Farm Wealth Implications of Canadian Agricultural Business Risk Management Programs

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Abstract
This paper examines the effect of Canadian agricultural business risk management (BRM) programs on farm financial performance. Monte Carlo simulation is used to model stochastic prices and production for a representative Alberta cropping operation. Net present value (NPV) analysis is used to evaluate BRM program participation. Participation is modeled for AgriInvest, AgriStability, and AgriInsurance. Adoption of select BMPs is also modeled to examine the impact of BRM programs on incentives to adopt environmental stewardship practices. Results indicate that BRM program participation significantly improves farm financial performance with a corresponding reduction in risk. Much of the benefit from participation comes from subsidization associated with the programs. While recent changes to BRM programs result in reduced support, the impact on representative farm performance is small. BRM program participation reinforces incentives to adopt BMPs that already have positive net benefits (e.g., crop rotation BMPs) and increases the magnitude of disincentives (i.e., net costs) associated with adoption of land use BMPs such as wetland restoration or buffer strips. The results from this analysis raise questions related to both risk management and environmental policy in terms of policy effectiveness, efficiency and compatibility.
Introduction

Agricultural producers face various types of risk, including price, production, and policy risk. The aggregate effect of risks encountered in agricultural production is “business risk” (Hardaker et al. 2004, p. 7). Historically, Canadian governments have intervened to assist producers in coping with business risk through public business risk management (BRM) programs. Over time, the nature of intervention and support has shifted from price and margin based programs to whole farm programs. This shift is attributable to national and international trade developments and agreements (Hardaker et al. 2004, p. ix; Rude and Ker 2011). Support payments provide a “safety net” for producers, but are often scrutinized for inefficient allocation of resources. These programs aim to reduce risk in agricultural production by providing subsidization of income in years when low returns are observed.

A recent trend in Canadian public BRM policy is reduced support. In particular, the most recent federal-provincial agricultural policy framework (Growing Forward 2) includes changes to BRM programs that will result in reduced support. These changes have implications for farm performance/viability. The objective of this paper is to determine the effect of agricultural policy programs on income level and stability and evaluate the impact of changes in public BRM programs on economic performance for a representative Alberta cropping farming operation. As well, the implications of participation in BRM programs (and associated changes in those programs) for effectiveness of agri-environmental policy instruments are investigated by examining incentives to adopt selected environmental stewardship practices.

Risk and Risk Management in Canadian Agriculture

Given the magnitude of risk in agriculture and the implications for farm performance and viability, risk management is an important consideration for many producers. There are many potential “market” risk management tools available to agricultural producers, including diversification and hedging instruments, for example. However, there are problems or limitations associated with many of these tools. For example, agricultural insurance markets are problematic due to factors such as systemic risk (Miranda and Glauber 1997). Systemic risk also limits the effectiveness of diversification as a risk management tool for producers.
Diversification also restricts the ability of producers to exploit economies of size, resulting in increased costs. Basis risk, transaction costs, etc., may discourage agricultural producers from using hedging tools such as futures and options contracts (Pannell et al. 2008).

As a result of these factors, governments frequently intervene to provide publicly funded agricultural risk management programs. For example, in many countries crop insurance is either directly provided by governments or there is subsidization of producer premiums (Mahul and Stutley 2010). Developed countries provide income support programs for domestic agricultural producers, either permanent or ad hoc (e.g., OECD 2010), and in many cases these are explicitly designed to address the inherent riskiness of agricultural production.

Governments in Canada, both federal and provincial, have a long history of intervention in the agricultural sector. One objective of this intervention has been to stabilize and support farm incomes. Low income was recognized as a problem in Canadian agriculture in the late 1960s by the Federal Task Force on Agriculture. The task force also listed price and income stability as important economic goals of relevance to rural Canada (Federal Task Force on Agriculture, 1969) and provided suggestions for support and stabilization policy instruments in its recommendations. Even by then, however, cost-shared crop insurance was a well-established risk management instrument used by Canada agricultural producers. Supply management was also introduced in the 1970s for some commodities (e.g., dairy and poultry), which contributed to price stability.

Over the last several decades, alternative government/public policies and programs have been implemented with the goal of stabilizing and/or supporting prices or income. The focus of these programs has changed over time from commodity-based programs such as the Western Grains Stabilization Program (WGSP), crop insurance and tri-partite stabilization, to whole-farm programs such as the Net Income Stabilization Account (NISA) and Canadian Agricultural Income Stabilization (CAIS) programs. As well, programs have changed from stressing price and revenue support (e.g., Gross Revenue Insurance Program) to focusing on income stabilization. Finally, federal, provincial and territorial governments have moved away from ad hoc assistance programs (e.g., Special Canadian Grains Program, Crop Drought Assistance Program) and instead negotiated comprehensive multi-year agricultural policy
agreements (e.g., Agricultural Policy Framework, Growing Forward) that include ongoing stabilization/support instruments. Again, NISA and CAIS are examples of these types of systematic programs. Freshwater and Hedley (2005) provide a summary of the issues surrounding the evolution of Canadian government policy as it relates to support for agricultural income.

**Canadian Business Risk Management Programs – Growing Forward (GF)**

In 2008, Canadian federal and provincial/territorial governments implemented the Growing Forward (GF) agricultural policy agreement. This five year agreement was comprehensive in nature, with a set of policies and programs to address areas such as competitiveness, innovation, environment, and BRM. With respect to BRM, the target for GF was to create an improved set of public programs to assist agricultural producers in managing risk. To that end, four programs were initiated; Agrilnurance, AgriStability, AgriInvest and AgriRecovery.

Agrilnurance is a federal/provincial program that provides protection by insuring producers against economic losses from “natural hazards” associated with production. For example, in Alberta the program insures against drought, excessive moisture, fire caused by lightning, flood, frost, hail, insect infestations, snow, wind, damage from wildlife/waterfowl and any other perils as designated by Agriculture Financial Services Corporation (AFSC) (AFSC 2013). Production insurance is not new and has existed in the form of crop insurance for many years. Agrilnurance is cost-shared between the federal and provincial governments, and producers. The details of the program (e.g., coverage levels, pricing options, commodity coverage) vary by province and administration of the program is primarily done at the provincial level. In some provinces (e.g., Alberta, Ontario) Agrilnurance includes not only crop insurance but also livestock price insurance.

AgriStability is a program intended to provide protection against large decreases in farm income. Unlike Agrilnurance where individual commodity coverage is provided, AgriStability is a “whole farm” program. AgriStability evolved out of a previous program, the Canadian

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1 In the following discussion, the terms “province” and “provincial” should be interpreted to refer to Canadian provinces and territories.
Agricultural Income Stabilization (CAIS) program, which had been implemented as part of the previous Agricultural Policy Framework.² Participating producers are eligible for an AgriStability payout if their program margin (i.e., eligible revenue minus eligible expenses) falls below a reference margin. The program margin is similar in concept to the margin of revenue over variable costs or gross margin, on an accrual basis. The reference margin is a historical average of program margins. An Olympic five year average is used where the highest and lowest values over the five year period are dropped from the calculation, resulting in an average of the remaining three values.

In the version of AgriStability initiated in 2008 under GF, the payment received by producers depended on the degree to which the program margin fell short of the reference margin. Program margin deficits within 15% of the reference margin (i.e., between 85% and 100%) were not covered by the program. If the program margin decreased below 85% of the reference margin, the “coverage” increased with the degree of shortfall.³ Participating producers paid an annual administration fee of $55 plus a “premium” which was set at $3.83 per $1000 of reference margin.⁴

AgriInvest is a savings program intended for use in covering small decreases in farm income.⁵ Under GF, participating producers set up an AgriInvest account with a participating financial institution into which they could make annual contributions up to 1.5% of allowable net sales (ANS). Sales of most non-supply managed agricultural commodities were included in allowable net sales calculations. These contributions were matched by a government contribution. The AgriInvest account earned interest, similar to a savings account. Withdrawals could be made at any time. There was a maximum account balance limit, equal to 25% of a historical average of ANS.

The fourth program in the suite of GF BRM programs, AgriRecovery, is intended to provide disaster relief (AAFC, nd). Unlike the other three BRM programs, producers do not

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² The specifics of the CAIS program evolved over time, until it was replaced by AgriStability. For details about the principles and mechanics of CAIS, see AFSC (2003) or Agricorp (2007).
³ The specifics and mechanics of the AgriStability program are not addressed here. For detailed information about the original program initiated under the Growing Forward policy framework, see AFSC (nd). Further discussion about the mechanics of the program is provided in the methods section of this paper.
⁴ The actual wording of the premium calculation (AFSC, nd) was $4.50 per $1000 of RM, multiplied by 85%.
⁵ Program details are provided in the AgriInvest Program Handbook (AAFC 2010).
apply or register for AgriRecovery. Instead, federal and provincial governments jointly assess potential disaster situations to determine if financial assistance under AgriRecovery is warranted and, if so, what the nature of the assistance should be. AgriRecovery represents a formalization of ad hoc processes used in the past by governments in Canada to address disaster situations. During the first three years of GF, AgriRecovery funded 21 initiatives, most of which addressed weather (drought or excessive moisture) or disease disasters (AAFC, 2011a).

**Canadian Business Risk Management Programs – Growing Forward 2 (GF2)**

The GF agricultural policy framework expired on March 31, 2013. Starting in 2010, federal and provincial governments undertook consultations and meetings with the objective of developing a policy framework to succeed GF. The result is Growing Forward 2 (GF2). The objectives and scope of GF2 are similar to those for its predecessor; innovation, competitiveness and market development, and BRM. In terms of risk management, the GF2 principles note that the framework covers governance of cost-shared BRM programs (AAFC, 2011b). Within the policy directions for GF2, however, there are statements about enhancing industry capabilities to use market-based risk management tools (AAFC, 2011b).

In terms of the specific programs, the structure of AgrilInsurance is unchanged from the GF framework. AgriRecovery remains part of the BRM program suite, with refinements being planned in terms of parameters used to determine eligibility for and levels of assistance. The provisions of GF2 do involve significant changes to AgriStability and AgrilInvest, however.

There are three changes in the AgriStability program under the GF2 policy framework. First, the level of program margin necessary to trigger an AgriStability payout is changed from 85% of the reference margin to 70% (i.e., the degree of decline necessary is increased from 15% to 30%). Secondly, the calculations for AgriStability payouts are based on 70% coverage of the eligible decline regardless of the degree of decline. In the GF version of the AgriStability, the coverage level depended on the degree of decline (i.e., different “tiers” of coverage). Finally, the calculation for the reference margin used to determine eligibility for an AgriStability payout has changed under GF2. It is now the lesser of the historical average program margin (i.e., as

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6 The specifics regarding changes to AgriStability and AgrilInvest presented here are based on information from AAFC (2013b).
per the GF version of the program) and the historical average of allowable expenses. The three changes have different directional impacts (potentially) on the likelihood and amount of AgriStability payouts. However, it is probable that the increased requirement for decline in margin necessary to generate an AgriStability payment will result in reduced effectiveness of the program in terms of supporting and stabilizing farm incomes.

Under the GF2 policy framework, the rules governing producer and matching contributions in AgrilInvest have changed. The annual producer contribution limit is increased from 1.5% of ANS to 100% of ANS. However, only the first 1% (down from 1.5%) is matched by government contributions to the AgrilInvest account. Secondly, there is now a “hard” limit on annual matching government contributions of $15,000. Finally, the account balance limit is increased from 25% of historical (average) ANS to 400% of ANS. These changes provide greater flexibility for producers interested in setting aside funds for future withdrawals to address income shortfalls. However, they also result in reduced “support” from the program that is provided through government matching contributions.

**Methodology**

The analysis in this paper made use of representative farms and Monte Carlo simulation methods. A farm model was developed and solved using @Risk software (Palisade Corporation 2010). Agricultural production and prices were modeled as stochastic variables, and values were drawn from distributions based on historical data. These values were then used to simulate financial performance for the representative farm. This process was repeated iteratively to generate a distribution of outcomes; 1000 iterations were used in each simulation. The simulation was also dynamic in nature, as the representative farm was modeled over a multi-year time horizon. Further details about farm characteristics and development of other model parameters are provided in this section. As well, the alternative BRM scenarios modeled for the representative farm are defined and explained.

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7 The historical average of allowable expenses is calculated using expenses from the same three years used for the five year Olympic average program margin calculation (i.e., the GF reference margin).
Representative Farm Characteristics

A representative Alberta cropping farm was defined for use in this analysis. Alberta is a large province with diverse agricultural regions. These regions may be defined in terms of climate, vegetation and/or soils (e.g., AAFC 2011; AARD 2009). If considering soil zones, cropping activities are most prevalent in black and dark brown soils. For the purposes of the current study, the representative farm was located in the dark brown soil region. Further, within this soil region the farm was located in Starland County. This location was chosen based on an evaluation of cropping intensity for municipalities within the dark brown soil zone in Alberta; 70% of arable land in Starland County was in crop production or summerfallow.

Choosing a farm size based solely on available statistics (e.g., Census of Agriculture) was problematic, as these data included non-commercial operations. Based on Census of Agriculture statistics and expert opinion, a farm size of 1295 ha (3200 acres or 20 quarter sections) was chosen. This was representative of a larger commercial cropping operation in the region. Starland County is located within the Prairie Pothole Region (PPR) which is a region characterized by wetlands. While much of the wetland area has been drained, it was assumed that wetlands were still present on the representative farm. Four percent of the arable land area was assumed to be covered by wetlands, which affected land area available for crop production.

Based on available Census data (Statistics Canada 2006), the four most common uses of crop land in Starland County are spring wheat, barley, canola and summerfallow. According to the 2006 Census of Agriculture (Statistics Canada 2006), area allocated in Starland County to spring wheat, barley, canola and summerfallow was 72964 ha, 30011 ha, 28277 ha and 19546 ha, respectively. As a result, these land uses formed the basis for the representative farm’s crop rotation; a four year rotation of spring wheat-canola-barley-summerfallow was used. This rotation was chosen based on available information and expert opinion to be consistent with agronomic practices in the region.

The actual crop rotation modeled in the simulation analysis was flexible in that crop substitutions into the basic rotation could be made in each year. A substitute crop was chosen for each base crop, based on agronomic compatibility in the rotation. The alternatives were
durum wheat (for spring wheat), flax (for canola) and oats (for barley). For both base and substitute crops, expected returns were calculated in each year of the simulation. If a) the substitute crop was not grown in the previous year of the simulation, and b) the expected returns for the substitute crop were greater than those for the base rotation crop, then half of the area intended for the base crop was reallocated to the substitute crop.

Area allocated to summerfallow in the simulation analysis was also flexible. Summerfallow has been decreasing in use in the Canadian Prairie Provinces, although it is still common in brown and dark brown soil zones. Based on expert opinion, it was decided that summerfallow area on the representative farm should be influenced by moisture conditions. Therefore, the actual area of summerfallow on a year to year basis varied from the full allocation (i.e., one-quarter of available cropland) in dry years down to zero in wet years where there had been summerfallow present in immediately previous years. “Wet” and “dry” years were identified based on the level of yields drawn from the estimated distributions (discussed below).

**Stochastic Production**

Representative farm crop yields for cereals/oilseeds were modeled as stochastic variables. In particular, county-level historical crop insurance yield data from 1978 to 2011 were obtained from Agriculture Financial Services Corporation (AFSC). The historical yields were fitted to a “best” distribution based on a Kolmogorov-Smirnov (K-S) goodness-of-fit test. Distributions defined for or capable of being truncated to non-zero values (e.g., Exponential, Gamma, LogNormal, Triangular, Weibull) were tested for fit. Based on this analysis, Weibull distributions were chosen for use in modeling stochastic crop yields.

Since available crop yield data were at the county level, the resulting variability estimates were lower than would be expected at the farm level (Marra and Schurle 1994). An

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8 Expected returns were determined using the historical average yield from the simulation and an expected crop price, calculated using the deterministic portion of the correlated time series price model (discussed below).
9 The “Fit Distributions” option in @Risk (Palisade Corporation 2010) was used to fit the yield data to alternative distributions and calculate the K-S test statistics.
10 The Weibull was the best fitting distribution for all of the base and substitute crops except flax, for which it was the second best fitting distribution.
adjustment based on Marra and Schurle’s (1994) discussion was used to “correct” the variability in the yield distributions upward. Stochastic yields in the simulation analysis were correlated using sample field level yield correlation coefficients obtained from Alberta Agriculture and Rural Development (AARD). Table 1 provides a summary of crop yield parameters used in the model.

**Stochastic Prices**

Crop prices were also modeled as stochastic variables in the simulation analysis. Historical provincial prices from 1984-2010 for base and substitute crops were collected from AARD or the Canadian Wheat Board (CWB), and converted to 2010 Canadian dollar values using Statistics Canada Consumer Price Index (CPI). The price data were tested for stationarity using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, with the null hypothesis being that the data are stationary. All prices for the crops in the representative farm rotation were determined to follow a stationary process.

Time series price models were then estimated. The number of lags for each crop price was determined using the Akaike Information Criterion (AIC). Individual equations within the system of price equations take the following form:

\[
P_t^j = \beta_0^j + \sum_{i=1}^{n} \beta_i^j P_{t-i}^j + \varepsilon_t^j
\]

where \(P_t^j\) is the current price for crop \(j\), \(P_{t-i}^j\) is the lagged \((i\) times\) price, \(\varepsilon\) is the error term, and the \(\beta\)s are parameters to be estimated. A system of crop price equations was estimated using SUR methods. Parameter estimates for this price equation system are provided in Table 2.

Random error draws and price equation error correlations were used, along with the time series model parameter estimates, to calculate annual crop prices for the simulation analysis. The deterministic portion of the pricing equations was used to calculate expected crop prices each year, for purposes of flex crop choices (discussed earlier) and for determining AgriInsurance coverage levels (noted below).
Economic Relationships and Performance Measures

An annual modified net cash flow (MNCF) measure was calculated within the simulation analysis. MNCF was defined as the sum of farm revenues minus the sum of variable expenses and annual machinery depreciation expense, plus or minus any cash flows associated with BRM programs. Revenue included returns from crop sales. Variable expenses included those expenditures related to inputs used in crop production and were calculated using budget information from AARD. Costs included were seed, fertilizer, chemicals and machinery (i.e., repairs, fuel and lube). Machinery depreciation expense was calculated as the annualized cost of maintaining the farm machinery complement at the initial book value. As such, it represented a proxy for machinery replacement expenditures and was included as a cash outflow. BRM program cash flows included AgriInsurance premiums and payments, AgriStability payments and fees and contributions to or withdrawals from the producer’s AgriInvest account.

Net Present Value (NPV) was calculated and used as a proxy for wealth. Changes in NPV were used as the basis for establishing the impact of BRM program participation on farm performance. In general, NPV is equal to the present value of future net cash flows, summed over the relevant time horizon, minus any initial investment. Since the farm was considered as an ongoing business, there was no initial investment expenditure.

NPVs were calculated assuming an infinite time horizon; that is, NPV in perpetuity. The MNCF in the last year of the simulation was treated as a perpetual annuity and the present value of this perpetual annuity was added to the NPV to obtain the NPV in perpetuity for each scenario. The resulting NPV formula used in the analysis was as follows:

\[
NPV = \sum_{t=1}^{T} MNCF_t (1 + r)^{-t} + \left( \frac{MNCF_T}{r} \right) (1 + r)^{-T}
\]  

(2)

where MNCF\(_t\) is the modified net cash flow for year \(t\), \(T\) is the time horizon (set at 40 years) and \(r\) is the discount rate, set at 10%.

\[11\] Debt servicing cash flows were not included in these calculations. This was done to avoid having capital structure decisions influence the model results. The analyses were all done on a before-tax basis.
In order to provide results on an annual basis (i.e., impact of program participation on annual performance), the NPVs were converted to annuities. Since the simulation NPV was “in perpetuity”, the perpetual annuity formula was used for this purpose:

\[ A = PV \times r \]  

where PV is the present value of the annuity, represented by the expected NPV in this case, \( r \) is the discount rate and \( A \) is the annuity or annualized NPV.

**BRM Programs**

The general structure of GF and GF2 BRM programs was outlined earlier in the paper. In this section, the details of how these programs were modeled in the simulation analysis are presented. The AgriInsurance program was not affected by the GF2 policy framework and so only one version of that program is discussed and modeled. For AgriStability and AgriInvest, modeling details for both GF and GF2 versions are provided.

**AgriInsurance**

AgriInsurance provides yield and price guarantees for coverage of crop yield losses. In the simulation analysis, 70% coverage was assumed to be chosen by the producer; that is, if the simulated yield for a particular crop in a particular year was below 70% of the individual normal yield, an insurance payment was generated.\(^{12}\) If a payment was triggered, it was calculated based on the spring insurance price (SIP), fall market price, risk area average yields, and actual yields.

For each crop, the basic level of insurance coverage is equal to the insured yield multiplied by the SIP. The insured yield was based on actual historical yields for the farm and “normal” yields in the crop insurance risk area along with the coverage level chosen by the producer. Individual normal yields were calculated as a blend of historical simulated yields for the producer for up to eight years, with the calculation being “cushioned” by removing the high and low yield values. The spring insurance price (SIP) is the expected or predicted fall market price for each crop and is based on market forecasts (AFSC 2013). In the simulation analysis, the

\(^{12}\) The coverage level options available within AgriInsurance in Alberta are 50, 60, 70, or 80% of the individual normal yield (AFSC 2013).
expected fall price for each crop was calculated using the deterministic portion of the time series price equation; that is, the SIP was a weighted average of lagged prices. If a crop insurance payment occurred, it was equal to the difference between the insured yield level and actual yield, multiplied by the SIP.

A variable price benefit (VPB) is also provided by AFSC. The VPB provides additional compensation to producers in the event that there is a yield shortfall (i.e., a crop insurance payment is generated) and it turns out that the actual fall price of the insured crop is at least 10% above the SIP (AFSC 2013). The VPB was calculated by multiplying the yield shortfall by the difference between the fall price and the spring insurance price, to a maximum of 50% increase (i.e., the benefit is capped at 50%). The VPB was incorporated in the simulation analysis by using the difference between the simulated crop price and the SIP.\(^{13}\)

AgriInsurance premiums are based on the coverage level for the particular crop and the risk region in which the farm is located. The premium is equal to the dollar value of the coverage level multiplied by a premium rate. AgriInsurance crop insurance premiums are subsidized by the provincial and federal governments, with governments paying 25% of total premiums and sharing 50% of the administration fees with producers. Overall, this represents approximately 60% of the total, leaving 40% for producers to pay (SCIC, 2013). In the simulation model, for simplicity purposes the overall premium rate was assumed to be 10% for all crops.\(^{14}\) Of the resulting premium, 40% was assumed to be paid by the producer and included as a cash outflow in the simulation model.

**AgriStability – GF Version**

The version of AgriStability implemented through GF provided support for participating producers when their program margin (PM) fell below 85% of a historical average margin, referred to as the reference margin (RM). The PM was calculated as the difference between allowable income and allowable expenses. Allowable income was revenue generated from the

\(^{13}\) Producers can also opt to purchase additional crop price protection, referred to as spring price endorsement (SPE). SPE is essentially price insurance and provides protection against price declines during the year. The representative farm was assumed not to purchase SPE in this study.

\(^{14}\) In reality, insurance premium rates vary by crop, risk area and year, although given historical rates for the crops modeled in this study 10% represented a reasonable approximation. Alberta is divided into risk areas for the purposes of crop insurance coverage and premium calculations; Starland County is located in risk area 8.
sale of agricultural commodities while allowable expenses are those costs directly associated
with agricultural production. For the purposes of this study the PM was calculated as the
difference between revenue from crop sales and variable costs of crop production.\textsuperscript{15}
AgriInsurance payouts were treated as income for the purposes of PM calculations while
insurance premiums were considered to be an allowable expense.

Equation 4 outlines the calculations used to determine AgriStability payments:

\[
Agri\text{Stability payment} = \begin{cases} 
0, & \text{if } PM \geq 0.85RM \\
0.7(0.85RM - PM), & \text{if } 0.7RM \leq PM \leq 0.85RM \\
0.8(0.7RM - PM) + 0.7(0.85RM - 0.7RM), & \text{if } 0 \leq PM < 0.7RM \\
0.6(0 - PM) + 0.8(0.7RM) + 0.7(0.85RM - 0.7RM), & \text{if } PM < 0
\end{cases}
\] (4)

If the PM was at least 85% of the RM (calculated using the five year Olympic average of PMs),
then there was no payment. If the PM was in the range of 70% to 85% of the RM, then the
payment was equal to 70% of the difference between the upper limit (85%*RM) and the PM;
that is, the producer received $0.70 per $1 of deficit in that range. If the PM was in the range
of $0 to 70% of the RM, then the total AgriStability payment was calculated in two parts; 70% of
the difference between the difference (85%*RM – 70%*RM), and 80% of the difference
between (70%*RM) and the PM; that is, the producer received $0.80 per $1 of deficit in the
lower range. Finally, if the PM was negative, there was an additional component of the
payment, with coverage of negative PM being 60% (i.e., $0.60 per every $1 of negative PM).
AgriStability payments were treated as cash inflows for MNCF calculations.

Fees for participating in AgriStability were $0.0045 per $1 of reference margin,
multiplied by 85%. There was a minimum fee of $45. The administrative cost share fee was an
additional $55. These fees were included as part of cash outflows for MNCF calculations.

**AgriInvest – GF Version**

In the GF version of AgrilInvest, producers could contribute up to 1.5% of allowable net
sales (ANS), where ANS is defined as sales of agricultural commodities minus purchase of
agricultural commodities. ANS was capped at $1.5 million per producer for lifetime
participation in the program for the purposes of AgrilInvest. Producer contributions were

\textsuperscript{15} Details concerning what constitute allowable income and expenses are provided in the AgriStability Program
Handbook (AFSC nd).
matched by government contributions. Producers were able withdraw funds from their AgriInvest account in any year.

Given the flexibility in the AgriInvest program with respect to contribution and withdrawal decisions, there are many potential producer strategies for making contributions and withdrawals. For the purposes of the simulation analysis, AgriInvest contribution and withdrawal decisions were linked to AgriStability PM calculations. This was done to be consistent with the principle behind the AgriInvest program; that is, it is intended to “manage” small fluctuations in income that are not addressed by AgriStability. In years for which the simulated PM was positive and greater than the RM, deposits were made to the producer’s AgriInvest account, in the amount of 1.5% of allowable net sales. This was treated as a cash outflow in MNCF calculations. The government deposited a matching amount equal to the producer’s contribution, up to $22,500 per year (i.e., maximum matching allowed within the program).

Similarly, if the representative farm’s PM in a particular year was less than the RM, and there were funds available in the AgriInvest account, a withdrawal was triggered. The AgriInvest withdrawal was equal to the difference between the PM and the RM, to a maximum of 15% of the RM (i.e., the deficit not addressed by AgriStability). If the calculated withdrawal was greater than the current AgriStability account balance, the withdrawal was limited to the account balance. AgriInvest withdrawals, whether from producer or matching contributions, were treated as cash inflows for MNCF calculations.

AgriStability and AgriInvest – GF2 Version

As discussed in the introductory section of the paper, the GF2 policy framework resulted in changes to AgriStability and AgriInvest. These changes were reflected in the simulation modeling of the programs. There were two AgriStability changes that affected payment calculations. First, the degree to which the PM must be less than the RM in order to trigger a payment was been increased from 15% to 30%; that is, AgriStability payments only occurred if the PM was less than 70% of RM. Secondly, the “coverage” level used to calculate AgriStability payments was 70% regardless of the degree of decrease in PM. The net impact on the AgriStability payment structure is reflected in the following revised version of equation (4):
A third change to AgriStability was with respect the calculation of the RM. As noted earlier in the paper, for the GF2 version of the program RM is now equal to the lesser of the five year Olympic average PM (i.e., the calculation used in the GF version of the program) and the three year average of allowable expenses, using the same three years as in the average PM calculation. To reflect the reduced AgriStability coverage, the marginal cost of participation is reduced from $0.0045 to $0.00315 per $1 of contribution margin. All of these changes were made to the simulation model in order to model the AgriStability program under GF2.

For the GF2 version of AgriInvest, the annual producer contribution limit was increased to 100% of allowable net sales. However, only the first 1% was now matched by government, to a limit of $15,000 per year. As well, the account balance limit was increased from 25% to 400% of historical average allowable net sales. Both of these changes were reflected in the simulation modeling of GF2 BRM programs. However, the decision rule incorporated into the simulation model governing the timing and amount of producer contributions and withdrawals was unchanged, with two exceptions. If a contribution was made, only 1% (i.e., the maximum matchable amount) of allowable net sales was assumed to be contributed by the producer. In addition, when a withdrawal was triggered under the assumed producer decision rule, the AgriInvest withdrawal was equal to the difference between the PM and the RM, to a maximum of 30% of the RM (i.e., the increased deficit now not “covered” by AgriStability).

Results

Table 3 provides summary information for the alternative BRM program participation scenarios modeled in this analysis; no participation, participation in the GF version of the BRM suite, and participation in the GF2 version of the BRM suite (i.e., AgriInsurance, AgriStability and AgriInvest). The expected or mean level of performance, defined in terms of farm level NPV and annualized NPV per ha, is reported for the three scenarios. Annualized NPV per ha is calculated by dividing the farm NPV by the farm area (1295 ha) and then converting the resulting value to an annuity using the perpetual annuity formula (i.e., equation 3). Variability
of performance is also reported, in terms of the standard deviation for the annualized NPV per ha and the coefficient of variation (CV); that is, the standard deviation divided by the mean.

Participation in BRM programs results in improved expected performance for the representative farm. Mean annual performance improves from $71.97 per ha to $110.07 if the producer participates in the BRM suite as structured in the GF policy framework (Table 3). This represents a significant increase in performance and resulting wealth. Much of the impact is attributable to the subsidization nature of the programs (e.g., subsidized insurance premiums, matching AgriInvest contributions, etc.).

Variability in performance (i.e., standard deviation of annualized NPV) increases slightly if the producer participates in the BRM suite (GF version), from $28.82 per ha to $29.88 (Table 3). However, this increase is very small (~$1 per ha) and is not surprising given the degree of increase in the level of performance indicated by the mean values. Expressed as relative variability, risk is significantly reduced with the CV decreasing from 0.40 to 0.27 (i.e., over 30%). Whether due to stabilizing or subsidizing effects of the BRM programs, the net result is a reduction in risk.

Table 3 also provides the same set of results for participation in the GF2 version of the BRM suite. Relative to the no BRM scenario, the pattern for GF2 is similar to that for GF. Expected performance is improved (i.e., from $71.97 per ha to $106.69), variability in absolute terms increases but in relative terms risk is reduced (i.e., the CV for NPV decreases from 0.40 to 0.29). The explanation for the pattern is similar as well.

By comparing results for the GF2 BRM scenario to those for the GF scenario, the impact of the changes in BRM programs can be seen. While both versions of the BRM suite improve expected financial performance and reduce risk relative to the base (no BRM) scenario, the degree of improvement is greater for GF than it is for GF2. Given the changes made to AgriInvest and (especially) AgriStability, this is not surprising. The reduction in matching contributions in AgriInvest and the decreased degree of coverage in AgriStability both contribute to these results. However, even with the reduced support from BRM programs under GF2, there is a significant positive impact on farm performance from participation.
Table 4 provides a summary of the results for the GF and GF2 BRM suites, by individual program. These results are generated by simulating the representative farm operation, assuming participation in each BRM program individually. AgriStability and AgriInvest are modeled for both GF and GF2. Since there were no changes made to the structure of AgriInsurance with the new policy framework, the results in Table 4 for this program apply to both GF and GF2.

As shown in Table 4, the biggest impact on expected farm performance and risk is attributable to participation in AgriInsurance or AgriStability. Looking at the results for the GF policy framework, AgriStability provides the biggest boost to expected financial performance; mean annualized NPV increases from $71.97 per ha without BRM participation to $98.56 per ha with participation in AgriStability (Table 4). This is accompanied by a corresponding increase in the standard deviation. That AgriStability provides the biggest boost is not unexpected, given the nature of potential benefits relative to the cost of participation.

In the case of AgriInsurance, there is also significant improvement in expected performance (i.e., as shown in Table 4, from $71.97 per ha to $84.90). This is attributable to the importance of yield risk in crop production and the fact that insurance premiums are subsidized by federal and provincial governments. In addition, both absolute and relative variability in performance is reduced through participation in the insurance program.

While the GF version of AgriInvest does result in increased expected performance and reduced relative variability, the effects are smaller when compared to the other two programs in the BRM suite. Annual expected NPV increases from $71.97 per ha to $74.17 with AgriInvest participation, and the CV decreases slightly from 0.40 to 0.39. The dollar values associated with both contributions (producer and matching government) and withdrawals are significantly smaller for this program than for either AgriStability or AgriInsurance. While it is the case that this result is driven in part by the assumed producer decision rules used for AgriInvest contributions and withdrawals, it is unclear if different rules would change this significantly, particular the impact on expected performance.

If the results for the GF and GF2 policy frameworks are compared in Table 4, the results are as expected. For both AgriStability and AgriInvest, there is a reduction in the degree of
improvement in expected performance going from GF to GF2 (e.g., expected annualized NPV for AgriStability is $98.56 per ha for GF and $91.76 for GF2). There is also a slight increase in the level of relative risk (i.e., CV). The impact of policy program changes (i.e., degree of “decrease” in risk management support) is greater for AgriStability than for AgriInvest. This is consistent with the differences in relative effectiveness of the two programs and the nature of the program structure changes.

Discussion and Implications

The direct effects of participation in Canadian public BRM programs and the implications for farm performance are relatively straightforward. Individually and as a group, these programs provide support for Canadian agricultural producers and represent effective risk management tools. Taken together, the three programs address yield and price risk and in the case of prices, both output and input price variability.

However, much of the effectiveness is caused by the degree to which subsidization is built into program structure. For example, from the results in Table 3 it can be seen that participating in these programs does not result in reduced variability in performance as measured by the standard deviation. This is also true for the individual programs, with the exception of AgriInsurance. Instead, the risk reduction benefits come through the fact that the increase in expected performance outweighs the slight increase in variability, so that in relative terms (i.e., the CV) risk is reduced. These programs do not stabilize returns over time as much as they reduce the “troughs” in returns.

The nature of the subsidization aspects for the different programs can be seen through their structure. In the case of AgriInsurance, premiums are subsidized by federal and provincial governments such that producers pay approximately 40% of the true cost. Individual producers can expect, over time, to receive more from the program in payouts than they pay in premiums. For AgriStability, producers pay an administrative fee and “premium”, as noted earlier, but these are not intended to represent actuarially sound premiums. For example, under the GF version of AgriStability a producer with an RM of $250,000 would pay approximately $1,013 to participate in the program. If the PM in that year is $200,000 (i.e.,
80% of the RM) the AgriStability payout would be $8,750. The potential for sizable payouts for a relatively small participation fee is significant.

AgriInvest is the one program which has an explicit stabilization element to it. Producers are expected to contribute cash flow in “good” years in order to have an account balance on which to draw in “bad” years. However, even this program is subsidized in that government matches (to a maximum limit) producer contributions.

**GF2 versus GF**

Given the nature of the changes in AgriStability and AgriInvest, discussed earlier, it might be expected that the ability of the GF2 programs to manage risk is weakened. The results presented here for the representative Alberta cropping operation are consistent with this expectation. While the GF2 version of the BRM suite still provides a significant amount of support and protection for participating producers, the degree of support is reduced. This is particularly true for the AgriStability program.

The changes to the BRM programs mean that producers may need to look elsewhere for other types of risk management tools to offset the lost coverage from the public programs. This is consistent with policy direction statements within the background document (i.e., the Saint Andrew statement) for the GF2 framework (AAFC 2011b). However, given the small degree of change in risk management suggested here by the simulation results for the representative farm, it may be the case that farmers will simply “live with” the changes to the BRM programs.

**Implications for Environmental Stewardship and Agri-Environmental Policy**

Risk management is just one component of Canadian agricultural policy. Environmental stewardship was and is also a key part of both GF and GF2 policy frameworks. GF provided policies and programs intended to encourage adoption of environmental stewardship practices

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16 In the Saint Andrew statement is the following policy direction statement: “Enhance the capacity of individual players to effectively anticipate and manage challenges and risks by facilitating risk management capacity at the farm/firm level—through use of sound on-farm management practices and private sector tools—to improve market-based profitability” (AAFC 2011b, p.7).
by agricultural producers. Often these policies/programs took the form of cost sharing arrangements for producers who adopt Beneficial Management Practices (BMPs).\textsuperscript{17} GF2 continues this pattern, although there are statements in the objectives for GF2 that suggest a greater emphasis on market based solutions for environmental challenges (AAFC, 2011b).

There are currently no links between agricultural risk management policy and agri-environmental policy within Canadian agricultural policy frameworks (i.e., no cross-compliance provisions). However, the impacts of participation in public BRM programs may well influence the uptake of environmental stewardship practices, and the costs of incentive programs associated with these practices. BMPs and other practices that contribute positively to environmental stewardship may result in net costs for adopting producers (e.g., Jeffrey et al 2012). The improved expected financial performance associated with BRM program participation may result in greater financial disincentives to adopt these types of practices (e.g., Cortus et al 2009). This in turn may result in greater costs associated with agri-environmental programs.

This was investigated in the current study by modeling adoption of selected BMPs by the representative Alberta cropping operation. This was done without and then with participation in the BRM suite in order to examine the impact of BRM programs on incentives to adopt these practices. Four BMPs were chosen to serve as examples for this analysis; two crop rotation BMPs and two land use change BMPs.\textsuperscript{18}

The two crop rotation BMPs considered were incorporating field peas or winter wheat into the representative farm’s rotation. Growing field peas may be considered as a BMP due to its properties as a legume. As such, the plant fixes nitrogen in the soil that may be used by subsequent crops. This reduces the need for chemical fertilizer thereby reducing potential for chemical runoff. Winter wheat is considered as a BMP due to the change in timing of seeding and other field activities associated with the crop. Since there is no spring field work (i.e., tillage, seeding, etc.), growing this crop results in improved wildlife/waterfowl habitat in the

\textsuperscript{17} BMPs are farming practices that contribute to reducing potential negative environmental impact from agricultural production (AAFC 2013a).

\textsuperscript{18} Full details regarding the parameters used for the two sets of BMPs (i.e., crop rotation and land use change) are not provided here, for the sake of space. These details are available from the authors, upon request.
spring period. There are also benefits in terms of timing of fertilizer and pesticide applications (i.e., reduced runoff potential). Adoption of these two crop rotation BMPs was modeled for the representative farm. In both cases, equivalent data sources and model parameter estimation procedures were used as for the crops included in the base farm scenarios. Published information and expert opinion were also used to establish the effects of these crops on the rotation.

The two land use change BMPs modeled were establishment of buffer strips around wetlands on the representative farm and restoration of previously drained wetlands. Buffer strips provide protection for wetlands against runoff of chemicals and sediment. They also provide enhanced habitat for wildlife and waterfowl. By restoring wetlands, a number of ecosystem services are provided, including improved flood control, wildlife and waterfowl habitat, aesthetic benefits, etc. In modeling these BMPs, implementation costs, calculating reduced area for crop production, etc., were all factored into the simulation analysis.

Summary statistics for the alternative BMP scenarios, with and without BRM program participation (for both GF and GF2 policy frameworks) are provided in Table 5. The impact of BMP adoption on expected farm financial performance is mixed. Both crop rotation BMPs result in improved expected performance. This is true regardless of whether or not the producer participates in the BRM suite. In the case of field peas, the impact is significant both at the farm level and if annualized on a per ha basis. In the case of a producer participating in the GF BRM suite, for example, incorporating field peas into the rotation results in annual expected performance increasing from $110.07 per ha to $137.89 per ha. Results are similar for the other BRM scenarios. This net benefit is due to the benefits derived from reduced nitrogen fertilizer costs and yield boosts in subsequent crops. A similar pattern, with a smaller degree of expected improvement, also exists for the winter wheat BMP. Both crops contribute positively to farm performance. As such it would seem that there is a potential “win-win” situation; the BMPs provide potential environmental benefits along with direct financial benefits.

Conversely, the impact of the two land use change BMPs is negative. As shown in Table 5, if the producer does not participate in BRM programs and implements the buffer strip or
wetland restoration BMP, annual expected financial performance decreases from $71.97 per ha to $71.29 or $70.21 per ha, respectively. Similar patterns exist for the two BRM suite scenarios as well. The primary cause of this result is the fact that both of these BMPs take land out of crop production; approximately 12 hectares in the case of buffer strips and 13 hectares in the case of wetland restoration. Therefore, there is an opportunity cost associated with the land use changes reflected in these outcomes.

Table 5 allows an overall examination of the impact on performance of BMP adoption, by BRM scenario. The pattern of BMP results seems to be consistent across the different BRM scenarios. Crop rotations result in improved expected performance (i.e., there are incentives to adopt the BMPs) relative to no adoption while land use change BMPs result in weakened expected performance (i.e., there are disincentives). However, a relevant policy question is whether or not the magnitude of incentives/disincentives for BMP adoption is affected by BRM program participation. In order to examine this, the simulation results for the BMP adoption scenarios are presented in a slightly different way. In particular, mean annual net benefits per ha of land affected by the BMP are calculated. This is done by taking the difference in expected farm NPV between the BMP adoption scenario and the baseline (no BMP adoption) scenario, dividing by the amount of land affected by the BMP, and converting that value to a perpetual annuity. In the case of the two crop rotation BMPs, the area affected is the whole farm (i.e., 1295 ha). For the buffer strip and wetland restoration BMPs, the area affected is the area removed from crop production, 12 ha and 13 ha, respectively.

The resulting values for the selected BMPs are presented in Table 6. For example, based on the representative farm characteristics and other simulation parameters the impact of incorporating field peas into the crop rotation is an expected net benefit of $26.56 per ha, assuming no BRM program participation. Thus there is a positive net benefit associated with adopting this BMP. Similarly, converting land to buffer strips to protect current wetlands results in a net annual cost (i.e., negative net benefit) of $72.82 per ha affected (again assuming

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19 Although not explicitly discussed here, these values are determined based on the area of current wetlands present on the farm, in the case of buffer strips, and the assumed number of previously drained wetlands and available producer time for undertaking restoration activities, in the case of wetland restoration.
no BRM programs). Thus there is a disincentive to adopt this BMP. The same is true for the wetland restoration BMP.

As shown in Table 6, the impact of participating in the BRM programs is to reinforce the incentives or disincentives associated with these BMPs. For the field pea and winter wheat BMPs, the positive net benefits are further increased. In the case of the buffer strip and wetland restoration BMPs, the degree of net cost or disincentive to adopt is increased. The degree of change varies, depending on the nature of the BMP.

This pattern of change can be explained by considering the impact of BRM program participation on expected financial performance. Since expected performance is enhanced by participating in programs like AgriInsurance and AgriStability, BMPs that generate positive expected net benefits through increased profitability will have those benefits further increased with BRM participation. Further, the expected opportunity cost associated with taking land out of production would also be reinforced, leading to greater disincentives for those types of BMPs (i.e., buffer strips and wetland restoration).

Finally, how does the change in BRM program structure in the GF2 policy framework affect these results? With reduced support from these programs, it might be expected that the opportunity cost for the land use change BMPs would decrease slightly, leading to a reduction in the net costs of adoption. In fact, this is the case for the buffer strip and wetland restoration BMPs. For example, the net annual cost of implementing buffer strips decreases from $106.56 per ha to $103.54, going from the GF to GF2 version of the BRM suite (Table 6).

Interestingly, the opposite pattern exists for the crop rotation BMPs. The net benefits for these BMPs increase when moving from GF to GF2 versions of the BRM suite (Table 6). For example, net annual benefits of growing winter wheat increase from $7.77 per ha to $8.35 per ha. As shown in Table 5, farm NPVs decrease for these BMPs when moving from GF to GF2 but the relative impact of adopting the BMP (i.e., relative to no BMP within the same BRM suite scenario) does increase. While there is no obvious explanation for this result, it may be the case that the diversification benefits of these two BMPs are of greater value to the farm business under the new policy framework and this is reflected in the results.
Concluding Comments

Dynamic Monte Carlo simulation analysis is used to model financial performance for a representative Alberta cropping operation, under alternative Business Risk Management (BRM) program scenarios. In particular, the farm is modeled first assuming no participation in BRM programs. The simulation is then repeated assuming participation in AgriInsurance, AgriStability and AgrilInvest. The simulation results indicate that participation in public BRM programs provides a significant net benefit to agricultural producers, both in terms of improved expected financial performance as well as reductions in relative risk. Much of the benefit arises from the support provided through the subsidization aspects of the programs.

Further, the recent changes to the BRM programs through implementation of Growing Forward 2 are also modeled for the representative farm. The nature of the changes is such that the degree of support provided by government is reduced. As a consequence, expected financial performance is reduced and risk is increased with participation in the revised BRM programs, relative to the original Growing Forward policy framework. However, the degree to which performance is “weakened” is minor and program participation still provides significant benefits.

While business risk management policy is not tied to environmental policy within the Growing Forward policy frameworks, there is a potential link through the impacts of BRM program participation on farm performance. This is seen by examining the impact of program participation on incentives/disincentives for adoption of environmental stewardship practices. Currently the Canadian agricultural policy framework has provisions for cost sharing programs associated with adopting agricultural BMPs, and the potential for the introduction of market-based environmental policy instruments (e.g., conservation auctions). Participation in public BRM programs may result in reduced uptake of many environmentally friendly production practices or land use changes (e.g., buffer strips or shelterbelts) if they are costly for producers to adopt. Alternatively, if market-based instruments are introduced, the costs of such programs may be increased due to the influence of BRM program participation on producer opportunity costs.
Finally, while the analysis in this paper does not address the policy decision making process explicitly, the results presented here are relevant for policy makers. Given the stated objectives in Growing Forward 2 to have producers make more use of market-based risk management tools, it is not clear that the changes to the BRM suite will have that effect. As well, given the emphasis in Growing Forward 2 on both risk management and promoting environmental stewardship in agriculture, it is also not clear that the current philosophy for BRM program structure is compatible with developing a cost-effective set of environmental policy instruments.

Acknowledgements
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References


Table 1. Stochastic Crop Yield Parameters

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Mean (kg/ha)</th>
<th>Standard Deviation (kg/ha)</th>
<th>Weibull α</th>
<th>Weibull β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>2635.87</td>
<td>695.09</td>
<td>5.15</td>
<td>2865.80</td>
</tr>
<tr>
<td>Canola</td>
<td>1268.64</td>
<td>416.13</td>
<td>3.73</td>
<td>1405.10</td>
</tr>
<tr>
<td>Durum Wheat</td>
<td>2276.46</td>
<td>672.60</td>
<td>3.95</td>
<td>2513.50</td>
</tr>
<tr>
<td>Flax</td>
<td>1177.60</td>
<td>368.47</td>
<td>3.74</td>
<td>1304.20</td>
</tr>
<tr>
<td>Oats</td>
<td>1896.95</td>
<td>572.16</td>
<td>3.86</td>
<td>2096.90</td>
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<tr>
<td>Spring Wheat</td>
<td>2158.99</td>
<td>603.87</td>
<td>5.27</td>
<td>2344.40</td>
</tr>
</tbody>
</table>

Yield correlation coefficients:

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Barley</th>
<th>Canola</th>
<th>Durum Wheat</th>
<th>Flax</th>
<th>Oats</th>
<th>Spring Wheat</th>
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</thead>
<tbody>
<tr>
<td>Barley</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Canola</td>
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<td>Durum Wheat</td>
<td>0.665</td>
<td>0.543</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flax</td>
<td>0.607</td>
<td>0.600</td>
<td>0.612</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td>0.654</td>
<td>0.503</td>
<td>0.653</td>
<td>0.548</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Spring Wheat</td>
<td>0.665</td>
<td>0.543</td>
<td>0.749</td>
<td>0.612</td>
<td>0.653</td>
<td>1.000</td>
</tr>
</tbody>
</table>

a The α and β values are estimates of shape and scale parameters, respectively, for the Weibull distribution, which is characterized by the density function \( f(x) = \frac{\alpha}{\beta} \left( \frac{x}{\beta} \right)^{\alpha-1} e^{-\left(\frac{x}{\beta}\right)^\alpha} \) (Palisade Corporation 2010).

b The standard deviation estimates here are the Weibull fitted values, adjusted to the farm level using the Marra-Schurle correction.

c The yield correlations are obtained from AARD.

Table 2. Coefficient Estimate, SUR Crop Price Models

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient Estimates</th>
<th>Coefficient Estimates</th>
<th>Coefficient Estimates</th>
<th>Coefficient Estimates</th>
<th>Coefficient Estimates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Barley</td>
<td>Canola</td>
<td>Durum Wheat</td>
<td>Flax</td>
<td>Oats</td>
</tr>
<tr>
<td>( P_{t-1} )</td>
<td>0.548** (0.0996)</td>
<td>0.810** (0.129)</td>
<td>0.272** (0.120)</td>
<td>0.565** (0.116)</td>
<td>0.271* (0.118)</td>
</tr>
<tr>
<td>( P_{t-2} )</td>
<td>-0.324** (0.0930)</td>
<td>-0.395** (0.126)</td>
<td>-0.465** (0.126)</td>
<td>-0.375** (0.116)</td>
<td>-0.224* (0.111)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.111** (0.0454)</td>
<td>0.234** (0.0417)</td>
<td>0.292** (0.0527)</td>
<td>0.297** (0.0523)</td>
<td>0.142** (0.0233)</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.0163</td>
<td>0.0454</td>
<td>0.0417</td>
<td>0.0527</td>
<td>0.0523</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.382</td>
<td>0.569</td>
<td>0.289</td>
<td>0.365</td>
<td>0.122</td>
</tr>
</tbody>
</table>

** and * represent statistical significance at the 1% and 5% levels, respectively. Standard errors are in parentheses. The overall system \( R^2 \) and Log Likelihood Function values are 0.944 and 470.56, respectively.

b \( P_{t-k} \) is the price, lagged \( k \) times, in \$ per kg.
The farm level NPV is converted to an annualized value by using the perpetual annuity formula, as presented in Growing Forward 2.

The farm level NPV is converted to an annualized value by using the perpetual annuity formula, as presented in the methods discussion.

### Table 3. Summary of Simulation Results, by Business Risk Management (BRM) Program Participation Scenario

<table>
<thead>
<tr>
<th></th>
<th>No BRM Programs</th>
<th>BRM Suite (GF)(^a)</th>
<th>BRM Suite (GF2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean NPV</td>
<td>$931960</td>
<td>$1425386</td>
<td>$1381693</td>
</tr>
<tr>
<td>Mean Annualized NPV per ha(^b)</td>
<td>$71.97</td>
<td>$110.07</td>
<td>$106.69</td>
</tr>
<tr>
<td>Standard Deviation of Annualized NPV per ha</td>
<td>$28.82</td>
<td>$29.88</td>
<td>$31.25</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>0.40</td>
<td>0.27</td>
<td>0.29</td>
</tr>
</tbody>
</table>

\(^a\) The BRM suite refers to AgriInsurance, AgriStability and AgrilInvest. GF refers to Growing Forward 1 while GF2 refers to Growing Forward 2.

\(^b\) The farm level NPV is converted to an annualized value by using the perpetual annuity formula, as presented in the methods discussion.

### Table 4. Summary of Simulation Results, by Individual Business Risk Management (BRM) Program and Policy Framework

<table>
<thead>
<tr>
<th></th>
<th>No BRM Programs</th>
<th>AgrilInsurance</th>
<th>Growing Forward 1</th>
<th>Growing Forward 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean NPV</td>
<td>$931960</td>
<td>$1099438</td>
<td>$1276402</td>
<td>$1188256</td>
</tr>
<tr>
<td>Mean Annualized NPV per ha(^a)</td>
<td>$71.97</td>
<td>$84.90</td>
<td>$98.56</td>
<td>$91.76</td>
</tr>
<tr>
<td>Standard Deviation of Annualized NPV per ha</td>
<td>$28.82</td>
<td>$26.54</td>
<td>$32.20</td>
<td>$33.39</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>0.40</td>
<td>0.31</td>
<td>0.33</td>
<td>0.36</td>
</tr>
</tbody>
</table>

\(^a\) The farm level NPV is converted to an annualized value by using the perpetual annuity formula, as presented in the methods discussion.
Table 5. Summary of Simulation Results for Adoption of Beneficial Management Practices (BMPs), by Business Risk Management (BRM) Program Participation Scenario

<table>
<thead>
<tr>
<th>BMP Scenario</th>
<th>No BMPS</th>
<th>Field Peas</th>
<th>Winter Wheat</th>
<th>Buffer Strips</th>
<th>Wetland Restoration</th>
</tr>
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<tbody>
<tr>
<td><strong>No BRM Programs</strong></td>
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<td></td>
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<tr>
<td>Mean NPV</td>
<td>$931960</td>
<td>$1275871</td>
<td>$992512</td>
<td>$923193</td>
<td>$909212</td>
</tr>
<tr>
<td>Mean Annualized NPV per ha&lt;sup&gt;a&lt;/sup&gt;</td>
<td>$71.97</td>
<td>$98.52</td>
<td>$76.64</td>
<td>$71.29</td>
<td>$70.21</td>
</tr>
<tr>
<td>Standard Deviation of Annualized NPV per ha</td>
<td>$28.82</td>
<td>$29.59</td>
<td>$29.88</td>
<td>$28.58</td>
<td>$28.59</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>0.40</td>
<td>0.30</td>
<td>0.39</td>
<td>0.40</td>
<td>0.41</td>
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<tr>
<td><strong>BRM Suite – Growing Forward 1&lt;sup&gt;b&lt;/sup&gt;</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean NPV</td>
<td>$1425386</td>
<td>$1785701</td>
<td>$1526008</td>
<td>$1412555</td>
<td>$1398509</td>
</tr>
<tr>
<td>Mean Annualized NPV per ha&lt;sup&gt;a&lt;/sup&gt;</td>
<td>$110.07</td>
<td>$137.89</td>
<td>$117.84</td>
<td>$109.08</td>
<td>$107.99</td>
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<tr>
<td>Standard Deviation of Annualized NPV per ha</td>
<td>$29.88</td>
<td>$29.72</td>
<td>$30.39</td>
<td>$29.63</td>
<td>$29.65</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>0.27</td>
<td>0.22</td>
<td>0.26</td>
<td>0.27</td>
<td>0.28</td>
</tr>
<tr>
<td><strong>BRM Suite – Growing Forward 2&lt;sup&gt;b&lt;/sup&gt;</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Mean NPV</td>
<td>$1381693</td>
<td>$1776223</td>
<td>$1489826</td>
<td>$1369226</td>
<td>$1355245</td>
</tr>
<tr>
<td>Mean Annualized NPV per ha&lt;sup&gt;a&lt;/sup&gt;</td>
<td>$106.69</td>
<td>$137.16</td>
<td>$115.04</td>
<td>$105.73</td>
<td>$104.65</td>
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<tr>
<td>Standard Deviation of Annualized NPV per ha</td>
<td>$31.25</td>
<td>$31.64</td>
<td>$31.96</td>
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<td>$31.01</td>
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<tr>
<td>Coefficient of Variation</td>
<td>0.29</td>
<td>0.23</td>
<td>0.28</td>
<td>0.29</td>
<td>0.30</td>
</tr>
</tbody>
</table>

<sup>a</sup> The farm level NPV is converted to an annualized value by using the perpetual annuity formula, as presented in the methods discussion.

<sup>b</sup> The BRM suite refers to AgrilInsurance, AgriStability and AgrilInvest.
Table 6. Impact of Beneficial Management Practices (BMPs), by Business Risk Management (BRM) Program Participation Scenario

<table>
<thead>
<tr>
<th>BMP Scenario</th>
<th>Field Peas</th>
<th>Winter Wheat</th>
<th>Buffer Strips</th>
<th>Wetland Restoration</th>
</tr>
</thead>
<tbody>
<tr>
<td>No BRM Programs</td>
<td>$26.56</td>
<td>$4.68</td>
<td>-$72.82</td>
<td>-$175.66</td>
</tr>
<tr>
<td>BRM Suite – Growing Forward 1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>$27.82</td>
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</tr>
<tr>
<td>BRM Suite – Growing Forward 2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>$30.47</td>
<td>$8.35</td>
<td>-$103.54</td>
<td>-$204.23</td>
</tr>
</tbody>
</table>

<sup>a</sup> Mean net benefits are calculated on a per ha basis based on the area directly affected by the BMP. In the case of field peas and winter wheat, the entire farm area is used. For buffer strips and wetland restoration, the area removed from crop production as a result of the BMP is used.

<sup>b</sup> The BRM suite refers to AgriInsurance, AgriStability and AgrilInvest.