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Cooperative Extension Service

Energy Costs Associated with Commercial Broiler Production

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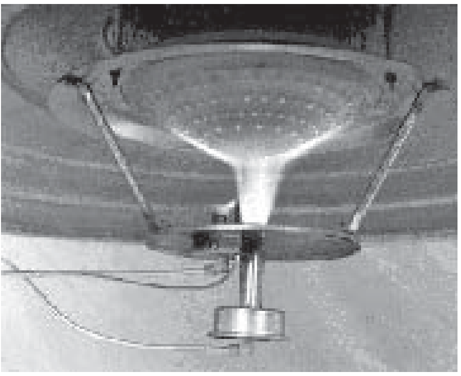
INSIDE



Introduction

Commercial broiler growers face a number of challenges associated with producing profitable broiler flocks. While unable to control all factors associated with broiler production, growers can control the key areas of temperature and ventilation, but maintaining adequate temperature and ventilation requires significant monetary expense. Data recently compiled at the Applied Broiler Research Unit may be of value in assessing your farms' energy demand and (based on your costs for fuel and electricity) monetary expense to meet this demand.

Housing and Management Practices

The information presented represents data from 38 consecutive flocks of straight run broiler chickens grown at the Applied Broiler Research Unit during the period October 1996 through June 2003. All flocks were grown for the same integrator under a standard broiler production contract. The houses were all 40 x 400 ft. Two houses (1 and 3) featured conventional cross-ventilation with low-pressure foggers, while the other two houses were curtain-sided and tunnel ventilated. One tunnel ventilated house (4) had evaporative cooling pads and the other (2) had an experimental sprinkler system. Detailed descriptions of the houses, environmental control systems, sprinkler system, and housing modifications was given by Berry et al. (1991), Xin et al. (1993) and Tabler and Berry (2001). Management practices were the same in all houses and the farm manger was the same individual throughout the study period. Half of the 38 flocks were grown for 49 days or less while the other half were grown for more than 49 days. The youngest flock was 39 days at harvest while the oldest was harvested at 57 days.

Propane Usage

Figure 1 presents propane usage by house during the seven-year period. As evident by the graphs and as many growers will remember, the winter of 2000 was the most costly in terms of fuel usage followed by the winter of 2001. The lower fuel consumption in House 3 during the winters of 1998 and 1999 was due to use of an experimental wood-burning pellet furnace. House 4 was the most challenging house to control from a management standpoint since it had more ammonia than any other house. This increased ammonia required increased ventilation to maintain the proper environment resulting in increased gas consumption during cooler periods of the year. Although House 4 consumed the most fuel during the seven-year period, it should be noted that when the 1998 and 1999 data were ignored, tunnel ventilated houses consumed only 2% more fuel than did conventional houses. Also, if the ammonia problem in house 4 could be solved, tunnel ventilated houses would likely consume less fuel than conventional houses.

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. . . helping ensure the efficient production of top quality poultry products in Arkansas and beyond.

Excellence

ENERGY COSTS— continued from page 1

Figure 1. Propane usage on the Applied Broiler Research Unit by house

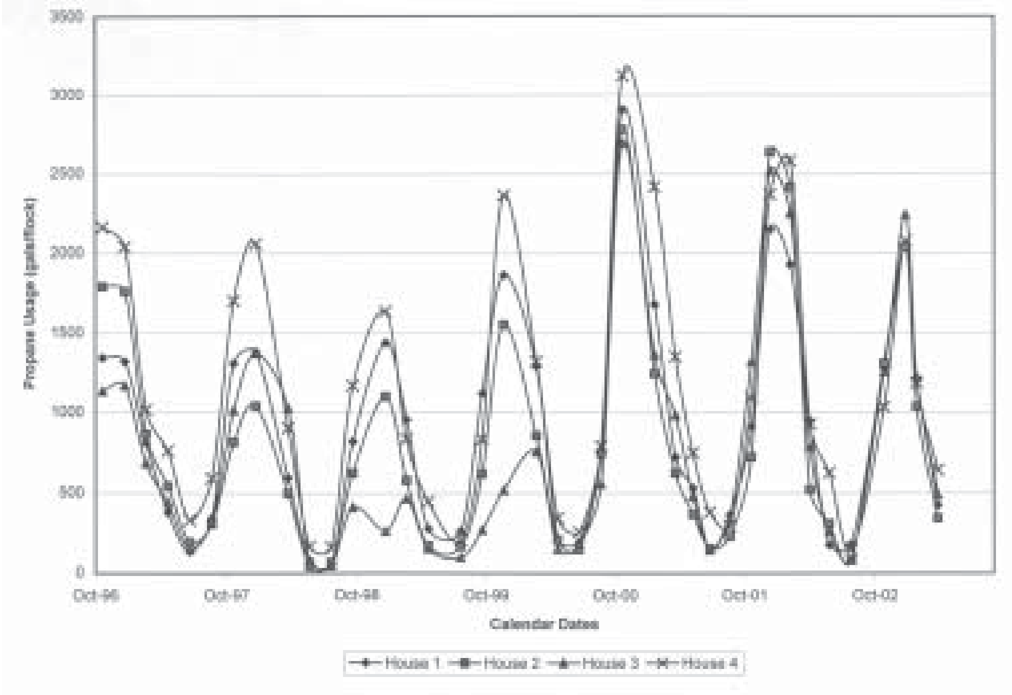


Table 1 lists the maximum, minimum and average fuel consumption per flock for each of the four houses. House 4 used the most fuel even during the summer flock when fuel usage was minimal. This was mainly associated with additional nighttime ventilation needed for ammonia control. Based on the figures in Table 1, propane consumption for the farm over the seven-year period averaged 3,657 gallons per flock. If we assume 5.5 flocks per year then the four-house farm would have used 20,114 gallons of propane per year or 5,029 gallons per house per year. If propane costs $1.00 per gallon, it would cost over $20,000 for a year's worth of propane. In view of these costs, growers may be tempted to reduce temperatures slightly. However, flock performance, and therefore, grower payment can be seriously affected if growers attempt to raise birds at temperatures cooler in the winter. The data in Table 2 illustrate how decreased temperatures can increase flock mortality.

Table 1. Propane Usage Extremes and Averages

Item	Start Date	House Numbers 1	2	3	4	Farm Total	House Avg
		Propane Usage (Gals)				Gals/Flock	
Min.	8/98	52	68	47	163	330	83
Max.	11/00	2906	2780	2694	3121	11501	2875
Avg.		910	830	782	1135	3657	914

Table 2. The Effect of Brooding Temperature on Mortality and Ascites[1]

Brooding Temperatures (°F)			Mortality	Ascites Mort.
Week 1	Week 2	Week 3	(%)	(%)
95	90	85	2.29	0.83
90	85	80	3.12	0.83
85	80	75	1.67	0.62
80	75	70	4.79	2.50

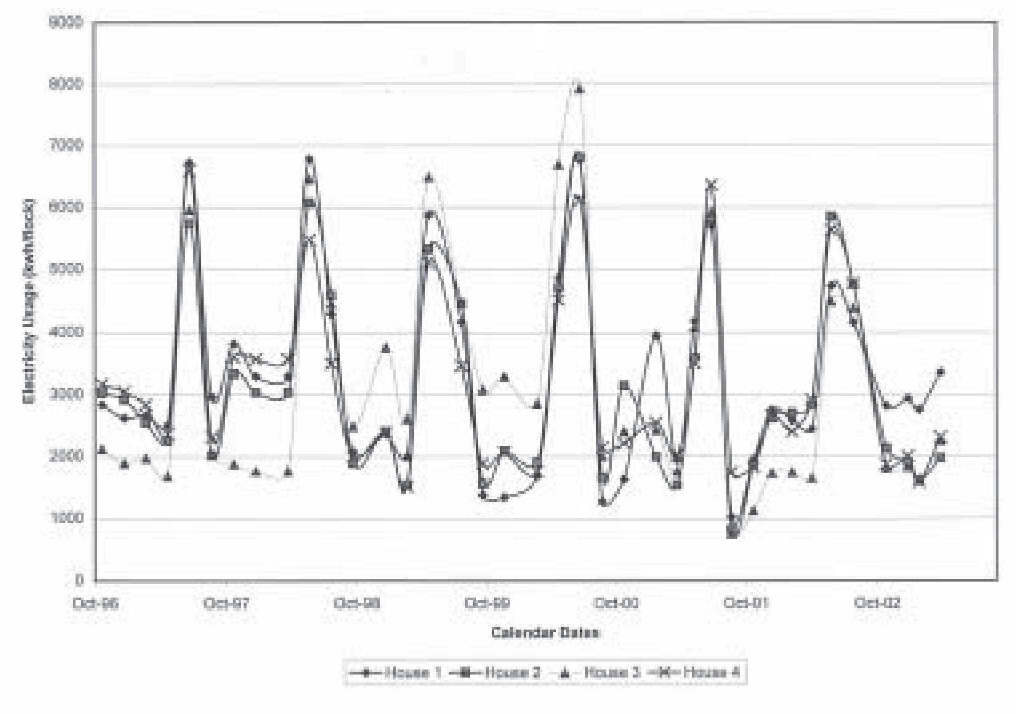
[1]From Deaton et al., 1996.

Electricity Usage

Figure 2 presents electricity usage by house. As every grower knows, electricity usage was greatest in the summer months and lowest in the winter months. The summer of 2000 was the most costly in terms of electricity usage followed by the summer of 2001. However, unlike propane usage, each house accounted for an equal amount of electricity usage (25%) during the 7-year period. The increased electrical demand in House 3 during the winters of 1998 and 1999 are again associated with use of the wood-burning pellet furnace in that house.

Table 3 lists maximum, minimum and average kilowatt hour (kWh) consumption per flock for each of the four houses. Even though House 1 showed the highest kWh usage as compared to the other houses, there was less than 185 kWh difference between houses and the houses were the same when compared on a percentage-of-use basis. Electricity usage for the farm over the 7-yr period averaged 12,617 kWh per flock (Table 2). Based on 5.5 flocks per year the farm would have used 69,394 kWh per year or 17,348 kWh per house per year. If electricity costs $0.06 cents per kWh, electricity costs would come to $4,164 for the farm or $1041 per house.

Figure 2. Electricity usage on the Applied Broiler Research Unit by house



Total Energy Costs

Energy costs (fuel and electricity) consume approximately 25% of the annual gross farm income at the Applied Broiler Energy Unit. Propane and electricity usage for the farm are presented together in Figure 3 and, as expected, indicates that the two consumption curves are essentially inverse functions of one another, representing the high demand for heating in the winter and cooling in the summer. However, because fuel costs are much greater than electricity, growers have a much more serious problem dealing with high fuel bills in the winter than they do the electric bill in the summer.

Figure 3. Average propane and electricity usage on the Applied Broiler Research Unit by house

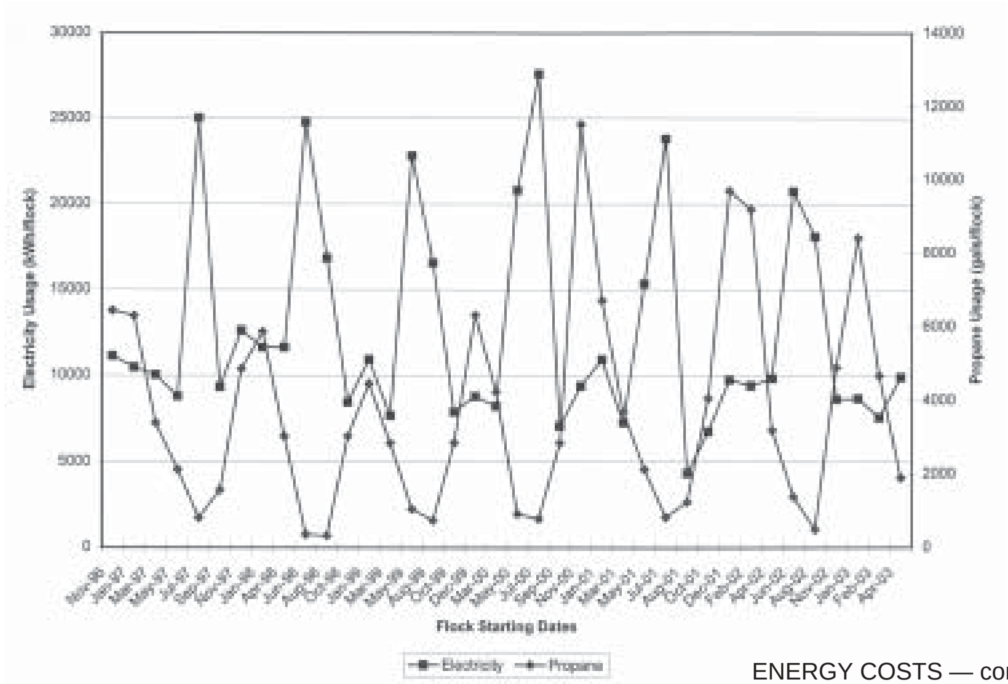


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Table 3. Electrical Usage Extremes and Averages

Item	Start Date	House Numbers 1	2	3	4	Farm Total	House Avg
		Electricity Usage(kWh)				kWh/Flock	
Min.	8/01	1016	820	754	1736	4326	1082
Max.	7/00	6757	6806	7924	6114	27601	6900
Avg.		3276	3108	3093	3140	12617	3154

Summary

Contract growers face numerous challenges associated with raising broilers. One significant challenge is the monetary expense related to fuel and electricity costs. Energy data from 38 consecutive flocks of straight run broilers over a seven-year period at the Applied Broiler Energy Unit indicate that approximately 25% of the gross farm income is required to pay the annual propane and electricity bills and that propane costs may be roughly four to five times the cost of electricity. While energy costs will vary somewhat from farm-to-farm, the wise use of energy should be a priority for all growers.

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Corona Virus Infections in Turkeys

Introduction

Corona virus is the causative agent of infectious bronchitis in broilers.

Corona viruses are small viruses that are named corona because it has projections on its surface that resemble a crown. The viruses are widespread in nature and are responsible for respiratory and enteric diseases in cattle, dogs, pigs, rabbits, humans, turkeys, chickens as well as other animals. In cattle and pigs corona virus causes intestinal infections that result in weight loss, diarrhea, and in some instances death. In broilers, a corona virus is the causative agent of infectious bronchitis. In contrast to chickens, turkeys infected with corona virus develop an enteric disease similar to mammalian species.

History:

The disease in turkeys was first seen in the state of Washington in the late 1940s and in the early 1950s in Minnesota where it caused heavy losses. The disease was referred to as "Mud fever" and "Bluecomb" but the causative agent was not identified as a corona virus until many years later. The disease has been seen in most if not all of the turkey producing areas of the United States, but is not a common isolate from normal turkeys. However, turkey flocks in Arkansas and Missouri continue to have problems with the disease.

Clinical Signs:

The virus can infect almost any age turkey but, the disease is more of a problem in poults during the first few weeks of life. The incubation period of the disease is within five days of exposure with most cases developing in two to three days. One of the most common signs is a sudden onset of depression, a drop in consumption of water, decreased appetite, and watery diarrhea in a large numbers of birds. The affected birds also chirp frequently, lose weight, and huddle together. Usually the entire flock is exposed to the disease, but mortality associated with the disease is commonly between 5-50%, but a few outbreaks it has exceed 50%. The number of affected birds may reach 100%. Flocks that have the disease have growth depression, stunting, weight loss, poor feed conversion, and are extremely uneven in size.

Lesions:

The lesions found with the disease consist of droopy wings, fecal staining of feathers, mucus or urates in the feces, pale flaccid small intestines, watery cecal contents, weight loss, dehydration, and atrophy of the Bursa of Fabricius. Since the Bursa of Fabricius produces immunity, the loss of this organ makes birds more susceptible to other disease organisms. When the disease affects breeder turkeys the eggshell quality usually deteriorates with eggs lacking pigment and having chalky shells. The only clinical sign that may appear in breeder turkeys may be a sudden drop in egg production.

Virus transmission:

The corona virus is shed in the feces of affected turkeys and is ingested by other turkeys. Insects are also mechanical vectors for the transmission of the disease. The disease spreads rapidly within in a flock and can be carried to other flocks via mechanical vectors such as people, vehicles, equipment, and animals. The virus is usually shed for several weeks after birds have recovered and can infect susceptible birds. Since older birds have been identified as a reservoir of infections for younger birds, it is crucial to avoid having different age birds on the farm.

Prevention and Treatment:

Recovered birds are resistant to infection; however, the extent and nature of the immunity is not fully understood. Since there is no cure for the disease, supportive care is recommended. Supportive care might include providing extra heat, use of milk replacers or calcium chloride in the water to aid in control of dehydration and control of secondary bacterial disease with appropriate antibiotics. However, supportive care has been used with mixed success in field outbreaks.

Corona viruses are readily inactivated by most common disinfectants, but can persist for extended periods in dirty or contaminated locations. Farms that have experienced the disease should be cleaned and disinfected after all fowl have been removed from the premises. Equipment, vehicles, and anything that will contact birds should be also be cleaned and disinfected. Recent research has shown that flies may be an important vector for carrying the viruses from house to house or farm to farm so insect control should be implemented. Additionally, a period of three to four weeks should elapse before new birds are introduced into the facilities.

The best method to control the disease is to prevent it from entering a flock. A good biosecurity program should be used to assist in the prevention of accidental introduction of the disease via vehicles, people, and/or equipment.

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Animal Welfare Audits: What to Expect and How to be Prepared

Introduction

In recent years customer demand has pressured restaurant chains and retail food stores to assure that the meat, egg and dairy products that they sell are produced in a humane manner. The only practical way these stores and restaurants can provide this assurance is to inspect the production and slaughter facilities of their suppliers such as poultry companies. For several poultry operations, animal welfare audits are old news since restaurant chains like McDonalds and Wendy's have been requiring supplier audits for several years. However, as more stores and restaurants feel public pressure to developed supplier animal welfare criteria, poultry companies that supply meat to several different customers could face a mass of confusing guidelines and audit schedules.

The National Council for Chain Restaurants and the Food Marketing Institute recently addressed the issue of dozens of types of animal welfare audits. Representatives from these trade organizations, representatives of the different meat and dairy industries as well as leading animal welfare experts sat down together to develop one comprehensive audit process. The result was the Animal Welfare Audit Program. Although the audit program is strictly voluntary, it will be difficult for a poultry company to refuse to participate when the request to participate comes from their best customer. One very good point about the audit is that customers will have the option to decide what level of conformance they are willing to accept. The audit is not a pass or fail program, but rather a process that looks at how well an operation is in conformance with industry derived animal welfare standards.

One major focus of this audit process is an on-farm inspection. For poultry producers, allowing a perfect stranger to scrutinize their operation and ask specific questions about how they rear their birds can be intimidating. However, by learning the issues that are addressed in an audit, and then preparing well before any audit occurs, a poultry producer can have a positive experience. Such an approach, will allow producers to consider the audit process as an opportunity to view their operation through a fresh and unbiased set of eyes, rather than a necessary evil. In addition, being in conformance with many of the audit questions is actually a reflection of good poultry husbandry techniques. The following paragraphs outline areas of the Animal Welfare Audit Process that will be a part of on farm audits.

Emergency Action Plan

Producers need an emergency action plan that includes contact information for local emergency services. This list should include not only the fire department and emergency medical services, but also utility company contacts should a power or rural water outage occur. Producers who use a well as a water source should also include contacts for pump and pressure tank repair on their emergency contact list. In addition, producers should post a list of poultry company emergency contacts. Most producers know how to contact their service technicians or feed delivery personnel, but what if the service person isn't available, who should then be called?

Every facility should also prepare a written emergency action plan that addresses what to do if the facilities are damaged by a storm, or if the ventilation or heating system fails or the feed auger breaks. This plan should include procedures to follow to maintain minimum ventilation and temperature until equipment repairs are completed. After it is written everyone who may potentially be required to follow that plan should become familiar with the plan and how to follow it.

Since most producers have primary responsibility for their operation, they may feel a bit annoyed by having to prepare a written plan, but remember, it is very difficult to think clearly during an emergency particularly one as devastating as a tornado. A plan and list of contacts that are easily accessible will prevent the confusion often associated with taking action during an emergency situation. There are two additional reasons why a plan can be beneficial. First, if the producer and close family members must unexpectedly have to leave the operation, will the person who must fill in be ready for emergencies? Secondly, putting a plan in writing allows the producer to actually think through the process and identify any weaknesses with the procedure. A well-prepared plan could save thousands of birds in an emergency situation.

A producer will also need to demonstrate that some type of alarm system will function properly should a power failure occur. Producers need to be prepared to show they can be warned of an emergency situation no matter where they are or what time of the day it is. An alarm that consists of a flashing light is helpful for personnel who are in sight of the light and so is inadequate. Producers need to also be ready to prove that the alarm systems are tested at least monthly and the person responsible for daily bird care must be prepared to show an auditor how the alarm system works.

A plan and list of contacts that are easily accessible will prevent the confusion often associated with taking action during an emergency situation.

Adequate Facilities

Producers must provide adequate lighting during the inspection process. Lights too dim to allow the auditor to clearly see the birds' eyes will not be acceptable. Producers must also be prepared to address the adequacy of feeding and watering systems. There should be a minimum ratio of 1 nipple drinker per 20 birds and one feed pan per 65 birds. If the equipment manufacturer gives different specifications meaning more birds per drinker or feed pan than this, then the producer should be ready to provide this information in writing. Auditors will also check litter quality. The litter should never be over 35 % moisture. This can be measured by pressing a handful together. Upon release the litter should easily crumble apart. If the litter sticks together, then the moisture would be greater than 35%. A rodent control program will also need to be in place. One final point that producers will need to work on with their integrators is monitoring the ammonia level in the bird breathing zone. This must be measured once a week during the last two weeks of grow-out and when measured, should not exceed 25 parts per million.

Flock and Facility Inspection

An additional focus of the audit process is proof that certain tasks are completed. While any good producer checks his birds at least twice a day, how can an auditor verify this? There should also be a mechanism in place, which on a daily basis allows producers to confirm that flock health as well as the feeding, watering and ventilation systems were checked. And if any of the systems are not working properly, actions taken to return the equipment to normal working order must be documented. The flock should be checked at least twice a day and signs of abnormal behavior or illness should be noted. One way to assure a third party that different tasks are completed is to hang a check sheet by the door that a producer or hired hand can initial after morning and evening flock visits. Although the audit process offers producers some freedom in how to prove they are in conformance with the daily flock inspections criteria, a daily log or check sheet takes all of the guesswork out of compliance for both the producer and the auditor. In addition, check sheets may be just the tool needed to discipline employees into conducting a doing thorough checks each time since good producers will want to confirm everything is O.K. before they sign off on tasks.

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During the audit, a minimum of 100 birds or 25 birds per house, whichever is more, will be checked for foot pad scores. Birds with any type of burn, ulceration or damage to the pad will considered to have injured feet. If more than 30% of the birds checked are considered injured, then the facility is out of conformance.

Bird Culling

Birds that are unable to stand or move of their own accord should be removed from the flock on a daily basis and humanely destroyed. Approved methods for culling birds include rapid cervical dislocation (breaking the neck), rapid decapitation (cutting off the head) or asphyxiation using carbon dioxide gas. Under no circumstance will it be acceptable for producers to cull birds by bludgeoning them with a bat or club. Anyone responsible for removing cull birds must show that they have been properly trained in the appropriate culling techniques. Producers must also prove that mortality is removed daily from the production area.

Conclusion

The animal welfare audit program offers a new set of challenges to the production of poultry. Unfortunately, this challenge will not go away as long as less than 2% of the population is producing food and the other 98% of the population expects some type of assurance that the animal products they consume were humanly produced. Because of the broad scope of the National Council of Chain Restaurants and the Food Marketing Institute, most poultry companies will probably be required to address these standards through on-farm audits. Therefore contract producers that expect to remain economically viable must be ready to make the transition to animal welfare auditing. By developing an animal care program that is consistent yet easy for a third person unfamiliar with the day-to-day operations of their specific farm to understand, producers will be well on their way to proving their operation is in conformance with the animal welfare standards.

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Broiler Nutrition, Feed Intake and Grower Economics

Introduction

Broiler growers spend a good deal of time checking, fixing and adjusting feed lines to make sure birds have a continuous supply of feed that is easily accessible at all times. However, it requires ideal management practices coupled with a continuous supply of feed and water to allow birds the opportunity to perform at their best. Modern genetics and today's broiler diets allow the bird to go from 1.3 ounces at hatch to 4.5 lbs or more by only six weeks of age. Most of us still have the same houses and equipment we had several years ago yet our birds grow heavier in less time and on less feed each year. Nutrition programs and grower management allow the poultry industry to grow broilers remarkably fast. It is clear that we can no longer manage birds as we always have.

Broiler Nutrition and Grower Economics

Two decades ago the goal of every grower was to ensure that the flock grew as rapidly as possible. However, the industry has developed a broiler that, if grown as rapidly as possible, will achieve a body mass that cannot be supported by the bird's heart, respiratory system or skeleton.

The situation has forced growers to make a choice. Is it more profitable to grow the biggest bird possible and have increased mortality due to heart attacks, ascites and leg problems or should birds be grown slower so that birds are smaller, but have fewer heart, lung and skeletal problems? As most growers know, the actual paycheck received for a flock will depend on many factors, including feed conversion and the pool of growers that settle when you do. A large portion of growers pay is based on the pound of salable meat produced, so simple calculations suggest that it is better to get the weight and ignore the mortality. Yet, we must remember that feed conversion also has a large bearing of grower pay. Therefore, every grower must evaluate his/her own situation to determine the best approach. It is clear, however, that every management approach should address feed management.

Feed is by far the single largest cost involved in producing broilers. Therefore it is important that growers manage feeding programs to improve efficiency and reduce waste. The problem with feeding broilers today is not the knowledge of optimum nutrients to use for maximum gains and feed efficiency, but how to align the growth of broilers to minimize mortality and skeletal disorders to produce more saleable meat after processing (Coon, 2002a). Unfortunately, as broiler growers know, not all birds within a flock grow at the same rate. Even a fairly uniform flock may have several different sizes and flocks with serious uniformity problems may have dozens of sizes making proper culling extremely difficult (Lacy, 2002). It is to every grower's advantage to minimize this flock variation with proper management and an appropriate culling program. A good management program will not eliminate size variation, but can go a long way in reducing it and minimizing its effects.

As birds mature, dietary needs change and these changes are reflected in the formulation of starter, grower, finisher and withdrawal diets. While several different diets are fed over the life of a broiler flock, integrators tend to use a minimum number of different diets due to additional costly bin space at the feed mill and greater opportunity for mistakes associated with additional formulas. Most integrators feed a specific quantity of starter feed to broilers and then feed the remaining diets based on a set number of days. In the US, a typical distribution of feed usage might be starter—12%, grower—33%, finisher – 25%, and withdrawal—30% (Coon, 2002a).

We are able to control feeding and lighting program more efficiently these days because of solid sidewalls houses. Curtain sided houses have served the industry well, but do not allow growers to control of light as well as solid sidewall houses. In fact, the greatest benefit of solid sidewall houses may be the grower's ability to control light, which controls both feed consumption and bird activity level. The light control offered by solid side wall houses allows growers to improve bird productivity (i.e. weight gain and feed efficiency).

Feed Intake Management

Figure 1 illustrates cumulative feed intake data from the Applied Broiler Research Unit for 38 continuous flocks of broilers during the period 1996 through 2003. Cumulative intake is low while the birds are young and small but increases dramatically as the birds increase in age and size. By 56 days a house of 25,000 broilers will consume approximately 300,000 pounds of feed. If the farm has 4 houses that will be approximately 1,200,000 pounds of feed consumed in only eight weeks. As a grower, how well you manage that million pounds of feed delivered to your farm has a huge impact on where you will rank on the settlement sheet. However, feed management is more than making sure the feed system is working properly. Growers should manage the house environment to alleviate as many stress factors as possible. Birds facing stressful situations will not convert feed to meat at optimum levels. The greater the stress level the poorer the conversion rate; and the poorer the feed conversion rate the farther down the settlement sheet you fall. Remember that settlement sheet rankings are based pounds of salable meet and pounds of feed consumed (i. e. feed conversion ratio).

Management of the feed system can also play a major role on feed intake and efficiency. Feed lines that are too high restrict intake by making it difficult for birds to access feed. If the lines are too low birds tend to keep feed pans too full and waste feed. Growers should constantly monitor their feed system and make height adjustments as the birds grow. Feed pans or chick mate tubes that develop leaks require immediate attention or replacement. A house environment that is too cold, hot, humid, or dusty can negatively impact feed consumption. In addition, too much ammonia will have negative consequences on feed intake and flock profitability.

Winter can be an especially difficult time for birds (and growers) because many times growers may be tempted to grow birds a little cooler than recommended to save a few dollars on the fuel bill. Although this may sound like a good idea, in practice it usually produces terrible results. If birds are not comfortable (too cool), they will consume excess feed in order to stay warm. The birds use this excess feed used to stay warm not to add weight and, simply put, this is wasted feed. Wasted feed, regardless of the reason, results in a poorer feed conversion ratio and puts a grower farther down the settlement sheet. That's why, even though gas may be expensive, it is still cheaper to heat birds with gas than it is to heat them with feed.

Summary

Formulating and manufacturing these broiler feeds are only a part of modern broiler production. Each grower must provide the managerial skills necessary to combine correctly formulated diets and genetically superior birds so that they express their full potential. A well-managed feed system and feeding program is critical success, as is a proper house environment. Stress levels must be kept at a minimum for birds to make optimum use of feed. Genetics has produced a bird capable of remarkable feats. However, genetics must be coupled with sound nutrition and farm management programs for today's broiler to perform at its most profitable level.

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Lacy, M. P. 2002. Broiler Management. Pages 829-868 *In*: (D. B. Bell and W.D. Weaver, Eds.) Commercial Chicken Meat and Egg Production, 5th Ed. Kluwer Academic Publishers, The Netherlands.

Figure 1. Cumulative Feed Intake on 38 Flocks of Straight-Run Broilers at Applied Broiler Research Unit from 1996 to 2003.

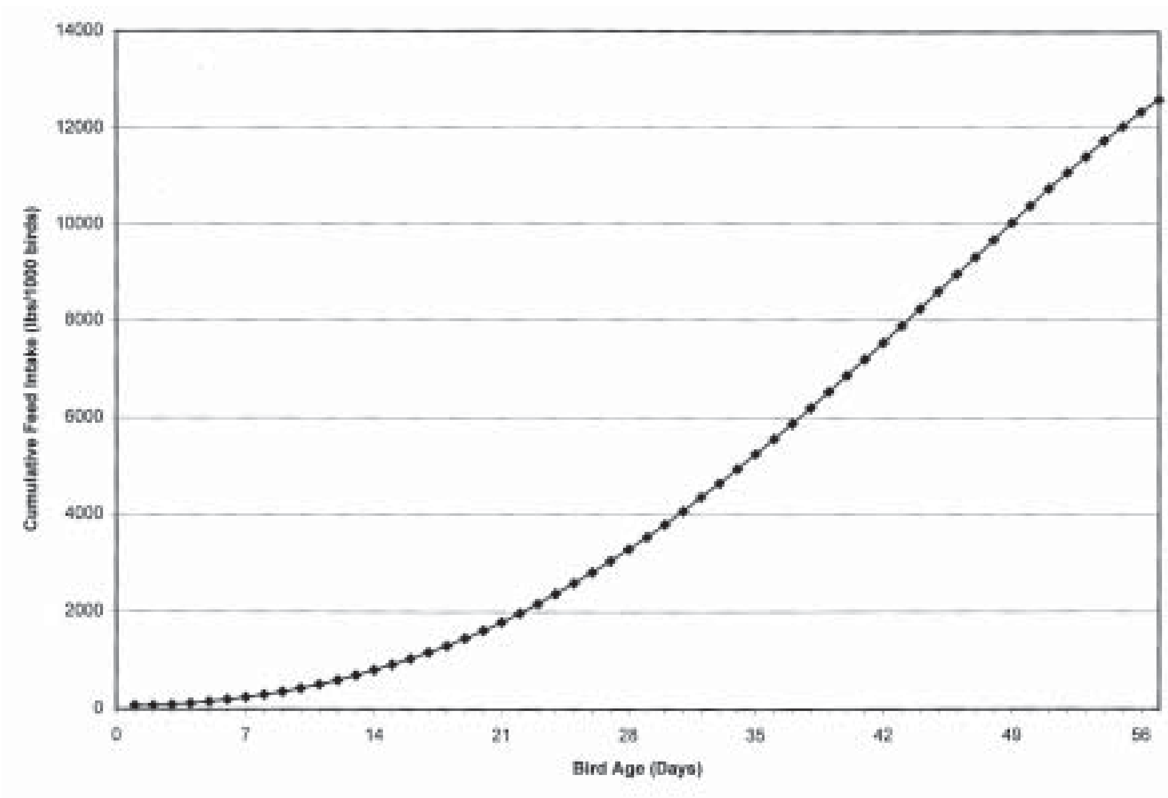

Table 1. Recommended Practical Broiler Nutrient Levels for Straight-Run Broilers[1]

Market Wt.		% Feed Fed		
Kg	Lb	Starter	Grower	Withdrawal*
1.75	3.85	25	42	33
2.00	4.40	24	42	34
2.25	4.95	21	45	34
2.50	5.50	17	48	35
2.75	6.05	15	48	37
		Starter	Grower	Withdrawal*
Protein, %		21.50	20.25	18.00
Calories/lb (kcal, ME)		1,400	1,450	1,475
Calories/kg (kcal, ME)		3,080	3,190	3,245

* The withdrawal feed schedule will depend upon the desired market weight. The program presented is based on an average broiler body weight of 4.15 to 4.25 lbs.

[1]Adapted from: (Coon, 2002a).

Coming Events

- **Southern Poultry Science Society**, January 26-27, 2004,
  Georgia World Congress Center, Atlanta, GA,
  U. S. Poultry & Egg Association, (770) 493-9401

- **International Poultry Exposition**, January 28-30, 2004,
  Georgia World Congress Center, Atlanta, GA,
  U. S. Poultry & Egg Association, (770) 493-9401

- **Short Course on Modern Poultry Production**, February 23-27, 2004,
  University of Arkansas, Fayetteville, AR,
  Frank T. Jones, (479) 575-5443

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Dr. R. Keith Bramwell, Extension Reproductive Physiologist, attended Brigham Young University where he received his B.S. in Animal Science in 1989. He then attended the University of Georgia from 1989 to 1995 where he received both his M.S. and Ph.D. in Poultry Science. As part of his graduate program, he developed the sperm penetration assay, which is still in use today, as both a research tool and as a practical troubleshooting instrument for the poultry industry. He then spent one year studying in the Animal Reproduction and Biotechnology Lab at Colorado State University. In 1996, Bramwell returned to the University of Georgia as an Assistant Professor and Extension Poultry Scientist. Dr. Bramwell joined the Center of Excellence for Poultry Science at the University of Arkansas as an Extension Poultry Specialist in the fall of 2000. His main areas of research and study are regarding the many factors (both management and physiological) that influence fertility and embryonic mortality in broiler breeders. Telephone: 479-575-7036, FAX: 479-575-8775, E-mail: bramwell@uark.edu

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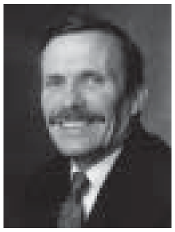

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