The Broiler-Corn Ratio: Is it an Indicator of Fattened Broiler Profits?

H.L. Goodwin Jr.

Department of Agricultural Economics and Agribusiness, University of Arkansas, 217 Agriculture Building, Fayetteville, AR 72701; Department of Poultry Science and Center of Excellence for Poultry Science, University of Arkansas, POSC O-114, Fayetteville, AR 72701, email: haroldg@uark.edu

Andrew McKenzie

Department of Agricultural Economics and Agribusiness, University of Arkansas, 217 Agriculture Building, Fayetteville, AR 72701; email: mckenzie@uark.edu

Sandra J. Hamm

Department of Agricultural Economics and Agribusiness, University of Arkansas, 217 Agriculture Building, Fayetteville, AR 72701, e-mail: shamm@uark.edu

Selected Paper prepared for presentation at the
American Agricultural Economics Association Annual Meeting
Portland, OR. July 29-August 1, 2007

The hog cycle has been used as an economic indicator for hog farmers for many decades. Hog cycles, on average three years in length, are recurring changes in production and prices and are often tied to the price of corn. They occur when producers respond to changes in market and economic conditions such as higher profits and increased sales by expanding their production operations. One historical indicator of profit from hog production is the hog-corn ratio that reflects the relationship between hog and corn prices, specifically how many bushels of corn it takes to equal the value of 100 pounds of live hog ($ per hundredweight hogs/ $ per bushel corn). As an indicator of pork production profitability, the hog-corn ratio tracks the reality that as hog production rises, hog prices normally trend down and as it declines, prices usually trend up.

The hog-corn ratio can be used to predict profitability in hog production because feed represents 65-70% of production cost and corn is 60% of the feed source (Global Financial Data). The hog-corn ratio is a simple ratio of market hog price in dollars per 100 pound of cwt. to the price of corn in dollars per bushel (Holt 2006). For example, if the hog-corn ratio is 20, history shows that pork production will exceed that of the previous year in approximately 12-18 months. Similarly, a hog-corn ratio of 16 or lower predicts a decrease in production compared to previous year figures (Meyer 2006). This type of ratio is still an indicator in today's production environment where intense growing practices are common and higher capital is required for specialized production. A six-quarter lag of the ratio from 1989-2006 suggests smaller ratios indicate narrower profit margins in the coming year (Lawrence 2007).

Because the ratio continues to work in pork production, the same concept using poultry production and corn prices could indicate production profitability to poultry companies. These changes in pork production mirror changes in intensified and specialized poultry production that have occurred since the 1950s. Corn accounts for an even greater proportion of feed in poultry rations, upwards of 70 percent, so it is not inconceivable that a broiler-corn ratio[1], if developed, would be similarly useful as a profit indicator for poultry production. The National Chicken Council (NCC) considers escalating corn prices as a result of ethanol production subsidies to be one of the industry's greatest threats in the coming years, a sentiment echoed by Keith Collins, Chief Economist of USDA. "The diversion of corn into ethanol and away from animal feed has already driven up the cost of feeding chickens by 45 percent", said NCC's Bill Roenigk. (Dateline: Washington, D.C.)

Contributing to the timeliness of this research topic regarding the 'broiler:corn ratio' is the recent surge in ethanol production and government policies that continue to encourage corn grown for ethanol production. Because corn price is the dominant cost factor in ethanol production, ethanol supply is necessarily sensitive to corn price. For example, ethanol production dropped sharply in mid-1996 when wet conditions resulted in late planting and higher prices for short-run corn supplies (Dipardo 2007). If the current trend of ethanol production continues, U. S. ethanol production could easily reach 11 billion gallons by 2011. This means the ethanol sector will need 4 billion bushels of corn per year, twice the amount consumed by the sector in 2006 (Baker 2007). According to Collins, the price signals for this increased production are in place. As of October 12, 2006 the December 2007 corn futures were at $3.15/bushel. A farmer's break-even price for corn relies on the price of soybeans, input production and nitrogen fertilizer costs (Babcock 2006). Considering these inputs, the break-even price of corn must be

$3.40/bushel or higher for a corn-belt farmer to switch soybean acres to corn. Higher corn prices could attract farmers to plant more acreage (Hart 2006).

Recent USDA projections suggest that the extra corn will be diverted from exports and feed. In 2003, the broiler industry required 1.2 billion bushels (34 million tons) of corn (National Chicken Council 2007) to produce 43,958 (USDA) million pounds live-weight (figure 1). In 2005, broiler production increased to 47,908 (USDA) million pounds live-weight. Changes in sales and exports of poultry and similar near-record numbers of cattle and hogs on feed contributing to the market's 'protein glut' may buffer impacts of corn's decreased availability due to an estimated increase of ethanol production from 5.6 billion gallons (annual capacity) to 11.8 billion gallons when current plant construction is final (Baker 2007). Decreasing profits for U.S. poultry integrators are directly tied to decreased end-product prices and increasing grain prices. These factors combine to make identifying an appropriately structured and useable broiler-corn ratio a possible key identifying profit opportunities in the industry and could lead to more appropriate decision making by industry professionals. Initial indications from simple regressions using the ten-year period of data discussed herein are that up to 40 percent of the variability in a company's profits may be explained with the broiler-corn ratio alone.

Given the rapid concentration and consolidation of the poultry industry (Ollinger 2005) and the fact that some of the largest poultry companies are diversified producers of beef and pork, empirical results thus far indicate industry structure could be a factor in the ability to respond to input and output price changes. Determining the predictability of the broiler-corn ratio is of interest for firms because decision makers may be able to anticipate, and therefore accommodate, price changes in one market and to predict not only the magnitude, but also the direction of profitability for the firm. Optimal economic results can then be attained while minimizing risk facing the traders in the markets.

Data

Data are gathered from a variety of primary and secondary sources (USDA-NASS, USDA-ERS and Urner-Barry) for the following: chicks placed and egg set; poultry in cold storage, broiler exports, price per pound for whole broiler without giblets (WOG), boneless, skinless breasts (BSB), line-run breasts (LRB) and leg quarters (LQ) for years 1995-2005 and USDA/NASS corn prices and broiler/feed ratio[2] for years 1995-2005. Data for monthly share prices (1995-2005) for the top four publicly-traded poultry companies are gathered from the Compu-Stat database within Wharton Research Data Services (WRDS). The top four poultry companies in order of ranking are: 1) Pilgrim's Pride, 2) Tyson, 3) Perdue, and 4) Sanderson Farms (Feedstuffs 2007). Perdue is a privately held company, so no data is available. Therefore data from ConAgra is used for this model as the fourth firm as it was a separate company during the period of research.

Empirical Model

Following Goodwin and McKenzie, a VAR approach is used to determine dynamic price relationships among different wholesale chicken cut ratios and poultry company share price. Specifically, the magnitudes and directions of price shocks in a particular market and its effect on other markets are analyzed. These broiler cuts and company share prices were modeled as a vector autoregressive (VAR) model. VAR models consist of a set of distributed lag equations to capture the relationships among variables in the system. It was argued that such a model reduces spurious *a priori* restrictions on the dynamic relationships (Goodwin, McKenzie 2003).

A VAR system for n variables may be defined as:

$$(1) \qquad Y_t = \bar{c} + \sum_{k=1}^{k} \begin{bmatrix} b_{11}(k) & . & . & . & b_{1n}(k) \\ . & & & & \\ . & & & & \\ . & & & & \\ b_{n1}(k) & . & . & . & b_{nn}(k) \end{bmatrix} Y_{t-k} + \sum_{i=1}^{11} a_i D_i + \bar{\varepsilon}_t$$

where

$\bar{c} =$ a vector of constant terms,

$t =$ time ($t = 1,......T$),

$Y_t =$ an n x 1 vector of economic variables,

$k =$ the lag order of the system,

$b_{ij}(k) =$ parameters to be estimated under the n by n system of equations, where i refers to each of ‘n’ estimating equations in the system and j refers to each coefficient associated with each i.

$D_i =$ eleven seasonal indicator variables.

$\bar{\varepsilon}_t =$ a vector of serially uncorrelated random errors, known as innovations, with constant variance.

Methods

By definition, the innovations or shocks on each variable will affect the forecast error variance (FEV) and the shocks can be decomposed into “own” shock and shock due to other variables. Each equation in the VAR system is estimated using ordinary least squares. Model selection in terms of the number of lags to include in the system is determined by using a battery of system residual diagnostic tests. The estimated innovation vector is then orthogonalized using Choleski decomposition, which transforms the covariance matrix of the innovations to an identity matrix. These functions are generated by separately shocking innovations for each of the variables by one standard deviation. Only significant impulse responses are of any interest and so Monte Carlo integration procedures outlined in Kloek and Van Dijk are used to construct 95 percent confidence levels around the impulses.

Results and Conclusion

Preliminary diagnostic testing on lag lengths from one to fourteen months indicated that a nine-month lag specification is necessary to adequately model the system. The nine-order VAR model also includes a constant term and a series of eleven indicator variables in each of the system's equations to account for seasonality. Ljung-Box Q-statistics for 16^{th} order autocorrelation show that no significant residual autocorrelation is present in any of the equations at the one percent level. Overall system residual diagnostic tests suggest that our chosen VAR model is appropriately specified.

One final potential concern with respect to model adequacy relates to structural change within the broiler industry and the possibility that there may have been a structural break in the data series. Babula, Bessler and Schluter found evidence of a structural change in retail poultry prices in 1970 using a sample period from January 1956 to November 1985. They noted that a number of demand and supply changes occurred in the poultry industry, over their sample period, since the 1950's. For example, on the supply side technological advancements shifted poultry supply rightwards, while consumer demand for poultry has also grown dramatically. Acknowledging that structural breaks in the data series could pose potential problems in terms of model stability, we argue that over our sample period January 1985 through December 2005 much of the structural change noted by Babula, Bessler and Schluter was already incorporated into the broiler industry. Therefore, although we do not formally test for structural change over our sample period, we do not believe that our model results are compromised.

As previously discussed, price shocks were made to the appropriate broiler:corn for each of the various cuts and resultant responses to cut prices were measured. Results are shown in the form of shock response curves for each of the cuts (figure 2) and two of the four firms in question (figures 3 and 4). The BSB price reaction in response to a shock (or increase) of 1 standard deviation to BSB ratio can be seen at months six, seven and eight and again at months fifteen through twenty (figure 2). This finding is consistent with the Lawrence study where little relationship between the hog-corn ratio and live hog prices within the first four quarters was found. Results began to show consistency with profits and hog prices reflecting a high ratio that resulted in expansion of production and lower future prices by the sixth quarter. In the case of broilers, an increase in the ratio is an indication of increased profits in the industry that induce an over-supply of broiler cuts, eventually resulting in a price decrease. Specifically, a shock to the BSB:corn ratio resulted in a spike in BSB price in months 1 and 2, with a rapidly decreasing price for BSB, reaching a minimum by month 8. A gradually increasing wave pattern continues with relative maxima reached in months 12, 24 and 36 and relative minima reached in months 18 and 28; the pattern returns to the level of its origin by the end of the analysis period.

Induced shocks in LQ and WOG cut ratios resulted in no significant reaction in the prices of other cuts. This result follows a previous study by Goodwin and McKenzie which found that prices of other broiler cuts had no response to a price shock of these cuts. Prior industry knowledge of BSB reflects the fact that white meat is the most valuable part in dollar terms of a chicken in the U.S. and that the decision of how much WOG and dark meat to produce depends heavily on the market demand for the white meat (Goodwin, McKenzie 2003).

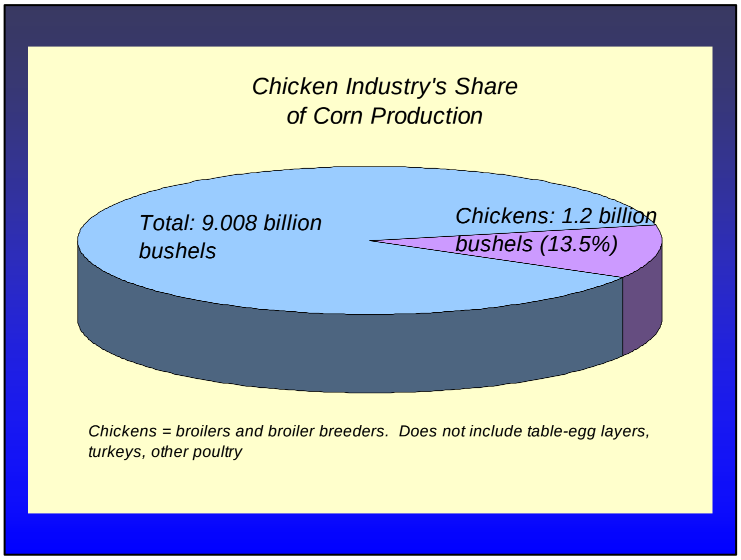
Two of the firm analyses are presented in this manuscript, those for Tyson and ConAgra. These two firms had the most stable structure over the study period in terms of acquisition and merger activity and firm organization. A shock to the BSB:corn ratio for ConAgra share price results in a (97% significance level) negative response beginning immediately but becoming substantial by month seven and a continuing decline through month fourteen, at which time the share price recovers gradually through the end of the 36-month period, although remaining negative (figure 3).

Tyson stock price also reacts negatively to a shock in the BSB:corn ratio (97% significance level) (figure 4). Tyson share price responds by small variation in price until month 5, when a sharp decline occurs through month 8, then recovers by month 10 to month 5 levels, declines again to month 8 levels by month 18 and recovers slowly throughout the remainder of the period. In no case is the decline as marked nor does it fall to so low a level as for ConAgra’s stock price. Tyson’s more moderate response could be due to its size as the #2 broiler producer but also to its diversity; Tyson is the #1 beef producer in the U.S., with 23% market share and is also #2 in pork production with 21%. ConAgra, although somewhat diversified, holds just 8% of the market share for beef and is not a player in the pork market (Fatka 2007).

In conclusion, the expected similarities between the hog-corn ratio and a broiler:corn ratio are confirmed with preliminary testing. The relationship brought an expected decline in price. The effect of an increasing broiler: corn ratio is to induce negative price response as a result of over-production. This is, in turn, reflected by a negative share price response. The fact that stock prices react negatively to a shock in product price could indicate market inefficiencies. Stock markets should be able to predict and adjust for change prior to happening. The importance of this result is the use of a broiler:corn ratio to be an indicator of industry profits. Future modeling utilizing additional variables and extended analysis intended to estimate actual changes in profit over the past twenty years will add robustness to this analysis and lend further support to the proposition that firm profit theory in the poultry industry should include some form of the broiler:corn ratio.

Future Research

Is corn the answer to our growing fuel needs? Crop residues, in particular corn stover represent just one resource base for biomass ethanol production. For example, over half of Brazil's annual fuel demand is fulfilled by ethanol derived from sugarcane (Baker 2007). In the long run, agricultural residues could be the exponent for substantial growth of the ethanol industry. Corn stover alone could support 7 to 12 billion gallons of ethanol production per year[3]. Further research would be required on the environmental effects of large-scale crop residue removal (Dipardo).



Source: http://www.nationalchickencouncil.com/statistics, accessed May 2007.

Figure 1: 2003 Broiler & Breeders Share of Corn Production Usage (Watts 2003)

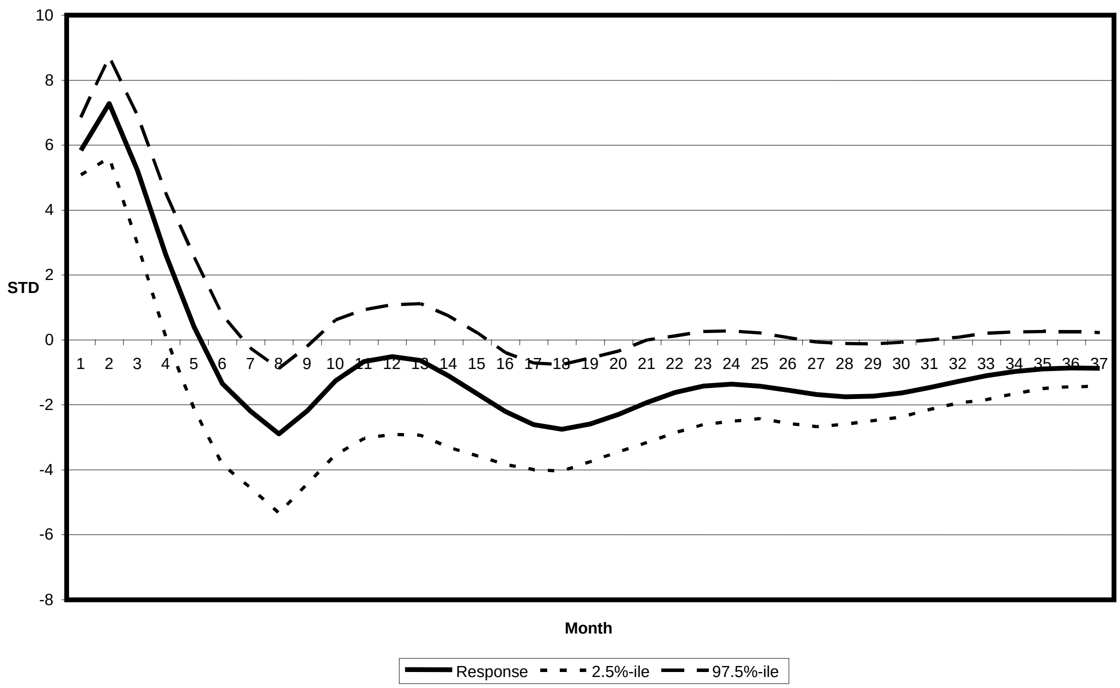


Figure 2: Standard Deviation (STD) Response of BSB Price to BSB ratio shock

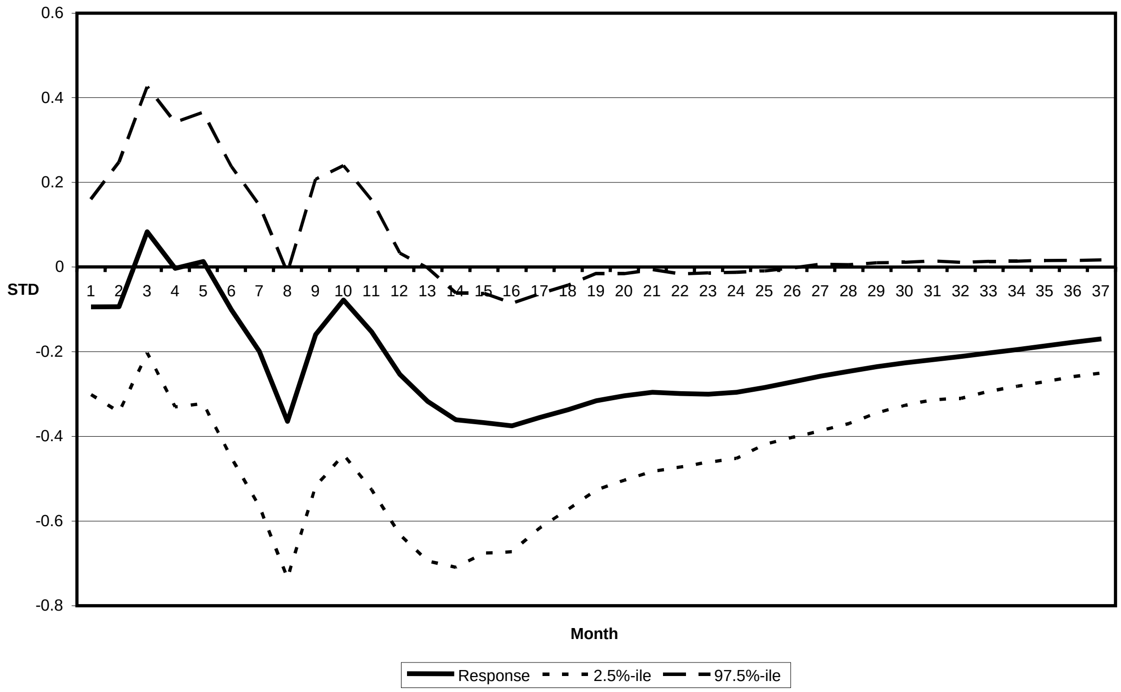


Figure 3: Standard Deviation (STD) Response of Tyson Share Price to BSB-Ratio Shock

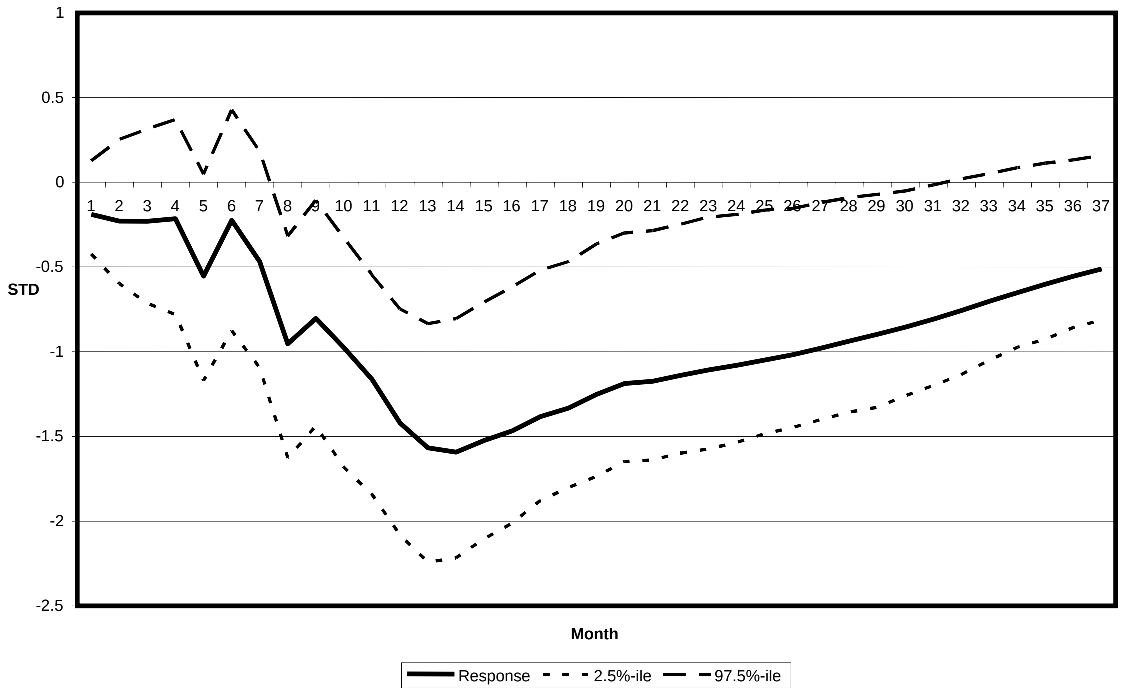


Figure 4: Standard Deviation (STD) Response of ConAgra Share Price to BSB Ratio Shock

References

Babcock, B.A., Hennessy, D.A., "Getting More Corn Acres from the Corn Belt", *Iowa Ag Review*, v12, n4, Fall 2006.

Babula, R.A., D.A. Bessler, and G.E. Schluter, "Poultry-Related Price Transmissions and Structural Change Since the 1950's" *Journal of Agricultural Economics Research* 42(1990):13-21.

Baker, A., Zahniser, S., "Ethanol Reshapes the Corn Market", USDA/ERS *Amber Waves*, May 2007, p66-71.

Dipardo, J., Outlook for Biomass Ethanol Production and Demand, http://www.eia.doe.gov/oiaf/analysispaper/biomass.html , accessed May 10, 2007

Fatka, J., "Broiler, hog industries save billions from corn", *Feedstuffs*, Issue 13, v79, March 26, 2007

Feedstuffs, http://www.feedstuffs.com/ME2/Default.asp, January 15, 2007

Global Financial Data, http://www.globalfinancialdata.com/index.php3?action=detailedinfo&id=3433#metadata, accessed May 2007.

Goodwin, Jr., H. L., McKenzie, A. M, Djunaidi, H., "Which Broiler Part is the Best Part?", *Journal of Agricultural and Applied Economics*, 35,3(December 2003): 483-495.

Hart, C.E., "Feeding the Ethanol Boom: Where will the Corn Come From?", *Iowa Ag Review*, v12, n4, Fall 2006.

Holt, M. T., L. E. Craig, “Nonlinear Dynamics and Structural Change in the U.S. Hog-Corn Cycle: A Time-Varying STAR Approach”, *American Journal of Agriculture Economics,* 88(1) (February 2006): 215-233.

Kloek, T., and H. Van Dijk, “Bayesian Estimates of Equation System Parameters: An Application of Monte Carlo” *Econometrica* 46(1978): 1-20.

Lawrence, J., “Hog:Corn Ratio What Can We Learn From the Old School?”, The Pig Site, http://www.econ.iastate.edu/outreach/agriculture/periodicals/ifo/documents/ifo101606_000.pdf, accessed May 2007.

Meyer, S., “Hog:Corn Ratio – Alive and Well”, *National Hog Farmer*, March 10, 2006, http://nationalhogfarmer.com/marketpreview/hog-corn-ration/, accessed May 2007.

National Chicken Council, http://www.nationalchickencouncil.com/statistics/stat_detail.cfm?id=4, accessed May 2007.

Ollinger, M., Nguyen, S. V., Blayney, D., Chambers, B., Nelson, K., “Structural Change in the Meat, Poultry, Dairy, and Grain Processing Industries”, USDA/ERS Research Brief, Resources and Environment, February 2005.

USDA/NASS, Statistical Bulletin 1003, Statistical Highlights of U.S. Agriculture for 2004-2005, April 2005, http://www.usda.gov/nass/pubs/stathigh/2005/stathi.txt, accessed May 2007.

USDA/NASS, Statistical Bulletin 1006, Statistical Highlights of U.S. Agriculture for 2005-2006, May 2006, http://www.usda.gov/nass/pubs/stathigh/2005/stathi.txt, accessed May 2007.

Watts, G., National Chicken Council, Statistics and Research," Chicken and Grain: Status and Projections", Annual Meeting May 2003

[1] Note: broiler feed contains 70% corn, 20% soybean meal hi pro, 6-8% meat and bone meal, 2% vitamins, mineral.

[2] Average broiler/feed conversion ration is 1.8 to 2.5 pounds of feed to produce one pound of live broiler.

[3] Conversion yields of around 60 to 100 gallons per dry ton