

Genetic Challenges of the Future – Panel Discussion

Diversity of Thought?

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Introduction

The leading presentation into this discussion, “Swine Genetic Challenges of the Future: One man’s thoughts”, presented by Dr. Max Rothschild of Iowa State University, incisively outlined the history of the discipline and provide a framework for the future while astutely acknowledging and outlining many of the challenges that lie ahead. Certainly the field of Animal Genetics has come far over the last two decades. What was once thought by some to be a “dead science” is alive and full of expectations that are, at times, hard to imagine. As the mysteries of the genome continue to unfold, the potential is vast and the development of discipline is limited only by the imagination of the human mind. However there are obstacles to overcome. Dr. Rothschild rightly asks, “Who will pay for further discoveries?” “Who will collect difficult to measure and expensive phenotypes?” and “Who will develop the statistical tools to use genomic results?” This paper addresses related questions to those stated by the lead speaker.

Past and Present

Many of the leading Animal Genetics programs, particularly Livestock Genetics programs have been a part of Animal Science Departments in Colleges of Agriculture. These programs have contributed greatly to the success of Livestock Agriculture in the U.S, which presently contributes \$110 billion to U.S. economy (Ireland et al., 2008). However, this success has not stabilized many of the research programs engaged in livestock research. From 1985 through 1996 there was a 44% loss in purchasing power and a 22% reduction in the number of scientists supported by the Cooperative State Research, Education and Extension Service. (Ireland, et al, 2008). Furthermore the number of earned doctorate degrees awarded from Animal Science Departments declined by 30% from 1985 to 2004 (Ireland et al., 2008). In addition, a recent survey revealed that 30 of 31 animal, dairy and poultry science departments, representing 29 states, reported significant downsizing or complete elimination of beef, dairy or swine herds or sheep or poultry flocks since 1985 (Ireland et al., 2008).

This depletion of the research, extension and outreach capacity within land-grant universities has changed the ability of the scientific community to respond and influence the livestock food system. A concern has been voiced regarding how this has impacted the animal breeding and genetics discipline (Green, 2009). In an effort to parallel the Ireland et al., (2008) report, information was gathered to determine the number of Animal Science Departments that had continued their development of viable swine genetics programs. In addition there was inquiry to ascertain the number of doctorate degrees granted in animal genetics over time along with a census of dedicated herds for swine genetics research in animal science departments or federal research stations.

Traditionally Animal Science Departments who had active swine genetics programs participated in a USDA Coordinated Regional Research Committee. This committee completes a revised

project proposal, every 4-5 years, stating how they will function and complete cooperative research. In 1980-82 the Regional Research Committee for swine genetics was called the NC-103 committee. This committee was comprised of representatives working in swine genetics from 15 animal science departments from 14 states and two USDA-ARS research laboratories. The listing of participating entities is found in Table 1. At that time, the scientists that participated in the committee were primarily quantitative animal geneticists, since the sub-discipline of molecular genetics was just emerging.

The present day counterpart of the NC-103 committee is the NC-1037 Committee. It is comprised of scientists from Animal Science Departments from 8 states, and scientists from two USDA-ARS laboratories (Table 1). Scientists from animal science departments in eight states which had participated in the NC-103 committee no longer participate in NC-1037. Yet scientists from animal science departments in two states have been added to this cooperative effort in swine genetics research. There are six fewer institutions involved in this regional research committee presently compared to 1980-1982, resulting in a reduction of 36%. The argument can be made that animal genetics research, not necessarily swine genetics research, has continued at 5 of the 8 animal science departments that no longer participate in the regional research swine genetic committee. Yet the net reduction in participation in the swine genetics regional research committee is a net loss to a collective effort addressing regional, national and industry priorities.

In an effort to determine if there has been a decline in the number of persons who have earned Ph.D. degrees in animal genetics from those animal science departments who historically participated in NC-103 or presently participate in NC-1037 an assessment was undertaken. For 16 institutions who had participated in NC-103 or are presently participating in NC-1037 (Table 2), an electronic database search of Ph.D abstracts was conducted to determine the number of earned Ph.Ds that been awarded in Animal Genetics. The years searched were 1980 to 1988 and 2000 to 2008, realizing that not all abstracts from completed Ph.D. dissertations in 2008 would have been cataloged in this electronic database at the time of this search. During 1980 to 1988 there were 119 Ph.D degrees awarded from these 16 institutions whose research topic related to Animal Genetics. From 2000 to 2008 there were 68 PhD degrees awarded from these 16 institutions in which the research topic related to animal genetics. This represents a net decline of 51 or a 42.8% decline in Ph.D degrees awarded in the field of animal genetics, which is larger than the overall decline in Ph.D degrees awarded by Animal Science Departments as reported by Ireland et al., (2008).

Critical to animal genetics research is access to livestock populations that can be studied and genetic causal relationships determined. Historically, scientists working in swine genetics had access to dedicated research herds to complete their work. Among those institutions that did participate in NC-103 or presently participate in NC-1037, 14 of the 18 institutions had dedicated herds for swine genetics research in 1980 to 1982 (Table 3). However in 2008, only 7 of these institutions have dedicated herds for swine genetics research. This 50% decline in research populations dedicated to swine genetics research certainly mirrors that reported for Animal Science Department research herds and flocks (Ireland et al., 2008).

Research support is critical for the success of any research program and is certainly true for swine genetics. For decades much of the research funding for Animal Science Departments as well as swine genetics programs came from formula Hatch funds distributed through Agricultural Experiment Stations located in each state. Unfortunately during the last 10-15 years much of this funding has been reduced or re-allocated away from traditional areas of research conducted within Animal Science Departments. This is also true for swine genetics research which has had an increased reliance on competitive federal funding all the while these funding programs have experienced minimal increases in funds available. Furthermore many of these programs have experienced increasing numbers of proposals competing for these funds which has decreased the percentage of proposals funded. Since 2001, only 5 of universities who did participate in NC-103 or are participating in NC-1037 have been awarded a federal grant from the National Research Initiative grant programs relating to swine genetics research. This certainly can not be considered a sustainable level of funding to complete the discoveries necessary as outlined in the lead paper of this discussion, nor train the scientists necessary for the future.

Future?

As outlined in the lead paper to this panel discussion, the future of swine genetics is one in which great discoveries can be achieved and the potential for genetic improvement of pigs for both traditional as well as emerging traits can be great. This emerging era has been called the “Second Renaissance Age” (Green, 2009) in animal breeding and genetics. As outlined in the Blueprint for USDA Efforts in Agricultural Animal Genomics (USDA, 2007) well developed populations that lend themselves to animal genetics research are critical as well as advances in bioinformatics and computational biology.

For the livestock industries in general and the swine industry in particular, to reap the benefits of all the proposed advances in swine genetics, research and training programs must be in place to span the field in its entirety as practically feasible. However the question must be asked, “How many institutions are to be included in the future of swine genetics research?” To answer this question effectively, the discussion can not be narrow in its scope. It must be remembered that all on-going work regarding the genetic control of reproductive efficiency, growth, production efficiency and product quality will need to continue. Yet research programs investigating the genetic control of immune response, behavior, adaptation to alternative production systems in traditional and emerging areas of the world must be created. Furthermore advances in bioinformatics, statistical genetics and usage of novel selection tools in breeding programs will be paramount to successfully incorporating these emerging genetic opportunities into the swine industry.

To maintain an effective number of institutions that can span the research field and have viable graduate education and training programs new ideas are needed. The historical models used for research and education funding are no longer viable for a multiple reasons. However some type of base or formula funding across institutions involved in the swine genetics research complex is necessary to ensure stability. Base or formula funding is critical in maintaining the research and education infrastructure so that multiple strong programs can successfully compete for competitive research and training grants. Without these base funds, institutions will struggle to maintain competitive research and education programs.

Graduate education in animal genetics should also look beyond historical models for formal coursework instruction. A national curriculum should be developed and adopted. The on-going development of distance-learning modules for graduate education in Animal Breeding is applauded for its foresight and innovation (Lewis, et al., 2008). Yet what will happen when the grant funding this effort expires? A national curriculum should be developed across universities so that comprehensive course offerings are available for developing scientists regardless of their geographic location or institution. The hurdles regarding the technology to deliver these courses are lowering and the ease of delivery should only improve in the future. This issue regarding course credits and payment for courses across universities is certainly a solvable one. University administrators need to get on with the development of a solution, realizing that this can be a win-win if done correctly. Finally, university administrators will have to acknowledge the Scholarship of Teaching within a national curriculum realizing that new and creative pedagogy (teaching) models will have to be developed for successful implementation of this method of graduate education.

Conclusion

The future of the swine genetics appears to be limitless. Solving the mysteries of the interworking of the genome and rapidly using new discoveries in pig improvement schemes should yield vast opportunities to develop pigs that will be adaptive to a myriad of environments, production schemes and markets. To competitively use these new opportunities the U.S. Pork Industry along with land-grant institutions, federal laboratories and state and federal agencies will have to develop new models for research and graduate education so that institutions involved can complete the necessary work to yield these discoveries and train the next generation of scientists.

Literature Cited

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Table 1. North Central Swine Genetics Regional Research Participation

Institution	NC-103 (1980-1982)	NC-1037 (2007-present)
Alabama (Auburn Univ.)	X	
Georgia (Univ. of Georgia)	X	X
Illinois (Univ. of Illinois)	X	X
Indiana (Purdue Univ.)	X	
Iowa (Iowa State Univ.)	X	
Kansas (Kansas State Univ.)	X	X
Maryland (Beltsville Agric. Res. Ctr.)	X	X
Michigan (Michigan State Univ.)		X
Minnesota (Univ. of Minnesota)	X	
Nebraska (Meat Anim. Res. Ctr.)	X	X
Nebraska (Univ. of Nebraska)	X	X
North Carolina (North Carolina State Univ.)	X	X
North Carolina (North Carolina A&T)	X	X
Ohio (Ohio State Univ.)	X	X
Oklahoma (Oklahoma State Univ.)	X	
Oregon (Oregon State Univ.)	X	
Pennsylvania (Pennsylvania State Univ.)	X	
Wisconsin (Univ. of Wisconsin)	X	
Washington (Washington State Univ.)		X

Table 2. Earned Ph.D Degrees From Animal Science Departments with Swine Genetics Programs.

Institution	1980-1988	2000-2008
Auburn Univ.	2	2
Univ. of Georgia	5	4
Univ. of Illinois	4	2
Purdue Univ.	6	2
Iowa State Univ.	23	15
Kansas State Univ.	2	0
Univ. of Minnesota	13	4
Univ. of Nebraska-Lincoln	14	9
North Carolina State Univ.	6	5
Michigan State Univ.	7	7
Ohio State Univ.	9	8
Oklahoma State Univ.	8	2
Oregon State Univ.	7	0
Pennsylvania State Univ.	2	1
Washington State Univ.	2	2
Univ. of Wisconsin	9	5
Total	119	68

Table 3. Institutions participating in NC-103 and/or NC-1037 with dedicated herds to swine genetics.

Institution	NC-103 (1980-1982)	NC-1037 (2007-present)
Alabama (Auburn Univ.)	X	
Georgia (Univ. of Georgia)	X	X
Illinois (Univ. of Illinois)	X	X
Indiana (Purdue Univ.)	X	
Iowa (Iowa State Univ.)	X	
Kansas (Kansas State Univ.)	X	X
Maryland (Beltsville Agric. Res. Ctr.)	X	X
Michigan (Michigan State Univ.)		X
Minnesota (Univ. of Minnesota)	X	
Nebraska (Meat Anim. Res. Ctr.)	X	X
Nebraska (Univ. of Nebraska)	X	X
North Carolina (North Carolina State Univ.)	X	X
North Carolina (North Carolina A&T)	X	X
Ohio (Ohio State Univ.)	X	X
Oklahoma (Oklahoma State Univ.)	X	
Oregon (Oregon State Univ.)	X	
Pennsylvania (Pennsylvania State Univ.)	X	
Wisconsin (Univ. of Wisconsin)	X	
Washington (Washington State Univ.)		X