The Professional Animal Scientist 32 (2016):495–506; http://dx.doi.org/10.15232/pas.2015-01499

Evaluation of statistics to be used to quantify the magnitude of errors in the sorting of pigs for market via simulation

F. Cabezon, A. P. Schinckel,[1] PAS, and Y. Que
Department of Animal Sciences, Purdue University, West Lafayette, IN 47907-2054

ABSTRACT

The BW growth curves for twenty-five 4,000-head finishing barns were simulated to (1) evaluate methods to quantify the errors in the estimation of BW for market pigs from available data and (2) estimate the effect of sorting errors on the mean and variance in BW and carcass weight. 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. Pigs were marketed in 3 marketing cuts (MCUT): 25% at 169, 25% at 179, and the remaining 50% at 193 d of age. The percentage of pigs sold correctly for each MCUT was determined. Two types of sorting errors, pigs not marketed that should have been or pigs marketed that should not have been, were evaluated. The magnitude of the sorting errors was estimated as the pig BW minus the cutoff BW for that day. Statistics identified that differed with ($P < 0.01$) and quantify the accuracy of sorting are percentage of pigs sold correctly, especially for the second MCUT; magnitude of the errors for pigs sold incorrectly; distribution of the sorting errors; and the SD for carcass weight for pigs of the second MCUT. These statistics can be estimated from currently available data to quantify the accuracy of sorting market pigs. The magnitudes of BWEE and PNVE affect the distribution of carcass weight.

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). On larger farms, pig sorting-marketing crews target a specific number of heavy pigs in each pen to be marketed each day (McBride and Key, 2003). In large pens, the sorting-marketing crew may identify the target number of pigs for marketing (i.e., 25%, 32 out of 125) before visually evaluating all the pigs in the pen. Thus, 2 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.

Traditionally, sort loss has been used to estimate the accuracy in which pigs are sorted for marketing. However, many factors beside the accuracy of sorting 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).

At the present time, the only feedback given to most pork producers are the CW of the pigs, sale date, number of pigs with sort loss, and amount of sort loss. These statistics do not provide a measure of the level of accuracy in which the pigs were sorted for marketing. Measures of sorting accuracy could be used as feedback to the sorting-marketing crews.

The objectives of this study were use simulated data to (1) evaluate methods to quantify the magnitude

[1] Corresponding author: aschinck@purdue.edu

of sorting errors for market pigs from currently available data, (2) estimate the effect of sorting errors on the mean and variance in CW, and (3) demonstrate the effect that each of the 2 sorting errors has on the identified measures of sorting accuracy.

MATERIALS AND METHODS

The BW growth curves for twenty-five 4,000-head wean to finish barns were simulated. Pigs were assigned to 32 pens of 125 pigs in each barn. Pigs were modeled to be born over a 5-d interval with 20% of the pigs born each day to reflect the range in age in the larger commercial production systems. The distribution of pig BW in the pens and barn was such that pigs could be removed equally or almost equally from each pen each marketing day. A marketing strategy was simulated to represent that currently used by pork producers. Twenty-five percent of the pigs were targeted to be marketed at 169 d, 25% at 179 d, and the remaining pigs marketed at 193 d of age.

The BW data were simulated using a generalized Michaelis-Menten equation. The equation has 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 the mean 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 WF is achieved, and C is a unitless parameter (Lopez et al., 2000; Schinckel et al., 2009a, 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). Pig-specific random effects (wf_i) were generated as 30 times a value sampled a standard normal distribution (z_1, mean = 0 and SD = 1). The BW for each pig were estimated using the generalized Michaelis-Menten equation including the random effect of each pig. The equation for CW included a random effect that was assigned a value sampled from a standard normal distribution [$CW = (1 + 0.02z_2) \times 0.721(BW)^{1.0061}$, Schinckel et al., 2012b].

Four BW assessment error rates (**BWEE**) were simulated to represent zero, low, average, and high levels of visual assessment of BW (Ahlschwede and Jones, 1992). The assessment errors were simulated to have standard deviations of 0, 4, 6, and 8% of each pigs actual BW by the equation predicted BW = [1 + (proportional error rate × z_3) × actual BW], where the proportional error rates are 0.0, 0.04, 0.06, and 0.08 for each level of BW assessment accuracy.

Each pig was randomly assigned to be evaluated for BW or not evaluated for BW based on values sampled from standard normal distributions. It is assumed that some percentage of the pigs that are available for marketing are not seen or not considered because the percentage of pigs targeted for marketing in that pen had already been achieved. For example, for the first marketing day, upon identifying 32 heavy pigs in the pen, the sorters would move to the next pen without evaluating the BW of the remaining percentage of pigs in the pen. The percentages of pigs with their BW not visually evaluated (**PNVE**) were 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, and 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 assessed (PNVE, 0, 8, 16, and 24%) were applied to each of the 25 barns as a factorial arrangement of treatments. Thus, each of the 25 barns was modeled to have 16 combinations of the 2 types of market BW sorting errors.

Several statistics were estimated from simulated CW data currently available from pork processers including date (used to estimate age at marketing), CW, and sort loss. Sort loss was calculated using a market value system for a midwestern United States pork processor (IPC, 2013; Table 1). The mean and variance for BW, CW, the total amount and mean sort loss per pig were estimated for each MCUT and the entire barn. The sorting accuracy and the percentage of pigs sold correctly for each MCUT and the entire barn based on the actual pigs marketed versus those that should have been marketed without error was determined. Note that the Indiana Packers Corporation grid (Delphi, IN) is actually both a CW and predicted percent lean grid. In this paper, it was assumed that the percent lean of the pigs is consistent within the range of CW evaluated.

The magnitude and type of sorting error (pig not marketed that should have been marketed or pig marketed that should not have been marketed) for each pig sold incorrectly for the first 2 MCUT were estimated. Using the simulated marketing without any error, the cutoff market BW was estimated for each marketing day as the mean BW of the lightest pig marketed and heaviest pig not marketed for each marketing day. The magnitude of the first error, the marketing of pigs that should not have been marketed, was estimated as pig BW minus the estimated cutoff BW for that marketing day (note all negative values).

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

Carcass weight, kg	Discount, $/kg
<68.49	0.441
68.49–73	0.242
73–75.3	0.1102
75.3–77.6	0.0661
77.6–82.1	0.0331
82.1–106.8	0
106.8–109	0.0661
109–111.36	0.2425
111.36–113.62	0.2866
113.62–115.9	0.3307
>115.9	0.3748

[1]Indiana Packers Corporation (Delphi, IN, 2013).