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# Optimal starter lactose levels maximize returns

*There is no optimal amount of lactose to feed that will fit all production systems, but available information suggests feeding 1.7-2.0 lb. of lactose per pig.*

By **DUSTIN DEAN***

PROVIDING a source of lactose in starter programs for weaned pigs is a standard practice to improve postweaning feed intake and their overall growth potential.

The growth promotion response to lactose is at least partially due to improving diet palatability and matching feed carbohydrate to the enzyme development of the pig following weaning, but research has also suggested more complex mechanisms such as microflora alterations and gut health effects.

Many factors influence the lactose level for nursery diets.

What type of feed budget is being fed? Are big, healthy pigs being weaned or challenged pigs? Is there a lot of variation in weaning age, or is it a tight age range? Are pigs being weaned before or after 18 days of age? Are problems with feed intake postweaning and starve-outs typical, or do pigs start well in pig flows? Is the economic model based more on maximizing throughput or minimizing input costs?

These are a few of the questions to ask to make the best decision regarding not only optimal lactose levels but the needed overall complexity of nursery diets in general.

## Empirical data

There isn't an abundant amount of published research that nails down the precise levels of lactose required for maximal growth in the starter period. However, the available data from university research trials (Owen et al., 1993; Mahan et al., 2004) suggest that the response to lactose is linear with levels up to 30% during the first week postweaning (Figure 1).

Mahan et al. reported that the response to lactose remained linear until at least 20% lactose the second week postweaning, while levels as high as 10-15% lactose were needed to maximize performance through day 35

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### 1. Quantities of lactose sources needed to provide 1.76 lb. of lactose per pig

| Lactose source | % lactose | Lb. per pig |
|---|---|---|
| Crystalline lactose | 95 | 1.85 |
| Whey permeate | 80 | 2.20 |
| Whey | 70 | 2.51 |

### 2. Deviations in feed budgets from "National Swine Nutrition Guide" recommendations

| | ----------Phase 1, 2 and 3 feed budgets, lb.---------- | | | | |
|---|---|---|---|---|---|
| | Swine guide | --Proposed alternative budgets and lactose levels-- | | | |
| **Phase 1** | **1/3/13.75** | **2/6/9.75** | **3/6/8.75** | **4/13.75/0** | **5/12.75/0** |
| Budget | 1 | 2 | 3 | 4 | 5 |
| Pig weight, lb. | 12-12.75 | 12-13.6 | 12-14.4 | 12-15.2 | 12-16 |
| Lactose, % | 23 | 19.5 | 18 | 17 | 16 |
| Lactose, lb. | 0.23 | 0.39 | 0.54 | 0.68 | 0.80 |
| **Phase 2** | | | | | |
| Budget | 3 | 6 | 6 | 13.75 | 12.75 |
| Pig weight, lb. | 12.75-15.15 | 13.6-18.4 | 14.4-19.2 | 15.2-25 | 16-25 |
| Lactose, % | 18 | 13 | 13 | 7.85 | 7.5 |
| Lactose, lb. | 0.54 | 0.78 | 0.78 | 1.08 | 0.96 |
| **Phase 3** | | | | | |
| Budget | 13.75 | 9.75 | 8.75 | NA | NA |
| Pig weight, lb. | 15.15-25 | 18.4-25 | 19.2-25 | NA | NA |
| Lactose, % | 7.2 | 6 | 5 | NA | NA |
| Lactose, lb. | 0.99 | 0.59 | 0.44 | NA | NA |
| Total feed, lb. | 17.75 | 17.75 | 17.75 | 17.75 | 17.75 |
| Total lactose, lb. | 1.76 | 1.76 | 1.76 | 1.76 | 1.76 |

### 3. Deviations in feed budgets from PIC recommendations

| | ----------Phase 1, 2 and 3 feed budgets, lb.---------- | | | | |
|---|---|---|---|---|---|
| | PIC | --Proposed alternative budgets and lactose levels-- | | | |
| **Phase 1** | **1/4/12** | **2/5/10** | **3/5/9** | **4/13/0** | **5/12/0** |
| Budget | 1 | 2 | 3 | 4 | 5 |
| Pig weight, lb. | 12-12.75 | 12-13.6 | 12-14.4 | 12-15.2 | 12-16 |
| Lactose, % | 20 | 18.5 | 18.3 | 17 | 16 |
| Lactose, lb. | 0.20 | 0.37 | 0.55 | 0.68 | 0.8 |
| **Phase 2** | | | | | |
| Budget | 4 | 5 | 5 | 13 | 12 |
| Pig weight, lb. | 12.75-15.95 | 13.6-18.4 | 14.4-19.2 | 15.2-25 | 16-25 |
| Lactose, % | 15 | 14 | 14 | 7.85 | 7.5 |
| Lactose, lb. | 0.60 | 0.7 | 0.7 | 1.02 | 0.9 |
| **Phase 3** | | | | | |
| Budget | 12 | 10 | 9 | NA | NA |
| Pig weight, lb. | 15.95-25 | 18.4-25 | 19.2-25 | NA | NA |
| Lactose, % | 7.5 | 6.25 | 5 | NA | NA |
| Lactose, lb. | 0.90 | 0.63 | 0.45 | NA | NA |
| Total feed, lb. | 17 | 17 | 17 | 17 | 17 |
| Total lactose, lb. | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |

postweaning.

Researchers at Ohio State University, the University of Missouri and the University of Kentucky demonstrated consistent linear responses to lactose levels of up to 7.5% in diets from day 14 to day 28 postweaning in pigs weighing 22-40 lb. (Cromwell et al., 2008).

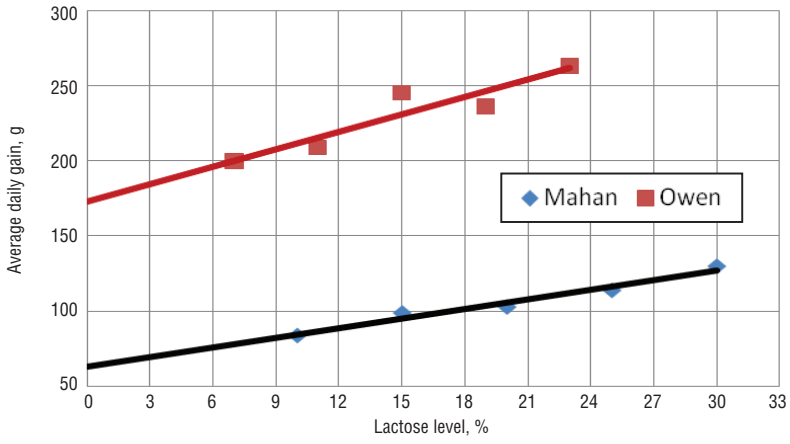
Research conducted by Dr. Gary Allee's lab at the University of Missouri to evaluate optimal lactose feeding levels in a commercial environment suggested that pigs responded linearly to lactose levels as high as 30% during the second week postweaning (Figure 2). However, in a separate study, no response was observed at levels greater than 18.5% lactose during the first week postweaning, highlighting the difficulty in determining an exact level to maximize growth performance for all groups of pigs.

In a series of three experiments to evaluate lactose levels the third week postweaning, an optimal economic level was near 7%; however, the growth response was linear to 14% lactose in two of the three trials (Figure 3).

When Allee's recent work is considered with other available data and experience from the field, it seems that the majority of pigs will respond linearly to at least 20% lactose from day 0 to day 7 postweaning and 15% lactose from day 7 to day 14, while 7.5% lactose is sufficient for days 14-21.

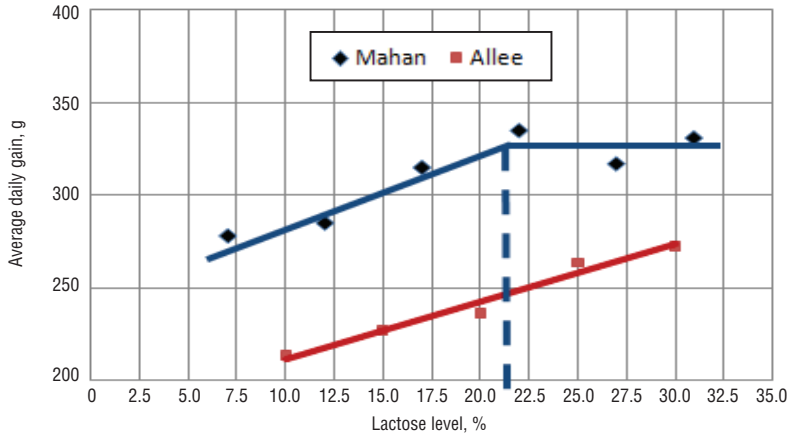
Assuming that a 2.5/5.0/10.0 lb. feed budget for phases 1, 2 and 3, respectively, would match up with time periods of days 0-7, 7-14 and 14-21 postweaning, the total amount of anhydrous lactose fed during the starter period would be 2.0 lb.

**1. Effect of lactose level on average daily gain from day 0 to 7**



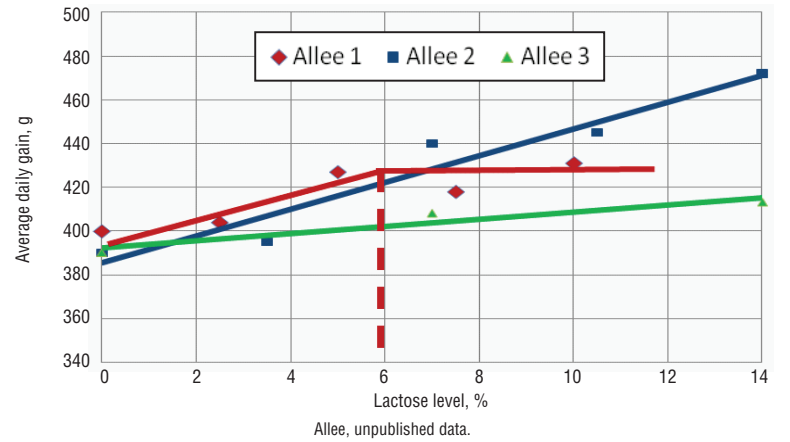

Owen et al., 1993; Mahan et al., 2004.

**2. Effect of lactose level on average daily gain from day 7 to 14**




Mahan et al., 2004; Allee, unpublished data.

**3. Effect of lactose level on average daily gain from day 14 to 21**




Allee, unpublished data.

## Economics

The basic economics of lactose feeding levels are relatively simple as long as they are included in the known range that elicits a linear increase in feed intake and gain. The increase in feed cost is virtually linear as lactose sources such as whey permeate or crystalline lactose are included.

Thus, most economic models are going to suggest that the highest levels of lactose within the linear growth promotion range are the most advantageous. The economics of reducing the number of starve-out pigs and fallbacks is more difficult to calculate but no less important. Generally, as lactose levels and diet complexity increase, the number of starve-out pigs will be reduced.

## Feed budgets

The ideal feed budgeting program is a big factor in determining the optimal level of lactose to which each diet is formulated. For example, some systems feed a phase 2 diet that has a 3 lb. budget, while phase 2 has a 13 lb. budget for other systems. Obviously, these "phase 2" diets will not need to have the same lactose level as a percentage of the diet.

Due to the variations in starter feed budgets and programs, it seems best to evaluate optimal lactose feeding based on the total amount of lactose a pig consumes during the starter period. It is then possible to adjust lactose inclusions

within diets based on the feed budget being fed.

Many production systems have moved toward a starter program that utilizes two bulk diets to get pigs to 25 lb. or more and onto simple diets, and often, this requires the first feed to have a larger feed budget than traditional nursery feeding programs to make it feasible to handle in bulk.

In wean-to-finish barns, this type of budget often works best because it can reduce the labor-intensive usage of bagged feeds and eliminates a diet change, which can greatly improve bin/barn management. Also, the pig is on the first feed longer before transitioning to phase 2, which may help more pigs get started better than they would with a sudden phase change within the first week postweaning.

Generally, for reasonably healthy pig flows, it seems that pigs will start off fine on a big budget first feed that is slightly lower in complexity to keep costs in check. However, it is likely that some specialty bagged feed will always be ideal for dealing with high-risk pigs and fall-back pigs.

## Swine guide recommendations

The "National Swine Nutrition Guide" was released as a practical guide for swine formulation and provides some good guidance on lactose levels in swine starter diets.

The guidelines suggest feeding a 12 lb. weaned pig 1 lb. of a 23% lactose diet, followed by 3 lb. of an 18% lactose diet and 13.75 lb. of a 7.2% lactose diet and then a simple diet after the pig reaches 25 lb.

This feed program would result in feeding 1.76 lb. of lactose, which equates to 1.85 lb. of crystalline lactose, 2.2 lb. of whey permeate or 2.51 lb. of whey per pig (Table 1).

Table 2 provides pig weight breaks, feed budget and recommended lactose levels for a 12 lb. weaned pig in the first column. The remaining columns provide examples of alternative feed budgeting programs that may better suit individual production systems and proposed lactose levels.

## PIC recommendations

Another industry reference that provides guidance on commercial lactose feeding levels is the "PIC Nutrient Specifications."

Lactose levels within this reference are at least partly based on Allee's work. The first column in Table 3 provides the PIC lactose levels and feed budgets, and the remaining columns provide some alternative feed budget programs that would result in the same amount of lactose being fed during the starter period.

## Summary

There is no one answer to the optimal amount of lactose to feed that will fit all production systems. Weaning weight and weaning age may have some influence in that lighter pigs and pigs fewer than 18 days of age may benefit from higher levels of lactose than levels discussed here.

Groups of pigs that are more health challenged and more difficult to get started onto dry feed can benefit from greater complexity of their starter program, including higher levels of milk products and lactose.

Research suggests that responses to lactose are linear, and therefore, the economics favor the higher levels that fit into the linear growth promotion range. In addition to measured growth responses in the nursery and the subsequent advantages in performance of pigs to market, the economics of reducing starve-out pigs and increasing the number of full-value pigs at market further favor the use of optimal lactose levels postweaning.

The available information on optimal lactose levels suggests feeding 1.7-2.0 lb. of lactose per pig and matching diets with feed budgets such that more than half of that lactose is consumed within the first 14 days postweaning.

## References

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