The Transfer Efficiency Assessment of Individual Income-Based Whole Farm Support Programs

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Prepared by

Calum Turvey
Karl Meilke
Alfons Weersink
Kevin Chen
Rakhal Sarker

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Farm Management Solutions Inc. and The Department of Agricultural Economics and Business, The University of Guelph

EXECUTIVE SUMMARY

Government intervention in agriculture is common place in Canada. During the last three decades farm support programs as well as support levels have increased substantially. Because of growing fiscal deficits and public debts all government programs including those for agriculture are currently under review. Transfer efficiency of all farm programs are being investigated and more efficient and trade friendly farm support programs are being sought. In light of the recent GATT Agreement, the current direction of Canadian agricultural policy is towards whole farm income stabilization and away from traditional commodity specific price and income support programs. New tools and concepts are required to evaluate such whole farm based programs. The major objective of this study is to develop a framework capable of evaluating whole farm based programs. In addition to the theoretical framework, a prototype programming model is developed to examine quantitatively the effects of various support programs on farm level production decisions. The report consists of five major sections.

Section two of the report reviews the classical economic arguments for government intervention in the market place including highly inelastic supply and demand, technological change, low farm incomes, incomplete contingency markets etc. To counter these problems governments have undertaken actions to distribute income from one part of the economy (consumers and tax payers) to another (farmers). The measurement of efficiency depends on what exactly is to be transferred and who is the intended beneficiary. Transfer efficiency is a measure of benefit distributions to the agri-food sector. Payments targeted to farmers may involve seepage to input suppliers, processors and consumers. Who gains, who loses and the degree of seepage depends very much on the relationship between domestic and international markets. For example, most of the benefits of transfer in a closed economy or in an economy with substantial market power accrues to consumers. However, in an export economy which is a price taker in the world market, much of the benefit accrues to producers, suppliers of inputs and processors.

The first part of section three provides an overview of the existing support programs for Canadian agriculture. It provides a brief historical perspective on the original intent of the current farm programs and how these programs evolved through time. The basic features of each program are described and their possible future directions are discussed. While the future directions of traditional commodity based price and income support programs like GRIP, NTSP etc., are uncertain, the future of whole farm based support programs like NISA or VAISA looks quite promising at the present time.

The second part of section three provides alternative definitions and interpretations of decoupled farm programs. The academic definition of decoupled programs differ from their institutional definition. While most economists consider production neutrality as an

important criteria for decoupledness, the GATT definition of the term emphasizes on the degree of trade-distortion. So, a program may not be production neutral but it can still be termed decoupled under the GATT definition.

Based on the degree of trade distortions, all farm programs can be classified into six major groups. Level 1 being the least trade-distorting and level 6 being the most. Level 1 refers to universal programs available to everyone; Level 2 constrains universal programs available only to producers; Level 3 provides payments to producers and some production of agricultural goods is required; Level 4 payments are related to the level of output but with limits; Level 5 provides open-ended direct payments related to the level of output/input use; and Level 6 provides administered prices applicable to all output with border controls and distorted consumption. Level 2-3 distortions would result from public research and administration such as inspection, infrastructure, and domestic food aid; supply management would be a level 4 distortion; GRIP and NTSP would be a level 5 distortion. It is unclear how NISA or VAISA would be considered since the GATT does provide criteria under which these programs would be `deemed' decoupled, including a stipulation that payment can't be triggered for losses above 70% of long-run averages. It is shown in section four that the NISA or NISA type programs would be risk as well as production neutral.

Section four of the report develops a general framework for analyzing the farm firm and examines the impacts of price stabilization/insurance and crop insurance, both of which can be viewed as Level 5 distortions, on farm level production decisions. It takes a different view of the problem and in doing so, provides a rationale for criticizing the way in which farm program distortions are defined and measured.

The premise here is that farmers are risk averse, and will, in the absence of farm policy, produce at a level of output below the optimum. With agricultural insurance two responses are recognized: First, the initial response by farmers is to increase output in response to decreased business risk (the risk adjustment effect); and second, a subsequent response to the degree by which premiums are subsidized in relationship to the expected benefits of the program. It can be argued that the risk reduction effect is a natural response to the provision of contingent markets. The only reason governments get involved in such programs is that contingent markets are incomplete, and this has already been cited as a reason for intervention. If contingent markets were complete then farmers could pay a premium to private insurers and speculators at least equal to the expected benefits. If such contingent markets were operated by the private sector they could not be deemed trade-distorting, even though adoption of contingent instruments would, through risk sharing, lead to increased output.

In contrast, subsidizing premiums, whether privately or publicly, results in a further expansion of output. It is this incremental increase in output which should be targeted by trade agreements.

Unfortunately this is not the way things work! Producer subsidy equivalents use an ex post measure of subsidy which is based on total payments after risk realizations have been observed, and trade-distortion is measured relative to the total output effect, rather than the incremental effect to subsidization alone. Although it is possible that even commodity specific policies can be deemed decoupled by the 5% de minimus standard.

In terms of transfer efficiency, benefits to producers, consumers and supplies of inputs depend on the degree of risk aversion within the agricultural sector, the relative elasticities of supply and demand, the existence of import and export markets and others. For example, programs used for commodities in which domestic production exerts substantial market power, or programs which influence production of commodities for which there is international market power, will not result in a great amount of transfer going to farmers, but rather to consumers, suppliers of inputs, and consumers in importing countries. In contrast, if domestic producers are price takers whose actions have little effect on market prices, then most of the transfers will accrue to them and the suppliers of inputs, with little benefit accruing to consumers. These transfers are impacted by relatively inelastic supply curves which become more elastic or shift outwards, and relatively inelastic input demand curves becoming more elastic.

The production and trade neutrality of commodity specific programs are questionable. One should exercise caution, however, in making broad statements in regards to whether all policies fall into the GATT 'amber' category. There are two responses to stabilization. The first is through risk reduction. Farmers' response to risk reduction is a natural one and should not be considered an 'amber' response if premiums are actuarially fair. For example, farmers will behave in a similar fashion to selection of options on futures contracts as a risk management tool. The problem in regards to GATT and other trade agreements is in the subsidies associated with these policies rather than the policies themselves. Farmers' response to subsidies is an income effect which exacerbates any output response from risk reduction. Therefore, any challenge to these programs by Canada's trading partners should be targeted only to the incremental response to the income effect, not the risk reduction effect.

Since the gains from incremental risk taking are high relative to the possible increase in NISA contributions it is unlikely that NISA will encourage risk taking activities. On the contrary, as NISA savings become economically more important, farmers will have the incentive to reduce revenue risks and they may achieve this through diversification into lower risk crops.

The results from the prototype model illustrate how agricultural policies affect farm level production decisions. The results indicate that none of the currently available commodity specific programs is decoupled. However, just because a program is not decoupled does not necessarily mean that there will be an increased output response. Given limited resources, farmers will substitute the most favourable crops, increasing supply in some markets, but decreasing supply in others. The efficiency of agricultural policies depends on the interrelationships among risky variables. In the above example, each crop was offered the same policy options, but still there were changes. Another issue relevant to the measurement of transfer efficiency is that not all policies are designed equiproportionately. Policy design can have a significant impact on the distribution of resources within the farm, so that the true source of observed changes at the aggregate level cannot easily be distinguished. It is possible to examine these impacts at the farm level using simple optimization models such as the one presented here.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background:

Governments of western democracies have been transferring considerable amount of public funds to their respective agricultural sectors through various price and income support programs since the Second World War. The number of such farm support programs as well as the levels of protection afforded have grown substantially through time. The growing fiscal deficits and public debt problems in these countries in the 1990s generated public pressure for rational evaluation of all government programs. Consequently, the programs for agriculture are also being placed under the microscope. Two major issues are being considered: (1) how efficient the existing farm programs are in transferring income to agriculture? and, (2) how can the farm programs be changed or repackaged to make them more efficient?

Agriculture Canada contracted Deloitte & Touche Management Consultants to investigate the effects of agricultural programs on the agri-food sector. The Deloitte & Touche report, *How Governments Affect Agriculture*, provides a framework for assessing transfer efficiency of various agricultural programs. The report examines how the benefits of government farm programs are shared among farmers, input suppliers, processors, consumers and government agencies. The study, however, focuses on the aggregate level with little emphasis on what happens at the farm level. Moreover, in light of the recent GATT Agreements there is a greater demand for developing domestic farm policies which are trade friendly.

1.2 Objectives and Organization of the Report:

One of the major objectives of this study is to analyze the rationale for, and the economic effects of trade friendly policies that reduce farmers production and consumption risks. The current direction of Canadian agricultural policy is away from commodity specific price and income support towards whole farm income stabilization. The analyses of this type of program requires tools and concepts not previously applied to the evaluation of government programs. This study is an attempt to fill part of this knowledge gap. The second major objective is to develop a prototype empirical model to examine how various government policies affect farm level production decisions.

Section two defines transfer efficiency and provides a brief review of the literature on transfer efficiency. Section three provides an overview of current safety net programs for Canadian agriculture. Section three also provides alternative definitions of decoupled farm programs with particular emphasis on the GATT (1994) criteria for decoupled programs. Section four develops a general framework for measuring the transfer efficiency of various government support programs. The analysis focus on farm level decision making rather than on the farm sector as a whole. Section five outlines an empirical methodology and develops a prototype model. Using the prototype model, this section also illustrates how various agricultural programs affect farm level production decisions.

2. THE ECONOMICS OF TRANSFER EFFICIENCY

Transfer efficiency is broadly defined as a measure of benefit distributions within the agri-food sector and effectiveness in farm income transfer due to government agricultural support programs and initiatives. In examining the efficiency of government programs and how such efficiency has been modeled, it is instructive to initially examine why governments intervene in the agricultural sector. The dominant view has been that agricultural policy is necessary to solve social problems related to market failures. A more recent alternative view is that government intervention is the result of rent seeking activities by producers.

The social problem that has tended to justify government aid to the agricultural sector is the tendency for low commodity prices to cause sudden drops in farm income and the secular decline in the number of farms. This "farm problem" has often been explained in terms of simple supply and demand concepts. The basic features of agriculture characterized by this model are the highly inelastic demand, the slow growth of total demand, rapid technological change which increases supply over time, and the tendency of resources to become fixed within the industry (Rausser and Hochman, 1979). Since supply has historically increased faster than demand, real commodity prices have fallen. Asset fixity with limited labour mobility means that the price decline is translated through to lower farm income and return on investments (Gardner, 1987b).

The farm problem scenario would predict chronic declines in land prices and farm wage rates, given the declining commodity prices over the last several decades. However, this has not occurred and farmers may be described as relatively wealthy. Thus, the rationale for public intervention in agriculture is now focused on public goods arguments involving the correction of market failures (Gardner, 1992). Several types of failures have been identified by Stiglitz (1987) to justify government support as a second-best policy. One failure is the incompleteness of insurance and credit markets to stabilize income for farmers who are subject to large and unpredictable market risks. A second is the level and variability of farm income which has been viewed as unacceptable by society. Another possible failure is imperfect competition in the markets faced by producers (McCalla and Carter, 1976). A fourth market failure that makes intervention attractive involves the public good aspects of information and the generation of new technology (Gardner, 1992). Another market failure is the existence of environmental externalities which may justify interventions such as government subsidization of soil conservation practices. Understanding the primary reasons for agricultural policy are necessary in order to evaluate their effectiveness.

Each possible form of government intervention will have positive and negative effects on at least part of the public. In order to evaluate the gains and losses from the alternate policy options, an objective method is required. Welfare economics has provided for the base for that method of measuring and weighting the net benefits (or losses) to market participants. The following review briefly summarizes how welfare economics has been used by agricultural economists to examine the transfer efficiency of government policy. The review highlights how the definition of transfer efficiency has been broadened over time.

The first studies estimating the benefit and costs of farm programs were by Wallace (1962) and Nerlove (1958). The redistribution of producers' and consumers' surplus under various policy instruments were approximated from data on the price wedge created by the policy and elasticities of supply and demand. The approach introduced by Wallace and Nerlove has been followed by most subsequent studies. The refinements to the basic supply and demand model are outlined below.

Efficient redistribution of income to support agriculture would increase producer surplus by a dollar, for every dollar that consumer surplus fell. In a single commodity market, as examined by Nerlove and Wallace, Gardner shows how a surplus transformation curve can be obtained by solving for the producer surplus as a function of consumer surplus. The deadweight loss can then be depicted as the distance between any point on this curve and the efficient redistribution line. The optimal intervention can be found through the use of a social welfare function which aggregates consumers' and producers' surplus.

In reality, commodity markets are not isolated from one another. In addition, the inconsistencies resulting from the simple formulation of the farm problem as outlined above, has led to more detail in specifying supply-demand for agricultural factors of production and their relationship to commodity markets. However, the efficiency of multimarket commodity programs can not be found by simply summing the net gains in each market individually and in isolation from other markets. For example, the effects of a price rise in one commodity depends upon its substitutability with other products. The efficiency of programs in multimarkets consequently not only depends on the supply and demand elasticities of a single good, but also on the elasticity of substitution between inputs; the supply elasticity of these inputs, who owns the inputs, and the cross elasticities of demand for other products. The beneficiaries under this model have been expanded from only aggregate producers and consumers under the supply and demand model of a single market to include producers and consumers of various outputs and inputs. This model has been used by Deloitte and Touche in their 1992 analysis of net benefits of government programs and in their 1993 report on how governments affect agriculture. Maier has extended (1994) this analysis to examine the effects at different stages in the marketing chain and for the impacts of imperfect competition.

Gardner (1987b) presents various refinements to the multimarket supply and demand model now used as the standard to examine the transfer efficiency of government policies. One of the extensions is to account for rational expectations where the producer decides how much to produce based on the best information available about future market conditions at the time that production decisions are made. Related to the issue of incomplete information is the inherent uncertainty in agriculture which, as discussed earlier, can be used to justify government action. Instability associated with sharp short term price fluctuations, random production due to natural events, unpredicted macroeconomic policies etc. impose losses on people which may be moderated by governmental intervention. Assuming farmers are risk averse there are social benefits of risk reduction since farmers will produce more when revenues fluctuate less. The subsequent increase in supply will then lower consumer prices. Just, Hueth and Schmitz (1982) show how such producer gains can be measured and conclude that the more inelastic the demand function, the more likely that risk averse producers will gain from stabilization. However, Gardner (1987a) concludes that policy analyses have not been able to incorporate risk considerations quantitatively in any convincing way. Instead, he suggests consideration of risk may be more fruitfully introduced in terms of the supply and demand for price insurance rather than by modifying commodity supply and demand functions.

The closed economy models outlined above can be substantially altered by international trade considerations. For example, an increase in the producer support level may not result in the expected decrease in consumer prices if the region is a price taker in the world market. The text by McCalla and Josling (1985) summarizes the basic economics of alternative policy instruments for importing and exporting countries. The model has been applied by de Gorter and Meilke (1989) in their evaluation of policies being considered by the EC in modifying the Common Agricultural Policy.

A final element to be considered in the assessment of the efficiency of government programs is the excess burden of taxation imposed on the public through the cost of these programs. Substitution effects created by taxes alter economic decisions and create a loss in welfare in addition to the tax revenues collected. Given the possibility of distortionary costs from general income (sales) taxes, it is important to examine whether payments to farmers financed from the collection of these taxes is more or less efficient than consumer transfers to farmers via commodity market intervention (Deloitte & Touche, 1993). Alston and Hurd (1990) propose that taxes be put on specific agricultural commodities until the marginal deadweight cost of distorting consumption in that commodity equals the marginal deadweight costs of the existing income tax. However, Ballard and Fullerton (1992) argue that the marginal excess burden of taxation is close to zero. Deloitte & Touche assume this value for general expenditure programs but not for programs based on raising market prices.

3. SAFETY NET PROGRAMS VS. DECOUPLED FARM PROGRAMS

3.1 An Overview of Canadian Safety Net Programs for Agriculture:

Safety net programs have been an integral part of Canadian agriculture during the post-war period. During difficult times, agricultural producers across Canada have benefited from various support programs under the: Agricultural Stabilization Act (ASA), Western Grain Stabilization Act (WGSA), Crop Insurance Act (CIA), Western Grain Transportation Act (WGTA), Feed Freight Assistance (FFA), Tripartite Stabilization etc. Some of these programs have been modified during the 1970's and in the early 1980's to make them more efficient under the changing economic environment.

Although the modifications served the interests of farm producers during the late 1970's and early 1980's, developments outside the Canadian economy made some of the safety net programs less effective during the late 1980's. This is particularly true for the grains and oilseeds sectors. The emergence of the European Union as a surplus producer of grains and oilseeds intensified the competition for export markets and led to competitive subsidization between the United States and the EU. Small exporters like Canada, Australia and Argentina were caught in the middle. The price of major grains, especially wheat in the international market, fell below $90/t. Even efficient Canadian producers could not cover their costs of production at this price. The safety net programs such as the WGSA and the ASA were judged not to provide enough financial support to grain producers under these circumstances. The federal and provincial governments devised a Special Assistance Program for grain and oilseed producers (called the Special Canada Grains Program). Under this special assistance program several billion dollars were transferred to prairie grain and oilseed producers during the late 1980's. Despite negotiations between the U.S. and the EU, and the launch of the GATT negotiations, the international agricultural trade situation remained largely unchanged. The special assistance programs also generated an equity debate between grain and oilseed producers in eastern and western Canada. Moreover, some of the Canadian safety net programs were coming under increasing criticism during the Uruguay Round of GATT negotiations.

Under these circumstances, the federal Minister of Agriculture initiated the National Agri-Food Policy Review in November 1989. The review was based on four basic principles: market responsiveness, self reliance, regional sensitivity and environmental sustainability. As a result of this review a safety net committee made up of farmers, and federal and provincial representatives was formed to provide advice on the longer term needs and sustainability of the agricultural sector. Based on the recommendations of the Agri-Food Policy Review, the federal government established the Grain and Oilseed Safety Net Task Force in January 1990. The responsibility of the task force was to develop a new national safety net program for the grain sector which could deal with low farm gate revenues. The task force recommended in January 1991, the establishment of the Gross

Revenue Insurance Plan (GRIP) and the Net Income Stabilization Account (NISA) as new safety net programs for agriculture. In March 1991, the Minister of Agriculture tabled the safety net legislation in the form of the Farm Income Protection Act (FIPA) [Bill C-98]. This bill consolidated all existing safety net programs as well as the newly developed programs, GRIP and NISA, under one Act. FIPA also repealed ASA, WGSA and CIA. Through the introduction of GRIP and NISA, the Farm Income Protection Act has dramatically altered the nature of agricultural stabilization in Canada.

The objective of this section is to provide an overview of the existing support programs for Canadian agriculture. The programs were designed to address the price, income and welfare concerns of various commodity groups from time to time. Although the original intent of most farm program has changed through time, to have a better understanding of the policies and programs, an attempt is made here to briefly document the original intent of each of the existing programs. The basic features of each of the programs are described and the possible future directions of the programs are discussed. Finally, an attempt is made to define decoupled farm programs and rate existing farm programs in Canada on the scale of acceptability under the recently concluded GATT Agreements.

3.1.1. The Western Grain Transportation Act (WGTA):

During the late 19th century and early 20th century the federal government used immigration policies and grain transportation subsidies as key instruments for regional development in western Canada. As an important component of the regional development strategy, the federal government signed an agreement with the Canadian Pacific Railway (CPR) in 1887, popularly known as the Crow's Nest Pass Agreement. Under this agreement, the federal government provided a subsidy for the construction of a 300 mile rail line from Lethbridge, Alberta to Nelson, British Columbia and the CPR, in return, agreed to a rate ceiling for moving grain and grain products eastward on its lines. The CPR also agreed to rate ceilings for moving a variety of settlers' effects to the west. The rate ceilings for settlers' effects were discontinued in 1925 and the rates were fixed in statue for grains. A number of amendments were made to the Agreement over the years to make grain by-products and oilseeds eligible for the special rates. From time-to-time, the federal government intervened to maintain freight rate differentials between raw and processed products from prairie agriculture. The primary objectives of this agreement were to stimulate agricultural production, particularly grains and oilseeds in the prairie region, and to reduce the financial risks to the railway companies associated with the construction of railroads across the prairie region, which was sparsely populated and underdeveloped at that time. The secondary objective was to keep the U.S. expansion forces at bay from western Canada.

The railway subsidy worked well for agricultural growth in western Canada. Grain transportation subsidies along with the production incentives implicit in various price and income stabilization programs, introduced since the Second World War, resulted in a huge expansion of agricultural production in the prairie region. New export opportunities abroad and technological progress in agriculture sustained the momentum for expansionary agriculture. In the early 1960's, while the cost of labour and other inputs increased due to inflation, the statutory grain-rail rates remained fixed at the 1925 levels. As a result, Canadian railways were experiencing growing revenue losses on grain shipments. In 1961, the MacPherson Royal Commission reported that the railways were losing money in grain transportation. Consistently large revenue shortfalls on grain shipments starting in 1960, and the lack of public support for freight adjustments to reflect changed circumstances led to the deterioration of the grain transportation system. During the mid 1970's when the export demand for Canadian grains increased significantly, the railway capacity to handle the increased grain shipments to the export ports became limiting. This helped to focus public attention on the fixed grain transportation rates.

In 1975, the Minister of Transport established the Snavely Commission to investigate the costs and revenues associated with transporting statutory grains by the railways, and the Grain Handling and Transport Commission, headed by Justice E. Hall to evaluate the needs for prairie rail branch lines. The Snavely Commission reported that the cost of transporting grain was 2.6 times higher than the statutory rate being paid by the producers while the Hall Commission recommended streamlining some prairie rail branch lines. In light of the findings of these commissions, a number of ad hoc measures were taken to fix the deteriorating grain transportation system and to expand its capacity; boxcars were repaired, hopper cars were purchased, ports were improved. Despite these measures, the grain transportation system continued to deteriorate. Under these circumstances, on Feb. 8, 1982 the federal government initiated a consultative process led by Dr. J.C. Gilson. A number of major policy and financial parameters recommended by previous commissions on grain transportation were used to guide the consultations. A set of basic principles to reform the grain handling and transportation system in Canada emerged from the Gilson consultation process. Based on the recommendations of this consultation process, the federal government passed the Western Grain Transportation Act (WGTA, Bill C-155) in 1983 (Tyrchniewicz 1984).

The key provisions of the WGTA are as follows:

1. **Freight Rates:** Under this Act freight rates are set each crop year for moving grain and grain products and oilseeds to various export destinations. The rates are based on forecast grain volumes, provided by the Grain Transportation Agency (GTA), and the estimated costs to the railways of moving grains to different ports, calculated by the National Transportation Agency (NTA). The freight rate structure is distance-based and is shared by the producers and the government. In 1993/94, for example, the producers and government shares of the freight rate were 42.8% and 57.2% respectively. For a hauling distance of 976-1000 miles the rate was $32.07/tonne; the producer paid

$13,73/tonne and the rest was paid by the government. In the future, the producers' share of the freight rate is expected to rise gradually.

2. **Crow Benefit:** The Crow Benefit is the federal government's revenue shortfall commitment to the railways under the WGTA. The Act provides for the payment of the 1981-82 railway revenue shortfall of $659 million on an annual basis by the federal government to the railways. This payment has been made entirely to the railways up to now. According to the Federal Budget of 1995, this Crow Benefit subsidy will be terminated on July 31, 1995.

3. **Future cost sharing:** The producers would pay a maximum of 3% per year of the future cost increases until 1985-86; any additional cost increases would be borne by the federal government. Beyond the 1985-86 season, the producers share would rise to 6% per year. This provision is no longer relevant. The Crow subsidy will be eliminated on July 31, 1995. The grain shippers will have to pay the full grain shipment costs by rail starting from August 1, 1995. However, the maximum legislated grain freight rates will be retained until 2000.

4. **Volume Limitation:** The Act provides for a volume cap of 31.5 million tonnes of grain. If shipments are higher than 31.5 million tonnes, the additional volume is charged the full cost of transport. This will be less binding after August 1, 1995 and irrelevant after 1999 when the grain freight rates are expected to be deregulated.

5. **Shipper Share Limitation:** Under this legislation, the producers share of the freight rate would not be allowed to exceed a fixed percentage of the weighted average price of the six major grains. The share was increased from 4% in 1984 to 10% in 1988. This provision has not been activated so far.

6. **Eligible Commodities:** The list of eligible products was expanded to include canola seed, oil and meal, linseed oil and meal, sunflower seed and oil, corn, mustard seed, canary seed, triticale, dehydrated alfalfa, and peas, beans, lentil, and their derivatives.

7. **Grain Transportation Agency (GTA):** The Act establishes the Grain Transportation Agency (GTA) and the Senior Grain Transportation Committee, and outlines their responsibilities. In particular, the GTA is responsible for promoting system efficiency, monitoring railway performance and investment, and rail car allocation. Under the Act, the GTA may "hold back" some portion of the annual subsidy to the railways if the railways do not meet performance and investment standards.

8. **Costing Review:** The Act requires the National Transportation Agency (NTA) to review the railways costs of moving grain every four years. The Act also requires the Minister of Transportation to undertake a review of the operations of the major sections of

the Act on a regular basis.

3.1.2. The Future directions of the WGTA:

The domestic and international production and trade environments have changed significantly since the 1980s. The interests and issues which generated the need for the Crow's Nest Pass Agreement and the subsequent enactment of the Western Grain Transportation Act are not as relevant as they were in the past. The transport subsidies are now considered as impediments to the diversification of prairie agriculture favouring the production of high value crops and livestock products. The federal governments financial commitments are also expected to change in light of increasing fiscal constraints. Moreover, under the recent GATT Agreement, the WGTA subsidies are considered export subsidies. In the Federal Budget of 1995, the annual subsidy under the WGTA has been terminated. Farmers shipping grains will have to pay the full grain shipment costs via rail starting from August 1, 1995. A one-time payment of $1.6 B will be made to prairie farmers as compensation for the loss of their crow benefits.

3.1.3. Feed Freight Assistance Program (FFA):

The Feed Freight Assistance program was originally conceived as a war time measure during the Second World War. In 1941, the Federal Department of Agriculture introduced this program in an effort to increase livestock production required to meet the war-time demand for meats. Under this program, the federal government paid a subsidy on the transportation of feed grains from the prairie provinces to eastern Canada and British Columbia. This program lowered the delivered cost of feed grains to livestock producers both in Eastern Canada and British Columbia. Since there were effective price controls over meats during the war, the FFA subsidy ensured a reasonable profit for livestock producers across Canada. The objectives of the program were as follows:

1. To make available adequate supplies of feed to maintain livestock production for domestic and export requirements;

2. To keep the costs of livestock production down during a period of price control over livestock and livestock products; and,

3. To equalize prices paid by users of feed grains across Canada.

The program was so rich during the war time that it virtually eliminated the freight cost of moving feed grains from the prairie provinces to feed deficit areas (i.e., Ontario, Quebec, Maritime provinces and British Columbia). Although it was initiated as a war time measure, it became a part of the post-war Canadian agricultural policy. During the post-war period, the continuation of the FFA was viewed as a way to preserve domestic markets for prairie grains. The original FFA program, however, has undergone a series of changes during the last four decades in response to changes in market conditions.

The opening of the St. Lawrence Seaway in 1959 reduced the costs of transporting grains to Ontario and Quebec and the FFA rates were adjusted to reflect this. In 1966, the federal government enacted the "Livestock Feed Assistance Act" (LFAA) and established the Canadian Livestock Feed Board (CLFB). The Board was given the responsibility of ensuring adequate supplies of feed grains to livestock producers in eastern Canada and in British Columbia at reasonably stable and fair prices. The Board was also responsible for making payments under the FFA program. In 1967, feed corn grown in Ontario and shipped to the Atlantic provinces became eligible for FFA payments. The FFA rates were modified in a major way in 1976. The subsidies under the FFA were eliminated for Ontario and western Quebec and the rates were reduced for the central Quebec. The rates for northern and eastern Quebec and for the Atlantic provinces remained unchanged. In 1980, transportation of feed grains to the Yukon and Northwest Territories became eligible for the FFA payment. Finally, in 1984, all feed grains of Canadian origin (local as well as those produced in other Canadian provinces), which passed through the commercial channels to users in areas eligible for FFA payments, were made eligible for FFA. Also the rates were raised for the Maritime provinces so that the grain prices paid by the Maritime users remained at par with the prices paid by grain users in Montreal. Since 1990, transportation costs beyond the lower St. Lawrence (up to $50/tonne) are eligible for the FFA subsidy. In 1990, the dairy and poultry sectors received about 67% of the FFA subsidies and British Columbia was the largest beneficiary (about 30% of total payments under the FFA).

The Federal Budget of 1995 has also eliminated the FFA subsidy. As of October 1, 1995, the FFA will cease to exist. An adjustment fund has been created to help the farmers benefiting from the FFA subsidies.

3.1.4. The National Tripartite Stabilization Program (NTSP):

The amendments to the ASA in 1975 represented a significant commitment on the part of the federal government to stabilize farm income (not only farm prices) at a politically acceptable level. It expanded the commodity coverage, changed the base period from a ten year to a five-year moving average, increased the guaranteed minimum support level from 80% to 90% of the base period price, introduced cost indexing of the support prices and introduced provisions for joint federal-provincial programs to provide support levels higher than the minimum guaranteed prices in the ASA. While these amendments were supported by most farm groups at that time, steadily increasing feed prices during the early and mid 70's made these programs rather unattractive for livestock producers. British

Columbia and Quebec introduced provincial income support programs for red meat producers which were considerably richer than those provided under the ASA. The red meat producers in other provinces put pressure on their respective provincial governments to implement similar programs.

A wide variety of provincial programs for the red meat sector emerged between the mid-1970's and the mid-1980's. While these programs were voluntary and required producers contributions, the richness of the programs varied considerably across provinces raising serious concerns about the equity of support levels offered. The equity situation deteriorated despite the threat from the federal government for a dollar-for-dollar deduction from its payment under the ASA to provinces which had richer provincial programs. The proliferation of provincial commodity-based price and income support programs also generated a national economic and political problem.

Under these circumstances, the federal and provincial authorities initiated discussions on "tripartite stabilization" programs in the fall of 1977. In January 1985, the ASA was amended to allow the formation of tripartite agreements. Tripartite Stabilization programs for red meats were effective on January 1, 1986 for Alberta, Saskatchewan, Manitoba and Ontario. Tripartite agreements were signed by other provinces for red meats, at a later date. Similar tripartite stabilization agreements were also signed for beans, apples, honey and sugar beets. Thus, the dissatisfaction of red meat producers and other commodity groups with the level of support payments under the 1975 ASA and the subsequent proliferation of provincial support programs were largely responsible for the establishment of tripartite stabilization programs in Canada. The tripartite stabilization programs are commodity specific and some aspects of the programs are designed to suite the needs of specific commodity groups. There are, however, certain generic features of the program. Those are as follows:

1. **Nature:** All producers of a particular commodity receive the same level of support per unit of production across Canada. All commodity plans established under the national tripartite program receive a comparable level of support.

2. **Program Costs:** All costs of the program are shared equally by the federal and provincial governments and participating producers. For some commodities(e.g., hogs, cattle and lambs), restrictions are in place for the maximum share of the program costs to be borne by the federal and provincial governments.

3. **Support Levels & Payouts:** Under this program, support levels are determined based on a guaranteed margin approach. Stabilization payments are made to the producers if the current year's margin falls below the minimum guaranteed margin.

4. **Entry and Exit:** In most cases, enrolment is voluntary up to the initial deadline. After the initial deadline, enrolments are subject to a phase-in rule. Under a phase-in rule,

a new participant will pay the full premiums for a certain period but will receive only partial (but gradually increasing [25% first quarter/year, 50% next, followed by 75% and finally 100% of the payments]) share of any declared stabilization payments. Producers can withdraw from the program by giving a notice three-years in advance. Producers who withdraw cannot rejoin the program until two years after the withdrawal takes effect. Any producers who may want to rejoin the program are considered late entrants and are subject to the phase-in rule. Thus, in most cases, entry and exit are rare.

3.1.5. The Future of the National Tripartite Stabilization Programs in Canada:

Like many other agricultural support programs currently available, the future of the NTSP is uncertain. Under the recently concluded GATT rules, stabilization payments are production and trade distorting and hence, countervailable by Canada's trading partners. It is, indeed, a challenge to devise agricultural stabilization programs which provide politically acceptable levels of support to commodity producers and yet are considered GATT green (i.e., decoupled under GATT rules). The NTSPs for cattle and hogs have already expired as of December 31, 1994. These programs have not been renewed or replaced with any other programs. Indications are that the remaining tripartite stabilization programs will also be discontinued. A number of discussions have been initiated to replace the NTSPs with VAISA type programs. It remains to be seen how such VAISA programs would be designed.

3.1.6. The Gross Revenue Insurance Plan (GRIP):

The Gross Revenue Insurance Plan is one of the two major safety net programs established under the FIPA of 1991. In fact, because of its remarkable departure from previous safety net programs for grains and oilseeds, GRIP has generated much discussion and debate among farmers and policy makers across Canada. At the time of its introduction, GRIP had been hailed in the policy making circle as a new generation safety net program which would eliminate differences in financial support to grain and oilseed producers in eastern and western Canada. The last four years of operation indicate that GRIP has failed to offer harmonized supports to grain and oilseed producers across Canada. Indeed, provincial top-loading continues through GRIP. Consequently, the GRIP in one province looks quite different than the GRIP in another province; both the structure of the program and support levels vary considerably across provinces (Turvey and Chen 1994).

The primary objective of GRIP is to provide gross revenue protection to grain and oilseed producers. In the past, price protection was offered largely through the ASA and the WGSA and limited yield protection was provided through crop insurance programs. The intent of providing price and yield protection through a single program was a clear departure from past tradition. In principle, GRIP is a tripartite stabilization program the direct costs of which are shared by the federal and provincial governments and farmers. The basic features of GRIP are as follows:

1. **Nature:** GRIP is a commodity-based voluntary insurance program in which participating farmers pay premiums and receive indemnities if their market revenues fall below the target revenues in a particular year. GRIP consists of two basic components: crop insurance and market/gross revenue insurance. In some provinces, these two components are integrated but they are offered separately in the majority of the provinces .

2. **Administration:** GRIP is administered provincially. The federal and provincial governments equally share the administrative costs of the program. The cost of insurance premiums is shared by the federal and provincial governments and farmers. Farmers pay 33%, the federal government pays 42% and the provincial government pays 25% of the insurance premiums.

3. **Commodity coverage:** All grain and oilseed crops covered by crop insurance are eligible for GRIP benefits. In addition, on-farm fed grain and grain crop silage are also eligible for this program.

4. **Support levels:** The support levels for each eligible crop under GRIP are determined by using target price and target yield levels. The target price for a crop is determined as the 15-year moving average provincial price for that crop adjusted for changes in Farm Input Price Index. The target yields are the historic average yield figures defined by crop insurance. For those not in the crop insurance, average yields of the last 7 to 15 years (depending on the province) are used as target yields. In most cases, 80-90% of the indexed moving average prices and 70-95% of the historic average yields are used as target figures to calculate indemnities for participating farmers.

5. **Payouts:** Payouts under GRIP are issued though the provincial crop or income insurance agencies. Provinces can make up to three interim payments and one final payment. Interim payments, however, are limited to a maximum of 75% of the total payment for the year. Since the payout levels for GRIP are based on the difference between the target revenue and the market returns for a given year, program payouts can result in a deficit. If a deficit is incurred, the federal and provincial governments advance 65% and 35% of the deficit respectively.

6. **Entry and Exit:** While entry into the GRIP is perfectly voluntary, exiting the program is not. Producers are required to give an exit notice three-years in advance. In addition, a farmer is not allowed to re-enter the program for two years after opting out. However, producers exiting grain farming or leaving farming for good are not penalized.

3.1.7. How Does GRIP Work? An Ontario Example:

Ontario has adopted a GRIP formula which combines market revenue insurance with crop insurance. The target price is based on 80% of the 15 year moving-average Ontario price and the target yield is 80% of the individual producer's long-run average yield. Suppose the 15 year average price is $3.82/bu. and average yield is 120bu./acre. Also, suppose the farmer insured 90% of his historic yield through crop insurance (i.e., at 108bu./acre). If, in a particular year, his yield drops to 60bu./acre and market price is only $2.50/bu., then he receives a payout through market revenue insurance worth (($3.18-$2.50)*(0.80*120)) or $65.28/acre. Crop insurance gives him another $120.00/acre. His market revenue is $150.00/acre but his total (gross) revenue including the GRIP benefit is $335.28/acre.

3.1.8. The Future of GRIP:

The future of GRIP is not very promising. There are economic and political reasons for this grim forecast. The program did not deliver comparable financial benefits to farmers in eastern and western Canada. During the first two years of the program when the world grains markets were depressed, the 15-year indexed moving average price (which included high real prices from the mid to late 1970's) were very attractive and farmers received substantial financial support through the program. However, the indexing formula has no relationship to current market conditions and hence the policy is rooted in the past. The averaging procedure will also eventually reduce the GRIP benefits causing an exodus from the program when payments seem remote.

The actuarial soundness of the GRIP is still a big question. The program has accumulated almost a billion dollar deficit during its first four years. While actuarial soundness is related to the entire life of the program and net payouts are expected during initial years, the voluntary nature of the program makes it difficult to predict the life span over which the GRIP would be actuarially sound. Evidence suggests that the premiums charged have little relationship to the underlying crop risks. Critics also argue that relative to other farm programs GRIP has a higher potential for generating moral hazard and adverse selection problems in agriculture. These problems may also jeopardize the long-run viability of the GRIP as a safety net program. Experts have also voiced their concerns about altered crop portfolio choices induced by GRIP. While these are all legitimate concerns, it is too early to undertake any empirical assessment of these inadequacies.

There are indications that GRIP may suffer a premature death. Its survival needs participation from all provinces. Newfoundland did not implement GRIP, Saskatchewan pulled out of the program at the end of the 1994 crop year and Manitoba is likely to exit at the end of 1995. Alberta has also given a notice of withdrawal. In view of its richness, adverse resource allocation effects at the farm level and its long-run financial viability, the current federal government is planning to discontinue the program and replace it with a whole-farm based income insurance program.

3.1.9. The Net Income Stabilization Account (NISA):

The Farm Income Protection Act of 1991 introduced a second safety net program for agriculture in addition to GRIP called the Net Income Stabilization Account (NISA). This program provides income stabilization through an individual account which encourages farmers to set aside money in individual accounts in high income years for use in bad years. NISA is designed as a whole farm based program in which participating farmers must register all crops. Other distinguishing features of NISA are as follows:

1. **Contribution:** NISA is a voluntary program. Once enroled in NISA, a farmer can have his or her own NISA account. He can contribute up to 2% of eligible net commodity sales (defined as gross farm receipts minus the cost of seed, livestock and feed purchased) in the NISA account each year. This amount receives a matching contribution from the government. The maximum net sale qualifying matching government contribution is set at $250,000 per farm. The cost of the matching deposits are split equally between the federal and provincial governments. In addition to the 2% the eligible sales, a producer may also contribute an additional 20% of net sales up to a maximum of $50,000. But this amount will not be matched. All contributions to the account will earn interest at a competitive rate. In addition, contributions made by the farmer will receive a 3% interest bonus over and above the competitive rates.

2. **Withdrawals:** Under NISA producers may also withdraw funds from their account on an annual basis. There are two ways a withdrawal can be triggered. First, if the farm's gross margin falls below the average gross margin for the previous five years (the stabilization trigger). For example, if the cash costs were $60,000 and net sales $80,000, the gross margin would be $20,000. If the average gross margin for the previous five years was $30,000, the farmer would be able to withdraw $10,000 from his account. Second, if the producers taxable income falls below $10,000 per enroled family member (the minimum income trigger). The farmer can withdraw the larger of the two amounts triggered. However, unlike GRIP, the withdrawal cannot exceed the account balance under NISA. Farmers do not have to make withdrawals as long as the account balance does not exceed their average net sales. Once the account balance is higher than net sales, the farmer can decline to withdraw only once in every five years.

3. **Commodity coverage:** NISA currently covers grains and oilseeds including farm-fed grains and edible horticultural crops (except apples, onions and white and coloured beans which are already covered by the National Tripartite Stabilization Program). In addition, red meats, sugar beets, tobacco, forage, other livestock and supply managed commodities are not currently covered under NISA. To make NISA a decoupled

program according to the GATT regulations, all agricultural sectors would have to be brought under the program. Currently, the concept of a Value Added type of NISA is being discussed for red meats and other sectors which are not included in the current program. However, the dairy sector, and other supply managed sectors are resisting participation because of the stability ensured by formula pricing.

4. **Administration:** NISA is a national program administered by a National NISA committee formed by the representatives of federal and provincial governments and farmers' unions. The head office is located in Winnipeg, Manitoba. The administrative costs are shared by the participants and both level of governments.

5. **Entry and Exit:** Both entry and exit are voluntary under NISA. When a farmer quits farming or fails to report his sales, the government moves to close the account. The entire balance including government contributions and interest accrues to the farmer. The retiring farmer has to withdraw the entire balance within five years. While the farmer's contributions are not taxable, the government matching contributions and the interest earned are, and taxes will be deducted from these amounts at the time of withdrawal.

The future of NISA seems quite promising as a safety net program in Canada. Although offered under the same legislation, there is a fundamental difference between GRIP and NISA. The former is essentially an insurance program; farmers enroled in GRIP receive payouts only under certain circumstances. NISA, on the other hand, is an individual producer's program. The funds contributed by the producer and the federal and provincial governments on the producer's behalf can only be withdrawn by the producer. Thus, a transfer of funds between producers cannot occur under NISA and it may prove to be a good program for encouraging self-reliance among farmers in Canada.

3.1.10. Value-Added Income Stabilization Accounts (VAISA):

The Value-Added Income Stabilization Account (VAISA) is a proposed safety net program which has the potential to replace NISA. As a safety net program, it is identical to NISA in all respects except for the calculation of contributions and payouts. It is proposed that under VAISA the contributions and payouts be based on Gross Value-Added figures rather than net eligible sales. Gross Value-Added is defined as gross farm receipts (including subsidies and income from custom work) less total farm operating expenses, plus all wages paid (to operators, family members and hired workers), plus rent paid (including crop share rent), plus gross property taxes paid, plus interest, plus capital cost allowance (or depreciation). Defined in this manner, gross value-added represents the return to land, labour, capital and management skills committed to farming. A closely related concept, Net Value-Added (which is equal to Gross Value-Added less depreciation charges), is also being discussed by stakeholders.

If implemented, VAISA will be a whole farm income stabilization program and will conform to most of the GATT regulations. Proponents of VAISA argue that a safety net program like VAISA will contribute to more efficient farming in Canada by inducing more rational input use decisions at the farm level.

3.1.11. A Negative Income Tax (NIT):

A negative income tax is a policy tool originally designed to combat poverty by making taxes negative at low income levels. It is based on the notion that in each society there is a poverty threshold; if a farm has an income above the threshold, it pays taxes. If, however, a farm has an income below the poverty threshold, it receives a payment (i.e., receives a tax credit from the government). A negative income tax program is simpler and perhaps easier to administer than many of the existing support programs in Canada. If designed properly, a negative income tax program has the potential of helping the financially constrained small and medium sized family farms to help themselves. Since the incentive to work on the farm will not be compromised under such a program, it may help reduce the burden of chronic and perpetual insolvency for some family farms in the long-run.

Different versions of the NIT have been proposed in the literature. We will discuss only two types to illustrate the basic feature of the program. Suppose that all Canadians agreed that a family of four should be allowed a minimum annual income of $12,000. The objective of the NIT program is to guarantee this income to a deserving farm family without removing it's incentive to work on the farm and become self-supporting in the future. One way to operationalize this program is to give each of the qualifying farmers $12,000 per year and let them find gainful employment in farming or outside. The income they will earn above $12,000 can be taxed at a constant rate (say, 40 cents of each dollar earned will be paid as tax) or at progressively higher rates (i.e., higher the income, the higher the tax rate).

A second version of the NIT could be tied to gainful employment in farming and income tax return. While society guarantees a minimum annual income in principle, it has no obligation to guarantee this income to a healthy adult (farmer or not) who do not work (the physically and mentally challenged and terminally ill are excepted). This is, indeed, a tougher version of the NIT. To qualify for the NIT benefit, for example, a farmer must earn some income from farming and file an income tax return. The government can add a tax credit (say, 15%) on the reported income up to $18,000. Any farmer earning more that $18,000 per year will pay a positive income tax. If earned farm income is zero, the amount of tax credit a farmer will receive is zero (i.e., 0 times 15%).

In a loose federation like Canada where the provinces have diverse income support and redistribution programs, it may well prove to be very difficult to agree on a minimum annual income to be supported throughout the country. If there is an agreement, however, it will go a long way to improve the financial viability of small and mid-sized family farms in this country. Since a negative income tax is calculated based on one's whole farm income, it is production and trade neutral and hence, could be considered 'GATT green'. A synoptic overview of various farm programs is given in Table 3.1.

3.2. Possible Future Directions of the Safety Net Programs for Agriculture:

In order to make domestic agricultural policies compatible with GATT regulations the current safety net programs for agriculture in Canada are expected to be redesigned. In this retooling process some existing programs may disappear and some new programs may be introduced. The following are some of the policy issues which have been discussed in recent months:

1. The Gross Revenue Insurance Plan appears to be in trouble both economically and politically. Saskatchewan has already pulled out of the GRIP. Manitoba is expected to exit as well. Alberta has also given a notice. As support levels under the GRIP decline, farmers in other provinces may find it less attractive, leading to a mass exodus from the program. The GRIP is also subject to our reduction commitments under GATT (1994) because of its production and trade distorting features. It seems likely that the federal government will kill GRIP by the end of 1995. A whole-farm income insurance program has been proposed as a replacement for GRIP. Under this program farmers will pay premiums into the program and will get payouts when farm income drops below their five-year average. However, farmers who get payouts will be defined as high risk and their premiums will go up. To avoid higher premiums, a farmer could withdraw money from his NISA account to supplement income.

2. Another proposal calls for a stronger NISA in 1995. It would be a whole farm based program for any agricultural product. The cost of the program would be shared by the producers (50%), the federal government (33%) and the provincial governments (17%). The value-added form of NISA could be used instead of the currently available NISA.

3. In case market revenue insurance under GRIP is eliminated, an enhanced NISA could replace it. Under this proposal, supply managed commodities could be included in the program and the cost of the program would be shared by producers (50%), the federal government (25%)

Table 3.1: An Overview of the Canadian Safety Net Programs for Agriculture

Program	Starting Year	Basic Features	Efficiency Implications for				
			Farm Production	Input Supplies	Processing Sector	Program Cost	Risk & Uncertainty
Western Grain Transportation Act (WGTA)	1983	- Freight rates are shared by the producers and the government; - The government pays Crow Benefit worth $659 million/year to railways; - Only the initial 31.5 mil. tonnes of grain receive subsidized freight rates; - Subject to our reduction commitments under GATT	Increased for supported commodities	Increased	Reduced	High	Reduced
Feed Freight Assistance (FFA)	1941	- Ensures adequate supplies of feed to livestock producers in deficit regions; - Equalizes feed grain prices across Canada; - Considered 'GATT Green'.	Increased	Increased	Increased	Low	Neutral
National Tripartite Stabilization Program (NTSP)	1986	- Commodity specific; - Support based on a guaranteed margin; - Costs shared equally by three parties; -Subject to our reduction commitments under GATT	Increased	Increased	Increased	High	Reduced
Gross Revenue Insurance Plan (GRIP)	1991	- A form of tripartite stabilization program; - Provides both price and yield protection; - Support based on target price and target yield levels; -Subject to our reduction commitments under GATT	Increased for grains & oilseeds but reduced for others	Increased	Increased	High	Reduced
Net Income Stabilization Account (NISA)[or Value Added Income Stabilization Account (VAISA)]	1991	- Producers contribute 2% of eligible sales (max. $5,000) matched by government contribution; - Producers can contribute additional 20% of eligible sales (max. $50,000); - All producers' contributions earn 3% interest bonus; - Withdrawal can be triggered by a fall in either gross margin or net income below a threshold; - Considered 'GATT Amber'.	Neutral	Neutral	Neutral	Moderate	Neutral
Negative Income Tax (NIT)	Being discussed	- No producer contribution; - Support based on net farm income; - Would be considered 'GATT Green'.	Neutral	Neutral	Neutral	Low	Neutral

and the provincial governments (25%). If supply managed commodities are left out of NISA, the general availability nature of NISA would be compromised under GATT regulations.

3.3 Decoupled Farm Programs:

Decoupled, production neutral and minimally trade distorting are all terms that have been added to the trade policy analysts lexicon in the past decade. While exact definitions of these terms vary across analysts the basic concept is simple; income support to farmers, which may be desirable on political grounds, should be provided in ways that leave production, consumption and hence trade unchanged from its competitive level.

Magiera, et al. have defined a decoupled government payment as one where "neither the implementation nor removal of a payment has any effect on production ... (p.7)". Obviously, in order for the payment to be completely non-trade distorting, it should have no impact on consumption. Using this strict definition of decoupling it is unlikely that any payments targeted to the agricultural sector are completely decoupled since they all affect the level of resources employed in agriculture, labour-leisure choices and/or producers' risk attitudes.

Although completely decoupled farm program payments are rare, there is little doubt that some ways of providing farm income support are more production and trade distorting than others. Magiera et al. categorized programs into six types, ranging from the least to the most trade distorting (Table 3.2). It is useful to review these, noting at the outset that the discussion is focused on domestic policy options. Frontier measures, which are required for the successful implementation of some domestic policies, are seen as the necessary outgrowths of these domestic policies. If the domestic policies are dismantled or reinstrumented in trade friendly ways, then there is little necessity for the border measures.

Turning to Table 3.2, the least trade distorting type of program (level 1) is a program which is generally available across the entire economy and which requires no agricultural activity to obtain. These national policies are not controversial, at least in trade policy terms, and minimally distorting. All nations deem these policies to be politically sovereign and desirable in a modern society; they are not the focus of attention in trade liberalization discussions.

Level 2 programs differ from level 1 programs in that they are available only to the agricultural sector. However, direct payments to individuals do not require the recipient to remain in farming to receive the program benefits. If the payments are tied to a resource, eg. land or labour, this resource is not required to remain in agriculture to receive the payment. Even though these programs are targeted at the agricultural sector, since agricultural activity is not required to receive benefits these policies should remain relatively production neutral. Examples of level 2 programs might include early retirement bonuses paid to older farmers or per area payments used to achieve conservation or environmental goals, while not requiring continued use in agriculture.

Table 3.2: Characteristics of Agricultural Programs and the Level of Trade Distortion

Trade Distortion	Descriptive Level	Characteristics of Programs
Least	Level 1	Available to Anyone No Agricultural Activity Required
Low	Level 2	Available Only to Agricultural Producers No Agricultural Activity Required Payments Unrelated to Output/Input Use
	Level 3	Available Only to Agricultural Producers Agricultural Activity Required Payments Unrelated to Level of Output/Input Use
	Level 4	Available Only to Agricultural Producers Agricultural Activity Required Payments Related to Level of Output/Input Use but With Limits on the Level of Output/Input Receiving Support
High	Level 5	Open-ended Direct Payments Related to the Level of Output/Input Use
Most	Level 6	Administered Prices Applicable to Total Output - Maintained with Border Controls and Involving a Consumption Distortion

The degree of potential distortion increases sharply as programs move into the level 3 category. In level 3, agricultural output is required to receive program benefits. This has the effect of holding land, labour and capital in the agricultural sector, and hence distorts production decisions. However, the fact that the benefits are not tied to the level of output or input use serves to eliminate the incentive to expand agricultural production to increase program rewards.

Most agricultural programs in Canada and elsewhere are level 4 or higher. Level 4 programs link payments directly to the level of output or input use but restrict the size of the program benefits by limiting the quantity of output or input to which the subsidy applies.

Level 5 programs are the same as level 4 programs but the extent of government transfers are open-ended. This provides an incentive to expand production to maximize profits, inclusive of the government payment. The larger and more certain this payment, and the more price elastic the producer's supply response, the more production and trade distorting the program. Historically, Canada has had several programs of this type: the Agricultural Stabilization Act, the National Tripartite Stabilization Program and the Gross Revenue Insurance Program come immediately to mind.

The final category of programs (level 6) provides open-ended administrative price supports coupled with a consumption distortion, which requires border controls to be effective. The Common Agricultural Policy of the European Union is of this type. Level 5 and level 6 programs are the most distorting of those surveyed. These programs change producer's marginal revenue and marginal cost calculations and encourage them to expand output in response to the availability of governmental subsidies.

One of the goals of the Uruguay Round of trade negotiations on agriculture was to provide an incentive for countries to move away from the most trade distorting policies and towards more trade friendly regimes. Unfortunately, no form of agricultural policy was eliminated. However, the constraints on export subsidies (both in volume and expenditure terms) and minimum access requirements will constrain countries use of the most highly distorting programs. In addition, the discipline on domestic support, the identification of "green" programs, the desire to avoid countervailing duties, and individual countries own desire to limit budget exposure will result, over time, in more trade friendly policies.

One issue addressed only indirectly in the work by Magiera, et al. is the effect of government policies that reduce the risk faced by primary producers. Welfare theory suggests that government intervention can be justified where there are incomplete markets in insurance and credit and agricultural producers are unquestionably subject to large and unpredictable market risks. Some risks can be hedged on organized future markets and farmers can also self-insure through precautionary savings, but these tools typically provide protection for only short periods.

The practical definition of decoupled income support is likely to be developed through multilateral trade negotiations. These are the rules that will provide the pragmatic answer to whether a sovereign nation's agricultural policies are in conformity with the commitments it has made in the GATT, and if these policies are countervailable. For that reason it is useful to review what was decided in the Uruguay Round and how Canada's agricultural policies stack up against these rules.

The GATT (1994) agreement on agriculture has adopted two general criteria to define decoupled or "green" programs. Green programs are important because they are not subject to the domestic support reduction requirements negotiated in GATT (1994) and in some cases are exempt from countervailing duty action.

The two general criteria were adopted for "decoupled" programs:

· Support must be provided through a publicly funded programme not involving transfers from consumers; and

· the support in question shall not have the effect of providing price support to producers.

The GATT (1994) goes on to further define specific criteria that can be used to exempt certain types of support to the agricultural sector from negotiated reductions. These can be delineated into four broad groupings: (1) production or trade distorting support that falls below a <u>de</u> <u>minimis</u> standard; (2) support for general services which does not involve a direct payment to producers; (3) direct payments to producers coupled with supply management; and (4) direct payments to producers not requiring supply management. The criteria for each of these "green" program types is reviewed below.

3.3.1. De Minimis Standard:

GATT (1994) states that government support provided to individual agricultural producers and to the sector in general is considered minimally trade distorting if it meets the following criteria:

· product specific domestic support where such support does not exceed 5 percent of the value of production; and

· non-product specific domestic support where this support does not exceed 5 percent of the total value of production.

These rules allow for some minimal support to all commodity sectors.

3.3.2. Support for General Services:

Support provided to the agricultural sector but not to individual producers is exempt from domestic support reductions if it involves: 1) research, 2) pest and disease control, 3) training services, 4) extension and advisory services, 5) inspection services, 6) marketing and promotion services, 7) infrastructure services, involving off-farm capital projects; 8) public stockholding for food security purposes, and 9) domestic food aid.

Programs falling into this category would be classified as level 2 or level 3 programs in terms of their distortionary impacts (Magiera, et al.).

3.3.3. Direct Payments Involving Supply Management:

These programs, level 4 in terms of production and trade distortions, were included in GATT (1994) to exempt certain forms of income support used in the EU and U.S. from the domestic support reduction commitments. Pragmatically, this "omission" was necessary to reach a successful conclusion to the Round.

The specific criteria state that direct payments made to producers are considered minimally trade distorting if:

· payments are based on a fixed area and yield; or

· payments are made on 85% or less of the base level of production; or

· livestock payments are based on a fixed number of head.

Interestingly, the degree of production restriction required to be considered under these criteria in GATT (1994) is left unstated. Under certain conditions these programs would be consistent with the idea of a production entitlement guarantee (IATRC).

3.3.4. Direct Payments to Producers Not Involving Supply Management:

While open-ended direct payments to producers (level 5) are one of the most distorting forms of agricultural program the GATT (1994) has adopted criteria that allows governments to give income support to producers under specified conditions which exempts them from domestic support reduction commitments.

A number of program types are considered under this category. Structural adjustment programs involving producer retirement programs, resource adjustment programs and investment aids are all allowed as long as the payments are not related to current production, prices or input use. Likewise, payments for the relief from natural disasters, environmental programs and regional assistance programs are exempt subject to certain conditions.

However, of most interest for this project are the criteria for decoupled income support and acceptable government contributions to income insurance and safety-net programs.

In order for GATT (1994) to consider income support to be decoupled, eligibility for payments must be determined by clearly defined criteria during a base period. In addition, the amount of the payments should not be influenced by the type or volume of production, prices or the use of factors of production beyond the base period; and no production should be required to receive these payments. The authors are unaware of any serious policy consideration being given to Canadian programs that would meet these criteria.

Of more interest are the criteria for income insurance and safety-net programs. The GATT (1994) criteria for these programs are:

· eligibility for payments based on income loss, which exceeds 30% of average gross income (or the equivalent in net income terms) in the proceeding 3 year period, or a three year average based on the proceeding 5 year period, excluding the highest and lowest entries;

· payments should compensate for less than 70 percent of the income loss; and

· the amount of payments should relate solely to income, not to type or volume of production, prices of factors of production.

If NISA is extended to all commodities, it appears it could be redesigned to conform to these criteria. The empirical question is to what extent a GATT (1994) "green" safety net program would stabilize farm income and consumption, the extent to which it would be production distorting, the political acceptability of such a program, the distribution of benefits from such a program and the transfer efficiency of such a program.

4. A GENERAL APPROACH TO MEASURING THE TRANSFER EFFICIENCY OF GOVERNMENT SUPPORT PROGRAMS

The measure of transfer efficiency must necessarily be identified by the incremental benefits associated with revenue enhancement and risk reduction. The very nature of stabilization policies guarantee that the two attributes are not mutually exclusive and, therefore, ought not to be treated separately.

It is unreasonable to consider a farmer decision making process which excludes simultaneous consideration of risk and return, and this has implications for the assessment of overall transfer efficiency. The following working definitions of risk reducing stabilization policies identify this importance.

1) Risk reducing policies: A risk reducing policy is one in which government stabilization policies are defined in terms of a specific payout or indemnity related in some fashion to a pre-specified target price and the actual cash commodity price at a specific moment, or specific moments, in time.

2) A pure stabilization policy is one in which producers direct (e.g. premiums) or indirect (e.g. set-aside or compliance) costs equal the expected benefits of the stabilization policy. Such a policy is actuarial sound and is thus revenue neutral.

3) A revenue enhancing policy is one in which farmers' costs of participation are less than the actuarial value of the program. In this instance, expected revenue enhancement occurs and is equal to the difference between the farmer's actual cost and the actuarial cost of participation.

While risk reducing transfer policies can, under some circumstances (actuarial soundness), be deemed revenue neutral (expected benefits equal expected costs), it is not true that, under conditions of risk, revenue enhancing policies are not risk reducing. This is clear in definition (3) above for stabilization policies such as NTSP, ASA or GRIP. Even non-targeted policies (such as lump-sum transfers, input subsidies, freight assistance, etc.) which do not affect risk directly can result in a variance preserving shift in expected income. When measured relative to a fixed target, lump sum transfers and other decoupled programs will reduce the chance of actual income falling below the target and can therefore, lead to increased output. These programs will also affect input demand.

The remainder of this section details a theoretical approach to measuring the costs and efficiencies of transfer programs and transfer efficiency in this context. This background will then be used as the basis for developing a farm-level optimization model which will identify portfolio shifts as a result of a variety of stabilization policies. These portfolio shifts will then be used to approximate and identify the transfer efficiency of stabilization programs.

4.1. The Firm's Response to Uncertainty:

Because the majority of risks in agriculture arise from prices and yields most policies have been directed towards stabilizing them. In this section three models of the firm's response to uncertainty are presented. The first two models are simple, based on a mean variance expected utility approach of the farm firm, under perfectly competitive conditions (i.e. price is exogenous). The third model also assumes perfect competition but differs in that it is used to examine the portfolio effects of stabilization policies. In all 3 models the focus is on output response to risk.

4.2. Output and Price Uncertainty:

In this section a simple model of production when yields are assumed deterministic but prices are random is used to evaluate the farm's response to price risk. It is assumed that farmers are risk averse. Under conditions of risk aversion, it is shown in Appendix A that:

> ***When product prices or commodity yields are risky, farmers will produce below the profit maximizing level of output.***

As shown in Appendix A, risk averse farmers will not optimize by setting marginal revenues equal to marginal costs, but will set marginal revenues equal to marginal costs, minus a deduction for marginal risks. This latter deduction represents the marginal income foregone to obtain more stable returns.

The impact of risk on output is shown in Figure 4.1. The farm's average cost curve is AC while MC' and MC represent the farmers marginal costs under conditions of risk and certainty respectively. The difference between the two marginal cost curves is attributed to farmer's risk perception. The risk premium, on the margin, is given by the vertical distance between the two marginal cost curves.

The result is that output is lower under conditions of risk and so are net revenues. Given that total variable costs are given by the area under the MC curve, expected net revenues are reduced by the area abc due to risk aversion.

4.3. The Effect of Price Insurance and Stabilization:

The major goal of government programs is to reduce income fluctuations and this is done to a significant extent by stabilizing prices such as in the Agricultural Stabilization Act or providing price insurance such as market revenue insurance (GRIP) and the National Tripartite Stabilization Policy.

The curve in Figure 4.2 represents the relationship between random prices and price insurance. The bell shaped curve is the probability distribution function, f(P), which describes the universe of possible price outcomes. The mean is given by P_m and risk is measured as a deviation from this mean.

Figure 4.1

Price insurance or stabilization provides a benefit to producers by `stacking' probabilities of outcomes below a target price, at the target price. For example in Figure (2), the density function is truncated at the target price P_z, such that the probability of getting below P_z is zero. For example, if the market price is at P_o, the farmer receives an indemnity equal to P_z-P_o as part of the stabilization payment.

The expected benefits from stabilization/insurance policies are equal to the expected payouts across all states of nature. This relationship is shown mathematically in Appendix B. In agriculture, policy is not designed to charge farmers an actuarial premium for the benefits of stabilization or insurance policies. The, now defunct, Agricultural Stabilization Act did not require producer contributions, whereas NTSP and GRIP charge a premium equal to 33% of the expected value of the policy. In the U.S., participation in the target price-loan program requires cross compliance with conservation policies and land set-aside which also results in some costs being levied against the benefits.

Stabilization policies have two, not mutually exclusive impacts on farm decisions and transfer efficiency. The first deals with the subsidization of premiums, which is income enhancing, while the second deals with risk reduction. The impact of premium subsidization and risk reduction is derived mathematically in Appendix B. The key results are:

1) When farmers pay a less than actuarially fair price for agricultural insurance, marginal revenues per unit of output, increase, leading to increased output;

2) the effects of risk reduction reduces the disutility associated with risk, and the opportunity costs of risk bearing. This in turn leads to increased output, relative to the no policy case; and

3) the effects of income enhancement and risk reduction mitigate each other so that output increases even more when both aspects of agricultural policy are present.

This is shown in Figure 4.3 where output will increase because marginal revenues have increased and the risk premium has decreased.

The reduction in risk causes the marginal cost curve to become flatter, moving it from MC_o to MC_1, and increasing output from Y_o to Y_1, increasing expected net revenues by an amount equal to the area abc. This is termed the risk reduction effect and is directly attributable to the risk reduction policies of agricultural insurance.

Farmers will view the premium subsidy on price insurance and stabilization as an increase in marginal revenues so output increases along the new marginal cost curve MC_1 from b to e, increasing output from Y_1 to Y_2, and net profits by the area abed compared to the net profit without premium subsidy. This is termed the income effect, and is directly attributable to the subsidization of agricultural insurance.

Figure 4.2

Figure 4.3

4.4. Market Impacts of Stabilization and Agricultural Insurance Policies:

The above discussion and theoretical model presented in Appendix B shows a dual response to stabilization policies which can increase output at the farm level. In this section the effects of policy on industry supply and demand are discussed.

In Figure 4.4 the demand curve for the product is shown along with the supply curve S_o, which is more inelastic because of risk and risk aversion, and the true supply curve which is measured by industry marginal costs.

With risk aversion the equilibrium price is P_o and industry output is Y_o. If risk were eliminated through actuarial insurance the short-term response would be to increase output to Y_3, decreasing prices to P_2. In the long run, through a Cobweb type adjustment mechanism, prices and industry output will converge to P_1, Y_1.

The net impact on the economy is to increase consumer surplus by the area bounded by P_o a b P_1 (i.e. to an area given by: II + III + IV) [Figure 4.5]. Since consumers can purchase more output at a lower price, this area represents a net transfer of program benefits to them.

Industry output increases from Y_o to Y_1 at the new price P_1. A gross revenue loss of II + III is given up for a gross revenue gain of VII + IX. But total costs increase from III+VI+VIII to VIII + IX. The change in producer surplus is measured by the difference in profit (net income) between the policy and no policy scenarios.

In the absence of risk reducing polices (i.e., we are at P_0Y_0 on S_0), net income is:

NI_o = II + V

and with the policy in place (i.e., we are at point b on S_1), the net income is:

NI_1 = V + VI + VII

The change in net income (i.e., producer surplus) due to policy is given by:

NI_1 - NI_o = V + VI + VII - II - V

Thus, the producers will gain from the policy only iff:

(VI + VII) > II

Note that this difference will depend on supply and demand elasticities and on the type of supply shift (i.e., parallel vs. pivotal shifts). It was assumed in the above analysis that the expected benefits of agricultural insurance/stabilization equalled the expected costs of the program, so no change in the price or industry marginal cost curve due to premium subsidization is observed.

Figure 4.4

Figure 4.5

However if premiums are subsidized then the shadow price increases from P_o to $P_o + (1+\delta)V$ over an output $\bar{Y}$, which we assume equal to the initial equilibrium level of output.

When producers view premiums subsidization as an increase in price then both price and output will fluctuate widely in the short-run. This will happen because the price signal received from the policy differs from that received from the market. For example, in Figure 4.6, $P_1 + \delta V_1$ is the price. At this price the signal is to increase output to Y_2. But at Y_2 consumers are only willing to pay P_3. In the next response iteration, the price is $P_3 + \delta V_3$ and output is reduced to Y_3. At this lower level of output consumers are willing to pay a higher price, and the price increases signalling an expansion of output.

Ultimately if subsidization is viewed as an increase in notional price an equilibrium may not be obtained and output and prices become, in the long run very unstable, and variance may actually increase with divergent oscillations between low output and high prices and high output and low prices. These models are based on the assumption of a closed economy. The impacts would be much less severe with international trade. If, indeed, competitive import and export markets exist, then net transfers to farmers will increase.

If producers view the subsidy as a decrease in marginal costs then a stable equilibrium can be found, as shown in Figure 4.7. In Figure 4.7, the industry MC curve shifts from S_1 to S_2 and output increases from Y_1 to Y_2 while prices decrease from P_1 to P_2. The transfer of income to producers through subsidized premiums will ultimately end up as a gain to consumers through an increase in consumer surplus. The extent of gain will be lower if the policy is coupled with supply restrictions or other compliance measures. While such restriction can lead to an increase in benefits transferred to farmers it comes at a cost to society as a whole.

4.5. The Transfer Efficiency of Crop Insurance:

Crop insurance is offered in many forms to farmers across Canada. Provincially administered, and financed by provincial, federal and farm contributions, it has been widely adopted by farmers and, unlike many of the price based insurance/stabilization policies, has remained fairly consistent over time.

Like price insurance the effect of crop insurance is to truncate downside yield risks. However, the nature of risk reduction and the marginal risk response is slightly different, and is derived in Appendix C. Like price insurance, crop insurance reduces risk by truncating the variance of yields. If insurance is offered on an actuarial basis then the marginal cost curve becomes flatter (more elastic) and an overall increase in output can be observed.

In Figure 4.8, MC_0 is the marginal cost adjusted for risk premium and is represented by a solid line. The marginal cost curve MC_2 represented by the dashed line would have been the actual marginal cost curve in absence of risk. Thus, if an actuarial priced premium is charged for the crop insurance, output will expand from Y_o to Y_2. This output response will be entirely due to risk reduction. Short run revenues will increase by $Y_o abY_2$, and net expected profits will increase by the area abc.

Figure 6

Figure 7

Subsidizing crop insurance premiums can also have an effect on output. This is shown in Figure 4.9. Depending on the nature of risk and degree of premium subsidization, output will increase from Y_2 to Y_3. Without insurance, marginal profit is given by the area Pao. With actuarial priced insurance, output increases to Y_2 and marginal profit increases by the area abc. Finally, with subsidized premiums the marginal cost curve shifts to the right, output increases to Y_3, and net profits increases by an area cde.

4.6. The Market Effects of Crop Insurance:

As in the price insurance/stabilization case crop insurance can have an impact on prices at the aggregate level. This is shown in Figure 4.10.

In the absence of risk aversion, production is at Y_o and the market price is P_o. The introduction of crop insurance will, in the short run, increase output to Y_2 due to the risk reduction effect, and to Y_3 due to the income (subsidy) effect. In the long run, as markets adjust to excess supply conditions following a cobweb type adjustment procedure, unsubsidized insurance would result in output at Y_1 and a price P_1, and when subsidized, equilibrium results in output Y_2 at price P_2.

Without crop insurance, consumer surplus is given by area a and producer surplus is given by b+e+j (Figure 4.11). Risk reduction with actuarial premiums increases consumer surplus by b + c + d. Producer surplus decreases by b + c + d but increases by f+g+k. If the objective of policy is to transfer benefits to producers through stabilizing risks, it is unlikely that producers will be the primary beneficiary. The greatest gain may go to consumers.

Finally, the effect of subsidizing premiums is to increase output and decrease price further (to P_2 and Y_2). Consumers gain e+f+g+h+i which is a loss to producers, but producers also gain an area represented by l+m+n.

4.7. Discussion on the Transfer Efficiency of Agricultural Insurance Policies:

The previous discussions focused on two aspects of transfer programs. It assumes that producers are initially risk averse and due to this risk aversion output is reduced below its socially optimal level.

To combat this, public policy provides an array of transfer programs to help farmers. These programs do two things: first they reduce risk and second they increase expected returns.

While the impact on consumers is clear - they benefit by having lower prices on more output - the impact on farmers is less obvious. Factors which affect producer surplus or enhanced net income are the relative elasticities of supply and demand. If the demand curve is very elastic, for example, the gains to consumers would be relatively less, while the gains to producers would be relatively more.

Figure 4.8

Figure 4.9

Figure 4.10

Figure 4.11

Collectively both price insurance and crop insurance used together can lead to a significant increase in output. The absolute change in output, and the intermediate to long-term market impacts depend on the elasticities of supply and demand. If supply is fairly inelastic the inevitable outcome is that it becomes less inelastic, but the change may not be so great.

The impact on market prices will, in the intermediate to long-run, result in a decrease in domestic prices, with the greatest reduction occurring for inelastic demands. Domestic price changes will, however, be dampened if an export market exists to absorb some of the excess supply.

4.8. The Impact of Stabilization Programs on Input Demand and Input Markets:

Under classical assumptions input demand is a function of output and the relative prices of inputs, while supply is a function of commodity prices and input prices. Through the economic relationships (vis a vis Hotellings Lemma) between the cost function and the profit function input demand can be expressed as a function of output prices and input prices.

As shown in Appendix D, the response in input use to an increase in expected marginal revenues will increase the demand for agricultural inputs. The result implies an outward shift in the input demand curve in response to a change in expected output price due to insurance. Costs to producers increase by the area $W_o(X_1-X_o)$ which is a direct increase in revenue to suppliers.

In the intermediate to long-run input supply will increase to meet the excess demand and input prices will increase.

The adjustment response to agricultural insurance is thus an increased use of inputs and an increase in price. Producer's costs ultimately increase by $W_1X_2-W_oX_o$ for total costs of W_1X_2.

Revenues to input suppliers increase from W_oX_o to W_1X_2, but total costs increase by the area below the supply curve and bounded by X_2 and X_o. Thus the direct effect of subsidized agricultural insurance in which $dP > 0$ is to increase costs to farmer and revenues to input suppliers. The degree by which the input demand curve shifts outwards depends also on farmer's degree of risk aversion and the response to risk.

4.9. NISA and Whole Farm Programs:

The economics of a NISA type program has not previously been determined. NISA and VAISA type programs have been designed to encourage self reliance in meeting liquidity requirements when adverse economic conditions prevail.

One approach to investigating the economic consequences, and transfer efficiency of NISA is to view the problem in the context of a savings-consumption problem rather than a production problem. This view is based on the premise that farm households are prudent in that they are willing to set aside current consumption as precautionary savings for stabilizing future consumption.

With NISA the transfer efficiency of funds are measured in terms of the matching government contributions, and the interest rate premium received on (eligible) deposited funds. The problem is to determine whether or not the transfer of these funds results in portfolio and production effects, as a result of increased risk taking.

4.10. A Simplified Approach to the Analysis of NISA and NISA Type Programs:

The introduction of whole farm insurance is a new concept in delivering public policy programs. There are, in essence, two distinct forms of whole farm insurance. The first is whole farm income insurance which provides a payout to farmers if income from operations falls below 70% of income from the previous years, averaged. These programs affect output by truncating the variance of the farm crop portfolio directly. Farmers' response to the program is based primarily on the policy parameters such as target incomes, and the amount by which portfolio variance can be reduced through truncation. A rational response to whole farm income insurance is to substitute less risky crops with more risky ones. The amount of substitution depends on the target income level (e.g. 70% or 85%) and the amount by which the actuarial value of the program is subsidized. The move towards higher risk and return opportunities will increase with increased coverage levels and subsidies. However, since the actuarial value of portfolio insurance increases, it is unlikely that such a program will encourage an otherwise risk averse farmer to behave as a risk neutral, profit maximizing farmer. The reason for this is that the marginal increase in risk, and hence premiums, will at some point exceed the marginal increase in expected benefits. At this point it would no longer be rational for the farmer to substitute for further risk increases.

In contrast to whole farm insurance, NISA and NISA type programs, have a mechanism which works through a savings account. In years in which net income (net eligible sales) exceeds historic income, money is deposited into an interest earning savings account which earns a premium rate, and deposits are matched by the government. For years in which net eligible sales are less than the historic average farmers can withdraw from the NISA account to make up the difference.

The mechanics of NISA has the appearance of separating savings/consumption patterns from production. Because withdrawal in poor years is not mandatory, the likely consequence is that NISA is viewed as a buffer to stabilize variability in consumption, rather than farm income per se. Because savings-consumption patterns are separated from production decisions by time, NISA type programs will have only a modest impact on production decisions. As shown below, factors which can possibly impact production decisions are the perceived correlation between production and savings; the subjective probability of contributing to, relative to withdrawing from, the NISA account; the proportion allowed to contribute to the NISA account; risk attributes; and levels of risk and return.

4.10.1. An Analytical Approach to Analyzing NISA

NISA distinguishes between two types of profits, net eligible sales, and other income and costs. Defining Π as random profit, Π_1 as random net eligible sales, and Π_2 as other net income,

$$(4.1) \quad \tilde{\pi} = \tilde{\pi}_1 + \pi_2$$

with expected profits equal to Π and variance equal to σ^2_p, where the subscript p denotes that prices are the random variable of interest. For purposes of this analysis it is assumed that contributions and withdrawals are made relative to gross margins. This is more consistent with the notion of value added income (VAISA). Hence,

$$(4.2) \quad \begin{aligned} \tilde{\pi}_t &= P_t Y_t - C_t(Y_t) - F_t \\ \tilde{\pi}_1 &= \tilde{P}_t Y_t - C_t(Y_t) \\ \pi_2 &= -F_t \end{aligned}$$

where P_t is price in period t, Y_t is output in period t, F_t are fixed costs in period t, and $C_t(Y_t)$ is the firm's cost function with $C'(y) > 0$.

If Π^* is the target level of income then a contribution of δ% of Π_1 is made to the stabilization account if $\Pi_t > \Pi^*$. This amount is matched by government transfers and earns a 3% interest rate bonus. Farmers can also contribute an additional 20% of eligible sales, but this is not matched by the government. If $\Pi_t < \Pi^*$, then farmers have the opportunity of withdrawing $\Pi^* - \Pi_t \geq 0$ from the NISA account. The two outcomes are mutually exclusive; one cannot withdraw and deposit at the same time.

The expected profits for a NISA type program is given by

$$(4.3.) \quad E[\pi)] = (PY-C(Y)) - \delta(PY-C(Y)) + \psi\delta(1+r+\theta)\ (PY-C(Y) + V$$

In (4.3) (PY - C(Y)) is expected net margin. In each year a proportion δ is withdrawn and placed in the NISA account. This account is matched by some proportion ψ (e.g. ψ = 2), and the total deposit earns the market rate of interest r plus a premium θ. In the event that C(Y) > PY the farmer can withdraw from the account an amount equal to $V = \text{Max}\ [R^* - (PY - C(Y)),0]$ where R^* is a critical margin requirement.

In this construct either prices or yields can be considered random. For simplicity it is assumed that only prices are random. Since prices are random and stochastic, a NISA-type program has the interesting attribute that farmer's contributions are stochastic, since they depend on P, and consequently accumulated savings are random.

Expected returns (equation (4.3)) can be rewritten as,

$$(4.4.)\quad E(\pi) = (PY - C(Y))\ (1+\delta(\psi(1+r+\theta)-1)) + v$$

and its variance is given by,

$$(4.5.)\quad \sigma^2 = Y_2(1+\delta(\psi(1+r+\theta) - 1))^2\ \sigma_p^2 + \sigma_v^2 - 2\rho_{pv}Y(1+\delta(\psi(1+r+\theta) - 1))\sigma_p\sigma_v\ .$$

In (4.5) variance increases with respect to all of the policy parameters including owner contribution, government matching, and interest rates. This increase in variance is a direct result of the fact that savings and savings-investment earnings are stochastically related to price uncertainty. The term σ^2_v is the variance of withdrawals from the NISA account. It too is a random variable which depends on the outcome of P. Its relationship to P is measured by the covariance term in Equation (4.5), where ρ_{pv} is the correlation coefficient between NISA withdrawals and random prices. ρ_{pv} will always be non positive since an increase in withdrawals is triggered by a fall in prices. If farmers contribute to NISA, but never opt to withdraw then this correlation coefficient will equal 0.

Defining $\delta^* = (1 + \delta (\psi (1 + r + \theta) - 1))$, the expected utility is given by

$$(4.6)\quad U(\pi) = (PY - C(Y))\ \delta^* + V - \frac{\lambda}{2}\ (Y^2\delta^{*^2}\ \sigma_p^2 + \sigma_v^2 - 2\rho_{pv}Y\delta^*\ \sigma_p\sigma_v)$$

First order conditions yield

$$(4.7)\quad \frac{\partial U(\pi)}{\partial Y} = (P - C'(Y))\ \delta^* - \lambda Y(Y\delta^{*^2}\sigma_p^2 - \delta^*\ \rho_{pv}\sigma_p\sigma_v)$$

and,

$$(4.8)\quad Y^* = \frac{(P - C'(Y))\ \delta^*}{\lambda(\delta^{*^2}\sigma_p^2 - \delta^*\rho_{pv}\sigma_p\sigma_v)} = \frac{(P - C'(Y))}{\lambda(\delta^*\sigma_p^2 - \rho_{pv}\sigma_p\sigma_v)}$$

There are several simplifications in this attempt to derive a tractable model for empirical measurement of the effect of NISA. For example, it is possible that there is a response $\partial V/\partial Y$ and $\partial \sigma_v^2/\partial Y$ in which output levels affect the expected withdrawals and the variance of those withdrawals. It is, however, unlikely that this should occur in practice simply because risk is captured through price variability, and most of this affect is captured through the price-savings covariance. Also, as long as expected growth in savings exceed withdrawals, it is unlikely that the incentives would exist to purposefully manipulate savings withdrawals.

From Y^* the effect of δ^* is to increase output through its risk reducing effects;

$$(4.9) \quad \frac{\partial Y^*}{\partial \delta^*} = \frac{-(P - C'(Y))\sigma_p^2}{\lambda(\delta^* \sigma_p^2 - \rho_{pv}\sigma_p\sigma_v)^2} \leq 0$$

Therefore, it must be true that $\partial Y^*/\partial \psi < 0$, $\partial Y^*/\partial r < 0$, and $\partial Y^*/\partial \theta < 0$. On the surface these results do not appear to be intuitive. However, what they imply is that as δ,ψ,r, and θ increases they become relatively more important in maximizing expected utility. As savings and potential earnings from savings increase, it is optimal to reduce risk in order to enhance the expected benefits from the NISA account. In a more general problem of portfolio choice this result would imply that in order to stabilize contributions to the NISA account, and hence returns to the NISA account, farmers would diversify out of high risk crops and into low risk crops. The result parallels an investment strategy in which wealth is transferred out of risky assets and into risk free investments as the benefits of risk free investments increase relative to risky investments.

This diversification or reduction in revenue risk is mitigated by savings, and the correlation between price risk and withdrawals. Differentiating Equation (4.8) with respect to ρ_{pv} yields $\partial^2 Y^*/\partial\delta\partial\rho_{pv} \geq 0$, which implies that the more highly correlated are withdrawals to price risk, the greater the output. A high correlation would indicate a high frequency of withdrawals, and hence the savings incentive is somewhat diminished. A correlation equal to zero would imply that the NISA account is being used as a pure savings account, and is not used to buffer consumption.

An alternative approach to assessing NISA type programs using Equation (4.8) as

$$(4.10) \quad Y^* = \frac{(P - C'(Y))}{\lambda\sigma_p^2(\delta^* - \rho_{pv}\sigma_p\sigma_v) / \sigma_p^2} = \frac{P - C'(Y))}{\lambda\sigma_p^2(\delta^* - \beta_{pv})}$$

where β_{pv} is the least square regression coefficient of withdrawals regressed against output prices. Since $Y^* \geq 0$, i.e. output must be non-negative, then it must be true that $\delta^* > |\beta_{pv}|$. Here $|\beta_{pv}|$ can be defined as the absolute value of $\partial V/\partial P$, the rate at which NISA withdrawals change with respect to a change in prices. With a 2% eligible sales contribution, matching contributions from government, and interest rate plus subsidy of about 9%, $\delta^* = 1.0226$, so for positive output response with NISA stabilization, $|\beta_{pv}|$ must be less than 1.0226.

Finally the above assumes that there is sufficient liquidity in the NISA/VAISA account. The balance in the account is equal to the annualized future value of expected NISA account balances, i.e.

$$(4.11) \quad S_t = \bar{S} \left[\frac{(1 + r + \theta)^{t-1}}{r + \theta} \right]$$

where S is the average or expected savings available. A necessary condition for the above results to hold is that

$$(4.12) \quad \bar{V}_t \leq \bar{S} \left[\frac{(1 + r + \theta)^{t-1}}{r + \theta} \right] \ .$$

Quite clearly, if expected withdrawals are greater than the NISA account balance, then the liquidity provided by the NISA account is inadequate to induce any output response and producers will maintain a higher level of output and risk.

From the analysis herein it does appear that some aspects of NISA may not be decoupled from production. The critical variable most likely to increase output is δ, the farmers contribution to the NISA account. As might be expected, the larger the allowable contribution the larger the increase in output. This response will be lower for more risk adverse individuals and high risk crops. It is interesting to note that since commodity variance is not truncated, as in the commodity specific programs, signals related to risk and return are maintained.

If any output effect is observed with NISA then it must be due to the relationship between savings and consumption. However, output response will not generally be directed towards higher risk - higher profit crops. Rather, the more likely response is to increase production of low risk and low return crops. Furthermore, any effect would not occur initially but only as riskless savings increase. If riskless savings are uncorrelated with risky production decisions there is an opportunity to increase risk taking activity, with the safe investment being used to leverage increased risk. However, this effect is dependent on the amount of funds in the NISA account. For example, if market revenues for crops sold increase over time then so will deposits and accumulated deposits in the NISA account. However, if consumption smoothing exists when markets are volatile there will be sufficient uncertainty in the NISA account balance to dampen any incentives to increase production risks.

The implication is that funds transferred to farmers through the NISA program will not be transferred to other agents in the agri-food sector. At most NISA savings would be used to satisfy payable accounts on expenses used in production but NISA in itself would not cause those expenses to be incurred.

4.11. Summary and Conclusions:

This section has developed theoretical models related to commodity specific agricultural insurance policies and examined them within the context of transfer efficiency.

With respect to agricultural insurance the following results pertain:

1) Farmers participating in programs such as GRIP or NTSP will respond to reduced risk by increasing output. This result follows from theoretical arguments which assign a risk premium to risk averse behaviour. This premium is a function of risk, and decreases with risk reduction. With respect to agricultural policies risk is reduced through truncation of the underlying probability distribution.

2) When premiums are subsidized there is a greater output response. In general, subsidized premiums can be viewed as an increase in marginal revenues. As marginal revenues increase relative to marginal costs (including the risk premium) new equilibria are established at outputs levels higher than what would have occurred without them. The same general results hold for crop insurance.

3) As output increases so does the demand for inputs. Risk reduction, and or premium subsidization tends to make the supply curve more elastic. In response to this market prices to consumers fall, although this may not be sustainable in the long run as markets adjust. In fact, in the situation where producers view subsidies as a premium, an equilibrium can never really be achieved as market signals become mixed with revenue increases due to premium subsidies. If, however farmers view premium subsidies as a reduction in marginal costs, then a long term stable equilibrium for market prices and supply can ultimately be determined.

4) Agricultural insurance in general, and price insurance in particular, leads to an increase in expected revenues. This has a direct impact on input demand to satisfy increased output. The result is a transfer of program benefits to the suppliers of inputs, and an increased cost to farmers.

The neutrality of commodity specific programs is questionable. However, one should be cautioned about making broad statements in regards to whether all policies fall into the GATT 'amber' category. There are two responses to stabilization. The first is through risk reduction. Farmers' response to risk reduction is a natural one and should not be considered an 'amber' response if in fact premiums are actuarially fair. For example, farmers will behave in a similar fashion to selection of options on futures contracts as a risk management tool.

The problem in regards to GATT and other trade agreements is in the subsidies associated with these policies rather than the policies themselves. Farmers' response to subsidies is an income effect which exacerbates any output response from risk reduction. Importantly, any challenge to these programs should be targeted only to the incremental response to the income effect, not the risk reduction effect.

5) Since the gains from incremental risk taking are high relative to the possible

increase in NISA contributions it is unlikely that NISA will encourage risk taking activities. On the contrary, as allowable contributions increase they become relatively more important in the economics of production process. As these savings become more important economically, farmers will have the incentives to decrease revenue risks. This could be achieved through reduction in output or through diversification into lower risk crops. If the diversification strategy is used an increase in low risk crop production may be observed. Because of the relatively low contributions (2%) required for the NISA (or VAISA) account it is unlikely that any portfolio shifts will be significant from a macro economic perspective. Furthermore, any response will likely be dampened if NISA withdrawals are highly correlated with decreased prices (or yields).

5. FRAMEWORK FOR INVESTIGATING TRANSFER EFFICIENCY

5.1. Incorporating the Stabilization Model Framework into the Deloitte and Touche Framework:

This section provides an approach to incorporating the stabilization framework into the Deloitte and Touche framework. As discussed earlier, the theoretical model is general, and holds for NTSP, ASA, GRIP or any other program which provides commodity specific support. The foregoing is developed as a prototype for a single commodity only, and as such should be adaptable to the Deloitte and Touche Framework.

The first 3 equations of the Deloitte and Touche framework are given by:

$$(5.1) \quad Q = Ga^{\alpha}b^{\beta}$$

$$(5.2) \quad P_a = (P+S)\ \alpha Ga^{\alpha-1}\ b^{\beta}$$

$$(5.3) \quad P_b = (P+S)\ \beta Ga^{\alpha}\ b^{B-1}$$

where Q is output, G is a constant, a is the level of farmer owned inputs, α its production coefficient or elasticity, b the level of purchased inputs, β its production coefficient or elasticity, P_a is the price of farmer owned inputs, P the commodity price, S the level of subsidy, and P_L the price of purchased inputs.

From previous sections of this report, and Appendix B the first order condition for a risk averse producer in the presence of risk reducing stabilization policies if given by,

$$(5.4) \quad P + (1-\delta)V = C^{/}(Y) + \lambda Y\sigma_T^2$$

where δ is the percentage subsidy, V the actuarial cost and benefit of agricultural insurance, C'(Y) is the marginal cost of output, λ is the risk aversion coefficient, Y is output or yield (Y = Q/a), and σ_T^2 is truncated variance.

To maintain consistency with the Deloitte and Touche model, Equation 1 in Appendix A can be used to replace Equation 1 in the Deloitte-Touche framework. This yields a utility function of

$$(5.5) \quad E(U) = PQ - aPa - bPb - \frac{\lambda}{2}\ Q^2\sigma_p^2$$

This form of the Deloitte Touche model assumes that λ is the average risk aversion coefficient of producers, and that Q is aggregate output.

The first order conditions are given by,

$$\frac{\partial E(U)}{\partial a} = \alpha PGa^{\alpha-1}b^{\beta} - Pa - \alpha\lambda QGa^{\alpha-1}\, b^{\beta}\, \sigma_p^2$$

$$\frac{\partial E(U)}{\partial b} = \beta PGa^{\alpha}\, b^{\beta-1} - P_b - \beta\lambda QGa^{\alpha}\, b^{\beta-1}\, \sigma_p^2$$

and,

$$(5.6) \quad P_a = \alpha Ga^{\alpha-1}\, b^{\beta}\, (P - Q\lambda\sigma_p^2)$$

$$(5.7) \quad P_b = \beta Ga^{\alpha}\, b^{\beta-1}\, (P - Q\lambda\sigma_p^2)$$

In an economy without any subsidies (5.6) and (5.7) would capture the output effects of a risk averse economy. The impact of risk is to dampen demand for inputs. For example,

$$(5.8) \quad \frac{\partial P_a}{\partial a} = \alpha(\alpha-1)\, \frac{Q}{a^2}\, (P - Q\lambda\sigma_p) - \frac{Q^2}{a^2}\lambda\sigma_p^2\, \alpha^2 \qquad < \quad 0$$

$$(5.9) \quad \frac{\partial^2 P_a}{\partial a \partial\lambda} = -\alpha(\alpha-1)\, \frac{Q^2}{a^2}\, \sigma_p^2 - \alpha^2\, \frac{Q^2}{a^2}\, \sigma_p^2 > 0 \ \ if\ \alpha > 1/2$$

which in turn implies that risk averse producers will use less of the input than (say) risk neutral producers.

5.2. Transportation and Ad Hoc Subsidies:

The basic Deloitte-Touche model assumes a subsidy which is independent of risk. Transportation subsidies, and ad hoc deficiency payments would fall into this category of support. The only impact this has on the model is to add to the output price, i.e. (P+S) rather than P, and Equations (5.6) and (5.7) become

$$(5.10) \quad P_a = \alpha Ga^{\alpha-1}\, b^{B}\, (P + S - 2\lambda Q\sigma_p^2)$$

$$(5.11) \quad P_b = \beta Ga^{\alpha}\, b^{B-1}\, (P + S - 2\lambda Q\sigma_p^2)$$

Risk under risk aversion will still dampen input demand and lower output, but the impact of including S is to shift the demand curve outward. Thus input demand will ultimately be higher than the case without subsidy, but will still be lower than that predicted for a risk neutral economy.

5.3. Stabilization Programs:

Stabilization programs differ from transportation or ad hoc subsidies because they reduce risk by truncating the variance, and increasing expected revenues through premium subsidization. On an actuarial basis (1-δ)V is the net benefit of the program which equals the actuarial premium, and δ is the actual premium paid by the producer i.e. (1 - δ) is the level of subsidy). The risk effect is such that $\sigma_p > \sigma_T$ where σ_T is truncated risk.

The input demand equations for a stabilization program defined by

$$(5.12) \quad P_a = \alpha G a^{\alpha-1} b^{\beta} (P+(1-\delta)V - 2Q\lambda\sigma_T^2)$$

$$(5.13) \quad P_b = \alpha G a^{\alpha-1} b^{\beta} (P+(1-\delta)V - 2Q\lambda\sigma_T^2)$$

Two impacts that such programs have on input demand and output are premium subsidization and risk reduction. The effect of increased subsidy is given by

$$(5.14) \quad \frac{\partial P_a}{\partial \delta} = -\alpha G a^{\alpha-1} b^{\beta} V \quad \leq \quad 0$$

indicate that all other things being equal, an increase in δ (i.e. farmer pays more of the premium) the shift in the demand curve will be less, and demand will decrease.

$$(5.15) \quad \frac{\partial P_a}{\partial a} = (\alpha-1) G a^{\alpha-2} b^{\beta} (P+(1-\delta)V - 2\lambda\sigma_T^2) \quad < \quad 0$$

$$(5.16) \quad \frac{\partial^2 P_a}{\partial a \partial \delta} = -(\alpha-1) G a^{\alpha-2} b^{\beta} V \quad \geq \quad 0$$

$$(5.17) \quad \frac{\partial^2 P_a}{\partial a \partial \lambda} = -2(\alpha-1) G a^{\alpha-2} b^{\beta} V \quad \geq \quad 0$$

(5.18) $$\frac{\partial^2 P_a}{\partial a \partial \sigma T} = -2\lambda(\alpha-1)G a^{\alpha-1} b^{\beta} V \geq 0$$

Equations (5.15) through (5.18) show how demand changes along the demand curve. Equation (5.15) shows that the demand curve is downward sloping. Equation (5.16) shows that the impact of a subsidy on actuarial premiums (i.e. a decreasing) results in an increase in the demand for inputs and will result in increased output. This is the income effect. Equation 5.17 reiterates theoretical results that demand decreases at an increasing rate with increased risk aversion. Equation (5.18) shows that demand decreases at an increased rate with respect to increased risk. But the impact of stabilization policies is to reduce risk. Hence as risk decreases due to the truncation effect, input demand and output increases.

5.4. Incorporating NISA into the Deloitte and Touche Framework:

In the context of the Deloitte and Touche Framework a NISA-type program can be incorporated into the prototype model. From the initial premise of an expected utility of profit mean-variance model the objective is to

(5.19) $$\text{Maximize } EU(\pi) = (PQ - aP_a - bP_b)\delta^* + V - \frac{\lambda}{2}[Q^2\delta^{*2}\sigma_p^2 + \sigma_v^2 + 2Q\delta^*\rho_{pv}\sigma_p\sigma_v]$$

Where δ^* is as defined with equation (4.6). Differentiating (5.19) with respect to a and b yields,

(5.20) $$P_a = \alpha\frac{Q}{a}[P - \lambda(Q\delta^*\sigma_p^2 + \rho_{pv}\sigma_p\sigma_v)]$$

and,

(5.21) $$P_b = \beta\frac{Q}{b}[P - \lambda(Q\delta^*\sigma_p^2 + \rho_{pv}\sigma_p\sigma_v)]$$

where δ^* is the farmer's contribution to the NISA/VAISA account, V is the expected withdrawal from the NISA account, σ_v^2 is its variance, and ρ_{pv} is the coefficient of correlation between prices and savings withdrawals, which as discussed in the theoretical section should be non positive.

The effect of δ^* on input demand can be observed by differentiating P_a or P_b, e.g.

$$(5.22)\quad \frac{\partial P_a}{\partial \delta^*} = \alpha \frac{Q^2}{a}\ \lambda\sigma_p^2 \ < \ 0\ ,$$

Equation (5.22) implies that NISA may result in a decreased demand for purchased inputs as either farmer contribution, government contribution, or interest rates increase. Risk aversion and price risk, as in the other models lead to a decrease in the demand for purchased inputs, but whatever decrease in aggregate output may be observed in the face of risk aversion or price risk is diminished with NISA. The actual output response, however, would be small if δ is small (i.e. 2 or 4%).

The correlation or covariance between prices and savings withdrawal is also an important determinant of input demand and output. The correlation between prices and NISA withdrawals will be negative, such that a fall in prices would trigger a withdrawal from the NISA account. Since $\rho_{pv} < 0$, the more negatively correlated are prices and withdrawals, the greater the increase in input demand. Rationally, this suggests conservative behaviour if withdrawals are frequent, purchasing less inputs and producing less output.

As discussed in the theoretical section computation of the relationships between risk and withdrawals is problematic. A pragmatic approach to enumerating this could be to regress aggregate owner withdrawals against the commodity price, P_t, for a single commodity, or price index for multiple commodities, using simple OLS regression, e.g.[1]

$$(5.23)\quad V_t = \beta_o + \hat{\beta}_{pv} P_t + e\ ;$$

where $\beta_{pv} = \rho_{pv}\sigma_p\sigma_v/\sigma_p^2$. One can rewrite (5.20) as

$$(5.24)\quad P_a = \alpha \frac{Q}{a} \left(P - \lambda\sigma_p^2\ (Q\delta^* + \beta_{pv})\right)$$

and substitute β_{pv} in (5.23) for β_{pv} in (5.24).

The foregoing models which incorporate risk into the Deloitte and Touche model may not be easy to implement because of data limitations. In addition to the Deloitte-Touche data requirements, values on actuarial costs of insurance, risk aversions coefficient, and ex-ante and ex-post measures of variance and the truncation effects on variance or measure of variance reduction are needed. One approach to resolving some of these issues is the use of farm level optimization models. A prototype model is discussed in the following section.

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[1] The independent variable in (5.23) should reflect the risky variable being considered. This would be yield in the case of yield risk, or gross revenue, or net income in the case of revenue (price and yield) risk or portfolio risk.

6.0. FARM LEVEL MODELLING OF COMMODITY SPECIFIC PROGRAMS

In addition to the problems identified in the previous paragraphs, there is the problem of multiple crops and covariance relationships between crop enterprises at the farm level and in the aggregate. To counter these problem we recommend that some of the risk information and, under the assumption of constant returns to scale, substitution among crops, can be rudimentarily exposed by using farm level modelling of a resource constrained - representative farm - under conditions of risk.

To do this, a prototype whole farm risk minimization model has been developed. Using B.E.A.R.Plus (Budgeting Enterprises and Analyzing Risk Plus financial statements; discussed in the following sections) as the basic management platform, a risk minimizing quadratic program was developed within a spreadsheet. The advantage of this approach is that B.E.A.R.Plus includes many different enterprise budgets from the grains, oilseeds, forages, tree crops, and livestock, sectors.

The optimization model uses a general framework;

$$
\text{(6.1)} \qquad \begin{aligned} &\underset{x}{\text{Minimize}} \quad x'Wx \\ &\text{S.T.} \quad Ax \leq B \\ &\qquad\quad C'x \geq K \\ &\qquad\quad\;\; x \geq 0 \end{aligned}
$$

where x represents the vector of choice variable (acres of crops to be grown; W is the variance covariance matrix of gross (or net revenues) which measures the variance of revenues as well as the risk relationships among variables; the matrix A represents the technical coefficients of production, including the amount of land, labour, machinery, etc. required to produce the output; the vector B represents the amount of resources available; C is the vector of net per acre (or hectare) returns as computed by the individual enterprise budgets; and K is a net farm income requirement which can be used to parameterize solutions to examine risk and return relationships.

The measure of risk, relative to commodity specific programs, is provided with the variance covariance matrix. Variances can be truncated according to the specific parameters of the crop insurance, price insurance, or revenue insurance programs, and these effects will be reflected in the covariances relationship as well. Note that it is only the marginal distributions (own variances) which are truncated, not the whole portfolio variance; that is, the portfolio variance reflects the summation of individual enterprise variances, weighted by the number of acres selected.

6.1. Risk Aversion:

Perhaps one of the most elusive measures in economics is the risk aversion coefficient. Using the risk minimization approach to portfolio selection can resolve this problem by providing an explicit measure of risk aversion which is based upon the farmer's selection of a farm plan. This measure of risk aversion is obtained by taking the inverse on the shadow price or the income constraint (Turvey and Driver) and is an exact and robust measure. This measure can be obtained from the optimization model and used as a proxy within the general equilibrium model.

6.2. The B.E.A.R.Plus Farm Planning Program: A General Description

B.E.A.R.Plus is a farm management planning tool which operates in Quattro Pro and provides a simple approach to farm management. It incorporates the key facets of farm financial planning, including enterprise budgets, financial statements and risk analyses. There are three component to B.E.A.R.Plus, the Commander, the Budget Module and the Financial Statements Module. The main purpose of the Commander Module is to allow the user to move easily between the Budget and Financial Statements Modules.

6.2.1 The Budget Module - was developed to assist farmers in making management and planning decisions. One of the most important and highly recommended practices is the development of enterprise budgets which are used to compare the profitability among competing enterprises and in the context of the whole farm. Managers often budget the whole farm in relation to outside competition, but place minor emphasis on competition for limited resources within the farm. The Budget Module consolidates the enterprises (Crops, Livestock, fruits, and Vegetables) grown on the farm for comparison and evaluation. Included in B.E.A.R.Plus is over 60 enterprise budgets ranging from grain and oilseed crops, to fruits, vegetables, beef, dairy, swine, poultry, sheep and goats. Budgets not included can be developed on request.

One of the unique and advanced features of B.E.A.R.Plus is its ability to perform enterprise risk analyses. The inclusion of price and yield risk in the enterprise budgets allows users to assess the probability that actual net enterprise revenues will fall above or below expected levels. Thus farmers, while hoping for favourable risk outcomes, can take actions to ensure that fixed financial obligations and other cash flow requirements are fulfilled if an unfavourable risk outcome occurs.

6.2.2 The Financial Statements Module - is comprised of a set of coordinated farm financial statements including past and projected (cash and accrual) income statements, beginning and ending (historical cost or market value) balance sheets, statement of changes in financial position, statements of changes in owner's equity, debt-servicing capacity report, a debt servicing worksheet, a cash flow statement and a farm business analysis report. If enterprise budgets are completed, data from the budgets can be imported to the financial statements module.

6.3. B.E.A.R.Plus and Whole Farm Optimization:

For purposes of this report, a quadratic programming module was added to

B.E.A.R.Plus, with the intent of providing a prototype model for investigating farm level effects of stabilization policies. The model queries the user for information regarding crops grown (through B.E.A.R.Plus), land available, resource utilization and machine time available, labour requirements, and crop rotation practices. The user is also queried for up to 6 years of price and yield information as the basic input to risk analysis. Since raw data is provided, this empirical distribution can be truncated, and by examining changes in expected values of prices, yields, and revenues, before and after truncation the actuarial value of crop insurance can be computed. Subsidies, measured by the difference between the actuarial value of the stabilization policy, and the premium paid is then added to the gross margin of each enterprise considered. While only a few crops are examined in this real case farm study, the model can be used to analyze any combination of 8 crops, drawn from over 60 different enterprises. The model is not set up to examine NISA or other whole farm stabilization policies, but the results of the optimization process can be used to evaluate these policies. In terms of the budget and financial statements module, only the budgets module is used directly in the risk programming model, although information can be transported to the financial statements module if required.

6.4. The Prototype Farm Planning Model:

This section provides the details of a spreadsheet modelling approach to evaluating the potential farm level impact of decoupled and partially decoupled agricultural policies. An actual case farm is then used to illustrate how the model can be used, and what information can be obtained from it.

As argued in previous chapters much of the response to stabilization policies is due to either risk reduction or income enhancement through subsidized premiums. The impact of stabilization policies on transfer efficiency is not direct because some of the benefits, e.g. risk reduction, can not ordinarily be measured in dollar terms. Subsidized premiums, on the other hand, can be measured directly, but the total effect of the subsidy should be measured in terms of the indirect output response as well as the direct income effect.

An appropriate methodology for measuring most of these effects is through farm level optimization and simulation. This research develops a prototype spreadsheet modelling approach using the mathematical optimization routine in QUATTRO PRO and a Farm Planning Spreadsheet program called B.E.A.R.Plus (Budgeting Enterprises and Analyzing Risks plus Financial Statements). The evaluation framework and methodology is outlined in Figure 6.1.

The procedure starts with gathering information on a representative or case farm. The farm in this example is a 630 acre cash crop farm growing corn, white beans, soybeans, and wheat. Using enterprise budgets contained in B.E.A.R.Plus, gross margins and anticipated yields were calculated. The example farmer maintained records and provided 6 years of price and yield data. This data makes up the basic risk information used in the analysis. The data are presented in Table 6.1.

Risk was measured in terms of truncated marginal probability distributions. For example if the policy being examined is crop insurance then the yield distribution was truncated at the coverage level. The policies examined are crop insurance, crop plus price insurance, and gross revenue insurance.

Figure 6.1 the framework

Table 6.1 Historical Yields, Prices, and Revenues of Case Farm								
Year	1993	1992	1991	1990	1989	1988	Avg.	Std.
			Crop Yield History (bu./acre, tonne/acre for white beans)					
Corn	114	84	131	115	120	117	114	14.5
Beans	12	12	17	15	17	16	15	2.2
soy	39	31	54	42	32	34	39	7.9
Wheat	42	81	59	55	54	52	57	11.7
			Crop Price History ($/bu., $/Tonne)					
Corn	3.36	2.67	2.64	3.07	3.63	2.57	2.99	.40
Beans	23.90	20.30	22.80	25.58	32.54	21.99	24.52	3.94
Soy	7.93	6.18	6.26	6.61	8.46	7.19	7.11	.85
Wheat	2.80	3.21	3.16	3.81	4.16	4.62	3.63	.63
			Crop Gross Revenue Histories ($/acre)					
Corn	385	223	347	353	436	301	341	66.5
Beans	288	246	401	401	544	360	373	95.3
Soy	309	194	340	274	271	244	272	46.2
Wheat	119	259	188	210	225	240	207	45.2

Given the policy parameter, assumed for this example to be 85% coverage on all types of insurance, crop revenue variances and covariances were computed. These risk measures are used as the objective function in a risk minimizing quadratic program which selects the most risk efficient farm plan given a specified level of expected income. Constraints on production are land, labour and machinery, with labour being hired as necessary.

The comparative response to policies can be determined by optimizing the farm plan for each of the policies and comparing them to a no-policy run. The advantage of this approach is that different policies affect the risks of specific crops in different ways. For example, if a crop benefits more from crop insurance than price insurance, then a measurable response can be obtained. In addition to this , since the measurement of risk takes into consideration the joint risks among crop substitution effects between crops can be observed. For example if the benefits from insurance is greater for corn than soybeans, then a noticeable increase in acres of corn planted would be observed. The direct risk reducing benefits of agricultural policies can be evaluated by comparing the optimal farm plan of the policy without subsidized premiums, i.e. actuarially priced insurance, to the no policy scenario. The incremental effects of subsidized premiums can then be observed by running the model once again, with the incremental gains from insurance being included in the marginal net revenues of the individual crops. This procedure is repeated for all policies to be examined.

Per acre risks are presented in Table 6.2 for the base case without insurance, and gross revenue insurance. In the base case the least risky crop is wheat, which is negatively correlated with corn and soybeans. The most risky crop is white beans, followed by corn and soybeans. As expected in theory the highest risk crops also provide the highest gross margin revenue. Gross margin revenues are $161/acre for corn, $220/acre for white beans, $179/acre for soybeans, and $116/acre for wheat.

The second part of Table 6.2 illustrates the effect of stabilization policies on risk. The variance (measured in terms of $/acre squared) of corn for example is reduced from 4,426 to 2,526, while the covariance between white beans and wheat is almost zero, at 11 ($/acre squared).

The actuarial price of the 3 insurance policies examined is found in Table 6.3. The premiums reflect the expected benefits from insurance and are measured on a $/acre basis. For example, the highest price of crop insurance is for corn ($6.44/acre) while the lowest is for soybeans ($2.80/acre). A price coverage level of 85% is not sufficiently high to provide a benefit for corn and soybeans with price insurance, but price insurance is beneficial to wheat. In terms of gross revenue insurance white beans has the highest cost. Corn premiums are zero, likely due to a strong negative correlation between prices and yields.

Table 6.2: Variance-Covariance Matrix of Crop Revenues for Example Farm

	Matrix without Agricultural Insurance			
Crop	Corn	White Beans	Soybeans	Winter Wheat
Corn	4426	4743	2034	-1624
White Beans	4743	9102	1481	515
Soybeans	2034	1481	2136	-1584
Winter Wheat	-1624	515	-1584	2046
	Matrix with Gross Revenue Insurance			
Corn	2562	2753	788	-731
White Beans	2753	5925	279	11
Soybeans	788	279	1364	-973
Winter Wheat	-731	11	-973	826

Table 6.3: Actuarial Agricultural Insurance Premiums at 85% Coverage Levels

Policy	Corn	White Beans	Soybeans	Winter Wheat
Crop Insurance	6.44	6.17	2.80	3.85
Price Insurance	0	1.38	0	2.75
Revenue Insurance	0	16.88	7.44	9.50

Optimal farm plans are reported in Table 6.5, for all three policies. These solutions will lie on an expected value=variance frontier such as that for the base case illustrated in Figure 6.2. In the absence of programs the farm would optimally grow 239 acres of corn, 82 acres of white beans, 128 acres of soybeans, and 185 acres of wheat to obtain expected income of $105,000 with a portfolio standard deviation of $23,620. By collecting the inverse of the shadow price on the income constraint it is possible to obtain a risk aversion coefficient. The measured risk aversion of the case farmer is .0000147 which is appropriately scaled to income [2]. The top scenario in Table 6.5 assumes that the farmer pays an actuarial price for protection so the only response is to reduced risk. There is no income effect.

Under this assumption there are significant responses. For example, with crop insurance alone, corn acres fall by 24% while soybean and white bean acres increase. For crop plus price insurance however there is no change in corn acres, and white beans fall by 24%. For Revenue insurance corn again falls by 24% and the response is similar to the crop insurance case.

The income effect is noted in the lower part of Table 6.5. When insurance premiums are subsidized this is viewed as a net increase in expected revenues. For crop insurance corn acres increase by 1% which is in contrast to the 24% drop observed without he subsidy. White beans
which increased by 13% without the subsidy falls by 52% with the subsidy. Similar contrasts are found for crop plus price insurance and revenue insurance.

It should be noted that all of the solutions in Table 6.5 have expected profits of $105,000. Hence farmers who target a particular income level for production can respond by reducing risk. Ideally, the quadratic program should maximize expected utility rather than minimize risk. One idea for this may be to run a farm plan using the risk minimization model, and then derive from a given solution the risk aversion coefficient. Doing this would make the income and risk reduction effects less transparent. The implication of the results are, however, clear. Stabilization policies do have an impact on farm portfolio decisions and these impacts should be included in any measure of transfer efficiency at the farm level.

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[2] The risk aversion coefficient as measured depends on the portfolio selected. If a lower risk portfolio, with an expected return of $85,000 was selected this would imply a risk aversion coefficient of .0000977. In general risk aversion coefficients are going to reflect the income risk trade-offs, however they are also sensitive to scale. For use in the prototype D-T model the appropriate scale would depend upon the units of measurement. For example if dollar units were 1,000 times higher than those used here the same amount of risk aversion would be of the order 98E-09. If profit maximization is assumed then the risk aversion coefficient would be 0.

Figure 6.2 the E-V frontier

Table 6.4: Output Effects of Agricultural Stabilization Policies for Example Farm and Target Revenue of $105,000

	Base Case	Crop Insurance		Crop + Price Insurance		Revenue Insurance	
	Acres	Acres	Change	Acres	Change	Acres	Change
Risk Reduction Effect with Fair Premiums							
Corn	239	180	-24.6%	240	0%	182	-24%
White Beans	82	93	13.4%	62	-24%	92	12%
Soybean	128	210	64%	182	42%	210	64%
Wheat	185	146	-21%	146	-21%	146	-21%
Portfolio Risk ($)	23,620	23,512		20,992		16,662	
Base Risk ($)	23,620	23,702		23,829		23,735	
Risk reduction Effect with Subsidized Premiums							
Corn	239	241	1%	238	-1%	160	-33%
White Beans	82	39	-52%	40	-52%	83	1%
Soybeans	128	187	46%	178	39%	178	39%
Wheat	185	163	-12%	174	-6%	210	13.5%
Portfolio Risk ($)	23,620	19,153		18,645		13,789	

Base Risk ($)	23.620	21,827		21,287		20,245	

6.5. Potential Market Response to Agricultural Insurance:

In previous sections the impact of stabilization policies on supply and prices was discussed. In Table 6.5 price flexibilities for the 4 crops are assumed to be -.1 for corn, soybeans and wheat, and because of the influence of Ontario white beans in the market place, -1 for white beans. Flexibilities can be used with a control optimization model if it assumed that technology at the farm level is linear homothetic which implies industry constant returns to scale. Given this assumption the potential impact of the policies on commodity prices can be derived. In the example the percentage change in prices is 2.46% for unsubsidized crop insurance, but due to the smaller effect only a -.1% increase when the crop is subsidized. Stabilization policies favour other crops, mostly soybeans, over wheat in all but 1 instance. Market prices will increase modestly in all scenarios except subsidized revenue insurance which will decrease the price by 13.5%.

Table 6.5: Example of Price Flexibilities and Market Impact of Agricultural Insurance

		Corn	White Beans	Soybean	Wheat
Price Flexibility (%change)		-.1	-1	-.1	-.1
Crop Insurance	No Subsidy	2.46%	-13.4%	-6.4%	2.1%
	With Subsidy	-.1%	52%	-4.6%	1.2%
Crop + Price Insurance	No Subsidy	0%	24%	-4.2%	2.1%
	With Subsidy	-.1%	52%	-3.9%	.6%
Revenue Insurance	No Subsidy	-2.4%	-12%	-6.4%	2.1%
	With Subsidy	3.3%	-1%	-3.9%	-13.5%

6.6. Summary and Conclusion:

This chapter has outlined a methodology, developed a prototype model, illustrated how agricultural policies affect farm level production decisions. It does not appear that any of the commodity specific programs are decoupled. However, just because a program is not decoupled does not necessarily mean that there will be an increased output response. Given limited resources, farmers will substitute the most favourable crops increasing supply in some markets, but decreasing supply in others. The efficiency of agricultural policies depends on the interrelationships among risky variables. In the above example each crop was offered the same policy options, but still there were changes. However, there is a genuine ambiguity as to pure cause and effect, especially when it comes to substituting one source of risk for another.

Another issue relevant to the problem of transfer efficiency and discussed above is that not all policies are equal. Policy design can have an impact on the distribution of resources within the farm, so that the true source of observed changes at the aggregate level cannot easily be distinguished. It is possible to examine these at the farm level using simple optimization models such as the one presented here.

Using a representative farm can also provide an indication of what the market impacts of a policy might be. In this chapter assumed price flexibilities were used to illustrate potential market price changes. While the changes appear to be dramatic in some instances, this is not unrealistic if in fact the relative shifts in product mix with the representative farm reflect typical farm decisions.

NISA/VAISA type programs were not included in this analysis because it would require a much more complex model requiring truncation of the joint probability distribution of outcomes as defined by the variance covariance matrix and the solutions. Furthermore, it is unlikely that NISA/VAISA type programs would have any real impact on risk bearing. For example, a risk response to VAISA (valued at gross margin such as is done here) would gain very little. In Figure 6.2 for example the farmer receiving $100,000 would contribute perhaps $4000 into his NISA account. To increase this would require a substantial increase in risk. For example, suppose that expected income were to increase by $10,000. The incremental increase in NISA contributions would be only $400, yet the increase in risk would be over $15,000. It is unlikely that farmers would be willing to increase risk by so much for such modest gains in a risk free deposit account.

From another perspective, the base case scenario with $106,000 of income and a portfolio standard deviation $23,620 would only collect if (at 80% coverage) income fell below $84,800. The risk of the portfolio is such that the probability of exceeding $84,800 is approximately 68%, which means that the chance of having to withdraw any amount is only 32%. The fact that the likelihood of making a withdrawal is so much lower than the likelihood of making a deposit adds further evidence to the contention that NISA-type programs are not going to induce dramatic increases in risk taking. Indeed, with the most likely outcome being deposits, these deposits take on significantly more importance and would, then, be more likely encourage risk reducing behaviour, and portfolio shifts into lower risk, lower return crops.

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Appendix A: Risk Aversion and Production

This appendix develops the theoretical proposition underlying risk averse behaviour, which states that producers, when faced with uncertain outcomes, will produce at below profit maximizing levels of output.

Here it is assumed that random price is described by $P = \bar{P} + \epsilon_p$ where $\bar{P}$ is the expected price and ϵ_p a random deviate with mean equal to zero and variance σ^2_p.

A simple approach is to assume constant absolute risk aversion as the behaviourial constraint. Then expected utility can be described by

$$(A.1) \qquad EU(\pi) = \bar{P}\bar{Y} - C(Y) - \frac{\lambda}{2} Y^2 \sigma_p^2$$

where π is profits, Y is output, C(Y) is a quasi concave cost function, and λ is the coefficient of constant absolute risk aversion. Differentiating (A.1) with respect to output yields,

$$(A.2) \qquad \frac{\partial EU(\pi)}{\partial Y} = \bar{P} - C^{\prime}(Y) - \lambda Y \sigma_p^2 = 0 \ .$$

The implicit solution to (A.2) provides the optimum level of output, Y^*. It is defined by

$$(A.3) \qquad \bar{P} = C^{\prime}(Y) - \lambda Y \sigma_p^2$$

Under purely deterministic conditions or risk neutrality, $\bar{P} = C'(Y)$, so the optimal level of output is determined by setting expected prices equal to marginal costs.

The risk premium has a dampening effect on this condition. As Y increases so does risk and the risk premium (equal to $\lambda/2\ Y^2\sigma^2_p$ in (A.1)). Risk averse producers will produce at an output level below the certainty level.

Appendix B: Truncated Risk and the Pricing of Insurance

This appendix derives the mathematical relations of truncated distributions and the pricing of agricultural stabilization policies.

Mathematically, the formula for determining the actuarial value of agricultural insurance is given by;

$$(B.1) \qquad V = \int_o^{Pz} (P_z - P) g(P) dP = E\,\{Max\ [P_z - P, 0]\}$$

In competitive insurance markets, V represents the actuarial value of insurance. In the absence of moral hazard and adverse selection, V plus a loading charge would be the price that the farmer would pay for insurance coverage P_z. The term g(P) is the probability distribution function of P.

While the benefits of stabilization/insurance are paid on a unit price basis (e.g. bushels or tonnes) they are paid out on a long run average yield basis. Thus the true value of the program is equal to

$$(B.2) \qquad V\,\bar{Y} = \bar{Y} \int_o^{Pz} (P_z - P)\ G(P) dP$$

where the left-hand side is the actuarial cost on a unit area basis (acre or hectare) and the right-hand side is the expected benefits.

There are two effects that price stabilization has on output decisions. The first effect deals with the subsidization of premiums while the second deals with the truncated down-side risk.

If δ, $0 \leq \delta < 1$ is the rate of subsidization then

$$(B.3) \qquad \bar{Y} \delta V < \bar{Y} \int_o^{Pz} (P_z - P)\ G(P) dP$$

so that the expected net benefits are

$$(B.4) \qquad (1 - \delta) V\,\bar{Y}_1 \quad .$$

The effect of stabilization/insurance on variance is to reduce downside risk. By defining variance as

$$(B.5) \qquad \sigma^2 = \int_o (P - \bar{P})^2 \; G(P) dP$$

The truncated variance is defined by

$$(B.6) \qquad \sigma_T^2 = \int_o^{P2} (P_z - \bar{P})^2 \; G(P) dP + \int_{P2} (P - \bar{P})^2 \; G(P) dP$$
$$= (P_z - \bar{P})^2 \; G(P_z) + \int P_z (P - \bar{P})^2 \; G(P) dP$$

where $G(P_z)$ is the cumulative probability of price falling below P_z. The result is that the change in variance due to insurance and stabilization is given by

$$(B.7) \qquad d\sigma = \sigma_T - \sigma < 0 \; .$$

This reduction in risk, combined with dP = (1-δ)ȲV (equation B.4) leads to the significant responses to stabilization. To show this equation (A.3) can be modified as

$$(B.8) \qquad \frac{\sigma EU(\pi)}{\partial Y} = P + (1-\delta)V - C'(Y) - \lambda Y \sigma_T^2 \; .$$

The difference between equation (A.3) and equation (B.8) is the addition of (1-δ) ȲV as an increase marginal expected revenue and substituting σ_T^2 as the truncated variance. Rewriting yields the equilibrium condition

$$(B.9) \qquad P + (1-\delta)V = C'(Y) + \lambda Y \sigma_T^2 \; .$$

Appendix C: Crop Insurance

To simplify the analytical approach it is assumed that prices are known and deterministic but output are described by

$$(C.1) \qquad Y = \bar{Y} + \epsilon_y$$

where ϵ_y is a random deviate from the mean $\bar{Y}$. The variance of yields is thus described by σ_y^2.

The expected utility model is defined by

$$(C.2) \qquad EU(\pi) = \bar{P}\,\bar{Y} - C(Y) - \frac{\lambda}{2} P^2 \sigma_y^2 \quad .$$

Differentiating (C.2) with respect to Y gives

$$(C.3) \qquad \frac{\partial EU(\pi)}{\partial Y} = \bar{P} - C^{/}(Y) - \lambda\, P^2\, \sigma_y$$

where $\partial \sigma_{y2} / \partial y$ indicates the change in risk with output. If increases in mean production are variance preserving, then optimal output is given by the implicit solution to

$$(C.4) \qquad \bar{P} - C^{/}(Y) = 0$$

and the optimum level of output will be higher.

The expected benefits of crop insurance are given by

$$(C.5) \qquad V_y = \int_o^{Yz} (Y_z - Y)\; F(Y) dY$$

which is usually on a yield per acre or hectare basis. Typically this is multiplied by an elected price so

$$(C.6) \qquad \bar{P} V_y = \bar{P} \int_o^{Yz} (Y_z - Y) F(Y) dY \ ,$$

and when subsidized by δ_y ,

$$(C.7) \qquad \delta_y \bar{P} V_y < \bar{P} \int_o^{Yz} (Y_z - Y)\ F(Y) dY\ .$$

Unlike price insurance a decision to increase output in response to the policy can increase the premium as well. If $(1-\delta_y)\ \bar{P} V_y$ is the expected net income benefit from insurance then

$$(C.8) \qquad (1-\delta_y)\ \bar{P}\ \partial V_y\ /\ \partial Y$$

indicates the change in the premium due to an output response, where $\partial V_Y / \partial Y$ is positive indicating that there is an interest to increase output based on the insurance subsidy alone. Substitution into the expected utility model's first order condition gives:

$$(C.9) \qquad \frac{\partial EU(\pi)}{\partial Y} = \bar{P} - C'(Y) + (1-\delta_y)\ \bar{P}\ \partial V_y\ /\ \partial Y - \lambda P^2\ \partial \sigma_y\ /\ \partial Y = 0$$

Here, as output increases and variance increases the expected benefits from subsidization increase. There is the potential for producers to balance the increased benefits from insurance with the increased risk of increased production, in which case optimal output would occur at P = C'(Y) and production would appear as if the producer is risk neutral. If $(1-\delta_y)\ P\partial V_y / \partial Y > \lambda^2 \partial \sigma_y / \partial Y$ then output could actually increase to an amount greater than that implied by P = C'(Y).

Appendix D: Impact of Stabilization on Input Demand and Input Markets

This section derives the mathematical relationships which show that increased demand for inputs can result from commodity specific programs if the programs are not offered at an actuarial price.

If X refers to input demand then

$$(D.1) \qquad X = X(P,W) = X(W,Y(P,W))$$

refers to the demand as a function of input and output prices, and output.

Total differentiation yields,

$$(D.2) \qquad dX = \frac{\partial X}{\partial W}dW + \frac{\partial X}{\partial Y}\frac{\partial Y}{\partial P}dP + \frac{\partial X}{\partial Y}\frac{\partial Y}{\partial W}dW$$

and

$$(D.3) \qquad \frac{dX}{dW} = \frac{\partial X(W,Y)}{\partial W} + \frac{\partial X(W,Y)}{\partial Y}\frac{\partial Y(P,W)}{\partial W} \leq 0 \quad ,$$

and

$$(D.4) \qquad \frac{dX}{dP} = \frac{\partial X}{\partial Y}\frac{\partial Y}{\partial P} \geq 0$$

If it is assumed that input prices do not adjust instantaneously to a price increase (i.e. perfectly elastic supply) then it can be assumed that the demand for inputs will increase. In (25) dP refers to the increase in expected output price due to subsidized agricultural insurance.