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Where has all the research gone?

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With this title, you may think I am here to talk about the dire research situation in the North American swine industry. That is not the case. Research is alive and well. There is more research work and greater quality swine research today than ever in the past. This is also not a plea for more dollars for universities. The reason for my interest in this subject is that we believe we are near a critical juncture in the US swine industry in terms of whether we will remain the research and production leader around the world or whether we cede our leadership role to other countries.

Why do I think we are at a critical juncture for applied swine research in the US swine industry? Many of the reasons are obvious. There are fewer university swine research programs and the number continues to decline every year. Fewer young people entering universities have a farm background and thus, fewer students have interest in applied swine research careers. Increasing tuition and selective admissions (Martin, 2006) further reduces the pool of students with agricultural background and interest. Public research dollars for applied research have been on a steady decline for decades. On a positive note, these public funds are being replaced by private dollars that fund research within production systems or by funding from industry suppliers. This industry infusion of capital for applied research is the main reason that research is alive and well. However, we would contend that current excitement of applied research breakthroughs in facilities built in swine production systems will wane with time and attrition due to long-term inability to replace the current research leaders in universities and production systems. We believe one of the key answers to having a continual supply of qualified, young researchers is to develop more public/private partnerships in order to maintain the critical research elements of research integrity, peer review, and student training.

Importance of technology adoption

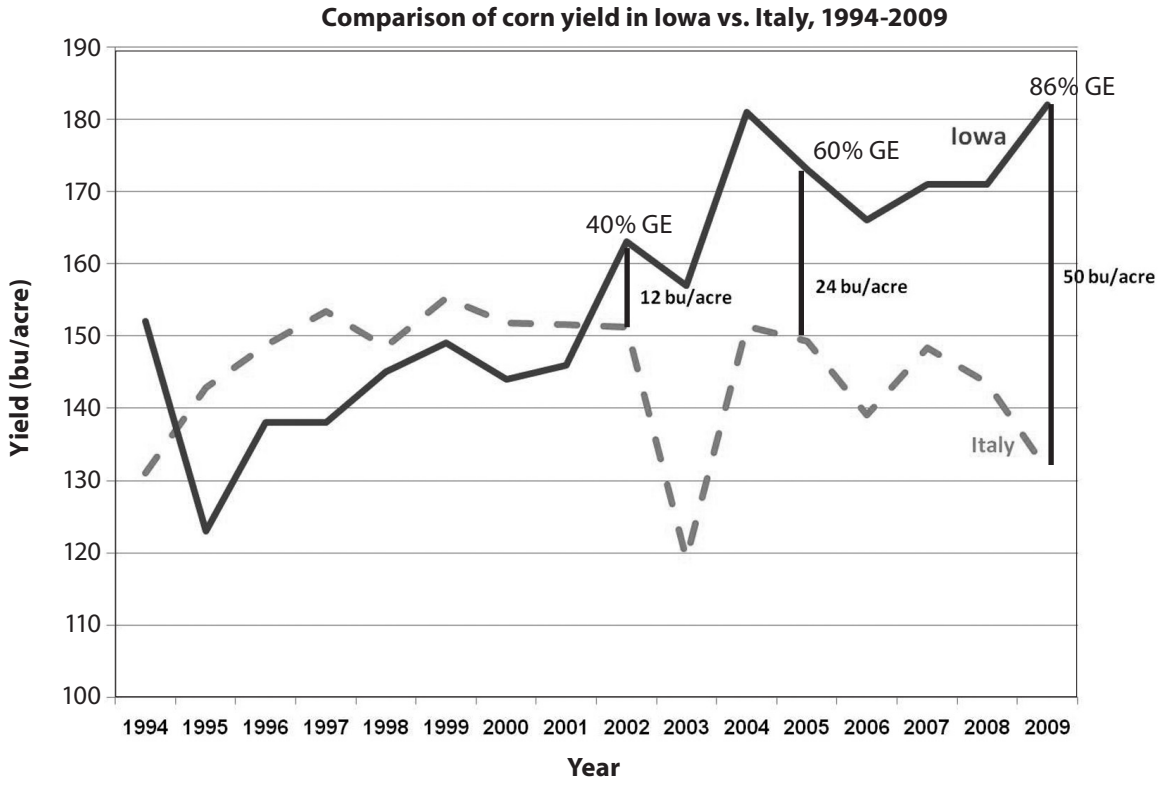
We don't need to spend much time with this audience on the importance of adopting technology; however, there are some examples that demonstrate the importance so well that we want to briefly highlight them. In a recent presentation at KSU Cattlemen's Day, Dr. Ted Schroeder shared a graph (Figure 1) that shows the explosive improvements in corn yield in Iowa as a result of technology adoption (genetically modified corn). He contrasted the improvements in Iowa to the corn yields in Italy. In the early 1990's Italy had higher yields than Iowa and is one of the EU's top corn-growing countries. Typically, Italy would out yield Iowa; however, Italy has made no progress in corn yields in the last 15 years which lead to Iowa producers now having a 30 to 50 bu/acre advantage over Italian corn producers. The main difference is that Iowa improved yields through adopting genetically-engineered varieties while Italy and the EU resisted adoption of those technologies.

For a pork industry example, the data from a North Carolina State University study (Fix, 2007) demonstrates technology adoption very well. In this study, 1980 vintage pigs were created through frozen semen and sows unselected since 1979 and compared to 2005 genetic era pigs while feeding them diets that were common in 1980 compared to 2005 diets. Application of the technology advancements in genetics and nutrition had a profound impact on economically important traits. The combined genetic and nutrition advancements led to a 13% reduction in days to market (6% due to genetics, 7% due to feeding program; Figure 2), improved feed efficiency by 27% (7% genetic and 20% nutrition), reduced backfat by 24% (all via genetics), increased loin area by 34% (21% due to genetics and 13% from nutrition), and improved lean efficiency by 45% (22% for genetics, 23% for nutrition). The US Swine industry would require an additional 12.5 million tons of feed and 5 million pig spaces if we were trying to produce today's numbers with 1980's pigs and nutrition programs.

Models of technology transfer and research adoption

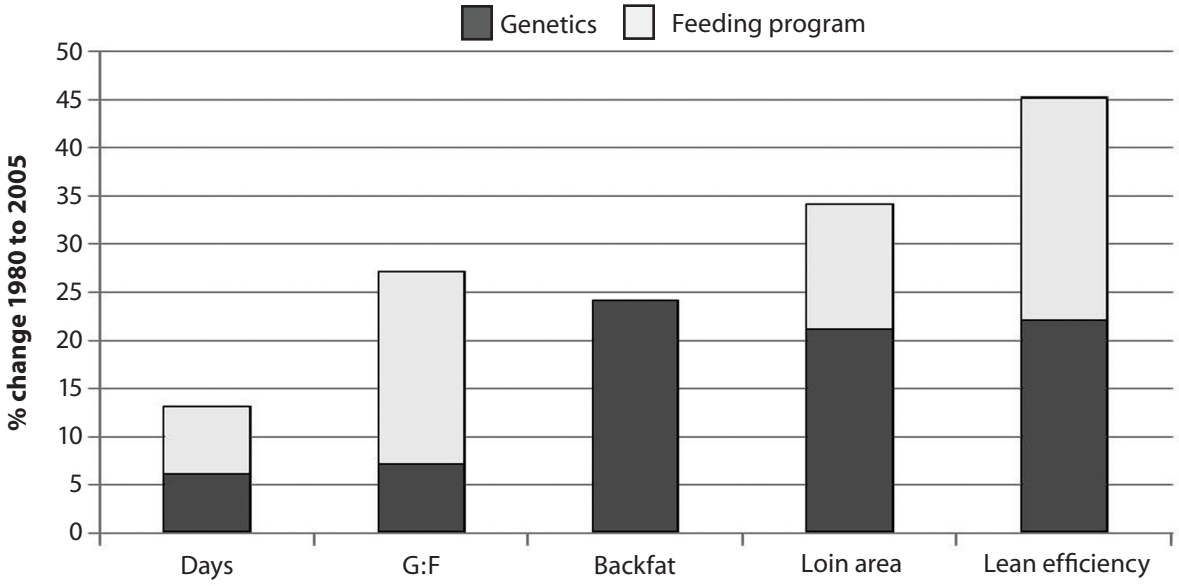
We often take technology development and transfer to practice for granted in the US. The Morrill Act began our long history of strong university research programs. The Smith-Lever Act led to development of extension programs that taught us how to extend university research breakthroughs to the industry. This model worked well for many years; however, one of the problems with the original structure and thought process is that it relied on innovations being made at the basic science level and those innovations to be forced down the chain in largely a one

Figure 1: Comparison of corn yield in Iowa versus Italy, 1994 to 2009. Adapted from T. Schroeder, Kansas State University based on data from USDA-FOASTAT and Eurostat.



Source: Ted Schroeder based on USDA-FOASTAT and Eurostat

Figure 2: Influence of genetic and feeding program advancements from 1980 to 2005 on economically important traits. Adapted from Fix, 2007.



Adapted from Fix, 2007

way communication channel (Figure 3). This is the model that most government policy is now following and has been referred to by some as the "pharmaceutical model" (Leaver, 2010). In this model, 'blue sky' research is done in university or research institutes with industry using the information to develop a saleable product. A problem with this research policy is the belief that all research innovation occurs at the basic research level. Because government policy follows this model, most federal dollars have been focused on basic science leading university administrators to hire faculty to pursue the basic sciences. This path increases the likelihood of researchers generating more overhead dollars to fund university operations.

As Leaver (2010) describes and those of us that are involved in agricultural research and development realize, innovation can and has to occur at all levels of the research and development chain (Figure 4). Knowledge has to flow up and down the chain and influence actions at other levels rather than simply in a top down manner as much of the governmental research policy is written towards. Unfortunately, an excellent example of what can happen when one segment of the research and development chain is removed and not replaced by a comparable structure is the U.K. swine industry. The loss of some strategic and most applied agricultural research and extension in the U.K. through lack of funding has created a knowledge and innovation vacuum (Leaver, 2010; Figure 5).

As Stuart Lamb summarized in a Pork Magazine article:

"We can't turn the clock back, but we can learn from history and how a country's swine industry has evolved — or devolved — and learn by others' mistakes. The United Kingdom is one such country as its swine industry has changed dramatically."

"Fifty years ago there were many U.K.-run Extension station farms and a country-wide Extension service. This helped pig farmers stay up-to-date and run efficient businesses. However, the Thatcher government ended those efforts, and money was funneled from applied research. That was to the U.K. pig farmers' detriment."

We need to learn from the U.K. history. We have been following their model by eliminating public funding for the applied research/extension parts of the research and development chain. Extension and applied research programs in most areas of agriculture, but particularly swine, are being downsized or eliminated at most land grant institutions. As we stated above, we have a great start on replacing some of this infrastructure though private industry funding; however, we need to make sure we don't forget about some key parts of the development chain during this transformation.

Example applied research models

We would suggest that there are three main applied research models: 1) university; 2) private; and 3) public/private partnerships. Each model has some unique benefits and downsides that must be considered.

University model. The biggest benefits of the university model are that it traditionally hasn't relied on much industry support, data is generally more unbiased than private data, and the research does not have to have immediate short-term application. This last benefit means that research can often be in areas with more long-term, exploratory focus or to develop basic knowledge that others need for their more applied research. Another huge upside of universities is that there are always young, bright inquisitive new minds that bring new ideas to the group. The recent lack of hiring at many universities has limited some of this advantage to graduate student influx rather than new faculty. The biggest downsides of university applied research models are that the data can often not be relevant or easily applicable by others. Research is often done in outdated facilities with too few of animals of the wrong genetics with the wrong health status to be readily used by producers. Most universities have not updated their facilities to match current industry standards. University models also work at a much slower pace due to regulatory requirements and other pressures on researchers' time and, for some, simply because the tenure process allows them to not be bottom-line driven and time sensitive. The other reality is that less university-only applied research will be available in the future simply due to a lack of funding of these programs.

Private model. The biggest benefits of private model are that the research can have rapid application, is relevant to the exact production system where it is being conducted, can be focused on the immediate situation, and be bottom-line driven. However, there are some downsides with private only models. Like the university model, they can lose creativity over time if new people are not infused into the group or if the system doesn't have dynamic people that are searching out new ideas and concepts to apply in the system. The bottom-line focus tends to move the thinking to the immediate and short-term which stifles creativity and can lead to fewer major breakthroughs. The biggest worry with replacing public models with private models is that there will be a void of people to replace the current generation of researchers trained in applied research that can bridge the gap between basic research and practice. We need to be cognizant of the long-term need to provide opportunities for future technologists in the swine industry to receive the proper basic training that is hard to accomplish in a private only model.

An often overlooked issue in most private research systems is the lack of peer review. Just the mention of peer

Figure 3: Historical research and development chain. Adapted from Leaver, 2010.

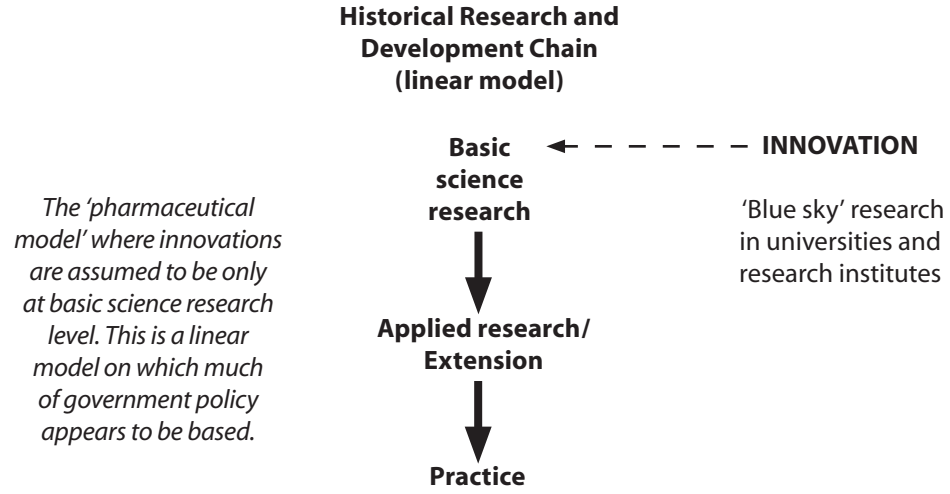


Figure 4: Agricultural research and development chain. Adapted from Leaver, 2010.

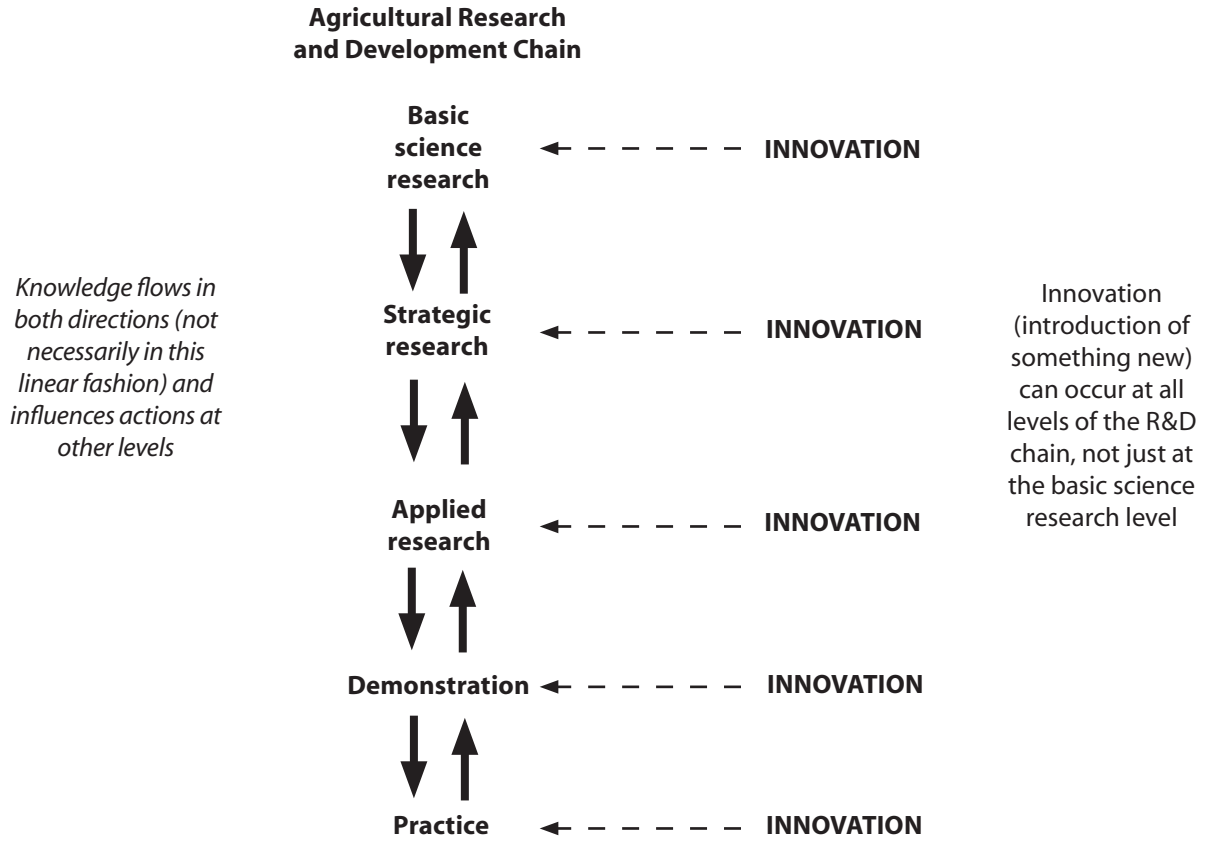
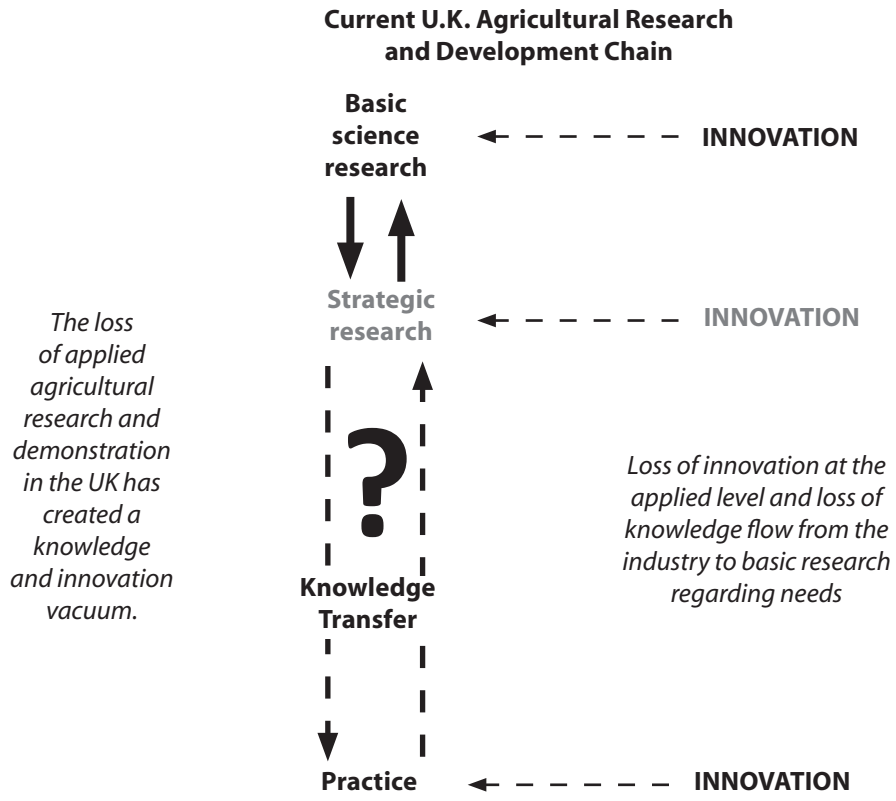


Figure 5: Research and development chain in U.K. Adapted from Leaver, 2010.



review implies a long drawn-out unnecessary delay in getting data into application; however, it is a process that makes us better. We are not advocating that all data should be withheld until it gets published in a journal article, but rather that we use multiple avenues of peer review to get feedback on our research results. These could include sharing data at meetings, such as the Leman Conference or meetings of the American Association of Swine Veterinarians or American Society of Animal Sciences, or even at local or regional meetings between production systems. These venues provide an opportunity where people can discuss and debate research findings. Peer review often allows alternative conclusions and improvements to future experiments to surface.

Confidentiality is another issue that can be problematic with the private only model. In some cases it can lead to "selective" publication of results. The only data that often gets circulated from the private applied research systems is data that shows a product in a positive light. Because University applied research programs have pressure for publications and abstracts, it is more likely that negative results or no response trials will still find their way into experiment station reports, abstracts, and papers. Because of the desire for confidentiality and lack of desire to publish, only those with a vested interest (usually suppliers) will share the results of research trials being done in many private-only models. We are often told that this is not a problem because "we will just test the product in our system before implementing". In reality, you cannot test everything or waste time and resources in testing products or concepts that shouldn't be tested. Also, we find that products get implemented into the system based on past relationships because there simply isn't enough time for everybody to test everything. Lowering the confidentiality bar by building collaborations between production systems or by publishing trials at some point after being done will be required if the US swine industry is to continue the pace of technological improvement that we have experienced in the past. The research programs in some private systems have already taken this step. In other systems, the CEO's (usually not trained in the research process) believe the need to protect the applied research investment via confidentiality outweighs the benefits that they receive from sharing information with others. This attitude has got to change. No swine production system has the expertise in all the areas that can be accessed through sharing of information and peer review.

Another problem that can occur in private systems is that the CEO may not value research highly and, thus, straps the researchers with other "more important" responsibilities in the company, thus, greatly diluting the private research efforts over time. There can be a tendency for private businesses to "try this new idea" as opposed to a systematic, valid, research approach. This is particularly true when management training is in a field where the value of the scientific approach is not fully understood or appreciated.

Public/Private partnerships. When done correctly, we believe the third model can encompass many of the benefits of the university model and private models while minimizing the downside. There are more and more examples of these types of partnerships being developed in the swine industry including the Maschhoff/University of Illinois partnership and the New Horizon Farms/Kansas State University team. The benefits that can be captured include the relevance of data, large system application, creativity, peer review, and the ability to add areas and depth of expertise that cannot be afforded within the production system. Certainly, there are downsides with these arrangements. The production system needs to recognize the commitment to research in added labor, equipment and any potential effects on pig flow and production. On the other hand, the university needs to recognize the commitment in resources the production system has made and not apply treatments or procedures that are overly disruptive to the production system.

The production system also has to be willing to give up some level of confidentiality. Also, decisions usually must be made on a team basis rather than an individual basis. Although we see the team decision making process as a benefit, some researchers (and university administrators) can view it as a downside because of the difficulty in determining who should get the credit.

Our belief is that much of the value in an internal production research program lies in the ability to execute change based on the data. Our observation is that production systems with excellent processes in place to execute change also have greater confidence to submit their internal research data to external review. Their belief is that the major technologic advantage is from adoption. Therefore, a model of being exposed to more outside ideas brings more opportunities for implementation and more opportunities to profit from the partnership.

Research model needs

Whether the research model is a university, private, or public/private partnership, we believe there are a few key requirements to make it successful long term.

Creativity. No matter where the applied research is being conducted, continual infusion of new ideas and new people is required. You have to be very careful to not squash the ideas of the "non-insiders" that bring suggestions to the research team. This can be a problem in a university or private system. Time is one of the biggest constraints on creativity. As a person becomes more successful, more requirements are placed on their time leaving less time to be creative. Researchers within universities and production systems have to find time to be creative. This can come through forced research meetings, brainstorming sessions, professional meetings, or other avenues. Besides time being required to allow those in the research team to be creative, adding outside people with new perspectives is another way to enhance creativity. People can be adding through hiring or, less expensively, by partnering with others whose expertise brings new ideas to the research team.

Dollars. Research and development is expensive. Partnerships between university and private systems have allowed us to spread the costs over multiple organizations and leverage expertise and resources; however, research still costs money. We believe it is a major mistake for a production system to view research as a profit center. The entire focus of the research unit changes once it is turned into a profit center. Instead of focusing on the biggest needs of the system, the focus becomes where we can find the necessary dollars to pay salaries and keep the research program running. Thus, you will fail to answer relevant questions and be driven by whoever can bring the most dollars to the table. For a veterinarian, this will most likely be a animal health company. For a nutritionist, it will most likely be an ingredient supplier. You will also find yourself compromising on experimental design and interpretation to satisfy the sponsor so they will fund more research in your facility. Bottom line is that you need dollars to run a research program, but don't let the dollars drive your research program.

Research mentality and commitment. Before a production system decides to build a research barn or start a research program, they need to determine whether they truly have the mentality and commitment to doing it correctly. For us, this entails two parts. First and simply, will the research get done according to protocol. For example, if the agreement is that pigs need to be marketed a certain way in order to collect carcass data, will they actually be marketed that way. This is a very simple example, but inability to follow the agreed upon protocol is one of the biggest problems that we find in trying to conduct field research. There must be a champion with the research mentality in the upper management team of the production system or organization. Without a champion, short-term costs or "the way we always do things" will win out over proper experimental design.

Rigor in execution is the second part of research commitment. There must be rigor in protocol development, experimental design, execution, data capture, analysis, and interpretation. Lack of discipline in any of these areas usually results in failure of repeatability of results

and failure of the research to have a true impact on the production system. Several examples can be given where lack of rigor could impact experiment results including: allotting pigs to treatments without balancing for genetic lines, gender, or location in barns, weighing on scales that have not been calibrated, not validating pig counts and carefully documenting pig removals, not treating all pigs on test in the same manner, not having sufficient replications to draw conclusions, or using the wrong statistical methods to analyze data. Over time, the lack of rigor will lead to lack of trust in the research results and lack of need for the researchers involved.

Peer review. We have already discussed the importance that we place on peer review. As stated peer review is one of the most frustrating and humbling parts of being a researcher. However, you must expose your warts to the outside world and accept criticism that comes in order to improve on the process and obtain new ideas from others to apply in your system. Peer review helps to force rigor back into your process control. It is simply too embarrassing not to have rigor when you expose yourself to peer review.

Credibility. In order to have value to the US swine industry or within the production system, the research program has to have credibility. By credibility, we mean can the results be trusted and repeated by others. Unfortunately, you do not have to have credibility to get research funding. We all know of researchers that appear to be able to find a positive response to anything tested, no matter how many others have not been able to show those benefits in the past or in the future. We believe that very little data is outright made up; however, burying negative data sets, repeating trials until you convince yourself that you have the "right" results, or finding conclusions not supported by the data will all impact credibility.

Sometimes credibility isn't that easily or greedily lost. Lack of rigor in experiment execution can lead to loss of credibility. Lack of open sharing of data can lead to loss of credibility. For example, if a research system conducts three trials with a feed additive and only one shows a positive response and that is the only data shared with the outside world, credibility is lost to those that cannot repeat the results over time. We all know that results aren't 100% repeatable and, thus, we should be careful to deem somebody as not credible based on a single instance or two; however, serial violations to our trust and confidence will cause loss of credibility. As university researchers, if our research is not credible, producers will fail to gain benefit from our recommendations and we will eventually lose their support. If the research program within a production system loses credibility, the system will eventually ignore their research results and not implement them leading to lack of need for the research program within that system.

Summary

We are not pessimistic so the glass is not half empty, nor is it really half full, it has just moved to a different table. Applied research is alive and healthy in the US swine industry; however, we do believe that the future is in danger due to loss of funding and increased privatization. Leaders in many of our private and public systems are getting older and will eventually need to be replaced. Our applied research models need to provide a place for training this next generation of applied researchers. By developing more public/private partnerships, we believe we can meet the applied research needs of the industry and train the next generation. Researchers in these public/private partnerships must remain an unbiased source of new creative ideas. The research needs to be focused on the long-term priorities of the partnership and not be driven by outside funding sources focused on placement of product in the production system. Because fewer universities will be involved in applied research, those in these public/private partnerships will have the opportunity to be well funded. To be successful long term, these research models must have creativity, dollars, a research mentality and commitment, peer review, and credibility. We have an increasing number of examples in our industry where this is occurring. As an industry, we need to learn from and improve on these models to keep the US swine industry in the leadership role as the research and production leader around the world.

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