The Future of Ag Biotechnology: Who Prevails?

Terry D. Etherton,
Department of Dairy and Animal Science
324 W.L. Henning Building
The Pennsylvania State University
University Park, PA 16802
Phone: 814-863-3665
FAX: 814-863-6042
Email: tde@psu.edu

Introduction

Since the onset of the modern era of biotechnology in 1973, impressive strides have been made in developing new agricultural biotechnologies (reviewed in Metabolic Modifiers, 1994; Etherton et al., 2003). Numerous plant biotechnology products have been developed for production agriculture that have been widely adopted worldwide. They have been widely adopted because of the tremendous benefits they provide. From 1996 to 2007, farmers worldwide have planted more biotech crops every single year. In 2007, for the twelfth consecutive year, the global area of biotech crops continued to soar (James, 2007). In 2007, acreage planted to biotech crops grew by about 12% (30 million acres) – the second highest increase in the last five years – reaching 282.4 million acres.

In 2007, the number of countries planting biotech crops increased to 23, and comprised 12 developing countries and 11 industrial countries; they were, in order of acreage, USA, Argentina, Brazil, Canada, India, China, Paraguay, South Africa, Uruguay, Philippines, Australia, Spain, Mexico, Colombia, Chile, France, Honduras, Czech Republic, Portugal, Germany, Slovakia, Romania and Poland (James, 2007). This very high adoption rate by farmers reflects the fact that biotech crops have consistently performed well and delivered significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. These benefits include crops that are more tolerant to the biotic stresses caused by pests, weeds and diseases. In addition, biotech crops have had substantive benefits on the environment by reducing the environmental footprint of agriculture. Progress in developing beneficial traits since the inception of biotech crops includes a significant reduction in pesticides, saving on fossil fuels and decreasing CO_2 emissions through no/less plowing, and conserving soil and moisture by optimizing the practice of no till through application of herbicide tolerance.

The biotechnology products that have been developed and approved for animal agriculture are designed to enhance productivity and *productive efficiency* (feed consumed/unit of output). Biotechnologies that improve productive efficiency will benefit both producers and consumers because feed provision constitutes a major component (about 70%) of farm expenditures. Advances in biotechnology research also have allowed impressive improvements to be made in diagnostic approaches, increasing microbial safety of food, and improvements in animal health (reviewed in Etherton et al., 2003).

The discovery and development of new animal biotechnologies are part of a continuum leading to the commercialization of biotechnology products for agriculture. In order to enter the marketplace, new agricultural biotechnologies are evaluated rigorously by the appropriate federal regulatory agencies to ensure efficacy, consumer safety, and animal health and well being (FDA, 2008). To benefit agriculture and society, products of biotechnology must be accepted by consumers. Central to consumer acceptance is the need to provide effective population-based education programs to enhance public understanding of the safety and benefits associated with technological advances enabled by agricultural biotechnology.

This brief review addresses the topic of who prevails with respect to the use of production practices and biotech products in animal agriculture. Despite remarkable advances in biotechnology research, and the need for biotech products in agriculture, a public discussion still continues about the need for, and safety of these biotechnologies. The "public discussion" in many instances is an attack on the use of biotechnology in agriculture. These attacks have several common themes – they are characterized by deceptive misinformation campaigns; use of the internet is a core component of these campaigns; they assault the integrity of science, scientists and farmers; they are very well funded; and there is a well-coordinated network of activist groups carrying out these attacks. The most recent estimates indicate that these groups collectively spend in excess of $500 million per year on their "agenda"!

It is evident that the benefits of investing in discovery research that improves animal agriculture must be championed, and the return on this investment clearly communicated to the public and policy makers. In my opinion, the agricultural community is going to navigate a period over the next few decades during which we will likely witness growing challenges, especially increased regulatory oversight in addition to the misinformation campaigns funded by activist anti-ag groups. For the full benefits of agricultural biotechnology to be realized by society, future regulatory policies and production practices must be guided by the scientific evidence base, not vocal anti-ag activist groups. It is becomingly increasingly evident that the scientific and agricultural communities have not been effective in this "battle" to inform the consumer about the need for, and benefits of biotechnology in agriculture. If this continues, then the issue of who prevails will be guided by the activist groups who are "anti" biotechnology and production agriculture.

Food Production: Uses of Biotechnology in Animal Production

Metabolic Modifiers. In the discussion about who "prevails", it is important to have a context about the biotechnologies that have developed for animal agriculture, and their benefits. Metabolic modifiers are a group of compounds that modify animal metabolism in specific and directed ways. Metabolic modifiers have the overall effect of improving production, productive efficiency (weight gain or milk yield/unit of feed consumed), improving carcass composition (lean:fat ratio) in growing animals, increasing milk yield in lactating animals, and decreasing animal waste/production unit (reviewed in Metabolic Modifiers, 1994).

Two classes of compounds have received major focus - somatotropins (STs) and ß-*adrenergic agonists*. The most commonly discussed ST is recombinant bovine somatotropin (rbST), which has been commercially used in the United States since 1994 for administration to lactating dairy cows to increase milk yield (about 10 lbs per cow per day), improve milk/feed, and decrease animal waste (Etherton and Bauman, 1998; Bauman, 1999; Capper et al., 2008).

Supplementing ß-adrenergic agonists to growing animals improves feed utilization and increases rate of weight gain, and improves carcass leanness and dressing percentage (Metabolic Modifiers, 1994).

Research has established that the mode of action involves changes in endocrine and cellular mechanisms (Metabolic Modifiers, 1994). The net effect is that ß-adrenergic agonists improve productive efficiency by modifying specific metabolic signals in a coordinated manner to increase nutrient use for lean tissue growth. The ß-adrenergic agonist, Ractopamine, has been approved by the FDA for use in
growing pigs (Paylean) and beef cattle (Optaflexx).

Cloning. Cloning, a term originally used primarily in horticulture to describe asexually produced progeny, means to make a copy of an individual or, in cellular and molecular biology, groups of identical cells, and replicas of DNA and other molecules. For example, monozygotic twins are clones. Animal cloning in the late 1980s resulted from the transfer of nuclei from blastomeres of early cleavage-stage embryos into enucleated oocytes, and cloning of livestock and laboratory animals has resulted from transferring a nucleus from a somatic cell into an oocyte from which the nucleus has been removed (Wilmut et al., 1997; Westhusin et al., 2001).

Somatic cell nuclear transfer also can be used to produce embryonic stem cells, which are undifferentiated, and matched to the recipient for research and therapy that is independent of reproductive cloning of animals. The progeny from cloning using nuclei from either blastomeres or somatic cells are not exact replicas of an individual animal due to cytoplasmic inheritance of mitochondrial DNA from the donor egg, other cytoplasmic factors which may influence "reprogramming" of the genome of the transferred nucleus, and subsequent development of the cloned organism.

Cloning by nuclear transfer from embryonic blastomeres (Willadsen, 1989) or from a differentiated cell of an adult (Wilmut et al., 1997; Polejaeva et al., 2000; Kuhholzer and Prather, 2000) requires that the introduced nucleus be reprogrammed by the cytoplasm of the egg and direct development of a new embryo, which is then transferred to a recipient mother for development to term. The offspring will be identical to their siblings and to the original donor animal in terms of their nuclear DNA, but will differ in their mitochondrial genes; variances in the manner nuclear genes are expressed are also possible. Although *clone* is descriptive for multiple approaches for cloning animals, in this article *clone* is used as a descriptor for somatic cell nuclear transfer.

On January 15, 2008, the Food and Drug Administration (FDA) published the "final" risk assessment (RA) on whether cloning affects food safety or animal health, and whether food products from livestock should be sold for consumption. The report "Animal Cloning – A Risk Assessment" (http://www.fda.gov/cvm/CloneRiskAssessment_Final.htm) concluded that meat and milk from clones of cattle, swine, and goats, and the offspring of clones from any species traditionally consumed as food, are as safe to eat as food from conventionally bred animals. Publication of the final version of the FDA Risk Assessment is an important next step in the process that will allow food from cloned animals to enter the food system.

A Look to the Future – Who Prevails?

A "case study" of the battle over animal biotechnology, and who prevails, is the use of rbST in the dairy industry. The benefits of supplementing lactating cows with rbST are well established (reviewed in Etherton and Bauman, 1998; Bauman, 1999). The current "state of affairs" with respect to rbST use in the United States is that the biotechnology is under attack, and many marketers of fluid milk have labels on the containers that tout the milk is from cows not treated with rbST. The obvious inference is that there is some "problem" with rbST use (which is nonsense), and that "sensible" consumers should avoid rbST. And, by the way, pay more for rbST-free milk. This is remarkably unfortunate since conventional and "rbST-free" milk do not differ compositionally (Vicini et al., 2008), and treatment of cows with rbST does not alter milk levels of the hormone. A detailed history of the attack on rbST, and on producers who use a profitable and safe biotechnology has been chronicled in my blog (see http://blogs.das.psu.edu/tetherton/). Inherent to the "attack" on rbST use is that it also represents an attack on the freedom of dairy producers to use a safe and profitable management tool.

The impressive growth in the science of biotechnology, and the many products of biotechnology that have been developed for medical and agricultural application is an impressive achievement. Predicting what scientific discoveries will be made and applied in production agriculture between now and 2050, however, is challenging. Before we in agriculture get carried away anticipating scientific advances in biotechnology over the next 40 years, there are several key issues that must be considered *and* addressed.

The Challenges. First, funding for discovery and applied research in animal agriculture must be increased. Second, innovative scientific discoveries made require a viable private sector to develop and commercialize new products of biotechnology. This is becoming more challenging for a variety of reasons. The process of moving a product through the regulatory approval process is becoming more complex, costly and lengthy. This growing burden makes it challenging for private sector companies to recover their investment costs from product sales. This is particularly important for agricultural biotechnologies where the margins on products are much lower than biomedical biotechnology products (using essentially the same science). Over the past 20 years, a number of companies have withdrawn from developing and commercializing biotechnology products that are not animal health products. This is an enormous problem. What has not been widely discussed is the question: what is the "cost" to society if biotechnological innovation in animal agriculture is hindered or even stopped? There are no good estimates for this, other than it will be enormous, and catastrophically hinder future development of new strategies to feed the World.

Another challenge to commercialization of biotechnology for animal agriculture pertains to the activist groups that are actively advocating that adoption of biotechnology-derived products be halted. In the case of rbST, they have been aggressively pushing the idea that use of an FDA-approved product be banned. The anti-animal ag and anti-biotech activist groups have a combined annual budget of close to $500 million to spend on efforts designed to influence elected officials and regulators, businesses, as well as consumers about issues such as animal welfare and housing, use of animals for research, animal and plant biotechnology, antibiotic use, BSE/mad cow disease, cloning, rbST, and pesticide use. Moreover, these groups have launched a media attack that claims consumption of food from cloned animals is dangerous, which is nonsense (discussed in detail at Terry Etherton' Blog on Biotechnology).

Scaring Consumers. A key strategy in the attacks by activist groups is to scare consumers. It is easy to scare the public in a 30 second TV clip; however, it is not possible to educate them about science, agriculture, and biotechnology in 30 seconds. Moreover, this "public discussion" is moving at the speed of the internet. Sophisticated websites, blogsites, and mass mailings of propaganda and letters by email are all standard tactics used by the Luddites.

Other communication mediums also are used effectively by activist groups. For example, a search of the YouTube website (on January 4, 2009) using the search phrase "PETA" yielded 15,800 video clips! The "Meatrix Videos" are another example of deceptive and inaccurate campaigns that attack animal agriculture. The activist groups who attack and terrorize animal agriculture and conventional agricultural production practices have as their objective to move consumers to a plant-based diet, and end "factory farming" (one of their favorite, deceptive sound bites used to scare consumers). Fear-based and emotional marketing strategies are their standard tactical approach.

A key question: Who is on the other side of this battle? Who is the voice for science, scientists, and production animal agriculture? Certainly, there is no organization or organized effort that is pro-ag biotechnology that has a budget like those of the larger activist groups. This is troublesome, and has the consequent effect that the public is inundated with misinformation about agricultural production practices and the importance of ag biotechnology.

While the "anti's" assert that advocacy is a core aspect of their mission, it is inaccurate to use advocacy as the descriptor because it implies that you are "for" something. It is abundantly clear that these groups are really "anti-everything." They embody a "take-away" strategy rather than championing the noble effort to pursue a mission of "adding to" society…of doing something for the greater good of society.

Conclusion

Attacks on production agriculture, best management practices used, and farmers' freedom to operate and use biotechnology likely will continue in the future. The recent passage of Proposition #2 in California exemplifies this trend. The activist groups that "drive" these attacks are vocal and adept at creating the impression that there are issues when the facts indicate other-wise. It will be crucial that pro-animal agriculture organizations, producer groups, and scientists become the voice of sanity and reason. If we don't take a proactive approach to this challenge, if we continue to sit on, or close to the sidelines, we may be marginalized in the process that builds the future regulatory environment for developing and applying biotechnologies for animal agriculture, and the use of best-management practices in the United States.

If this happens, we could well witness a substantial core of our food production system move off-shore. Then the issue looms as to whether we can have national security in the absence of food security? This will be a short debate since the answer to this question is obviously no.

With respect to who prevails in the battle for determining whether we "use" safe and effective ag biotechnologies in the future, I believe we in agriculture are at a tenuous time. There are many indicators of the increasing need to develop biotechnologies to feed a growing world (reviewed in Terry Etherton's Blog on Biotechnology). Yet, there is no pro-ag biotech effort that has thus far proved effective in swaying the public about the need for and value of science for agriculture. To educate the population about science and agriculture is a large, costly and timely process. A large majority of consumers are not well informed about science or production agriculture practices, which creates learning barriers. Furthermore, there is a clear anti-science element that pervades a significant portion of contemporary print journalism. The marketing tactics used by the organic food sector adds to the confusion. A typical marketing campaign for organic food vendors is to subtly, or not so subtly, infer that the food produced by production agriculture is not as safe or as healthy as their products. To appreciate the scale of these marketing efforts by organic vendors, all one has to do is visit your closest organic grocery store.

In closing, there should be no "public discussion" about the safety and need for ag biotechnologies. Moreover, farmers should have the freedom to use safe approved biotechnologies that improve food production efficiency and provide a fair return on their investment. However, the reality that confronts production agriculture is that there is an active cohort of activist groups who aggressively promote their misleading "propaganda". The existing and looming challenge for all participants in the food production system who value the development and application of science is to become actively involved in the effort to educate consumers about the importance of biotechnology in food production.

References

Bauman, D.E. 1999. Bovine somatotropin and lactation: From basic science to commercial application. Domest. Anim. Endocrinol. 17:101–116.

Capper, J. L., E. Castañeda-Gutiérrez, R.A. Cady and D.E. Bauman. 2008. The environmental impact of recombinant bovine somatotropin (rbST) use in dairy production. Proc. Natl. Acad. Sci. USA. 2008 105:9668-9673.

Etherton, T.D. and D.E. Bauman. 1998. The biology of somatotropin in growth and lactation of domestic animals. Physiol. Rev. 78:745–761.

Etherton, T.D., D.E. Bauman, C.W. Beattie, R.D. Bremel, G.L. Cromwell, V. Kapur, G. Varner, M.B. Wheeler and M. Wiedmann. 2003. Biotechnology in Animal Agriculture: An Overview. CAST (Council for Agricultural Science and Technology) Issue Paper, No. 23.

Faust, M. 2002. New feeds from genetically modified plants: the U.S. approach to safety for animals and the food chain. Livestock Prod. Sci. 74:239–254.

FDA. 2008. Animal Cloning: A Risk Assessment.
http://www.fda.gov/cvm/CloneRiskAssessment_Final.htm

James, C. 2007. *Global Status of Commercialized Biotech/GM Crops: 2007*. International Service for the Acquisition of Agri-biotech Applications. Brief Number 37-2007. ISAAA, Ithaca, New York.

Kuhholzer, B. and R.S. Prather. 2000. Advances in livestock nuclear transfer. Proc. Soc. Exp. Biol. Med. 224:240-245.

Metabolic Modifiers: Effects on Nutrient Requirements of Food-Producing Animals. 1994. T.D. Etherton (Ed.). Board on Agriculture, National Research Council, National Academy of Science Press, Washington, D.C.

Polegaeva, I.A., S.H. Chen, T.D. Vaught, R.L. Page, J. Mullins, S. Ball, Y. Dai, J. Boone, S. Walker, D.L. Ayares, A. Colman and K.H. Campbell. 2000. Cloned pigs produced by nuclear transfer from adult somatic cells. Nature. 407:86-90.

Terry Etherton Blog on Biotechnology. http://blogs.das.psu.edu/tetherton/.

Vicini, J., T. Etherton, P. Kris-Etherton, J. Ballam, S. Denham, R. Staub, D. Goldstein, R. Cady, M. McGrath and M. Lucy. 2008. Survey of retail milk composition as affected by label claims regarding farm-management practices. J. Am. Diet. Assoc. 108:1198-1203.

Westhusin. M.E., C.R. Long, T. Shin, J.R. Hill, C.R. Looney, J.H. Pryor and J.A. Piedrahita. 2001. Cloning to reproduce desired genotypes. Theriogenology. 55:35-49.

Wilmut I., A.E. Schnieke, J. McWhir, A.J. Kind and K.H. Campbell. 1997. Viable offspring derived from fetal and adult mammalian cells. Nature. 385:810-813.

Willadsen, S.M. 1989. Cloning of sheep and cow embryos. Genome. 31:956-962.