

**Assessment of Economic Risks,  
Costs and Benefits: Consideration of  
impacts on the market economy**

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## Preface

This Guide is part of a series of technical guides produced by ERMA New Zealand to help people involved with the HSNO Act. It will be particularly helpful for those people who are reviewing applications (and that is the way it has been written), but it may also be useful for applicants and those people interested in HSNO related risks more generally. People with a less technical interest in HSNO are advised to start with the other series of documents we publish, especially:

The quick guides (aimed at a very general audience or for those making a first acquaintance with HSNO);

The user guides (aimed at those directly involved with HSNO but not a great degree of technical detail).

Publications in this technical series are not formally endorsed by the Authority and they are not a required basis for decision making. However, they are approved by the Chief Executive of ERMA New Zealand and in that sense are strongly recommended by the Agency for use. They are intended to provide a technical point of reference. Most of the documents are authored by a member of staff, but in other cases, there may be an external author.

This Guide is relevant for applications to applications for the importation, development, field testing, conditional release or full release of new organisms (including genetically modified organisms), and the importation, manufacture and release of hazardous substances. The Guide is likely to evolve with experience and will be updated from time to time.

A handwritten signature in black ink, appearing to read 'Bas Walker', with a large, stylized initial 'B'.

Bas Walker  
Chief Executive

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# 1 Introduction

This Guide has been developed firstly to provide guidance to the Authority and to Agency staff, and secondly to provide stakeholders with assurance that the Authority is adopting best practice approaches.

This Guide addresses the elements of the decision making process, and includes definition of the overall process, and the individual steps within the process, that is the identification, assessment, and overall weighing up of adverse and beneficial effects (risks, costs and benefits).

In addition to guiding the processes used by the Authority in making decisions, the Guide will also be used by the Agency staff in the preparation of the Evaluation and Review reports. Where appropriate these reports are used to provide technical support to the published decisions of the Authority, therefore it is important that their structure should be consistent with the framework described in this Guide.

The Methodology Order (ERMA New Zealand, 1998) describes how the Authority will make decisions on applications lodged under the Hazardous Substances and New Organisms Act (HSNO, 1996). As the Methodology is primarily a legal document, it does not contain details of the particular tools or techniques that the Authority will apply to the different tasks required by the decision making process. This Guide is a best practice guide and addresses this gap. However, it is not a statutory document and does not include comprehensive cross-references to statutes. Some particular references are made for the purpose of aligning the statutory process with best practice.

Thus, this Guide is intended for use by:

- The Authority in making decisions
- Agency staff in preparing Evaluation and Review reports on applications
- Stakeholders in making submissions
- Applicants in preparing applications.

For simplicity, all references to the Act refer to the HSNO Act, 1996 and its subsequent amendments, and all references to the Methodology refer to the Methodology as specified by Order in Council, 1998. ‘The Agency staff’ refers to staff of ERMA New Zealand, while ‘the Authority’ refers to the decision makers, the members of the Environmental Risk Management Authority.

This guide is intended to address the way in which the application will affect the market economy, as distinct from health, social, ecological and amenity impacts. While it is accepted that there are significant overlaps between these areas, the intent is to allow the Authority to understand in a distinct way how costs and benefits arise in the traded sector. This will include impacts on the supply of goods through their production, distribution and marketing, and on the domestic and export demand for those goods.

Readers should note the restricted nature of this guideline. Its purpose is to assist in describing impacts - not to assist in making a decision. This assessment of impacts on the market economy will be followed by a decision making step. In the decision making step the assessments of impacts on the market economy will be brought together with the impacts on the social, ecological, health and amenity values, and a decision will be made on whether the application generates a net benefit overall. The way in which this will be done is described in the ERMA New Zealand Technical Guide to Decision Making.

The current guide has been developed in association with selected stakeholders, and using input from outside experts. It is applicable to decision making in general. The guide does, however, recognise the specific considerations required to cover the analysis of applications for commercial release of new organisms. The most demanding category of release is likely to be for a genetically modified crop and that particular situation is covered explicitly.

## 2 Decision Making Context

### 2.1 Decision making objectives

The decision making paradigm in the HSNO Act (with which this or any other methodology must be consistent) is formed of two basic steps:

- (a) Preventing, or managing to an acceptable level the types of risks and costs (adverse effects) covered by the HSNO Act;
- (b) Ensuring that benefits (beneficial effects) are sufficient to outweigh residual risks (taking into account the impact of controls where relevant).

For new organism releases (including conditional releases), there is an intermediate step. Irrespective of benefits, the minimum risk standards set out in section 36 of the Act must be met. For these applications, the decision process continues to Step 2 if and only if the section 36 test is met.

In economic analysis terms the paradigm is thus one of identifying where there is a sufficient level of benefit to merit approval. This is different to, and in some case more limiting than, the objectives that might normally be associated with economic analysis, such as maximisation of net benefit.

It is noted that the Act requires the consideration of a range of risks, costs and benefits (adverse and beneficial effects) that extend beyond elements that may be readily amenable to economic analysis. These are set out in section 6 of the Act. The overall decision must accommodate all of these possible effects.

### 2.2 Risk context

Economic risks and benefits are defined as those which have an economic impact (as compared to biological, physical, social and cultural impacts) and can usually be quantified in monetary terms (\$). In the further discussion below, the term risk is used to cover both adverse and beneficial effects, unless the particular meaning of risk is evident from use.

The context for the assessment of economic risks is provided by the HSNO Act and the Methodology Order. Any analysis of this nature needs to start from basic principles. The following are of special note –

- The Purpose of the Act under which ERMA undertakes its assessments is to protect the environment and the health and safety of people and communities by preventing or managing the adverse effects of hazardous substances and new organisms (section 4).
- People and communities need to have the capacity to provide for their own economic wellbeing (section 5(b)).
- Economic benefits and costs must be considered (section 6(e)).
- Treaty issues and Māori interests need to be considered (sections 6(a) and 8).
- International obligations must be considered (section 6(f)).
- The need for caution in the face of uncertainty needs to be considered (section 7).
- Under the methodology (clauses 12 and 13) it is necessary to consider the impact of uncertainty and distributional effects over time, space and groups in the community.
- Under the methodology (clause 33), it is necessary to consider a range of risk characteristics in determining how risk averse decision making should be.

## **2.3 Special issues for new organism releases**

### **2.3.1 Distributional effects**

Distributional effects can be ascribed to time, location or to groups in the community.

Effects due to time are conventionally dealt with through techniques such as discounting. However, discounting is of limited value where there is a long lead time before the effects of most potential significance are realised. There can also be considerable debate over the level of discount rate applicable and whether it should be constant or variable. Where intergenerational issues can be identified then they should be considered.

Effects arising from uneven distribution amongst groups in the community are likely to be significant for genetically modified (GM) food crop releases especially. A possible outcome is that the groups to whom economic benefits will accrue (typically the applicant and the related sector) will differ from those who potentially incur economic risks and costs (the most common example proposed being non GM crop producers versus GM crop producers). This uneven distribution can occur both in terms of groups current affected, but also in terms of time with one generation gaining the benefits of the application and another bearing the costs.

### **2.3.2 Dealing with the concept of ‘co-existence’**

“Co-existence as an issue relates to the economic consequences of adventitious presence of material in one crop transferred from another and the principle that farmers should be able to cultivate freely the agricultural crops they choose be they conventional, GE or organic” (EU Commission).

Although the principle of coexistence applies to all commercial releases, it is especially pertinent to GM crops.

A key issue in HSNO decision making for GM crops will be the practical implications of achieving co-existence in these terms. The issue is key because of the biological mechanisms available for gene transfer from crops (particularly cross-pollination and contamination with pollen), and the need to consider the management implications of restricting the operation of these mechanisms to achieve acceptable levels of risk.

The meaning of ‘acceptable’ in this context is a significant issue in itself. In a technical sense, acceptable levels may derive from an agreed technical specification, or in the absence of this may refer to levels below the level of detection. However, some may argue that no level is ‘acceptable’ and that the mere possibility of contamination i.e. proximity of GM and non-GM crops, creates an acceptability issue.

These issues are unlikely to be resolved in a general way in the immediate future. Issues to do with co-existence and especially economic implications, will thus again need to be assessed on a case-by-case basis.

### **2.3.3 Dealing with uncertainty<sup>1</sup>**

The risk-benefit assessment process always deals with potential effects, or things that might occur in the future. In most circumstances, there will be a degree of uncertainty around expected risks, costs and benefits. The way the Authority approaches uncertainty is to obtain as much information on the issue as possible to reduce areas of uncertainty. Where uncertainty persists, the Authority must

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<sup>1</sup> Further guidance and information on the Authority’s approach to risk and uncertainty is given in the ERMA paper Approach to Risk

determine both the significance of the uncertainty to the overall decision, and how to take account of that uncertainty in coming to a decision.

Uncertainty relates to both the likelihood and the magnitude of economic risks and benefits. Traditional cost-benefit analysis includes the notion of risk by incorporating likelihood (probability) into the individual elements. The risk-benefit analysis that is the basis of the HNSO methodology is consistent with this approach.

Uncertainty is a particular issue for GM food crop releases, at least in the short term. Amongst other things, uncertainty arises from the lack of a reliable history of data to draw on. This is likely to be particularly so for the first commercial GM crop release application.

The approach taken in this situation is likely to consist of the following elements:

- focussing on obtaining the best quality of relevant information possible through applicants (both in applications and through additional information requests) through submissions from other interested parties, from the open literature and from non applicant expert sources, from work commissioned by ERMA New Zealand and from overseas experience,
- extensive sensitivity analysis, through modelling and other techniques, to characterise the uncertainty and variability, and impacts on economic outcomes to the greatest extent possible,
- adopting a cautious approach to the weighting of long term and speculative impacts (whether in the form of benefits or risks/costs) that takes account of the extent to which these can be substantiated to a reasonable degree, and
- understanding that there may be ways in which impacts arise which are completely unexpected.

### 3 Decision Principles for Impacts on the Market Economy

This section outlines a number of key principles that underpin analysis under the HSNO Act. They are described at the ‘principle’ level because they apply across the board to all applications and are not subject to variation on a case-by-case basis. Therefore, they act as touchstones for an assessment of the economic risks, costs and benefits.

#### Principles

1. The approach to assessing economic effects must be grounded in the requirements of the Act and the Methodology Order. An important principle is that people and communities should be able to provide for their own economic wellbeing. This principle applies equally to all of those parties affected by an application.

The Authority interprets this principle to mean that it is not the Authority’s role to promote individual or community economic wellbeing. It must though when making decisions consider the economic impacts on people and communities that go beyond the normal operation of a market economy.

2. The Act requires that the economic benefits and costs are considered (section 6(e)). Relevant costs and benefits are those that accrue to New Zealand rather than to overseas interests. Given the difficulty at times in distinguishing between foreign and domestic gains, the Authority will only consider those benefits accruing to New Zealand domiciled interests (section 6(e)).
3. Following from Principle 2, relevant benefits must be net gains in economic wellbeing. Transfers in benefits and costs per se are not considered as net gain.
4. The Methodology Order requires that all risks, costs and benefits be considered. In addition to the net benefit (refer to Principle 3), the Authority will therefore consider the distribution of costs and benefits across different parties, and in addition make a distinction between public and private costs and benefits. Public benefits and costs are defined as benefits and costs that do not accrue to the applicants and/or users of the organism or substance but are disseminated more widely in the economy. Changes in the distribution of costs and benefits may also create social impacts, which the Authority will address in its assessment of social effects.
5. Given that it is the net benefit to New Zealand that is important, this benefit must have accounted for any costs of mitigation measures required to manage any adverse public effects i.e. the transfer of private benefit to offset public costs.  
This principle does not stipulate who should bear the costs or how transfers should be made. This will be dealt with on a case-by-case basis.
6. The Authority will consider the overall impact of the approval on economic activity. Indicators may include:
  - Change in profitability
  - Change in value added (GDP)
  - Changes in employment
  - Changes in capital investment including foreign investment
  - Changes in knowledge and the innovative capacity of the economy

**Note:** Changes in total output will not be a significant consideration for the Authority. Multiplier analysis indicating the total impact on the economy will be taken into account, but more weight will be given to direct effects.

7. Economic costs and benefits need to be measured against a baseline. The correct assessment involves a 'with' and 'without' comparison. This involves the Authority comparing what would be likely to occur with the approval in place with what it considers would occur in the absence of the approval being granted. This requires the development of two hypothetical futures that recognise that business and market conditions continually adjust and change in a dynamic fashion regardless of whether the approval is granted or not. A 'with' or 'without' consideration is therefore considered more appropriate than a 'before' and 'after' comparison. More than one alternative for the 'with' and 'without' scenarios may be appropriate.  
The Authority assumes that the applicant has chosen the highest value use for their investment. The next best use of the applicant's investment is considered to have been taken into account by the opportunity cost of capital.
8. The distribution of benefits and costs over time is important. More weight will be given to economic benefits and costs occurring sooner rather than later. However, this will not be done in such a way as to override longer term e.g. intergenerational effects.
9. The Authority understands that given future scenarios of equal value, it will prefer those that provide for greater options in the future. Information on the degree to which different actions foreclose options in the future is relevant to the decision making.

## **4 Analytical Framework**

### **4.1 Context and scope**

The extent of risk analysis undertaken must in the first instance take into account the purpose and type of application being considered. The HSNO Act provides for a range of different application types but in practical terms provides for containment approvals at one extreme and release approvals at the other. The extent of analysis on impacts on the market economy undertaken by applicants and the Authority will vary substantially between these two general application types.

#### **4.1.1 Containment Approvals**

Containment approvals include work on hazardous substances and new organisms undertaken in the confines of fully enclosed laboratories and also outdoors in field trial situations.

Regardless of whether or not containment is inside or outside the fundamental requirement is that the organism or substance is contained. The risk assessment must start from this premise. Hence, the focus of ERMA's evaluation is on the adequacy of containment and the effects of the organism or substance on the laboratory or field test site and surrounding environment. Because containment requires a very low probability of release or escape, there is a reduced requirement for detailed information and analysis of possible effects. While the consequences of escape are a necessary part of the risk assessment, significant supporting information and detailed economic analysis of consequences is generally not required. The focus is on containing the organism and taking steps to ensure that the likelihood of escape is minimal regardless of the magnitude of any possible effects.

The relevant effects are those that result directly from the contained activity. Future effects that may result from the release of the substance or organism are not relevant to a containment risk assessment. While applicants are advised that such effects may require analysis in the future, and hence information on these should be collected early on in the research, such effects do not form part of the evaluation for a containment application. Likewise, postulated future benefits do not form part of the benefit assessment. The only benefits that are relevant relate to the purpose for which the containment approval is being sought.

The context in which containment risk assessments are undertaken therefore means that in general, national level economic impacts will not be relevant to containment applications. This means that while the consequences of escape will need to be considered, detailed quantitative supporting information and economic modelling will not be required. An example in the new organisms area is the field testing of a GM plant. Postulated negative impacts on New Zealand's clean green image as a result of the trial are negligible to the extent that such effects do not justify in-depth evaluation. Neither would be the impact on New Zealand's organic sector. However, the impact on neighbouring farms should the organism escape and contaminate local crops would warrant further consideration in the risk evaluation.

#### **4.1.2 Release (including conditional release)**

Release approvals are of a different character to containment approvals. In the case of new organisms, release approvals include both conditional release applications where controls can be placed on the organism to manage risks, and full releases where no controls are imposed. In the case of hazardous substances, all approvals have controls attached.

Because we are talking about releasing a substance or organism the risk assessment context is generally far broader compared to that for a containment assessment. The risk assessment must take into account the full range of possible economic impacts. Using the example above, the possible

impacts on New Zealand’s clean green image and the organic sector would be relevant factors in the risk assessment that would require supporting quantitative information.

Overall, the amount of supporting economic information and risk analysis required is strongly influenced by the type of application being considered. Generally, less is required for containment and considerably more for release applications.

## 4.2 Risk identification

The range of economic effects to be considered is strongly influenced by the economic principles set out in section 2 and the type of application being considered as discussed above. Nevertheless, a common theme regardless of the application type is consideration of the impacts on third parties or in economic terms, the externalities of the organism or substance. In the case of containment this includes the possible effects on neighbouring properties resulting from accidental contamination. For a release, the impacts on other business and sectors of the economy resulting from the deliberate release of an organism or substance are relevant.

The risk identification starts with identifying sources of risk, possible impacts and risk pathways. All three of these components are required before a risk can eventuate. Therefore, further risk analysis will only be undertaken if these three components can be identified and verified.

As an example, the range of factors that might be considered in the risk identification for a GM food crop is set out in Appendix A. Using the same example, the second part of Appendix A provides a list of variables that need to be considered for the benefit identification of a GM crop.

## 4.3 Risk analysis

Economic risk analysis involves assessing the magnitude and likelihood of potential economic costs and benefits and coming to a conclusion on the overall level of risk. As part of the analysis it is necessary to consider the distribution of costs and benefits both in time and sectors of the economy, and the identification of areas of uncertainty. It may be convenient to capture this information in the following format:

### Scenario A/B – With/Without organism /substance

Economic Costs / Benefits	Affected parties (distributional aspects)	Direct / Indirect	Monetary / Non-monetary	Time dimension	Uncertainty
Cost / Benefit description					

### 4.3.1 Scenario Analysis

The principles described above require that at least two scenarios are evaluated. The first considers a future with the substance or organism while the second evaluates costs and benefits without the substance or organism.

Any form of risk-cost-benefit analysis is an evaluative or comparative tool. That is, the results of assessing risks, costs and benefits for one option need to be compared against an assessment for one or more alternative options. In the case of HSNO decision making, the baseline should be considered to be the *status quo*, or what would happen if the application were to be declined. An applicant should not assume the baseline to be static over time. In most cases, the baseline will need to be projected over the estimated life of the project. This will mean postulating a scenario for what is expected to happen if the application is declined. For example, consider an application to import a new agricultural chemical to replace one that is becoming less effective. The baseline projection should take account of the fact that more of the original chemical will be required over time, thus increasing the cost of maintaining the current position.

When developing scenarios (for both the introduction of the substance or organism and the baseline) it may be desirable to postulate a range of futures.

For example, consider an application for the release of genetically modified crop for an industry where there are existing conventional and organic productions and markets. These may be assumed to be in a state of (temporary) equilibrium. While the possible impact of the introduction of a genetically modified crop on the two existing systems may be unknown, it may be possible to postulate several future scenarios based on different sets of assumptions on market share. Similarly, a set of baseline scenarios (i.e. without release) should be specified. Three typical scenarios might be based on the assumption that the current equilibrium would continue, and that one or other of the existing systems would dominate.

The analysis of these alternative scenarios, for both the baseline and the proposed introduction will help ERMA to identify those parameters to which the modelled futures are most sensitive. This will also help to determine the scenarios that are most likely to eventuate. Comparative analysis against a baseline is illustrated in Appendices B and C.

### **4.3.2 Quantitative assessment**

It is expected that for release applications (including conditional release) applicants will need to provide quantitative analysis of the economic costs and benefits of the organism or substance. Likewise, submitters opposing any such application on economic grounds would also need to substantiate any claims using accepted analytical procedures. Appendix B gives an example of the application of a quantitative analysis to a new organism release (non GMO), while Appendix C shows a non quantitative analysis for a hazardous substance.

### **4.3.3 Economic modelling**

Where potential economic costs and benefits are expected to result in national level impacts or the impacts are expected to extend more widely than a specific industry or location, then economic modelling of possible impacts may need to be undertaken. The Authority will not undertake modelling itself but will engage experts to review any modelling undertaken. The Authority's analysis will focus on the assumptions used to support any modelling conclusion. However modelling is a tool that needs to be used with caution because of the requirement for good quality data to reproduce meaningful results.

### **4.3.4 Overall Evaluation**

It is important to remember that the assessment of impacts on the market economy is only one component of the overall risk evaluation of the application. Other assessments of potential risks to the natural environment, human health and cultural and social values will also be undertaken. Decision makers are then faced with the task of weighing up all the risks, costs and benefits in order to reach a decision.

# APPENDIX A - GM Crop Release example

## A.1 Matters to be taken into account

The following series of tables set out the range of considerations that could be relevant to an application for release or conditional release of a genetically modified food crop. The information is presented in a form that identifies the generic impacts that would need to be considered by the Authority (both costs and benefits) and then a more detailed identification of the range of possible effects and assessment tools that might be used. The list is not exhaustive but does cover off the major areas of interest to the Authority.

Potential Economic Impacts	Issues, Information Requirements and Tools
<p>1. Implications for market access</p> <p>Loss of market access due to: Inadvertent presence of GM material</p> <p>Consumer perceptions</p> <p>Image or brand effect e.g. ‘clean green’</p> <p>Inability to meet Non-GM market requirements</p>	<p><b>Scope</b></p> <p>Inadvertent presence of the proposed GM product in the same non GM product (e.g. GM corn with non GM corn)</p> <p>Inadvertent presence of proposed GM product with a different non-GM product (e.g. GM corn in non-GM wheat)</p> <p>Products from livestock that have been fed GM material</p> <p>Different products grown in the same area as the GM crop</p> <p>Impacts on unrelated sectors (tourism and fibre sectors)</p> <p>Dependant sector impacts (e.g. beekeepers)</p> <p>Market perception impacts</p> <p><b>Effects</b></p> <p>Loss of markets</p> <p>Loss of price premium or price discounts</p> <p>Market diversion</p> <p>Contract disputes /damaged customer relations, costs of product recall</p> <p>Impacts on Consumer choice</p> <p>Impacts on New Zealand’s international trade position</p> <p><b>Information/tools for effected producers/sectors</b></p> <p>Non-GM market requirements - including both regulatory and informal (gatekeeper house standards)</p> <p><b>Production statistics, import/export earnings</b></p> <p>Demand and pricing analysis/statistics</p> <p>Market access restrictions</p> <p>Domestic market impacts analysis, prices, supply and demand profiles</p> <p>Customer perceptions, evidence of market sensitivity e.g. changed certification/assurance requirements for non-GM suppliers</p> <p>Trade model analysis where appropriate</p> <p>Expected net returns of both GM and non-GM producers</p>

		<p>Irreversible market cost – costs of price premium reductions ,and reallocation of trade</p> <p>Overseas market requirements and the costs of meeting these (e.g. the new EU labelling/traceability laws)</p>
2.	Feasibility and costs of segregation systems	<p><b>Scope</b></p> <p>Current production standards in place for effected products</p> <p>Changes to farming practices required to meet existing production standards</p> <p>Supply chain impacts – segregation, identity preservation and traceability impacts and costs including costs of auditing and enforcement</p> <p>Costs that will be incurred by effected parties to ensure continued supply of their chosen market</p> <p>Level of sector agreement to segregation requirements</p> <p>Practical limitations for non-GM supply chains</p> <p><b>Information/Tools</b></p> <p>Product chain analysis</p> <p>Supply chain structure e.g. long, short, specialised, concentrated</p> <p>Role of imports</p> <p>Role of manufacturers and retailers</p> <p>Where are the cost pressures</p> <p>Who will bear the costs and for how long</p> <p>Long term balance of control in supply chain</p> <p>Product chain value analysis</p> <p>What changes in supply chain will be required, what are the costs, how are they to be distributed in the supply chain and what will be the impact on prices and sector profitability if product segregation is required.</p>
3.	New Zealand’s international obligations	<p><b>Scope</b></p> <p>Implications for New Zealand in terms of its international agreement obligations (economic and environmental)</p> <p><b>Information</b></p> <p>Details of relevant international agreements</p>

Potential Economic Benefits		Issues, Information Requirements and Tools
1.	Source and magnitude of benefit	<p><b>Scope</b></p> <p>Production benefits</p> <p>Market benefits</p> <p>Growers/farmers</p> <p>Other supply chain participants</p> <p>Other related sectors</p> <p><b>Other sector benefits</b></p> <p>Industry</p> <p>Science and research</p> <p>Capability</p> <p>International reputation</p> <p><b>Information requirements/tools</b></p> <p>Benefit analysis-production</p> <p>Yield, impacts on farming costs, changes in farming practices, premiums, incremental sales and increased market share and value added benefits, overall farm profitability.</p> <p><b>Domestic and International market analysis</b></p> <p>Regulatory approval requirements, identified markets for GM product, consumer preference analysis, market access issues, market statistics, current market supply and demand evaluation, consumer surveys/ buyer evidence, impacts on New Zealand's international competitiveness, macro economic impacts</p> <p><b>Tools</b></p> <p>Sensitivity analysis</p> <p>Trade modelling if appropriate</p> <p>Specific market demand and supply chain investigations</p> <p>Farm profitability analysis</p> <p>Scenario analysis for different demand profiles</p> <p>Discounted case flow analysis</p> <p>Macro economic modelling</p>
2.	Distribution of benefits	

## **A.2 Information Requirements for the Assessment of Benefits and Costs of GM Crop Releases**

The following discussion sets out key information requirements for an application for the commercial release of a GM crop. The information requirements focus on the benefit side of the application.

### **Assumptions**

For a commercial release to have a benefit for the NZ agricultural sector, it must be profitable for producers. The following lists key assumptions in three groups –

- Import information regarding production.
- Consumer information required.
- Sensitivity analysis of an applicant's information.

### **Important questions regarding production**

Some change or changes will result from using a GMO in agriculture. Broadly speaking, the GMO can reduce costs or raise farm gross returns. ERMA's assessment of an application will need to determine exactly how costs and gross returns would be affected, and what the net effect might be.

A good example of the assessment problem is Round-up Ready (RR) soybeans. These soybeans are genetically engineered to tolerate the herbicide Roundup, allowing farmers to spray for weeds over the top of a standing crop. As would be expected, farmers using RR soybeans switch from using other herbicides to using Roundup. If farmers can substitute one treatment of Roundup for multiple treatments of other herbicides, they reduce their costs. If they have to spray two or three times with Roundup, their cost savings are eroded. An additional consideration is whether yield will be affected—either enhanced or reduced as a result of the genetic modification.

Questions that ERMA considers are relevant regarding production are divided into two categories: Costs and Producer returns.

### **Costs**

- What will be the technology fee, the cost to producers for using the GM technology?
- How will production of the GMO affect variable inputs, such as fertiliser, pesticides, etc?
- How will capital costs, such as machinery costs, be affected? For example, will new machinery be required?
- What will be the impact on labour – will the time required for crop production (including harvesting) increase or decrease?
- Will changes in labour requirements affect labour availability – will it improve or exacerbate labour bottlenecks?
- Will the crop production compete with labour and machinery used elsewhere, and how will that affect their prices and availabilities?
- Water is becoming an important issue – will there be any effects on water use?

### **Producer returns**

- Is the GMO expected to affect crop yields?
- Is the GMO expected to affect the crop quality?
- In either case, what will be the effect on crop prices?

## **Important questions regarding consumer demand**

Important considerations are whether New Zealand producers will be able to sell their products and what price they will receive. These depend on consumers in overseas markets. The GM crop should have intended purchasers, consumers who realistically would buy the product at the estimated price. Information contained in applications can be assessed on whether consumer segments are identified; how realistic the estimates of market size are, and how realistic price estimates are, given the prevailing commodity prices, price trends, and consumer perceptions at the time of application and expected changes in these variables over time.

## **Markets for the commodity**

- What are the intended markets for the commodity, by country and by market segment?
- What market share does NZ have, and how might this be affected?
- What are the trends in those markets, such as changes in tastes, income per capita, etc?
- What is the elasticity of demand in those markets, that is, how sensitive are consumers to changes in price? What is the substitutability?
- What are NZ's competitors doing, and what impacts could they have?

## **The GM issue**

- How sensitive are the proposed markets to the issue of genetic modification?
- What proportion of the markets is particularly sensitive to the GM issue?
- Have any estimates been made of possible discounts facing GM products in the markets?
- Are gatekeeper effects likely to exist? What is the level of concentration of food wholesalers, distributors and retailers in the market for the commodity?
- What are the requirements for labelling of GM products?
- What proportion of NZ's exports is exposed to these labelling requirements?
- What costs will be incurred complying with labelling and other regulations?
- What are competitors doing regarding GM? How widespread is the particular GM technology being employed?

## **Sensitivity analysis**

- An application should present calculations demonstrating a product's profitability. Its assessment should consider alternative scenarios that might impact on profitability.
- What if costs increased/decreased by 10%?
- What if yield or prices increased/decreased by 10%?
- What would be the effects of possible market reactions, such as changes in labelling laws or negative consumer reactions?
- What alternative markets exist for the product – if the product could not be sold in a high-value market, where would it need to be sold and at what price?

## APPENDIX B – New organism release (non GM) example

### Biocontrol agent – benefit cost analysis (quantitative)

The following example illustrates how ERMA New Zealand might address the analysis of effects on the market economy for a new organism release, where quantitative information is provided. As noted, in this instance the analysis is highly simplified.

In most circumstances the outcome of a benefit cost analysis for a non GM new organisms release will be expected to be a positive net present value or benefit cost ratio greater than unity. Therefore, the amount of information required will be related to relative magnitude of the adverse effects on the environment, human health, society and culture. Where possible quantitative information should be supplied either at a national level or for a case study example. In the latter case, the case study should be put into the national context by estimating the percentage of the national economy affected.

### Scenario

The organism to be released is a parasitoid that infects a mite that affects citrus crops, and which is expensive to control by chemical means. While there is no evidence that current methods of control are becoming any less effective, there is some concern that within five years growers will have to stop using the current chemical control because of international pressures. There are other chemicals available, but they are less effective, and even more expensive.

Five years ago a study showed that uncontrolled orchards lost 30% of their crop to the mite.

Overseas experience (evidence provided) shows that in Australia, four years after release, the parasitoid was established in 60% of the crop (year 1: 10%, year 2: 25%, year 3: 50%). It was also estimated that by year 4, 50% of mites had been destroyed. These numbers were based on the results from a simulation model that used data from 10 test orchards. There has been limited verification of the model (in two other orchards).

The mite is also established in Japan and California, but there is no numerical data available (verbal reports from orchardists indicate that they believe it is successful).

**Table 1: Direct monetary costs \$m**

	Year 1	Year 2	Year 3	Year 4	Year 5	Uncertainty / variability	Costs borne by
Rearing, distribution and establishment	0.1	0.05	0.2	0	0	+/- 10%	Applicant / Growers

**Table 2: Direct monetary benefits \$m**

	Year 1	Year 2	Year 3	Year 4	Year 5	Uncertainty / variability	Benefits to
Increased production	1.3	5.2	17.3	17.3	17.3	+/- 20%	Applicant / Growers
Reduced pesticide costs	0	1.0	2.0	3.2	3.9	+/- 20%	Applicant / Growers
TOTAL	1.3	6.2	19.3	20.5	21.2		

Basis for figures: 10,000 ha producing 5 tonnes/ha and \$500/tonne (base figures). In year 1, the model predicts an increase of 5% (i.e. from \$25m to \$26m), in year 2 a further 15%, and in year 3, 40% - this increase is expected to continue to rise, but for the purposes of this analysis it is kept as constant.

Pesticide costs for the current year are estimated as \$500 per ha (total \$5m). Pesticide use is expected to be at the current level for the first year, to reduce by 20% in the second year, by a further 25% in the third year, and 40% in years 4 and 5, levelling off at about 20% of current usage (remember that a replacement needs to be found anyway).

A survey of orchardists and Accident Compensation Commission data show that on average 400 person-days per year are lost to illness related to spraying (all chemicals). It is estimated that 5% are due to the chemical used to control the mite, that is, 20 days. It is assumed that the reduction of sick days builds up slowly from 0 to 20 days over a five-year period (0, 3, 7, 13, 20). Table 3 shows the monetary valuation of this indirect benefit.

**Table 3: Indirect monetary benefits \$m**

	Year 1	Year 2	Year 3	Year 4	Year 5	Uncertainty / variability	Benefits to
Reduced sick days	0.0000	0.0005	0.0013	0.0023	0.0035	+/- 30%	Applicant / Growers

Using these costs and benefits, and assuming that they stabilise after five years, the Net Present Value (NPV) for a 20-year planning horizon can be calculated. Table 4 shows the variation in the NPV where three scenarios are given, where the low and high scenarios are calculated using the variability estimates given for costs and benefits. Three fixed discount rates are used<sup>2</sup>.

**Table 4: NPV**

NPV \$m	Low	Mean	High
Discount rates			
5%	183	230	275
10%	118	148	177
15%	82	102	123

Benefits not able to be measured in dollar terms are identified as –

- Improved integrated fruit production.
- Decreased insecticide resistance, lower environmental pollution, increased overseas consumer confidence in NZ clean green image.
- Significantly increased opportunities for organic production.
- Less chance of spray drift affecting neighbouring properties.

Indirect benefits:

- Economic benefit of improved industry returns.

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<sup>2</sup> While in some circumstances there might be an argument for adopting variable discount rates, in most cases the data will be insufficient to support this.

## Baseline scenario

The effects of the organisms or substance must be measured against a baseline or counterfactual scenario, based on what would be expected to happen if the application were not approved (Principle 7).

If the parasitoid is not released, then the direct costs of mite control will increase slightly from the current baseline of \$5m/year for five years (10% per year – as slight resistance develops), then significantly (i.e. by 50%) as the current chemical is replaced. It is expected that the chemical will be discontinued in five years time, but external pressures may mean that it is still available for a further five years. No estimate of the likelihood of it being phased out in five years is available, a guestimate suggests 60-70% chance. The alternative (baseline scenario) therefore postulates that the current chemical is phased out at year 8. Pesticide costs increase by 50% and this is maintained for the 20-year period.

**Table 5: Pesticide costs \$m**

YEAR	1	2	3	4	5	6	7	8	9	10
Mite control	5.00	5.25	5.51	5.79	6.06	6.38	6.70	10.05	10.05	10.05

**Table 6: Increased pesticide costs \$m**

YEAR	1	2	3	4	5	6	7	8	9	10
Mite control	0.00	0.25	0.51	0.79	1.06	1.38	1.70	5.05	5.05	5.05

The revised NPV for a 20-year planning horizon and 10% discount rate (mean scenario) is calculated as -\$22m.

The total economic benefit from the introduction of the mite (based on mean value scenarios) is therefore \$148m – (-\$22m) = \$170m.

The approach adopted in this example may be considered simplistic in terms of the level of economic analysis. However, it is realistic in terms of the type of data that is commonly available.

## APPENDIX C – Hazardous substance release example

### Herbicide – benefit cost analysis (qualitative)

This example illustrates how ERMA New Zealand might address the analysis of effects on the market economy for the release of a new herbicide. In this instance the analysis is qualitative rather than quantitative.

Where information is provided in a qualitative form as shown here then it will be considered adequate if there is a clear difference between the scenarios, as in this illustration. If this is not the case, then ERMA New Zealand may request quantitative data from the applicant to refine the analysis.

Consider an application for release of a specialist herbicide that has residual effects requiring a standing period before it biodegrades sufficiently to allow treated products to be used, for example, in composting processes. While current alternatives exist, it is known that within 5-10 years these will need to be replaced by new products as they become less efficacious.

The product will mainly be used by large scale commercial operators, with approximately 1% use by home gardeners.

Two scenarios are presented for the identification and assessment of costs and benefits:

- Scenario A - substance available
- Scenario B - substance not available

The purpose of this analysis in this instance is to estimate the net benefit (benefit-cost) of the substance being available. The analysis also needs to consider the cost of the substance not being available (-ve net benefit of Scenario B).

For Scenario A, the net benefit (excluding cost of not being available) is  $NB_A = B_A - C_A$

For Scenario B, the net benefit is  $NB_{NA} = B_{NA} - C_{NA}$

Thus, the overall net benefit for the application is  $NB_A - NB_{NA}$ .

This can be written as  $B_A - C_A - (B_{NA} - C_{NA})$ .

For economic benefit to outweigh economic cost ( $B_A - B_{NA}$ ) must be greater than  $(C_A - C_{NA})$ .

### Time dimension

One of the difficulties in undertaking qualitative assessment of costs and benefits is in allocating costs and benefits across different time frames. It is clearly not possible to use discount rates to assist in this allocation since only qualitative information is available.

The following table includes a qualitative assessment of the time frame in which the effects are likely to occur, i.e. short term (one year), medium term (1-5 years) and long term (more than 5 years).

### Distributional aspects

While there may be some geographical differences, the main distributional aspect relates to the type of use of the product.

## Substance available – Scenario A

<b>Economic costs (including likelihood and magnitude)</b>	<b>Level of effect</b>	<b>Direct/ indirect</b>	<b>Monetary / non M</b>	<b>Time dimension</b>	<b>Uncertainty</b>
<p><b>Home users</b> Marginal cost of disposal of treated material</p> <ul style="list-style-type: none"> <li>▪ Extremely likely (effectively certain)</li> <li>▪ Magnitude – minimal given small scale</li> </ul>	High	Direct	Monetary	Long-term – on-going	There is little uncertainty w.r.t. either the likelihood or the severity.
<p><b>Commercial users</b> Marginal cost of disposal of treated material</p> <ul style="list-style-type: none"> <li>▪ Extremely likely (effectively certain)</li> <li>▪ Magnitude – minimal</li> </ul>	High		Monetary	Long term – on-going	There is some uncertainty about the cost depending on how much material would require special disposal.
<p>Cost of incorrect use (remediation) <b>Home users</b></p> <ul style="list-style-type: none"> <li>▪ Improbable – very unlikely</li> <li>▪ Minimal</li> </ul>	Very low to insignificant				
<p>Cost of incorrect use (cost of remediation in the case of incorrect disposal) <b>Commercial users</b></p> <ul style="list-style-type: none"> <li>▪ Highly improbable</li> <li>▪ Major</li> </ul>	Low				While the severity is given as major, there is some uncertainty, since the severity will depend on the amount of material involved
<b>Economic benefits</b>					
<p><b>Cost savings</b> Cheaper and more convenient to use (mixture of economic, social and ecological effects)</p> <ul style="list-style-type: none"> <li>▪ Very likely</li> <li>▪ Major</li> </ul>	Very high				

## Substance not available – Scenario B

<b>Economic costs (including likelihood and severity)</b>	<b>Level of effect</b>	<b>Direct/ indirect</b>	<b>Monetary / non M</b>	<b>Time dimension</b>	<b>Uncertainty</b>
Home users Cost of use of other products Extremely likely to certain Minimal, given small scale of home use	High				There is little uncertainty
Commercial users Cost of use of other products Extremely likely to certain Moderate	Very high	Direct	M	Short term – on-going	Uncertainty is low.
Cost of transfer to other products over time as the existing range becomes ineffective Likely Moderate	High	Indirect	M and non M	Medium term – one- off	Medium uncertainty (related to when a switch is required and what else is available at that time)
<b>Economic benefits</b>					
nil					

### Overall summary

For Scenario B costs outweigh benefits.

For Scenario A, costs and benefits are reasonably balanced (taking into account the small amount of use by home users).

The net benefit for the application (net benefit Scenario A – net benefit Scenario B) is therefore likely to be positive unless there are identifiable significant benefits for the substance not being available. Note that this analysis does not consider costs and benefits to the manufacturer, importer or retailer.