The objective of this research is to evaluate the effectiveness of the materials when applied with stacked bedding management to improve conditions for bird growth and health. Stacked litter management has been observed to provide the greatest benefit from the bedding materials by frequently applying thin layers of fresh absorbent bedding over the surface of tightly caked litter surfaces. That allows for drying and absorbing the new excreta and for ammonia reduction and absorption. This also improves foot pad, leg, and breast health.

In this study we combine investigations of some trial bedding materials with the use of the stacked litter method to find ways of improving bird performance and health. In comparing these newer materials with a standard control of sawdust we learn more about ways to improve bird health.

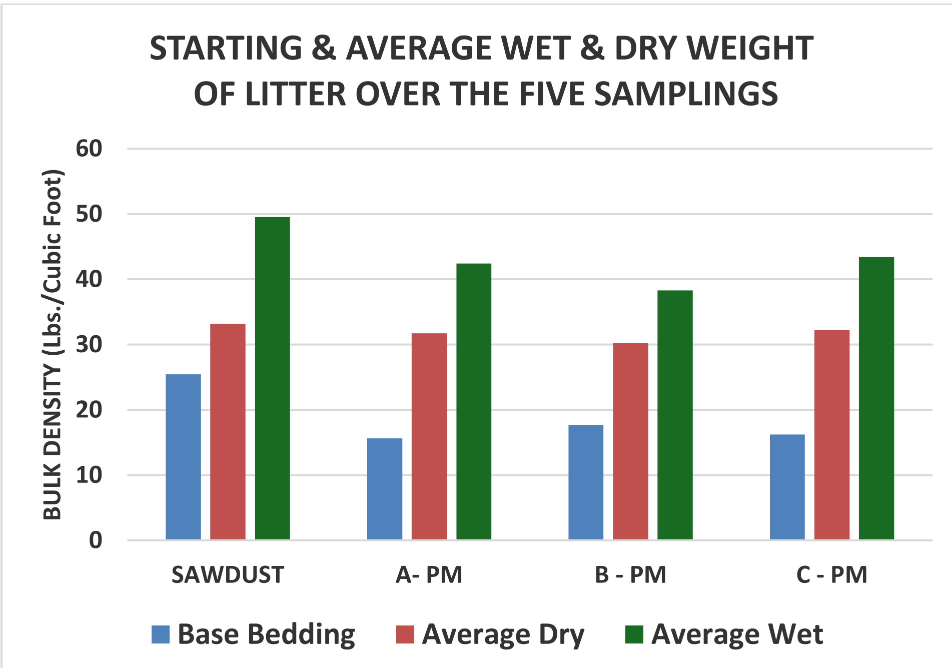
The project was conducted in a turkey production facility in central Pennsylvania. A brooder pen was divided into four equal quadrants with the four test bedding materials used in each quadrant. The fore materials included a control of sawdust and three more advanced bedding materials produced by PittMoss LLC from Ambridge Pennsylvania. Throughout the study the three materials are designated as A-PM, B-PM, and C-PM. All three materials are covered by a patent and are different renditions of absorbent materials manufactured from clean recycled industrial cardboard and paper waste. The cardboard and paper stock are fiberized and reformatted into particles engineered to optimize porosity and absorption for applications to poultry bedding.

## IMPORTANCE OF PHYSICAL PROPERTIES:

Poultry bedding materials are used to promote health and cleanliness. The physical properties of the bedding must produce high absorbance and remain as dry as possible while protecting the birds from the effects of their own excreta. The density needs to be sufficient to stay in place and provide a structure that is not damaging to the bird's feet and breast. Material must have the ability to absorb and hold moisture to maintain dryness providing for disease reduction. Good physical properties impact the chemistry of the litter and helped to reduce ammonium emissions and avoid low oxygen conditions that can lead to increased disease development. Particle density, size, and form influence the ability to absorb excreta and hold moisture while still drying from the surface.

## BULK DENSITY (WEIGHT/CUBIC FOOT)

The density of a material used for bedding must be light enough for easily handling, shipping, and application. It must be heavy enough when dry to stay in place with the movement of birds and air. The particle that make-up the mass cannot be too dense and must readily absorb fluids and help to dry the feces. The accompanying figure ‘Average Bulk Density by Bedding Type” presents the density (weight per cubic foot) of the four trialed materials.  It also presents the  wet sampled and oven dried densities as averaged over  the five samplings. The samples were taken after each set of brood poults were removed and extracted from three location in each of the trial sectors and down to the full depth of the litter (new and old).

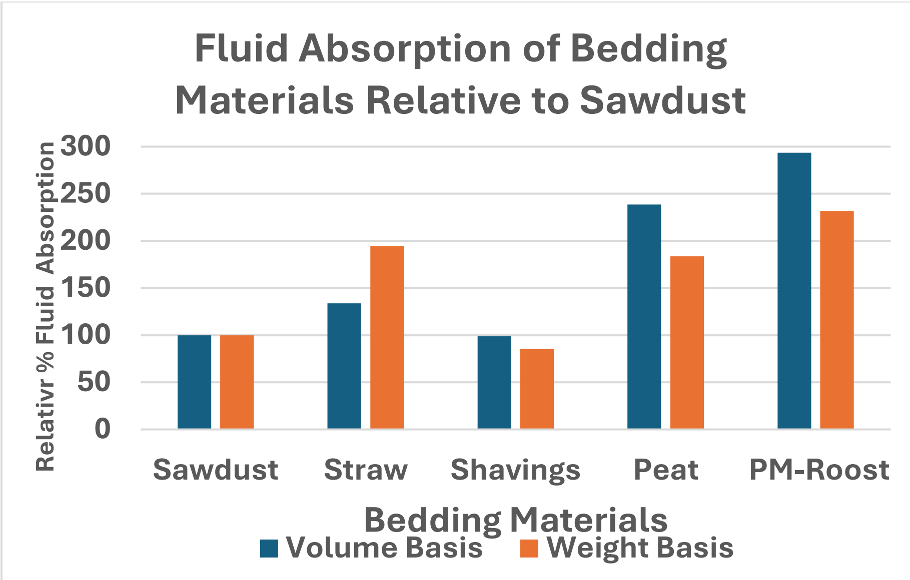


In the graphic we see that the sawdust Base Bedding material was considerably heavier than the three experimental blends.  After being successively spread in layers over the surface of the “floor” then trampled and absorbing deposits of excreta the dry density becomes much higher and more uniform between bedding types. This uniformity in dry weights after cropping indicates that the three research blends absorbed proportionately more excreta than the sawdust.  Additionally, the lower wet bulk density in the research materials indicates that the research materials are tending to dry more readily during cropping. From these observations it is clear that the research bedding materials work very favorably in the stacked bedding system

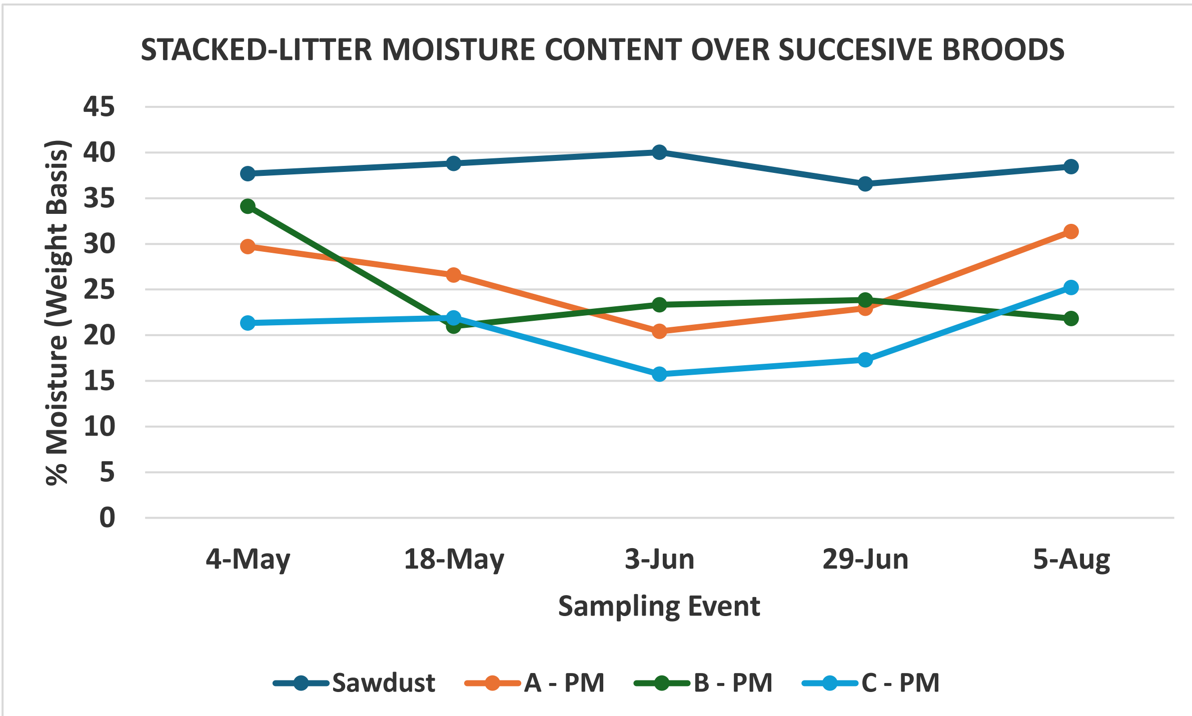
**Moisture Absorption and Drying**

The moisture absorbing and holding ability is the most significant part of this study. Absorption of fluids is critical to maintaining good bird health. Some bird houses do not have sufficient ventilation and the humidity and ammonium levels can become so high that damage occurs in the birds, reducing feed conversion and growth rates as well as creating long lasting health problems.

The ability of bedding materials to absorb fluids can be easily measured by comparing weights of dry and wet bedding.  This is accomplished by soaking the bedding material and comparing wet and dry weights. The graphic on “Fluid Absorption Ability” presents the relative percent by weight and by volume of five different common bedding materials. The figure shows that sawdust and shavings have the lowest moisture holding ability while straw is higher but approximately the same as peat and the PittMoss base product used for the experimental blends (PM-Roost) had the highest absorption based on both weight and volume.

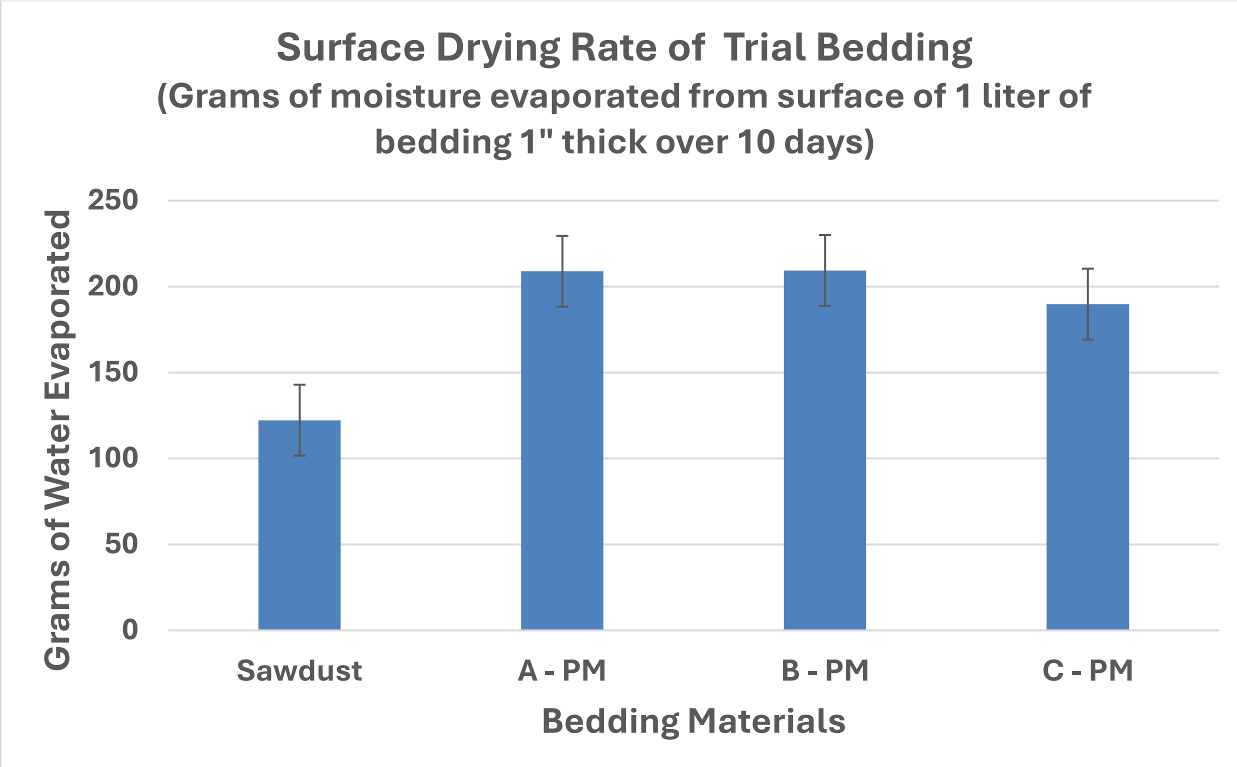



A graphic presentation of the comparisons of the bedding types in "Stacked Litter Moisture Content Over Successive Broods" from this research project is linked here. It shows the moisture levels on a weight basis beginning on May 4th at the end of the first brood through to August 5th at the end of the fifth brood. It charts the moisture levels for each of the research materials and as the stacked bedding accumulated. Across the board the sawdust moisture level was the highest from the beginning until the end. Keep in mind that the moisture levels are a reading from the fully stacked top to bottom sampling. They all maintain the same general pattern but the three PittMoss research blends did not rise to the high moisture level of the sawdust blend at any time. The moisture increased the most during the first and fifth broods. These three middle samplings on May 18th, June 3rd, in June 29th were lower. In this observation it is proposed that the lower mid-term moisture is due to the more effective surface drying during those warmer times and the PittMoss blends with the good hydraulic conductivity draw moisture from the lower levels of the stacked litter more effectively. In all we clearly see that for stack litter management the treatments including the three PittMoss blends yielded a much lower over-all moisture than the sawdust bedding.




**Relative Drying Rates**

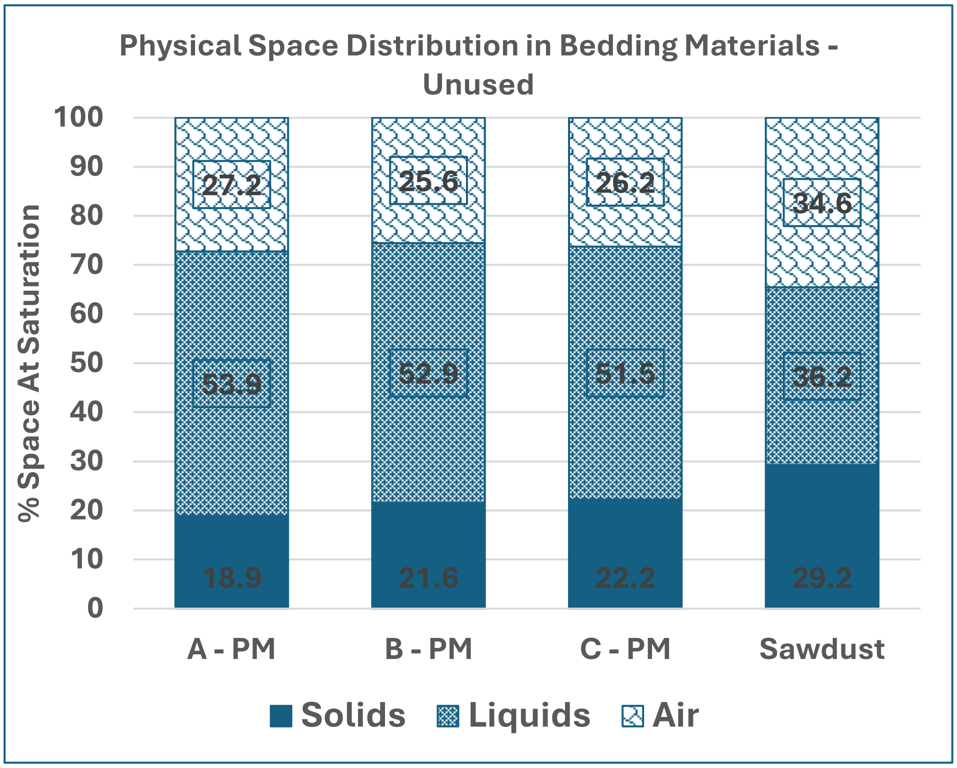
Significant differences were observed in the relative drying rate of the trial bedding materials. This was demonstrated in an experiment that compared evaporation of the water from the surface of each fully saturated bedding material. In the experiment we placed triplicate replications with one liter of fully saturated bedding layered one inch thick on plates that sat in ambient air for 10 days. The results are displayed in the graphic "Surface Drying Rates of Trial Bedding" In it we can see that the sawdust evaporation amount over the ten days was about 58% of the PM-A & PM-B formulations and 64% of the evaporation amount for the PM-C formulation. All three of the PittMoss formulations had a significantly higher water evaporation than the sawdust. The physical structure and the engineered particles in the PittMoss trial blends are believed to contribute to better drying.




**Physical Properties & Changes from Cropping**

The physical space distribution in the bedding materials influences the ability to absorb the bird excreta while maintaining good properties for holding urine and feces. As the birds age and grow the pressures on the bedding (litter) become greater. Typically, the bedding material is most effective when first applied but in two to three weeks the bedding can become caked-over with feces and has little effect on absorption of added moisture and feces. That then increases the possibilities of high surface moisture and toxic ammonia emissions. This then presents the main argument for the stacked litter management system. Regular and repeated applications of a thin layer (1 to 2 inches) provide for ready absorption of newly deposited excreta. The absorptivity of the bedding is a result of the physical properties of the bedding. Particle sizes and density influence the rate and quantity of absorption. Those particles create a physical environment for holding fluids while also allowing for sufficient air space thus allowing for oxygen to penetrate the litter.

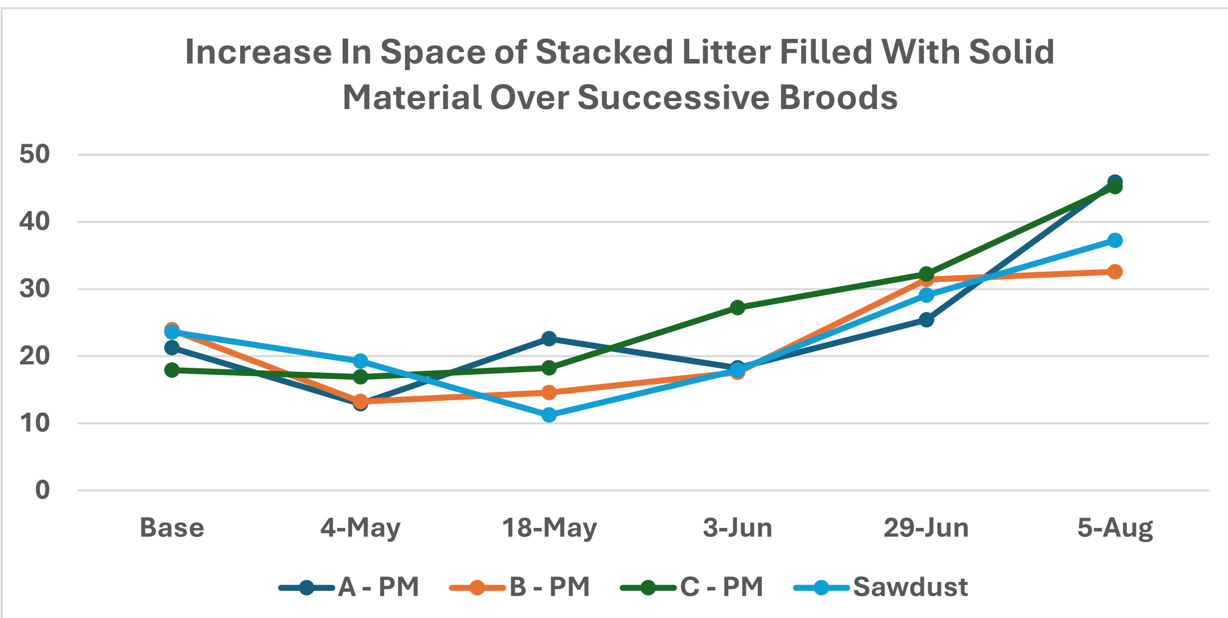
By defining the physical properties provided when the bedding is laid down, we can quantify the physical space distributions in the bedding materials. Testing the materials by saturating each with water, then draining each we can determine the air space at saturation. This is accomplished by measuring the quantity of the water drained. Then by measuring the weight change in drying we can obtain the capacity of the material to hold fluids (from fully dry to fully saturated). Finally, the remaining weight represents the solids that take up space. The linked graphic "Physical Space Distribution" presents the measurements of the percentages of space that is occupied by solids, liquids, and air when fully saturated. This provides a measure of the theoretical capacity for holding gasses and liquids.




In this graphic we see that in the fresh unused bedding materials the quantity of theoretical air space, which provides for gas exchange, is approximately identical for all three PittMoss research materials and the sawdust can provide greater air space. The space represented as solids is the percentage of space occupied in the bedding material that cannot absorb fluids or provide gas exchange. In comparing the solids present in each of the bedding types we see that sawdust has approximately 7% more of the space occupied by solids therefore it has 7% lower total absorptive capacity compared to the three PittMoss experimental versions. The percentage of space that can hold liquids, or be filled with excreta, ranges from approximately 15 to 17 percent higher in the PittMosstTrial blends than in the sawdust.

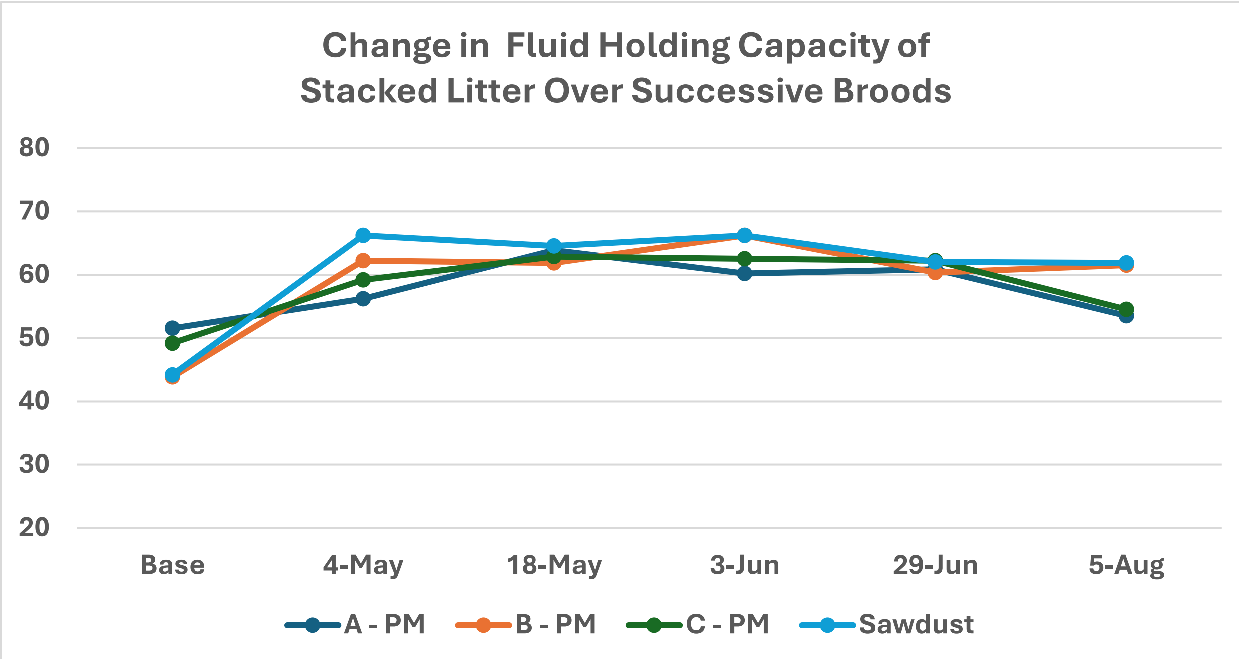
**Accumulated Solids**

As anticipated for the project the solids accumulated at approximately the same rate for all tested substrates in each sector of the communal trial room. The linked graphic "Increase In Space Occupied by Solids" charts the accumulation of solids. It shows that there is very little differences in the rate of accumulation for different bedding types. From this representation it is apparent that over the sequence of five different settings of brooding poults, the solids increase averaged approximately 20% in each material. That further indicates that the young poults spent approximately equal residence time over each of the experimental quadrants. This increase in solids is due to increased feces deposits and compaction from bird traffic. Together they impact the ability to absorb additional solids and fluids while reducing air space.



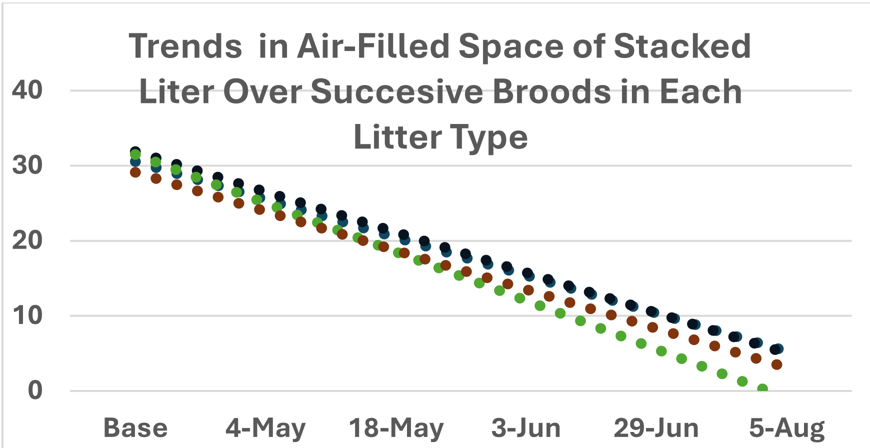

**Capacity To Hold Fluids**

The capacity to absorb moisture were measred over successive broods of poults. Those changes are depicted in the attached graphic showing the "Capacity to Hold Fluids". Note that the potential fluid absorbing capacity appears to have substantially increased after the first set of poults (for reasons not explained) and then tended to remain the same with the added bedding layers through to the end of the fifth set of poults. Keep in mind that this represents the capacity for holding fluids if totally saturated and not the content of fluids in the sampled litter.




**Trends In Air Space**

The accumulation of fluids and the increase in accumulation of solids reduced the airspace over the series of successive broods of poults. The linked graphic shows the "Trends in Airspace" for all four trial materials. The changes in solids within the composite of stacked litter appear to be approximately the same for all the materials The airspace was reduced in each at about the same rate consistent with the litter accumulation of more excreta. This reduction in air space also reduces the possibility of gas exchange, which is not necessarily a problem, to a point but can develop conditions that liimit oxygen penetration into the litter and intern can increased ammonia gases.


Trends in Air-Filled Space of Stacked Liter Over Succesive Broods in Each Litter Type
40
30
20
10
0
Base
4-May
18-May
3-Jun
29-Jun
5-Aug