A Tool To Determine The Optimal Productive Life Of A Terminal Sire In A Boar Stud Owned By A Production Company

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Introduction

With any genetic selection program there is continued genetic improvement and consequently a continued availability of genetically superior boars available to be purchased and/or placed into production. As a result, determining the length of time in production for a terminal sire is of great economic importance to a swine production company; especially, when ownership consists of all phases of production, beginning with the boar stud and ending with the market hog. When focusing on the terminal side of such a production company, there are two objectives, the terminal sire used to produce the commercial market hogs and the commercial market hogs themselves. While the goal of any production operation should be to maximize profit, in a situation such as the one described above, the maximization of profit would come through maximizing profit in the boar stud through time and through maximizing profit from the production of a commercial market hog. With respect to the boar stud segment of the company, the goal is to produce large volumes of high quality semen. When considering the commercial market hog, the focus is to continually produce larger quantities of higher quality pork in a more efficient (profitable) manner. These two objectives are antagonistic. More specifically, from the boar stud's perspective, an inventory consisting of more mature boars with few young boars would be more desirable to maximize number of doses. However, from the commercial market hog perspective, semen from boars with the greatest genetic merit is most desired, which with continued genetic improvement would lead to an inventory consisting of younger boars.

Previous work done by Fix *et al.* (2008) created a tool to assist in determining the optimum time for a boar in production when the boar stud and commercial market hog are owned by separate entities. The objective of the project reported here was to design a robust user friendly spreadsheet tool that calculates the optimum length of time a boar should be in production for a company that owns the boar stud and commercial market hogs.

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Materials and methods

Tool design. To determine the optimum length of time for a boar in production, a tool was designed with the capability of adjusting future revenue and costs into "today's" dollars using an assumed interest rate; referred to as the net present value (NPV). Models used herein build on principles applied by Perrin (1972) and Chavas *et al.* (1985) for maximizing the value of future returns by selecting the best time to cull or replace an asset. In general, a boar can be culled and replaced with a new boar each time the isolation facility is emptied. Eventually, if genetically superior boars are not available, majority of boars will be culled for non-economic selection index (index) reasons, such as health, size, semen quality, etc. For work conducted herein, an assumed time was used for the non-index culling threshold: 156 weeks.

Basis for culling decisions is every 5 weeks, beginning with initial week of collection. Each culling decision or option is based on comparing NPV of future revenues minus costs (profit) across culling options. A boar could be culled at week 5 and replaced with a new boar (average index of incoming boars) or week 10 and continued in 5 week increments up to 156 weeks in production. Potential options are compared and the alternative with the highest NPV of profit is the suggested length of time a boar should be left in production. One option that is provided in the tool is different beginning index values for boars in the stud, since it is common for there to be variation in this measure. However, in reference to boars replacing those in stud, an average is used. An average was utilized to simplify assumptions about which boar would be replacing a given boar in stud. It was assumed, that boars are mated randomly acrosss sows of comparable genetics and therefore, would influence the same number of pigs per litter with equal genetic merit from the dam side.

To allow for an accurate depiction of the future revenues and costs of a boar, the tool needs to allow for the input of numerous data. Inputs for the tool are provided below and formulas used to calculate future revenues and costs in today's dollars are presented in figure 1.

Production parameters.

- Semen production curve
    - Doses and collections per week
- Annual genetic improvement (change in index points per year)
- Percent nonproductive culls
    - Boars that are placed into isolation but never produce semen
- Pigs weaned and pigs marketed per litter
- Semen doses per litter farrowed

Economic values.

- Interest rate
- Purchase cost of boar
- Isolation cost for a boar
- Value of an average dose of semen produced
- Value of an index point
- Collection and post collection costs (semen handling, processing, etc.)
- Royalty costs (per weaned pig or per dose)

Costs

$$\sum_{\text{Week}=1}^{156} \left[\text{Boar Space} + \left(\begin{matrix}\text{Doses} \times \\ (\text{Royalty} + \text{Post Collection})\end{matrix}\right) + \left(\begin{matrix}\text{Collections} \times \\ \text{Collection Costs}\end{matrix}\right)\right] \times \left(\frac{1}{(1 + \text{Discount Value})^{\frac{\text{Week}}{52}}}\right)$$

Revenues

$$\sum_{\text{Week}=1}^{156} \left[\text{Doses} \times \left(\begin{matrix}\text{Value of Average Dose} + \\ ((\text{Index} - \text{Average Index}) \times \text{Index Point Value per Dose})\end{matrix}\right)\right] \times \left(\frac{1}{(1 + \text{Discount Value})^{\frac{\text{Week}}{52}}}\right)$$

Figure 1: Formulas used to calculate future revenues and costs in today's dollars

Results

Outcomes provided by the tool are a balance or optimization of several factors. First is the semen production curve of the boar; as boars become older they typically produce a greater volume and thus more doses of semen which provide value to the company. Second is the rate of genetic improvement; the longer a boar is in production, the more genetically superior his replacement will be. Third is the beginning index value of the potential boar to be culled. Boars are not of equal genetic merit when they are placed in stud.

Figure 2 provides a graphical depiction of the change in NPV of profit for each culling decision over the 156 week productive life. Inputs used to create figure 2 were general averages provided by a genetic company. Also shown, are how the curves differ based on the initial index value; the curves mirror the starting index value, the bottom curve on the graph is the lowest starting index value up to the top line which is the highest beginning index value. Each curve presented, represents a difference in beginning index of two points. The curves do shift up and down and the slopes do vary when comparing different inputs. However, regardless of inputs the curves are quadratic in nature; they increase at a decreasing rate until reaching a maximum and then begin to decrease. Curves for boars with poorer beginning indexes reach their maximum quickest, approximately 40 weeks, and appear to experience a much greater decrease the longer they are left in production. More specifically, the penalty in terms of lost profit if boars are left in production too long is greatest for the boars with the least genetic merit and decreases to the point where for the most superior boars leaving them in production the entire 156 weeks is within a few percentage points of the maximum profit decision. Based on the general inputs for figure 2, there is a considerable, 40 vs. 110 weeks, of suggested length in production. Although, an exact number would be difficult to predict, an outcome such as the one described would not be unexpected.

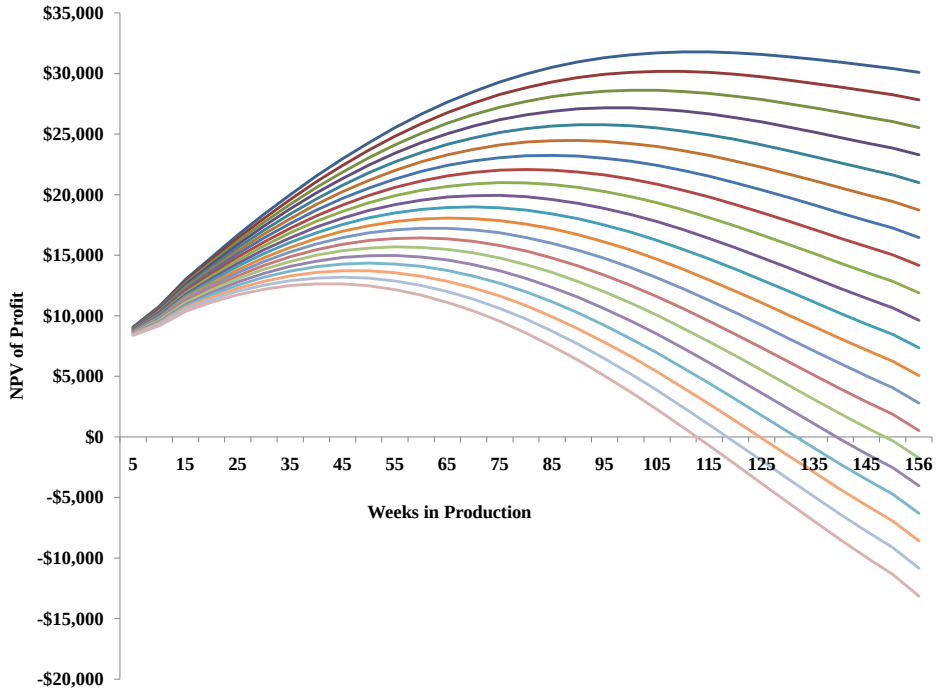

Figure 2: Depiction of the NPV of profit for each culling option by index value. Curves represent a difference of 2 index points at placement in the boar stud

Implications

Usage of this tool allows for swine production companies which consist of ownership of the boar stud through to the commercial market hogs, an opportunity to determine how long a still productive boar should be allowed to stay in stud. Also, it allows for a balance between two differing perspectives within a production company. Management suggestions from this tool are based on the inputs of the company and therefore allow for decisions to be made that directly impact their profitability.

References

Chavas, J. P., Kliebenstein, J., and Crenshaw, T. D. (1985). *Amer. J. Agri. Econ.*, 67:636-646.

Fix, J. S., See, M. T., and Casey, D. S., (2008). *J. Anim. Sci.*, 86(E-Suppl. 2):556.

Perrin, R. K., (1972). *Amer. J. Agri. Econ.*, 54:60-67.