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REVIEW

Agricultural support policy in Canada: What are the environmental consequences?

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Abstract: This paper reviews annual government spending on Canadian agriculture that attempts to stabilize and enhance farm incomes. Over the past 5 years, 2/3 of the $3 billion spent on agriculture went into stabilization programs to support farm incomes. However, this level of support raises questions about the environmental consequences of enhanced agricultural production. Environmental impacts from agriculture are well known and addressed in US and EU policies. In contrast, Canadian government expenditures on environmental initiatives in agriculture, as a share of farm income, are more than 10 times smaller than those in the US and the EU. Nonetheless the evidence is that Canadian programs have modest impacts on production, but that chemical and fertilizer input use may be higher than in the absence of the program. One possible course of action is to introduce cross-compliance between program payments and environmental objectives. However, there are no requirements that Canadian producers receiving support comply with environmental standards. While cross-compliance could be considered in the Canadian context, policies that directly target specific environmental issues in agriculture may have greater impact.

Key words: Environment, government programs, agriculture, Canada.

Résumé : Les auteurs passent en revue les dépenses annuelles du gouvernement canadien en Agriculture visant à stabiliser et augmenter les revenus des fermes. Au cours des cinq dernières années, les deux tiers des $3 milliards dépensés pour l'agriculture sont allés pour les programmes de stabilisation des revenus des fermes. Cependant, ce degré de support soulève des questions au sujet des conséquences environnementales de cette augmentation de la production agricole. Les impacts environnementaux de l'agriculture sont bien connus et pris en compte par les politiques aux US et en UE. Au contraire, les dépenses du gouvernement canadien pour les initiatives environnementales en agriculture, en pourcentage des revenus des fermes, sont plus de dix fois plus petites que celles des US et de l'UE. Tout de même, la preuve est faite que les programmes canadiens exercent des impacts modestes sur la production, mais que l'application de substances chimiques et de fertilisants pourrait être plus élevée qu'en absence de programme. Un mode d'action possible serait d'introduire la conditionnalité croisée entre les programmes de paiements et les objectifs environnementaux. Cependant. Il n'y a pas d'exigences que les producteurs recevant du support respectent les standards environnementaux. La conditionnalité croisée est utilisée dans d'autres juridictions et devrait être considérée dans les politiques canadiennes de support agricole. [Traduit par la Rédaction]

Mots-clés : environnement, programmes gouvernementaux, agriculture, Canada.

Introduction

Significant changes in developed country agricultural policy have taken place over the past 20 years, spurred by budgetary concerns and the desire to limit production incentives and minimize distortions to trade. Commodity price supports were commonly used in the past, however, these measures frequently increased production, putting downward pressure on world prices. The unintended consequence was that producers in other countries faced lower prices and reduced market access. More recent reforms in the United States and the European Union have shifted farm support to direct payments, which presumably have fewer production incentives. The Canadian approach has been to provide whole-farm support programs, which prompt minimal production incentives. Canadian programs aim to offer protection from "severe market volatility and disasters" (AAFC 2014), and are described as business risk management (BRM). The current suite of BRM programs includes *AgriInvest* (a subsidized savings account), *AgriStability* (a deficiency payment triggered by a margin based measure of overall farm income), *AgriInsurance* (production or crop insurance), and *AgriRecovery* (a safety net program for disaster assistance), all of which pay out when current income is lower than a predefined threshold.

In 2013, US$258 billion (18% of total farm receipts) was transferred from developed country government treasuries to agriculture (OECD 2012). In the mid-1980s, government support was nearly twice as high (37% of farm receipts), and agricultural economists determined that total government payments exceeded the benefits to consumers and producers (Alston and Hurd 1990; Chang et al. 1992). While some of these dead weight losses still exist, there is also an overriding concern that negative externalities from agricultural activity (especially fertilizer and pesticides) carry additional societal costs. These concerns have led to calls for reallocation of government payments toward encouraging environmental stewardship (Legg and Diakosavvas 2010).

The Canadian experience with agri-environmental policies is relatively limited. For the most part the programs involve cost-sharing activities that reduce nutrient loading and payments for provision of ecosystem services. However, these programs have involved small

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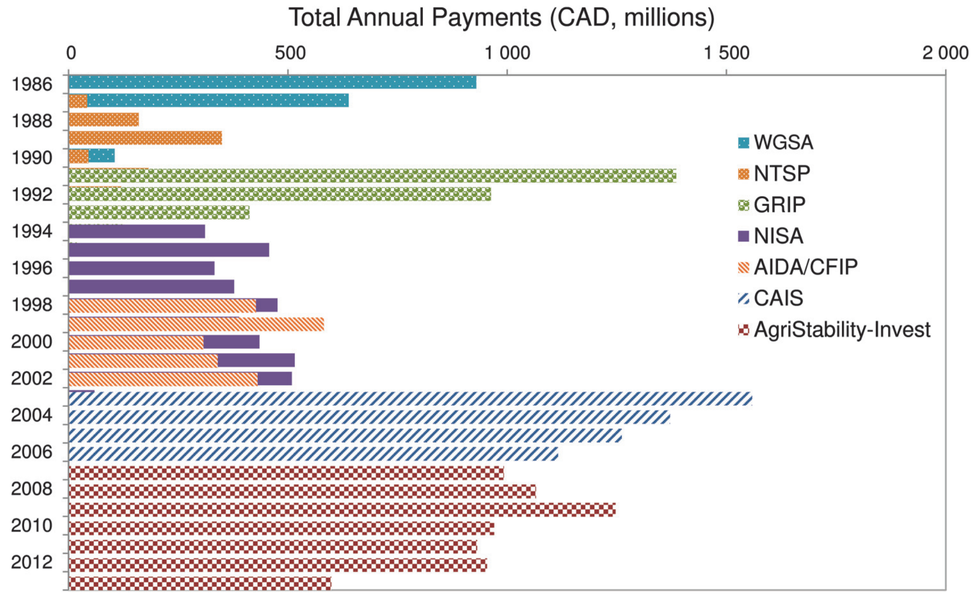
Fig. 1. Major BRM program payments to the Canadian agriculture sector, federal and provincial combined, 1986 through 2013. Source: OECD PSE database.



monetary allocations in relation to the size of Canadian BRM programs. In addition, an audit of the early cost-share environmental program suggested that it was ineffective in terms of participation at the farm level and that its environmental effectiveness would be extremely difficult to evaluate (Auditor General of Canada 2008). Nonetheless, there is popular support for increased environmental programming and explicit calls for efforts that link agriculture support payments to environmental objectives (Seguin 2012). Agricultural support programs have indeed been reformed in the direction of becoming more "production neutral", but there remain ongoing concerns with environmental externalities. The motivation for this study is the unresolved question of spillovers from Canadian agricultural support policies to issues of environmental management.

The objective of this study is to examine the rationale for government support for domestic agriculture and to explore the unintended consequences of this support, especially the negative environmental impacts. Specifically, we ask how society's welfare is affected: what are the benefits and costs of risk management programs, and what other market failures or under-provision of public goods should be considered in new policy? The focus is on Canada, with comparisons drawn to other regions, especially the United States and Europe.

Agricultural support programs in Canada

In Canada, total annual payments made to agriculture from government sources averaged $3.1 billion per year from 2007–2013 (OECD 2015),[1] which equaled approximately 0.5% of total federal and provincial government expenditures and 7.7% of gross farm revenue. Between 2007 and 2009, BRM programs accounted for 84% of federal spending and 66% of provincial spending on agriculture (Rude and Ker 2013). Additional public support for farm income arises from agricultural policy that affects market prices and other factors, so that 16.0% of total Canadian farm income for 2008–2010 came from public (consumer and taxpayer) support. These policy-driven monetary transfers to agricultural producers jointly comprise the producer support estimate (PSE).

The Canadian government has for many years provided safety net programs to support and stabilize farm income, with the aim to reduce the negative impacts of production disasters and volatile commodity prices (Fig. 1). Detailed historical summaries of these programs are provided by Schmitz (2008) and Skogstad (2008, ch. 3). The first major stabilization program, the *Agricultural Stabilization Act* (ASA, 1958–1991) was commodity-specific, incurred no cost to farmers, and guaranteed 90% of a three-year (later five-year) moving price average for grains and livestock commodities. Seven prairie crops were moved from the ASA program in 1975 to a safety net under the *Western Grains Stabilization Act* (WGSA, 1975–1990). The program trigger was based on aggregate net cash flow for the basket of crops. Tripartite programs (1985–1994) were jointly funded by federal and provincial governments and by producers. Product coverage included beef, pork, beans, sheep, and honey, with payouts if the current year's margin fell below the minimum guaranteed margin.[2] The WGSA and remainder of the ASA were replaced by the *Gross Revenue Insurance Program* (GRIP, 1990–1995) and *Net Income Stabilization Account* (NISA, 1990–2002). Both programs were voluntary and jointly funded by government and producers. GRIP was a commodity-specific revenue-based insurance program and NISA used an individual margin approach based on net income covering most commodities. A similar whole-farm income-margin approach continued to be used in subsequent programs: *Agricultural Income Disaster Assistance* (AIDA, 1998–2001), *Canadian Farm Income Program* (CFIP, 2001–2002), *Canadian Agricultural Income Stabilization Program* (CAIS, 2002–2006), and *AgriStability* and *AgriInvest*[3] (Growing Forward, 2007–2012; and Growing Forward 2, 2013–2018).[4]

[1]This is similar to the values reported by Statistics Canada (2014), which indicates total agricultural payments (including private insurance sources and all public programs) that range from $3.1 billion (2010) to $2.7 billion (2013).

[2]Margin is equal to revenue minus associated costs, although the definition varies by program.

[3]*NISA* and subsequently *AgriInvest* are both government-subsidized producer savings accounts, which can be used to smooth declines in farm income.

[4]The objectives of *Growing Forward* (1 and 2) are vague: (*i*) a competitive and innovative sector, (*ii*) a sector that contributes to society's priorities, and (*iii*) a sector that is proactive in managing risk. It is likely that the second objective relates most directly to environmental issues.

The evolution of policy has been to move from price-based commodity-specific instruments to generally available whole-farm margin-based programs. This evolution has the benefit of being less distorting with respect to production decisions, but has the downside that the more general programs do not address all the objectives of varied producer groups.

While the income stabilization programs targeted net cash flow and net margins, crop insurance began in 1959 to address problems of significant yield loss, with financial support from federal and provincial governments. Crop insurance (*AgriInsurance* in the Growing Forward suite of programs) is specific to each cropping year, and payments account for yields that are below a predetermined threshold. With quicker and more predictable payments than the whole-farm margin-based programs, crop insurance fills a somewhat different niche. The government contribution has increased over time to the current 60% of total premiums plus administrative costs (Antón et al. 2011), so that crop insurance is managed more like a program of payments than an insurance business.[5]

The dairy and poultry sectors do not receive government payments but nonetheless receive market price support, through a system of supply management. The legislative basis for supply management is the 1972 *Farm Products Marketing Agencies Act* that supports a regime of production and import quotas, which reserve the Canadian domestic market for Canadian producers and restrict supply to guarantee a minimum producer price, thus raising and stabilizing farm income. Market price support comprised an average of 51% of the total OECD PSE for 1986 through 2007, but this share rose to 58% for the 2008–2013 time period (OECD 2015). Dairy is the largest sector, with 56% and 65% of the market price support allocation in 1986–1988 and 2008–2013, respectively. Therefore, 38% of all support to producers in 2008–2013 accrued to the dairy sector. Market price support remains one of the most distorting forms of government assistance, and is the subject of continued controversy (e.g., between Canada and its trading partners).[6]

Program objectives

The rationale for government support of agriculture in Canada and other countries has generally centered around three main themes. First, there is a common belief that low levels of income for farms and farm families are less than socially desirable. Second, proponents assert that farms are exposed to abnormal levels of risk beyond the proprietor's control. Finally, there is the belief among some that supporting agriculture also fosters rural development, the latter of which has long been a public policy goal (Blake 2003).

Skogstad (2011) describes a multiplicity of policy objectives that have been historically provided for government intervention in Canadian agriculture. However, a striking feature of this review is the limited number of policy instruments available to achieve these objectives. Tinbergen (1952) advocated a rule that the number of policy instruments has to equal the number of objectives. Attempting to address multiple objectives with a single instrument risks not only the ability to determine if the policy instrument has been successful but also may lead to interest groups continually asking for new programs to replace the existing policies. This is evident in the succession of safety net programs presented in Fig. 1. The problem is that it has never been defined whether BRM programs aim to support and augment agricultural income, to reduce risk, or to pursue environmental and other social goals. This section describes the role of BRM programs in the transfer of income to agriculture, reducing risk, and other reasons for government involvement.

Transfer of income to agriculture

During the first half of the 20th century, income levels for farmers were significantly lower than for other citizens. This gap has been erased over time and, in 2007, household income for farm families on unincorporated farms averaged $93 703 (AAFC 2010), comparable to the before-tax total income of the average Canadian household, $86 300 (Statistics Canada 2009). On the other hand, increased reliance on off-farm income could be an indicator of financial stress on the farm. Comprising a growing share of total household income, off-farm income rose from 68% in 1990 to 77% in 2009 for the typical farm (Beaulieu and DiPiétro 2003; Statistics Canada 2012*a*) and is especially important for small farms (annual gross farm revenue of $10 000–$99 999), where off-farm income comprises 89% of total household income. From 2001 to 2009, medium-sized farms (annual gross farm revenue of $100 000–$249 999) experienced a 14% decline in net farm operating income and a corresponding 34% increase in off-farm employment income (Statistics Canada 2012*b*). These farms are large enough to require almost full-time farm labour, but not large enough to achieve economies of scale; therefore, they have limited opportunities to reduce costs and consequently do not provide enough returns to labour. For those farms where the operator has skills that are specific to farming, there are also limited opportunities to pursue higher paying off-farm employment.

However, there are problems with using net farm income as a measure of producer welfare. Measures of farm profitability can be manipulated by changing the reporting of depreciation and inventory adjustments. Farm returns can be re-invested into agriculture and net farm income can be reduced by paying wages to family members — neither of which has a true negative impact on the farm household. Net income cannot be used as the sole determinant of farm financial health.

An alternative measure of producer welfare examines the return on assets (ROA). For the aggregate Canadian farm sector,[7] the 9 year period from 2001 to 2010 saw a small (0.2% annual) increase in farm family wages, but a much more significant gain in total farm assets from $163 billion to $276 billion, representing annual growth of 6% (Statistics Canada 2013). Caldwell (2008) indicated that when calculating ROA from agriculture on the basis of historical asset values, resulting ROAs are comparable to other sectors within the economy. It should also be noted that as returns are re-invested into agriculture this increases expenses (land value and input prices) and puts further pressure on farm financial performance, which can increase government payments. This significant increase in total wealth raises the issue of why government programs continue to provide large financial support to agriculture.

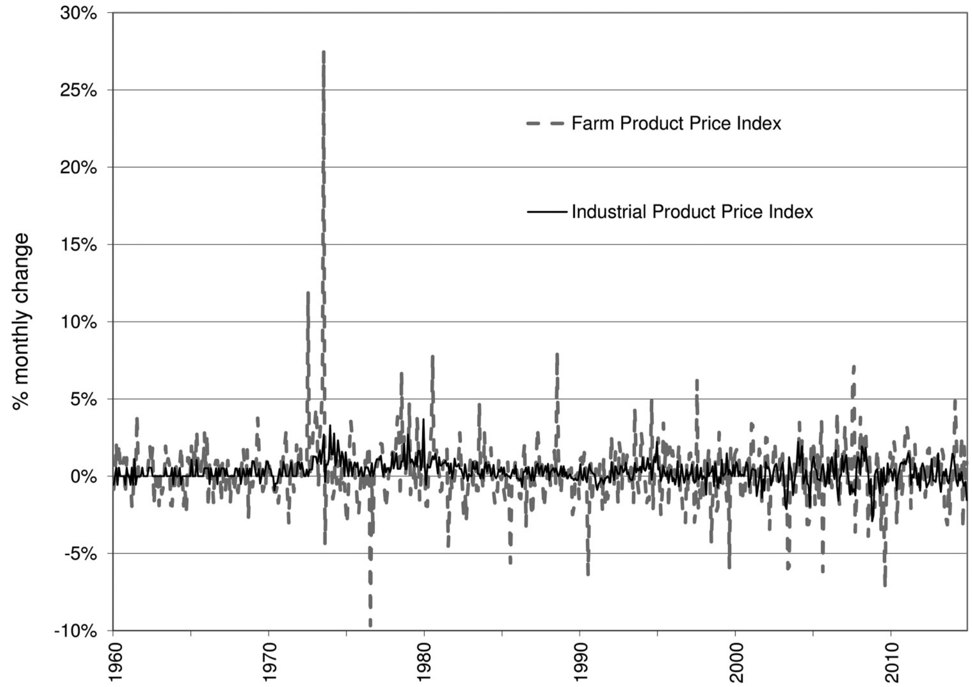
However, diversity in farm size, demographics, and household income can increase the difficulty in measuring the true profitability of the agricultural sector. Therefore, while there may be certain types of agriculture or segments of the farm population for which public support of farm income is justified, identification of these situations and appropriate targeting may prove to be challenging.

[5]Crop insurance payments are counted as income for the calculation of *AgriStability* and *AgriInvest*, the latter of which acts as a savings account for an allowable portion of farm income, with government matching contributions.

[6]Under supply management, considerable transfers from consumers to producers occur, likely with associated environmental externalities. However, because this is not a BRM program, these effects are outside the scope of this paper.

[7]The annual Farm Financial Survey draws from a sample from all farms with >$10 000 in gross annual income.

Fig. 2. Variability in farm prices versus industrial prices, 1960–2014, Canada. Source: Calculated from Statistics Canada. Table 002-0021 – Farm product price index (FPPI), monthly. Statistics Canada. Table 329-0057 – Industry price indexes, by North American Industry Classification System (NAICS), monthly.



Reducing risk in agriculture

Two factors contribute significant risk to farm income: production uncertainty (related to weather, pests, etc.) and price uncertainty. Government action is seen as necessary if no contingency markets exist to share the risk and the resulting level of risk is beyond that felt in other sectors. There is some evidence that Canadian farm prices are more variable than the industrial product price index, with an average monthly change of 1.4% and 0.5%, respectively, over the period of 1960 to 2014 (Fig. 2). However, price risk may be negatively correlated with production risk, so measures of price variability are not sufficient measures of agricultural risks. Farm household income is generally more stable than farm income because of the large share of off-farm income. Critics also argue that risk is part of any business, and variability in agricultural systems is what generates innovation and adaptation needed for a changing world (Gardner 1987; Tweeten 1995).

While futures markets may be available to manage price risks, prices only determine part of income variability. The private sector does not provide multiple peril crop insurance in any major agricultural market because of systemic risks and information asymmetries, such as moral hazard. In these situations of market failure, government intervention may be necessary (OECD 2011). So government assistance with production (e.g., crop) insurance is commonplace. Privately offered revenue insurance is available in the US but the programs are heavily subsidized by government. Insurance for catastrophic risks (flooding, drought, or disease outbreaks) is typically not available through private markets.

Other reasons for government involvement

When compared with urban dwellers, rural citizens face increased distance from services, a smaller range of employment opportunities, and challenges related to communication and transportation. Rural development has historically been equated to agricultural development, and support for agriculture was therefore viewed as supporting rural communities. However, in contrast to the past, rural populations in Canada have increasing numbers of non-farm households, and the majority of payments from current farm programs tend to go to a relatively small number of households with the highest farm income.[8] Over time, farmers' incomes have increased relative to those of other households, there are fewer farmers, and farm sizes have generally increased (with the exception of areas dominated by hobby farms, such as the peri-urban regions in British Columbia). Thus, the question arises as to whether farm support or other action would best achieve the objective of rural development.

Believing that government assistance maintains a safe and stable food supply, taxpayers in the US support subsidies to agriculture (especially to smaller farms), even when informed and shown that farmers are doing well financially (Ellison et al. 2010). Public opinion also tends to support government expenditures on agriculture in the form of tax relief or other support to maintain attractive landscapes and preserve historical agrarian values (Nelson 1992). Survey results from British Columbia suggest that, in a similar manner, Canadian citizens tend to positively support government involvement in farmland conservation and other agricultural programs (Androkovich et al. 2008; Quayle 1998).

Social and environmental goals

Even though public opinion seems to favour some continued government support for agriculture, general awareness of the environmental consequences associated with agricultural land management has also increased over time, and with that, questions about how government involvement affects environmental stewardship. Certain significant events — at least in terms of media coverage — have enhanced concerns about food safety or security (e.g., melamine contamination in Chinese milk products, listeriosis in meat, and *E. coli* in vegetables). The increasing media

[8]In 2012 71% of government support went to 17% of the farms and these farms all had annual revenues over $500 000 (AAFC 2015).

focus on environmental quality, food safety, and local food supply further suggest that changes in agricultural policy may be desirable from a domestic perspective. Well-managed farms can provide not only food and fibre goods, but also services, such as water and air cleansing, carbon storage, and improved wildlife habitat. Farmland preservation and the provision of these ecosystem services become especially important near urban areas where farmland is more visible to the general public. Such societal benefits tend to be under-provided because there is no functioning market, and government intervention can address the market failure.

While publicly funded research and development resources may be directed to environmental stewardship, only four specific programs oriented toward environmental protection of agricultural land resulted in program payments to farmers and are reported in the OECD list of Canadian agricultural support. Until 2003, the only active program was *Wildlife Crop Damage Compensation*, which paid farmers for damage to crops from big game and birds.[9] Average payments amounted to $5.45 million per year from 1986–2010 (0.02% of total farm income). Wildlife damage compensation programs are cost-shared with the federal government, administered at the provincial level, and qualification does not require participation in crop insurance programs. *Greencover Canada* was a five-year (2003–2007), $110 million program that focused on converting sensitive land to permanent grassland cover, planting shelterbelts, and protecting water quality. The *Cover Crop Protection Program* (2005–2010) provided $90 million to assist farmers in planting cover crops on flooded cropland, aiming to prevent further soil erosion. The *National Farm Stewardship Program* invested almost $200 million (2004–2008) to help farmers adopt beneficial management practices to protect the environment. Total payments for all these environmental programs from 2003–2010 amounted to $392 million, 0.13% of farm income and 1.32% of total program payments to agriculture in Canada (OECD 2015).

Because natural resources fall under provincial jurisdiction, most environmental policy is the responsibility of the provinces. However, the federal government takes a role when issues cross provincial and national borders, and the *Growing Forward 2* policy framework also provides substantial support for provincially administered programs. Provincial oversight covers both regulations and price interventions (taxes and subsidies), with financial support in agriculture covering a broad variety of concerns across different provinces. Ontario initiated environmental farm plans (EFP) in 1993 (Robinson 2006), and these programs were formally launched in 1995 with support from AAFC's *Green Plan*. These EFPs form the basis for a number of federal–provincial *Farm Stewardship Programs*. The funding basis for these programs is to cost share with individual producers and local conservation associations to implement a wide variety of beneficial management practices (BMPs). The BMPs cover (*inter alia*) soil and water management, nutrient management, watershed management, livestock waste management, climate change mitigation, and other ecological goods and services. Municipal programs in Manitoba, Ontario, Alberta, and Saskatchewan include Alternative Land Use Services (ALUS), a land conservation program that makes payments for the development and maintenance of habitat and provides financial support for environmentally beneficial farming practices.

Evolution over time

When Canada signed the World Trade Organization (WTO) Agreement on Agriculture in 1994 it agreed to limit domestic support. These reductions were based on very high levels of baseline support[10] so the reduction commitments were never binding for Canada. Annex 2 of the Agreement on Agriculture established criteria for domestic support programs that would not be subject to reduction commitments. AIDA and CFIP followed paragraph 7 of Annex 2 and were not subject to reduction commitments. NISA, CAIS, and *AgriStability* did not meet the criteria of paragraph 7, but because the expenditure on these programs was less than Canada's WTO commitment, the programs were not effectively disciplined by the Agreement on Agriculture. However, outside observers have questioned whether these policies are efficient and achieve their stated goals. OECD economists recently analyzed Canadian agricultural policy and concluded that the large number of risk management options lead to crowding out of private risk management and a lack of real incentives for farmers to take much responsibility for management (Antón et al. 2011). As a result, there is over-reliance on government assistance.

Freshwater and Hedley (2005) describe five drivers of the evolution of Canadian agricultural stabilization policy: (*i*) growing influence of the provinces, (*ii*) changing structure of agriculture, (*iii*) influence of the United States and its pursuit of countervail actions against Canadian programs, (*iv*) the trend to decouple production decisions from support programs, and (*v*) the desire by central budget agencies for stable funding demands. These five factors explain the direction of recent Canadian agricultural policy and point to future changes in policy.

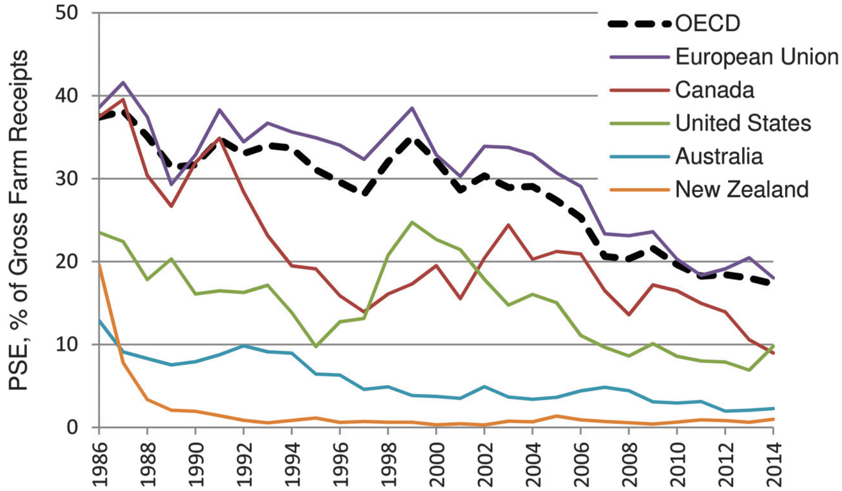
BRM programs have been especially important in provinces that are highly dependent on agriculture. In recent years 61% of all program payments and insurance proceeds have been directed to the three prairie provinces, which produced 50% of all farm sales (2001–2011 average, Statistics Canada 2013). As well, differences between commodities remain. Based on recent data, grain and oilseed farms produce 33% of Canadian farm gate sales and receive 49% of all program payments and insurance proceeds (2001–2011 average). Beef farmers and ranchers receive 22% of total payments and produce 19% of farm gate sales. Farmers of other products may experience less need for assistance because they face less risk, are managing risk on their own, decide not to participate in programs, or the products they raise are less eligible for assistance.

In addition to the changes in types of government support (i.e., moving from price support for limited numbers of commodities to whole-farm income risk management), the value of government payments to Canadian farmers has decreased over time. The OECD PSE decreased from an average of 35.7% in 1986–1988, to a low of 13.9% in 1997, with a slight upswing in the early 2000s. On the other hand, government funding directed to agricultural research and development, and food and crop inspection, infrastructure, and marketing has remained relatively stable over the same time period, amounting to between 5% and 10% of total farm income, with annual average expenditures of $2.5 billion from 2007–2012. This general support is not included in PSEs, because it does not directly affect farm income.

[9]These compensation programs were originally instituted to provide recompense to landowners who maintain wildlife habitat on their farms — wetlands in particular. Because such habitat areas either attract wildlife or enhance their reproduction, and hence local population size, this can lead to crop depredation. With the expectation that compensation for wildlife damage would help allay incentives to restrict wetland areas, such compensation programs can have significant environmental impacts.

[10]The Uruguay Round WTO Agreement on Agriculture established reduction commitments to reduce domestic support. Each member's current expenditures are to be compared with average support payments between 1986 and 1988, notified to the WTO, and subsequently reduced if they exceed 20% of this average support.

Fig. 3. PSEs for the OECD and selected member countries over time, 1986–2014. Source: OECD (2015).



Comparison with other countries

With 34 member countries and close relationships with six others, the OECD brings together government leaders who account for 80% of global trade and investment. The OECD works to develop country-specific information and provides a forum for policy discussion. It is very influential in many worldwide policy-setting processes, so its recommendations can have wide-reaching implications for production and land management. With this in mind, and because the statistical resources of the OECD are substantial, OECD data are superior for examining the status and impacts of agricultural policy for Canada, especially in comparing Canada with other countries.

For most OECD members the proportion of farm income coming from government support has decreased over the past 25 years. Figure 3 shows PSEs for Canada and a number of major competitors. Although Canadian PSEs fell throughout the first decade, they have roughly stabilized in the 15% range since that time. In contrast the EU has continually liberalized so that the 2010–2014 average PSE as a percentage of gross farm gate receipts is 19% versus 13% for Canada. Over the same period the percentage PSEs are considerably lower in the US (8%), Australia (2%), and New Zealand (1%). Reform of support to agriculture has been particularly dramatic in New Zealand and Australia. What little support remains is for disaster relief and income smoothing through the taxation and social security systems.

Part of the drive to reduce agricultural support is a result of the recognition that improved farm household income reduces the need for government transfers. For example, US farm income in the 1930s was one-third of that of the rest of the population (Mercier 2011), whereas in 2008 US farm household income was greater than that of the average household. Similar trends are noted in Canada.

The structure of government support in Europe, the US, and Canada has moved away from commodity-specific payments to less distortionary approaches. Coupled commodity-specific programs have been reduced and, to a limited extent, risk management programs have been introduced (i.e., revenue insurance in the US and insurance and mutual fund programs in the EU). Risk-reduction policies now account for a significant share of PSEs in OECD countries. Relief from natural disasters (e.g., drought) may still be needed, because systemic risks and potential for significant losses make it difficult for private insurance companies to cover multiple peril risks. Although Canada and developed countries continue to provide financial support for crop insurance and whole-farm income insurance, some analysts believe that market solutions better attenuate risks without reducing incentives to diversify and crowding out private risk management strategies. Canada is unique in that a large proportion of support payments are based on overall farm income, rather than on output or area planted (Dewbre and Short 2002).

Over time, a larger proportion of resources have been directed toward environmental concerns and the associated long-term risks. For example, for 2003–2010, total government agricultural payments for environmental incentives in the US and EU amounted to 1.3% and 1.6% of all farm income. This is significantly more than the 0.13% of farm income value invested in similar incentives in Canada (OECD 2015). Agri-environmental programs in the US are dominated by the Conservation Reserve (CRP), Wetland Reserve (WRP), and Environmental Quality Incentives (EQIP) Programs. These programs aim to reduce negative externalities including soil erosion and nutrient leaching into ground- and surface-water. The EU, on the other hand, directs agri-environmental funding to address a wider range of externalities, including public financial support for providing attractive agricultural landscapes (Baylis et al. 2008). This is consistent with the shift of European farm programs from production agriculture to rural development as well as environmental or other issues of consumer importance (Rude 2008). By paying for environmental services rather than agricultural product, agri-environmental programs provide income to farmers, but still need to be designed carefully to minimize production effects and related distortion to trade markets.

In addition to the programs that specifically target environmental goals, European farmers must meet minimum environmental standards to qualify for commodity programs or other farm payments (Baylis et al. 2008; Heinz 2008). Cross-compliance was introduced in the EU Common Agricultural Policy (CAP) in 2000, and made compulsory in 2003 reforms that answered a lobby of public interest in sustainable farming practices, food safety, food quality, and animal welfare (Rude 2008). Similarly, 90% of farmers in Switzerland are covered under cross-compliance rules that tie agricultural support payments to the maintenance of 7% of farm land for an "ecological compensation area". Other measures address maintenance of appropriate nutrient balance, soil protection, crop rotation, and specific animal welfare practices (Legg and Diakosavvas 2010). While cross-compliance linkages may generate action above that required by regulation, and attach monetary value to ecosystem services, the difficulty remains in achieving complex landscape goals through the use of these land management rules (Brady et al. 2012).

There have been calls for similar measures to be integrated into farm programs in Canada and the US. A more limited form of cross-compliance in the US requires the use of practices designed to control soil erosion and protect wetlands to qualify for federal, agriculture-related payments. This applied to 40% of farms (with 85% of farm are) as of 2004 (Legg and Diakosavvas 2010). Other environmental conservation practices have not been included. In Canada, *AgriStability* and crop insurance programs are not tied to any conservation initiatives (Cortus et al. 2009), and Canadian experience with cross-compliance is limited overall. The federal–provincial policy framework Growing Forward 2 introduced the possibility of cross-compliance conditions for the support program *AgriInvest*. Individual provinces or territories "may require participants to comply with certain criteria before they are eligible to receive government contributions under AgriInvest" (AAFC 2014). To date no such conditions have been applied to *AgriInvest*.

In 2004, Quebec instituted policies "implementing cross-compliance measures linking the payment of government assistance with respect for environmental standards" (Gouvernement de Québec 2014). As of 2014, Quebec policy requires livestock farmers to submit a phosphorous compliance report to be eligible for the *Farm Income Stabilization Insurance* program ASRA and for crop insurance. The other form of cross-compliance currently in place relates to the *Farm Stewardship Program*. Applicable in all provinces, this program provides funding to assist in implementing certain beneficial management practices and requires producers to complete an *Environmental Farm Plan* (EFP) (Robinson 2006).[11] In general, however, Canadian environmental standards tend to be regulated, rather than encouraged through payment programs (Jongeneel 2007). The few experimental and pilot-scale markets for ecosystem services have no relationship with BRM programs.

Environmental implications of agricultural policy

Drawing on empirical comparisons across countries, Anderson (1992) argued that the liberalization of developed-country agricultural policy would reduce production levels and thereby reduce global environmental damage and chemical residues. Indeed, farming intensity and input use decreased in the short term after New Zealand removed subsidies in 1984, but direct farmer investment in soil conservation also declined as a result of new income constraints (Bradshaw and Smit 1997). Acknowledging that agricultural price support policy is linked to agricultural pollution, Just and Antle (1990) presented a model framework to examine the interaction. They concluded that generalizations are difficult to make because of the complex nature of yield response to inputs, environmental response to production, and farm economic response to varied policy drivers. With the relationship between damage and input use highly dependent on local conditions, the interactions between agriculture support and environmental outcomes continue to be a challenge for both global-level models (Lewandrowski et al. 1997) and farm-level models (Brady et al. 2012). The rationale for BRM programs is of course to address risk, but Pannell (2003) emphasizes the importance of uncertainty as a driver in the adoption of environmental management practices. Therefore the next section explores the implications of risk for on-farm decisions, and how farmers respond to risk. Following that, we present evidence from the literature on both direct and indirect environmental impacts resulting from BRM programs.

Risk and on-farm decisions

Risk is a natural part of agricultural production and adds to the cost of production. This additional cost can be conceptualized as a risk premium that is a function of the producer's risk aversion, the degree of risk, and the base value of production. Anything that reduces the risk premium reduces the cost of production and induces production. In the absence of a full set of contingency markets to mitigate risk, economic efficiency is reduced by the extra costs. Government intervention can be used as a second best solution to help offset the loss in efficiency, but these interventions can produce unintended consequences. Government programs truncate the distribution of outcomes, reducing risk and affecting production decisions. The biggest problem with the provision of insurance is an information problem, known as moral hazard, which leads to engagement in riskier behaviour, simply because the insured will not fully bear the negative consequences of their actions (Hennessy 1998; McLeman and Smit 2006).

Government direct income transfers do not affect the variance of income but can affect producer behaviour through the risk premium. Decoupled income transfers (i.e., support for farmers not linked to prices and production) can make producers less risk averse, lowering the risk premium and as a result reducing the marginal cost of production. Koundouri et al. (2009) found this to be the case in Finland, when EU area payments increased in the mid-1990s, and farmers became significantly less concerned about risk. These effects can induce more production or increase the willingness to use riskier inputs or practices (Hennessy 1998; Rude 2008). The availability of subsidized insurance may also encourage farmers to take more risk in other aspects of their business operations, such as investments in additional land, new equipment, or other improvements that involve taking on more risk (Rude 2008). Gabriel and Baker (1980) and Uzea et al. (2014) showed that farmers make financial adjustments leading to increased financial risks in response to lower business risks that result from stabilization. Lower risks and increased expected returns also lead to increased leverage, resulting in more debt.

Government risk management programs also affect the adoption of other forms of risk management and could inhibit the adoption of market-based tools like insurance (Elbehri and Sarris 2009). Therefore, the government programs may crowd out other options that could be available on the farm or within the market, resulting in what some would call an unnecessary use of public funds. For example—because crop diversification has been used by many farmers as a risk management tool—risk reduction, through government programs, can result in less incentive to diversify crops. In such cases, the positive environmental benefits associated with crop diversification are also foregone.

The interaction between environmental practices, risk, production decisions, and government programs is complex. Agricultural production and environmental emissions are both stochastic processes. With respect to the environment the uncertainty can be due to randomness and unobserved or unmeasured heterogeneity of the production process. Increased agricultural production is typically viewed as using more inputs, which can have negative environmental externalities. However, environmental effects frequently exhibit thresholds, that is, concentrations of pollutants at or below which there are no environmental effects because of natural degradation and (or) detoxification processes. Increases in certain agricultural inputs or adoption of specific practices can be either risk-enhancing or risk-reducing or possibly have both effects separated by a threshold, resulting in differing environmental impacts. For example, while crop diversification, which some associate with environmental benefits, is risk-reducing, organic rotations tend to be slightly more risky (Smith et al. 2004).[12] Crop yield and economic returns are more variable for organic agricultural systems than conventional ones, although longer rotation

[11]For example, see http://www.agriculture.gov.sk.ca/FSP-Environmental-Farm-Plans.

[12]While there are indications that organic agriculture contributes positively to agro-biodiversity and natural biodiversity, the jury is still out on the overall environmental benefits. For example, impacts on nitrate and phosphorous leaching and greenhouse gas emissions are mixed (Mondelaers, Aertsens and Van Huylenbroeck 2009).

length can reduce this variability (Cavigelli et al. 2009). Furthermore, government programs can be too far removed from farm-level decisions and choices with respect to the choice of sustainable policies and have detrimental impacts on the environment. In practice, policies that are targeted at the externality would likely be most effective.

An example: nitrogen fertilizer and risk

Most studies on the topic have determined that nitrogen fertilizer is a risk-increasing input for crop production (Babcock 1992; Rajsic et al. 2009; Paulson and Babcock 2010). That is, higher application rates of nitrogen fertilizer produce greater yield variability, and more variability in profits. Given this, a risk-averse farmer would apply less fertilizer than one who is less concerned about risk (Paulson and Babcock 2010). In this situation government programs (insurance or other stabilization programs) could increase the total amount of nitrogen applied, with unintended environmental consequences (Rajsic et al. 2009).

However, the mechanism may not be clear-cut. In fact, typical practice suggests that fertilizer is risk-reducing: farmers could use fertilizer as “insurance” and thus apply nitrogen fertilizer at rates above the economic optimum (Babcock 1992; Millar et al. 2010). To explain this contradiction, Archer et al. (2002) determined that although risk — in terms of standard deviation of total returns — increased with nitrogen application, average net returns were also substantially higher, potentially offsetting the increase in risk. Therefore, even if risk may be higher with a certain activity, it does not necessarily mean that the activity is less desirable.

The contrasting results may also be due to the fact that risk has various components that may generate different responses. Output price uncertainty may reduce input use (for a risk-averse producer), but production uncertainty may make the same producer increase input use (Isik 2002). Therefore the combination of different sources of risk and stabilization policies can produce different environmental impacts depending on the intensity of input use, the source of the risk, and the producer’s reaction to the government program.

Direct evidence of environmental impact

Simulation and econometric models of landowner decisions have been used to study the environmental impacts of government payments. Wetland conservation (versus drainage), especially in the prairie pothole region has been subject to significant discussion. In an attempt to facilitate the settlement of the west, early government programs in Canada and the US provided direct support for wetland drainage and the conversion of natural land to agricultural production. Even when these programs were discontinued, support via other program payments, insurance, and stabilization continued to encourage higher levels of Canadian cultivated land (and associated wetland drainage) than would have been the case in the absence of government support (van Kooten 1993). Changes to BRM programs over time have not completely erased these impacts. In a study looking at on-farm decision-making, Cortus et al. (2009) modeled wetland drainage in a multi-year east-central Saskatchewan grains and oilseed cropping system. With crop insurance and CAIS subsidies, the area of wetland drained increased by 8%–9% relative to the scenario with no programs.

In the prairie pothole region of the United States, results from similar models tested various scenarios, including price and income supports, and found that all farms performed better economically when draining wetlands (US Department of the Interior 1988). However, in this case, it was difficult to determine whether the programs actually spurred more drainage than would have occurred without them. With a more broad-based empirical model of land-use change in the 48 contiguous states, Lubowski et al. (2006) estimated that 20% of net wetland loss in the US from 1992 to 1997 was related to increases in crop insurance subsidies. In 1997 alone, the total cropland area was 0.8% greater (2.5 million acres) as a result of the increased subsidies. Therefore, marginal land, including wetland, was converted to agriculture, even though the Swampbuster[13] provision of the 1985 Farm Bill denied direct payments, marketing loans, and other federal farm support to landowners who drained protected wetlands (Heimlich et al. 1998). The way in which the Swampbuster rule was implemented did not, however, penalize farmers for planting perennial crops on drained wetlands, and only denied benefits in a specific year in which annual crops were planted (US Department of the Interior 1988). Furthermore, in a year with high prices, when a farmer could not anticipate government payments, there was no penalty for draining wetlands, especially if the former wetland could later be planted with perennial crops. In fact, there is evidence that concerns over more restrictive measures in the future prompted some farmers to convert sensitive land to non-program agricultural crops (thus avoiding the penalty), even if there was little economic incentive for the conversion at the time (Batie 1990).

Other models investigating relationships between environmental variables and public agricultural programs include Goodwin and Smith (2003) who used US county-level data to examine soil erosion patterns, agricultural production, fertilizer use, and crop insurance participation before and after the 1985 introduction of the CRP. While they found crop insurance to have minimal effect on soil erosion, other government payment programs were associated with higher levels of soil erosion and offset about half of the conservation benefit from the CRP. In contrast, Bradshaw and Smit (1997) found evidence for increased soil erosion and other land-use problems with subsidy removal in New Zealand. They concluded that investments in environmental conservation were less important than immediate income concerns.

Indirect evidence of environmental impact

Given the changes in agricultural risk management policy that have taken place since the 1990s, an important question to ask is whether the remaining programs still have distortionary effects on production. By modifying risk faced by farmers and increasing average income, BRM programs may alter the level and mix of production and farm inputs. These effects are reflected at the extensive margin (e.g., conversion of marginal or environmentally sensitive land) and at the intensive margin (i.e., changing the crop and input mix on existing land). Any alterations can then indirectly influence environmental outcomes. For example, wildlife habitat may be compromised when additional land is brought into production. Greater intensity of chemical fertilizers and pesticides used to increase production negatively affects water quality and other environmental parameters.

Regardless of production effects, other factors (e.g., farm size, tenancy, education level of operators, and proximity to urban areas) may also affect environmental stewardship. Some of these factors are important in the context of government agricultural support programs because they may garner differential treatment within the agricultural policy framework. For example, tenants are less likely to make capital improvements, and this effect could have either positive or negative environmental implications (e.g., establishing shelterbelts or draining wetlands). Therefore, the allocation of funds to landowner versus farm operator may be an important consideration in policy design. Also, farm size may affect participation in government support programs and the subsequent environmental impact.

[13]Swampbuster is a provision of the *Food Security Act* of 1985 (P.L. 99-198) that discourages the conversion of wetlands to cropland use.

Impacts on input use

Data on input use have been used to examine possible links between government support and the environment.[14] Lewandrowski et al. (1997) examined data from 22 countries and the EU from 1982 through 1987 and found fertilizer use was positively related to government support (as measured by PSE). However, total land use in high income countries was reduced with higher levels of support. The authors suggest that the effect on land use may have been related to supply controls. Similarly, Bradshaw and Smit (1997) found that the removal of subsidies in New Zealand reduced fertilizer inputs and Hennessy (1998) determined that removal of US farm target price programs would reduce nitrogen fertilizer use by 7%–10% for a mid-western corn farm. Other studies of US crop insurance participation and premium subsidies found both positive (Horowitz and Lichtenberg 1993; Wu 1999) and negative (Babcock and Hennessy 1996; Smith and Goodwin 1996) associations with fertilizer and chemical use. Horowitz and Lichtenberg (1993) observed higher rates of fertilizer and pesticide use on US mid-western corn farms that had greater program participation. It should be noted, however, that some of the earlier models focused on price support subsidies that have largely been replaced by decoupled program payments and revenue insurance.

Perhaps more closely applicable to current programs are the results from Mishra et al. (2005), who used an empirical model with data from 17 US states producing winter wheat. They determined that US wheat farmers who purchased revenue insurance reduced fertilizer use, but did not alter pesticide expenditures. Similarly, Koundouri et al. (2009) found that lower fertilizer nitrogen application rates were associated with higher levels of government support in Finnish cereal systems. Goodwin et al. (2004) also identified negative relationships between insurance subsidy level and fertilizer and chemical application rates for different grain crops in the mid-western US, and by contrast, at the extensive margin, they noted a positive correlation between crop acreage and crop insurance subsidy level. In these cases, the risk-reducing nature of the subsidy seems to make it less necessary for farmers to handle risk with additional purchased inputs, but also encourages cultivation of more risky marginal land. These increased cultivation rates at the extensive margin may be one reason that US farm households with crop insurance exhibit higher fuel consumption rates (Chang et al. 2011).

Canadian studies examining BRM programs have mainly investigated crop allocation effects. Turvey (2012) used a mathematical programming model to look at the production implications of whole-farm income insurance for a representative farm in Manitoba, finding significant changes in land allocation to different crop types. The level of subsidy associated with crop insurance played an especially significant role. Similarly, using a market-level simulation model, Rude and Ker (2013) examined the impact of *AgriStability* on farm inputs and crop allocation. They found that the program induced modest increases in crop production with roughly 2% more wheat, coarse grains, and oilseeds. *AgriStability* distorted input use by penalizing farmer-owned inputs (non-eligible inputs under the program) in favour of purchased inputs (eligible inputs under the program). This bias to purchased inputs may encourage increased use of fertilizers and chemicals, resulting in negative environmental consequences. Indeed, increased crop production was driven by a 7.7% increased usage of chemicals, energy, and fertilizer; while land use barely increased. Neither of these studies examined the impact on the extensive margin with respect to marginal land being brought into production.

While not directly related to BRM programs, the differential subsidization of production inputs can also affect input choices, with varying environmental effects. Nearly 5% of the 2013 OECD PSE for Canada consists of fuel tax refunds and rebates administered by individual provinces. The subsidization of these inputs may increase their use resulting in negative environmental impacts, although the proportional impact will depend on the elasticity of input demand. Tax exemptions or reductions for agricultural land could be seen as another indirect subsidy for agriculture, reducing the cost of land as an input. Studies of agricultural land zoning as an indirect subsidy in the Netherlands have demonstrated negative environmental consequences in that context (van Beers et al. 2007).

Overall production impacts

Agricultural income stabilization programs truncate the probability distribution of net income facing farmers, increasing the mean of the distribution, and thereby increasing the average total farm income over time and creating positive incentives for production (Rude 2008; Koundouri et al. 2009). Any farm policy that positively affects agricultural production will either lead to expansion onto more land area, which is often marginal, or result in greater intensity of production, which tends to involve greater fertilizer or pesticide use. Even so, the total production impact of current farm programs in Canada appears to be relatively small. Coyle et al. (2008) demonstrate that the production effects of CAIS (a predecessor to *AgriStability*) for Manitoba farms would be less than 5%. The mix of outputs may also be affected by increasing the expected unit return and reducing risk.

In the past, commodity price supports and market price support of agriculture raised production levels of the targeted commodities. This additional production necessitated more cultivated area. Miranda et al. (1994) found that the Canadian *Western Grains Stabilization Program* (1975–1990) increased total cropped area by an average of 4.1% over the level without the program. The authors estimated that 58% of the effect was due to risk reduction, with the rest attributable to general increased revenue. Schoney (1995) reviewed studies that investigated the production effects of risk management, and found that in all cases production was either increased or not affected. Schoney suggested that the increased production that accompanies risk management may increase total profits. These excess profits are often capitalized into land values, which may be beneficial for current farmers, but contribute to difficulties experienced by potential farmers looking to enter the industry.

Decoupled payments and whole-farm margin-based programs that replaced price supports are intended to have fewer trade implications, and have also generally reduced the impact on production decisions. While the evidence in Canada indicates little change in the impact of agricultural programs on production from the 1970s to the present (Miranda et al. 1994; Coyle et al. 2008), other countries have seen a somewhat greater response following the decoupling activities of the 1990s and 2000s. Models comparing policy regimes in Europe have found that, in general, the replacement of crop-specific compensatory payments with the area-based Single Farm Payment resulted in lower total farm production, although never by more than 10% (Rude 2008). This fits with the goals of decoupled programs, and suggests that the earlier programs in Europe may have been more production-distorting than any of their Canadian counterparts.

Synopsis of BRM environmental impacts

The public costs of agricultural support policy have been one of the key factors encouraging reform, with environmental implications playing a lesser role. The most significant farm payments in Canada originate from the Growing Forward suite of programs

[14]The problem is that these data are not as available in Canada as in other regions of the world.

(*AgriStability*, *AgriInsurance*, *AgriRecovery*, and *AgriInvest*), and generated combined program payments from federal and provincial government treasuries averaging $1505 million per year for 2007–2013 (OECD 2015). These payments are split between the federal and provincial governments with a 60/40 sharing formula. The federal budget for Growing Forward 2 is somewhat smaller at $3 billion for the 5 year program (AAFC 2014).

This current suite of BRM programs has varying incentives for agricultural production decisions and thus different spillover implications for the environment. *AgriStability* has relatively modest incentives to induce increased production (2%), but this increase is probably driven by 8% higher use of chemicals, energy, and fertilizers (Rude and Ker 2013), which can translate to negative environmental impacts. The question remains if earlier commodity-specific programs had greater environmental impacts than current whole-farm programs. In general, analysts expect that commodity-specific programs increase the effective producer price for individual crops inducing increased production by using more land, more fertilizer, and more pesticides. GRIP (1991–1995) was the last federal commodity-specific support program. Empirical evidence of the production impacts of GRIP is scarce; nonetheless a peer-reviewed study on an earlier program, WGSA, predicted a 4% increase in cropped area (Miranda et al. 1994). Although the WGSA pre-dated GRIP, it was more broadly based (i.e., a basket of seven crops), so it is reasonable to expect a larger increase in cropped area as a result of GRIP. Rude and Ker (2013) predict an approximate increase of 0.3% in grain cropped area as a result of *AgriStability*. So at least a 5% difference in seeded area may be expected as a result of movement from commodity-specific to whole-farm programs. This impact should be put into the context of Cortus et al. (2009), who found that crop insurance combined with CAIS decreased wetland areas on farms in Saskatchewan by 8%–9%.

Conceptually, *AgriInsurance* may have a bigger environmental impact than *AgriStability*. This view is partially based on the Cortus et al. (2009) findings, but also the more general notion that commodity-specific programs, including crop insurance, are more distorting. Furthermore, there is evidence that crop insurance results in wetland loss (Lubowski et al. 2006), increased nitrogen applications (Rajsic et al. 2009), and additional farming of marginal acreage (Gardner and Kramer 1986; Young et al. 2000). Of course, the size of these effects depends on size of the subsidized premium.

Of the Growing Forward programs, *AgriInvest* and *AgriRecovery* are least likely to induce production and have negative environmental spillovers. While *AgriInvest* may affect savings investment decisions it is unlikely to induce production increases or change resource use. *AgriRecovery* is a very low-slung safety net where payments cannot be anticipated, so it is also unlikely to affect production decisions or the environment.

Conclusion

The basis for providing government support to agriculture remains vague. Average farm family income is comparable to both non-farm rural and urban families, so the rationale for the objective of transferring income to agriculture is in doubt. Growing asset values put this objective even further in doubt. The notion that agriculture faces greater risks than the rest of the economy is also debatable, so this reason for government intervention can also be questioned. Canadian agriculture policies are designed to attempt to achieve several objectives with a single instrument (BRM), yet good policy design requires one policy instrument for each objective. Given this setting, the objective of this study was to assess the impact of BRM programs on the environment.

The natural conduit between BRM programs and the environment is through farm-level production decisions and input choices. The stochastic setting in which agricultural production takes place and environmental impacts occur blurs the path between production decisions and observable environmental impacts. These relationships may change with the intensity and level of agricultural production. One conclusion from this study is that the current suite of BRM programs is unlikely to induce significant additional agricultural production — which could be viewed positively in terms of environmental impact. On the other hand, while the BRM transfers resources from the public to the agricultural sector, these programs do not address key public environmental goals related to the agricultural sector.

Anderson (1992) argued that improvements in agricultural risk management policy should not be held captive by anticipated threats to environmental quality, as other policy instruments can effectively be used to address the environmental issues. "Again, the task involves solving the problem with the appropriately targeted policy instrument rather than the much blunter and less efficient instrument." (Anderson 1992, p. 169). It is therefore preferable to address the negative environmental externalities more directly. In this regard, the policy of tying current payments to cross-compliance conditions is a viable option that remains unexplored in the Canadian setting. Implementing cross-compliance has its challenges both in terms of requiring the program payments to be sufficiently large so as to cover compliance costs while still allowing the government to monitor the agent's actions. This is an issue of mechanism design and the approach is open to moral hazard (Hart and Latacz-Lohmann 2005). Alternatively, the resources could be redirected to different programs that pay farmers to provide desirable environmental benefits. But this approach is also open to regulatory capture and has to be closely monitored in order that the payments do not just become another venue to transfer income to agriculture. These are issues that await further research.

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