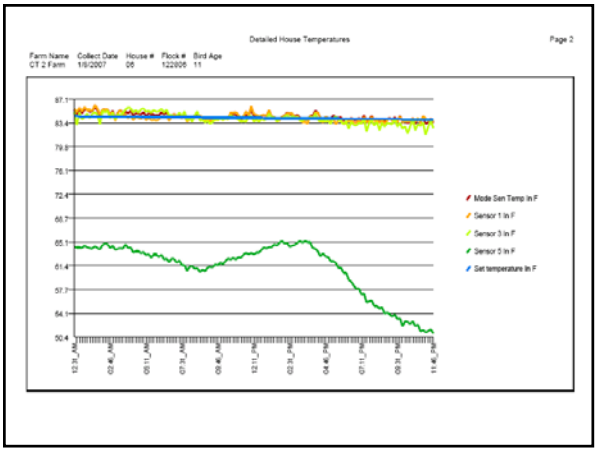
- There are commercial systems available today that can collect, analyze, report and database farm/bird performance.

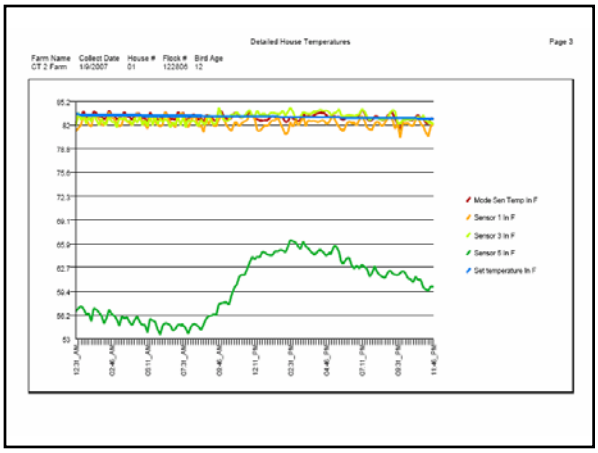
Farm reporting/data collection systems

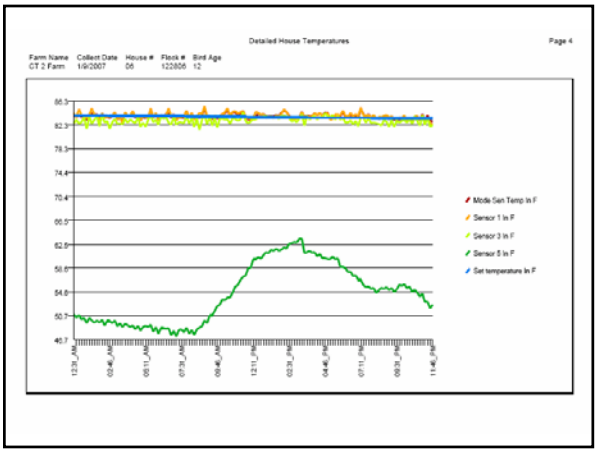
- System A
  - PC on the farm that collects the info.
  - PC e-mails reports daily
  - Call pc to get additional information
- System C
  - Controller sends info to a central server
  - Server e-mails reports daily
  - Call server to get additional information

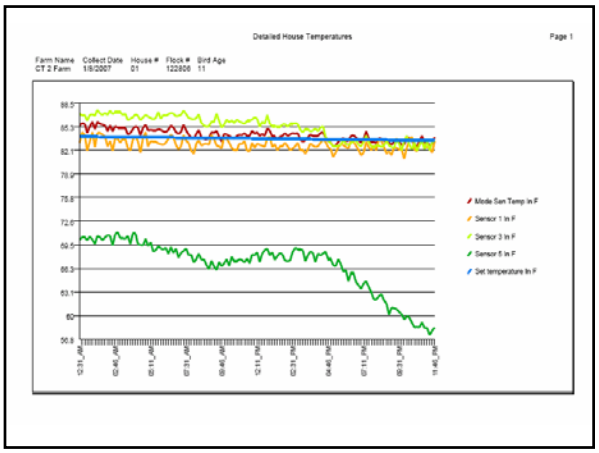


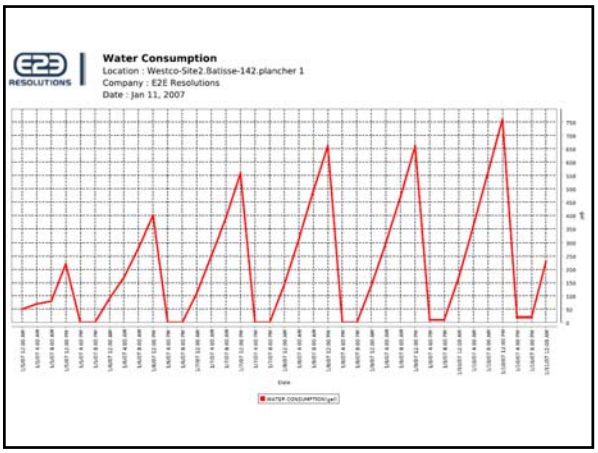


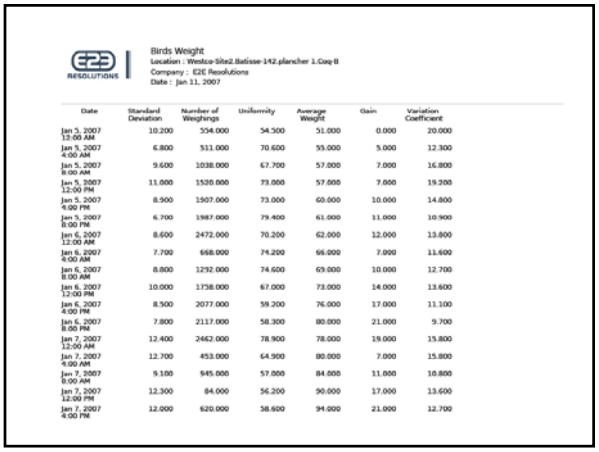




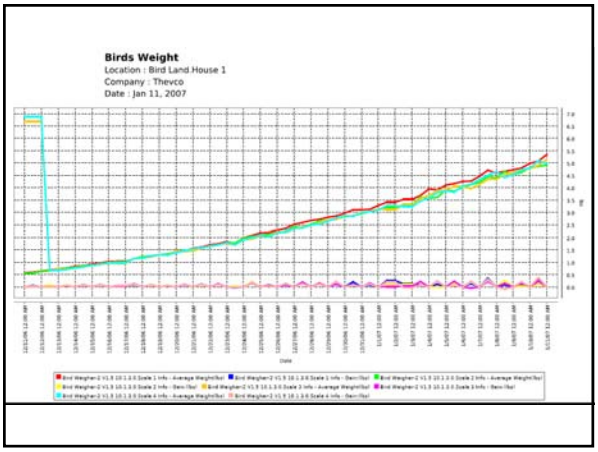


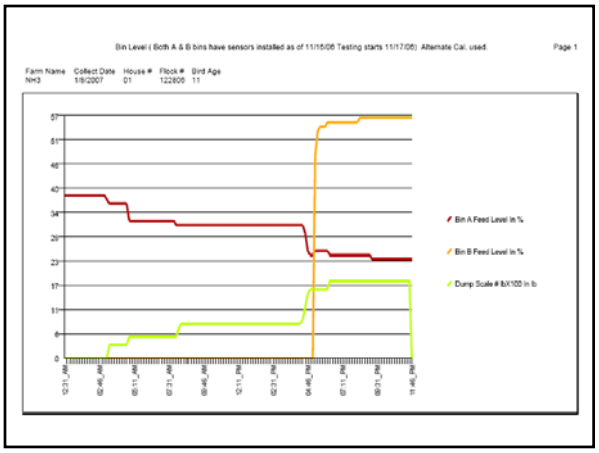


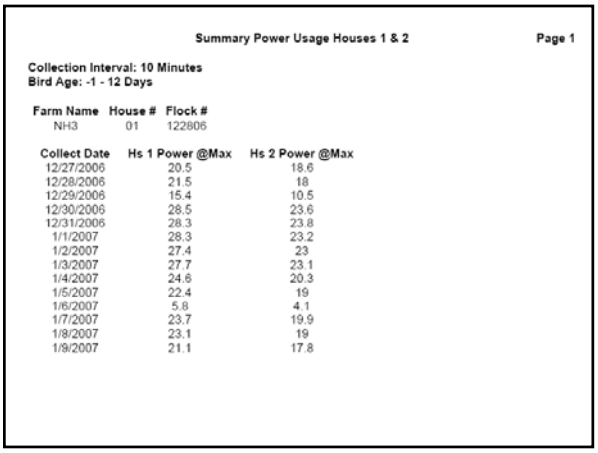




Date	Standard Deviation	Number of Weighings	Uniformity	Average Weight	Gain	Variation Coefficient
Jan 5, 2007 12:00 AM	10.200	554.000	54.500	51.000	0.000	20.000
Jan 5, 2007 4:00 AM	6.800	511.000	70.600	55.000	5.000	12.300
Jan 5, 2007 8:00 AM	9.600	1038.000	67.700	57.000	7.000	16.800
Jan 5, 2007 12:00 PM	11.000	1535.000	73.000	57.000	7.000	19.300
Jan 5, 2007 4:00 PM	8.900	1907.000	73.000	60.000	10.000	14.800
Jan 5, 2007 8:00 PM	6.700	1987.000	79.400	61.000	11.000	10.900
Jan 6, 2007 12:00 AM	8.600	2472.000	70.200	62.000	12.000	13.800
Jan 6, 2007 4:00 AM	7.700	668.000	74.200	66.000	7.000	11.600
Jan 6, 2007 8:00 AM	8.800	1292.000	74.600	69.000	10.000	12.700
Jan 6, 2007 12:00 PM	10.000	1758.000	67.000	73.000	14.000	13.600
Jan 6, 2007 4:00 PM	8.500	2077.000	59.200	76.000	17.000	11.100
Jan 6, 2007 8:00 PM	7.800	2117.000	58.300	80.000	21.000	9.700
Jan 7, 2007 12:00 AM	12.400	2462.000	78.900	78.000	19.000	15.800
Jan 7, 2007 4:00 AM	12.700	453.000	64.900	80.000	7.000	15.800
Jan 7, 2007 8:00 AM	9.100	945.000	57.000	84.000	11.000	10.800
Jan 7, 2007 12:00 PM	12.300	84.000	56.200	90.000	17.000	13.600
Jan 7, 2007 4:00 PM	12.000	620.000	58.600	94.000	21.000	12.700







Summary Power Usage Houses 1 & 2 Page 1

Collection Interval: 10 Minutes
Bird Age: -1 - 12 Days

Farm Name	House #	Flock #
NH3	01	122806

Collect Date	Hs 1 Power @Max	Hs 2 Power @Max
12/27/2006	20.5	18.6
12/28/2006	21.5	18
12/29/2006	15.4	10.5
12/30/2006	28.5	23.6
12/31/2006	28.3	23.8
1/1/2007	28.3	23.2
1/2/2007	27.4	23
1/3/2007	27.7	23.1
1/4/2007	24.6	20.3
1/5/2007	22.4	19
1/6/2007	5.8	4.1
1/7/2007	23.7	19.9
1/8/2007	23.1	19
1/9/2007	21.1	17.8

Remote monitoring

- Allows farm monitoring when servicemen are pulled from the field.
- Not only provides general reports but alarm reports as well

Not only do they report they store data

- Database farm information
  - Study how environment and management practices affect performance
    - Actually determine ideal house temperature, rh, wind speed.
    - Actually have targets on water consumption, weight gain, feed consumption, etc.
  - Data mining

Cost?

- System A
  - Minimal installation cost
  - Monthly charge
- System C
  - New farms, essentially no cost
  - Older farms between $200 and $1,000 per house

Additional costs

- Bird scales = $1,500 per house
- Dump scales = $1,500 per house
- Someone has to maintain the system

Modern house costs around $250,000

What is holding it back?

- High speed internet connection
  - $40 a month
- No universal communication standard
  - If a complex has just one type of environmental controller, no problem.
  - Different types, different ages.
- Mindset

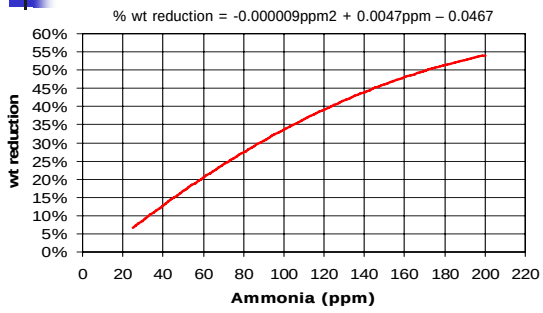
What's next?

- Ammonia control
  - Internal – bird welfare/performance
  - External - environmental

Effects of ammonia on broiler performance

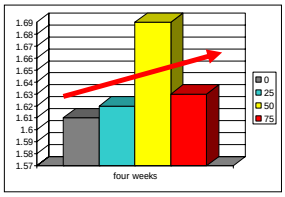
- Bird weights

Effect of ammonia on body weights at 28 days of age



Effects of ammonia on broiler performance

- Bird weights
- Feed conversion

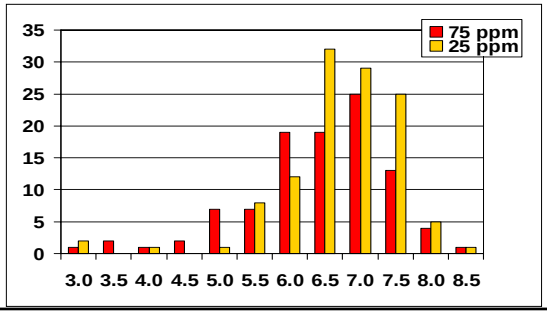


(Lott et.al, 2002)

Effects of ammonia on broiler performance

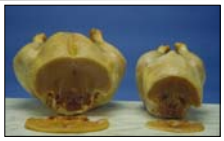
- Bird weights
- Feed conversions
- Bird uniformity

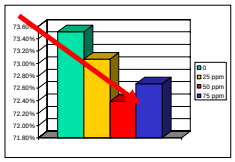
Affect of ammonia on weight distribution



Effects of ammonia on broiler performance

- Bird weights
- Feed conversions
- Bird uniformity
- Yield





(Lott et.al, 2002)

Effects of ammonia on broiler performance

- Bird weights
- Feed conversions
- Bird uniformity
- Yield
- Bird health
  - Cornea lesions

Effects of ammonia on broiler performance

- Bird weights
- Feed conversions
- Bird uniformity
- Yield
- Bird health
  - Cornea lesions
  - Disease susceptibility

Ideal target ammonia concentration

20 ppm or less

Easier said than done

Average generation rate

- 0.102 lbs NH_3/hr per 1,000 ft^2
- For a 40' X 250' brood area:
  - 0.007 ft^3/sec (0.19 liters/second)
  - If the fans were shut off this generation rate would result in the ammonia concentration increasing at a rate of 4 ppm/minute

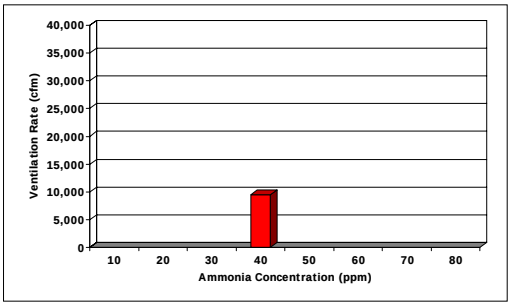
Ammonia generation rate
(0.19 liters/second)

- From generation rate we can calculate the required ventilation rate to maintain any concentration of ammonia
- V = (l/s X 200) / (ppm/10,000)

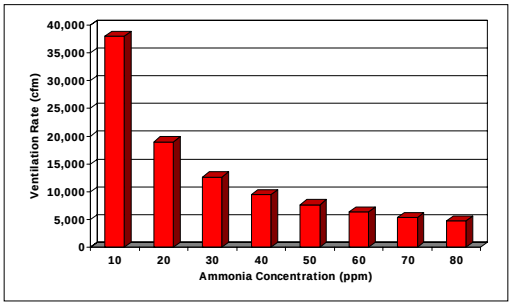
Ammonia generation rate
(0.19 liters/second)

- What if we wanted to maintain 40 ppm?
- V = (l/s X 200) / (ppm/10,000)
- V = 0.19 X 200 / (40 ppm/10,000)
- = 38 / 0.004
- = 9,500 cfm

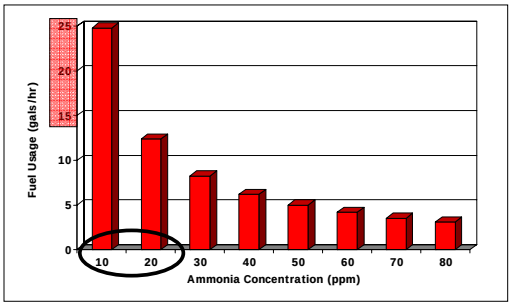
Ventilation rates for ammonia control



Ventilation rates for ammonia control



Fuel usage to control ammonia
(inside temperature = 90ºF, outside temperature = 32ºF)



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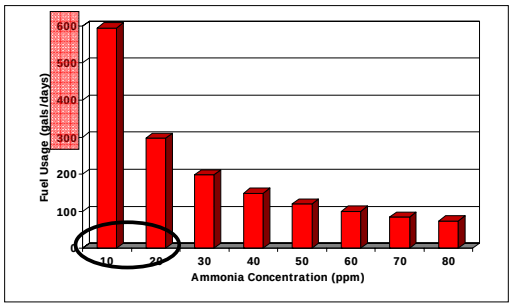
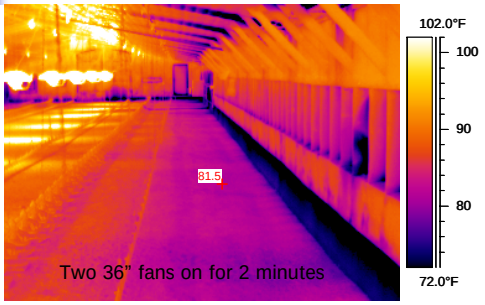


Floor temperatures with fans off



Environmental

- If we could ventilate enough to keep ammonia levels low it wouldn't solve the environmental issues.
  - Trees, etc. some help
  - Only proven method are ammonia scrubbers.
    - Expensive to install
    - Expensive to operate

Litter treatments?

Controlling ammonia on built-up litter

- In general it takes approximately 7 pounds of litter treatment to neutralize 1 pound of ammonia gas

Since we have some idea of ammonia generation rates on built up litter

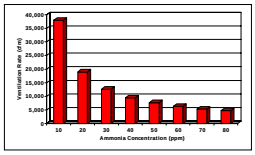
- Average ammonia production on deep built-up litter:
  - 0.10 lbs NH_3/hr per 1,000 ft^2
  - 2.4 lbs NH_3/day per 1,000 ft^2

We can calculate a rough idea of litter treatment requirements

- 170 lbs of litter treatment to neutralize all the ammonia generated per day in a 10,000 ft^2 brood area.
  - 50 lbs/1,000 ft^2 = 3 to 6 days
  - 100 lbs/1,000 ft^2 = 6 to 12 days

Litter treatments offer some help for in house ammonia levels

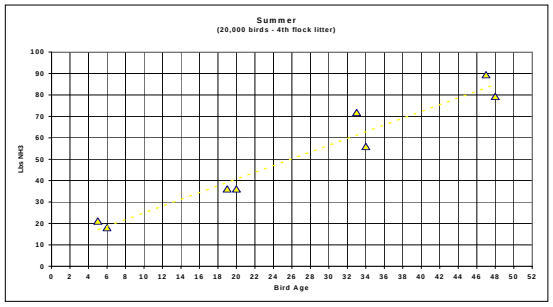
- Can keep it under control for maybe couple of weeks
- After this point with proper ventilation producers should be able to keep ammonia below 30 ppm, under 20 ppm is very difficult



Litter treatments and ammonia emissions

- But latest research is showing they do not significantly affect overall ammonia emissions.

Broiler House in Kentucky



Clean out after every flock

- Reduce ammonia emissions from the house between 30 and 50%

Manage litter between flocks

Ammonia control

- We need something that keeps the ammonia from being generated in the first place.
- Once it is there it is very difficult (expensive) to control.

Future of ammonia control

- We need something that keeps the ammonia from being generated in the first place
  - Something in the feed
  - Something in the water
  - Something in the litter

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