Motivating and monitoring minimal crossfostering management

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Summary

Management interventions can be as effective as traditional veterinary medical interventions to control disease and increase productivity. The challenge to the swine practitioner is to motivate the producer to embrace such management changes and then track their implementation. Here we describe a new algorithm to help accomplish this task for farrowing house management. Our crossfostered piglet analysis provides an opportunity to readily document and visualize management patterns. This novel metric can be output as a graphic display, providing a simple tool to help farm employees implement minimal crossfostering strategies aimed at improving piglet growth and potentially minimizing the impact of infectious agents.

Keywords: swine, crossfoster, baby pig management

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Traditional veterinary interventions in the swine industry include treating and controlling infectious disease with antibiotic therapy and/or vaccination. However, a more progressive view of veterinary services extends beyond disease and considers management, facilities, genetics, and nutrition to maximize profitable production on a farm. Accordingly, many swine veterinarians have recognized the importance of incorporating these factors into their recommendations.

Often with management interventions, the challenge lies not merely in recognizing when to enact an intervention, but in motivating the producer to embrace this management change and then monitoring progress towards achieving and maintaining the new objective. Recent studies suggest that minimal crossfostering—i.e., limiting crossfostering to the immediate postpartum period—can increase piglet growth rate[1] and potentially minimize the impact of infectious agents, such as porcine reproductive and respiratory syndrome virus (PRRSV).[2] However, in many herds extensive crossfostering policies are common.[3] Piglets are initially sorted, and then disadvantaged animals are moved on a regular basis throughout lactation in an attempt to maintain size uniformity within a litter. Disruption of the majority of litters is common. To help implement minimal-crossfostering strategies, we have developed a simple analytical tool that allows us to determine when during lactation crossfostering is occurring. Using standard data extracted from a recordkeeping program such as PigCHAMP®, the output of this analysis can be displayed graphically so that it can be used as a simple on-farm motivational tool.

The problem

Recognizing and reinforcing appropriate piglet management practice (crossfostering)

Standard piglet management information, such as that collected for PigCHAMP®, can be used to summarize crossfostering of pigs, split weaning of pigs, and the use of nurse sows in a herd. Standard PigCHAMP® reports, however, do not readily provide information about the temporal patterns of crossfostering, i.e., the number of piglets fostered at specific ages.

Our solution

We have developed a novel analytical approach, based on data exported from PigCHAMP®, that allows us to assess these temporal patterns. Our crossfostered-piglet analysis algorithm demonstrates when during the lactation period crossfostering is occurring. This analysis is akin to a survival analysis[4,5] of the subpopulation of piglets that will ultimately be crossfostered. A quantity Q is defined at any time t as:

$$Q_t = P - \sum_{i=0}^{t} p_i$$

where:

- P is the total number of piglets crossfostered
- p_i is the number of piglets crossfostered during a given time interval
- t describes the number of days postfarrowing, and
- i is the time interval over which observations are made—usually a day.

The result of this calculation can be divided by total piglets crossfostered during the total lactation period to yield a proportion or normalized metric that permits the user to compare the number of piglets being crossfostered at different time points within one herd or to make comparisons between herds. Note that this analysis can only be performed after the cohort is weaned.

Preparing our crossfostered piglet analysis graph

The first step to construct the graphic output of this information is to use the Database Application feature of PigCHAMP® to extract the information needed. List the following data (List Data):

- ID,
- FARROWDATE, and
- FOSTERDATE AND FOSTERPIGS (Figure 1).

You must limit this information with filters to extract only the data needed for the analysis, so you should select a time

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interval over which you want to perform the analysis. Specify this for FARROW-DATE. Furthermore, only FOSTER ON events need to be included, so set a filter for FOSTERPIGS > 0.

Now the information is ready to be transferred to a spreadsheet for further analysis (a sample Excel™ spreadsheet is available for review online at `http://www.aasp.org/shap/`).

- First, calculate the age at fostering by subtracting FOSTERDATE from FARROWDATE (Figure 1).
- Next, create a distribution of the number of fostered pigs by day of age for every day during the entire lactation period. We have used the conditional sum function of Excel™ to tally the number pigs fostered on each day postfarrowing (Figure 1).
- Then, obtain the cumulative total of pigs crossfostered by summing the number of pigs crossfostered on each subsequent day. The crossfoster metric is calculated for each day by subtracting the cumulative total of piglets crossfostered between birth and the day of interest from the total number of piglets crossfostered.
- To compare trends arising from different herds or different time periods, divide the crossfoster metric by the total pigs fostered. This normalized metric describes the proportion of pigs to be fostered over time.
- Finally, plot the data versus days postfarrowing, and select a logarithmic scale for the *y* axis (Figure 2).

Using the analysis: Farm examples

Figure 2 shows an example of the graphic output of our crossfostering analysis using data taken from two real farms over a 4-month period in juxtaposition to a trendline showing the target pattern of crossfostering for optimal management. We used a logarithmic scale on the abscissa to emphasize late crossfoster events (i.e., crossfostering that occurred when pigs were ≥ 2 days old). These are the events that we are most interested in eliminating. By plotting the data from our algorithm in this

Figure 1: Example spreadsheet design, incorporating data derived from PigCHAMP® and calculation of crossfoster metric

	A	B	C	D	E	F	G	H	I	J
1	ID	FARROWDATE	FOSTERDATE	FOSTERPIGS	Age at foster	Lactation day	Daily sum	Metric	Normalized metric	
2	G2001	9/6/99	9/8/99	1	① 2	0	② 17	④ 456	⑥ 100%	
3	G2015	8/6/99	8/23/99	1	17	1	35	⑤ 439	96%	
4	[illegible]	[illegible]	[illegible]	2	2	2	252	404	89%	
5	[illegible]	[illegible]	[illegible]	2	2	3	78	152	33%	
6	[illegible]	[illegible]	[illegible]	3	2	4	[illegible]	[illegible]	16%	
7	G2041	11/26/99	11/26/99	3	0	5	[illegible]	[illegible]	12%	
8	G2041	7/11/99	7/14/99	1	3	6	[illegible]	[illegible]	11%	
9	G2041	11/26/99	11/29/99	1	3	7	[illegible]	[illegible]	11%	
10	G2043	8/18/99	8/20/99	2	2	8	[illegible]	[illegible]	11%	
11	G2053	8/22/99	8/24/99	3	2	9	[illegible]	[illegible]	10%	
12	G2130	8/14/99	8/16/99	4	2	10	1	47	10%	
13	G2133	9/2/99	9/16/99	1	14	11	1	46	10%	
14	G2183	10/21/99	10/25/99	4	4	12	12	45	10%	
15	G2184	9/9/99	9/11/99	1	2	13	8	33	7%	
16	G2195	8/31/99	9/4/99	2	4	14	9	25	5%	
17	G2195	8/31/99	9/16/99	2	16	15	4	16	4%	
18	G2204	8/13/99	8/16/99	2	3	16	4	12	3%	
19	G2207	9/5/99	9/7/99	1	2	17	4	8	2%	
20	G2209	9/8/99	9/11/99	1	3	18	1	4	1%	
21	G2211	11/26/99	11/29/99	2	3	19	3	3	1%	
22	G2214	11/3/99	11/15/99	5	12	20	0	0	0%	
23	G2216	9/20/99	9/22/99	2	2	21	0	0	0%	
24	G2224	10/9/99	10/11/99	1	2	22	0	0	0%	
25	G2228	9/15/99	9/15/99	2	0	23	0	0	0%	
26	G2235	8/31/99	9/2/99	3	2	24	0	0	0%	
27	G2235	8/31/99	9/4/99	2	4					
28	G2239	9/19/99	9/20/99	5	1	Total Fostered	③ 456			

These first four columns are imported or copied from farm records (e.g., PigCHAMP®)

Fill this formula (E2) down at least as many rows as you have data

Create this series of values (0–24) in cells F2 through F26

Fill these formulae (G2, H3, I2) down through Lactation Day 24 (row 25)

code for formulae:

① Age at foster [E2 through Exxx]: difference between farrow date and foster date
   Excel: =C2-B2
   Quattro: +C2-B2

② Daily sum [G2 through G26]: total number of foster pigs at each lactation day (age at foster)
   Excel: =SUM(IF($E$2:E***xxx***=F2,$D$2:D***xxx***,0))
   . . . and press control-enter [apple-enter] to indicate an array formula
   Quattro: @SUMIF(***sheetname***:E,***sheetname***:D)

③ Total fostered [G28]: sum of all pigs fostered on all lactation days (0-24)
   Excel: =SUM(G2:G26)
   Quattro: @SUM(G2..G26)

④ Metric [H2 only]: copy of Total fostered (no pigs were fostered prior to this day)
   Excel:=G28
   Quattro:+G28

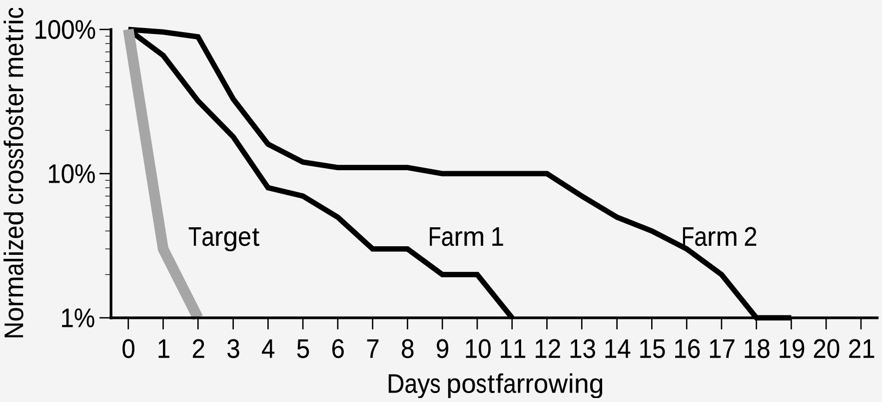
⑤ Metric [H3 through H26]: number of pigs not yet fostered prior to this lactation day
   Excel: =H2-G2
   Quattro: +H2-G2

⑥ Normalized metric [I2 through I26]: percent of pigs not yet fostered prior to this lactation day
   Excel: =H2/$H$2
   Quattro: +H2/$H$2

"***xxx***" must be replaced by the highest row number in which data is present

"***sheetname***" must be replaced by the name of the worksheet/tab (e.g., "a" or "farm data"; Quattro only)

Figure 2: Crossfostered piglet analysis of two farms. The crossfostered piglet metric for two farms is plotted and compared with the target for optimum crossfostering management



way, the temporal pattern of crossfostering in a herd is graphically revealed.

To assess the utility of our graphic to depict real differences in crossfostering patterns, we performed a statistical analysis on the data from the two real herds. The Student's t-test (Statistical Analysis Systems; Cary, North Carolina) was used to test the null hypothesis that the crossfostering pattern of these two herds was the same across the entire 4-month period represented by the data. The survival function of pigs destined to be fostered was estimated using the Kaplan-Meier estimator. The null hypothesis that the survival functions for the two herds were the same was tested in PROC LIFETEST (SAS) by calculating the log-rank statistic for each time interval and then calculating a χ^2 test statistic from the log-rank statistics. The graph reflects a significant difference (P<.0001) in the crossfostering patterns of these two herds. This is supported by the prominent differences in piglet management between the two farms (Table 1). Farm 1 fostered fewer pigs (P <.0001), fostered at a younger average age (P <.0001), and disrupted fewer litters (P <.0001) compared to Farm 2. The visual depiction of the differences in the temporal patterns of crossfostering, then, reflects significant differences between these two herds in crossfostering management.

Extent of crossfostering

Our metric focuses on the temporal patterns of crossfostering—i.e., when during lactation crossfostering is occurring in a herd. An important but separate question is determining to what extent crossfostering is occurring on the farm. The extent of crossfostering may be simply addressed by dividing the total number of crossfosters by the total number of piglets at risk of being crossfostered (i.e., the total number of piglets born alive)[6] (Table 1).

The population of pigs at risk to be fostered does, however, change during the course of lactation. Our crossfostering metric in theory could be divided by the total number of pigs alive on each given day of lactation to account for such subtleties, but this practice promises to complicate its implementation. Such changes in the "at risk" population are a function of preweaning mortality, which under usual conditions will diminish by only 10±5% from the beginning to end of lactation. Given that most of this preweaning mortality occurs in the immediate postpartum period (i.e., the first 3 days of life),[7,8] the impact of changes in the population of pigs at risk to be fostered should be minimal during late lactation (i.e., after 1 week) – our period of interest.

Discussion

Fostering is considered an important farrowing house management practice. If performed in the immediate perinatal period, crossfostering can reduce preweaning mortality and improve piglet growth.[9–11] The goal is to balance the nutritional needs of the piglets with the nutrition provided by the sow. Extension of this rationale has lead to management schemes that involve the movement of piglets between dams throughout lactation.[12] However, several biological and behavioral factors can complicate the success of the crossfostering strategy if it is practiced beyond the first 24 hours postfarrowing, and these may negate the possible benefits of this management intervention.[1,10,13]

Social hierarchy and, specifically, teat preference within the litter begins to form at birth and is largely settled by day 3 postfarrowing.[14] Disruption of litters later in lactation can reduce growth rates and cause behavioral problems in fostered pigs, resident pigs, and the sow. Fostered pigs after this age demonstrate increased ambulation, vocalization, and increased reluctance to

Table 1: Comparison of piglet management parameters

Parameter	Farm 1	Farm 2	*P**
Number of litters	606	344	
Proportion of pigs crossfostered (total number of pigs crossfosterd was divided by the total number of pigs born alive)	6.5%	9.8%	<.0001
Average age of foster in days (mean number of days postfarrowing was determined of all FOSTER ON events)	1.6	3.3	<.0001
Disrupted litters (total number of litters minus total number of litters without either a FOSTER ON and/or a FOSTER OFF event, all divided by the total number of litters)	46.4%	86.3%	<.0001

* Probability that H_0:Farm 1=Farm 2 is true. These two farms were part of a common production system that used similar genetics, feed, facilities, and (in theory) management schemes. However, it is clear that implementation of baby pig management differs between the two herds

engage in suckling.[15] Such disruption of the litter causes more pig-to-pig aggression, even among resident pigs. In addition, many sows exhibit aggression toward foster pigs, especially older pigs.[16] As age at fostering increases, these behavioral abnormalities increase, extending the time required for fostered pigs to integrate into their new environment and compromising their performance.[1,10,13]

At birth, piglets also receive passive colostral immunity against the pathogens transmitted by the dam—the most significant source of pathogens in their environment. Clearly, moving piglets after the period during which passive immunity is transferred puts them at risk by moving them into an environment containing pathogens against which they may not have adequate protection. This is especially the case with such infectious agents as PRRSV, since circulating antibodies may not be protective.[17] Late-fostered pigs are unable to benefit from the passive transfer of maternal leukocytes and the cell-mediated immunity they confer.[18,19] In addition, as is the case with PRRSV, crossfostered pigs may indeed provide a convenient vehicle for the spread of the disease.[2]

The possible untoward effects associated with late crossfostering—i.e., the disruption of the social hierarchy and the transmission of highly infectious pathogens such as PRRSV—arguably has a more salient impact upon the litter or at least upon several littermates rather than necessarily upon an individual piglet. Accordingly, the relevant measure of population at risk in late crossfostering might be the litter rather than the piglet, and thus disrupted litters (Table 1) may well be the best index for assessing the extent of crossfostering.

It should also be noted that data integrity is critical to successfully implementing our crossfostering analysis. Unfortunately, FOSTER events are events notorious for being inaccurately recorded. One simple check of data integrity is to see that there is relatively good agreement between total FOSTER ON and FOSTER OFF events.

This production tool addresses a critical aspect of farrowing house management: crossfostering. Our crossfostered piglet analysis algorithm provides a convenient metric to track crossfostering. Once graphed, temporal patterns of crossfostering are revealed and can easily be compared to goals for crossfostering. Specifically, the graphic display can underscore the frequency of late fostering events, providing a simple method to help on-farm employees focus on the appropriate execution of minimal-crossfostering strategies.

Implications

- In addition to recommending production interventions in swine herds, an important role of the consulting swine veterinarian is to motivate and monitor such change.
- Our crossfostered piglet analysis, particularly when its output is graphed to show temporal patterns in crossfostering, provides a useful tool to motivate and monitor appropriate farrowing room management.

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