Management and Genetics Research to Improve the Quality of Animal Products: A Beef Perspective\textsuperscript{1}

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Primary Audience: Extension Personnel, Researchers, Leaders in the Agricultural Industry

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INTRODUCTION

Clearly, the quality of food products from animals is determined by animal management, genetics, and postharvest management and processing. For some products, animal management plays a much greater role than genetics, and the effects of genetics on quality of some products may not be fully known. In general, when management of animals and processing of products are near optimum, genetics may play a very important role in determining ultimate quality. On the other hand, the importance of genetics may be overshadowed when animal management is poor or when postharvest management or processing is inadequate.

The broadest definition of quality includes 1) the composition of animal products; 2) visual quality, such as the color of meat, eggs, etc.; 3) sensory properties, such as flavor, texture, tenderness, juiciness; 4) nutritional contribution to the diet, such as protein quality, mineral content, fat composition, etc.; 5) long-term health benefits or detriments, such as impact on bone and muscle development, serum cholesterol, colon health, etc.; and 6) safety from microbiological and chemical residue standpoints. My emphasis will be primarily on the composition, visual quality, and sensory properties of beef.

The compositional, visual, and sensory qualities of beef clearly can be affected by important management factors such as breed, lines within breeds, crosses of breeds, nutritional regimen, implant strategy, age at slaughter, gender, environment, transportation, preslaughter stress, electrical stimulation at slaughter, chilling rate, fabrication procedures, aging regimen, mechanical tenderization procedures, packaging method, marination and injection enhancement, muscle differences, cooking method, and degree of doneness.

INTERDISCIPLINARY RESEARCH EXPERIENCE

During my career, I have enjoyed being involved in many interdisciplinary and inter-institutional research projects that interface cattle management, genetics, and postharvest processing technologies. From my perspective, an ideal research program would be one in which a researcher has proven his or her competence as a specialist or as an expert in a discipline and who

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has a genuine interest in collaborating with scientists in other disciplines in systems research to obtain fundamental information and to solve industry problems. An ideal research blend would be to conduct research that is on the cutting edge of one’s specialty as well as cooperating in interdisciplinary research. I believe that a researcher can be stimulated significantly by interfacing with scientists in other disciplines, that research funds can be used more efficiently when various disciplines and perspectives are involved, and that the industry can be served more effectively when animal management, genetics, and postharvesting technology are integrated. When interdisciplinary research is conducted that involves more than one department or institution, there is a great opportunity for synergism, and it seems that administrators look very favorably upon interdepartment and inter-institutional research.

I have been involved in several research projects that integrate or interface beef cattle genetics, nutrition, and management with meat quality evaluations and postmortem technology to enhance meat quality. One of the most stimulating and productive interdisciplinary projects in which I have been involved was one at Kansas State in which we studied various nutritional management strategies of different biological types of cattle, different postmortem technologies to enhance visual and sensory quality of meat, and the economics of different management strategies and postmortem technologies. This study involved a nutritionist, a geneticist, agricultural economists, and meat scientists with various specialties. This project provided synergism among faculty and graduate students, it was a very effective use of resources, and it resulted in numerous progress reports, abstracts, and journal manuscripts. This project was highly favored by our administration and has helped us in maintaining support even 20 yr later. An example publication from this particular research is Dikeman et al. [1].

I have also cooperated with the US Meat Animal Research Center at Clay Center, Nebraska, for 16 yr on the Cattle Germ Plasm Evaluation and Cattle Germ Plasm Utilization research projects that have made noteworthy contributions to the beef cattle industry and meat processing industry. The cooperative Germ Plasm Evaluation research integrated genetics and meat science very effectively, whereas the Germ Plasm Utilization research integrated nutritional management, genetics, and meat science. Numerous industry reports, progress reports, and journal publications have come from this cooperative research. Example publications from this cooperative research are Gregory et al. [2] and Kochk et al. [3].

I am currently involved in an interdisciplinary, inter-institutional project in which several universities and private industry organizations are cooperating [4]. This extensive research project is funded by the National Cattlemen’s Beef Association (NCBA), Celera AgGen, and 13 beef cattle breed associations. It is a 4-yr project that will involve data collection for 9,000 progeny of the most widely used artificial insemination sires in the participating breeds. The primary objectives of this project are 1) to obtain carcass data, shear force data, and trained sensory panel data so that expected progeny differences can be developed for the respective breeds, 2) to validate DNA markers that have been previously identified at Texas A & M for carcass traits and meat palatability, and 3) to study the direct and opportunity costs and benefits of obtaining carcass and meat data and DNA marker analysis data.

The 13 beef cattle breed associations are conducting progeny tests of the most widely used sires in their respective breeds. The breed associations have control of sire selection, test herd selection, matings, nutritional regimen and management, and slaughter endpoint. Because this study is not for breed comparisons, it is important that proper contemporary groups are developed and maintained. A contemporary group is a group of animals of the same sex that have been managed similarly from birth to slaughter. At least one reference sire is required for each contemporary group. At the time of slaughter, carcass data are obtained, and a loin section is harvested and shipped to Kansas State for Warner-Bratzler shear force determinations (an instrumental measure of tenderness) on all animals. Trained sensory panel evaluations are also made on a representative number of progeny. The database is maintained by an animal breeder and geneticist at Cornell University, as are some of the data analyses.

Blood samples are obtained when cattle enter the feedlot, and a muscle sample is harvested at the time of slaughter for DNA analysis and validation of the DNA markers. The DNA analy-
ses and marker validations are being conducted by molecular geneticists at Texas A & M University and Celera AgGen. An agricultural economist at Colorado State University is studying the direct costs, opportunity costs, and the economic benefits to seedstock producers and to the entire beef industry for collecting various levels of carcass and meat data.

This project has the keen interest of many registered breeders of the various breeds as well as various segments of the beef cattle industry. There is considerable synergism among the various researchers involved, and such an extensive project could only be conducted as a cooperative, interdisciplinary, inter-institutional project. It contains a very practical, applied aspect in which user-friendly expected progeny differences for carcass and meat traits for the most widely used artificial insemination sires in the purebred industry will be developed.

It is the first project to provide expected progeny differences for meat tenderness and other palatability traits, and it should allow the beef cattle industry to genetically improve meat palatability. The project also contains a fundamental component in which DNA analysis for markers previously identified for carcass and meat traits can be tested and, potentially, new markers identified. It contains a modeling component by evaluating ways in which the presence or absence of markers can be incorporated into traditional mathematical or statistical calculations for development of expected progeny differences. In addition, there is an economic component in which the economics of collecting various levels of carcass and meat data will be analyzed. It should result in an extensive database that can be used for several years for statistical analyses. And, it will result in numerous publications, ranging from progress reports to scientific journal manuscripts. In my opinion, the project is a “win-win-win” situation in which the beef cattle industry will have useful information from which to make progress, the knowledge base relative to the value of DNA markers will be increased, and we as scientists will be stimulated by the research.

VISION FOR FUTURE INTERDISCIPLINARY RESEARCH

My vision is that, with decreasing or limited research funds, interdisciplinary, inter-institution, and institution-industry research that integrates management, environmental issues, nutrition, physiology, genetics and animal breeding, post-harvest technology, and animal-product quality investigations will become necessary for many researchers, departments, and institutions to remain viable in the future. Those studies that pursue both fundamental and practical components and those that have potential to answer industry questions or solve industry problems will be favored and funded. To be successful, researchers will need to have proven or established themselves as experts or specialists in one or more disciplines, to have an interest and understanding of more than their discipline area, and to be willing to cooperate or collaborate in interdisciplinary research in a systems approach.

PROCESS FOR CONDUCTING INTERDISCIPLINARY RESEARCH

The first step in the process is that an individual scientist must have proven himself or herself competent in conducting high quality research in their respective discipline area. This requires a strong background in statistics, biochemistry, physiology, nutrition, etc.; a good work ethic; and creativity. In addition, the ability to publish and some success in obtaining grants are very important. Cooperative, interdisciplinary, and integrated research does not compensate for poor quality, shallow, “dull-edge” research, and unsuccessful grantsmanship.

The second step in the process is for researchers to have their “radar screens” up and attempt to stay in tune to changes in the livestock or poultry and animal product industries, to keep abreast of numerous discipline areas, and to have an industry interest.

The third, and probably the most important, step in the process is to have demonstrated an attitude of cooperation and collaboration with researchers in other disciplines. An isolationist type of researcher is not the type that will complement other researchers in interdisciplinary, cooperative research. Cooperative, interdisciplinary, integrated research should bring about a synergistic outcome that will stimulate all researchers involved and lead to better focus on research questions that need to be addressed.

The fourth step in the process is to build upon, expand, or leverage against other research that
has been done. Our Carcass Merit Traits project leveraged an investment by NCBA in the previous Bovine Genome Mapping project, and the resulting knowledge aided in the discovery of DNA markers with the opportunity to validate or test the markers in a larger, independent population in our project.

The fifth step is to be motivated and dedicated to completing research and being responsible in communicating results to the industry and to other scientists. Research cannot be classified as excellent if it is not analyzed and communicated in a timely, effective manner to administrators, the industry, and to other scientists. When several scientists are involved in cooperative, interdisciplinary research, there often is greater stimulation to complete data analyses and to communicate results than when a scientist is working alone. I see no reason why quality, interdisciplinary, cooperative research cannot be communicated in the popular press, in technical bulletins, and progress reports, as well as in scientific journals. Timely and effective communication of results will open doors for further opportunities for research funding.

Perhaps the sixth step in the process involves emphasizing to administrators the importance and long-term benefits of quality, interdisciplinary, cooperative research that is effectively communicated to the industry in contrast to simply counting the number of publications by a researcher.

**SUMMARY**

To summarize, I am making acronyms out of the words “vision” and “process” to emphasize the points that, in my opinion, are important regarding interdisciplinary research.

**Vision**

V: Visionary thinking is necessary in order to be creative and be on the cutting edge in interdisciplinary research.

**Process**

P: Proven scientific competence. One has to prove competence in a discipline or specialty before he or she can effectively contribute to interdisciplinary research.

R: Radar screen. Researchers must have their “radar screens” up and attempt to stay in tune to the changing livestock or poultry and animal food product industries.

O: Original research is the goal and often the outcome of collaborative thinking and planning.

C: Cooperation and collaboration are essential to conduct quality, cutting edge, interdisciplinary research.

E: Excellence in research involves timely, effective communication of results to the industry and to other scientists.

S: Synergism results from quality, cooperative, interdisciplinary research.

S: Systems research addresses industry issues and problems and is an efficient use of financial resources.

**REFERENCES AND NOTES**


