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Field Report: Assessing the Sustainability of Slow-Grown Broilers

Abstract

A field study was conducted to evaluate the sustainability of slow-grown broiler birds by comparing that kind of operation to conventionally grown broiler. The poultry houses where the birds were grown were managed by the same poultry company and were operated under similar management practices. Greenhouse gas (GHG) emissions from both production practices were estimated using the Poultry Carbon Footprint Calculation tool (PCFCT). This tool was designed specifically to calculate emissions from broiler grow-out farms, pullet farms or broiler breeder farms. In this study, the activity data for one year of operation was collected from all the broiler farms within the broiler complex that we evaluated. The activity data included electricity usage in kw/H, propane use in gallons, and diesel oil use in gallons, and were obtained from farm records. This was used to calculate the emissions from mechanical sources (e.g., heaters and incinerators), non-mechanical sources (e.g., manure), and electricity used during the study period. There was a total of 571 conventional grown broiler (CGB) houses and 952 slow grown broiler (SGB) houses.

The increase in the number of SGB houses was because slow grown birds required a larger square footage per bird than the regular grown broilers. This led to an additional 381 houses to raise them. The SGB required an additional 17.2 days to grow the birds. Over 3 million more SGB were placed than conventional birds with 3.07 million more birds placed in SGB production. No medication was administered to the slow growing flocks. The livability for both flocks during the period that the farms were evaluated was 96%. Slow grown birds had higher total greenhouse gas emissions than conventionally grown birds with 25.7% more total emissions than the conventionally grown birds.

Abbreviations: CGB – conventional grown broiler; FACTA – Food Agriculture Conservation and Trade Act; GHG – green house gas; NASA – National Sustainable Agriculture Coalition; PCFCT – poultry carbon footprint calculation tool; SGB – slow grown broiler; USDA – United States Department of Agriculture

Introduction

According to United States Department of Agriculture, poultry meat consumption has trended up and has displaced a large amount of red meat consumption in the past few decades (USDA 2023). Sustainability is the new “buzz word” in conversations. In agriculture, the term is the center of debates when comes to food security and the fast-growing world population. Sustainable agriculture was addressed by congress in the 1990 Farm Bill (FACTA 1990). The National Sustainable Agriculture Coalition (NSAC) defined in short Sustainable Agriculture as “an integrated system of plant and animal production practices having a site-specific that will over the long term; satisfy human food and fiber needs, enhance environmental quality, make the most efficient use non-renewable resources, sustain economic viability of farm operations and enhance the quality of life for farmers and society (NSAC, 2023). In a statement by the Union of Concerned Scientists (1999), the importance of sustainability in perspective for agricultural production was addressed as they stated that “Sustainable agriculture does not mean a return to either the low yields or poor farmers that characterized the 19th century. Rather, sustainability builds on current agricultural achievements, adopting a sophisticated approach that can maintain high yields and farm profits without undermining the resources on which agriculture depends.

For over fifty years, countries around the world, including the United States, have been using sub-therapeutic antibiotic in poultry feed to fortify the broiler diet. Utilizing antibiotics and/or antibiotic growth promoters improves birds' health, growth and development and improves feed efficiency (Rossen 1995; Danzeisen et al., 2015). However, the application of anti-microbial results in the emergence and spread of anti-microbial resistance (Garcia-Migura et al., 2014). There is a growing concern for anti-microbial resistant Campylobacter impacting human's health especially for individuals who are immune-deficient and rely on antimicrobials for systemic infections (White et al., 2002; Lund and O'Brian 2011). Griggs et al. (2006) observed that 96% of raised without antibiotic (RWA) chicken carcasses, tested positive for campylobacter. Retail poultry meats and products are often associated with contamination of pathogenic microbes (Jacobs-Reitsma et al., 2008). There has been growing concern with little scientific evidence that the use of antibiotics in food producing animals is a contributing factor to antibiotic resistance in humans (Cox et al., 2007; Phillips et al., 2004). This is the major contributing factor to the rapid growth of antibiotic free (ABF) and organic foods since 1990. Van Loo et al. (2012), stated that the growing popularity of organic poultry leads to an increasing market share for these products. Several challenges arise with the production of these slow growing ABF or RWA birds. Production, management, health, and welfare challenges have been documented (Cervantes 2015). Castellini et al. (2008) stated that the organic-plus system, which uses slow-growing strains and higher pasture availability, improved animal welfare and meat quality but due to low production efficiency had a negative impact on the environment.

Most of the carbon dioxide equivalents (CO_2e) that are generated from the poultry industry are primarily from feed production, the utilization of fossil fuels, and manure management (Pelletier 2008; Dunkley and Dunkley 2013). While the poultry producer does not have control over the production of the feed that is used on the farm, there are other GHG emissions that occur on the farm that are under their control. The highest emissions from poultry on-farm activities are from fuel combustion from energy use and manure management. These emissions may be in the form of purchased electricity, propane used for heat and incineration of dead birds, diesel used in farm equipment which includes generators and emissions from manure management (Dunkley et al., 2015). The majority of direct CO_2 emission from animal agriculture is usually from fossil use; for example; the use of propane or natural gas in furnaces or incinerators and the use of diesel gas to operate farm equipment and generators results mostly in CO_2 emissions (Dunkley et al., 2015), this type of emission can be described as “mechanical emissions.” The use of electricity on animal production farms results in indirect emissions since the emissions do not occur on site. For non-mechanical emissions, direct emissions can be a by-product of digestion through enteric fermentation (CH_4 emissions). Direct emissions also occur from the decomposition and nitrification/denitrification of livestock waste (manure and urine) where CH_4 and N_2O are emitted. Managed waste that is collected and stored also emits CH_4 and N_2O. Indirect emission of N_2O occurs when nitrogen is lost from the system through volatilization as NH_3 and N. Also, indirect emissions can result from nitrogen that is runoff or leached from manure management systems in a form other than N_2O and is later converted to N_2O offsite (IPCC 2006). In this study we used two objectives to determine the sustainability of slow grown broilers: First we evaluated the environmental impact of slow-grown ABF broilers by comparing the greenhouse gas emissions to conventionally grown birds. And secondly, we compared additional inputs for the production of slow grown broilers to conventionally grown broilers.

Methods

A study was conducted to evaluate the sustainability of slow-growing broilers (SGB) by evaluating the production inputs and environmental impact from GHG emissions and comparing the inputs and emissions to those from conventionally grown broilers (CGB).

Flock information

The flock specification and production data (Table 1) was obtained from a commercial complex that grows conventionally grown broilers and slow-grown broilers for retail customers. Birds from both SGB and CGB flocks were grown in identical 20,000-square-foot houses operated at industry standards; fewer birds were placed in the SGB houses. The stocking density for the CGB was 0.93’ ft^{2}sq/bird, and for the SGB 1.24 ft^{2}sq/bird, giving the SGB birds more space in the house. The CGB flocks were grown in 571 houses while the SGB were placed in 952 houses. The extra 381 houses were to accommodate the increased number of birds that would be placed in each grow-out and the increased square footage required for each bird. This is necessary due to the increased mortality typically observed in birds which are slow grown because they are not medicated or treated whenever there is a disease outbreak. Approximately three million more birds were placed for the SGB. The CGB flocks were grown for 53.8 days, while the SGB were grown for 71 days, resulting in approximately 5.3 grow-outs of CGB birds grown per year and 4.5 of SGB grow-outs per year. The feed formulation was different in that no anti-coccidials or other medications were included in the feed of the SGB. The decision was made not to medicate the SGB birds in the case of disease outbreak. Both flocks had a 96% livability bearing in mind that 3 million SGB birds were placed. All other production practices for commercially grown broilers were the same for the two types of flocks.

Emissions

The GHG emissions were obtained using the Poultry Carbon Footprint Calculation Tool (PCFCT). The tool calculates emissions based on information obtained from activity data that was obtained from the farm. The farm information gathered included; number of houses on the farm, the size of house, construction of house, method of waste disposal, number of birds per flock, number of flocks per year, electricity and fuel usage. The activity data included; electricity usage in kw/H, propane use in gallons, and diesel fuel use in gallons were obtained from farm records World Research Institute (WRI, 2007). Emissions associated with manure management were evaluated using emission factors from the International Panel on Climate Change (IPCC, 2006). All emissions were calculated using the PCFCT. The tool was designed using emission factors and formulas from the IPCC (2006) and WRI (2007) GHG protocol to calculate emissions from broiler grow-out, pullet or breeder farms. The emissions are reported in metric tons carbon dioxide equivalents (CO_2e).

Results and Discussion

Mottet and Tempe (2017) stated while that the poultry sector needed to respond to the growing demand for meat and eggs to enhance food security and nutrition, they also needed to do it in a sustainable way, producing more with less. They also indicated that the sector should use natural resources efficiently and reduce environmental impact. The industry should also improve animal health and welfare (Mottet and Tempe, 2017). The results from the study showed that growing SGB flocks was not as cost efficient as growing CGB for several reasons. From the SGB grower's standpoint, they had 15% less flocks than the CGB grower growing four flocks while the CGB grew five flocks per year (Table 1).

Table 1: Production data of conventionally grown broilers and slow grown broilers. Numbers in the "change" column show the percentage increase or decrease in slow grown broilers from what is seen in conventionally grown broilers.

	CGB	**SGB**	**Change**
Days Grown	53.8	71	32%
Batches/Year	5.3	4.5	-15%
Bird Density (ft^2sq/bird)	0.93	1.24	33%
Total Square Feet Required (ft^2sq)	11,420,000	19,040,000	66.7%
Capacity Required (number of birds)	12,279,570	15,354,839	25%
Square feet per House(ft^2sq/house)	20,000	20,000	-
Houses Required	571	952	66.7%
Average Weight (lbs.)	7.5	7.5	-
Feed Conversion Ratio	1.89	2.3	21.7%
Water usage(gal)	4,241,250	7,233,329	70.5%
LPG use/yr (gal)	2,246,885	2,996,896	33.4%
Electricity use (kwatt)	21,892,140	36,499,680	66.7%

The SGB also had a smaller number of bird/flocks in each house compared to the CGB growers because the SGB were given more space per bird. The company compensated for the increased square footage per bird by adding approximately 381 more houses to raise 3 million more SGB birds. At the same time, they grew the birds for a longer period but the average weight of the birds was the same (7.5 lbs.) as the CGB. The feed conversion ratio for the SGB was higher, requiring 2.3 lbs. of feed to gain 1 lb. weight, compared to 1.89 lbs. for the CGB to gain 1 lb. body weight. This translated to a 21.7% increase in the amount of feed from what is required for SGB flocks. The SGB growers had additional costs for water usage as they had an additional 2.99 million gallons of water used for the 4.5 flocks each year (Table 1) using 41.36% more water than the CGB. The extra water used came from the extra 17.2 days the birds were grown in addition to the extra days water was used for the cool-pads. We observed that electricity use increased for the SGB to 36,499,680 KWH, this was a 66.7% increase from what was in the CGB houses. Slow grown broiler farms used an additional 750,011 gallons of LPG per year, a 33.4% increase when compared to CGB farms. Greenhouse gas emissions were reported from three areas (Figure 1).

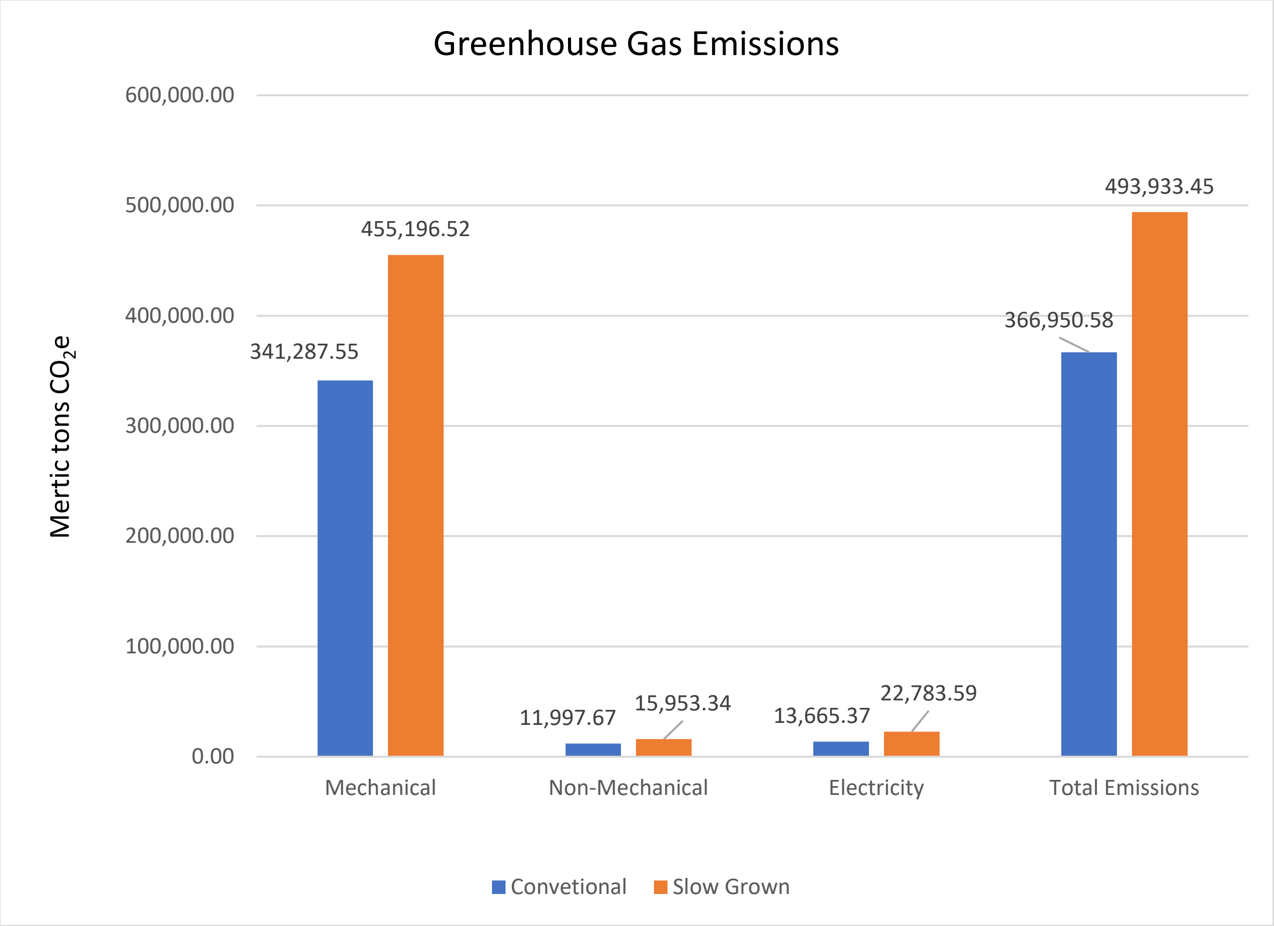

Figure 1: Diagram comparing the greenhouse gas emissions from conventionally grown broilers to slow grown broilers in one production year.

1. Mechanical sources include heating systems, incineration, diesel for tractors, generators, etc. Emission data was based on liquid and gas fuel use.
2. Non-mechanical sources include primarily emissions from manure management (Dunkley et al., 2015). These emissions were estimated based on the type of operation, number of houses, size of birds, and the duration of time the birds remained on the farms.
3. Electrical sources include ventilation, lighting, and various other equipment that require electricity to operate. Emissions were based on the use of electrical energy on the farm even though the electricity was generated off the farm.

The emissions from the mechanical sources for both flocks represented the largest amount of emissions. The SGB had a greater total amount of GHG emissions (455,196.52 metric tons CO_2e) compared to the emissions from the CGB farms (341,287.55 metric tons CO_2e), a difference of 34.6%. Most emissions from both production types were from mechanical sources (Figure 1).

Due to the longer period of grow-out, the SGB houses generated 33.38% more GHG than the CGB houses. Also, because the SGB spent more time in the houses compared to the CGB, they produced more manure, resulting in non-mechanical emissions increasing from 11,997.67 metric tons CO2e to 15,953.34 metric tons CO2e, a 33% increase, compared to the CGB. emissions). Electricity use increased in the SGB houses over the growing period and this resulted in a 66.7% increase in GHG emissions from this source. Both the CGB and SGB houses had the majority (93 and 92.2% respectively) of GHG emissions coming from mechanical sources used in the houses and on the farm (Figure 2).

This was expected since the majority of GHG emissions observed on poultry farms are from fossil fuel use (Dunkley et al., 2015). The SGB houses produced a higher (4.6%) percentage of the total amount of GHG emissions than the CGB (3.2%), and a higher percentage of emissions from manure management (non-mechanical sources). This was a direct result of the SGB remaining in the growing houses for a longer period, generating more manure over the extended period.

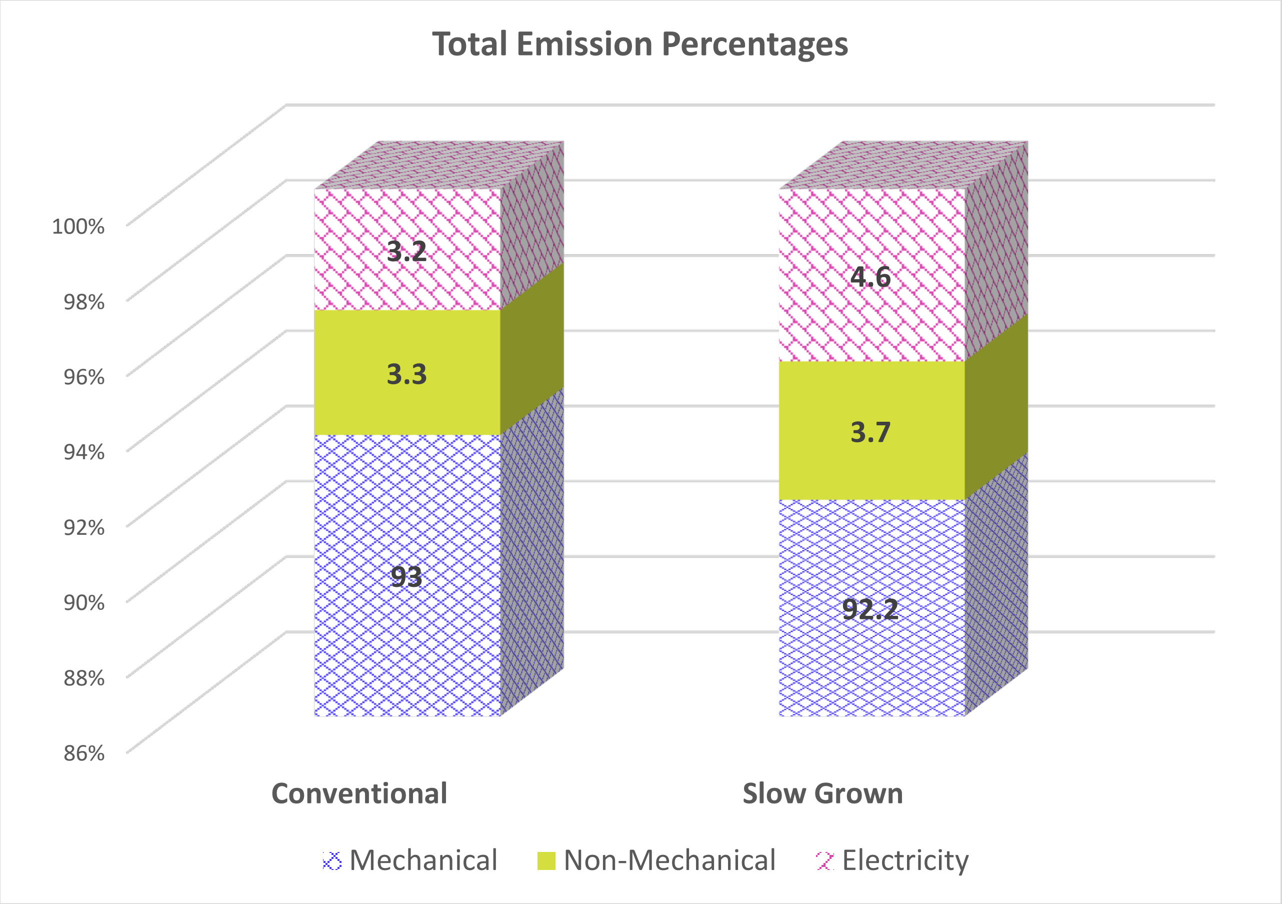

Figure 2. Percentage distribution of greenhouse gas emissions from conventionally grown broilers and slow grown broilers in one production year.

There were limitations to this study since it was field research with one poultry complex so there was no statistical analysis. The study was a “Farm-Gate” study, the data was collected from each of the production farms within the complex, and the emission calculations were the results of what occurred on the farms. Therefore, the emissions from the production of the feed were not considered since the chicken producers did not grow or process the crops, and as such would not be able to initiate mitigation or abatement strategies to reduce emissions from these sources.

Conclusion

As was stated by the Union of Concerned Scientists (1999), “Sustainable agriculture does not mean a return to either the low yields or poor farmers that characterized the 19th century. Rather, sustainability builds on current agricultural achievements, adopting a sophisticated approach that can maintain high yields and farm profits without undermining the resources on which agriculture depends.” Based on this characterization of sustainable agriculture, slow grown broiler as a sustainable production practice falls short because:

1. Slow grown broilers require more input of natural resources to produce a similar output compared to conventionally grown birds.
2. More environmental waste is generated and GHG emissions are increased during the production of slow grown broilers.
3. The feed conversion ratio was higher for the slow grown broilers.

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