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Growth Promotant Antimicrobials (GPA's) used in pork production: Are they worth it?

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“The theory that can absorb the greatest number of facts, and persist in doing so, generation after generation, through all changes of opinion and detail, is the one that must rule all observation.”

— Adam Smith
(Scottish Economist, 1723-1790)

Therapeutic and growth promotant usage of antimicrobials: A narrower industry and broader human health context

“In its broadest ecological context, economic development is the development of more intensive ways of exploiting the natural environment.”

— Richard Wilkinson
(Epidemiology & Public Health, University of Nottingham Medical School, UK)

There is no question whatsoever that, subsequent to the development and acceptance of the germ theory of disease in the late 1800's followed by the discovery and first use of antibiotics in the early 1900's, the many available antimicrobial compounds have made immeasurable positive contributions to the health and well-being of humans, companion animals, and food-producing animals in their constant battle with a host of infectious disease agents found in their respective natural environments. More specifically, it is readily arguable that growth promotant antimicrobials (GPA's) have played an important role in the economic development of the pork production industry for the past several decades, contributing to the creation of value for many pork producers through a positive influence on production efficiency – primarily improvements in weight gain, feed conversion, and mortality (Hays, 1978; Zimmerman, 1986).

As with all such tools, the magnitude and duration of GPA impact depends largely on the pre-existing conditions under which they are used:

- Stage of production/age of pig
- Type, combination, level, and duration of disease agent challenges
- A variety of environmental and production process factors (e.g., animal density, continuous flow, ventilation & waste management, to name a few)

When scrutinized within the context of pig production, and due to the various combinations of above conditions, for many production businesses GPA's can and have consistently provided favorable financial returns (Hays, 1978; Zimmerman, 1986), and for some others they have not proven to be of consistent financial value (Dritz et al., 2002).

Since a favorable financial value when using any available production tool cannot be guaranteed, making decisions to begin, continue, or discontinue use of GPA's must be based, in part, on an acceptably sound foundation of information – including well designed well-controlled experimental research as well as within-production system research under less controlled/controllable “real world” field conditions. Further, these GPA performance data must be viewed, in part, in light of the cost of GPA inputs compared to the financial value of any detected meaningful performance effects – typically expressed as a benefit: cost ration and/or net benefit.

“Always design a thing by considering it in its next larger context - a chair in a room, a room in a house, a house in an environment, an environment in a city plan.”

— Eliel Saarinen
(Finnish Designer & Architect, 1873-1950)

While it is well beyond the focused scope of this paper, it is nonetheless appropriate to at least mention and be cognizant that, within a much broader context – inclusive of the more indirect generalized use of GPA's in animal agriculture as well as the more direct indiscriminant over-use of antibiotics to treat non-bacterial conditions (e.g., viral-induced colds) and under-use (e.g., under-doing and/or insufficient duration of treatment) to treat bacterial conditions in humans – antimicrobial usage practices are being heavily scrutinized for their roles in contributing to increasing bacterial resistance to important antibiotics used to treat various infectious conditions in human health.¹⁻¹⁵

“People almost invariably arrive at their beliefs not on the basis of proof but on the basis of what they find attractive.”

— Blaise Pascal
(French Mathematician & Philosopher, 1623-1662)

- 1 http://www.environmentaldefense.org/documents/619_abr_general_factsheet_rev2.pdf
- 2 <http://www.environmentaldefense.org/pressrelease.cfm?ContentID=4475>
- 3 <http://www.environmentaldefense.org/article.cfm?ContentID=4154&CFID=27233012&CFTOKEN=97348896>
- 4 http://www.environmentaldefense.org/documents/4301_AgEstimates.pdf
- 5 http://www.environmentaldefense.org/documents/4300_welcome_calculator.htm
- 6 <http://www.environmentaldefense.org/issue.cfm?subnav=1>
- 7 <http://www.environmentaldefense.org/article.cfm?ContentID=4310>
- 8 http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1509257&dopt=Citation
- 9 http://www.fda.gov/oc/opacom/hottopics/anti_resist.html
- 10 <http://www.niaid.nih.gov/factsheets/antimicro.htm>
- 11 http://www.fda.gov/fdac/features/795_antibio.html
- 12 <http://whyfiles.org/038badbugs/>
- 13 <http://whyfiles.org/038badbugs/fixes.html>
- 14 <http://www.cdc.gov/drugresistance/community/>
- 15 http://www.ems.org/antibiotics/sub2_antibiotics.html

The debates and arguments as to what, if anything, might constitute “responsible use” of GPA’s for food animal production (e.g., GPA usage reduced to only those antimicrobials that are not used in human medicine human vs. blanket elimination of all use of GPA’s in food animal agriculture regardless of their use/non-use in human medicine) will no doubt vigorously continue. Although clearly important to the long-term survival and quality of life of animals and humans alike – inclusive of each of us – the purpose of this paper is not to contribute fodder to the arguments on either side of that particular discussion. Rather, the purpose of this paper is to focus quite narrowly on the wisdom – in strictly financial terms – of using GPA’s for deriving sufficient additional value for the owners of food-producing businesses that have chosen pork as their marketable product, all the while appreciating the reality that broadly optimal and responsible GPA usage decisions should not be made based exclusively on narrowly focused financial criteria.

Do the GPA’s used in pork production have any value? Yes, no, or it depends...

“Accurate knowledge is the basis of correct opinions; the want of it makes the opinions of most people of little value.”

— Charles Simmons
(Author, 1924-)

We all have an opinion on most topics we’re confronted with – some of our opinions are more informed and based on greater objectivity than others. The views and opinions on the financial value (where “value” is defined as having an acceptably large and adequately consistent benefit:cost ratio) of a GPA’s population-level usage are

many and varied. The basis, context, and conditions for those views and opinions are, likewise, many and varied.

A swine industry survey

“The rule is perfect: In all matters of opinion, our adversaries are insane.”

— Mark Twain
(American Humorist & Author, 1835-1910)

To begin to get a sense of the views and opinions on the value, if any, of GPA’s of those within the pig/pork industry, an email survey was conducted. There were 285 individuals surveyed, consisting of swine producers, veterinarians, and nutritionists.

The emailed survey consisted of the following questions:

- Question 1: As feed cost per ton INCREASES the financial value (benefit) of feeding GPA’s INCREASES.
 - Agree?
 - Disagree?
- Question 2: As pig market price per 100 lbs INCREASES the financial value (benefit) of feeding GPA’s INCREASES.
 - Agree?
 - Disagree?
- Question 3: The financial value (benefit) of feeding GPA’s INCREASES as feed cost per ton...(select only one):
 - Increases?
 - Decreases?
 - Feed cost per ton is irrelevant when measuring the value of GPA’s
- Question 4: The financial value (benefit) of feeding GPA’s INCREASES as pig market price per 100 lbs...(select only one):
 - Increases?
 - Decreases?
 - Feed cost per ton is irrelevant when measuring the value of GPA’s
- Question 5: Which one of these four graphs best represents the direction of INCREASING benefit:cost when including any of the available antimicrobial feed additive formulations as a growth promotant in nursery and/or finishing diets? (**Figures 1-4**)
- Question 6: When used in nursery and/or grow-finish feeds, in general, most growth promotant

Figure 1:GPA emailed opinion survey Graph A.

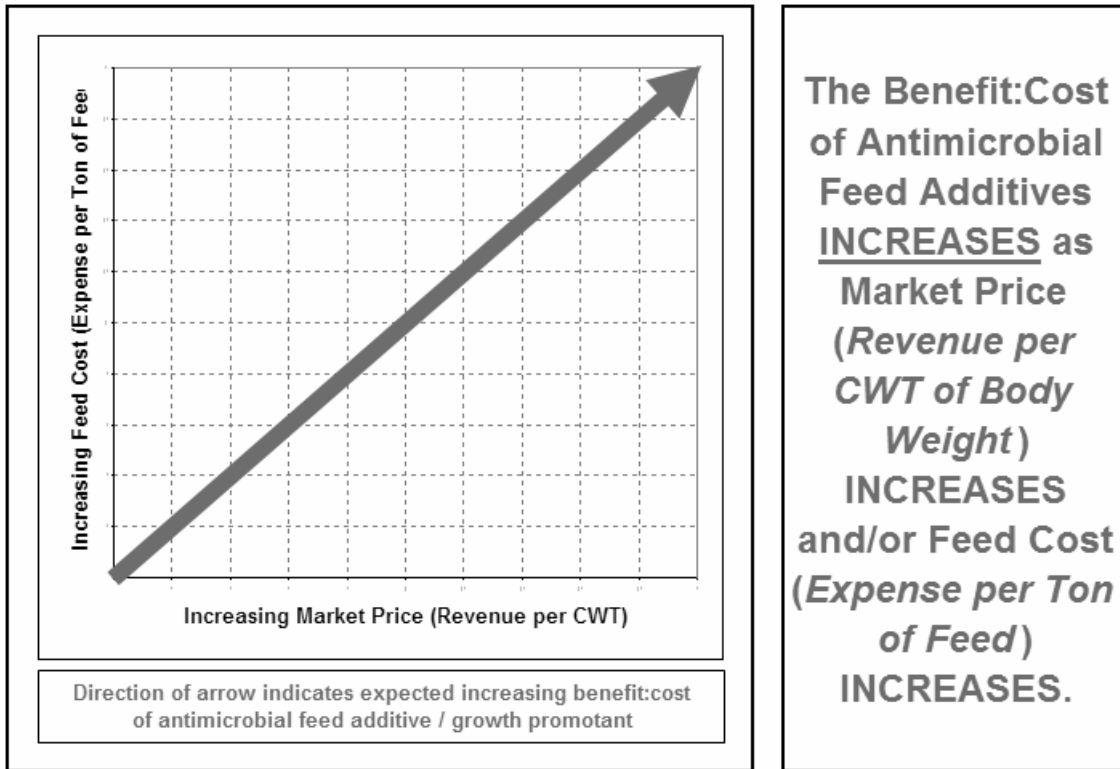


Figure 2: GPA emailed opinion survey Graph B.

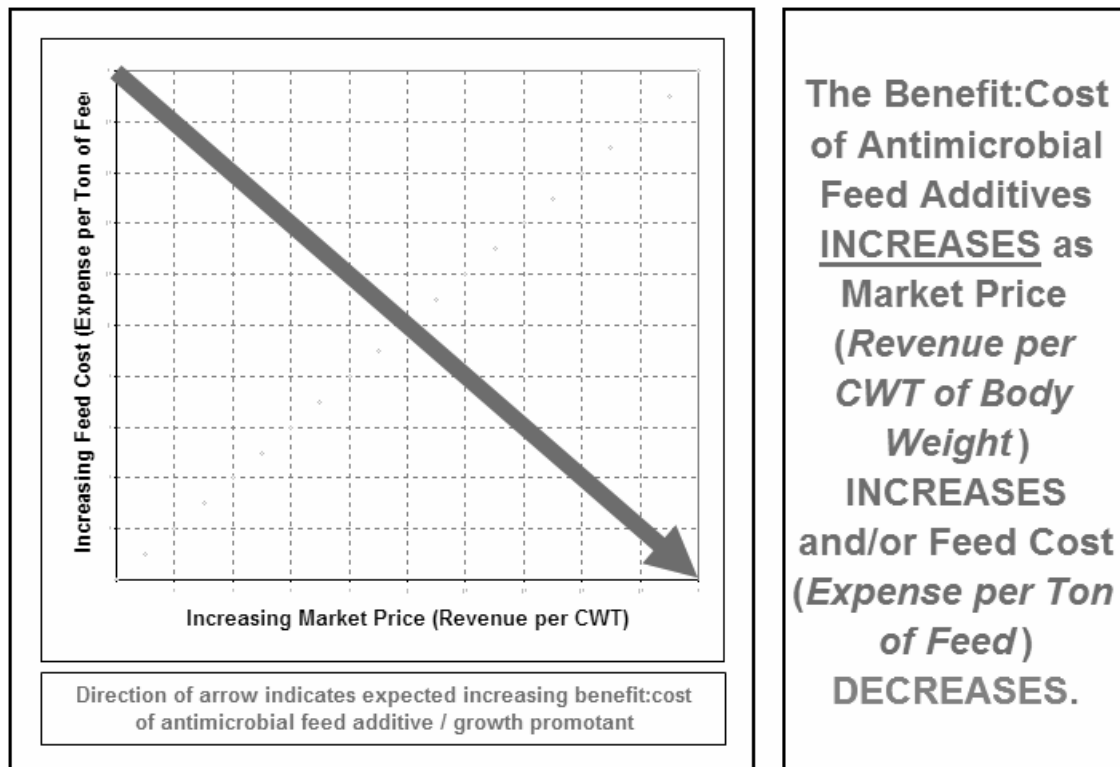


Figure 3: GPA emailed opinion survey Graph C.

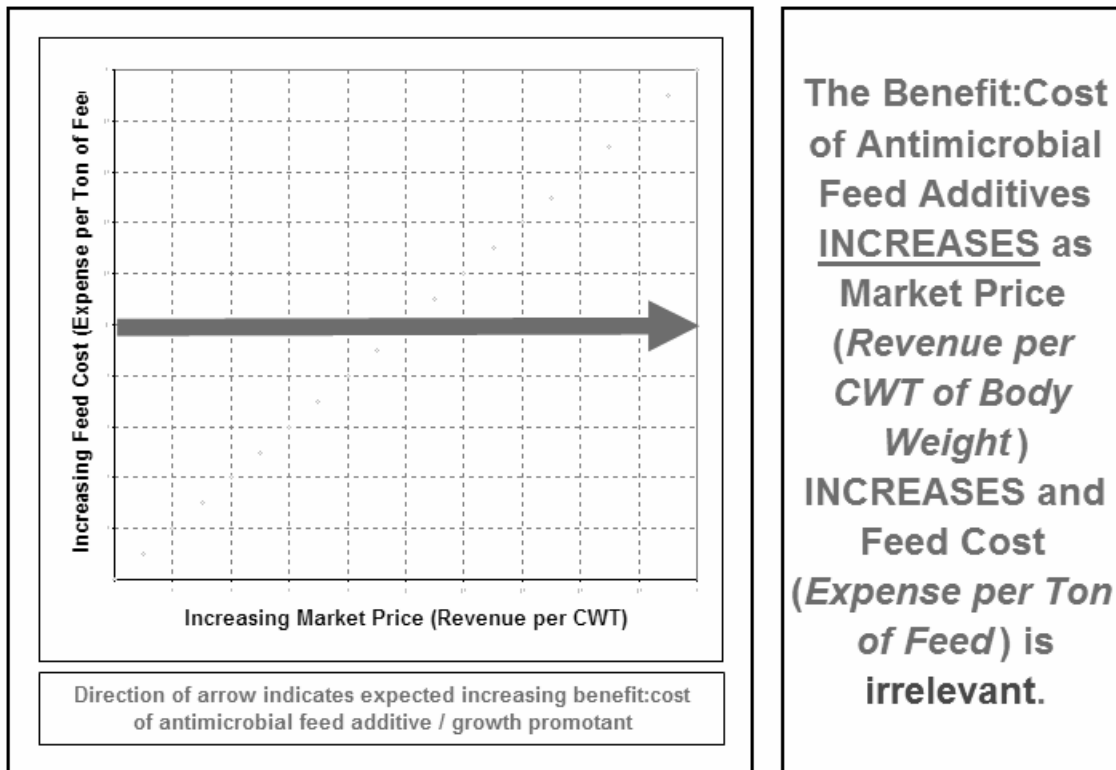
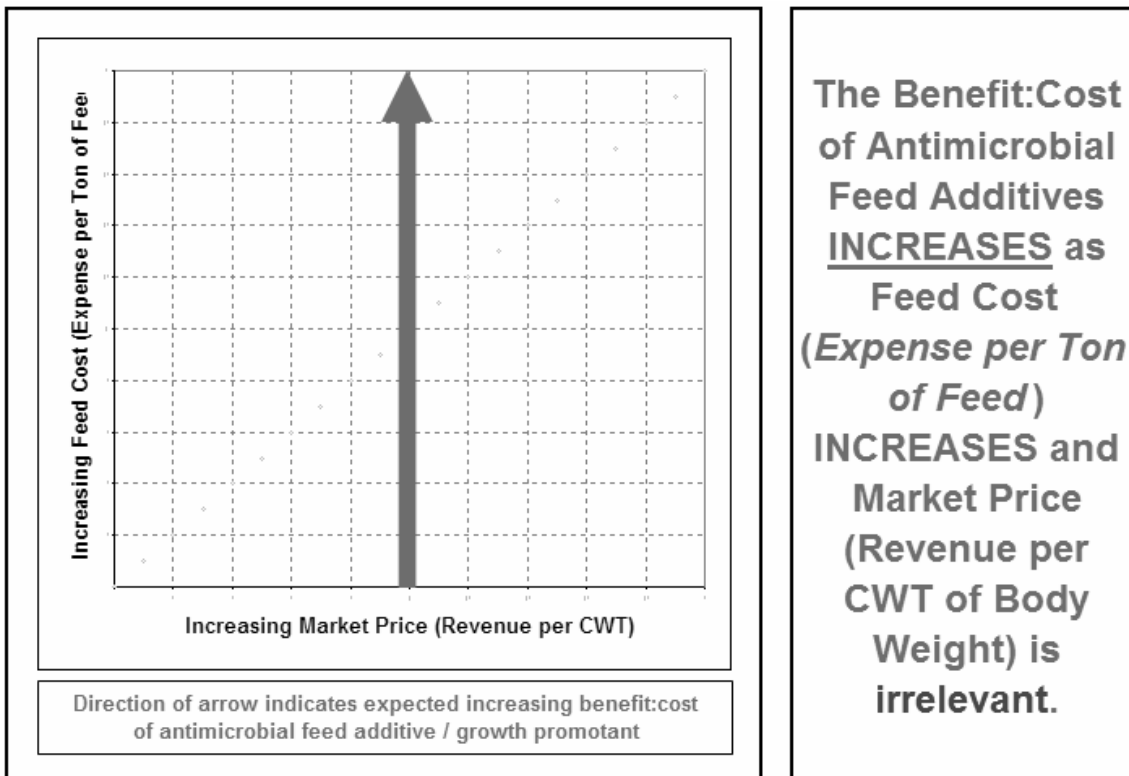


Figure 4: GPA emailed opinion survey Graph D.



antimicrobials...(select the ONE response you feel is most correct):

- [A] generate a greater percent improvement in ADG than Feed Conversion
- [B] generate a greater percent improvement in Feed Conversion than ADG
- [C] generate the same percent improvement in both ADG and Feed Conversion
- [D] generate an improvement only in ADG, but not in Feed Conversion
- [E] generate improvement only in Feed Conversion, but not in ADG
- [F] generate no improvement in either ADG or Feed Conversion

As a follow up to the initial survey, one additional question was asked via email:

- Question 7: Were your responses to the first six questions about growth promotants based on...(select ALL that apply):
 - [A] your familiarity with and/or study of available GPA research literature?
 - [B] your own direct controlled research studies/trials you have conducted?
 - [C] your own direct experience using GPA's as part of your production operations?
 - [D] your objective evaluation of data obtained from others measuring their use of GPA's in their production operations?
 - [E] discussing with others their experiences and observations with using GPA's in their production operations?
 - [F] something else (Please describe)?

As of this writing, responses to the initial 6-question survey had been received from 164 (57.5%) of the 285 surveyed. The following are a brief description of the initial survey results:

- Question 1: "As feed cost per ton increases the financial value (benefit) of feeding GPA's increases..."
 - 84.1% (138) agreed
 - 15.9% (26) disagreed
- Question 2: "As pig market price per 100 lbs increases the financial value (benefit) of feeding GPA's increases..."
 - 65.0% (106) agreed
 - 35.0% (57) disagreed

• Question 3: "The financial value (benefit) of feeding GPA's increases as feed cost per ton..."

- Increases (80.4%, 131)
- Decreases (5.5%, 9)
- Feed cost per ton is irrelevant (14.1%, 23)

• Question 4: "The financial value (benefit) of feeding GPA's increases as pig market price per 100 lbs..."

- Increases (61.1%, 99)
- Decreases (9.3%, 15)
- Pig market price per 100 lbs is irrelevant (29.6%, 48)

• Question 5:

- 54.9% (90) selected Graph A
- 10.4% (17) selected Graph B
- 11.6% (19) selected Graph C
- 23.2% (38) selected Graph D

• Question 6:

- 47.8% (75)
- 23.6% (37)
- 21.7% (34)
- 1.9% (3)
- 3.8% (6)
- 1.3% (2)

A more complete summary of the industry survey data will be presented at the September 2005 meeting once additional responses are gathered from the remaining survey procrastinators as well as for the 7th survey question from all respondents.

For the remaining text of the survey section of this paper, let me disclose my own responses to the survey questions as follows:

- Q1 – Disagree
- Q2 – Agree
- Q3 – Decreases
- Q4 – Increases
- Q5 – Graph B
- Q6 – A

In other words I am of the view that the financial value to a pig/pork production business of specific GPA's which have been shown across dozens of published peer-reviewed papers to generate a detectable response in ADG and feed conversion (Hays, 1978; Zimmerman, 1986):

- increases as feed cost per ton goes down, not up...feed cost per ton is relevant, but not the way that some of us might think it is
- increases as pig market price per 100 lb goes up...market price may be relevant – depending on your underlying assumptions or actual production flow conditions

Beyond the basic GPA review data available from Hays (1978) and Zimmerman (1986), the key assumptions for my own survey responses are:

- For nearly all pig/pork production businesses in operation today, finishing space / capacity are the key pig production constraint and pigs are weaned to nursery and moved to finishing on primarily a calendar-based schedule more so than on all marketable pigs (exclusive of culls) reaching the optimal target weight window – the “same-days/different-weight” production model. In other words, most all pig/pork producing businesses do not have capacity built into their production flows such that finishing is not the primary system flow constraint.
- For most all marketing matrices that are currently in-effect for pork slaughter/packers:
 - the non-conformance penalties (sort loss) are weighted to penalizing light pigs below the target range to a relatively greater degree than heavy pigs above the target weight range (i.e., selling lights hurts you more than selling heavies), and
 - the penalties at both the light and heavy ends of the matrix do not result in a net market price that results in a MOVC of ≤ 0 .

Now for an important caveat – Where a production system has purposely built into their production flow “excess” – some would argue the better term would be “adequate” – capacity in finishing (to accommodate a primarily “same-weight/different-days” or a different-days/different-weight” production model for all marketable pigs), I would answer the survey questions this way:

- Q1 – Agree
- Q2 – Disagree
- Q3 – Increases
- Q4 – Irrelevant
- Q5 – Graph D
- Q6 – B or E

Even though I’ve afforded myself the luxury of “it depends” (on the underlying assumptions or existing conditions for a production flow) to offer my “if this, then that, else the other” views, in either case described above and

based on the financial modeling I’ve done, I’m of the very strong opinion that with all currently researched GPA’s I’m aware of the answers that are not correct are:

- Q1 – Agree
- Q2 – Agree
- Q3 – Increases
- Q4 – Increases
- Q5 – Graph A
- Q6 – B

Why not? To respond to this question, I’d like to closely examine two widely know (but in my opinion relatively poorly understood) reviews of published GPA literature.

What do the data in Hays (1978) and Zimmerman (1986) really tell us?

“Every man has a right to his opinion, but no man has a right to be wrong in his facts.”

— Bernard M. Baruch
(American Businessman & Statesman, 1870-1965)

Back in 1978, Virgil Hays (and whoever all helped him...I know how this works because I was a University graduate student once – the rhetorical mantra of our graduate professors was, “What’s time to a graduate student?!”) did a very useful thing – he compiled a literature review evaluating GPA performance from hundreds of individual published studies. Several years later, in 1986, Dean Zimmerman (and whoever all helped him) compiled a literature review of GPA performance studies conducted and published since the Hays review.

For this paper, the point of utilizing these relatively “old” Hays (1978) and Zimmerman (1986) data is not to necessarily suggest that the GPA performance responses they summarize are unchanging and timeless. There are other data (Dritz et al., 2002) that would suggest that the magnitude of these responses for at least some GPA’s still available today may have changed, at least for some production systems, due to improvements in other aspects of pig/pork production that help accomplish the same sorts of things that GPA’s accomplish:

- Process & Flow Management
 - implementation of multi-site production versus single site production
 - moves toward all in/all out pig flow by at least room, if not also by barn and site, and away from continuous pig flow
 - a re-popularization of single sourcing and falling from favor multi-sourcing
 - a rebound in weaning ages of 3 or even 4 weeks

- of age and move away from early (< 3 weeks of age) weaning
- Health Status
 - *M. hyo*-negative
 - Atrophic rhinitis-negative
 - App-negative
 - PRRSv-negative (where PRRS acts as a trigger for a smorgasbord of secondary bacterial agents like *H. parasuis* & *Strep suis*, to name a few).
- Animal Environment & Facility Design
 - moves to total slats away from partial slats or solid flooring
 - improvements in ventilation, e.g., tunnel ventilation
 - improvements in feeder/waterer design

One could also legitimately add to the above list the potential of bacterial resistance to the various GPA's developing over time where the same GPA's are used within the same production systems over a long period of time. As was described earlier in this paper, there is most definitely no shortage of concern and opinion on this particular issue.

There are also newer GPA's in use today that were not in use at the time the studies included in these reviews were

compiled (e.g., tiamulin and tilmicosin). Given the likely similarities in the fundamental modes-of-action for GPA's, it is very unlikely that the nature of the ADG and feed conversion responses for newer GPA's is all that different from the GPA responses summarized by Hays and Zimmerman even though the relative magnitude of response may be different (bigger or smaller).

Regardless, of the reason or reasons for any real change in the performance characteristics of GPA's, the foundational financial value evaluation principle that is true for all inputs utilized by all businesses of every kind in all industries everywhere still applies to GPA's for pig/pork production businesses:

If you need it, use it.
 If you don't need it, don't use it.
 Learn how to tell the difference.

In **Tables 1-3**, we see summarized the data reported by Hays (1978) – informative, but not all that interesting, and certainly not surprising to any of us in the industry. What I do find interesting in these data, however, is not described in Hays, but becomes evident when viewing the Hays summary data through a financial value modeling lens (**Table 4**).

The “response ratio” (RR) was calculated as follows:

$$RR = (\text{percent response in ADG} / \text{percent response in FCR})$$

OK, nice ratio...simple, clean, very numerical...so what?

Table 1: A summary of GPA performance trials in Nursery-age pigs (15 lb – 60 lb) – adapted from Hays (1978).

Nursery (15 lb – 60 lb)			
Growth Promotant Antimicrobial (GPA)	N Trials	% change ADG	% change FCR
Chlortetracycline-Sulfamethazine-Penicillin	87	+22.5	+8.5
Chlortetracycline-Sulfathiazole-Penicillin	82	+18.6	+8.7
Carbadox	17	+17.7	+6.8
Tylosin-Sulfamethazine	40	+14.8	+7.4
Penicillin-Streptomycin	21	+14.8	+6.0
Tylosin	3	+11.1	+7.6
Lincomycin	23	+11.0	+5.0
Virginiamycin	59	+10.8	+6.3
Tetracyclines (Oxytetracycline & Chlortetracycline)	11	+9.7	+3.3
Bacitracin	7	+9.5	+8.7
Penicillin	23	+8.0	+2.3
Nitrofurans			
Bambermycins			
Arsenicals			
Weighted Average	373	+16.0	+7.1

Table 2: A summary of GPA performance trials in Grower-age pigs (40 lb – 110 lb) – adapted from Hays (1978).

Grower (40 lb – 110 lb)			
Growth Promotant Antimicrobial (GPA)	N Trials	% change ADG	% change FCR
Chlortetracycline-Sulfamethazine-Penicillin	27	+17.5	+6.4
Chlortetracycline-Sulfathiazole-Penicillin	15	+15.1	+6.9
Carbadox	5	+5.1	+2.2
Tylosin-Sulfamethazine	27	+10.9	+4.2
Penicillin-Streptomycin	4	+2.4	+2.5
Tylosin	52	+10.7	+6.6
Lincomycin	120	+10.9	+3.9
Virginiamycin	22	+5.1	+2.5
Tetracyclines (Oxytetracycline & Chlortetracycline)	8	+2.5	+1.2
Bacitracin			
Penicillin			
Nitrofurans			
Bambermycins			
Arsenicals			
Weighted Average	280	+10.8	+4.6

Table 3: A summary of GPA performance trials in Finisher-age pigs (90 lb +) – adapted from Hays (1978).

Growth Promotant Antimicrobial (GPA)	N Trials	% change ADG	% change FCR
Chlortetracycline-Sulfamethazine-Penicillin			
Chlortetracycline-Sulfathiazole-Penicillin			
Carbadox			
Tylosin-Sulfamethazine			
Penicillin-Streptomycin	34	+3.9	+1.7
Tylosin	26	+4.6	+1.5
Lincomycin			
Virginiamycin	21	+5.7	+3.2
Tetracyclines (Oxytetracycline & Chlortetracycline)	108	+6.6	+2.6
Bacitracin	29	+2.5	+2.7
Penicillin			
Nitrofurans	7	+1.4	+0.6
Bambermycins	12	+1.9	+1.2
Arsenicals	42	+0.7	+0.7
Weighted Average	279	+4.4	+2.1

Table 4: The calculated “response ratio” of various GPA’s for aggregated research studies conducted in Nursery, Grower and Finisher pigs and summarized by Hays (1978).

Growth Promotant “Response Ratio”			
Growth Promotant Antimicrobial (GPA)	Nursery	Grower	Finisher
Chlortetracycline- Sulfamethazine-Penicillin			
Chlortetracycline-Sulfathiazole- Penicillin	2.65	2.73	
Carbadox	2.14	2.19	
Tylosin-Sulfamethazine	2.60	2.32	
Penicillin-Streptomycin	2.00		2.29
Tylosin	2.47	2.60	3.07
Lincomycin	1.46	0.96	
Virginiamycin	2.20	1.62	1.78
Tetracyclines (Oxytetracycline & Chlortetracycline)	1.71	2.79	2.54
Bacitracin	2.94	2.04	0.93
Penicillin	1.09		
Nitrofurans	3.48		2.33
Bambermycins		2.08	1.58
Arsenicals			1.00
Weighted Average	2.30	2.40	2.06

Legitimate question. If you financially model the response ratio, you will find the following:

- While the majority (54.9%) of the emailed survey respondents view Graph A as best representing the picture of GPA financial value (GPA value increases as feed cost goes up and/or market price goes up), in reality it is...
 - Graph B (where finishing capacity is the primary production flow constraint) or
 - Graph D (where finishing capacity is not the primary production flow constraint)

...that better represent the GPA financial value dynamic.

- Why? Because where the ADG:FCR response ratio is approximately 2:1 or higher (i.e., ADG improves at a relatively greater rate than FCR to the tune of 2:1 or higher) the faster growing pigs eat enough additional feed to support that faster growth that they more than offset the feed savings from the improved feed conversion. Consequently...
 - ...where the production capacity conditions exist such that Graph B best applies, there is a net increase in the amount of feed consumed and where the feed cost per ton is increasing this net additional feed consumed carries with it an increasing feed cost per pound, per pig and per group.
 - ...where the production capacity conditions ex-

ist such that Graph D best applies, the fact that pigs are growing faster and sold sooner when they reach the target market weight is irrelevant. Thus the only GPA performance characteristic (of the two being considered from the Hays data) that offers financial value is an improvement in FCR where the pig/group eat less feed to get to the same target market weight with the GPA versus without the GPA, almost (but not completely) regardless of the effect of the GPA on ADG.

- The response ratio, on average, equals or exceeds 2:1 for 19 (67.9%) of the 28 combinations of GPA x stage of production (**Table 4**).
- So what about the 9 (32.1%) of 28 combinations of GPA x stage of production shown in **Table 4** that have a response ratio of less than 2:1, with a few right at 1:1? Don’t those GPA x stage combinations get you to a situation where Graph A best applies? Nice thought, but no, they don’t. Not until the response ratio gets to around 0.5 or lower (i.e., the rate of improvement in FCR is at least two times that of the rate of improvement in ADG) does the financial value graph begin to resemble Graph A.

So – when considered in conjunction with the results of the email survey – what this means to me is that, while we generally have a decent grasp on what the performance response typically looks like where GPA’s are used, we have not been very good at translating this understanding

of the physical performance characteristics of GPA's to the proper understanding of the corresponding financial value characteristics.

What do the data in Hays (1978) and Zimmerman (1986) not tell us?

"If we all worked on the assumption that what is accepted as true is really true, there would be little hope of advance."

— Orville Wright
(American Inventor, 1871-1948)

Missing ingredient #1

I wish that Hays and his cadre of graduate students (1978) as well as Zimmerman and his stable of graduate students (1986) who compiled all of that data would have also published the within GPA-type response distribution variation characteristics. From a meta-analytic standpoint, it would have been much more useful by far to have all of the individual study response raw data so that we could not only evaluate the mean response within GPA-type but also assess the variability of response – is there a larger standard deviation for one GPA over another even where the mean response of both is similar?

Now for a brief side-bar – We have no idea what we're missing out on. Meta-analytic methods properly applied have proven hugely beneficial to the behavioral and social sciences (Hunter and Schmidt, 2004) and represent one of the most important yet most under-utilized analytical methods in the various sciences which serve pig/pork production.

"The small scale studies typical of psychological [any!] research produce seemingly contradictory results, and reliance on statistical significance tests causes study results to appear even more conflicting. Meta-analysis integrates the findings across such studies to reveal the simpler patterns of relationships that underlie research literatures, thus providing a basis for theory development. Meta-analysis can correct for the distorting effects of sampling error, measurement error, and other artifacts that produce the illusion of conflicting findings." (Hunter and Schmidt, 2004)

When we finally accept the truth that "no single primary study can ever resolve an issue or answer a question" (Hunter and Schmidt, 2004) then we'll position ourselves as an industry where we should have been long ago to be much more effective in how we generate, analyze and learn from studies we collectively conduct.

Missing ingredient #2

Of course, even with all of the individual study raw data, one of the classic and at least sometimes valid criticisms of such "meta-style" literature reviews is the non-publication of unfavorable results (Dohoo et al., 2003) – the

argument that people/companies tend not to publish results of studies that don't make them/their product look good. The argument goes something like this: "For every favorable published study, there is probably an unfavorable study or 'X' unfavorable studies that has/have never and will never see the light of day."

In my mind this is a very simple issue to address – Regardless of if and to what extent you trust your GPA supplier, here is all the more reason to test for yourself what that supplier tells you/shows you for their GPA performance results. Keep in mind, as Yoda might say (the Yoda of Star Wars, for those of you who don't keep up with popular culture), "One small primary study does not a conclusive answer to a question make." In fact, here is all the more reason to actively and proactively work with your GPA input supplier of choice along with some of your pig/pork producing peers to arrange for enough multiple within-system performance studies to cooperatively execute a "mini-meta" set of studies applying the same fundamental study protocol. If there is sufficient potential GPA business there to be had, if there is sufficient confidence in the GPA product's performance capabilities, and if the capability to execute a properly designed study is available, any credible GPA input supplier worthy of trust would enthusiastically pursue the opportunity.

Of course, each and every such field-based study costs somebody somewhere some money to execute and represents an investment in money, time, and resources that carries with it an expectation for a return...naturally that's just the way that business has to work to be sustainable. We each certainly have to be realistic in that, if there isn't sufficient direct and/or indirect business potential (either due to the scale of the production system and/or a commitment to a long-term usage provided the a priori agreed to performance and financial results are observed from the properly designed and executed study/studies) then it would be unwise from a business standpoint to do a study. Also, despite what we each may believe about our specific pig/pork production operations, our "uniqueness" has its limits – yes each of us are different, but our individual operational differences exist within the context of a distribution where there are other operations who have very similar "uniqueness" to ours (Polson, 2001).

Given this, we can very often utilize for GPA input decision-making purposes what has already been observed, documented and learned elsewhere among other production systems whose "uniqueness" is very similar to our "uniqueness". The obvious key here is that there must be a valid and accessible database from a credible and trusted source that contains results of studies – favorable, unfavorable, and inconclusive alike - using a menu of standardized study protocols. Just another opportunity waiting to be realized!

And now for three “Yeah buts...”

“The opposite of a correct statement is a false statement.

But the opposite of a profound truth may well be another profound truth.”

— Niels Bohr

(Danish Physicist & 1922 Nobel Prize Winner, 1885-1962)

“Yeah but...” #1: “...it’s all about the distribution, not the average!”

Well of course it is. But this isn’t an “either/or” point anyway...you cannot have an average without a distribution that spawns it, and a shift in the distribution will usually also change the average (yes, there are possible exceptions but most are not very probable in real life). Where there exists (within an all in/all out flow by site system) a finishing capacity that is not the primary flow constraint, the system can be operated such that there will be little or no financial value of increasing ADG in the fastest growing pigs in the population (i.e., those that achieve a weight at the maximum end of the marketing matrix “sweet spot”) since you could market those pigs at the high end of the optimal weight range at or before exceeding the date required for closeout and preparation for the next group due to be placed on-feed. In effect, all you would be doing by feeding a GPA to these top-end pigs and helping them grow even faster would be reducing days-to-market (DTM).

So isn’t lowering DTM this way in these pigs still at least somewhat financially beneficial? Not at all – under all in/all out pig flow conditions where refilling any pig spaces does not occur until all pigs are gone from the prior group you are only creating more empty pig spaces faster and have them be empty longer (Polson, 1994). This would be loosely (very loosely) akin to finishing your 400 meter leg of the 1600 meter relay ahead of everyone else and having the next runner on your team in the relay not there yet waiting to hand the baton off to...instead all of the next leg’s runners show up only after the slowest runner in your leg of the race gets to the hand-off zone...you haven’t gained anything that improves your event time because your event time is constrained by the last runner to arrive.

Under these conditions, a GPA could only be of direct financial benefit via ADG in those pigs that would not otherwise have attained the maximum end of the optimal market weight range by the time a barn or site would have to close out to prepare for the next group placement. Consequently, it is this subset of pigs that would have to shoulder the burden of off-setting the entire cost incurred feeding the GPA to the entire group of pigs.

Now if you were operating a continuous flow system within a site/barn/room and always had available pigs of the targeted placement weight to fill open spaces, you

could capitalize on any GPA improvement of ADG, even in the fastest growing pigs. However, you would very likely pay an unacceptable price related to deterioration in overall health and consequent performance due to moving away from all in/all out flow. Even if health was pristine enough to accommodate continuous flow it is highly unlikely that enough pigs at the targeted placement weight would be consistently available to fill spaces as they came open.

Of course even without the opportunity to capitalize on an ADG effect there is still potential to benefit from feeding a GPA if there are positive effects on feed conversion, mortality and/or treatment costs. However, research reviews (Hays, 1978; Zimmerman, 1986) indicate GPA-induced improvements in performance measures like feed conversion are relatively smaller and less consistent than improvements in ADG.

All of the above has potential for relevance for any individual production system’s finishing flow. However, I would argue that there are very few finishing flow capacities across the pig/pork production industry today which would accommodate such an excess (adequate?) capacity scenario, and this is unlikely to change much given the variety of challenges typically faced by pig/pork producers when pursuing permits for construction of new production sites.

“Yeah but...” #2: “...performance is the same with or without feeding GPA’s...there’s no difference.”

If such a judgment is based on valid objective data (which is not necessarily always the case), then where there is no consistent detectable GPA response in ADG and feed conversion (attributable to things like the targeted elimination and/or prevention of specific diseases that have significant negative influence on growing pig performance), there would clearly be no favorable financial value to feeding a GPA. This observation has been made in some more recently published peer-reviewed literature (Dritz et al., 2002) in addition to specific production systems capable of objectively discerning such things via proper objective measurement.

If you’re already hitting on all cylinders and running consistently fast and smooth thanks to all of the other management, process, and health improvements you’ve executed then you obviously wouldn’t improve on the already ideal. Any credible GPA input supplier worthy of even a modicum of trust would not expect, and would actively discourage, use of GPA’s where they were clearly not financially beneficial to a pig/pork production business.

On the other hand, if there are a variety of things related to improvements in management, process and/or health that you are not doing now but that you can/should effectively implement which, when put in place, would make

using GPA's redundant and be of even greater financial benefit than your current use of GPA's, then what in the world are you waiting for? Any credible GPA input supplier worthy of your trust who is also aware of management, process, and health improvement alternatives to GPA use that have been clearly shown to provide a relative benefit: cost advantage over GPA use would actively encourage you to implement, if not also assist you with implementing, these alternative improvement options.

“Yeah but...” #3: ”...what if I don't always get the same expected beneficial effect from feeding GPA's?”

No worries! You can feel safe and have unshakable confidence in the iron-clad-get-your-money-back-guarantee fact that you most certainly will not see the same effect all of the time. For all users of GPA's who appreciate even the most basic principles of statistics, there should be absolutely no expectation that they will always achieve the same degree of performance improvement.

This is just another variation on “it's all about the distribution”. Some groups of pigs will perform the same as what a within-system GPA study (let's call this your “in-house standard”) may have shown, but other groups will perform better and yet others will perform poorer relative to an in-house standard. Why? Each single group of pigs placed into a nursery or finisher within a production flow – within the range delineated by the nature of the production system of course – has some degree of variation in a host of placement and in-process characteristics that influence the degree to which an in-feed GPA can influence their performance. There will unquestionably be differences in the level and degree of infectious agent exposure and infection among groups placed over time attributable to things like the inevitable ebb-and-flow of pig source health status as well as variation in post-placement factors like the impact of season (temperature, humidity) on ventilation and air quality – to name only a few.

In theory there would exist an expected distribution of collective net financial response (with a definable central tendency and variation) with some portion of that distribution expected to fall below the acceptable benefit:cost threshold and the rest of the response distribution exceeding that threshold. In reality such a distribution certainly does exist for GPA's whether we do what's necessary to define it or not. However, the commitment and procedures required to continuously measure (thus define) the GPA performance effects and adequately characterize this distribution rarely if ever exist within pig/pork production systems. Short of such an ongoing characterization of a GPA response distribution, pig/pork producers must exercise a degree of reason and judgment based on the available data – including any within-system evaluation trials of GPA's used as inputs for their routine production operations.

So, as long as the average response over time satisfies your targeted benefit:cost expectation, does it even matter what percent of GPA-fed groups do you get that meet/exceed your minimum (lower specification) expected return (benefit:cost)? Maybe not, unless of course greater variation makes you nervous, and you don't like being nervous. In reality, you are likely not now and won't soon be (if ever) capable of effectively and objectively measuring this in an ongoing manner anyway without some significant changes in how you flow pigs and measure performance.

Final thoughts

”What is laid down, ordered, factual is never enough to embrace the whole truth: life always spills over the rim of every cup.”

— Boris Pasternak
(Russian Poet & Author, 1890-1960)

For any business – including those specifically involved in pig/pork production – a degree of financial objectivity to decision-making is certainly essential to the long-term viability of that business (in the absence, of course, of dumb luck and/or an industry transitionally tolerant of gross inefficiency). Making decisions built largely on objectivity about whether or not to begin and continue/discontinue using production inputs, such as GPA's, are an ongoing challenge and necessitate both good quality data from a number of reliable sources (including oneself) as well as the appropriate analytical perspective. Those pig/pork production operations which place further importance on a longer-term and broader context for their businesses will also consider valid available factual information (sans any apparent underlying biases, agendas and consequent dogma on either side of the issue) looking at whatever degree GPA's may truly relate to changing bacterial resistance to antimicrobials that are important to human medical therapeutics.

It is certainly beneficial to take our pig/pork production businesses both seriously enough but yet not too seriously. We achieve such a balance when we not only put forth our best-efforts at making informed objective decisions, but also when we enjoy the process of reaching those decisions. We not only need to make our respective business investments of time and resource pay off in a business/financial sense but we should also expect those same investments to result in more personal pay-off measured in terms of our satisfaction in what we do and how we go about doing it.

“So I saw that there is nothing better for a man than to enjoy his work, for that is his lot.”

— Solomon, in Ecclesiastes 3:22
(King, 975BC-922BC)

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