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# ECONOMIC ANALYSIS OF ISSUES SURROUNDING COMMERCIAL RELEASE OF GM FOOD PRODUCTS IN NEW ZEALAND

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# *Abstract*

This paper concentrates upon the market impact of commercially releasing current generation genetically modified (GM) food and food production in New Zealand (NZ). It evaluates the producer benefits of growing GM food and consumer attitudes towards GM food. Current commercially released GM products affect the type of production rather than the nature of the product itself and include herbicide resistant soybean and canola as well as insect resistant corn. Evidence of producer benefits from growing GM products is mixed, with some reports of increases in producer returns. However, there has been a definite shift in consumer preference away from GM food. This is seen both in the development of price premiums for GM-free food; trade diversion away from GM sources to GM-free sources, particularly in the Japanese market; and the positioning of key retail outlets in Europe as GM-free.

However, issues remain as to how preferences will develop and whether current trends are short term or not. Of relevance to NZ is what would impact be of different preferences and impact of GM technology on key commodities for NZ. Therefore in this paper the impact of GM food on producers, consumers and trade in NZ is simulated under various scenarios using the LTEM (Lincoln Trade and Environment Model). The model simulates, against various assumptions of proportions of GM/GM-free production, the impact of various scenarios relating to preference for or against GM production. The results from this preliminary analysis show that the greatest positive impact on NZ income is the GM-free strategy where it is assumed such markets as the EU and Japan have a large switch in preference away from GM food, followed by a 20 percent preference for GM-free. In conclusion the analysis shows that the preferred option for NZ would be to delay the commercial release of GM food until the extent of the negative consumer attitude can be seen and the producer benefits become more apparent. This would enable NZ to position itself as being GM-free and obtain current price premiums and preferential market access.

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# 1. Introduction

The commercial release of genetically modified (GM) food production is of considerable international debate and in NZ is subject to a Royal Commission. This paper addresses the economic impact on NZ of commercially releasing GM food. A problem with the evaluation of releasing GM production relates to the current state of the technology. Currently only first generation GM products are available for commercial release. These generally affect the production system and potentially benefit the producer by reducing production costs. Second generation GM food is anticipated to influence the product itself and have the greatest potential benefits for consumers, for example, nutriceuticals. However the potential benefits of second generation GM are virtually impossible to assess given they have yet to be commercially released and still are the subject of research.

There are also possible costs and/or risks of GM which are also potentially large and difficult to assess and include such factors as potential environmental problems, problems of cross pollination and mixing of GM modified species. As it is impossible to evaluate the potential benefits of second generation GM as well as the potential risks of GM production, this paper will concentrate upon evaluated the short and medium term impact of commercially releasing GM food production, which is currently available. Thus this paper initially reviews existing studies which have evaluated the impact of introducing GM technology on both the producer and consumer. The paper then reviews existing literature on trade modeling and its use in evaluating international markets implication of introducing first generation GM production. Then the specifics of LTEM are discussed. This is followed by the results from the trade model simulation based on various scenarios relating to the proportions of uptake of GM production against various scenarios relating to preferences of consumers and producers, in the major countries concerned in GM production and/or consumption around the world. The implications of these different scenarios for NZ producer returns are then considered[1] in particular for milk, apples and kiwifruit.

[1]Definition of GM: Before any analysis of the potential risks and benefits to NZ of releasing GM what is meant by GM has to be defined. Moreover, as most of NZ's food production is exported NZ has to consider overseas definitions of GM. The definition of GM-free varies across countries, mainly in line with attitudes and the practicalities of implementing labelling laws. Whilst they vary most allow a small percentage (ranging from 1 to 5 percent) of GM product. Even currently in NZ there are GM imports of feed and GM in enzymes for cheese production. Thus in discussing GM-free production this is assumed to allow for small amounts of GM as defined by labelling law.

## 2. Impact of GM Food Production on Producer and Consumers

The economic/financial impact of the commercial release of GM depends upon the interaction between and the responses of both producers and consumers to GM within the international trading environment. Initially, however, this section assesses the impact of introducing GM food and its production on producers and consumers in isolation followed by the trade impacts. As the commercial release of GM food has mainly been in the US most of these studies relate to the US.

***Producer Impacts of GM***

As stated above the current commercial release of first generation GM food affects the production system. The main commercially released GM food crops being insect repellent maize as well as herbicide tolerant soybeans and canola. Thus, most of the current benefits of GM can be expected to come from the supply side and relate to potential increases in yield and/or reduction in costs. However, it should be emphasized that the evidence so far on the impact of GM production techniques can only be treated as preliminary as the crops have not been grown commercially over a long period.

The results from various studies show the impact of GM production on yield varies according to the crop type. In the case of soybeans and canola there has been little change in yield, in the case of soybeans there have actually been recorded falls in the yield of the GM crop compared with GM-free. This result is perhaps not surprising as these GM released soybeans and canola are not targeted at the productivity of the plant but rather at changes in input use, so expected gains should be from savings in input costs. In the case of maize there are reported increases in yield, which vary according to the level of insect infestation in the particular year. These gains in yield have been estimated to range from 0.26 to 1.88 tonnes per hectare depending upon the degree of infestation and the study (Gianessi and Carpenter, 1999; Furman and Seltz, 1998 and Duffy et al., 1999 (cited in CEC, 2000)).

There is a reduction in the cost of herbicides for GM production of soybeans and canola, of up to 30 percent in the case of soybeans. The cost of seed was higher for all GM production products as expected. Another benefit from GM production reported by producers was increased flexibility in production. For example, it was found that 12 percent of farmers surveyed cited increased flexibility as a reason for going GM (Duffy et al., 1999). This increased flexibility may lead to lower costs but these are difficult to quantify.

The impact of any changes in yield and costs on gross margins (assuming no impact on demand and therefore prices) has been so far indeterminate. For GM soybeans the fall in herbicide costs was reported to be offset by rises in seed costs, with the net returns to land and labour being slightly more for GM-free (Duffy et al., 1999 cited in CEC, 2000). This is supported by an USDA study which reported that whilst there was some positive impact on yield and reductions in herbicide use from GM production, net returns did not change (Fernandez-Cornejo and McBride, 2000). It is more difficult to assess the impact on gross margins for GM corn given that it is highly dependent on the level of insect infestation, and thus the potential losses in yield have to be set against the higher price for GM insect resistance seed. A study by Furman and Seltz (1998) reported in Commission of European Communities (2000) shows a gain in returns from using GM corn especially under heavy insect infestation. However, Gaisnessi and Carpenter (1999) found mixed results from using GM corn with a gain in returns in 1997 but a loss in 1998, whereas Duffy et al. (1999), cited in CEC (2000) found a small gain. In the case of canola results are again mixed with Fulton and Keyowski (1999) reporting lower returns with GM canola, whereas the results from a study in Alberta in 1999 found that GM gave lower returns on one type of soil but a higher returns on another (CEC, 2000).

***Consumer Impacts of GM***

The consumer response to the commercial release of GM are of course important and have not always been positive. As the first wave of commercially released GM has only affected the production process, and not the nature of the product, this may not be surprising. Moreover, given recent history relating to food scares it is again not surprising that there has been price premiums emerging for GM-free food and trade diversion away from countries exporting GM products. Thus, countries are developing varying regulations regarding the production and marketing of GM foods with other market influences including major European supermarket chains positioning themselves as selling only GM-free products (CEC, 2000).

Studies of consumer attitudes into GM have been considerable and show that these attitudes vary regionally with, for example, GM being more acceptable in North America than within

Europe. Also they do conclude that information provision is important in increasing the acceptability of GM, as is the source of that information. However, transgenics that is transferring genes across species and the manipulation of genes of human and animals have a lower acceptability than gene manipulation in plants, which is disturbing as some of the greatest potential benefits from GM come from the former types of biotechnology (Campbell et al., 2000).

Price premiums for GM-free products are beginning to appear with two tiered pricing structures developing in some markets such as Japan, Korea, and Europe. The introduction of labelling laws has also encouraged markets to source GM-free food. In Japan, for example, GM-free sources are being targeted for future supply, in anticipation of labelling laws, leading to a boost for EU and Australian exports.

The result of the market changes outlined above are that any potential benefits from planting the current commercially released GM products are further reduced when differential prices are included in the analysis. Even a ten percent premium for GM-free products further reduces the incentive to produce GM food. Moreover, if substantial markets begin to ban the use of GM the negative impacts would be much larger. Of course it is uncertain how these preferences will develop into the future and whether consumer acceptance will change.

# 3. Trade Impact of GM Production

***The Literature***

The trade impact of introducing GM has been estimated by few studies. Moschini et al. (2000) attempts to quantify the effects on production, price and welfare from adopting roundup ready (RR) soybeans. This study uses a three region, US, South America and rest of the world (ROW), bilateral partial equilibrium trade model and which focuses only on soybean and soybean products (meal and oil). To model the innovation at the production level, at the first step Moschini et al. (2000) quantifies the per hectare cost, profit and yield effects of RR soybean seed adoption. Then, they calculate the price effects of quantity changes in the innovator country. The effect of trade polices in their model are assumed to be captured by price differentials between the regions. Finally, Moschini et al. (2000) quantifies the consumer and producer surplus measures of welfare effects of RR adoption in the innovator country and in the other regions. They also provide the welfare effects under the assumption of international technology spillover from innovator country to other regions.

Nielsen et al. (2000) analyzes the impact of consumers' changing attitude toward GMOs on world trade patterns, with emphasis on the developing countries. They use a multi-regional computable general equilibrium (CGE) framework that models the bilateral trade among seven regions, that are high-income Austral-Asia, low-income Asia, North America, South America, Western Europe, Sub-Saharan Africa and the ROW. Production is aggregated into ten sectors in each region including five primary agricultural products (cereal grains, oilseeds, wheat, other crops, and livestock), three food processing industries, and a manufacturing and services industry at the aggregate level. The goods are assumed to be imperfect substitutes in the international market. Regional production is achieved by using five factors of production: skilled and unskilled labor, capital, land and natural resources.

Nielsen et al. (2000) allows the GM and non-GM production of maize and soybeans in their model. Initially, they assume an identical production structure in terms of the composition of intermediate input and factor use in the GM and non-GM varieties and also same structure of exports in terms of destinations for both varieties. The producers and consumers' decision to use GM versus non-GM varieties in their production and final demand respectively is endogenized for maize and soybeans sector. For the other crops, intermediate demand is held fixed as proportions of output and final consumption of each composite good is also fixed as a share of total demand.

They base their policy scenarios on the assumption that the GM-adopting sectors do make a more productive use of the primary factors of production as compared with the non-GM sectors. Therefore, they introduce a 10 % higher level of factor productivity in GM-adopting maize and soybean sectors in all regions as compared with their non-GM counterparts. The factor productivity shocks are introduced in alternative scenarios which differ in terms of the degree to which consumers and producers in high-income regions find GM and non-GM products substitutable. Starting from the perfect substitution case they lower the degree of substitution among GM and non-GM maize and soybeans in production and consumption as the citizens of high-income, Western Europe and High-Income Austral-Asia, regions become more skeptical of the new GM varieties. In the other regions, the citizens are assumed to be indifferent, and hence the two crops remain highly substitutable in those production systems.

Nielsen et al. (2000) includes NZ in high income Austral-Asia group. The main findings of their study, related to GM-critical high income countries, can be summarized as follows. They find out that trade diversion becomes significant when the GM-critical regions change their preferences towards GM-free products. The trade of GM-varieties is found to divert towards GM-indifferent markets and GM-free varieties divert towards GM-critical regions. This is explained as a result of the price differential between GM and GM-free varieties, which is a consequence of factor productivity differences in the production of these varieties. However, the degree of the price differential and its impact on the supply show differences between the GM-critical and GM-favorable regions. In particular, in GM-favorable regions the prices of the GM-free varieties declines as well as the price of GM-varieties, due to the high degree of substitution between the two varieties in consumption and to the increased production to supply to GM-critical regions. In the GM-critical regions on the other hand, the price differential impact on the supply of GM-free goods is minor. Moreover, as there is not perfect substitutability between GM and GM-free products in these regions, there is still possibility for both varieties to access the GM-critical markets.

In a similar work that focus on production of GM maize and soybean crops, Anderson and Neilsen (2000) uses a CGE model, GTAP, to quantify the effects on production, prices, trade patterns, and welfare of certain countries adopting GM maize and soybean crops[2]. They analyze the policy impacts in various scenarios with and without considering the trade policy and/or consumer reactions to GMOs. GTAP is a static CGE model that provides the bilateral trade relations among countries by using the Armington (1969) approach to differentiate the products. Anderson and Nielsen focus on 17 industries of which agricultural production is disaggregated into coarse grains, oilseeds, livestock, meat and dairy products, vegetable oils and fats, and other foods. The world is aggregated into 16 regions in which North America, Southern Cone, China, India, Western Europe, Sub-Saharan Africa, other high-incomes, and Other Developing and Transition Economies are specified explicitly.

Their policy scenarios are based on the assumption that the GM-adopting sectors are assumed to experience a one-off increase in total factor productivity (including all primary factors and intermediate inputs) of 5%, thus lowering the supply price of the GM crop to that extent. Anderson and Nielsen first analyze the impacts of GM-driven productivity growth of

[2] Neilsen and Anderson (2000) also try to quantify the effects on production, prices, trade patterns and national economic welfare of certain countries adopting GM cotton and rice in another study by employing the same approach used in Anderson and Neilsen (2000).

5% in the related countries when others such as Western Europe, Japan, and Other Sub-Saharan Africa are assumed to refrain from using or be unable to adopt GM crops in their production systems. In another scenario, the case of a policy and/or consumer response in Western Europe is introduced by banning the imports of maize and soybean products from GM-adopting regions. This scenario is based on the implicit assumption that labelling enables Western European importers to identify such shipments. The distinction between GM-inclusive and GM-free products is based directly on the country of origin, and labelling costs are ignored. In a subsequent scenario, consumers in Western Europe are assumed to shift their preferences away from imported coarse grain and oilseeds and in favor of domestically produced crops. This scenario involves an exogenous 25% reduction in final consumer and intermediate demand for all imported maize and soybeans. Incomplete information about the imported products in terms of whether they are GM-free or not is the implicit assumption behind this scenario.

Anderson and Nielsen (2000) include NZ in Other High Income countries together with Japan, Australia and newly industrialised Asian countries. They analyze the impact of policy scenarious on Other High Income economies by showing the change in economic welfare. In the case of GM adoption by other regions (except Western Europe), their findings show that the increase in economic welfare (equivalent variation) of Other High Income group is higher, when Western Europe bans the GM imports, compared to “no policy response” case. The same result also applies when consumer preferences in Western Europe shift towards GM-free varieties and away from GM products.

***The Empirical Model***

The empirical model, LTEM, is a multi-country, multi-commodity setting, which focuses on the agricultural sector in a partial equilibrium framework. The framework is used to analyze the impact of various domestic and border policies on the country and commodity based price, demand, supply and net trade levels. LTEM is a price equilibrium, non-spatial model and the commodities in LTEM are considered to be homogenous. It is a dynamic framework since it provides the time paths of endogenous variables within a short to medium-term time horizon. LTEM allows the application of various domestic and border policies explicitly such as production quotas, set-aside policies, input and/or output related producer subsidies/taxes, consumer subsides/taxes, minimum prices, import tariffs and quotas, export subsidies and taxes. The economic welfare implications of policy changes are also calculated in the LTEM framework by using the producer and consumer surplus measures. The general equation structure of each commodity at country level in LTEM is represented by eight behavioral equations and one economic identity as in the equations 1 to 9.

$$pt_{ij} = f(WDpt_i, ex_j) \quad (1)$$
$$pp_{ij} = g(pt_{ij}, Zs_j, ppb_{ij}) \quad (2)$$
$$pc_{ij} = h(pt_{ij}, Zd_j, pcb_{ij}) \quad (3)$$
$$qs_{ij} = l(ssft_{ij}, Z_j, pp_{ikj}, pp_{ij,GM}, ssft_{ij,b}) \quad (4)$$
$$qd_{ij,fo} = m(dsft_{ij,fo}, pc_{ikj}, pinc_j, pc_{ij,GM}, dsft_{ij,fo,b}) \quad (5)$$
$$qd_{ij,fe} = m'(dsft_{ij,fe}, pc_{ikj}, pc_{ij,GM}, dsft_{ij,fe,b}) \quad (6)$$
$$qd_{ij,pr} = m''(dsft_{ij,pr,b}, pc_{ikj}) \quad (7)$$
$$qst_{ij} = n(stsft_{ij}, qs_{ij}, pc_{ij}, stsft_{ij,b}) \quad (8)$$
$$qt_{ij} = qs_{ij} - qd_{ij,fo} - qd_{ij,fe} - qd_{ij,pr} - \Delta qst_{ij} \quad (9)$$

The trade price (*pt*) of a commodity ($_i$) in a country ($_j$) is determined as a function of world market price ($WDpt_i$) of that commodity and the exchange rate ($ex_j$). The total effect of world market price on trade price of the country is determined by the price transmission elasticity. The domestic producer ($pp_{ij}$) and consumer prices ($pc_{ij}$) are defined as functions of trade price of the related commodity and commodity specific production and consumption related domestic support/subsidy policies. The prices ($pp_{ij}$) and ($pc_{ij}$) also incorporate the domestic producer and consumer price impacts of import ban on GM product by the variables ($ppb_{ij}$) and ($pcb_{ij}$). The domestic supply and demand equations are specified as constant elasticity functions that incorporate both the own and cross-price effects. Domestic supply ($qs_{ij}$) is specified as a function of the supply ($ssft_{ij}$) shifter, which represents the economic factors that may cause shifts, a policy variable ($Z_j$) that reflects the production related policies, and producer prices of the own and other substitute and complementary commodities ($pp_{ijk}$). In addition, supply equation is specified to include the cross-price ($pp_{ij,GM}$) effect of GM and GM-free products on each other. An additional supply shift variable ($ssft_{ij,b}$) is also included in supply function to reflect the effect of ban on imports of GM products. Total demand is separated into food ($qd_{ij,fo}$), feed ($qd_{ij,fe}$) and processing industry ($qd_{ij,pr}$) demand. Food demand ($qd_{ij,fo}$) is specified as a function of the demand shifter ($dsft_{ij,fo}$), consumer prices of the own and other substitute and complementary commodities ($pc_{ijk}$) and per capita real income ($pinc_j$) created in the economy. Feed demand ($qd_{ij,fe}$) is defined as a function of demand shifter ($dsft_{ij,fe}$), consumer prices of the own and other commodities ($pc_{ijk}$). Processing industry demand ($qd_{ij,pr}$) is defined as a function of consumer prices of the own and other commodities ($pc_{ijk}$). Demand equations also include additional shifters ($dsft_{ij,fo,b}$), ($dsft_{ij,fe,b}$), ($dsft_{ij,pr,b}$) respectively, to incorporate the impact that may be caused by import ban. In addition, food and feed demand functions also incorporate cross-price effect of GM and GM-free products through the variable ($pc_{ij,GM}$). The stocks ($qst_{ij}$) are determined as a function of the stock shifter ($stsft_{ij}$), quantity supplied ($qs_{ij}$) and consumer price ($pc_{ij}$) of the commodity and also an additional stock shifter ($stsft_{ij,b}$) that may be effected by an import ban. Finally, net trade ($qt_{ij}$) of the country ($_j$) in commodity ($_i$) is determined as the difference between domestic supply and the sum of domestic demand components and stock changes in the related year. LTEM is a synthetic model since the parameters are adopted from the studies in the literature. The model works by simulating the commodity based world market clearing price on the domestic quantities and prices in each country. The world market-clearing price is determined at the level, which equilibrates the total demand and supply of each commodity in the world market. LTEM can capture the disequilibrium situations in the economy that may result from temporary shortages or excess supply situations by allowing the determination of stock levels endogenously.

The regional coverage of LTEM is specified as six countries plus the European Union as a single country and one region (rest of the world). Fourteen products are included but these are differentiated into GM and GM-free components and each is dealt as a different product effectively meaning twenty-eight different products are modelled (see Appendix 1 for the list of products and countries). The model is calibrated to year 1997 and short- to medium-run simulations are carried out up to 2010.

# 4. Empirical Analysis

Given the limited release of commercial GM primary production, it is impossible to currently assess the market performance of actual goods produced in NZ. Thus it is assumed that GM technology is available for certain key commodities in NZ, that is milk, apples, kiwi fruit and cereals, and various scenarios constructed to assess the possible economic performance of these products.

LTEM shows the impact, for certain key agricultural commodities, on NZ trade, output, and producer returns that accrue from various scenarios associated with the trade in GM/GM-free food. The scenarios run to estimate the impact particularly on NZ producer returns of different assumptions about market developments for GM/GM-free products. The scenarios form the basis of the model runs and relate both to assumptions about production costs, consumer preferences and market access for GM/GM-free food which then are tested against different assumptions relating to the proportions of GM/GM-free food in the various countries in the model. These scenarios were developed to reflect current and potential developments and include the following:

- no difference in preference for or against GM,
- a 20 percent price premium for GM-free food,
- a 20 percent price premium for GM food,
- a large shift in preference from Japan and the EU away from GM food,
- a 10 percent reduction in producer costs of GM food.

These five scenarios were then simulated against different assumptions regarding the proportion of GM/GM-free food produced in the countries modeled. These assumptions reflect current levels of GM/GM-free food, predicted levels of GM/GM-free production estimated from various studies which have assessed the likely proportions of farmers who would convert to GM production, (Cambell et al 2000), and the most likely "high uptake of GM scenario". These scenarios applied to all products in the model, and are outlined below:

1 GM/GM-free proportions similar to at present, these were based on estimates of the uptake of GM and are given in Appendix 2,

2 an increase in the projected amount of GM-food being produced to 75% in the US and Canada, 20% in NZ and 26% in Australia and,

3 as in 2 above but NZ zero GM,

4 a high uptake of GM-food with NZ 50% GM and Japan and the EU 20% GM.

The results of this analysis are presented initially by their impact on overall producer returns in NZ by the commodity groups, kiwifruits, apples, and milk. Cereals and oilseeds were incuded but as the production of these are insignificant in NZ their results have not been included here. This is followed by the impact of the various scenarios on total NZ producer returns across all commodity groups analysed.

Figure 1 illustrates the impact on NZ producer returns by commodity across the different scenarios assuming that the current proportions of GM/GM-free food in the countries in the model. This shows the dominance of the dairy sector in the commodities modeled. Figure 1 illustrates that compared to the no change scenario, that is current producer and consumer market conditions, a 20 percent preference for GM-food simulates an increase in producer returns across all commodities with a 15 percent increase in producer returns from milk, 20 percent from kiwi fruit and 29 percent from apples. A ban on access for GM food into the Japanese and European markets leads to a greater increase in producer returns, with a 37 percent increase in returns from apples, 43 percent from milk and almost double the returns from kiwifruit. A 10 percent reduction in costs of GM production and a 20 percent preference for GM have an insignificant impact on returns. These results are not surprising given the small proportions of GM produced currently in NZ.

The direction of changes in NZ producer returns are similar, but lower than the above, when predicted proportions of GM/GM-free are assumed, as illustrated in Figure 2. Assuming a 20 percent preference for GM-free food results in an increase of producer returns of 27 percent for apples, 18 percent for kiwifruit and 11 percent for milk, compared to the no change in consumer preference scenario. Again the Japan/EU ban on GM food leads to the greatest increase in NZ producer returns, of 35 percent for apples, 41 percent for milk and 90 percent for kiwi fruit. Assuming a reduction in costs for GM of 10 percent, given projected proportions of GM-food, does lead to increase in returns of 3 percent for apples and kiwifruit and 10 percent in case of milk. However assuming a 20 preference for GM has negligible impact on returns under this scenario.

Figure 3 shows the impact on NZ producer returns assuming that other countries in the model have same GM/GM-free as the scenario above, but NZ has no GM. These results show that producer returns are greater than the scenario above when a 20 percent premium is assumed for GM-free and when Japan and the EU are assumed to ban GM. There was no significant change in producer returns from a 10 percent reduction in GM production costs or a 20 percent preference for GM.

Figure 4 illustrates the impact on producer returns assuming NZ and other countries have relatively high proportions of GM production. Assuming a 20 percent preference for GM free does lead to increase in returns, but as expected these are lower than the 20 percent price premium at 17 percent for apples, 14 percent for kiwifruit and 6 percent for milk. Assuming a Japan and EU ban for GM NZ still experiences an increase in producer returns of 21 percent for apples 68 percent for kiwifruit and 8 percent for milk. A 10 percent fall in production costs of GM lead to increase in returns of under 10 percent for apples and kiwifruit but a rise of 22 percent for milk. A 20 percent preference for GM only led to a 3-5 percent increase in producer returns for NZ in apples, kiwifruit and milk.

To assess the impact on total producer returns to NZ of the commodities modelled the producer returns under each scenarios by commodity were summed and results presented in Figure 5. This shows that there is an insignificant impact on NZ producer returns if current consumer and producer conditions are assumed to exist, under all of the scenarios relating to the uptake of GM production, apart from a small predicted loss in total producer returns to NZ if it has a high uptake of GM. Under the assumption of a 20 percent preference for GM-free products there is a rise in producer returns, under all GM uptake scenarios, except where NZ has 50% GM. Not surprisingly the rise in producer returns are greatest when NZ has low or zero GM production. This is replicated in the scenario where preferences in Japan and the EU appreciably shift away from GM consumption, with the predicted rises in income being much more significant. The scenario simulating a 10% reduction in GM production costs shows little impact on producer returns, except when NZ is projected to have 50% GM production. Surprisingly, a 20 percent preference for GM again has less impact on income even in the scenarios where GM production is relatively high.

The results of these scenarios are consistent with theory and expectations. It is not surprising that markets such as Japan and the EU have such influence on world and NZ trade, moreover it is also not surprising that reductions in costs do not flow through to the same increase in producer returns. Of greater concern is the relatively little impact simulated increased preferences for GM have on returns. However this may reflect fact that NZ still produced relatively lower proportions of GM than some other countries.

# 5. Conclusion

The commercial release of GM-food is controversial. Current evidence of the impact of available technology on producer costs is mixed with reduction in some cases and the potential for more flexibility in production. However, there seems to be definite shift away from GM-food by consumers. There is trade diversion away from countries which are producing GM-food to those which do not; such as a rise in GM-free imports into Japan from the EU and Australia and a fall of imports from the US. In addition, many of main markets for NZ products are stating that GM-food or even animal products produced using GM-feed are not acceptable.

It is therefore perhaps not surprising that the results of the scenarios run through the LTEM on NZ producer returns seem to indicate that given current technology and predictions about consumer preferences NZ has higher returns with low or zero GM food production. Of course these results are dependent of the assumptions behind these scenarios. Different technologies could change the results as second generation GM products become available.

NZ has a unique position in being an island nation which does not have the potential for cross pollination from GM crops and therefore can maintain a GM-free status; unlike many other continental countries. Even countries like the UK have problems with the cross pollination of canola and other crops. NZ thus is uniquely placed to take advantage of any consumer preference shifting towards GM-free food.

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**Figure 1**
**NZ producer retuns by commodity, assuming current proportions of GM/GM-free**

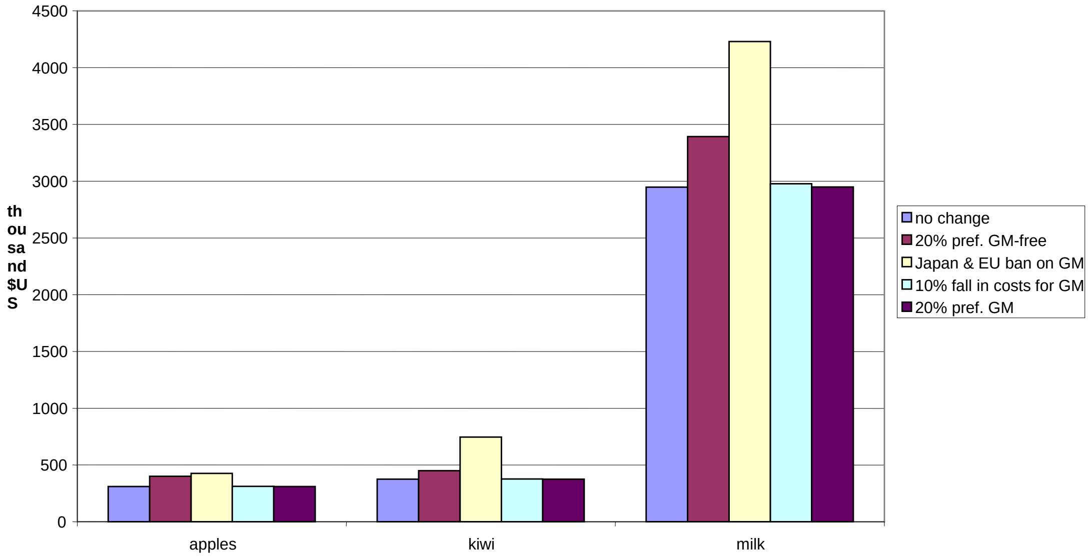



**Figure 2**
**NZ producer returns by commodity, assuming predicted proportions of GM/GM-free**

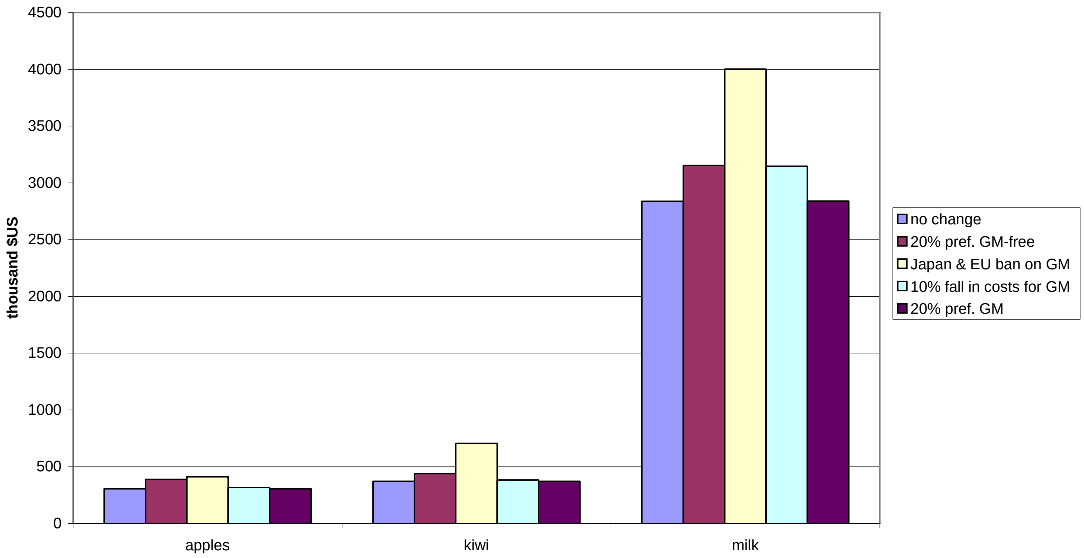


**Figure 3**
**NZ producer returns by commodity, assuming predicted proportions of GM/GM-free but NZ zero GM**

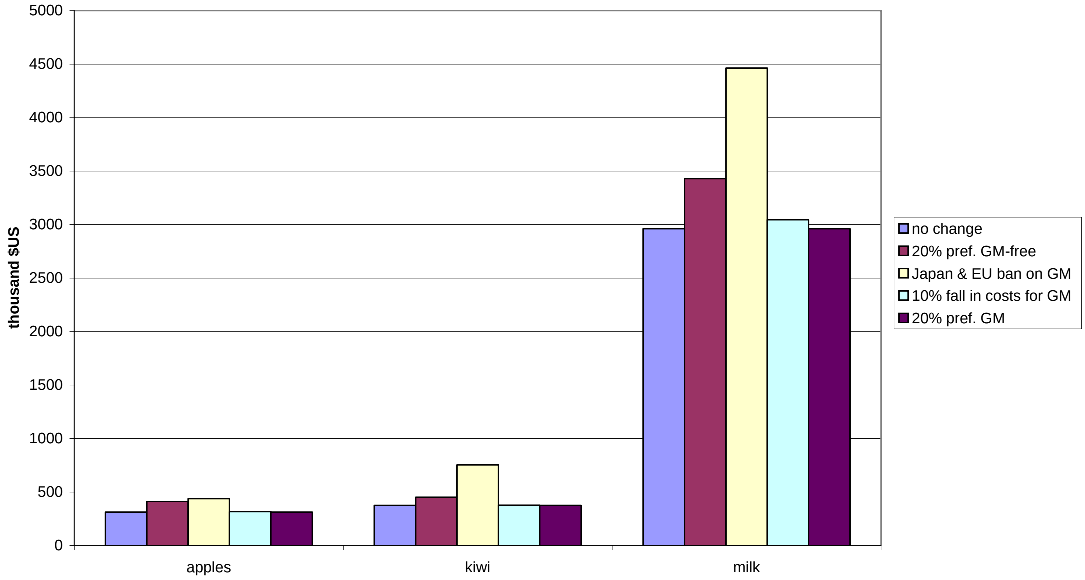



**Figure 4**
**NZ producer returns by commodity, assuming relatively high proportions of GM/GM-free**

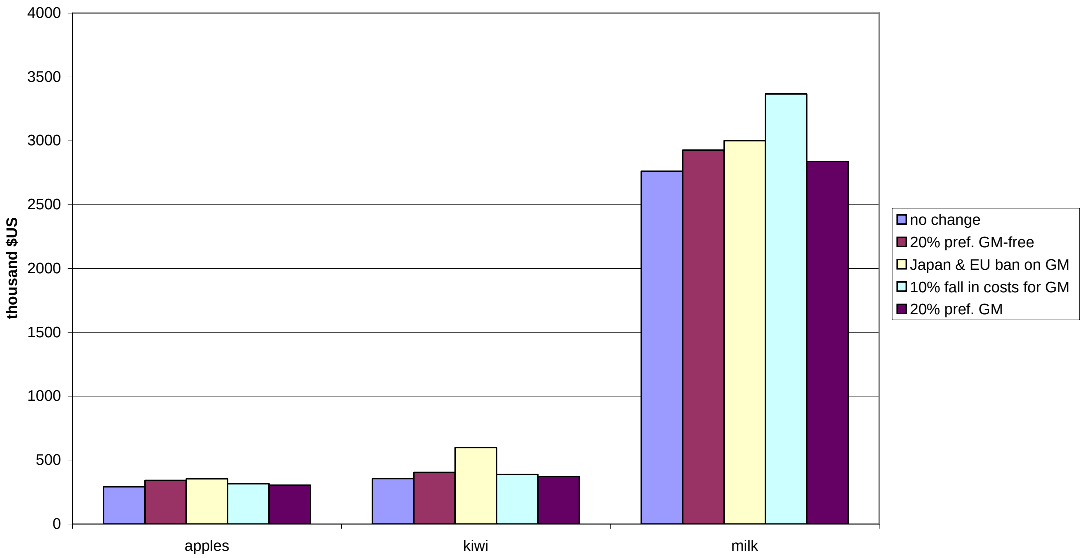
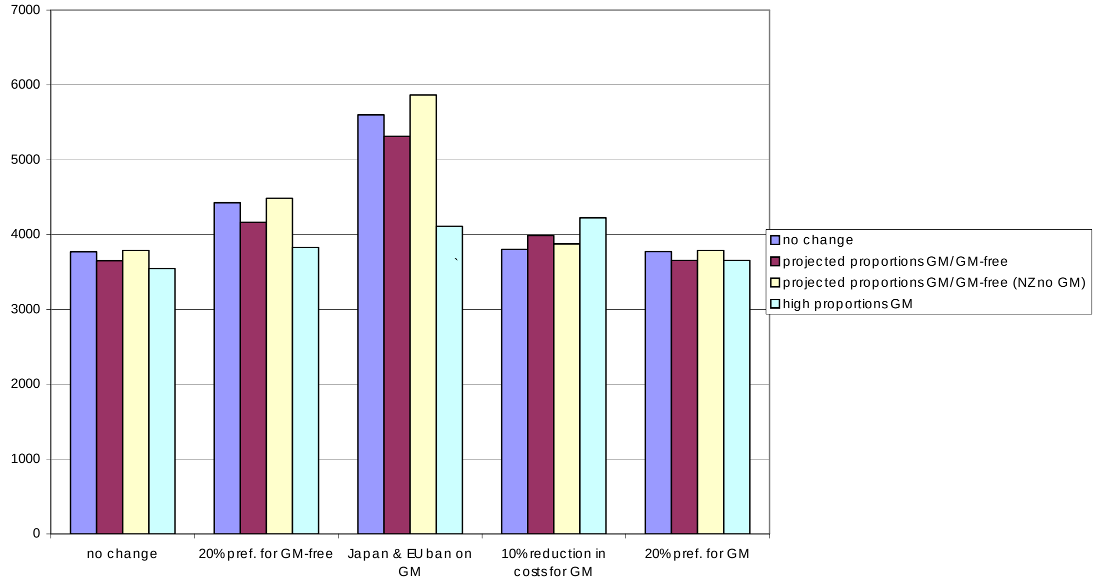


**Figure 5**
**Total producer returns for commodities modelled in NZ- million $US**



## Appendix 1

*Table A1: Country and Commodity Coverage (each commodity is included as GM and GM-free components):*

| | | |
|---|---|---|
| AR-Argentina | Wheat | Raw milk |
| AU-Australia | Coarse grains | Milk (liquid, other products) |
| CN-Canada | Maize | Butter |
| EU-European Union (15) | Oilseeds | Cheese |
| JP-Japan | Oilseed meals | Whole milk powder |
| MX-Mexico | Oils | Skim milk powder |
| NZ-New Zealand | Apples | |
| US-United States of America | Kiwifruit | |
| RW-Rest of World | | |

## Appendix 2

*Table A2: Percentage of Food which is GM*

| | **AR** | **AU** | **CN** | **EU** | **JP** | **MX** | **NZ** | **US** | **RW** |
|---|---|---|---|---|---|---|---|---|---|
| GM Wheat | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Coarse grains | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Maize | 0.05 | 0.05 | 0.40 | 0.05 | 0.05 | 0.30 | 0.05 | 0.30 | 0.20 |
| GM Oilseeds | 0.50 | 0.05 | 0.50 | 0.05 | 0.05 | 0.50 | 0.05 | 0.50 | 0.30 |
| GM Oilseed meals | 0.50 | 0.05 | 0.50 | 0.05 | 0.05 | 0.50 | 0.05 | 0.50 | 0.30 |
| GM Oils | 0.50 | 0.05 | 0.50 | 0.05 | 0.05 | 0.50 | 0.05 | 0.50 | 0.30 |
| GM Apples | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Kiwifruit | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| GM Raw milk | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Liquid milk | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Butter | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Cheese | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Whole milk powder | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM Skim milk powder | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM fed wheat | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM fed coarse grains | 0.01 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.01 |
| GM fed maize | 0.05 | 0.30 | 0.40 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.20 |
| GM fed oilseeds | 0.30 | 0.30 | 0.50 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.20 |
| GM fed oilseed meals | 0.30 | 0.30 | 0.50 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.20 |