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Policy Recommendations from the 13th ICABR Conference on the Emerging Bioeconomy

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The International Consortium on Agricultural Biotechnology Research held its 13th annual conference in Ravello, Italy in June 2009. The theme of the conference was the bioeconomy, and this topic was addressed through research presentations from academia, government, and industry. Numerous presentations from developing countries highlighted the benefits of agricultural biotechnology in these nations. The broad range of presentations provided a wealth of insights, resulting in three policy recommendations regarding future funding, international regulation, and technology transfer.

Key words: global food crisis, biofuels, food safety, innovation.

Introduction

The bioeconomy includes the economic activity from products and technologies derived from biology. The bioeconomy has been 'emerging' for the better part of the first decade of the 21st Century, and questions about what exactly fits into the bioeconomy, how important it is, and how large it will become are important topics for debate. Some sectors of the bioeconomy have emerged and are growing, but several major constraints to further growth still exist in other sectors. The 13th International Consortium on Agricultural Biotechnology Research (ICABR) Conference in Ravello, Italy (June 17-20, 2009) examined these constraints from six unique and distinct perspectives.[1]

The first of the emerging bioeconomy issues is the speculation that a combination of problems led to the 2007-2008 spike in world food prices; some of these problems include weather problems in key exporting countries, high oil prices that pushed up the price of agricultural inputs and transportation, policies that encouraged the growth of biofuels, and other policies of key exporter nations that reduced food exports,. The rise in commodity prices increased the income of some developing-world farmers but reduced the incomes and raised the price of staple food products for millions of poor people. The annual reports of the International Service for the Acquisition of Agricultural Applications[2] (ISAAA) identify that agricultural biotechnology has spread rapidly from developed to developing countries;

1. *Further information on the ICABR conferences can be found at: http://www.economia.uniroma2.it/icabr/index.php?p=5.*
2. *For the most recent report of the ISAAA, see their website: http://www.isaaa.org/.*

however, transition from commodity crops to staple crops such as rice, wheat, cassava, beans, and bananas has been considerably slower.

A second issue is the sustainability of the biofuels industry. As a means of encouraging investment into this area of the bioeconomy, many governments around the world have provided subsidies to biofuel production. In addition to subsidization, there are a host of logistical issues, from railcar shortages to outdated docking facilities in dense population centers. Issues of importance are the long-term sustainability of biofuel growth and the need to better ascertain how biotechnology can contribute to the growth of biofuels.

Third is the issue of food safety and nutrition. Strengthening food safety is on the agenda of policy makers in almost all countries today. There is the tragedy of lost lives and illness, but there is also a loss of consumer confidence, the cost of product recall and the time required to identify the source of the problem. There is a strong role for biotechnology in the prevention of food-borne illnesses and in the identification of the sources of food-borne pathogens and zoonotic diseases. Additionally, both genetically modified (GM) and non-GM plants can now be used to improve the nutrition of basic foods and reduce naturally occurring toxins such as fumonisins.

A fourth aspect of the emerging bioeconomy is the impact of the world financial crisis and other constraints and incentives for biotechnology innovation and globalization. Will the financial crisis reduce the flow of venture capital investment into biotechnology? The transition of agricultural biotechnology from the developed to the developing world—and continuing concerns by consumers in both parts of the world—has led to increased regulations in some countries, while other countries lack a functioning regulatory system. Consumer concerns continue to slow the spread of biotechnology adoption in many countries and new concerns are emerging about the safety and ethical aspect of cloning animals. At the same time, some countries such as Indian and China have gradually strengthened their intellectual property rights systems, a practice that is affecting investment in biotechnology.

The final two themes were specifically focused, with one on the European Union's Transcontainer Project and another on the role and structure of intellectual property rights in biotechnology. The Transcontainer theme focused on the socio-economic aspects of this research project. The intellectual property session concentrated on identifying systemic gaps in the current framework of intellectual property rights that require further research.

The above themes set the agenda for the ICABR conference, which saw six key note speakers and 55 academic research paper presentations over the three days of the conference. The variety of research papers examined constraints, opportunities, and implications and provided evidence from GM crop adoption. The result of these papers is that opportunities for benefits do exist, however the degree of constraints seriously threatens to marginalize most of the potential benefits.

Agricultural Biotechnology's Response to the Global Food Crisis

The global food crisis of 2007-2008 and the land-use issue of food versus fuel production made headlines across the world. The increased demand for biofuel feedstock was met by producers transferring land from food-crop production to biofuel-crop production. Numerous commentators on this crisis speculated, and even identified, that the increase in the demand for biofuels was the leading cause of the rise in food prices. The increased use of biofuel feedstocks has been examined for its contribution to the increase in food prices and, based upon this, it is not possible to isolate this effect (Gilbert, 2009). Factors with a higher degree of significance have been identified as currency depreciation, rising oil prices, and futures trading activity.

While the recent spike in food prices has largely been alleviated, food prices have not returned to the pre-spike levels (Zilberman, 2009). Given that the food crisis was not based upon biotechnology and biofuels, it raises the question of whether agricultural biotechnology can contribute to minimizing the impacts of future crises. While much of the developing world maintains an aversion to agricultural biotechnology research and the resulting crop varieties, GM food grains have been commercialized in South Africa and the Philippines. The adoption of GM crops increases year-over-year, and the benefits of this adoption will be able to contribute to off-setting a portion of the next food crisis.

While it is not possible to directly attribute the increased growth of land used for biofuel feedstock production to the rise in food prices, the reality is, there will be an increase in biofuel feedstock production. While it is possible that some of this increased production could come from marginal agricultural land that is presently grassland, some will have to come from food-producing land. Additionally, the potential exists that some of the

strain to use food-producing land could be alleviated through the use of agro-forestry or food-crop residues.

Assessing the Long-term Sustainability of Biofuels

During all of 2007 and the first half of 2008, the world witnessed a dramatic rise in the price of oil as the price of light crude oil rose from US$60 per barrel at the start of 2007 to just over US$140 per barrel in July 2008. In the 18-month run-up in the price of oil, increasing attention was given to the development and role of alternate fuels. While some arguments have been advanced that the need for this research is less important now that the price of oil has retreated, the reality is that this research is more important than ever. Biofuel research investments need to continue to ensure that the next time there is a run-up in the price of oil, there are viable alternatives to assist in off-setting the cost of oil.

Modeling the use of, and role for, biofuels reveals that they can be an alternative to fossil fuels and, additionally, that their production can reduce fuel prices, reduce the incentives for the supply of fuel sources such as coal and tar sands, and reduce greenhouse gas emissions (Vulsteke, 2009). However, these benefits are not costless; there is a substantial subsidization of biofuels which puts pressure on domestic budgets in a period of global economic downturn. Research on the production of ethanol in the United States indicates that without government subsidies, the ethanol industry is unsustainable (Crawford, 2009).

If ethanol production is not sustainable in the long-term, what other options exist? It is anticipated that the second generation of biofuels will contribute at a substantially higher level than the first generation of biofuels. Cellulosic biofuels would appear to have a more favorable economic perspective, yet they have been slow to develop due to the limited success of scale-up plants and limited investment funding. Algae has the potential to produce 10,000 gallons of biofuel per acre, per year, whereas corn-based ethanol production ranges from 400-600 gallons per acre, per year (Kovacevic, 2009). However, using current algae production technologies, it is unable to economically compete with existing technologies, such as soybean oil. Research is underway regarding switchgrass and willow as biofuel feedstock (Richardson, 2009). One of the challenges faced by biofuel production is to identify land that is not presently engaged in the production of food crops.

One of the leading constraints in the further development of second and third generation biofuels is the dramatic lack of scale-up capacity. In part, this might be due to a lack of public funding; however, it could also be partially due to the market power exerted by existing fuel companies. The inability to financially compare the economic costs of biofuel scale-up and the market price of second generation biofuels create a defined knowledge gap regarding the development of the biofuel industry.

Improvements to Food Safety and Nutrition

The dependency on one crop type as the dietary staple in some countries highlights the challenges of improved food nutrition on low income families. For example, in Southeast Asia, many countries rely on rice as the main source of food energy; some countries rely on rice for three-quarters of their food energy. Rice is not a high-nutrient cereal; therefore, children in these countries receive about one-third of the required daily nutrient intake as recommended by the World Health Organization (Potrykus, 2009).

This gap between food supply and nutrient availability is further exacerbated by the well identified decline in annual crop yield increases. Annual yield increases of 2% are required to feed the present population growth rate, however yield increases in the major cereal crops have declined to slightly above 1% (Byerlee, 2009). Rectifying this gap is of paramount importance to ensuring that the food energy and daily nutrient availability does not further decline.

Regulatory delays also raise consternation regarding the commercialization of new crop varieties for developing nations. Some studies estimate that it might take until 2016-17 before drought-tolerant maize is commercialized in the first African nations and as long as 2040 before the level of adoption reaches 50% (Paarlberg, 2009). Research from Uganda regarding GM bananas indicates that the greatest level of benefits accrue to poor households in rural areas, however commercialization is still many years away due to field trials and food safety assessments (Kikulwe, 2009).

Drought-tolerance research is one of the leading areas in addressing food production challenges in both Africa and Asia. For example, it is estimated that in Eastern India alone, the annual rice loss is 1.7 million tonnes, worth US$250 million (Steele, 2009). New research (Steele, 2009) indicates that conducting field trials with the actual farmers that will ultimately adopt the new varieties can shorten the time between development and adoption as compared to private field trials undertaken by firms or government agencies.

While genomic advances are emerging in rice, there are serious lags in the other food crops mentioned above. It was reported in the American press in the summer of 2009 that research will recommence with GM wheat, with GM varieties expected in the market between 2017 and 2020. It may take a decade for GM wheat to exist in developed countries, never mind the developing countries. Much of this technology transfer to other food crops is constrained by functioning regulatory systems in numerous developing countries, as well as a lack of international harmonization.

Constraints and Incentives for Innovation and Globalization

Intellectual property (IP) and the role of patents in innovative research have increasingly become barriers to technology development and transfer. Recently, there have been international calls for new models of intellectual property, ideally ones that will contribute to, and even facilitate, a truly global bioeconomy (The Innovation Partnership, 2008). The challenge is to achieve a balance that adequately rewards the investor, yet still promotes the broader social interest. This becomes an increasing challenge for innovators in many developing countries that lack IP enforcement mechanisms, as they will be faced with numerous imitators, yet lack the legal ability to adequately protect their IP.

The lack of an international governance capacity for regulations and efficient IP mechanisms for innovative technologies like agricultural biotechnology has created an international field of uncertainty. The lack of harmonization regarding field trials, biosafety testing, and regulatory approvals can been seen as retarding the growth in international adoption of GM crop innovations (Potrykus, 2009). The rationale that has been advanced for this regulatory and IP governance diversity is that no two countries have identical economic, social, political, and cultural conditions, and therefore every single aspect of approving an innovative crop variety has to be duplicated in each country. A substantial portion of this conundrum is due to the polarization between those that identify with the economic benefits of an innovation and those that have grave concerns about the social risks of an innovation.

Economic benefits from GM crop adoption in developing nations are slowly being quantified. Recent research shows that small land-holders are benefiting from the global diversification of this innovation. Maize in Honduras is a staple crop, yet insect damage can result in a yield loss of 40% in some years. The adoption of GM insect-resistant maize by small land holders in Honduras has resulted in a yield increase of more than 1,100 kg per hectare over conventional landrace maize varieties (Falck-Zepeda, 2009b). Soybean production in Bolivia is an important part of the economy, accounting for nearly 5% of GDP and 10% of exports. The adoption of herbicide-tolerant soybeans has increased the net benefits to adopters by almost US$200 per hectare over non-GM soybean producers (Falck-Zepeda, 2009a). In Uganda, bananas are part of the daily diet for 65% of the urban population. In a survey of consumers, 58% of urban Ugandans would be in favor of GM bananas if they were resistant to pests and diseases (Kikulwe, 2009).

The research presented in this theme highlights the need for improved regulatory systems in developing countries. Clearly, benefits are being identified in developing countries by subsistence farmers. However, these benefits will be marginalized if a regulatory facilitating mechanism is not identified. This lack of technology transfer capacity continues to be one of the leading constraints for the further development of the bioeconomy.

Coexistence Containment

This theme focused on the span of research that has been undertaken through the Transcontainer project[3] and discussed the possibilities for the implementation of biological transgene containment strategies, involving modification of the GM crop in such a way as to minimize the spread of transgenes through pollen, seed, or both as a contribution to coexistence in Europe.

Preliminary results show biological containment can generate substantial benefits in the case of oilseed rape and poplar, while the economic benefits are moderate in the case of sugar beets, eggplants, tomatoes, and high fructan grasses (Groenveld, 2009). The high benefits for biologically contained oilseed rape can be explained by the constraints coexistence measures impose on the adoption of non-contained transgenic oilseed rape, while in the case of poplar the main benefit is the increase in the growth rate reducing the optimal rotation rate and increasing the benefits from carbon sequestration by about 100%. The low benefits for the other crops can be explained by the small effect of coexistence measures on adoption.

The economic benefits and costs of biological containment systems have been investigated for some

3. *For further information on this project, see http://www.transcontainer.org.*

model crops, while the developed technologies may have application in a number of other crops where gene flow is important, such as rice or other forest trees. One of the major underlying assumptions is the approval of biological containment methods being developed. The public debate about those methods casts doubts. The technologies might pass the risk assessment by the European Food Safety Authority (EFSA), but not the political assessment by the council of ministers (Waigmann, 2009).

Intellectual Property Rights

The presentations on intellectual property rights (IRPs) were designed to provide an overview of the current state of IPRs and then to identify challenges to the existing framework. The presentations and resulting discussions identified four key areas that require further research. First, the role for, and use of, precision licensing. Second, the need to re-examine the regulation of IP and the corresponding rights. Third, to examine the relationship between IP and market power of innovative firms. Fourth, to more clearly identify the role that trade secrets play in innovative research. International research collaborations were identified at the end of the session, with the expectation that this research will be reported at the 2010 ICABR conference.

Policy Implications

The 13th ICABR conference produced a wealth of new information and insights on all themes. While a considerable amount of this research was focused on developed countries, more than 20% of the papers presented focused on developing countries. From this diverse compilation of knowledge and information, it is possible to synthesize the following three crucial policy implications.

First, second generation biofuels have considerable potential at the pilot-scale level, so investment is needed for scale-up and commercialization of these innovative technologies. While a consensus has yet to be reached on the initial biofuels technologies such as ethanol and biodiesel, there seems to be an increasing degree of opinion that these technologies are not sustainable in the long-term. Second-generation technology research to date is considerably more promising regarding the long-term sustainability. To be able to make an accurate assessment of these technologies at the commercial level, countries and international funding agencies need to make a substantial commitment to continue to fund this research.

Second, the lack of an international regulatory capacity is negatively impacting the commercialization and adoption of innovative technologies of the bioeconomy by the very countries that stand to benefit the most. Small land holders in developing nations are benefiting from the limited adoption of GM crops to date and efforts need to be organized to assist developing countries to establish a regulatory framework capacity. This effort is beyond the ability of one country or the countries of a particular region; rather, this effort needs to be lead by credible international agencies. The Organization for the Economic Cooperation and Development (OECD) or Food and Agriculture Organization (FAO) would be well positioned to initiate and lead this effort.

Third, the transfer of the technological innovation driving the bioeconomy to developing nations is creating economic benefits for users. What is now needed is for the developed nations to identify ways and means of increasing the efficiency with which this transfer takes place. Governments and research organizations in developed nations need to establish policies that encourage the international transfer of technology. If the bioeconomy is going to have the global impact that many of the early innovators envisioned, then this needs to become a priority for all OECD countries.

A final observation from an assessment of the constraints as they relate to each of the themes is that there is a noticeable cross connection of constraints. 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.

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