The Professional Animal Scientist 33:585–595
https://doi.org/10.15232/pas.2017-01616

Evaluation of the effect of the magnitude of errors in the sorting of pigs for market on the optimal market weight

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ABSTRACT

The objective was to estimate the effect that sorting accuracy at marketing has on the optimal market carcass weight (CW) and economic returns. Two types of errors were evaluated: BW estimation error (BWEE) and percentage of pigs not visually evaluated (PNVE). Four levels of BWEE with SD of 0, 4, 6, and 8% of BW and 4 levels of PNVE (0, 8, 16, and 24%) were simulated. Initially, pigs were marketed in 3 marketing cuts: 25% at 169, 25% at 179, and the remaining 50% at 193 d of age. The timing of marketing was shifted in 7-d intervals. Sort loss was calculated using a market system for a United States pork processor. Sort loss ($/pig) values were fitted to a polynomial function of mean CW for each combination of BWEE and PNVE. The increase in mean sort loss for each unit increase in CW above 93 kg increased as BWEE and PNVE increased ($P < 0.001$). With accurate sorting (BWEE = 0%, PNVE = 0%), the optimal mean age for the 3-marketing-cut strategy was 190.5 d at a mean CW of 97.0 kg and profit of $3.35/pig. With less accurate sorting (BWEE = 8%, PNVE = 24%), the mean age decreased to 184.5 d with mean CW of 93.4 kg and profit of $2.00/pig. The optimal market ages and CW decreased as BWEE and PNVE increased ($P < 0.001$). Current marketing systems direct pork producers with less accurate sorting of pigs to market their pigs at lighter CW.

Key words: pork, marketing, sort loss, stochastic model, pig supply chain

INTRODUCTION

Pork processors have established marketing grids in which carcasses heavier or lighter than a specified carcass weight (**CW**) range are discounted in value. To reduce sort loss and target the optimal market BW, most commercial producers visually evaluate the BW of each pig and try to identify the heaviest pigs for marketing on multiple marketing days (Li et al., 2003; Boys et al., 2007). Pork producers visually evaluate the market pigs and target a specific number of heavy pigs in each pen to be marketed each day (McBride and Key, 2003). Two types of pig marketing errors exist: errors in the estimation of BW for the pigs that are visually evaluated and the percentage of pigs that are not visually evaluated (Cabezon et al., 2016).

The marketing strategy has the goal to maximize the daily returns above feed and other variable costs so that the annual returns for the facility are maximized (Li et al., 2003; Boys et al., 2007; Frey, 2007). The pork processors marketing grid discounts for excessively light or heavy carcasses sets the upper and lower bounds for market CW (Boland et al., 1993). Traditionally, sort loss has been used to estimate the accuracy with which pigs are sorted for marketing. However, many factors, including the marketing strategy, variation in BW growth, and mean CW, affect the total sort loss per pig (Korthals, 2001; Hubbs et al., 2008). Marketing strategies to reduce sort loss, such as targeting the midpoint of the pork processors undiscounted CW range, may minimize sort loss but in most cases will not optimize the objective for a finishing barn, to maximize daily returns above daily variable and feed costs (Li et al., 2003; Boys et al., 2007; Frey, 2007).

The accuracy with which pigs are sorted for market affects the distribution in CW, which in turn affects the relationship of sort loss to the mean market CW (Que et al., 2017). The optimal market weight may be affected by the accuracy with which pigs are sorted for marketing. With new procedures to estimate the accuracy of sorting market pigs (Cabezon et al., 2016; Que et al., 2016), pork producers could adjust their marketing strategy for their estimated level of sorting accuracy.

The objective of this study was to use simulated data and apply actual production costs to estimate the effect that the accuracy with which pigs are sorted for marketing has on the optimal market CW and economic returns.

MATERIALS AND METHODS

The simulation data used are described in detail in 2 papers (Cabezon et al., 2016; Que et al., 2017). The BW growth curves for twenty-five 4,000-head wean-to-finish

The authors declare no conflict of interest.

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barns were simulated using data from a single sire line and dam line (Schinckel et al., 2012a,b). A marketing strategy was simulated to represent that currently used by pork producers. Initially, 25% of the pigs were targeted to be marketed at 169 d, 25% at 179 d, and the remaining 50% marketed at 193 d of age, with a mean marketing age of 183.5 d. Then the timing of marketing was shifted in 7-d intervals with mean marketing ages of 155.5 to 211.5 d with mean CW of 75.66 to 108.65 kg.

The BW data were simulated using a Michaelis-Menten equation with the form $BW_{i,t} = WT_0 + (\{[(WF + wf_i) - WT_0](t/K)^C\}/[1 + (t/K)^C])$, where WF is the mean mature BW, WT_0 is birth BW assumed to be a constant 1.6 kg, i is the pig identification number, t is the days of age, K is a parameter equal to the days of age in which one-half mean mature BW is achieved, and C is a unitless parameter (Lopez et al., 2000; Schinckel et al., 2009a; Schinckel et al., 2012a). The values for WF, K, and C were fixed at 270 kg, 191.5 d, and 2.221 based on previous data (Schinckel et al., 2012a, WF equal to 261.7 for gilts and 278.7 for barrows). Pig-specific random effects (wf_i) were generated to reproduce the variation in BW. The BW for each pig were estimated using the Michaelis-Menten equation including each pig's random effect. The equation for CW included a random effect that was assigned a value sampled from a standard normal distribution: $CW = (1 + 0.02z_2) \times 0.721(BW)^{1.0061}$, where z_2 is a value sampled from a standard normal distribution (mean = 0.0, SD = 1; Schinckel et al., 2012b).

Four BW visual assessment error rates (**BWEE**) were simulated to represent zero, low, average, and high levels of visual assessment of BW (Ahlschwede and Jones, 1992). The visual assessment errors were simulated to have SD of 0, 4, 6, and 8% of each pigs actual BW. Each pig was randomly assigned to be evaluated for BW or not evaluated for BW. The percentage of pigs with their BW not visually assessed (**PNVE**) was 0, 8, 16, and 24%. These values are based on the inspection of carcass data obtained from several 4,000-head barns with 3 marketing cuts per barn (**MCUT**, Que et al., 2016; Y. Que and A. P. Schinckel, unpublished data).

The 4 levels of visual assessment accuracy (BWEE with SD of 0, 4, 6, and 8% of BW) and 4 levels for the percentage of pigs not visually accessed (PNVE with 0, 8, 16, and 24%) were applied to each of the 25 barns as a 4 by 4 factorial arrangement of treatments. Thus, each of the 16 treatments were applied to the pigs in the 25 barns (Cabezon et al., 2016).

Sort loss is amount that each carcass is discounted for having too light or too heavy a CW. Sort loss was calculated using a market value system for a midwestern United States pork processor (Indiana Packers Corporation, 2015, Table 1) that has different discount rates ($/kg) for different ranges of CW. The number of pigs with sort loss, the total amount of sort loss, and mean sort loss per pig were estimated for each MCUT and the entire barn at each weekly marketing time.

The daily feed intakes used for the gilts and barrows of sire line 1 were from the study by Schinckel et al. (2012a). The equations for the gilts was as follows: DFI, kg/d = $3.45[1 - \exp(-0.025811BW^{1.322})]$, and the equation for the barrows was as follows: DFI, kg/d = $3.33[1 - \exp(-0.00616418BW^{0.9073})]$.

Pork production costs were estimated using the Provimi Pig Flash Spreadsheet (Provimi, 2016). Ingredient costs ($/kg) were set at 0.1377 for corn, 0.3579 for 48% soybean meal, and 0.1738 for distillers dried grains and solubles (**DDGS**). Pigs were modeled to be fed 3 starter diets with a total cost of $11.72. Six grower-finisher diets primarily composed of corn, soybean meal, and DDGS were modeled to be fed. For simplicity, ractopamine was not fed in the final diet, which would have required additional modeling of the ractopamine responses on several growth parameters (Li et al., 2003). The grower-finisher diets were modeled to contain 27.5% DDGS except the final finisher diet with 25% DDGS. A $0.0143/kg feed processing and delivery cost was added to each diet.

Death loss, interest, and yardage costs ($41.00/yr) and a management cost ($0.01/d) were assigned as daily costs (total $0.1572/d). Pig costs ($/pig) also included marketing costs ($2.50 plus 0.50 checkoff), veterinary medical costs ($4.50), and insurance ($0.40).

Base carcass prices were set at $1.433 and $1.653 per kilogram of CW to represent a situation of a small and large profit per pig. Using previous data (Schinckel et al., 2012b), predicted pork processor percent lean (**PL**) was estimated as PL = $b_0 - 0.063(CW - 80, kg)$, where b_0 = 58 for gilts and 56 for barrows. Using a stochastic model and linear regression, lean premium (**LPREM**, $/100 kg of CW) for gilts was estimated as LPREM = 21.202 − 0.09017CW, kg ($R^2 = 0.989$), and for barrows it was LPREM = 18.94 − 0.09833CW, kg ($R^2 = 0.993$). The mean sort loss per pig was estimated for each MCUT and the entire barn at each weekly marketing time (Que et al.,

Table 1. Carcass weight discount rates for different carcass weight classes[1]

Carcass weight, kg	Discount, $/kg
<68.5	0.441
68.5–73.0	0.286
73.0–75.3	0.176
75.3–77.6	0.121
77.6–82.1	0.077
82.1–107.0	0
107.0–109.3	0.0661
109.3–111.6	0.2425
111.6–113.9	0.2866
113.9–116.1	0.3307
>116.1	0.3748

[1]Indiana Packers Corporation (2015).