

Animal and Range Sciences — The Next Decade

Clayton Hauge
Department of Animal and Range Sciences

Animal agriculture has two characteristics absent from most industries; major dependency on space and weather as limiting factors. The future of animal agriculture then will be influenced not only by factors having a direct effect on animal production, but by consumer income and preferences, environmental constraints, animal welfare pressures, impact of energy and labor on marketing, processing and transportation, and political influence on the free movement of products.

Dr. Max Lennon, President of Clemson University, commented on the future of animal science research, "The only safe prediction about the world of animal agriculture is that it will change," and secondly, "If the U.S. animal industry sleeps while the rest of the world is innovative, resourceful and forward thinking, considering the next 100 years may indeed prove to be a purely academic exercise."

At present, almost 70 percent of this country's total agricultural area is range and pasture land. The available photosynthetic energy captured by grasses and forages must be processed through livestock if it is to be used for human nutrition. About 85 percent of the corn crop, 70 percent of the soybean crop, 21 percent of the wheat, 94-95 percent of the grain sorghums and barley, and most of the oats and rye crops are currently fed to livestock. Animal livestock sales account for approximately 50 percent of the sales value of agricultural products.

The lifestyle and eating habits of people in the U.S. are playing an important role in how meat, poultry and dairy products are produced, processed and served. Public opinion about long term effects of animal products on health is an important factor to be considered. Changing attitudes are reflected in changing demand.

Production agriculture is a way of life, but it must be more efficient to survive. The trend indicates that production units will continue to become larger and fewer in number. Nationally, it is predicted that poultry consumption will continue to increase at the expense of beef production; pork consumption will remain about the same. Consumption of dairy products is below the production level, suggesting that dairy cattle numbers be reduced.

Animal production systems vary a great deal in their efficiency. Production units which survive will be those that improve their efficiency. Problems which relate to losses in-

come are low production, disease control and the lack of record systems.

Feelings for animals are increasingly being expressed in a number of ways. Several organizations have been formed for animal rights and animal welfare. These organizations are attempting to influence legislation that will restrict the use of animals in various research activities. We cannot dismiss animal rights advocates as misguided cranks. They are generally articulate, dedicated individuals with a deep sense of conviction. We must be aware of the various issues and provide animals excellent care. We must be willing to defend our production practices as being in the best interest of both the animals and their owners. If not, then we must be willing to change.

The animal industry must prepare itself to capitalize on major opportunities developing on the horizon. According to Max Lennon, the greatest challenge for animal agriculture is to look upward and outward rather than downward and inward. Success will not be achieved in isolation. To be successful in any field will require the assistance of scientists in a number of the disciplines present on a university campus. Animal scientists need to become more aggressive in their own laboratories along with developing new methods of networking the entire campus for solving some of the significant problems in the animal industry.

The future will be filled with a number of opportunities. A major commitment to education and research is needed to prepare the nation's animal industry to capitalize on those opportunities. The following discussions were prepared by staff in the major research areas indicating the research direction planned or opportunities for the future.

Ruminant Nutrition

The overall goal of animal agricultural research is to increase the efficiency of producing items that benefit society. Achieving this goal will enable producers to make a profit while allowing consumers to purchase food items at a reasonable cost. Future research in ruminant nutrition will have to provide answers to a wide array of questions if efficiency is to improve.

Research is needed to determine how nutritional programs alter events occurring at the cellular level, including gene expression and nutrient uptake. This type of research



Dale Redmer, animal and range sciences, and technician Kim Kraft count cells using a computerized image analysis system as part of studies related to the growth and development of blood vessels in the reproductive system.

is essential for the development of transgenic cattle and sheep. These types of animals could be designed to produce medically important products such as interferon or speciality food products such as low lactose milk.

Research is also needed to determine how ruminants extract nutrients from their feed. The exact chemical composition of feeds largely determines digestibility. Forages are the cornerstone to efficient and profitable production of ruminant animals, but because of large inherent variation in composition, they need to be analysed and evaluated more accurately. This will require the development of new analytical techniques and evaluation systems. This type of information will permit more accurate diet formulation which should increase efficiency by reducing digestive and fermentation losses of feeds.

Additional research is needed on nutrient requirements of animals and factors affecting nutrient requirements. As the genetic potential of animals increases and new products that increase production are developed, it becomes more challenging to formulate adequate diets. Plants are also being changed by genetic selection that in turn alters their nutrient content. Nutritional information on new plants, by-products and processing techniques needs to be refined. Furthermore, as consumer tastes change, different types of meat and milk products will need to be produced. Information regarding how the diet of the animal modulates the composition of meat and milk is needed.

The single most important factor in ruminant animal production is still management. Research is needed to determine how different management systems affect performance and profitability. This type of research requires a team approach. Nutritionists, economists, range scientists, agronomists and others will continue to work together to develop new management methods. Much of this research

involves development and testing of computer simulation models. These models are also useful in identifying areas that need additional research. Accurate models will allow producers to evaluate different situations and determine which possibility is most likely to produce acceptable results under given conditions.

There is a huge potential for significant improvement in the utilization of forage resources through ruminant nutrition research. This is a challenging and exciting area that will have a positive impact on the profitability of livestock production when they come to fruition.

Non-Ruminant Nutrition

Swine nutrition research in the future will emphasize nutritional requirements as influenced and modified by the alternative management practices that will be available. For example, the nutritional implications of the use of repartitioning agents for maximizing lean growth potential or the potential use of porcine growth hormone must be defined. These aspects and others created by biotechnology will have considerable impact upon swine production and nutrition.

The availability of a new feed mill will expand the opportunities to investigate the effects of processing on nutritional characteristics of feedstuffs. Examples include the effects of extrusion on the digestibility of nutrients and the effects of particle size and texture upon the acceptability of mixed feeds by swine of several age classifications.

It must be re-emphasized that the common threads in future swine nutrition research will be the interdisciplinary activities to resolve mechanisms of action and to determine the nutrient requirements under various alternative management practices. Examples include the use of growth hormone, compensatory growth, new strains of breeding stock and the potential influences of biotechnology upon both crops and livestock.

Reproductive Physiology

The discipline of reproductive physiology is relatively new, and its potential contribution to animal agriculture is great. In fact, an economic analysis indicates that poor reproductive performance is, by far, the major constraint on improving the efficiency of meat animal production.

Because of the diverse mechanisms of reproduction in domestic species, a comparative approach to research is necessary. Research findings in reproductive physiology not only increase our base of knowledge but often have the capability of revolutionizing the animal production industry. New information and levels of technology have increased dramatically in the last decade. For example, embryo collection and manipulation have been combined with gene transfer (transfer of genetic material between species) to produce "transgenic" farm animals. In the future, such techniques will allow us to rapidly transfer beneficial genetic traits from one species or breed to another. Our basic knowledge of the estrous cycle and pregnancy also have increased

dramatically and as such are beginning to be applied in the reproductive management of animals.

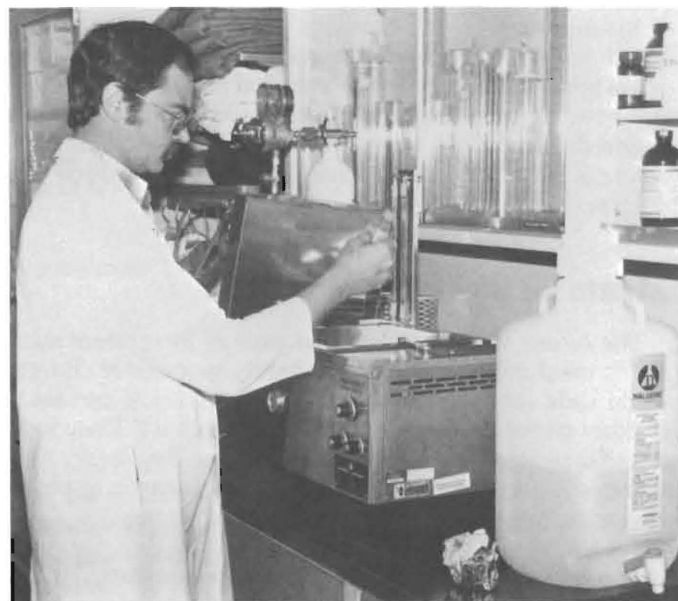
Our past efforts, however, are only the initial steps and have led to the recognition that many problems are yet to be fully investigated. A preliminary list of future research areas include: harvesting eggs (oocytes) directly from ovaries of very young animals to examine future performance of that female as well as dramatically extend the use of superior females; control of maturation and development of oocytes; control of time of ovulation; harvesting of sperm; storage and manipulation of gametes and embryos; prediction and control of fertility and development and survival; control of time of birth; understanding the influence of various environmental factors (light, temperature, humidity, space, etc.), and changes in these factors, on reproduction; and understanding the role of various hormones of the brain-pituitary-gonadal axis in reproductive processes. Many of these areas already are being actively investigated by reproductive physiologists at NDSU.

Future studies in reproduction will continue to utilize the latest laboratory techniques in microscopy, immunology and cell culture, as well as recent advances in biotechnology. The continued incorporation of these procedures into research efforts will do much to advance the frontiers of science in the discipline of reproductive physiology, and will lead to further development of techniques for managing reproductive processes in farm animals.

Range Sciences

One of the most pressing problems in range science today is understanding the role that large grazers play in ecosystems processes and landscape dynamics. This is an area that is at the forefront of ecological range research. Range science deals primarily with the utilization of rangelands for grazing, and as a consequence this topic is a key area of research. Range research at NDSU has concentrated on the development of grazing systems designed to increase meat production and maintain range condition along with other techniques and management practices. Important progress has been made, but we are now at a point at which further progress will depend on a renewed emphasis on basic research, designed to acquire an in-depth understanding of plant-animal interactions.

In the last few years, we have developed the faculty and research facilities to establish a multi-disciplinary basic research program alongside the existing applied research program. Within this basic research program we will emphasize five core areas: (1) Spatial and temporal distribution of populations selected to represent trophic structures in grassland ecosystems (to determine pathways of energy and nutrient transfers in the system as well as its structural organization) and how they are affected by grazing and fire events; (2) determine the pattern and frequency of disturbances in particular ecosystems (to compare natural and man made disturbances) and how they affect the ecology of the landscape; (3) determine the evolutionary role of grazing (grazing intensity, grazing behavior, etc.) and fire in the development of rangelands (for instance, how some key mechanisms involved in the structure and function of



Kim Kraft examines tissue incubations.

ecosystems may be adapted or related to grazing); (4) monitor the pattern and control of primary production by biotic (grazing in particular) and abiotic factors in order to determine the energy limits of system function, and (5) use computer simulation modeling to integrate results from this multidisciplinary effort to develop efficient economic grazing strategies for North Dakota ranchers and others with similar environmental and soil conditions.

Animal Breeding and Genetics

Productivity of farm and range animals is shaped by their genetic makeup, nutrition, and environment. Improvement in animal productivity in recent years is the result of increased genetic capacity for synthesis of meat, milk, eggs, wool and other animal products. Application of new technology to breeding and genetics can lead to identification and increase in the number of animals with desirable traits. Departmental research will be in two directions, first in the development of sophisticated parameter estimation and genetic evaluation procedures that will take advantage of the availability of super computers and their associated parallel processing and vector processing capabilities. The aim of the research will be to select animals specifically suited for particular environments and management situations. The matching up of the genetics of the animals with the needs of the farmers and ranchers will continue to be aided by the results of systems analysis research. Records which will enable accomplishment of this objective are becoming more and more available.

The second research approach will be looking from inside the animal out. This research involves studying, mapping and relating the genome of the animal to production traits. The idea is to take advantage of the DNA manipulation

techniques now available to help select animals genetically. This involves using animal breeding theory to help map genes and the use of progeny testing at the gene level, gene insertion, *in vitro* fertilization, and oocyte maturation for hundreds of offspring from selected females, increasing the potential of genetically superior animals for livestock production.

Meats Science

The future of meat research in view of the current status of the meat industry is, at best, highly speculative. Barring world wide famine, major economic or political upheavals or other global catastrophies, meat research will likely focus on efficiencies. The identification of the five basic meat eating consumer groups will stimulate research aimed at answering the demands of each of these groups.

The meat lover group comprises approximately 10 percent of meat eaters and this group will probably demand the least research effort in the future simply because they enjoy eating meat and will continue to do so. These consumers are more concerned with an abundant supply of flavorful product than they are with price or nutritional aspects. Traditionally, production-oriented research focusing on supplying efficiencies may be all that is necessary to satisfy the needs of the meat-lover group.

The creative cook segment involves about 17 percent of meat eaters. This group encompasses the gourmet, the innovator, the food adverturer, the person who is not only willing to spend the time cooking a meat entree', but thoroughly enjoys the creation of a meal. This group is the foundation of the current impetus for "branded" meat products because they expect consistency. Research designed to fulfill the needs of the group will involve the development of both live animal and carcass evaluation techniques aimed at ensuring product consistency. Post slaughter handling practices intended to ensure or enhance flavor, juiciness and tenderness also fit within the needs of this segment.

The health oriented group, some 24 percent of the meat eaters, will need a research effort similar to that of the creative cook segment, only the selection parameters will be different. While the creative cook group will most likely demand a very high quality product with little regard to assumed health aspects, research generated by the needs of the health-oriented segment will place primary emphasis on animals produced without the influence of feed antibiotics, artificial hormones or even those finished in commercial feedlots. This group will demand that a research effort focus on the basics of growth and development.

The active lifestyle segment is the fastest growing group, consisting of some 26 percent of the meat eaters. This group will probably generate the greatest amount of futuristic

research. The members of this group eat meat only when it is available in a convenient form. Precooking of complete meals, processing techniques designed for rapid meal preparation, dehydration techniques and other methods of preparation aimed at reduction in "kitchen time" will appeal to this group. Problems involving shelf-life and storage, packaging, off-flavors associated with the pre-processing, in-home handling and storage all need to be addressed.

Research efforts focusing on the restructuring of some of the less desirable (cheaper) portions of the carcass or attempting to utilize the cull maternal unit will be important to the fifth consumer group, those who are price driven (23 percent). This group primarily, but all groups eventually, will benefit from research designed to reduce cost of production, whether through animal selection, post-natal production practice enhancement or slaughter and processing efficiency improvement.

The future of meat research should not (cannot) be separated from animal production research. The advances in both production and laboratory equipment, especially electronic equipment, have opened new doors to previously impossible areas of research. Biotechnological procedures aimed at the enhancement of meat yield per unit of production will become commonplace. Research on increasing productivity of the female, for example the introduction of litter-bearing sheep breeds, has begun. Embryo freezing and transplant are commonplace, the sexing of semen, *in utero* castration, selection or gene infusion for disease resistance will all have a tremendous impact on meat production and its availability to the consumer groups.

Strict meat research continues to focus on the edible portion of the post-mortem animal. The industry must support, conduct and publish research which removes healthfulness doubts, documents the nutrition excellence, improves the eating satisfaction aspects and ensures the abundant supply of meat. If this is accomplished, the five consumer groups may eventually be condensed into one — the meat lover group.

There will be a limit to the changes that will occur in animal agriculture as a result of utilizing some of the new technologies. Research must continue in the applied as well as the basic area. We need a better understanding of the basic functions that we are trying to measure, control or change. Research does not necessarily lead to surpluses, but it is how the new information is used (or misused) that leads to problems. The future will be filled with opportunities.

The role of the department leadership will be to provide an environment which will allow and encourage scientists to be creative and imaginative. A major commitment to education and research is necessary in order to capitalize on those opportunities which will enhance animal agriculture.