The University of Georgia

College of Agricultural and Environmental Sciences
*Cooperative Extension*

# *Poultry Housing Tips*

## *Variable-speed Tunnel Fans...Broiler House Upgrade*

**Volume 31 Number 5** **2019**

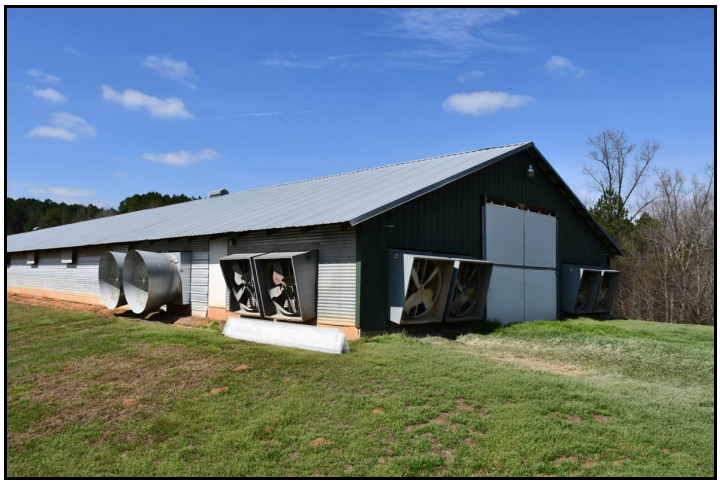

Figure 1. Tunnel-ventilated house equipped with eight 48" fans and four 54" cone fans.

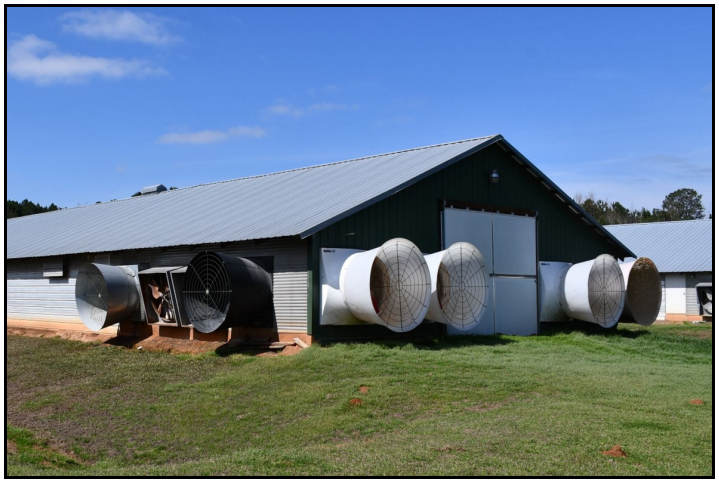

Figure 2. Retrofitted house where four of the 48" fans were replaced with four variable-speed 54" fans.

Variable speed tunnel fans have shown to be capable of significantly reducing power usage on poultry farms. On a broiler-breeder farm in Northeast Georgia, replacing eight older slant wall 48" fans with six new 55" variable-speed fans (SKOV DA 1700-5 LPC) was found to reduce annual tunnel fan operating cost more than 50% (*Poultry Housing Tips*. Vol. 30, No. 7). This of course doesn't necessarily mean that all poultry farms would experience this level of savings. The savings associated with the installation of variable-speed tunnel fans depend on the type and size of bird grown, the type of variable-speed fan installed, how the fans are managed, and climate, to name a just a few of the variables involved.

To gain more insight into this relatively new technology, a second study was initiated on a broiler farm in Northeast Georgia. The farm consisted of three, 40' X 500', tunnel-ventilated, totally-enclosed houses which were equipped with eight 15 year-old, slant-wall, 48" fans and four seven year old, 54" cone fans (Figure 1). When all tunnel fans were operating, the houses were capable of producing an average air speed of over 600 ft/min. The farm produced approximately 4.5 lb birds in 38 days at a density of 0.77 square feet per bird.

The primary objective of the study on this particular farm was to determine what level of savings could be realized if the obsolete 48" slant wall fans were replaced with new 54" Multifan belt-driven variable-speed fans (Model C4E4P3). At full speed (600 rpm) the 54" fans were capable of moving 34,800 cfm @ 0.10", roughly twice that of 48" slant wall fans (approximately 17,500 cfm @ 0.10"). This meant that the eight 48" fans could be replaced with just four of the variable-speed 54" fans (Figures 2, 3 and 4). The 54" Multifans 54" have a energy efficiency rating of 19.3 cfm/watt (BESS Labs test #16834), while the 48" fans had a field-measured energy efficiency rating of approximately 18 cfm/watt @0.10", a nearly 10%

increase in energy efficiency. Since the existing 54" fans were in good shape and had an energy efficiency rating of over 20 cfm/watt @ 0.10", to reduce the cost of the energy-conservation retrofit it was decided they would not be replaced with the 54" variable-speed fans. Essentially 60% of the total tunnel fan capacity in the retrofitted house was provided by the four new 54" variable-speed fans.

Four 54" variable speed fans were installed in one of the houses on the study farm in the fall of 2017. Power usage of each of the four variable-speed fans along with the eight corresponding 48" fans in an adjacent house were recorded on a 15 minute basis over the course of each flock. Since the focus of the study was to determine the cost savings of replacing older tunnel fans with modern variable-speed fans, the power usage of the four existing 54" fans in each house was not monitored.

The poultry house environmental controllers (Choretime C2) were programmed identically in both houses. In the house with the variable-speed fans, when the controller called for a 48" fan, the variable-speed controller on one of the 54" fans was programmed to operate the fan at 340 rpm, 57% of full speed, which resulted in the 54" fan moving the same amount of air as one of the slant wall 48" fans in the adjacent house (17,500 cfm). When the controller called for each of the next three 48" fans, a 54" fan was set to operate at 340 rpm. When a fifth 48" fan was needed, the speed of the four 54" fans would be increased to 415 rpm (69%), thereby moving the equivalent amount of air as five 48" fans. The speed of the four variable-speed fans would be increased incrementally (450 rpm/74%, 505 rpm/85%, 600 rpm/100%) to match the air-moving capacity of six, seven, and eight 48" fans in the adjacent house as the poultry house controller called for them. The four existing 54" fans in each of the houses were staged to turn on only after all eight of the 48" fans or the four variable-speed fans were operating at full speed. The four remaining 48" fans in the house with the 54" variable-speed fans were not used during the study. They served as backup in case of unforseen issues with the variable-speed 54" fans.

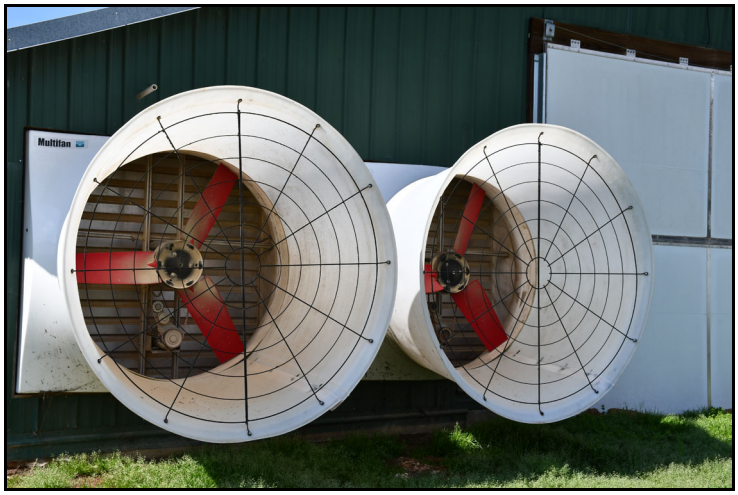

Figure 3. Variable-speed Multifan 54" Tunnel Fan.

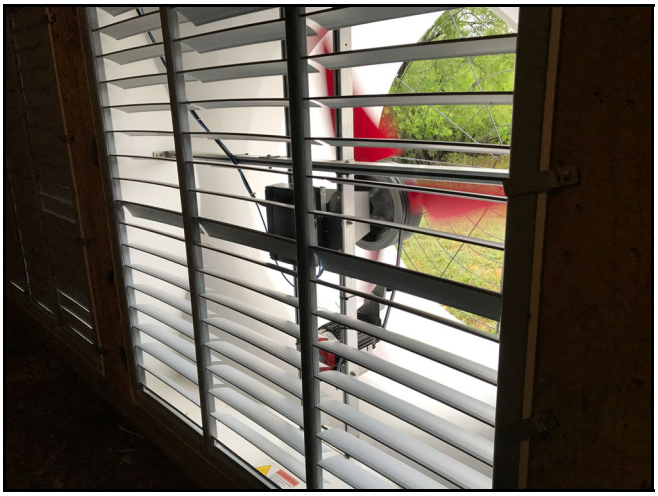
Figure 4. Interior view of fan and controller (plastic shutter was replaced with aluminum shutter after the first flock due to excessive leakage)

As discussed in previous *Poultry Housing Tips* (Vol. 29, No. 6, Vol. 30, No. 7) the advantage of using a variable-speed fan is that a fan is much more energy efficient when operating at less than full speed. Though the air moving capacity of fan reduces linearly with fan speed, power usage reduces exponentially. For instance, reducing fan speed by 20% will typically result in the air moving capacity of the fan being reduced by approximately 20%, but the amount of power used by the fan would be cut by roughly 50%. The greater the reduction in fan speed, the more dramatic reduction in fan power usage. In this case, reducing speed of the 54" fans by 57% to match the air moving capacity of 48" fans reduced their power usage from 1,954 watts to only 454 watts. Considering the fixed-speed 48" fans consumed 975 watts of power, this meant the variable-speed 54" fans when operating at 57% of full speed were moving the same amount of air as the 48" fans but using only half the amount of power, resulting in a energy efficiency rating of 38 cfm/watt! As the speed of the fans was incrementally increased to match the air moving capacity of five, six, seven, or eight 48" fans, the power savings were reduced incrementally (Table 1). By the time the fans were operating at 100%, matching the air moving capacity of the eight 48" fans, the reduction in power usage using the variable-speed fans was less than 5%.

In order for the Choretime C2 controller to "communicate" an inexpensive interface box was installed between the controller and the variable-speed fans. The speed of the fans at each ventilation "stage" could be adjusted by simply adjusting a nob corresponding to each ventilation stage. There were no significant issues related to the performance or reliability of the

Multifan variable-speed fans over the 18 month long study. The originally installed plastic shutters were replaced with aluminum shutters after one flock due to excessive leakage from the plastic shutters during cold weather.

The power usage of the eight 48" fans in the "control" house and the four variable-speed fans in the "treatment" house along with the reduction in power usage are shown in Table 2 on a flock by flock basis over the 18 month study. Table 2 illustrates the flock tunnel fan operating costs based on an electrical rate of $0.12 per Kw*hr.

| | Power Usage of 48" Fans (watts) | Power Usage of 54" Fans (watts) | Percent Reduction |
|---|---|---|---|
| **1 "48" fan"** | 960 | 450 | 53% |
| **2 "48" fans"** | 1,950 | 940 | 53% |
| **3 "48" fans"** | 2,890 | 1,370 | 53% |
| **4 "48" fans"** | 3,880 | 1,820 | 53% |
| **5 "48" fans"** | 4,875 | 2,830 | 42% |
| **6 "48" fans"** | 5,820 | 3,670 | 37% |
| **7 "48" fans"** | 6,950 | 4,990 | 28% |
| **8 "48" fans"** | 7,925 | 7,700 | 3% |

Table 1. Tunnel Fan Power Usage

During the first three flocks the variable-speed tunnel fans reduced power usage over the eight 48" fans by approximately 35%. The manufacturer of the variable-speed fans believed that they could improve the energy savings of the fans and modified the fan blades so that the fan capacity was increased. The speed of the fans was adjusted down so they would again match the air moving capacity of the 48" fans in the adjacent house, which resulted in average reduction of power usage by approximately 20%. The effect of the fan modifications can be seen when you compare the winter flock power savings of 2018 to that of the winter of 2018 where the percent reduction in power usage went from 35% to roughly 50%. The percent reductions in power usage were greater during the winter months because the variable-speed 54" fans rarely operated above their base speed of 57%. During the warmer months when the houses were calling for up to eight 48" fans to keep the birds cool, power savings were reduced as the variable-speed fans were operating a greater percentage of their time near or at their maximum speed when power savings were negligible. It is important to note that percent reduction in power savings for Flock 9 was relatively low compared to the other flocks. This is due to one of the fixed speed 54" fans was inadvertently programmed to turn on before variable-speed fans.

| Flock # | Dates | Fixed Speed 48" Fans | Variable-speed 54" Fans | % Reduction |
|---|---|---|---|---|
| **1** | Dec - Jan (2018) | 434 | 272 | 37% |
| **2** | Feb - Mar | 704 | 459 | 35% |
| **3** | Apr - May | 840 | 547 | 35% |
| **4** | Jun - July | 2,547 | 1,869 | 27% |
| **5** | Aug - Sep | 2,607 | 1,788 | 31% |
| **6** | Sep - Oct | 797 | 386 | 52% |
| **7** | Nov - Dec | 441 | 235 | 47% |
| **8** | Jan (2019) - Feb | 543 | 265 | 51% |
| **9** | Mar - Apr | 1,006 | 773 | 23% |

Table 2. Tunnel Fan Power Usage (Kw*hrs) and Percent Reduction in Power Usage

Table 3 illustrates the operating cost of the 48" fans in the control house and the variable-speed 54" fans in the treatment house assuming an average electrical rate of $0.12 per Kw*hr. Though the fan operating costs may look low at first glance, it is important to keep in mind that the cost of operating the fixed-speed 54" fans or the five 36" side wall fans in each house is not included. Furthermore, there are feed motors, auger motors, evaporative cooling pumps, heaters, lights, well pump, etc., that are not reflected in Table 3 and contribute to a monthly farm power bill. It is also important to keep in mind that the study farm produces a "small bird", so tunnel fan runtime hours tend to be significantly lower than on a "large bird" farm. Therefore, tunnel fan operating costs/savings would be lower than what would be seen on a "large bird" farm. Also contributing to the relatively lower tunnel fan power usage is the use of the five, side wall 36" fans. Previous studies have shown that 20% or more of a broiler farm's fan power usage can be contributed to use of side wall 36" fans. The more the variable-speed tunnel fans are used in place of the 36" side wall fans, the greater the savings would be for installing the variable-speed tunnel fans.

| Flock # | Dates | Fixed Speed 48" Fan Operating Cost | Variable-speed 54" Fan Operating Cost | Savings |
|---|---|---|---|---|
| **1** | Dec - Jan (2018) | $52.02 | $32.65 | $19.37 |
| **2** | Feb - Mar | $84.53 | $55.04 | $29.48 |
| **3** | Apr - May | $100.79 | $65.69 | $35.10 |
| **4** | Jun - July | $305.68 | $224.23 | $81.45 |
| **5** | Aug - Sep | $312.78 | $214.50 | $98.28 |
| **6** | Sep - Oct | $95.60 | $46.30 | $49.31 |
| **7** | Nov - Dec | $52.88 | $28.16 | $24.72 |
| **8** | Jan - Feb | $65.16 | $31.74 | $33.42 |
| **9** | Mar - Apr | $120.74 | $92.78 | $27.96 |

Table 3. Tunnel Fan Operating Costs and Savings @ $0.12 per Kw*hr.

The variable-speed motor and controller added $800 to $900 to the price of each of the 54" Multifan tunnel fans used in this study. With a yearly savings of approximately $400 per year seen in the study at current electrical rates, the payback would be nearly 10 years. That being said, if the fans were installed on a farm growing a larger bird, in an area of country with higher power rates and/or they were operated a little differently, it wouldn't be unreasonable to see where a payback of five years or less is possible. Even on this particular farm, as electrical rates inevitably increase and cost of the new variable-speed fan technology inevitable decreases, it is not hard to predict a time in the relatively near future where the owner may seriously consider installing variable-speed fans in the other houses on the farm. It is also important to keep in mind there are energy conservation programs available to farmers looking to make their farms more energy efficient. The Rural Funding for America Program - REAP (USDA) and Environmental Quality Incentive Program On-Farm Initiative (EQIP) are possible avenues where 25% to 75% of the cost of installing variable-speed tunnel fans could by covered, thereby dramatically reducing payback time. So though at this current time variable-speed tunnel fans may not be a good investment for everyone, it is not hard to see how in the future they will likely become as commonplace as LED lighting, which was once considered a very expensive way of reducing farm power usage.

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