Livestock Science 157 (2013) 9–19

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Evaluating breeding objectives for sow productivity and production traits in Large White Pigs

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ARTICLE INFO

Article history:
Received 3 August 2012
Received in revised form
10 June 2013
Accepted 12 June 2013

Keywords:
Genetic parameters
Economic return
Genetic selection
Response to selection

ABSTRACT

the objective of the study was to develop and evaluate different breeding objectives for sow productivity and for production traits, using economic selection indices. Genetic parameters were generated using a repeated records model for sow productivity traits and a maternal effects model for production traits, in ASREML. Stochastic simulation models based on a hypothetical 100-sow model were performed for each line, i.e., a dam line and a terminal sire line, respectively, to derive economic values. The traits included in the study were number born alive (NBA), 21-day litter size (D21LS), 21-day litter weight (D21LWT), average daily gain (ADG), feed conversion ratio (FCR), age at slaughter (AGES), dressing percentage (DRESS), lean content (LEAN) and backfat thickness (BFAT). The economic values for LEAN and BFAT were derived using the partial differentiation of the profit function, while those for the other traits were derived using the partial budget approach. An economic value of a trait was the change in profit per unit genetic change in that trait. Breeding objectives were developed with a corresponding selection index, for improvement of that objective. Three combinations of breeding objectives and selection indices were developed for sow productivity traits, while there were 15 combinations for production traits. Responses to selection and economic return were computed for each combination to determine the most appropriate combination for the improvement of the breeding objective traits. The most appropriate index to improve sow productivity consisted of NBA and D21LWT. For production traits, the combination that consisted of a selection index with AGES, DRESS and BFAT, and the breeding objective ADG, DRESS, FCR and LEAN, was considered the most appropriate. Age at slaughter and BFAT were, respectively, included as indicator traits for ADG and LEAN. The recommended breeding objectives were sensitive to changes in economic values, indicating that economic values for breeding goal traits should be updated periodically to ensure proper weighting of traits, hence maximization of economic return.

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1. Introduction

Commercial pig production in South Africa is mainly based on crossbreeding, with dam lines contributing to sow productivity and terminal sire lines contributing to performance in production traits. The breeding programs thus aim to improve these traits by having separate genetic improvement programs for the respective lines. In the past, pig production in South Africa focused on input parameters, such as, feed intake and feed conversion efficiency, with little emphasis on output parameters, such as, carcass yield and quality (Visser, 2004). Profitability has been viewed as a logical unit of expression for the final evaluation of a pig enterprise (MacNeil et al., 1997). Thus,

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1871-1413/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2013.06.018

of late, consideration of sow productivity, input and output parameters has been central to the South African pig improvement programs, through multi-trait selection and selection indices to improve the profitability of pig enterprises (Visser, 2004). This has been driven by the need to shift from production to productivity and sustainability, which is a common feature of modern pig industries (Olesen et al., 2000).

The use of selection index methodology to select for more than one trait by weighting EBVs with economic values has long been established in the livestock industry (Banga, 2009; Groen, 1990; Wolfova et al., 2007). The original selection index developed by Hazel (1943) generated phenotypic weights, which have been discouraged in genetic improvement programs because of the limitations outlined by Bourdon (1998). Thus, an index that utilizes EBVs weighted by economic values is ideal for modern genetic selection programs (Bourdon, 1998; Wolfova et al., 2007). Use of economic values allows animals to be ranked based on their aggregate genetic values in monetary terms, instead of biological values. Development and evaluation in monetary terms of breeding objectives is necessary to identify the most appropriate breeding objective for maximum productivity and economic efficiency. Economic return for a breeding program makes it possible to evaluate that breeding program objectively (Conington et al., 2001).

The conventional selection index development is mainly summing the products of breeding values and economic values (Banga, 2009; Groen, 1990). The prerequisite for this method is to have similar traits in the breeding objective and selection criteria. In the approach suggested by Gibson (1995) and Schneeberger et al. (1992), the traits in the breeding objective can be different from the selection criteria, and therefore allows the use of indicator traits in selection indices. Application and evaluation of the approach of Gibson (1995) and Schneeberger et al. (1992) in practical breeding goal development has been limited, at least in the pig industry. Use of this approach may be beneficial to pig improvement programs as it will maximize profit, while minimizing the traits in the index. In addition, indicator traits that have been extensively used in selection programs may be objectively weighted during selection.

The selection indices used by the South African breeding programs do not conform to the confines of economically relevant traits and selection index methodology as suggested by Bourdon (1998). Non-objective methods are used to derive index weights; hence the relationship between genetic improvement and profitability may be limited, which may restrain profit maximization by pig producers. Therefore, proper development and implementation of breeding objectives by objective methods is needed if the pig industry is to be productive, profitable and sustainable.

The objectives of this study were to (i) develop breeding objectives that will maximize profit by using economic selection indices and (ii) evaluate the contribution made by indicator traits in South African Large White pig improvement programs.

2. Materials and methods

2.1. Performance testing and recording

Pig performance testing was done at three testing stations, namely Irene, Elsenburg and Cedara, to evaluate production traits. The pigs were tested and slaughtered at these testing centers. Every year each member submitted 44 pigs (22 boars and 22 gilts) for testing. These pigs represented a minimum of five herd sires per breed or line, or 50% of the herd sires per breed or line. On arrival, the pigs were treated for internal and external parasites and quarantined, individually penned on solid concrete floors and fed until they commenced testing at 27 kg. During the test period, animals were individually housed and fed ad libitum using individual self-feeders and water was also available ad libitum from nipples. Daily feed intake was calculated as the difference between feed provided at the start of the day and the feed left in troughs at the end of the day. Backfat measurements were taken using a Backfat Scanner A100 probe at slaughter (86 kg), 6.5 cm from the midline between the second and the third last rib. Weighing during the test period was done weekly without any change in the feeding routine and performance testing. At the completion of the test, the pigs were fasted for 24 h before slaughter to empty stomach contents. Live weights were then measured, after which the pigs were electrically stunned with 250 V for 7–10 s before exsanguinations at the various abattoirs. Lean content (LEAN) was determined using a Hennesy Grading Probe. Animal ethics approval was obtained from the Agricultural Research Council Animal Ethics Committee. A state veterinarian or meat inspector performed the necessary inspection of the carcasses after slaughter. Dressing percentage (DRESS) was cold carcass weight expressed as a proportion of live weight at slaughter.

2.2. Biological traits affecting profits

Sow productivity traits were number born alive (NBA), 21-day litter size (D21LS) and weight (D21LWT). Number born alive refers to the number of live piglets born to a particular sow in a particular farrowing. This affects the number of piglets that survive to weaning and the number of pigs marketed. Twenty-one-day litter size is the number of piglets from a particular sow's farrowing that reach 21 days of age, and the total weight of these piglets is D21LWT. Twenty-one-day litter weight affects post-weaning growth performance, ultimately affecting days to reach slaughter weight and the total costs incurred.

The production traits included in the analyses were average daily gain (ADG), feed conversion ratio (FCR), age at slaughter (AGES), ultrasonic backfat thickness (BFAT), LEAN and DRESS. Ultrasonic backfat thickness indicates the level of carcass fatness and therefore reflects the leanness of a carcass. Average daily gain is the rate of body weight gain of a pig from birth to marketing and determines the number of days required to reach market weight (AGES), thus affecting production costs. Feed conversion ratio is the amount of feed consumed for a unit body weight gain, which should be reduced to improve

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