

In-House Composting of Litter



In house composting of litter between flocks is a litter management technique of growing interest in the poultry industry. This procedure is also called in-house pasteurization and windrowing. The basic principle is to stack used litter in such a manner that it promotes thermophilic bacteria growth resulting in a rapid increase in litter temperatures. At these higher temperatures the pathogen load in litter is reduced. The following presentation will describe the procedures and benefits of this program based on current information.

Disclaimer

The procedures for in-house composting and performance data in this presentation are continually being updated as new information becomes available.

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Presentation developed 1/09

The procedures for in-house composting and performance data in this presentation is continually being updated as new information becomes available. The following represents our lessons-learned on Delmarva as of January 2009.

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Hello, my name is Bud Malone, Extension Poultry Specialist with the University of Delaware. During the past 34 years with the University I have devoted much of my career in the area of alternative bedding materials, and litter plus waste management opportunities in the poultry industry. In recent years my applied research and extension programs has focused on composting, both litter and catastrophic mortalities events.

In-house composting of litter is not a new concept! In the late 1980's I heard a presentation by a Mid-West turkey operation that was deep stacking litter as pasteurization technique for the safe reuse of litter. So intrigued by this concept, I conducted a broiler study and found it several advantages over both used litter as well as fresh bedding. Unfortunately, the timing and issues were not right for our poultry industry to seriously consider this litter management technique.

Issues Driving Adoption of In-House Composting



However, today there are a number of issues driving adoption of in-house composting throughout the US.

*The poultry industry in many parts of the US face issues with the cost, quality or availability of bedding materials. With extended reuse of litter to conserve bedding materials to lower production cost, poultry grown on built up litter may be exposed to higher pathogen loads.

*At the same time our industry has been under increased regulatory oversight as it relates to adoption of nutrient and waste management plans. In-house composting is a technique that may complement farm plans by better sequencing litter removal at times of the year for more appropriate land application or alternative uses. It may aid in minimizing the need for on-farm or outside litter storage, and may reduce or eliminate the need for decaking houses.

*It is likely public pressure will continue to demand our industry minimize the use of many of our anti-microbial products to treat for disease.

*In-house composting may aid in reducing use of these products by breaking the disease challenge on farms, improving the bird's immunity and also reduce the darkling beetle population in built-up litter.

*The bottom-line, we see increased profits for many growers and companies that have adopted this litter management technique.

In-House Composting and Disease

- **Eliminates E. coli, staph, aspergilla, Salmonella and respiratory virus.**
- **Reduces aerobic and anaerobic bacterial populations.**
- **Eliminates/reduces cocci!**

Research at LSU, U of AR, Auburn U and the U of D have found in-house composting –
*essentially eliminates E. coli, staph, aspergilla, and Salmonella. It also inactivates most heat-sensitive respiratory viruses such as LT, but not immunosuppressive viruses like infectious bursal disease virus.

*This procedure also reduces both aerobic and anaerobic bacterial populations and one of particular interest is clostridium, which is responsible for dermatitis challenges on farms.

*Of particular significance, the U of D has recently found in-house composting reduces, if not eliminates coccidial challenges in broilers. This could have huge economic impact in our industry.

In-House Composting Methods

I would now like to review some of the methods for forming and managing in-house compost piles

Methods of In-House Composting: **Blade**



Since equipment is often available, some have used blades on their tractors to form the windrows. This method requires a certain amount of practice, skill and time to perfect.

*In most cases it requires removing or tilling the caked litter before building the windrow. The piles are often small and turning the piles can be a challenge using a blade. As will be discussed later, turning the windrow aids in pathogen kill and the release of ammonia and moisture.

Methods of In-House Composting: **Skid-steer**



Another method that has been used is forming a single windrow down the center of the house with a skid-steer or front-end loader. With this method one is able to get all the litter from the sidewalls and corners, as well any hardpan formation on the pad surface into the pile.

*These piles tend to be larger, non-uniform shape and take longer to reach desired temperatures.

*Unless there is specialized equipment to turn the windrow,

*this method will require decaking after leveling out the piles. There may also be a potential for higher ammonia levels in the subsequent flock.

Methods of In-House Composting: **Aerator**



Using aeration equipment that has been specially designed for constructing windrows is, in my opinion, the preferred method of in-house composting. Over the past year and half on the Delmarva Peninsula we have seen six contractors using the Brown Bear aerator to offer windrowing services for our grower. In addition, some individual growers with larger capacity have also purchased aeration equipment.

**The unit can be mounted on skid-steer loaders or the front or rear of farm tractors.

Windrows formed with the aerator tend to heat faster while reducing, if not eliminating, the caked litter.

*Aerators are designed to turn windrows, which promotes more uniform pile temperatures while releasing moisture and ammonia.

*On farms with a disease challenge it may require additional equipment to get the litter from along the sidewalls and corners into the windrow for heat treatment.

All Methods Require Proper Leveling !



**A critical part of the in-house composting procedure is to properly level the litter. This can be done with a blade, skid-steer or aerator.

*Those using a box blade have found a depth gauge helps keep a uniform depth throughout the house.

*It may require some method of smoothing the surface once the litter has been distributed evenly in the house.

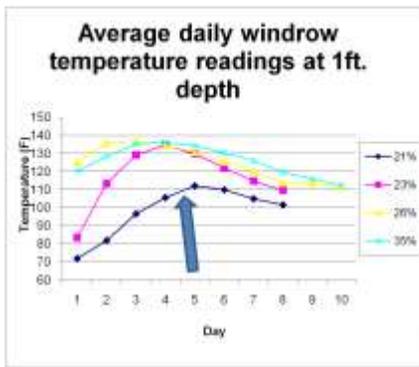
In-House Composting Guidelines

Lessons-Learned to Date!!!

During the past year and half on Delmarva we have gone thru a learning curve on how best to implement in-house composting. The following is a review of what we have learned to date using aeration equipment.

Please remember these guidelines are based on our local production practices, bird programs, housing, litter management and climate. These guidelines may need modification for other regions of the US.

Role of Litter Moisture on Compost Temperature



- Pathogen reduction via thermal, chemical and biological.
- Litter moisture key to heating.
- *Goal is minimum of 130 F for 3-5 days.*

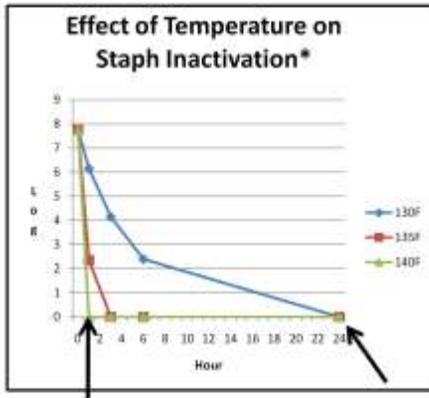
*Although the pathogen reduction mechanisms with composting may be partially due to chemical means such as gases like ammonia, or biological from competitive exclusion or anti-pathogen by-products from the composting process, it is thermal inactivation that is most important.

This graph from the LSU clearly shows the relationship between litter moisture and compost temperatures. Litter moisture typical in most houses is often adequate to achieve desired temperatures,

*only when we get dry litter does heating become a concern..

*It is generally recognized the goal is a minimum of 130F for 3-5 days for pathogen reduction.

Role of Compost Temperatures on Pathogen Reduction



*University of Delaware Research

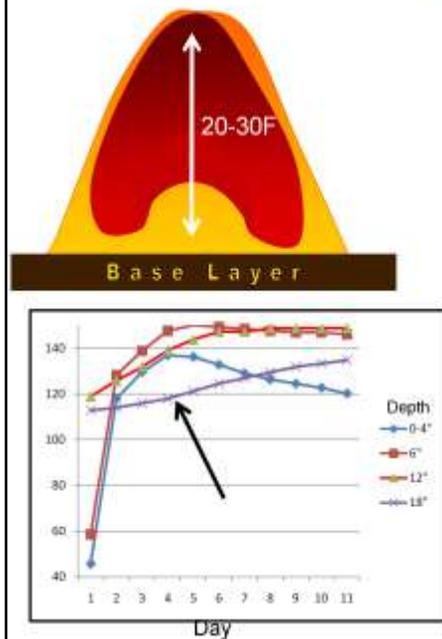
- Lower compost temperatures may take longer for pathogen kill.

*If the litter moisture is inadequate to achieve the desired temperatures, it may take a longer period of time to achieve pathogen kill. As shown in this time/temperature graph,

* at 140 F staph was inactivated within the first hour,

*but it took up to 24 hours to achieve inactivation at 130F

Windrow Compost Temperatures



- Piles heat from outside inward.
- House temperature has little influence on pile temperatures.

Turning pile aids in pathogen kill!

Contrary to popular believe compost piles heat from the outside inward! Other than the outer most surface layer, the coolest portion of the pile are in core and at the base. It is not uncommon for a 20 to 30F temperature differential between within a pile.

This temperature graph is an example of windrow temperatures at the various depths.

*Note, temperatures at the 18 inch depth were the coolest due to limited oxygen to support the growth of thermophilic bacteria.

*Another misconception is to close the house to keep the piles warm. Other the outer most surface layer, house temperature will have NO effect on the windrow temperatures.

*What is important is to turn the pile! Turning provides oxygen to the bacteria responsible for heat production. Temperatures after turning are often 5 degrees higher than before. Turning also exposes the cooler portion of the pile to higher temperatures for more effective pathogen kill, and aids in releasing moisture and ammonia.

***The Benefits of
Composting to Reduce
Pathogens/Improve
Performance are
Diminished if Ammonia
is Not Managed!!!***

The benefits of composting to reduce pathogens and improve performance are diminished if ammonia is not managed in this procedure. Therefore, adhering to guidelines to manage ammonia as well as compost moisture and temperatures are critical.



Managing Ammonia

- Ideal to start following total cleanout.
- With build-up litter, start during warm/moderate weather.
- Initially may require *more* litter treatment.

On Delmarva we have found it may be best to implement an in-house composting program following the first flock after a total cleanout. This tends to conserve the litter base since there is often excessive bedding removed during the first decaking on new bedding.

*However, it is often necessary to start an in-house composting program on built-up litter. When possible, implementing the procedure during warm or moderate weather helps manage the ammonia in the subsequent flock. Disturbing built-up for the first time creates excessive ammonia release that poses real challenges particularly if done during cold weather.

*When first initiating the in-house composting program, it may be necessary to use up to 25% more litter treatment for ammonia control. As more flocks are windrowed, the litter becomes “conditioned” and ammonia control tends to be more manageable.

Managing Ammonia and Moisture



Aerator not designed to remove hardpan!

- Remove hardpan?
 - 3 times more ammonia.
 - >10% higher moisture.
 - Beetle habitat.
 - Uncertain contribution to pathogen load.



In houses that reuse litter for several years there can be a very compacted litter layer or “hardpan” develop on the dirt floor or pads of houses.

Compared to the loose litter above, this material contains ~3 times more ammonia and preliminary tests suggest it elevates ammonia during brooding. In addition the hardpan contains more than 10% higher moisture than litter and provides habit for darkling beetles to migrate into lay their eggs. Its contribution to pathogen load is uncertain but some think one of the benefits of in-house composting is exposure of the dirt floor to air on a regular bases. For these reasons, it is my believe the hardpan should be removed when implementing this program. The aeration equipment will prevent this layer from developing once the windrowing program has been implemented.

- For those familiar with this hardpan, it can be several inches thick and require specialized equipment to rip or remove this material.
- An aerator is not designed to remove this very difficult layer.

Managing Ammonia and Moisture



- Remove excessive cake **before or after** windrowing.

Another aspect of managing ammonia and moisture is how to deal with the cake.

*As a rule-of-thumb, if the cake under nipple lines is greater than 3 ft wide and 3 inches thick, it should be removed before windrowing. This would be particularly important in cold weather. During other times of year and with less cake, it is often advantageous to incorporate the cake into the windrow to get the added moisture. This would be most important if the litter base is very dry.

Managing Ammonia and Moisture



- Must ventilate from day of windrowing to placement.
- Increase ventilation rate during turning and spreading.



High levels of moisture, ammonia and heat will be released during the composting procedure. In order to aid in moisture and ammonia removal from the litter, it is absolutely critical the house be ventilated from the day windrows are constructed to the day of chick placement. This could be several min vent fans operating on timer during cold weather to run a tunnel fan continuous during warmer times of the year. Leaving houses closed during composting can cause condensation resulting in electrical shortage and ammonia levels dangerous to human health.

As a reminder, the ambient temperature in the house will have little influence on the windrow temperatures.

*As the heat, moisture and ammonia are being released during turning or leveling piles, this is an ideal time to increase the ventilation for additional moisture and ammonia removal. It is also needed to create a better working environment for the equipment operator.

Turning Windrows

- Releases ammonia and moisture
- Mixes, aerates, exposes more pathogens to higher temperatures.
- Helps reduce cake

Turn piles at least once!



Turning the windrow is an essential part of the in-house composting procedure. Turning aids in releasing moisture and ammonia. It mixes, aerates and exposes more pathogens to higher temperatures. Often the temperatures following turning will increase 5F higher than previous levels. Turning also helps reduce cake particulates.

- All piles should be turned at least once and to incorporate any undistributed litter at the base of the windrow into the mix. Turning can be done once the temperatures begin to fall or around 3-4 days. If equipment availability and downtime is not an issue, some growers will turn piles 2 or 3 times during the layout.

* Due to high ammonia and dust levels, all operators are strongly encouraged to wear PPE when constructing, turning or leveling piles.

Managing Ammonia and Moisture



- Level piles after meeting temperatures guidelines.
- Till or re-crust for additional moisture and ammonia control.
- Pre-heat houses .

After meeting the temperature guidelines the piles can be leveled out, leaving 3-4 days for set up. There is some speculation that leaving windrows piled for a minimum of 7 days, and 10 days if possible, aids in additional moisture and ammonia removal.

*If moisture and ammonia are potential concerns especially during cold weather or there is excessive cake, after leveling the piles, some growers will till or re-crust the house prior to set up.

*It may also be necessary to preheat 48-72 hours prior to placement as an additional step to control ammonia during cold weather.

Managing Ammonia and Moisture



- Need a *minimum* of 10 days to implement.
- May need to skip a flock in coldest weather or short summer layout.

In most circumstances a minimum of 10 days downtime is needed to implement the in-house composting procedure.

*In some situations, such as extremely cold weather or during a very short layout in summer, you may want to skip windrowing a flock.

Managing Ammonia and Moisture



- Cut centers to reduces total N pool and potential summer heat stress.
- Partial annual removal may complement NMP and minimize litter storage capacity.

Since the aeration equipment is not designed to handle deep litter and efficiency of windrowing decreases at depths greater than 8 inches, it is critical litter depth be managed in houses. A depth of 4-6 inches appears to be ideal. Removing litter from the center of the house before windrowing is a common practice. By reducing the depth, you are reducing the total nitrogen pool that can influence ammonia levels and the potential for summer-time heat stress from deep, built up litter.

*Another benefit of partial annual or bi-annual litter removal is a more balanced flow of litter for nutrient management plans, less on-farm storage capacity for stockpiling litter, and potentially minimize the need for outside stockpiles.

Optimizing Temperatures for

Pathogen & Beetle Kill



- **Windrow within 2 days after movement.**
- **Remove hardpan and litter from sidewalls and corners?**
- **Need 2-3 ft high conical shaped piles.**
- **Incorporate cake or add water to dry litter to increase temperatures.**



Before the bacteria for heat production start to die off and litter moisture is lost to the environment, it is important to construct windrows within the first 2 days following bird movement to aid maximizing temperatures for pathogen and beetle kill.

*To break the cycle quicker, on farms with a severe disease challenge and those with high beetle populations, it is important to get all litter, including the corners, sidewalls and any hardpan into the windrow. The litter along sidewalls and corners could represent up to 20% of the house floor space that still has a high pathogen load and needs treating.

*Another aspect of optimizing temperatures is pile size. Research would suggest with aeration equipment, piles in the range of 2 to 3 feet high and conical shape tend to work best.

*For houses with dry litter, 20% or less, it may be important to incorporate cake, washdown prior to windrowing or find other suitable means of adding moisture to get adequate windrow temperatures.

*Finally, you have no means of determining your potential success if you don't monitor windrow temperatures. This can be done with inexpensive digital thermometers inserted into the top of the pile to a depth of 1 foot.

Optimizing Temperature for Pathogen and Beetle Kill

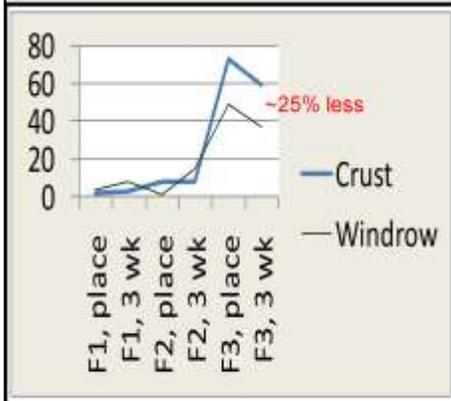


- **Best time to treat for beetles may be immediately (within 12 hrs) after pile formation.**

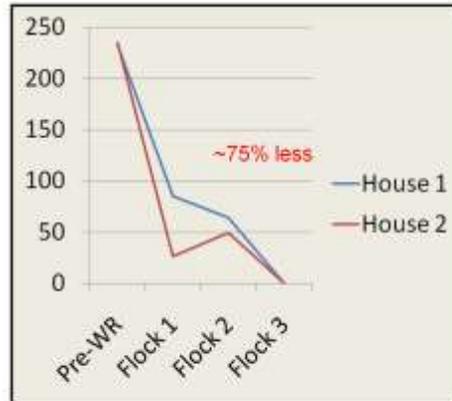
Within the first hour after forming a windrow the darkling beetles will start migrating to the surface of the pile. If practical, within 12 hrs this might be a strategic time to apply an insecticide to the pile and any remaining litter along the sidewalls or corner.

Optimizing Temperature for Pathogen and Beetle Kill

Relative # Adults – Farm A



Relative # Adults/Larvae – Farm B



A sample of litter from multiple locations under the feed pans have been collected on 2 farms to quantify the relative number of darkling beetles on windrowed farms. Farm A, on the left started with new litter, the windrows were not turned, and each flock treated with an insecticide. By flock 3 the number of adult beetles in the windrow house was 25% less than the crusted house.

On the right, farm B with 2 houses had 3 year old litter with high initial populations. The piles were turned once and litter only treated for beetles in flock 3. Adult and larvae populations decreased an average 75% after starting in-house composting. It is uncertain if composting temperatures kills the adults, larvae or eggs. Population reductions up to 90% have been reported when combined with an effective insecticide program.

Why Consider Composting:

- It is more costly and labor intensive!
- Has logistical challenges!
- Potential for higher ammonia!
- Learning curve on procedures!

Based on everything discussed why consider in-house composting?

*It is more costly, labor intensive and requires special equipment!

*There are a number of logistical challenges for proper implementation!

*There is potential for higher ammonia levels, and!

*There is a learning curve for grower on implementing proper procedures?

Why consider in-house composting, there are potential performance improvement benefits!!!

Performance Improvement Using In-House Composting on a Disease Problem Farm

Parameter	Change from Previous Flock	Change from Previous 4 Flocks
Total mortality (%)	-5.3	-3.1
Body Wt (lbs) (Age, d)	+.87 (-1)	+1.28 (+2)
Feed Conversion	-.24	---
Grower pay/lb (\$)	+.0099	+.0066

This data reflects one of our first Delmarva poultry farm having a significant disease challenge in which in-house composting was used break the disease cycle. Compared to the previous flock's settlement, following in-house composting, the total mortality was reduce 5.3%, body weights were .87 lbs heavier at a day earlier to market, feed conversion was 24 points better and grower pay was almost a cent/lb better.

Compared to the previous 4 flocks with conventional litter management, mortality has been improved by 3.1%, weights heavier even after adjusting for 2 days older birds, and grower pay improved by almost 7/10th cent per lb. For this grower his increased pay would far exceed the added cost of implementing in-house composting.

Performance Improvement with In-House Composting on a Farm with Dermatitis

Litter Management	Mortality (%)	Competitive Ranking (0-100%)	Change in pay (\$/1000)
Crust	6.2	9	-----
1 st Windrow	4.9	20	+\$23
2 nd Windrow	4.1	47	+\$89
3 rd Windrow	3.2	55	+\$103

- May require consecutive windrowing to break/reduce disease cycle.
- Disease may re-appear after 1 flock.

Benefits appear to be accumulative over time!!!

This 85,000 capacity farm growing a large broiler had a history of dermatitis with the previous flock prior to composting having 6.2% mortality and placing near the bottom in his settlement.

Following the first flock that had been windrowed, his mortality improved to 4.9%, his ranking to 20% and his flock pay \$23/1000 birds more. The onset of dermatitis was delayed by 2 weeks and incidence reduced by ~50%

The second windrowed flock showed a slight improvement in mortality with only a few birds with dermatitis late in the flock. He placed near average and his pay was \$89/1000 more.

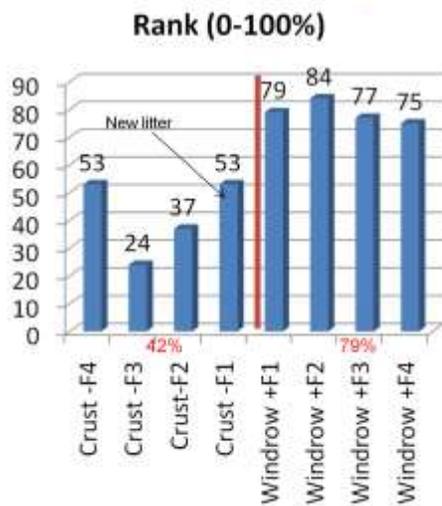
Flock 3 showed no signs of dermatitis, he placed slight above average and his pay was over \$100/1000 more.

*What is important to emphasize it may take several consecutive flocks of windrowing before breaking or reducing a disease challenge.

*If windrowing is stopped on these disease challenged farms we may not see it the next flock but by two flocks it may reappear.

*The take home message is the benefits of windrowing appear to be accumulative over time and one should not judge a response to this program on just the first flock.

Performance Improvement with In-House Composting on a Farm with Periodic Dermatitis and Respiratory Challenges



Windrow advantage over previous flocks:

- Body wt = +.26 lbs
- Feed conv = -.05 pts
- Grower pay = \$.0085/lb
- Grower payment = +\$80/1000 birds

On this 8 house, 150,000 capacity broiler farm growing large birds, there was a history of periodic dermatitis and respiratory challenges. The grower decided to purchase a BB aerator to improve his performance. In the 4 flocks prior to windrowing he was settling below average. In the first flock following a total cleanout he implemented an in-house composting program. For the next 4 flocks he has placed near the top 80 percentile in his complex.

*Compared to the 4 previous flocks, his past 4 windrowed flocks has averaged .26 lbs heavier

*5 point improvement in feed conversion

*His pay per lbs is 85 hundredths of cent better

*and his average pay is \$80 more per 1000 birds. On this size farm he has more than paid for the cost of the aerator equipment.

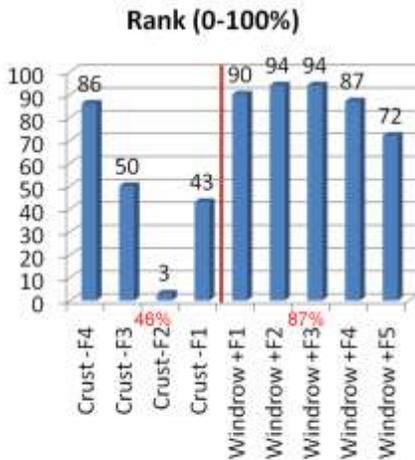
Performance Improvement with In-House on Farm with Necrotic Enteritis

Parameter	Change from Control House
Body weight (lbs)	+0.17
Feed conversion	-0.07
Mortality (%)	-2.44
Condemned (%)	-0.07
Cost per pound	-\$0.0099

(Adopted from Flory, et al. 2008)

On a farm having a history of necrotic enteritis, a paired house study compared in-house composting to their conventional litter management. Results from the first flock found an improvement of 17 points better weight, 7 point improvement in feed conversion, 2.44% less mortality, .07% fewer condemns and almost a cent per lb less cost in the house with birds grown on the composted litter.

Performance Improvement with In-House Composting of a Farm with RSS



Windrow advantage over previous flocks:

- Body wt = +.35 lbs
- Feed conv = -.10 pts
- Mortality = -5.7%
- Grower payment = +\$127/1000 birds

Here is another example of a Delmarva farm that had a different disease, RSS. On this 144,000 capacity farm his performance had dropped below average in the 4 flocks prior to windrowing his litter. Once he started his performance went to the top and has average in 87 percentile for the past 5 flocks.

*His birds are 35 pts heavier

*He has 10 pts better feed conversion

*His mortality has been reduced 5.7%

*And his pay per 1000 is \$127 more than his previous conventionally crusted flocks.

Why Consider In-House Composting?

- Consistently controls disease and improves profits on challenged farms for most operations **IF** you properly implement and control ammonia.
- Does it pay for “good” growers to compost???

Why consider in-house composting of litter between flocks?

*In most cases we see it consistently reduces disease challenge and improves profits on below average farms IF the grower properly implements the program and is able to manage his ammonia, litter moisture and compost temperatures.

*But the question remains, does in-house composting pay for good growers and those without a major disease challenge??? Although I have limited data to date, I will share the preliminary results from 2 above average farms that I have monitored.

Performance Improvement with In-House Composting on a Farm Without a Disease Challenge

Parameter	Flock 1*	Flock 2	Flock 3	Flock 4	Average
Layout (days)	30	19	22	33	26
Adj.Wt (lbs)	+0.29	+0.57	0	+0.59	+0.36
Adj Feed Conv.	--	-0.04	+0.04	-0.22	-0.07
Mortality (%)	+0.68	.00	-0.91	+0.12	-0.03
Prime Cost (\$/lb)	--	-0.0089	+0.0128	-0.0232	-0.0064

*Previous flock had new litter.

On this 155,000 capacity farm with large birds, following a total cleanout, we compared 3 houses that were windrowed to 3 crusted over 4 consecutive flocks.

The layout was between 19 to 33 days with an average of 26 days.

Since placements and movements were not the same for each treatment, I have adjusted the body weights to a common age. Based on this adjusted weights, birds grown on the composted litter were heavier in 3 of the 4 flocks and average ~1/3 lb more.

Feed conversion data from 3 of 4 flocks also suggest an average 7 pt improvement.

The overall mortality for the 4 flocks was similar

And prime cost was less in 2 of 3 flocks with an average of ~6 tenths of cent less for the composted flocks.

Performance Improvement with In-House Composting with Above Average Growers

Parameter	Farm A*	Farm B*
Market Age (day)	42	53
Wt (lbs)	+0.10	+0.14
Adj Feed Conv.	-0.044	-0.015
Mortality (%)	+1.76	-0.41
Prime Cost (\$/lb)	-0.0044	-0.0027
Grower pay (\$/k)	+20.95	+18.59

*3 year old litter on both farms.

In a current paired-house study, in-house composting is being compared to conventional litter management on 2 above average farms starting with 3 year-old litter. Results from the first flock suggest Farm A growing a 42-day broiler had 10 pts better weight and Farm B with a 53 day bird program had 14 pts more weight when grown on the composted litter.

Feed conversion adjusted to standard body weight was 4 and 2 pts better. Although Farm A had an E. coli related hatchery infection with higher mortality, birds reared on the composted litter not only recovered from the infection, the flock actually placed first in the complex for the week.

Prime cost for both composted houses were less and from a grower standpoint, pay per 1000 was \$20.95 and 18.59 higher than the control houses.

Cost Comparison of Crusting vs Windrowing

- Assuming two 42 x 500 ft houses:
Crusting = \$417 per farm
Windrow, turn, level = \$860 per farm
Difference = \$443 more (\$10.55/1000 ft²)
- **IF** advantage to a “good” grower is \$20/k more:
= ~\$500 to grower.
- For a below average or health challenged farm it might return 3-5 times more.

On Delmarva, using a contractor to crust out two 42 x 500 ft houses will cost ~\$417 per broiler farm. This same size farm using contractors to windrow the litter, turn it once and level out the litter will be \$860, a difference of \$443 more or \$10.55 /1000 ft².

*If the cost advantage to a good grower for composting is \$20/1000 birds, the procedure would return ~\$500 to the grower. For below average growers and in particular those facing a disease challenge, the return for composting could be 3 to 5 times more than the cost to implement this procedure. Not included in these crude calculations are potential savings in bedding replacement cost and any waste or nutrient management benefits.

Depending on the growing contract, the poultry company will also benefit from improved performance with this program.

Cost Share Incentives

- In-house composting encouraged by all Delmarva companies.
- Some companies offer incentive to offset the added cost.
- Delaware NRCS working on cost share assistance as a waste treatment standard (#629).

All companies on Delmarva have implemented some type of in-house composting program, either targeting problem farms or for all farms in their operation.

*Some companies provide monetary incentives to help growers with the added cost.

•In Delaware, our NRCS office is currently working on a cost share incentive using EQIP funds to implement this program under the waste treatment standard, #629.

Summary

- Implemented properly and done repeatedly, in-house composting yields performance and cost benefits, especially on disease challenged farms.
- Delmarva, like many other regions are rapidly adopting this litter management technique.

When implemented properly and done on a continuous bases, body wts, feed conversion, livability and production costs are improved with in-house composting of litter. This is especially true for farms that have various types of disease challenges. The reduced pathogen load in litter appears to be the prime factor for these improvements.

- Delmarva, like many areas of the US are rapidly adopting this litter management technique to address various issues and improve efficiency. Cost share incentives has and will continue to play a role in widespread adoption of this practice.

Special Thanks To Brown Bear Corporation

In closing, I would like to thank the Brown Bear Corp for their support and guidance over the past year and half as Delmarva implemented in-house composting using their aerator equipment. Both contractors and growers using this equipment have also provided extremely useful feedback as we developed the guidelines applicable for our industry.