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Economic Benefits and Costs of GM Moratorium in Hawke's Bay

Prepared for

Pure Hawkes Bay

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Contents

Executive Summary 1

1 Introduction 2

2 Benefits and Costs 3

2.1 Market Preferences 5

2.2 Production-Based Benefits 7

2.3 Costs of Proposal 8

3 Timing, Flexibility and Precaution 11

3.1 Discounting 11

3.2 Option Values 12

3.3 Precautionary Principle 13

4 Investigating the Effects 15

4.1 Scenarios 15

5 Conclusion 19

Executive Summary

The Hastings District Council (HDC) is considering new provisions that would prohibit outdoor release of genetically modified organisms (GMOs), treat outdoor field trials of GMOs as a discretionary activity and allow the use of financial bonds to manage liability issues.

Pure Hawke's Bay (PHB) is a voluntary association of food producers that supports the HDC proposal. PHB has commissioned this investigation of the economic benefits and costs arising from the proposal. This report contains the independent views and analysis of the author. It draws on a range of information including

- Data on the value of primary exports from Hawke's Bay by destination;
- Productivity data for pastoral dairying;
- Investor-sourced estimates of productivity gains from GM grass;
- Submissions opposing the HDC proposal from Federated Farmers and NZBIO, an association of biotech researchers and companies;
- The views of the US Department of Agriculture on consumer preferences in favour of GM-free food;
- Statements supporting controls on GM release by major food exporters including Fonterra and Horticulture NZ; and
- Academic literature on real options theory and catastrophic risk.

The conclusion from analysing this information is that the HDC proposal preserves existing benefits, has low and deferred costs and avoids a series of risks from GM releases which could carry significant cost to the regions' producers. Primary reasons for this conclusion are the following:

- Major food exporters consider that consumer preferences for GM-free status are currently delivering a benefit;
- The proposal retains the option to release GMOs at a later stage if the cost benefit analysis changes due to the emergence of a serious prospect for commercial cultivation and/or a shift in consumer preferences, on which point it is relevant that;
    - Opponents have cited no actual GMO that could deliver benefits to the District now or in the near future; and
    - If such a GMO prospect emerges over the life of the plan, a plan change could be used to ensure it was available for release; and
- Commercial costs of GMO contamination and market rejection are significant and well documented.

Quantification is challenging due to uncertainties over the size of the relevant effects but a scenario analysis is nevertheless undertaken. It is heavily influenced by the fact that any costs will not arise until towards the end of the plan's life, if at all while benefits are immediate. Five different effects were considered in a scenario analysis, using a range of values drawn from public sources where possible. This work reinforces the above conclusion that the HDC proposal is likely to be beneficial overall.

1 Introduction

The Hastings District Council (HDC) is considering new provisions in respect of genetically modified organisms (GMOs). The primary measures under consideration are to prohibit outdoor release of GMOs and to treat outdoor field trials of GMOs as a discretionary activity. Pursuant to the Resource Management Act 1991 (RMA) an analysis of the costs and benefits of this proposal has been prepared and hearings on the matter will be held in late May 2015.

Under the proposed discretionary status for field trials, the HDC would require a resource consent application. HDC would reserve to itself the discretion to approve or deny any such applications and/or to impose conditions on its approval. The posting of a financial bond is under consideration as a condition that might be imposed on outdoor field trials.

Pure Hawke's Bay (PHB) is a voluntary association of food producers with an interest in protecting the region's GM Free status in law. PHB has commissioned Covec to investigate the economic benefits and costs arising from the proposal. This report contains the independent views and analysis of the author.

PHB would prefer stronger controls on outdoor GM cultivation than are proposed by HDC, including a prohibition on outdoor field trials for example. A question therefore arises over whether this analysis should investigate the HDC proposal or the somewhat stronger version preferred by PHB. For practical purposes these differences have only a minor bearing on the cost benefit analysis for reasons that will become clear.

This report assumes that the HDC proposal amounts to a conditional moratorium on outdoor GM cultivation. No outdoor release would be the default setting, but there are two separate conditions under which that could be varied. One is if an applicant was able to satisfy the HDC that it should exercise its discretion to grant consent for an outdoor field trial. Alternatively, if the commercial environment warranted it bearing in mind consumer preferences and the actual GMO release options, a plan change could be pursued.

The analysis takes the Hastings District as the community of interest, so all costs and benefits are assessed from the perspective of the residents and ratepayers in that district. We use a 10 year time horizon, corresponding to the expected life of the District Plan.

In the remaining sections of this report we

- Identify the main categories of benefit and cost;
- Discuss some important timing and flexibility issues;
- Develop a scenario analysis of the costs and benefits; and
- Offer some concluding comments.

2 Benefits and Costs

The Hastings District is the largest in Hawke's Bay, representing 37% of the region's land area. It includes the fertile Heretaunga Plains, a 300km^2 area on which around half of New Zealand's total supply of fruit and vegetables is produced.[1] The economy of the broader Hawke's Bay region relies heavily on primary and secondary production with around 36% of the region's GDP estimated to have come from these sources in 2014.[2] Manhire (2015) estimated that exports of land-based products from Hawke's Bay are worth around US$870m per annum and that 42% by value is exported to Europe.[3]

Tourism is another major earner of export revenue for Hawke's Bay and these earnings are likely to be at least partly induced by agricultural and horticultural activity. The latest information puts visitor spending at $554m per annum. Much of this income is earned from residents of other New Zealand regions (80%) with the balance from international visitors.

Submitters on the HDC proposals agree that the GM provisions would have economic effects but there is no consensus on the relative size of those effects. In general terms, we can characterise the main effects as arising from two sources:

- Market preferences for non-GM products; and
- Potential for higher productivity from GM technology.

We will investigate these in more detail below, but at this point we note that many of the perceived benefits of the HDC proposals arise from the demand side of markets for the District's primary production, while costs arising from foregone opportunities for higher productivity would fall on the supply side of those markets. If consumers prefer non-GM products, then there could be a benefit from the HDC proposals. If productivity would be enhanced without the HDC proposals then there could be a cost from the HDC proposals. Both of these effects could occur at the same time.[4]

It is immediately clear that such benefits only exist if the relevant demand curve is downward sloping, indicating that consumers do not view Hawkes Bay's exports as identical to other products. This point is illustrated in Figure 1 which shows two possibilities.

On the left is a market for differentiated products for which lower prices allow Hawke's Bay producers to sell more output. In this context, if consumers prefer non-GM products then the demand curve will shift out to the right as a result of the HDC proposals, allowing Hawke's Bay producers to either sell more product or gain higher prices, or some combination of both effects.

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[1] Heretaunga Plains Groundwater Study, Hawkes Bay Regional Council, 1997

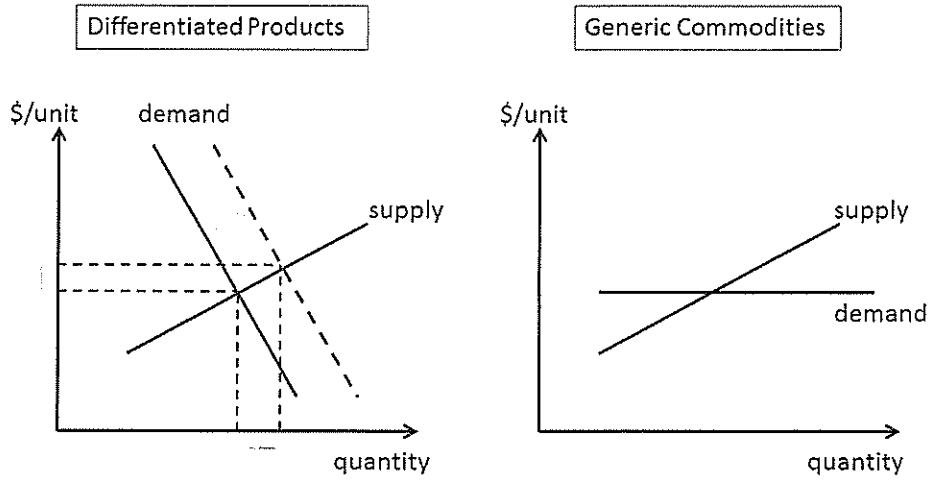
[2] http://www.businesshawkesbay.co.nz/why_hawkes_bay/economic-monitor/index.htm

[3] Jon Manhire, A Review of the Potential for Establishing a GM Free Hawke's Bay Region, May 2015.

[4] This classification is not complete; exceptions are discussed below.

On the right, we draw the demand curve as horizontal which is appropriate for generic commodities sold at world prices. If this scenario were true, Hawke's Bay growers would be price takers: able to sell all they want at a going price, but unable to affect that price in any way. The market would view Hawke's Bay products as identical to other products and attach no value to GM-free status. Consequently there would be no benefit from the HDC proposals.

Figure 1: Benefits depend on downward sloping demand



Hawke's Bay's produce is sold in both types of market. For example, dairying outputs are primarily sold as commodities whereas wine products are highly differentiated. Growers and processors are using their location in Hawke's Bay as a point of difference in marketing their output. The Gimblett Gravels wine group[5] is a good example, as is the regional provenance of ENZA's fruit and vegetable products.[6]

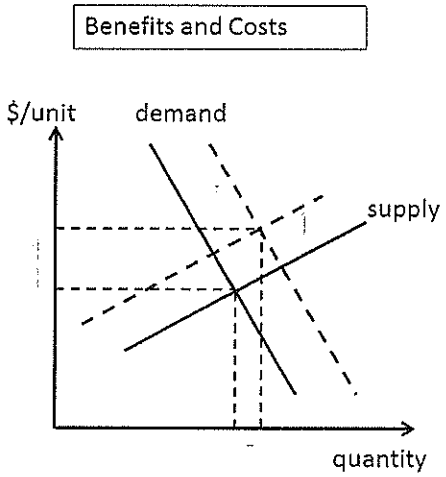
Turning now to the production side of the market, if the HDC proposals prohibit more efficient methods they have the effect of driving unit costs upwards relative to the counterfactual world (i.e. relative to the scenario in which GM is not restricted). We can model that as an upwards shift in the supply curve.

Figure 2 shows graphically how cost and benefit effects could co-exist. In this particular illustration the net effect is higher prices and higher sales volumes, but note that we could easily have drawn the curves in a way that would indicate lower sales volumes.

[5] http://www.gimblettgravels.com/

[6] http://www.enzafoods.co.nz/growers

Figure 2: Benefit and Cost effects together



These graphical illustrations are simply illustrations. The shape and position of the curves will vary across crop and product types sold from Hawke's Bay. Moreover, at this point they diagrams have no empirical basis and nor do they reveal any of the important time-based effects we discuss below (section 3).

This section now proceeds by discussing the potential benefits and costs in more detail.

2.1 Market Preferences

To the extent that consumers and potential consumers of Hawkes Bay products care about GM status, those preferences may show up in various ways including:

- Willingness to pay higher prices;
- Preferential access into markets; and/or
- More inbound tourism

These are all potential benefits from the HDC proposals. While there is some dispute about whether such benefits exist and how large they are, we have seen no claim that there would be a cost arising from consumer preferences.

It has been argued by NZBIO that *"consumers are less concerned about GM than has been supposed"* and that *"even in Europe, consumers express a spoken preference for non-GM products but when it comes to purchase are happy to accept GM products with a price or quality advantage"*. Reports from 2003 and 2005 are cited in support of the latter claim.

That view contrasts with recent work by the US Department of Agriculture on the GM in the European markets which concludes that *"due to the fact that European consumers are exposed to consistent negative messaging from activists, their perceptions are mostly negative"* and that *"food retailers adapt their offer to consumer perceptions"*.[7]

[7]USDA, Biotechnology and Other New Production Technologies, GAIN Report Number: FR 9169, 31 December 2014.

It is a basic tenet of economics that consumer preferences are sovereign. Whatever we might think about the reasoning or emotion lying behind these preferences, they are the main determinant of value from the consumers' perspective. Even if European consumers have been misled by "consistent negative messaging from activists", they are still the people who might or might not buy products from Hawke's Bay.

This crucial point seems likely to lie behind the views of Fonterra in respect of GM releases and field trials. Even though Fonterra is an investor in the Pasture Genomics consortium developing GM grass, it is opposed to release of GM plants and to field trials. Fonterra's view was expressed in 2012 as follows.

> *Customers view New Zealand dairy as GM Free and the introduction of GM pasture would have a significant impact for some customers and New Zealand's reputation. [...] However Fonterra does not support field trials of GMOs in New Zealand at this time and would only support such trials if we can be convinced that this would not be perceived as a release; containment could be assessed; and that doing so would not be counter to the needs and desires of customers, consumers and key stakeholders. At this time we do not have the confidence that such criteria can be met.*[8]

Dairy products represent 8% of Hawke's Bay's primary-based exports. Horticulture is a much larger earner, representing 55% of Hawke's Bay's exports by value, so the views of the industry association Horticulture New Zealand on GM are also relevant. Its 2009 policy includes the following statements.

> *Horticulture New Zealand recognises that there is considerable consumer opposition to genetically engineered food products and that it is critical that the industry continues to be market focused supplying products that exceed customer and consumer requirements.*
>
> *New Zealand horticulture industry must stay at the forefront of science and innovation. However, research for the New Zealand horticulture industry should at this stage focus on the application of technologies in areas other than those that will result in the production of genetically engineered crops.*

These views and policies of major food exporters directly contradict the NZBIO view. It is important to note that NZBIO's aim is to promote "bioscience", which is a potential input cost for agricultural producers, rather than to sell food products. The distinction is important for two reasons. First, NZBIO is at least one step removed from the relevant markets, limiting its ability to understand consumer preferences in those markets. Second, as an association of technology sellers, it also has a clear incentive to understate consumer opposition to those technologies.

For these reasons it seems safe to conclude that there is indeed some consumer preference that is opposed to GM food crops. If there was no such preference, the stated positions of major producer groups such as Fonterra and Horticulture New Zealand could not be rationally justified.

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[8] Statement on Radio New Zealand 9 December 2012.

Consumer opposition is likely to vary across export markets and possibly also across product types. We discuss the modelling of these effects in more detail in section 4 below. However at this point it is worth noting that these preferences are apparent right now: they are not preferences that might emerge at some future time.

2.2 Production-Based Benefits

The fact that consumers do care about GM foods raises the potential for other benefits to arise from the HDC proposal. In the absence of outdoor cultivation of GM plants, there is no risk of spill-over effects that harm the business of non-GM producers. Such effects could arise from:

- The escape of a GM organism into the broader environment with consequent ecological and/or biosecurity risks plus costs for clean-up and/or containment; or
- Contamination of non-GM outputs that is subsequently detected by customers resulting in a loss of trade or a value downgrade.

The recent fruit fly outbreaks in Auckland are an illustration of how organisms can relocate and impose ecological and biosecurity costs. Notwithstanding the best efforts of all involved, accidents and errors do occur.

There are several previous examples of GM plant products contaminating non-GM products. They include the following.

- Between 2000 and 2008 there were five "field events" in New Zealand involving the detection of GM in maize or corn products.[9] The cost of these events is not known with certainty however July 2008 event involved quarantine of 13,500 tonnes of maize seed plus tracing and testing work. The July 2003 event is reported to have cost the company involved around $500,000.
- Contamination in 2009 of flax exports from Canada with a GM flax called "triffid" that was supposed to no longer exist. This was estimated to have cost $29m which is 15% of the total annual export *revenue* of Canadian flax. The profit impact would have been proportionately much larger.[10]

In addition there have been major costs incurred by USA producers as a result of attempts to pre-empt regulatory approval in export markets (e.g. gaining approval in the USA, then exporting before the buying country approves the product). The Financial Times reports that costs of "hundreds of millions of dollars" were incurred in 2013 alone from this effect and that more are likely.[11]

The HDC proposal may not totally eliminate the risk of such events but it does seem likely to reduce that risk.

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[9] http://www.biosecurity.govt.nz/imports/plants/papers/gm-seeds/maize/factsheet.htm

[10] Camille D. Ryan and Stuart J. Smyth, 2012, Economic Implications of Low-level Presence in a Zero-Tolerance European Import Market: The Case of Canadian Triffid Flax, AgBioForum, 15, pp. 21-30.

[11] Gregory Meyer, Trade fears sprout in the GMO divide, Financial Times, 10 March 2014.

2.3 Costs of Proposal

Costs will arise from the HDC proposal if it prevents or delays the use of GM technology that would be economically beneficial. In that event, there would be a non-cash opportunity cost equal to the foregone productivity benefit. We can define this cost as the difference between grower profit with and without GM. In this event there might also be some dispute costs as growers and GM technology suppliers attempt to over-turn the HDC's decisions.

It seems very unlikely that any dispute costs would arise unless the HDC proposal does actually prevent the use of a GMO that growers wish to use. We therefore start the cost side analysis by investigating which GM crops might be prevented or delayed.

Of the main GM crops worldwide, only maize is grown to any appreciable extent in Hawkes Bay.[12] However GM maize is not cited as having potential in Hawke's Bay by NZBIO or by Federated Farmers which also oppose the HDC proposals.

Indeed, Federated Farmers do not point to any specific crop as having GM potential in Hawke's Bay, focusing instead on its views of the appropriate role of councils, concerns with strict liability and legal precedents. Neither does NZBIO mention specific crops that might be restricted under the HDC proposal, referring instead terms to *"species of importance to the country"* and arguing that GM technologies *"could be applied in the near term"*.

It seems likely that if there was a GM technology ready to deploy in Hawke's Bay, or almost ready, it would have been cited in these submissions. Since that has not occurred, we need to instead think about what costs might arise in the future. In so doing it will be useful to draw on an analytical device used by the Commerce Commission to assess future market developments. Known as the LET test, this involves separately considering the

- Likelihood of the new development occurring;
- Extent to which it would change the market; and
- Timing of the development.

Regarding "extent" the diverse nature of Hawkes Bay's primary production is relevant. GM techniques are highly specialised to individual plants. So a single GM plant, even one that was highly effective and safe, could not assist more than a modest proportion of the district's production.

In respect of "timing", GM entrepreneurs appear to be no less optimistic than any other entrepreneurs. There is a natural tendency to upgrade hopes and plans into predictions, so it is not surprising to see reality falling short of previous expectations. Drought resistance is a good example of this phenomenon. The New York Times, reporting on a new drought-tolerant GM corn developed by Monsanto in 2011 said the following.[13]

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[12] Manhire 2015

[13] http://www.nytimes.com/gwire/2011/05/11/11greenwire-usda-looks-to-approve-monsantos-drought-tolera-84634.html

Drought tolerance has been a longtime goal of the agricultural biotech companies, who hold up the trait as one way they could aid both their bottom line and farmers in drought-prone regions. But the trait, influenced by a wide variety of genes, has proved difficult to develop.

[...]However, Monsanto's corn is unlikely to perform well enough to tap this potential, USDA found.

While the agency's draft environmental assessment of the modified corn found the crop unlikely to pose a plant pest risk, prompting USDA to seek deregulation, the agency also noted that many corn varieties on the market match Monsanto's strain in their water use.

To some extent, all U.S. corn varieties have been becoming more drought resistant over time (Yu and Babcock, 2010), but others have been specially selected for drought tolerance. Therefore, the impacts of a determination of nonregulated status of MON 87460 would not likely be different from the corn seed options that currently exist.[14]

Similarly the history of Golden Rice is that the anticipated benefits have yet to be established. This GM plant, intended to boost the vitamin A content of rice, has been reported since at least 2000 but following field trials in the Philippines the International Rice Research Institute reported in March 2014 that that more work was needed.[15]

Preliminary results were mixed. While the target level of beta-carotene in the grain was attained, average yield was unfortunately lower than that from comparable local varieties already preferred by farmers.

An important goal of the trials was to test whether the agronomic performance of the new rice variety would be acceptable to farmers. The initial results indicate that more research is needed, with greater focus on increasing yield.

It is not clear whether these are isolated and a-typical examples. However they are consistent with analysis of the incentives facing GM developers, who have an interest in attracting and retaining capital and in promoting acceptance by growers, consumers and regulators.

When set alongside the absence in submissions of any mention of specific GMOs that would be beneficial to Hawke's Bay, this international evidence reinforces the view that there may be no near-term costs associated with the HDC proposal. What is less clear is whether any real costs might emerge over the 10-year life of the plan.

For example, suppose that a GM developer has a successful innovation that requires or would benefit from outdoor cultivation in the district. Under the RMA, this activity can

[14] http://www.aphis.usda.gov/brs/aphisdocs/09_05501p_fonsi_rtc.pdf

[15] http://irri.org/golden-rice/faqs/what-is-the-status-of-the-golden-rice-project-coordinated-by-irri

be enabled provided the benefits exceed the costs. The plan change process offers a safety valve in such cases, so even though the HDC proposal is scheduled to endure for 10 years that could change in the light of new information. This suggests that the downside costs are limited by the cost of plan change processes.

3 Timing, Flexibility and Precaution

The district plan is expected to last for 10 years, so that is the relevant time horizon for this analysis. We need to consider how to evaluate costs and benefits over this time horizon and to incorporate the irreversible nature of a decision to not manage outdoor GMOs release into the analysis.

This section addresses these issues under three sub-headings dealing with:

- Discounting the future;
- The value of flexibility and options; and
- The precautionary principle.

3.1 Discounting

Any analysis of costs and benefits that occur over time needs to recognise that future values are worth less than current values. A dollar due to be paid next year is worth less than a dollar paid today because we can use it to obtain value during the intervening period.

The standard method for accommodating this effect is to apply a discount rate to future costs and benefits, and then add up the discounted streams of costs and benefits to express them in "present value" (PV), meaning in the dollars of today. This process is not mathematically difficult, but it does require us to choose a discount rate.

The Treasury recommends using 8% discount rates as the default setting for regulatory analysis.[16] Private firms operating in risky industries are likely to use higher rates, but lower values could also be used in some situations. Patient individuals might be comfortable with quite low discount rates for example. Our view is that 8% is a reasonable rate for the matter at hand.

The implications of discounting are illustrated in the following table which might be indicative of the matter at hand. Suppose there are immediate benefits arising from the HDC proposal valued at 100 and that this benefit is expected to continue for ten years. Suppose also that some new GM technology could be released after 5 years at which time it would be worth 500 per annum.

If we simply counted the raw costs and benefits we would conclude that the costs are higher. However the timing of the costs and benefits is relevant and when discounting is applied we find that he present values of the benefits exceed the present values of the costs by 10.

16

http://www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/currentdiscountrates

Year	Benefit	Cost	Discount Factor	PV
1	200	0	1.00	200
2	200	0	0.92	184
3	200	0	0.85	169
4	200	0	0.78	156
5	200	0	0.72	143
6	200	500	0.66	-198
7	200	500	0.61	-182
8	200	500	0.56	-167
9	200	500	0.51	-154
10	200	500	0.47	-142
Totals	2000	2500		10

For the avoidance of doubt, these numbers are merely being used for illustration; there is no suggestion they accurately reflect costs and benefits of the HDC proposals. However they do show that immediately available annual benefits can outweigh much larger annual costs if the costs are deferred.

3.2 Option Values

Let us now extend the above illustrative example by considering what happens after year 10. It will be clear from the table that merely continuing these same flows of costs and benefits would reverse the conclusion we drew above. In fact that would occur in year 11.

However year 11 is beyond the planning cycle, so we cannot assume that the above pattern would continue. Plans usually take at least a couple of years to develop, so we need to stand in the shoes of planners and councillors at year 8 and consider how they would react. If the existing provisions were costing 300 per annum (i.e 500 – 200) in the currency of year 8 then we would expect the next plan development to seek to remove that net cost.

This illustrates the value of the flexibility that can arise from a periodic planning process. By deferring the decision to release GM plants, the district gains any benefits that are currently available from GM-free status without foregoing the option to use GM to increase productivity later should that turn out to be desirable. There is also an analytical benefit: provided the flexibility exists we do not need to look beyond year 10 because we will have an opportunity to change the plan at that time.

3.2.1 Irreversibility

This flexibility to change is not always present however. HDC currently has an option to defer the outdoor release of GMOs. This option is the source of the flexibility discussed above and the value arising from flexibility.

Once that deferral option is extinguished by releasing GMOs in the district, GM-free status could never be recovered. Releasing GMOs is an irreversible decision because of the potential for interactions between those plants and other plants and insects in the

environment, and because of the inability to monitor and document and track all of those interactions over time.

A decision to allow GMOs, or equivalently to not manage them, destroys the option to defer that decision.

3.2.2 Real Option Value

The above analysis shows that HDC currently holds what is known as a real option. It has the right, but no obligation, to allow (by declining to manage or restrict) GMOs outdoors, which would be an irreversible decision. Real options lie at the heart of the economic theory of investment under uncertainty. There is a well-established set of analytical methods for valuing real options and guiding optimal decision making in their presence.[17] These methods are used in many commercial contexts including in the oil, gas and mining industries.[18]

The most basic prediction of real options theory is that the value of the option is higher when the expected benefit from exercising the option:

- Is growing relatively slowly on average; and
- Has a relatively uncertain growth rate.

Intuitively, one's confidence in taking an irreversible decision is higher when the payoff from that decision looks to be experiencing strong and stable growth.

By contrast, if the growth rate is weak and/or unstable, then an option to defer a decision has more value because it allows time for new information to arrive. When faced with an irreversible investment decision that has uncertain future payoffs, it is optimal to defer that decision until the payoff is sufficiently large and certain as to overwhelm the value of the deferral option.

This decision-making guidance is very general: it applies to all situations where one has the ability to defer an irreversible decision. Applied to the matter at hand, it implies that HDC should defer a decision to allow (not manage) GMO releases unless/until the benefits to the district of doing so are clearly evident.

3.3 Precautionary Principle

The real options analysis presented above can be seen as a form of risk management that requires caution before making irreversible commitments with uncertain benefits. The theory is largely based on the view that the potential error cost is limited to the amount of cash invested in a project with uncertain benefits, which is a reasonable assumption in the case of commercial investments.

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[17] A.K. Dixit and R.S. Pindyck, Investment Under Uncertainty, Princeton University Press, 1994.

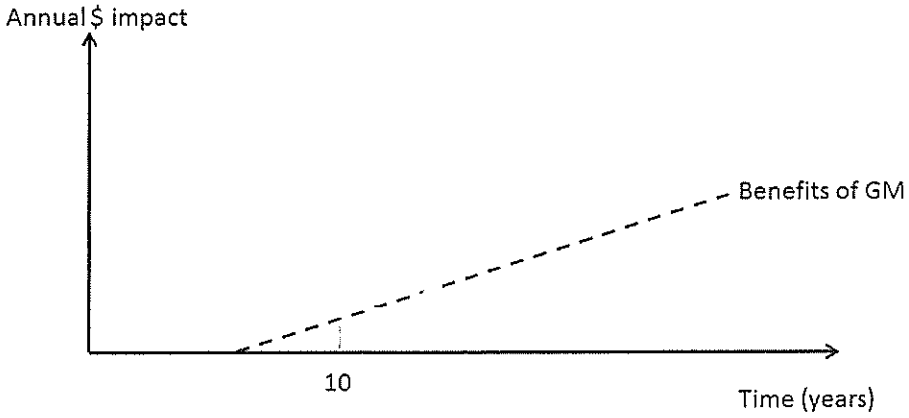
[18] Y. Fan and L. Shu, 2010, "A real options based model and its application to China's overseas oil investment decisions", Energy Economics, 32, pp.627–637.

A related risk management approach known as the precautionary principle allows for much greater costs, but yields predictions that are similar. The precautionary principle applies where there is an uncertain risk of serious harm. Recent academic work by risk expert Nassem Talib[19] and co-authors has placed the precautionary principle into a statistical and probabilistic structure of "ruin problems" and applied it to nuclear energy and GM technology.[20] It concludes that severe restrictions should be placed on GM technology. The paper considers GM technology to be much more risky than nuclear energy because it carries a public risk of global harm whereas the risk from nuclear energy is both localised and better understood scientifically. Even a very small probability of ruin will eventually lead to ruin over time.

The HDC has local rather than global jurisdiction however, and it might reasonably argue that GM releases in Hawke's Bay are very unlikely to initiate global ruin. In effect, Hawke's Bay could free-ride on the global risk as a result of its relatively insignificant size. Along the same lines, one could argue that HDC has no obligation to protect the world and should concentrate on looking after the interests of its own population.

If Professor Talib is correct however, then the benefits of remaining GM-free are likely to grow over time as other parts of the world experience harm from adopting GM. That could occur even while narrowly defined productivity benefits from adopting GM emerge. For example, the pattern of relative benefits over time might look like Figure 3.

Figure 3: Possible future pattern of relative benefits



Other patterns are of course entirely possible. We simply do not know how these relative benefits are going to change over time. However that is all the more reason to respect the predictions of real options theory (section 3.2.2) by deferring an irreversible decision to adopt or not manage GM plant release until the benefits are clearly apparent. Thus, even taking account of the potential for Hawkes Bay to free-ride on global risks one arrives at the same conclusion which is that caution is optimal.

[19] http://en.wikipedia.org/wiki/Nassim_Nicholas_Taleb

[20] http://arxiv.org/abs/1410.5787v1

4 Investigating the Effects

It will be clear from the above analysis that there is a limited fact basis for modelling the benefits and costs of the HDC proposal. There are many different future developments that could occur and would be affected by the proposal if they did occur. However at this point both the scale of those affects and their probability of occurring are uncertain. Under these conditions any direct forecasting model for costs and benefits would have very wide confidence intervals at best, but even then would be at risk of conveying a false sense of precision.

The alternative approach adopted here is scenario-based. We explore several scenarios separately without attempting to estimate the dollar impact of each.

4.1 Scenarios

Five scenarios are described in this section and indications of their value are developed. While described as distinct effects there are some interactions between them and different classifications are possible. The scenarios are

- Market-related benefits, the effect of which is based on views of major exporters and analysis of export markets for the district's outputs;
- Opportunity cost of GM grass, which is based on potential productivity gains for the dairy sector;
- Plan change, in which a GM developer with a commercially viable opportunity applies for a plan change that would avoid some aspects of the HDC proposal;
- Ecological clean-up, which considers the counterfactual possibility of a GM organism escaping and triggering costly remedial action;
- Commercial contamination, another counterfactual scenario in which commercial harm is suffered as a result of GM contamination of other products.

We discuss each of these in turn.

4.1.1 Market-related benefits

As discussed in section 2.1, major exporters of primary products including Fonterra and Horticulture New Zealand are opposed to release of GMOs in New Zealand. It is therefore reasonable to infer that they consider New Zealand's GM-free status to be a commercial advantage. Notice that this benefit

- Exists right now;
- Arises solely from consumer preferences; and
- Need not imply any price premium.

The benefit depends on the extra protection the HDC proposal would give, over and above that provided by national level gatekeeping by the Environmental Protection Agency through the Hazardous Substances and New Organisms Act 1996.

One way to gain insight into market-related benefits is as a percentage of total export value. Even a few percent of that value runs well into the tens of millions of dollars over the life of the plan

4.1.2 Opportunity cost of foregone GM development

The main potential cost of the proposal is from foregone opportunities for GMOs to add value to the district. However it appears from the analysis of submissions in section 2.3 that there are no such opportunities being foregone at present, so we should model this effect as a potential cost that might emerge in the future.

GM technology is not a single thing; there are many ways it could be used on many different agricultural plants and livestock. Given the very broad potential reach of the technology and the time since it was first discovered it is all the more surprising that none of the opponents of the HDC proposal have cited an actual GM opportunity that would be foregone as a consequence of the proposal.

I note that the Pastoral Genomics consortium is one of those opposed. This group has been working on a GM pasture grass for many years with the aim[21] of increasing grass biomass by 25%. The fact that the Pastoral Genomics website has not been updated since 2008, combined with the long lead times for GM development and the consortiums' own predictions of commercialisation timeframes[22] casts doubt over whether that outcome is likely over the life of the HDC plan.

However even optimistic projection of its potential in the Hastings District would need to factor in three time lags. One is to gain EPA approval, which would itself presumably require Fonterra (as an investor in Pastoral Genomics) to change its views on GM. The second is to persuade farmers to adopt it, which task would depend on its pricing relative to alternatives. Even then, pasture renewal is a gradual process as farmers need to take land out of production temporarily to re-sow it in new pasture. Renewal rates of 10% would mean that 10 years is required before full uptake was feasible.

4.1.3 Plan Change

The scenario in the previous sub-section assumes that a profitable business opportunity that requires outdoor cultivation of GMOs in the Hastings District is foregone. However simply abandoning such an opportunity is not the only possibility. Another is to seek a plan change so that the opportunity can be pursued. Any party can seek a plan change, including the Council, and the requirements for having a plan change approved are governed by the RMA rather than any council plan.[23]

As with any other business investment, including investment in GM developments, a plan change involves an upfront cost and an uncertain payoff. If the potential payoff is

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[21] http://www.pastoralgenomics.com/outcomes

[22] Finnie S. 2012. Dilemma over GM Pasture Research. *Straight Furrow* August 14.

[23] http://www.environmentguide.org.nz/rma/planning-documents-and-processes/plan-making/private-plan-changes/

large enough, investors will rationally prefer to seek a plan change than forego the opportunity.

It follows that the (risk adjusted) cost of pursuing a plan change is effectively a cap on the opportunity cost of the HDC proposal. A risk adjustment is needed because even if the GM-based business opportunity would actually provide positive net benefits, there is a risk that it may be declined.

The costs of a plan change are not known for certain and will depend heavily on the level and intensity of opposition it attracts. For example, if preferences of consumers changes markedly in favour of GMOs and local producers seek to respond to that change, then a plan change seeking greater enablement of GMOs would be popular and therefore of modest cost. On the other hand, a plan change proposal to relax GMO provisions that was somewhat "ahead of its time" might be expected to incur greater costs arising from a more contested process. Such costs should however be generally considered efficient rather than excessive since they are a natural consequence of local democracy.

4.1.4 Ecological Clean Up

One of the risks with GM technology is that organisms escape into the broader environment where they interact with other species with overall negative effects. Taleb et al (see footnote 20) discuss how GM organisms pose systemic risk due to their widespread impact on the ecosystem and on health.

In the event of an outbreak, it is not clear whether clean up would be feasible, or whether instead we would simply need to live with whatever consequences arose. However by way of a recent example, the recent discovery of Queensland fruit flies in Auckland illustrates the kind of measures that might be required for a clean-up operation. In that case, an intensive trapping and monitoring programme was implemented, along with insecticide spraying and the use of cordons to divide Auckland suburbs and prevent the transport of fruit and vegetables between them.

We have been unable to locate estimates of the cost of this operation but its scale and intensity suggest that it would have been well into the millions of dollars. That does not count any risk to commercial activity which is considered in the next scenario.

It must be noted that the national regime operated by EPA mitigates some of the potential for significant clean-up costs. Equally however, the EPA has no particular concern about resource management outcomes in the Hastings District. In my view, the HDC proposal should be viewed as reducing the risk of incurring clean-up costs.

4.1.5 Commercial Contamination

Another possibility is that products that are supposed to not contain GM are accidentally contaminated. This is an ever-present risk and has occurred several times, including in New Zealand (see section 2.2). The relatively minor New Zealand examples that have occurred to date are estimated to have cost between $500,000 and $1m each.

These five events have all occurred in the context of very use GMOs. In each case the GMOs themselves were supposedly well controlled in order to prevent contamination.

If release of GMOs were undertaken in the Hastings District, it would be reasonable to expect more contamination events and larger events. The cost of such an event to the Canadian flax industry was 15% of revenue, which would almost certainly exceed 30% of profit. The USA corn contamination costs ran into the hundreds of millions and illustrate the fact the risk that contamination poses to major commodity export products.

While this scenario could occur for the same reason as the Ecological Clean Up scenario discussed in section 4.1.4, it refers to a separate effect. Commercial losses as a result of contamination would be additional to any clean-up cost.

5 Conclusion

The HDC proposal would restrict outdoor cultivation of GMOs for ten years though the decision would begin to be reviewed within at least eight years.

The benefits of the proposal arise from consumer preferences for non-GM products. It is safe to take the word of major food exporters that such benefits exist because they sell to the relevant customers and they are profit motivated. Whether or not one might consider those consumers misguided is irrelevant: consumer valuations are always subjective but will always be crucial to social choices over the management of GM plants.

The conclusion from analysing this information is that the HDC proposal avoids a series of risks from GM releases which could carry significant cost to the regions' producers and opens up opportunities for additional earnings.

The HDC proposal would create costs if it prevented or delayed a socially profitable release of GMOs. That could only occur if release of a GMO was privately profitable, but there appears to be no such GMO and no near term prospect of one being developed. The costs of the proposal would, however, be capped at the price of a plan change.

Scenario modelling that aimed to err towards rejecting the HDC proposal suggests the proposal is beneficial.