

Overview of Special Issue from the 2009 ICABR Conference

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Until the recent financial crisis, biology-based industries were some of the most rapidly growing sectors of the world economy—the biofuels business was booming, agriculture commodity prices were high, agricultural biotechnology firms were making record profits, and the pharmaceutical industry was increasingly based on biologics. A recent European Union report has estimated that the contribution of modern biotechnology to the European Union's gross value added is just under 2%, about the same size as the contribution of all agriculture or the chemical industry. The financial crisis has had impacts on the bio-economy, and these impacts will continue.

The bio-economy has been 'emerging' for some time now and questions about what exactly fits into the bioeconomy, how important it is, and how large it will be in the future are important topics for debate. Within the bioeconomy, some components are emerging, but several major constraints to further growth still exist.

These aspects and a few more were discussed at the 13th International Consortium on Agricultural Biotechnology Research (ICABR) conference on 'The Emerging Bioeconomy.'¹ This special issue includes a selection of 10 articles presented at the conference. The issue further includes a summary of the key findings from the conference as well as the *Santaniello Memorial Lecture* given by Odin Knudsen, Managing Director of Environmental Markets at J.P. Morgan.

Outcomes of the 2009 ICABR Conference

In an effort to capture what was learned at the ICABR conference, Smyth et al. (Article 1) provide an overview of the structural outline of the conference and then a concise summary of the four themes of the conference. The overall conference theme was 'The Emerging Bio-

economy,' and within this there were four sub-themes that contained the vast majority of presentations: the global food crisis, long-term sustainability of biofuels, food safety and nutrition, and constraints and incentives for innovation and globalization. In addition, two roundtable sessions were held on co-existence and intellectual property rights. The article offers three policy recommendations based upon the research presented at the conference.

The Vittorio Santaniello Memorial Lecture

In his *Vittorio Santaniello Memorial Lecture*, 'Turning Black Swans Green' (Article 2), Odin Knudsen picks-up the Black Swan metaphor introduced by Nicolas Taleb. In his presentation, the Black Swan is the 2008/09 financial crisis. Knudsen argues that the financial crisis provides an opportunity to address other threatening issues that can result in Black Swan events, such as energy insecurity and climate change with the associated extreme weather events. The financial crisis has been catalytic in reassessing risk and the likelihood of extreme events—whether in finance, energy, or climate. Already, a large part of expenditures from the global stimulus have been directed to diversifying the energy base of economies towards less carbon-intensive energy options. Biofuel technologies in combination with biotechnology offer the potential to mitigate greenhouse gas emissions, while at the same time addressing energy security problems. This win-win solution requires substantial investment by the public as well as private sector in new technologies. Knudsen's main message is that the lesson from the financial crisis implies addressing energy security and climate change to avoid the development of Black Swans by turning them green through massive investments in biotechnology.

1. <http://www.economia.uniroma2.it/icabr/index.php?p=5>

Markets and Economics of Biofuels

Hochman, Rajagopal, and Zilberman show that turning Black Swans green is not that simple and requires an understanding of the economic mechanisms at work. In ‘The Effect of Biofuels on Crude Oil Markets’ (Article 3) they show that the introduction of biofuels reduced international fuel prices and gasoline consumed by oil-importing countries by 1% and 1.2%, respectively. At the same time however, the total amount of fuel consumed (oil-importing and exporting countries) increased by 1.15% due to the reduction in fuel prices. Welfare in oil-exporting countries declined by 2% and rose in oil-importing countries by 2.8%. To have a positive impact on greenhouse gas emissions, the introduction of biofuels requires 50% less carbon emissions from biofuels in comparison to fossil fuels. This substantial amount of emission reduction is still a challenge for biofuel technologies. The authors also raise concerns about using ‘dirty fossil-fuel technologies’ such as oil sands. Putting those into use may easily off-set carbon-emission savings from biofuels.

A clean-energy technology that may provide substantial carbon-emission savings is the use of microalgae. Microalgae has the additional advantage of creating almost no problems in direct and indirect land use. Richardson, Outlaw, and Allison investigate ‘The Economics of Microalgae Oil’ (Article 4) through the use of Monte Carlo simulation to compare two types of microalgae production technology. One production assessment is based on standard technologies, while the other is calibrated on more advanced technologies. While the results for both technologies show costs are highly variable, the average costs of the more advanced technology are substantially lower. Comparing the results with oil prices, the authors conclude that microalgae production can compete if the advanced technology can indeed be scaled-up at constant or decreasing returns to scale. While this is often not the case, technical efficiency needs to be further improved.

Supporting policies can play an important role in increasing technical efficiency. Ninni assesses the European biofuel policy landscape in ‘Policies to Support Biofuels in Europe: The Changing Landscape of Instruments’ (Article 5). The main European biofuel policy consists of a mandate for a 5.75% rate by 2010 and a 10% rate by 2020 of the final consumption of energy in transport from renewable energy sources within each EU member state. While these targets have not been controversial, the debate of food versus fuel has lately become more important and an essential part of the EU

directive on the promotion of energy from renewable resources in 2009. The author expects that meeting the 10% target will be difficult and in the end EU policies will change by directing more resources to the development of second- and third-generation biofuels than by trying to meet the 10% target.

The Three A’s of Agbiotech: Adoption, Attitudes, and Asynchronous Approval

In ‘The Adoption and Diffusion of GM Crops in the United States: A Real Option Approach’ (Article 6), Scandizzo and Savastano estimate the effect of the hurdle rate on adoption and diffusion of GM crops in the United States. They find a significant irreversibility effect for the adoption of Bt and herbicide-resistant corn and the diffusion of herbicide-resistant soybeans. While a number of studies have used a real option approach within an ex-ante assessment of the GM technology, this is the first study using ex-post cultivation data. The significance of the hurdle rate is remarkable as, at the farm, ‘real’ irreversible adoption costs for Bt corn and herbicide-resistant corn have not been reported. Hence, the significance of the hurdle rate indicates the presence of perceived irreversible adoption effects by adopters.

Perceived irreversible effects of using GM crop technologies not only affects adoption but also the attitudes of consumers towards the technology. In ‘Is Agricultural Biotechnology Part of Sustainable Agriculture? Different Views in Switzerland and New Zealand’ (Article 7), Aerni compares the attitudes of stakeholders in Switzerland and New Zealand with respect to agricultural biotechnology as part of sustainable agriculture. While respondents from Switzerland largely consider agricultural biotechnology to be a threat to sustainable agriculture, their counterparts in New Zealand think it must be an essential component of the future of sustainable agriculture. The differences in results have been explained by the progressive attitude toward sustainable agriculture in New Zealand related to the influence of innovative food research organizations and entrepreneurial producer associations in public policy, and the defensive attitude towards sustainable agriculture in Switzerland are largely due to the importance of government institutions, NGOs, and large retailers in particular not in favor of agricultural biotechnology.

Stein and Rodríguez-Cerezo (Article 8) present the results of the Institute for Prospective Technological Studies’ workshop on ‘The Global Commercial Pipeline of New GM Crops,’ held in November 2008 in their article entitled ‘Low-Level Presence of New GM Crops:

An Issue on the Rise for Countries Where They Lack Approval.’ Attendees at the workshop included national regulators, private sector technology providers, and public sector research scientists from nearly 40 different stakeholders. The workshop acknowledged that as of 2008, there were 33 different GM crops in production worldwide and that this is expected to increase to 124 by 2015. With adventitious presence of approved events beginning to have an impact on international trade, there was a recognizable concern about the potential market situation in the near future. With this in mind, the discussion focused on the asynchronous approval process between the US and the EU. It was noted that delays of two years were common and in one incidence, the delay was a full decade. The workshop participants identified that an international agreement on asynchronous approval is needed.

Advancing Innovation

The article by Ryan and Smyth (Article 9), entitled ‘Facilitating Innovation in Agricultural Biotechnology: An Examination of the Ag-West Biotech Model, 1989-2004,’ provides one of the initial assessments on the role of industry associations relating to agricultural biotechnology. The review and economic impact of Ag-West Biotech, a not-for-profit corporation located in the agricultural biotechnology cluster in Saskatoon, Saskatchewan, Canada, highlights the importance of a central actor in the facilitation of innovative clusters. The authors present the structure of the business model and then undertake an assessment of the entity’s three key activities: financing, networking, and advocacy. The assessment period begins with Ag-West Biotech’s founding in 1989 and ends in 2004, when a restructuring occurred within the organization. Established by the province of Saskatchewan to promote biotechnology

and to assist in the commercialization of technologies from the agricultural biotechnology cluster, the result has been positive. Over the 15-year period, \$9.3 million was invested into Saskatoon-based biotechnology companies, creating an estimated 784 person-years of employment. The important observation in this article is that while the value of financing was important, the role of networking and advocacy was viewed as equally important by the innovation cluster based in Saskatoon.

The final article by Butler and McGarry Wolf (Article 10), entitled ‘Economic Analysis of the Impacts of Cloning on Improving Dairy Herd Composition,’ provides an analysis of the potential economic impacts of cloning in the dairy industry. The authors provide an extensive review of reproductive technology options and identify the advantages and limitations of using cloning as a reproductive technology. To provide an economic estimate of the impacts, a Monte Carlo simulation model is used to generate changes in net present values. The authors identify that the major challenge of this analysis is that cloning is not yet a viable reproductive technology. Genetic advances have been made (and continue) through the use of other reproductive technologies, and the cost of cloning is recognized as the major obstacle of application to the dairy industry.

A final observation from an assessment of the contributions as they relate to the emerging bioeconomy is that there is a noticeable cross connection of constraints and options. The growth of the bioeconomy will be limited by the amount of capital invested into new research and product scale-up and by defined governance capacity. Without concrete strategies to address these two fundamental constraints, the bioeconomy may continue to be emerging for most of the coming decade, but otherwise the future looks bright.