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From the Department of Dairy and Animal Science

This regular column from Penn State's Department of Dairy and Animal Science features the research findings, student opportunities, and resports on other important topics generated in the Department. The back issues of the column are archived on *Lancaster Farming's* Internet *www.lancasterfarming.com* home page. Look for them.

Genetic Engineering – From Mice To Cows?

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Twenty-five years ago, genetic engineering merely served as fodder for science fiction writers. However, as we now enter the 21st century, genetic engineering is poised to make a substantial impact on our lives, food supply, and medicines.

The roots of genetic engineering can be traced to the late 1970s, when methods to manipulate the genetic material, DNA, became available. Mutations (or changes) in DNA sequences can cause the formation of abnormal proteins, which lack normal activities and may lead to disease. Genetic engineering techniques allow us to identify the mutations responsible for human and animal diseases. These methods provide a powerful means of studying the genetic makeup of animals.

Genetic Engineering of Mice:

It is now possible to genetically engineer mice – that is, add or remove fragments of DNA by manipulating embryonic stages of the mouse. These techniques allow researchers to use mice to develop models of human and animal diseases. Researchers already are using genetically engineered mice to study defects in human DNA which might lead to cancer, Type-II diabetes, or mental illness. Since 1990, researchers have produced literally hundreds of mouse disease models to enhance researchers' abilities to understand how inherited diseases develop.

Genetic Engineering from Mice to Livestock

For many years scientists have been interested in the phenomenon, double muscling. This trait, observed in cattle, is associated with a dramatic increase in muscle mass. Researchers at Johns Hopkins University identified a DNA mutation in the gene thought to be responsible. When this mutated gene was introduced into mice they also displayed the "double muscling" phenotype observed in Piedmontese cattle. This suggests that mice and livestock share common biological functions, and that mice can be used as models for larger animals. As a result, agricultural scientists are exploring the feasibility of genetically engineering livestock species for specific purposes.

A number of studies already conducted in sheep, goats, pigs and cows have introduced individual genes into these species that lead to the production of proteins not otherwise found in milk. These proteins are isolated from milk and used for a variety of clinical uses in human medicine. This emerging field of gene "pharming," in which the regulatory fragments of genes that direct the production of proteins normally found in milk are tested with hybrid genes in mice, pigs, and cows. Pharmaceutical companies are particularly interested in these studies because it may afford the opportunity to produce therapeutic proteins like erythropoietin for kidney dialysis patients. If selected proteins can be produced and subsequently isolated from milk without destroying their natural activity, a variety of expensive drugs may become more widely available by using "engineered" livestock.

An advantage of genetically engineered livestock is that they are renewable by breeding, can provide large quantities of milk as starting material, and can be maintained on farms with the same technology used for current animals. Pilot studies using farm animals as "bioreactors" are being conducted at a few universities and "biotech" companies; Penn State is presently not conducting any of these studies.

While the future of genetically engineering in animal agriculture is promising, further research is needed. First, the technology must advance significantly before it will be cost effective to produce genetically engineered livestock. The first reports of cloning (manipulating DNA outside the animal and exchanging an engineered nucleus for a non-engineered nucleus) may be a significant step forward. However, the success ratio in these experiments is very low and requires further improvements.

Second, are engineered products superior to naturally produced products? Will they be cost effective? Further, can the byproducts of this manufacturing process be utilized elsewhere? This requires a good cost/benefit ratio to be profitable.

Finally, are genetically engineered products safe as well as therapeutic? The evidence to date indicates that biotechnology and genetic engineering are safe, however, any new product needs to be rigorously evaluated.

The Department of Dairy and Animal Science at Penn State's University Park campus has created "The Mouse Farm," a genetic engineering program involving mice. We believe that genetic engineering studies of prototype DNA molecules in mice can be translated to larger animal species. However, these advances will depend on the availability of more information from genome databases for livestock, the continued refinement of genetic methods, and more cost-effective production.