# IMPROVING ANIMAL AGRICULTURE THROUGH BIOTECHNOLOGY

*By Terry D. Etherton, Distinguished Professor of Animal Nutrition, The Pennsylvania State University*

*Livestock feed derived from biotechnology has been shown to increase production efficiency, decrease animal waste and lower the toxins that can cause sickness in animals, asserts Terry Etherton, distinguished professor at The Pennsylvania State University. Genetically modified feed also can improve water and soil quality by reducing levels of phosphorous and nitrogen in animal waste.*

## INTRODUCTION

Over the past 20 years, biotechnology has lead to the development of new processes and products that have benefited agriculture and society. Between 1996 and 2002 there was a 35-fold increase in acreage planted globally with genetically modified (GM) crops, from 1.7 to 58.1 million hectares, and more than a quarter of GM crops are grown in developing countries. While there has been considerable discussion about the benefits of GM crops in the grains and fruits humans consume, less public debate has been forthcoming about GM crops' profound effects on improving the health of livestock grown for meat products and on reducing some of the environmental costs of livestock wastes.

Adoption of products produced by modern biotechnology will be important to enable the production of food sufficient to feed a growing world population.

Biotechnologies that enhance productivity and productive efficiency — feed consumed per unit of milk or meat produced — have been developed and approved for commercial use in many countries. New biotechnology products have enabled improvements to be made that increase food safety and improve animal health.

Biotechnology also offers considerable potential to animal agriculture as a means to reduce nutrients and odors from manure and volume of manure produced. Development and adoption of these biotechnologies will contribute to a more sustainable environment.

In order to be approved for commercial use in the United States, new agricultural biotechnologies are evaluated rigorously by the appropriate federal regulatory agencies to ensure efficacy, consumer safety, and animal health and well-being. Successful development and adoption of emerging biotechnologies for agriculture require improved public understanding of scientific, economic, legislative, ethical and social issues. The objective of this paper is to provide a brief overview of some of the existing and emerging modern agricultural biotechnologies that affect animal productivity and discuss their current or potential food safety and environmental benefits.

## FEEDING LIVESTOCK

Scientific studies evaluating feed components derived from genetically modified (GM) plants have focused on beef cattle, swine, sheep, fish, lactating dairy cows, and broiler and layer chickens, and have included nutrient composition assessments, digestibility determinations and animal performance measurements. These studies have shown that feed components derived from GM plants are equivalent in terms of nutrient composition to non-GM plants. Feeding components derived from GM plants, such as grain, silage and hay, also show results in growth rates and milk yields that are equivalent to those food components derived from non-genetically enhanced feed sources. Studies have reported that GM maize altered for protection against the "corn borer" can have lower contamination by mycotoxins — toxic substances produced by fungi or molds — under certain growing conditions, resulting in safer feed for livestock.

## METABOLIC MODIFIERS

Metabolic modifiers are a group of compounds that modify animal metabolism in specific and directed ways. Metabolic modifiers have the overall effect of improving productive efficiency (weight gain or milk yield per feed unit), improving carcass composition (meat-to-fat ratio) in growing animals, increasing milk yield in lactating animals and decreasing animal waste.

The first modern biotechnology to be approved for animal agriculture in the United States was bovine somatotropin (bST) for use in the dairy industry. Application of recombinant bST to dairy cows, by injection every 14 days, increases milk yield and productive efficiency (milk/feed) and decreases animal waste. Milk yield

response to bST in the United States is typically 10-15 percent, approximately 4 to 6 kilograms per day, although larger increases may occur when the management and care of the animals are excellent. Commercial sales of bST began in 1994 in the United States and use has increased in the industry. Presently in the United States, more than 3 million dairy cows are receiving bST supplements. Bovine somatotropin is being used commercially in 19 countries worldwide.

Porcine somatotropin (pST) has been developed for the swine industry. Administration of recombinant pST to growing pigs increases muscle growth and reduces body fat deposition, resulting in pigs that are leaner and of greater market value. Pigs treated with pST use dietary nutrients more efficiently, which improves feed utilization. In the United States, pST is undergoing testing required for FDA evaluation. Worldwide, pST is approved for commercial use in 14 countries.

## GM CROPS THAT DECREASE PHOSPHORUS AND NITROGEN EXCRETION

Phosphorus (P) from manure run-off can significantly impact the quality of fresh lakes and streams. P content in swine and poultry manure is high because these species consume diets consisting of cereal grains and oilseed meals in which most, 60 to 80 percent, P is not absorbed in the digestive tract and is excreted in the feces. Consequently, relatively large amounts of dietary P must be fed to pigs and poultry to meet their dietary P requirements. This problem is not observed in ruminants — cattle, sheep and goats — because their digestive tract is more efficient in utilizing dietary P. To solve this problem for pigs and poultry, a special variety of GM maize has been developed that makes the dietary P more available to the animal. Thus, this variety of GM maize offers the potential to further decrease excretion of P by pigs and chickens. A similar GM soybean variety has been developed. Soybean meal derived from this variety of GM soybeans provides more dietary P to pigs and poultry than meal from conventional soybeans. Studies have shown that diets containing GM maize and meal from GM soybeans decrease P excretion in manure by 50 to 60 percent in pigs and chickens. Inclusion of these special varieties of GM maize and soybeans in diets fed to pigs and chickens offers great potential to dramatically reduce P excretion into the environment.

GM crops with improved amino acid profiles have great potential to decrease nitrogen (N) excretion, especially in pigs and poultry. Nitrogen can contaminate ground and surface waters, contribute to “acid rain,” which increases the acids in soils, and be the source of odors. Increased levels of the amino acids lysine, methionine, tryptophan, threonine and other essential amino acids in grains would mean that the essential amino acid requirements of pigs and poultry can be met with lower-protein diets. Such diets contain fewer excesses of other amino acids that eventually must be degraded to urea N and excreted in the urine. Feeding these GM varieties to pig and poultrywould greatly reduce the amount of N — such as urea — from being excreted into the environment.

## SAFETY OF FOOD BIOTECHNOLOGIES

In the United States, there is a long history of assessing the safety of foods introduced into the marketplace. The assessment of GM plants and animal biotechnologies is science-based and rigorous. The discovery and development of new animal and plant biotechnologies are part of a continuum leading to the commercialization of agricultural biotechnology products.

Historically, equivalence of composition GM plants, GM animals or animals treated with biotechnology products, such as bST, has been an important component of the regulatory process. Establishing equivalence of composition is evidence that substantive changes did not occur in the plant or animal as the result of the genetic modification event. One endorsement of the robust nature of the comparative safety assessment process used with GM plants is that more than 223 million hectares of GM crops have been commercially grown over the past 10 years with no documented effects to humans, animals or the environment. Likewise, there have been no documented adverse effects of meat and milk derived from cows supplemented with bST, the most rapidly adopted animal biotechnology to date.

## CONCLUSION

Agriculture is transiting a remarkable scientific era with respect to the myriad of processes and products that have been developed using biotechnology. Moreover, many new products of biotechnology are being developed that will benefit the food sector. Implicit to approval of these new products is a robust safety assessment process. To date, the approved GM plants and animal biotechnologies have been judged to be as safe as conventionally produced counterparts. Development and adoption of new biotechnologies will be crucial in meeting the challenge of producing enough food for a growing world population while reducing impacts on the

environment. The impact these technologies have on society in the future, however, will be largely dependent on the extent to which they are adopted by producers and the agricultural community and accepted by consumers. Questions about societal impacts and safety often arise as the result of technological change. Inherent to the successful development and adoption of new biotechnologies for agriculture is the need to increase public understanding of the scientific, economic, legislative, ethical and social issues associated with emerging agricultural biotechnologies. ❑

---

*Note: The opinions expressed in this article do not necessarily reflect the views or policies of the U.S. Department of State.*