From the editor

Biofuel: Good or bad? No easy answer!

Christiane L. Girard

Dairy and Swine Research and Development Centre
Agriculture and Agri-Food Canada, Sherbrooke, Québec, J1M 0C8, Canada

The opinions on biofuels are, to say the least, highly diversified. For some, it is the answer to all their prayers. For others, it is the worst evil. Who is right? Are biofuels the only way to maintain our lifestyle while reducing our environmental footprint, the only sustainable alternative to fossil fuel? Or is it a choice between feeding the world and fulfilling our thirst for energy? This issue of Animal Frontiers tries to provide some answers to these fundamental questions.

When we are talking about biofuel, what are we talking about? By definition, biofuels are fuels that are generated from biological material, but what are first-, second-, or third-generation biofuels? Roland A. Lee and Jean-Michel Lavoie, from the Université de Sherbrooke in Canada, define and explain the production methods for each of them (Lee and Lavoie, 2013). The best known first-generation biofuels are ethanol and biodiesel. First-generation biofuels are generally, with the exception of jatropha, produced using an edible biomass, such as corn, sugarcane, soybean, or rapeseed. This technology generates co-products that can be used as feedstuffs and consumed by ruminant (Donkin et al., 2013) or non-ruminant animals (Zijlstra and Beltranena, 2013). Second-generation biofuels are defined as fuels produced from highly different feedstocks and are generally non-edible. Their production requires more complex conversion processes than those used to produce first-generation biofuels. The best known feedstock for production of second-generation biofuel is lignocellulosic feedstock, but it can also be produced from feedstocks as different as agricultural and forest residues or municipal solid wastes. Biofuel produced from algal biomass is considered as the third-generation. Production of second- and third-generation biofuels still face many technological challenges.

In the next manuscript, Alexandros Gasparatos (Biodiversity Institute, Oxford University, Oxford, UK), Per Stromberg (Institute of Advanced Studies, United Nations University and Policy Analysis Unit, Swedish Environmental Protection Agency), and Kazuhiko Takeuchi (Institute for Sustainability and Peace, United Nations University and Integrated Research System for Sustainability Science, University of Tokyo, Tokyo, Japan) focus on socioeconomic and environmental impacts of first-generation biofuels. They highlight the difficulties to predict impacts of biofuel production and utilization (Gasparatos et al., 2013). The amplitude of the environmental and socioeconomic impacts differs according to the kind of biofuels, their modes of production, and the regions where they are produced. In most cases, biofuel sustainability is assessed taking into account greenhouse gas production as well as food and energy security. The authors emphasize the fact that the problem is a lot more complex, and narrowing prediction of sustainability to these factors is dangerously misleading and could prompt erroneous decisions. Impact of biofuel production and use should take into account many factors such as energy provision and security, greenhouse gas emission, atmospheric and water pollution, soil erosion, biodiversity loss, rural development, food security, public health, and social conflicts. The decision to produce biofuel will always bring about changes, positive and negative, and will require trade-offs from the involved parties. Taking the whole picture into account is absolutely essential to mitigate the negative impact.

The following paper by Paula M. Meyer (Brazilian Institute of Geography and Statistics, São Paulo), Paulo H. M. Rodrigues (University of São Paulo), and Danilo D. Millen (São Paulo State University) illustrate the principles described by Gasparatos et al., 2013. The authors describe the impact of ethanol production from sugarcane on social economics, especially on exodus of rural population in Brazil (Meyer et al., 2013). Changing crops, especially increasing sugarcane production, affects appreciation of land prices in some regions of the country. On one hand, the increase in land prices causes migration of beef production towards other regions, some of which are ecologically fragile and must be protected by legislative regulations. On the other hand, land appreciation contributes to promote intensification of beef production, increasing efficiency of the production.

Farzad Taheripour, Chris Hurt, and Wallace E. Tyner (Purdue University, West Lafayette, IN, USA) also concluded that production of ethanol from corn combined with the increased prices of feedstuffs during the last years pushed towards intensification of livestock production. However, according to these authors, these trends, combined with the growing international demand for meat, will favor poultry and pork production because they are more efficient feed converters than ruminants. These shifts in livestock production are likely to continue even if the increases in feedstuffs prices and production of ethanol from corn slow down (Taheripour et al., 2013).

Supporting the trends described by Taheripour et al. (2013), Ruurd T. Zijlstra and Eduardo Beltranena, from the University of Alberta, Edmonton, AB, Canada and Alberta Agriculture and Rural Development, Edmonton, AB, Canada, respectively, explain the ability of pigs to efficiently transform food and biofuel co-products in meat (Zijlstra and Beltranena, 2013). Dietary inclusion of co-products in pig diets reduces competition with humans for cereals, decreasing feeding cost while providing a good source of high-quality protein (pork) for human consumption. Therefore, it should improve swine production sustainability. Nevertheless, switching from a rather simple diet based on a single grain as an energy source and a single protein source to diets using industry co-products while maintaining feed efficiency raises many challenges. The main challenge is to precisely define the nutritional properties of these different co-products. Determination of the nutrient profile of these co-products is an essential knowledge for their successful utilization. Moreover, presence of mycotoxins, chemical
residues, or other contaminants in these products should also be assessed to avoid negative effects on animal performance and meat quality.

Shawn S. Donkin (Purdue University), Perry H. Doane, and Michael J. Cecava (Archer Daniels Midland Company, Decatur, IL, USA) forecast that ruminant production would also benefit from technology developed for cellulosic ethanol production (Donkin et al., 2013). Use of innovative approaches for cellulosic biomass pretreatment for production of second-generation biofuel has the potential to improve feeding value of low quality forages or feed residues. Obviously, ruminant production and production of second-generation biofuel would compete for the same biomass and land use, but synergies could also be developed that will favor both productions.

“Is biofuel good or bad?” This issue will not provide a universal answer. The objective of this inquiry is to promote awareness and arouse the attention of the readers to the complexity of this simple question. Sustainability of biofuel production cannot be assessed based only on a few factors. Consequences of biofuel production on different human communities, including socio-economic and environmental effects, should be weighed against the effects on energy security alone. Knowledge and awareness will be the keys to limit negative impacts of biofuel production. Increasing biofuel production is likely to change livestock production by competing for land use. Nevertheless, with acquisition of appropriate knowledge, animal production could be part of the solution, as animals could efficiently transform co-products non-edible for humans into high-quality protein, meat, or milk.

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**About the Author**

Christiane L. Girard is a research scientist at the Dairy and Swine Research and Development Centre, Agriculture and Agri-Food Canada at Sherbrooke, Québec, Canada since 1985. Her two major research interests are 1) defining B-vitamin requirements of high producing dairy cows to optimize their well-being and metabolic efficiency; currently focusing on the metabolic interactions between folic acid and vitamin B12, and 2) defining dietary conditions affecting ruminal synthesis and supply of B-vitamins to dairy cows. She is the editor-in-chief of the *Canadian Journal of Animal Science* and a member of the board of the Canadian Society of Animal Science.

**Correspondence:** Christiane.Girard@agr.gc.ca

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