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Food Security and Trade: Some Supply Conundrums for 2050

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Global food demand is expected to double by 2050, partly as global population rises to nine billion and also because the nature of demand will change as incomes rise considerably for large numbers of individuals in developing countries. The projected rise in demand for food has sparked concerns regarding global food security. To maintain or improve food security will require a major increase in agricultural production. To date, considerable thought and effort have been put into issues related to increasing output in developing countries, which will be where the additional demand will be located. It has also been recognized, however, that developing countries are unlikely to be able to increase production sufficiently to meet the increased demand and that additional food supplies will have to be available through international trade. The latter is simply assumed – that some countries will have considerable surpluses available at tidewater that can enter international food supply chains. This article calls into question that assumption. Four conundrums for future agri-food supplies are examined in this article: (1) the ability of surpluses from the Canadian Prairies to move to tidewater; (2) the high degree of uncertainty regarding Ukrainian supplies; (3) the lack of transparency in U.S. biofuels policy; and (4) the inhibiting effect of EU policy toward genetically modified foods on global investment in biotechnology. It is concluded that the assumption regarding future available international supplies needs to be revisited by those concerned with global food security.

Keywords: biofuels, biotechnology, Black Sea, Canadian Prairies, food security, trade

Introduction

> Recent studies suggest that the world will need 70 to 100% more food by 2050.
>
> Godfray et al., 2012

World population is projected to reach over nine billion by the middle of the 21st century (Evans, 2009). This compares to approximately 6.7 billion at the turn of the century – a 35 percent increase. In addition, in many developing countries, large segments of the population are experiencing rapid income growth. The growth of income, particularly from low levels, leads to significant changes in diets and food expenditures. The net result of these two forces has led to projections that demand for food may double by 2050. Most of the growth in food demand will take place in developing countries. Given a host of constraints on expanding agricultural output (little surplus land, limited availability of water, poor input supply chains, farming conducted on an unsustainable basis, negative effects of climate change, underdeveloped credit institutions, low levels of technical efficiency, etc.) in the parts of world where demand is expected to grow most rapidly, if the increase in demand is to be met it will be through significant increases in imports. Many of these imports are expected to come from a few countries that have the capacity to further increase output that is surplus to domestic requirements.

Considerable attention has been given to how supply can be expanded in developing countries over the period up to 2050 (e.g., World Bank, 2007). Except for extensive discussions of the problems of trade associated with the Doha Round, and its lack of progress (Blandford and Josling, 2008; Anderson and Martin, 2005), the supply side of agricultural surplus countries' contribution to the rising demand for food over the next 40 years has been largely taken for granted. In reality, however, expanding output and moving that additional output to market will require substantial investments in machinery and other inputs at the farm level, in increasing the productivity of plants and animals, and in pre– and post–farm gate infrastructure (Gaisford and Kerr, 2001). For the most part these investments are of a long term nature (e.g., improvements to ports, railways, genetic potential, etc.) and require a perception that the long run economic environment is secure before such major investments are made. The lead times for such investments to be completed are very long, often 15 to 20 years, and even longer investment horizons are relatively common. Regulatory hurdles related to the environment and safety can add years of uncertainty to an already lengthy period of investment in scientific research or infrastructure construction. It often can take more than a decade to develop and commercialize a new genetically modified variety in the relatively “friendly” regulatory environment that exists in the United States (Phillips, 2014). The size of the regulatory hurdles also distorts the investment market in ways that, to a considerable degree, restrict activity to a few large firms with “deep pockets” (Hobbs, 2014). Construction of new (or upgrading existing) railways, inland waterways or ports often brings forth serious opposition on the basis of environmental concerns, “not-in-my back yard” (NIMBY), or disputes over property rights that add time and may require political intervention. Political intervention is often unpredictable or changeable over time, and creates risks of its own for potential investors.

As yet, little attention has been given to (1) the scale of investment required in potential surplus countries to double (or more than double) the volume of agri-food products that can enter international trade flows at tidewater; (2) changes in the policy landscape that will be required to ensure that sufficient volumes of additional agri-food products will be produced and available for export. This article examines some key future sources of exports and assesses the likelihood that they will be supply constrained by mid-century.

The Canadian Prairies

The Canadian Prairies are one of the areas of the world that exhibit the potential to significantly increase production over the next 40 years. Relative to the land base, Canada’s population is relatively small – meaning that there are considerable surpluses of dryland crops such as grains, oilseeds and pulses available for export. The agriculture of the Prairies is increasingly characterized by large scale, extensive, dryland farming operations. If prices for crops increase with the rise in global demand over the next few decades, yields can be significantly increased through the application of additional inputs and adoption of new technologies.

The harvest on the Canadian Prairies in 2013 produced a bumper crop – the largest volume of production on record. The bumper crop, however, pointed out numerous problems with moving the crop to tidewater. The expanding markets for Canadian grains, oilseeds and pulses have been in Asia over recent decades – meaning shipments out of the Prairies should move to the West Coast. The Canadian rail transport system to the West Coast is based on two railroads, three rail lines[1] and two ports. The rail lines were constructed between the 1880s and the First World War. While the railways have been substantially renovated over the years they are essentially the networks that were put in place a hundred years ago. The part of the network consisting of feeder lines on the Prairies, which were constructed to facilitate the collection of grain at the time the railroads were built, has been gradually rationalized, with road transport providing the link between farms and fewer collection points along railway lines.

The major port for grain shipment, Vancouver, is now at the heart of a large urban conurbation. There are consistent problems matching up supply of products available and the cargoes expected by ships arriving in Vancouver, such that ships must await cargoes. These delays lead to considerable demurrage charges that reduce the returns to farmers. Given the urban congestion surrounding the port at Vancouver, any major expansion of the port to facilitate a significant increase in the export of grain will probably require the construction of a new port at an entirely different location. Given the topography of coastal British Columbia, this new port would likely have to be south of Vancouver harbour but north of the U.S. border – within what is now the extended urban area of greater Vancouver.

An expansion of the port at Prince Rupert can more easily be accomplished. The rail line that services it would likely require a considerable upgrade to handle the increased traffic.

Moving grain has not been a priority for Canada's railways for many decades. Agreements, such as the "Crows Nest Pass" rate agreement signed by the Canadian Pacific Railway and passed into law and applied to the Canadian National Railway, kept the rates paid by farmers for shipping grain fixed and unadjusted for inflation for decades (Klein et al., 1993). As a result, the two railways resisted investing in moving grain. Subsequent policy changes that removed the "cap on rates in perpetuity" arising from the "Crows Nest Pass" agreement failed to fully liberalize rail rates, thus limiting the revenues railways received from moving grain, further inhibiting investments in the movement of grain (Klein et al., 1994; Nolan and Kerr, 2012). While there may have been good political reasons for keeping grain shipment rates for farmers restrained, it did have significant impact on the investment strategies of the railroads. The underinvestment by the railways in rolling stock led to, for example, large purchases of grain cars by various levels of government in Canada.

In part as a result of constraints on the revenues realized from shipping grain, railways have found shipping other resources such as potash, coal and latterly oil more lucrative. Being unable (or unwilling) to move the very large quantities of grain arising from the 2013 harvest has also provided a windfall of sorts for the railways and/or the grain handling companies. As the system became clogged, farmers desperate2 to move their crop stored on farm were forced to accept lower and lower prices to access the grain handling and transportation system. Hence, the prices at port in Vancouver – the international price – and the prices received by farmers (the basis) diverged. Thus, farmers received much less for their crop than they would have if the transportation system had had the capacity to move sufficient volumes. As a result of low prices, farmers are unlikely to invest in yield enhancing technologies and inputs.

The problems with the large crop of 2013 should provide a spur to thinking about how the much larger volumes that will be needed over the next 40 years will be moved to tidewater. There is some spare capacity for moving additional volumes out of the Prairies eastward through the great lakes at Thunder Bay. The new Panama Canal will make it easier to use this route to supply the Asian market. Some African and Middle Eastern markets that are expected to grow can probably be served by the eastbound routes – but the spare capacity on this route is limited.

In the end, if the expected increase in demand from a global population of nine billion is to be met by an increase in Canadian supply, major investments in the westbound grain handling system will be required. As yet there is no sign that this conversation is taking place, but the lead times for any such expansion of the grain handling system will be very long – easily 20-plus years.

The reality is that construction of Canadian railways has never been financed solely by private capital. The construction of the first Canadian transcontinental railroad – the Canadian Pacific Railway – was only accomplished though government guarantees and extensive land grants (Emory and McKenzie, 1996). The Canadian Pacific Railway was completed in the 1880s. Two additional transcontinental railways were constructed in the early 1900s – the Canadian Northern Railway and the Grand Trunk Railway. The Canadian Northern Railway relied heavily on grants and other forms of subsidies from various provincial governments in Canada as well as the Canadian federal government. The Grant Trunk system's financing was heavily subsidized by the Canadian federal government. The Grand Trunk was finished in April 1914. The Canadian Northern was completed in January 1915. Both suffered from the disruptions to traffic and immigration as a result of the First World War. Neither railway proved financially viable, and both had to be nationalized leading to the establishment of the Canadian National Railway system. Thus, even with the large subsidies received by both of these railways, they proved to be poor investments. This over expansion of the rail system in Canada provided a "well learned" lesson for potential investors, as it took decades before extensive rationalization and economic growth eventually brought the Canadian National Railways into a position of profitability.

Major upgrades to Canada's rail system are likely to appear daunting to private sector investors – just as they did to potential private sector investors in the 19th and 20th centuries. This is why the government – which wanted the railways built – had to provide large subsidies and other inducements (Emory and McKenzie, 1996). Current Canadian governments have no particular goal of upgrading the rail system as they did for the initial construction of the railways. Major subsidies are unlikely to be forthcoming. Further, any upgrading of the grain transportation system will suffer from “chicken and egg” problems. Ports will not be expanded or constructed on a “greenfield” basis unless there is a co-commitment to improve the rail system. Rail companies will not make the investment to upgrade their systems unless there is a commitment to improve the ports. The rolling stock used to transport grain is aging and it is not clear who would replace the heavy investment in grain handling rail cars previously made by governments in Canada.

Any major upgrading of the grain handling system is likely to face considerable resistance on environmental grounds and, in the case of a new port near Vancouver, “not in my back yard (NIMBY)” opposition. While such opposition may not be successful, it will add years of time in terms of legal delays and costs. Until it is certain such opposition can be overcome, investors will perceive such ventures as too risky to begin. If the investments in upgrading the grain handling and transportation system were to begin today, it could take upwards of 20 years to construct the required infrastructure. Thus far, there has not been a serious conversation in Canada about what is needed to allow Canada to contribute to feeding the nine billion people by 2050. Neither the Canadian federal government – which would have to play a major coordinating role – nor the private sector has shown any interest in the question. Unless serious discussions begin in the near future, Canadian agri-food products will be very much supply constrained in the struggle to feed nine billion.

The Black Sea Region

The grain producing areas collectively known as the Black Sea Region – Ukraine, Russia and Kazakhstan – have long been see as major potential contributors to global food supply (Falkus, 1966; Schmitz and Bawden, 1973). The key word, however, is “potential”. For a century a string of events have thwarted the realization of that potential: the First World War; the Russian revolution and subsequent civil war; the putting in place of a command economy; Stalin’s collectivisation of agriculture; the devastation of the Second World War; the forced creation of a grain-based livestock industry in the latter part of the soviet era; the end of the communism and the Soviet Union; and the chaotic early years of transition to a market-based economy (Hobbs, Kerr and Gaisford, 1997; MacKay and Kerr, 2007). At the start of the 21st century there was a period of relative stability, which encouraged investment in agri-food supply chains (Burkitbayeva, 2013; Hobbs and Boyd, 2007). This led to a major increase in the contribution grain from the Black Sea Region made to global supplies – from, for example, 2 percent in 1991 to 23 percent in 2008 for wheat (USDA, nd). While the economies of the Black Sea Region were far from modern market economies (MacKay and Kerr, 2007), being rife with corruption and other forms of rent seeking, investments in grain handling infrastructure were being made – largely by the public sector (Burkibayeva and Kerr, 2013). To fully realize the Black Sea Region's potential as a contributor to global food demand, considerable private sector investment will also be required.

The events in the Black Sea Region in 2013 and 2014 are likely to deter any large scale investment in grain handling infrastructure for the foreseeable future. The decision of Ukraine's President Yanukovych to eschew an economic agreement with the European Union (EU) and opt for an economic deal offered by Russia set off a political crisis. It is clear that Russia did not want Ukraine to strengthen its economic ties with the EU and would rather it stay within the Russian sphere of influence – hence the lucrative deal offered President Yunukovych by President Putin. Clearly, the Russian government believed they had "bought" Ukrainian loyalties through the deal. This did not turn out to be the case. Instead, it precipitated a political crisis that led eventually to the ousting of President Yukukovych. Russian retaliation for Ukraine's failure to be "bought" was swift. The seizure of the Crimea was the first such "transfer" of sovereignty in Europe since the end of the Second World War. It is certainly not likely to inspire the confidence of investors thinking of investing in major infrastructure projects.

Further, if Russia can seize the Crimea and get away with it, what else might be up for grabs in the future? Eastern parts of Ukraine have been subject to the same type of de-stabilizing activity that characterized the Crimea before Russian troops moved in – pro-Russian militias seizing government buildings and establishing road blocks, etc. Even if Russia does not move to formally annex areas of eastern Ukraine, it seems clear that Russia wants Ukraine to be a weak state characterized by considerable uncertainty. If it cannot have a pliant neighbour, one which is relatively ineffective will have to do. Of course, if Ukraine remains unstable, with the threat of further Russian territorial acquisitions possible, there is little chance that major investments in upgrading grain handling infrastructure will be made.

Russia itself appears increasingly unpredictable. Relations with modern market economies have deteriorated in the wake of the Crimean seizure and subsequent events in Ukraine. This is hardly a business environment that is likely to encourage major investments in the Russian economy, and in particular in facilities dependent on the Black Sea. Kazakhstan's grain exports are also dependent on moving grain through Black Sea ports (Burkitbayeva and Kerr, 2013). Its long supply chains combined with a less predictable Russia will also likely cause investors to think twice before making the substantial investments in grain transportation and handling infrastructure. Even if events in Ukraine and neighbouring areas eventually stabilize, the investments in infrastructure required will take decades to complete. As a result, the Black Sea Region may also be supply constrained in the run up to 2050.

The United States

One major constraint to the United States contributing to feeding the world in 2050 is its biofuels policy. The initial rationale for the development of policies to foster the development of a biofuels industry in the United States was improved energy security through reducing dependence on oil imported from unstable places (Viju and Kerr, 2013). Latterly, reduction of greenhouse gas emissions and supporting farm incomes became, if not official, de facto, goals of the policy. As a result, U.S. biofuels policy has been characterized by ambitious targets and short time horizons.

This has led to the rapid expansion of corn-based ethanol production, primarily because the feedstock – largely corn – was widely grown and the distilling technology was well understood. The incentives provided in the United States proved to be generous, and rapid investment in entire ethanol supply chains followed. The effect of the diversion of large volumes of corn out of food production and into ethanol production was, however, largely unanticipated and poorly understood. Although the diversion of corn into ethanol production was far from the only reason for the global spike in food prices in 2007, it was a major contributing factor (Mitchell, 2008; Meilke, 2008).

Partially in response to rising food prices, the U.S. Congress passed the U.S. Energy Independence and Security Act, 2007 (EISA), which set out a revised U.S. Renewable Fuel Standard (RFSII) that required long term use of renewable energy in transportation, subject to sustainability criteria. The latter represents, in part, an attempt to limit the impact of biofuels policy on food prices. In essence, the new biofuels regulations mandate the blending of ethanol in transportation fuels but cap the amount of corn-based ethanol – the major competitor for food – at approximately the current capacity. The remainder of the mandated use of ethanol in transportation fuel is to be sourced by specified non-corn feedstock sources. The endpoint of the biofuels mandate in the United States is 2022 – less than a decade away. This date is important because in this short time span the quantity of ethanol available for blending is mandated to almost triple, but without corn-based ethanol production being allowed to expand.

In 2012, the United States was the number one producer of ethanol in the world, with a reported production of 13.3 billion gallons (Renewable Fuels Association, 2012). A total of 36 billion gallons (bg) of renewable fuel is mandated to be blended with gasoline by 2022. From 2015 onward, however, the contribution corn-based ethanol can make to satisfying the 36 bg mandate is capped at 15 bg – only slightly more than existing U.S. capacity.

The problem is that none of the non-corn based feedstocks envisioned in the ESIA is commercially viable. The types of fuels eligible for consideration include ethanol derived from cellulose, hemi-cellulose or lignin, sugar or starch and waste material. Biodiesel, biogas, butanol and other fuels derived from cellulosic biomass may also be considered (Sec. 201, Paragraph B, Energy Independence and Security Act, 2007). The major feedstock for ethanol that was envisaged as an alternative to corn-based ethanol is cellulose. Of the 36 bg mandated for 2022, 16 bg is reserved for cellulosic-based biofuel.

This technology has not yet reached the point of commercialization. The U.S. Department of Energy indicates that infrastructure is a major constraint on cellulosic ethanol supply. The expected increase in production capacity of cellulosic ethanol is 250 million gallons (mg) per year (United States Department of Energy, n.d.). If this optimistic expansion of capacity could be achieved between 2012 and 2022, the ability to produce cellulosic ethanol would only reach 2.5 bg, less than 20 percent of the mandated quantity. The EPA is responsible for setting the annual volume of mandated cellulosic ethanol. For 2013, the EISA (RFSII) provides for one billion gallons of cellulosic ethanol but the EPA set a significantly lower target of 14 million gallons (a shortfall of 99 percent), which implies domestic cellulosic supply is significantly lower than the mandated volume as found in the EISA. Hence, it may be inferred that the 2022 mandate of 16 billion gallons is unlikely to be realized due to technical infeasibility. A major breakthrough in cellulosic technology has not yet been achieved, and even if it were to happen tomorrow the likelihood of bringing an extra 13 billion gallons of capacity on line by 2022 would seem unlikely, if not impossible – large scale investments would have to be made both in the production of whatever feedstock became technically feasible and in refining capacity.

Thus, there seems “no feasible set” whereby the objectives of U.S. biofuel policy can be achieved (Williams and Kerr, 2011). There exists a major disconnect in U.S. policy – which creates considerable uncertainty as to how it is to be resolved. In addition, there is a further constraint that does not seem to be accounted for in official U.S. biofuels policy – although it is well known. This is the technical constraint known as the “blend wall”. As currently engineered, almost all gasoline engines powering automobiles in the United States can operate efficiently with a maximum blend of 15 percent ethanol mixed into conventional gasoline.3 Lifting the 15 percent maximum for blending, while technically feasible, would require an entire re-engineering of automobile engines and the fuel distribution system required to supply vehicles powered by such engines. Such a major change in the automobile and associated industries cannot be expected in the next couple of decades – if ever. Given that consumption of gasoline is projected to be approximately 140 bg in 2022, the volume of renewable fuel that can possibly be blended with gasoline is constrained to 21bg – well below the mandate of 36 bg (Williams and Kerr, 2013). As yet there has been no indication that the mandate will be adjusted to reflect this technical reality.

From the viewpoint of potential investors in U.S. agribusiness there are a number of potential scenarios that may play out over the next decade. First, the cap on corn-based ethanol can be lifted – a least to the degree that would meet the “blend wall” constraint for 2022. That would allow an additional 6 bg (from 15 bg to 21 bg) in corn-based ethanol – a 40 percent increase. This would effectively remove a large quantity of grain from being available for export supply. The corn diverted to produce the current 15 bg mandate is equivalent to the total quantity of U.S. corn exports prior to the implementation of the biofuels policy.

It might also be that the mandate of 36 bg could be abandoned or significantly reduced. The underlying rationale of U.S. biofuels policy – enhancing energy security (Viju and Kerr, 2013) – may already be in doubt given the rapid uptake of fracking technology in the petroleum industry. Expectations are that the United States may become an energy exporter in the near future due to the technologically driven surge in domestic petroleum supplies. Reducing the biofuels mandate, however, would encounter significant political resistance from environmentalists, vested interests in the development of cellulosic-based technologies and the farm lobby.4 The most that the mandate could be reduced is to the current cap of 15 bg of ethanol. This is because farmers benefit from the higher prices for corn (and other crops whose prices are enhanced by high corn prices). There has been major investment in distilling capacity which is relatively new and undepreciated. If the cap were lifted to allow corn-based ethanol to satisfy the “blend wall” constraint, as suggested above, there would be fierce resistance in the future to any reduction from 21 bg given that investments would have been made to put refining capacity in place to produce the extra 6 bg of production.

The bottom line is that the U.S. agri-food market is likely to remain significantly distorted by domestic biofuels policy. Further, given the existing “failure to deal with the realities” of the biofuels industry by policy makers, investors are confronted with an opaque future which is permeated with uncertainties. Hence, market forces are unlikely to prove to be a driving force in determining U.S. supply response to the expected increase in global demand for food over the next decades.

The European Union

The effect of the European Union on the ability of the global food supply to keep up with the expected growth in demand over the next 40 years is less direct than the other likely constraints on supply discussed above but, nonetheless, may be of a significantly greater magnitude. This is because of the inhibiting effect on investment in biotechnology that its policy toward genetically modified (GM) foods creates (Smyth, Kerr and Philips, 2013a). The current negative effect on the investment decisions firms make regarding the potential returns expected from research and development in biotechnology arises from the smaller expected global market for any GM crop due to the EU's failure to allow the adoption of GM technology in agricultural production and for food imports.[5] The eschewing of GM imports further reduces the market for the products of biotechnology research because countries which currently export agri-food products to the EU worry that adopting GM products will threaten their ability to export conventional crops to the EU. This is particularly the case for developing country suppliers of the EU, which worry that they will not be able to segregate their supply chains to a sufficient degree to satisfy EU tolerances for unintentional mingling of GM and conventional products (Smyth, Kerr and Philips, 2013). Political rejection of GM products in the EU itself and defensive nonadoption among foreign suppliers of the EU significantly reduce the expected market size (and, hence, benefits) when making investment decisions pertaining to research and development in biotechnology (Kerr and Yampoin, 2000). Biotechnology is recognized as one of the technologies that can make a major contribution to increasing agricultural productivity (Beddington, 2010). Less research and development undertaken in biotechnology reduces the contribution the technology can make to increasing global food supplies.

The negative externalities for investment in biotechnology arising from EU policy are, however, expected to rise due to the regulatory approach taken toward "adventitious presence" of unapproved GM products found in conventional shipments of agri-food products. "Adventitious presence" is the official term used for the unintended mingling at low levels of GM products with conventional crops. The EU policy is zero tolerance, meaning that any trace of unapproved GM product found in conventional shipments bound for the EU leads to rejection of the shipment. Further, all imports of the particular crop may be embargoed until a system can be put in place by the exporting country that satisfies EU requirements. For the Canadian flax industry, a case of "adventitious presence" of unapproved GM flax led to disruptions to Canadian exports for months, and an ongoing and expensive testing regime is now required for exports of Canadian flax to the EU (Viju, Yeung and Kerr, 2014).

The EU regulatory regime for GM products, both for approving new products for domestic production and for approving products for import, is slow by international standards, costly in terms of its information requirements and opaque, rendering it unpredictable for those who might seek approval (Viju, Yeung and Kerr, 2011). The process is no longer "science based" but rather science only provides information for what is a political process (Smyth, Kerr and Philips, 2013a; Viju, Yeung and Kerr, 2011). The result is that the pace of approvals of new GM crops is much more rapid in many jurisdictions, meaning that approvals are asynchronous internationally. Further, given the slowness, unpredictability and cost associated with seeking approval in the EU, some developers of biotechnology do not bother to seek approval in the EU. Further, in some cases new biotechnology products are not suitable for the EU market and no approval would ever be sought. As a result, the number of GM products approved in some jurisdictions but not in the EU is set to increase rapidly over the next decade. The likelihood of unintended mingling of GM agri-food products unapproved in the EU in conventional shipments will increase considerably – leading to disruptions to trade and negative impacts on domestic exporters of conventional crops. To prevent these losses they can be expected to lobby against additional approvals of new GM crops. To the degree that they are successful, this will feed back into the expected returns from investing in research and development in agri-food biotechnologies, further limiting the contribution they are likely to make to increasing global food supply. Given that the lag between when investments are made in agricultural technologies and when the increases in yield are fully manifest is often 20 years or more (Alston, Beddow and Pardey, 2009), even if the uncertainty created by EU policy could be removed tomorrow, any contribution to increasing global food security from additional GM crops is likely to come only in the latter part of the lead-up to 2050.

Policy making regarding GM agri-food products in the EU, rather than providing clarity for potential investors, often further obscures the likely outcome of any attempt to bring forth a product of biotechnology for regulatory approval. For example:

> EU environment ministers last Friday gave the green light to a legislative proposal that would allow member states to restrict or prohibit the cultivation of genetically modified organisms (GMOs) in their territory, even if the crop was authorised at the EU level.

> Under the current rules, member states may invoke national "safeguard" bans based on assessed risks to human health or the environment, supported by scientific evidence. These are temporary measures, however, and must be perpetually renewed.
>
> The new draft proposal – passed by 26 out of the EU's 28 member states – would amend this arrangement to provide countries with the legal basis to implement prohibitions for additional reasons, including socioeconomic concerns, land use and town planning, agricultural policy objectives and public policy issues. (Bridges, June 19, 2014).

Thus, even after having cleared the EU-wide regulatory hurdle for gaining approval of a GM crop, a potential investor in GM research and development is faced with denial of approval by individual EU member states. Further, the potential reasons for denying approval are wide ranging and impossible to predict. This type of uncertainty will factor heavily in the decisions of potential investors in biotechnology no matter where they reside.

The European Union has the sovereign right to determine its policy on GM products. The issue of GM products is undeniably divisive within the EU (Perdikis, 2000). Given the size and influence of the EU in the global agri-food economy, however, its policies impose externalities. One of these is the negative impact on investment in research and development in biotechnology. The effect can be a reduction in global food security through a reduction in the potential productivity gains which investments in biotechnology can be expected to provide. In other words, a reduction in potential global food supply. It is not clear whether those expecting a contribution from biotechnology to reach global security goals have taken the potential size of the negative externality of EU policy fully into account.

Conclusion

The food price crisis of 2008 brought the question of global food security to the forefront of the international agenda. This rise in consciousness allowed for serious questions to be asked regarding how global agriculture would be able to respond to the feeding of nine billion people by 2050. There is general agreement on a likely doubling of demand. In a flurry of activity in the wake of the food crisis, a number of initiatives were put in place to study the problem and suggest solutions. A considerable number of food security institutions were established. There has been considerable work done on how agricultural output can be expanded in developing countries and on the types of technological improvements that will contribute to achieving food security globally. There is also a general consensus that developing countries, where most of the additional demand for food is expected, alone will not be able to provide the necessary increase in food output. It is commonly assumed that trade will also have to make a contribution – that some countries will have considerable surpluses available at tidewater that can enter international food supply chains. This article calls into question that assumption.

A scan of the literature since 2008 yields a paucity serious discussion regarding potential constraints on international supplies that may be manifest as demand expands between now and 2050.6 The potential problems discussed in this article suggest that those concerned with global food security, agri-food trade and agricultural policy need to broaden their research agendas to examine the assumption that international supplies will make a major contribution to meeting growing food demand. Once an assessment of the likely availability of future international supplies has been made, then if the results warrant it, new strategies and policies may have to be devised to ensure future global food security.

The potential constraints on international volumes of agri-food trade outlined above are true supply conundrums – none has an easy solution. Other potential areas of concern regarding future international supplies of agri-food products could also have been discussed, such as the effect of climate change on Australian grain supplies and the poor performance of the Argentinian economy, to name two. There may be others. Mobilizing agricultural producers in developing countries so that they can make a significant contribution to their own (and global) food security is a daunting task and one that has absorbed the lion's share of effort pertaining to food security since 2008. The question of the future availability of international supplies, however, is also worthy of a thorough examination.

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Endnotes

1 The Canadian Pacific Railway line that leaves the Prairies at Calgary and terminates at tidewater in Vancouver. The Canadian National Railway line that leaves the Prairies at Edmonton and terminates at tidewater in Vancouver. The Canadian National Railway line that leaves the Prairies at Edmonton and terminates at tidewater in Prince Rupert.

2 They need to sell their crop so as to finance the planting of next year's crop.

3 Older models can only effectively utilize a maximum blend of 10 percent ethanol and gasoline.

4 The latter expect to benefit either from the lifting of a cap on corn-based ethanol if the 36 bg mandate cannot be achieved – as discussed above – or because they expect to benefit from growing the potential non-traditional crops expected to be part of the feedstocks for cellulosic ethanol (e.g., switchgrass).

5 In the wake of no suitable alternative sources of supply the EU has, however, recently loosened its import regime for GM products used for animal feed (Hobbs et al., 2014).

6 Of course, there is considerable discussion in the popular media about the short term problems arising from the crisis in Ukraine and the inability to move the bumper crop out of the Canadian Prairies. The EU policy on GM foods and the U.S. biofuels policy receive considerable popular and scholarly attention, but not in the context of long term food security.