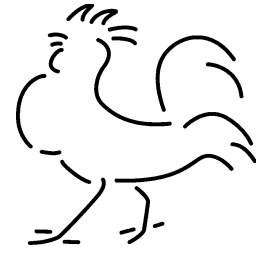


Factors Influencing Optimal Feed Withdrawal Duration



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Introduction

Removal of feed and water from market-aged broilers before catch and live haul is a standard management practice that has been used by the poultry industry for more than 40 years. During this feed withdrawal time, broilers will evacuate their digestive tracts, and carcass contamination in the plant will be reduced. Numerous factors influence the effectiveness of feed withdrawal; however, before discussing these factors, you need a clear understanding of the goals behind implementation of a feed withdrawal program.

Feed withdrawal refers to the total length of time the bird is without feed before processing. This includes the time the birds are in the house without feed, as well as the time the birds are in transit and in the live hold area at the plant.

Feed Withdrawal = Time in house without feed
+ Live haul time
+ Time in plant holding area

Length of feed withdrawal is important because it affects the following:

- 1) Carcass Contamination and Yield (reprocessing and live weight losses)
- 2) Plant Line Efficiency (removal of contaminated carcasses)
- 3) Grower Payments (live weight loss)
- 4) Product Safety and Product Quality (pathogenic and spoilage bacteria)

Ideally, the length of feed withdrawal before processing should be the shortest amount of time required for the broilers' digestive tracts to become empty; however, this time will vary because of differences in house environmental conditions. Recommended length of time off feed for broilers before processing is between 8 and 12 hours because the majority of the birds in the flock will have had enough time to properly evacuate, and the effects of the time period without feed on their carcass weight will be minimal. Although 8 to 12 hours of feed withdrawal is recom-

mended, feed withdrawal programs should be tailored to fit the unique conditions that exist at each complex. It is not uncommon to have some plants processing broilers with minimal carcass contamination using a 7- to 8-hour feed withdrawal schedule, while other plants require 12 to 13 hour of feed withdrawal to achieve the same results. For optimal feed withdrawal, the environmental conditions surrounding broiler grow-out must be considered. Thus, attaining optimal feed withdrawal requires cooperation and communication between live production and processing personnel. The rest of this overview will discuss several factors which affect feed withdrawal.

Live Production Factors

Live production management practices affect the results of feed withdrawal by altering the birds' eating patterns or by changing the rate at which feed passes through the bird's digestive tract. In order for a feed withdrawal program to work as designed, birds must have normal feed consumption pattern and normal feed passage during the week before feed withdrawal. Changes in lighting or temperature regimes (hot or cold), a disruption immediately after feed is removed, and the stressors of catching and holding can slow feed passage in broilers. When the rate of feed passage is slowed, it may not be possible to correct this problem simply by holding the birds for a longer period of time before processing. It is best to minimize exposure to any condition that slows the passage of feed or causes the birds to gorge immediately prior to feed withdrawal.

Lighting and Cooping

Lighting (intensity and duration) and cooping affect activity, and the activity of the bird affects the rate of feed passage. Under continuous light and access to

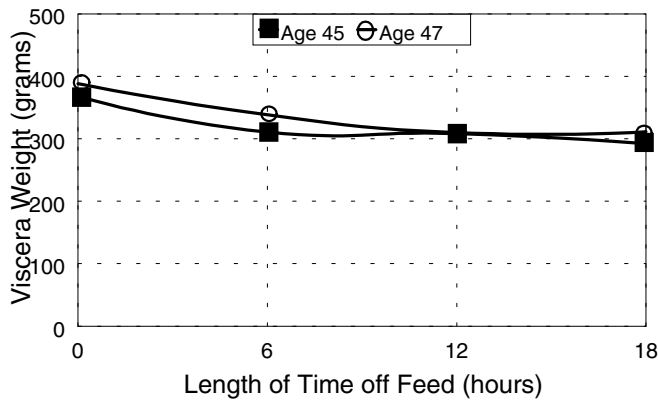


Figure 1. Effects of length of feed withdrawal on broiler viscera weight (Northcutt and Buhr, 1998).

water, 80 to 85 percent of the ingesta (partially digested food) within the broiler’s digestive tract will be evacuated during the first 6 hours of feed withdrawal (Figure 1). However, when broilers are exposed to darkness, or after broilers are cooped, the evacuation rate is much slower. Research has shown that after a 2-hour feed withdrawal period, broilers in a dark environment had more feed in their crops than broilers in lighted environments (Table 1). After 4 hours of feed withdrawal, lighting made no difference in the crop contents, except when it was combined with cooping. Cooped broilers held in darkness for 2 hours had more than twice as much feed in their crops than cooped broilers held in the light. In addition, after 4 hours of feed withdrawal, there was twice as much feed with in the crop of broilers held in darkness as compared to broilers held in light. This information suggests that for optimal feed passage, broilers should stay on litter 4 hours or longer, and they should have adequate lighting up to the time of catching and during holding.

Temperature

Although variation in temperature of either the grow-out house or the holding shed is known to influence the effectiveness of feed withdrawal, little attention has been given to studying these factors. Of the information that has been published, most of the studies have focused on feed withdrawal during hot weather. The list below summarizes some of the findings.

- 1) Hot weather causes birds to be less active and to consume less feed, but water consumption is greater at higher temperatures. This can affect the consistency of fecal material within the intestines.
- 2) In the evening and late afternoon after the sun goes down and the temperature drops, birds may gorge themselves. If feed is removed after the birds have gorged, a normal withdrawal period may not be long enough for adequate evacuation before processing.
- 3) As environmental temperatures approach 90 degrees F and above, feed is retained for a longer period of time in the crop, gizzard and small intestines of broilers.
- 4) In general, it is recommended that feed withdrawal programs be extended 2 to 3 hours for broilers during the summer months to accommodate changes in the slower rate of feed passage.

Broilers grown during cold weather with house temperature below 60 degrees F also retain feed in their digestive tracts longer, and the birds are often too cold to get up and eat. As indicated by May and Lott (1992), “broilers are nibblers and eat regularly when the temperature is constant, and lighting is continuous.” When birds do not have normal eating patterns,

Table 1: Effects of lighting and cooping on the crop contents of 45-day old broilers

Weight of Crop Contents Following Feed Withdrawal					
Holding conditions	Lighting	2 hours (grams)	4 hours (grams)	6 hours (grams)	8 hours (grams)
Litter	Light	13.8 ^{bc}	2.3 ^b	0.6 ^a	0.2 ^a
Litter	Dark	29.2 ^a	4.0 ^b	3.1 ^a	0.5 ^a
Cooped	Light	11.8 ^c	6.0 ^b	0.4 ^a	2.1 ^a
Cooped	Dark	21.0 ^b	17.0 ^a	3.5 ^a	1.4 ^a

May, J.D., B.D. Lott, and J.W. Deaton, 1990. Poultry Science 69:1681-1684.

^{a-c} Means within a feed withdrawal time with no common superscript are significantly different.

there is greater variability in the content and condition of their digestive tracts. This can be detrimental for the processing plant in terms of carcass contamination.

Gastrointestinal (Digestive) Tract And Fecal Contamination

Short Feed Withdrawal

When a complex designs a feed withdrawal program, they are deciding what they want in the bird's intestinal tract when it enters the plant. Table 2 summarizes the condition and contents of broiler viscera after various lengths of feed withdrawal (Northcutt *et al.*, 1997). If the length of feed withdrawal is too short (less than 6 to 7 hours), the birds' digestive tracts will be full of feed at slaughter, and the intestines will be large and rounded. For full fed birds, the feed filled large intestines take up a great deal of space in the birds' abdominal cavity, such that the duodenal loop is positioned close to where the vents are opened. For this reason, the filled intestines are easily cut during vent opening. In addition, processing broilers that are full of feed increases the likelihood that the force of evisceration will cause intestinal material to leak out onto the carcass.

Long Feed Withdrawal

If the length of feed withdrawal is too long (greater than 13 to 14 hours), the intestines will be weaker, and the incidence of intestinal tearing during evisceration may increase. Figure 2 shows intestinal strength data of broilers after various feed withdrawal periods (Bilgili

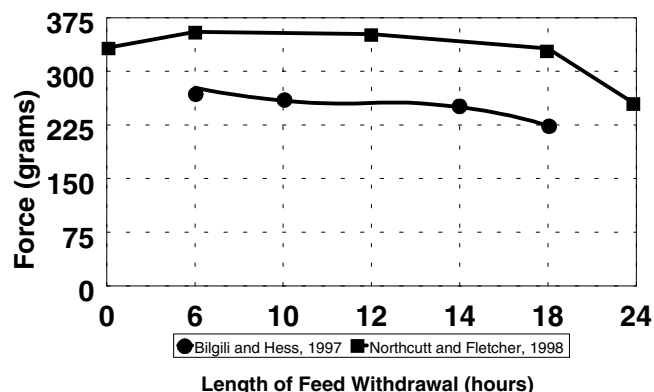


Figure 2. Intestinal strength of broilers held without feed for various times before processing (Bilgili and Hess, 1997; Northcutt and Fletcher, 1998 unpublished).

and Hess, 1997; Northcutt and Fletcher, unpublished). Intestinal strength of broilers was approximately 10 percent lower when the bird was held without feed for 14 or more hours before processing.

In addition to weaker intestines, longer feed withdrawal times often result in bile contamination of carcasses because continuous bile is produced, and the gall bladder becomes enlarged. An enlarged gall bladder may break more often during evisceration. When the gall bladder reaches maximum capacity, excess bile backs up into the liver and also releases into the duodenum and gizzard with antiperistalsis (Figure 3). This can alter the appearance of the liver and may alter the flavor of the liver. As a result of the bile, the gizzard lining will have a green appearance, indicating the feed withdrawal may be excessive.

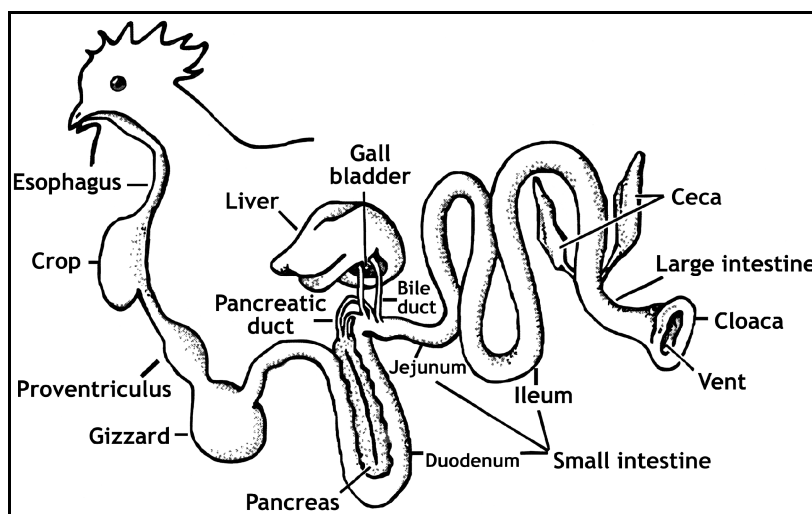


Figure 3. Diagram of the digestive tract of a broiler (Parkhurst, C.R., and Mountney, G.J. 1987).

Table 2: Viscera contents after feed withdrawal.¹

Time off feed (hours)	Crop contents	Gizzard contents	Intestinal shape	Sloughing of intestinal mucus	Gizzard bile (percent)
0 - 3	Feed	Watery feed	Round	No sloughing	0
9	Water	Litter	Flat	Mild sloughing	30
12	Empty	Litter	Flat	Sloughing	30
14	Empty	Litter	Flat and round	Sloughing to heavy sloughing	35
16 - 19	Empty	Litter and feces	Flat and round	Sloughing to heavy sloughing	40 to 70

¹ Visual assessment of the intestinal contents. Intestinal shape indicates if the intestine is actively passing ingesta.

After 4 hours of feed withdrawal, birds begin to consume anything that is available, including litter and fecal material. Thus, there is a mixture of feed, litter, water and feces during the early withdrawal period. Because of the presence of the other material (residual feed, water and litter), feces is not easy to identify in the bird's digestive tract until the bird has been without feed for more than 14 hours (Table 2). Consumption of fecal material should be avoided because it increases the potential for carcass contamination in the plant, and it may affect the plant's ability to meet the USDA established microbiological standards for poultry.

Optimal Feed Withdrawal

With optimal feed withdrawal (empty digestive tract) before processing, the following advantages are realized:

- Birds entering the plant carry less bacteria on their feet and in their feathers because less fecal material is excreted in the coops during transportation and on the conveyor belts during unloading.
- Contamination of the scald water is reduced because birds defecate less material during stunning and bleeding.
- Less fecal material in the bird's digestive tract means less material is available for carcass contamination during evisceration.
- When carcass contamination is reduced, the processing lines run more efficiently, there is less carcass trim (higher yields), lower water usage, and lower carcass *E. coli* counts.

In addition to reducing the amount of fecal material that is present in the birds' digestive tracts at slaughter, feed withdrawal and water consumption by birds may affect the consistency of the fecal material. Table 3 shows the relationship between feed withdrawal, fecal

consistency, and amount of fecal material (Wabeck, 1972). As the length of time off feed increases, fecal material may become more watery. In the plant, this may translate into a higher percentage of carcasses that are contaminated. When a carcass becomes contaminated during processing, it is identified by the inspector or a plant employee and removed from the main processing line and placed on the salvage line for reprocessing. Each plant must use USDA approved conditions to reprocess carcasses, including washing with chlorinated water, trimming, or vacuuming. Following reprocessing carcasses are re-inspected. If the contamination is too great, a part (wing, drum, etc.) of the carcass or the whole carcass will be condemned (discarded as unfit for human consumption).

Table 3: Effect of feed withdrawal on consistency and amount of broiler fecal material

Hour	Condition	Amount
0	Moist	-
4	Moist	2.30
8	Firm	1.49
10	Firm	1.57
12	Loose	1.72
24	Watery	1.90

Wabeck, 1972.

Wesley (1972) found that plant carcass contamination was lowest (0.65 to 0.68%) for broilers processed after 8 to 12 hours of feed withdrawal, and highest (2-6%) for broilers processed after 16 hours of feed withdrawal (Figure 4, page 5).

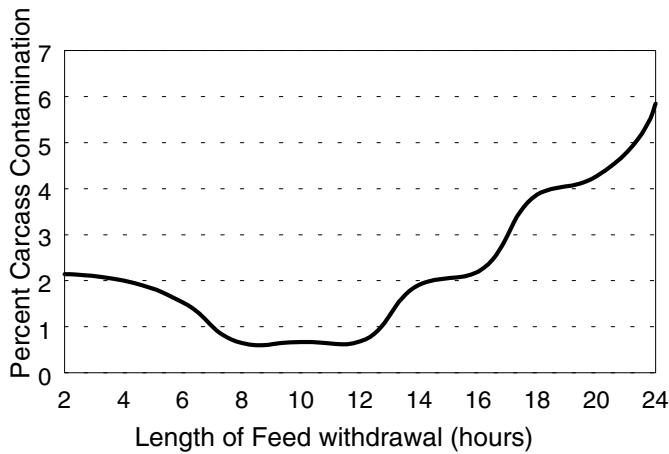


Figure 4. Effects of Feed Withdrawal on Carcass Contamination in the Plant (Wesley, 1972, reported by Wabeck, 1992).

Plant equipment and the USDA, Food Safety and Inspection Service’s inspection system have changed dramatically since 1972 when Wesley conducted his study on contamination. Most plants have a goal of 1 percent reprocessing; however, even with as little as 1 percent reprocessing, the plant loses a significant amount of yield. Using a conservative estimate, a plant may lose between 5 and 7 percent carcass yield for each bird that is reprocessed. Suppose an average-sized plant (250,000 birds per day), processing 4 lb birds, has to reprocess 1 percent of their carcasses. The following calculations can be made:

$$\begin{array}{r}
 250,000 \text{ bird processed per day} \\
 \times \quad \underline{1\% \text{ Reprocessing}} \\
 2500 \text{ birds hung back each day (salvage)} \\
 \\
 2500 \text{ birds reprocessed per day} \\
 \times \quad \underline{4 \text{ lb live weight}} \\
 10,000 \text{ lbs live weight} \\
 \\
 10,000 \text{ lb} \\
 \times \quad \underline{68\% \text{ Carcass Yield (approximate carcass yield as a percentage of the live weight)}} \\
 6800 \text{ lbs carcass weight} \\
 \\
 6800 \text{ lbs carcass weight} \\
 \times \quad \underline{5\% \text{ Yield loss}} \\
 340 \text{ lbs yield} \\
 \\
 \mathbf{340 \text{ lbs lost product per day}}
 \end{array}$$

Three hundred forty pounds of lost product may not seem like much, but the losses can add up considering that an average plant processes 260 days each year.

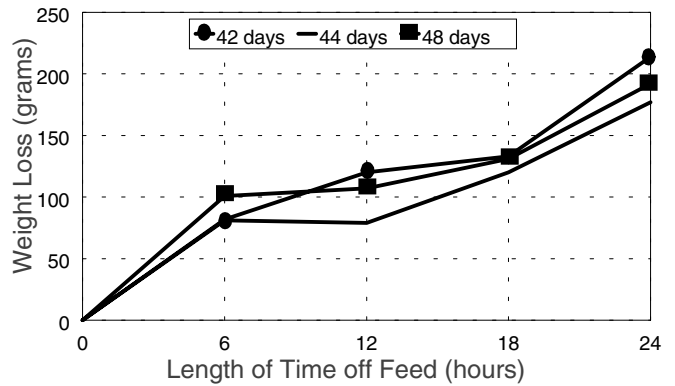


Figure 5. Effects of Feed Withdrawal on Live Shrink in Male Broilers (Buhr *et al.*, 1998).

$$\begin{array}{r}
 340 \text{ lb} \\
 \times \quad \underline{260 \text{ days}} \\
 88,400 \text{ lbs lost product per year}
 \end{array}$$

Eighty-eight thousand, four hundred pounds of lost product per year occurs for 1 percent reprocessing; thus, if plants reprocessed 5 percent of their carcasses, they would lose close to 450,000 lbs each year. These calculations demonstrate the need for plants to keep carcass reprocessing as low as possible.

Carcass Yield and Contamination Live Shrink

Live shrink refers to the weight lost by broilers during feed withdrawal. After broilers have been without feed for more than 6 hours, they begin to draw moisture and nutrients from their own body tissues, and this weight loss may then affect edible yield. The degree of live shrink due to feed withdrawal is affected by bird age, sex, house temperature, eating patterns before feed withdrawal, and preslaughter holding conditions (cooping time and holding temperature). Live shrink for a market-aged broiler ranges from 0.2 to 0.3 percent of the bird’s weight before catching per hour of feed withdrawal (Figure 5). The higher live shrink per hour of feed withdrawal occurs in male broilers. With live shrink, a broiler held off feed for an extra 3 hours before processing (*e.g.*, 15 hours instead of 12 hours) will weigh approximately 0.03 lb less than a broiler processed 3 hours earlier. In an operation that processes 250,000 birds a day, the extra 3 hours of feed withdrawal equates to reducing the live weight processed each week by 37,500 lbs. The majority of the growers in the United States are contract growers, which means that the company supplies the chicks, feed, litter, fuel and medication, while the grower sup-

plies the housing and labor for care of the birds. Growers receive payment for a flock based on its weight at slaughter, which will be reduced if the birds are held without feed for an excessive length of time (high live shrink).

This does not mean that broilers given no feed withdrawal will have the highest carcass yields. In fact, birds full of feed that weigh the same as birds held off feed have lower carcass yields because their initial weight includes the digestive tract contents. Figure 6 shows data for live weight, dry carcass weight, and chilled carcass weight for 45 day old male broilers. Carcass yield was highest for broilers on a 6 hour feed withdrawal schedule. A 6-hour feed withdrawal program is impractical for industry because of carcass contamination; however, these data demonstrate that the highest yield will be obtained by companies who strike a balance between live shrink and carcass contamination.

Carcass Contamination

Carcass contamination has become increasingly important for the poultry industry because of the implementation of the USDA’s Pathogen Reduction; Hazard Analysis and Critical Control Point System; Final Rule. One of the requirements of this rule is the zero tolerance of fecal material on carcasses entering the chiller. The ruling states that “visible fecal contamination is an important food safety standard because fecal contamination is a major vehicle for spreading disease-causing microorganisms, such as *Salmonella*, to raw poultry.” Because of this ruling, companies are closely monitoring carcass fecal contamination, and many have lengthened their feed withdrawal programs because they feel that this will assist them in meeting

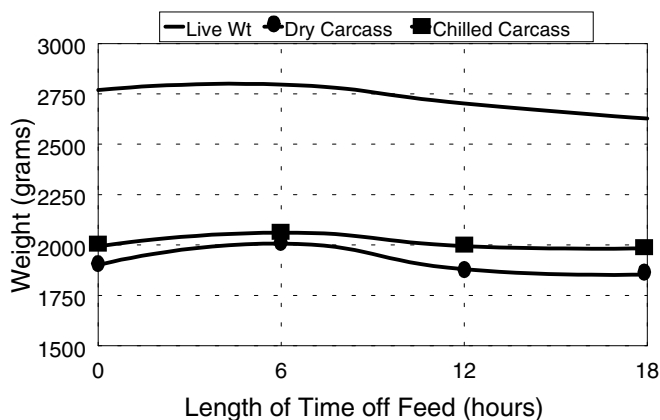


Figure 6. Effects of Feed Withdrawal on Live Shrink, Dry Carcass Yield (before chilling), and Chilled Carcass Yield in 45-Day Old Male Broilers (Northcutt and Buhr, unpublished data).

the zero tolerance policy. This bulletin has already discussed the detrimental conditions associated with excessive feed withdrawal, and thus lengthening the withdrawal period beyond the recommended length creates more problems than it solves. Additionally, length of feed withdrawal affects the microbiological condition of the broiler’s digestive tract, which may in turn affect the plant’s ability to meet the carcass microbiological standards as stated in the final ruling. Hinton *et al* (1998) demonstrated that increasing the length of time broilers were held without feed before processing caused the pH of the ceca (pH 5.3 versus 6.5) to increase. At the higher pH, bacteria in the Enterobacteriaceae family, which includes *Salmonella* and *E. coli* among others, multiply more readily. Figure 7 shows the change in the bacteria populations of this family of bacteria in the ceca and the crop. According to Hinton *et al.* (1998), increasing the length of feed withdrawal causes a decrease in the lactic acid bacteria found in the bird’s digestive tract, and with less lactic acid bacteria available to produce acid, the pH increases. At the higher pH, the environment is more favorable for growth of Enterobacteriaceae bacteria. This research demonstrated that longer feed withdrawal time can create undesirable changes in the bacterial populations of the digestive tract, and thus, excessive withdrawal periods should be avoided.

Recommendations

Because of the impact that feed withdrawal has on a company’s bottom line profits, designing and implementing an effective program should be a team effort with live production, and processing plant personnel. The following list contains factors to consider when evaluating your feed withdrawal program:

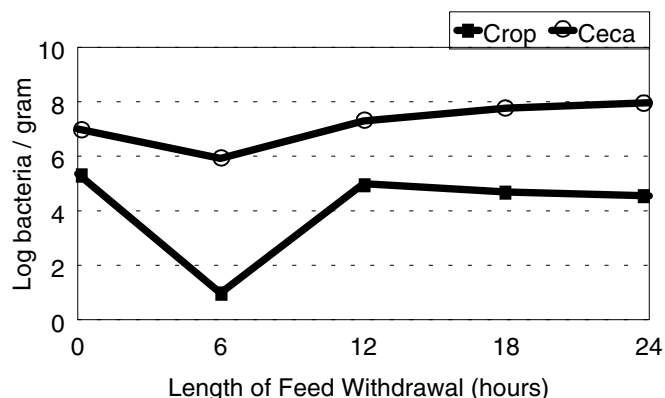


Figure 7. Enterobacteriaceae counts for crop and ceca of broilers held without feed for various time periods (Hinton *et al.*, 1998).

- 1) Keep accurate records of your actual feed withdrawal period (feeders empty to slaughter). You may not be operating on the schedule that you think you are operating.
- 2) Monitor your flock for proper house temperature, litter moisture, and eating patterns. If the litter is too wet, birds will find it difficult to get up and walk to the feeders, and they will be more likely to remain in a sitting position in which case defecating is difficult. You want to see birds moving about in the house, with no gorging patterns.
- 3) Try to avoid disturbing the flock immediately after feed withdrawal. This includes changing the lighting, opening doors, etc., because any change will slow the evacuation of the digestive tract.
- 4) Keep the birds on litter with access to water as long as possible to facilitate digestive tract emptying. Do not coop before 4 hours of withdrawal.
- 5) During hot weather, keep the birds as cool as possible in the house and in the holding area.
- 6) Before the scheduled feed withdrawal time, do not allow birds to run out of feed; however, if you run out of feed (less than 0.5 lb of feed per feeder) at the scheduled withdrawal time, leave the feeders down until the catch crew arrives. By leaving the feeders down during this early withdrawal period, birds are more likely to peck on the feeder than they are to peck at the litter. Since it is impossible to consume litter without consuming feces, minimizing litter consumption is advantageous.

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