ASSESSING THE MARKET POTENTIAL OF PROPOSED TECHNOLOGIES: EX ANTE EVALUATION OF R&D

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by

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ABSTRACT

Ranking of research proposals represents a key challenge to funding organisations that have limited funding available for distribution. Benefit/Cost analyses (BCA) have helped discriminate among competing projects and is now a routine part of project appraisal in the Corporation.

One of the difficulties is applying BCA techniques is the estimation of market potential. Recognising this difficulty, the MRC commissioned the development of a framework to assist applicants and staff estimate the market potential of proposed technologies.

A wide body of marketing literature from the areas of consumer behaviour modelling and the adoption of innovations underpins the framework which is discussed in some detail in this paper. A simple yet rigorous scoring system for estimating market potential must recognise the interaction between the characteristics of the decision maker, the environment in which the decision maker operates and the specific attributes of the innovation.

Unless greater consideration is given to market potential in BCA analysis, such analysis will largely remain a tool for academia rather than for business.

INTRODUCTION

The Meat Research Corporation is responsible for investing funds in research and development projects for the benefit of Australia's Meat and Livestock industry, and therefore strives to maximise the returns that can be generated from such investment. In order to do this, Corporation staff must focus clearly on the likely industry impact of each project proposal submitted for funding consideration.

Each year a major part of the Corporation's research budget is allocated to the funding of projects submitted by the research community. Because of the large number of proposals received each year, the Corporation has endeavoured to apply rigorous methods of project evaluation. Since 1990, Benefit/Cost analysis (BCA) has been the main quantitative method used by the Corporation to evaluate individual projects.

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[1] Prepared by Violeta Espinas, Program Support Manager, Meat Research Corporation (MRC). The paper is based on various projects commissioned by MRC on benefit/cost evaluation of submitted projects. A recent report "Assessing Market Potential: Guidelines for Funding Applicants" jointly prepared by Michael O'Keefe, Fiona Manifold & Paul Steffens (Agricultural Research Business Unit of Monash University) and D & B Collins is available from MRC.

Since then the Corporation has revised its method of evaluating the likely pay off from investing in R&D, and now has in place an effective, simple and consistent method that can be applied across all submitted projects. A booklet "Overview of MRC Benefit Cost Evaluation of Projects : Guidelines for Funding Applicants" has been prepared at MRC to give an overview of benefit/cost analysis and provide details of the evaluation model use by the Corporation. A "Data Compendium for MRC Benefit/Cost Evaluation of Submitted Projects" is also available from MRC; this publication is updated regularly and is the recommended source of data in the evaluation of projects to ensure consistency across all applications.

The most difficult part of any BCA is determining the likely industry impact of a given project proposal. Once this has been done it is a reasonably straight forward procedure to estimate the expected pay off to the funds invested in a project. On the following page the steps used in the benefit cost evaluation of projects submitted to the Corporation for funding consideration are shown.

Estimations of project benefits remain a difficult task in ex-ante evaluation, particularly in view of assessing the market potential of any new technology. Most often, market potential is often overlooked, or at most very subjectively assessed. To help address this problem, the Corporation commissioned the development of a framework for estimating the market potential for an innovation at the submission stage. In this paper, a simple yet rigorous method for assessing the likely maximum and annual rate of adoption from technologies (products, processes, information) generated through research supported by the Corporation is presented.

This paper is hoped to provide researchers with

(i) a better understanding of what factors influence the ultimate market potential of a proposed technology;

(i) a broad framework for assessing the market potential of proposed technologies when R&D projects are being formulated; and

(iii) a common language which can be used in all project evaluations.

Steps in Project Evaluation

1. Identify likely industry impact

2. Estimate project costs
   - Research Costs
   - Development Costs
   - Commercialisation Costs

3. Estimate project benefits

   Total net gains → Select representative Business

   - Determine profit increase
     - Higher yields
     - Higher prices
     - Lower cost of inputs
     - Less inputs used
   - Subtract implementation costs
     - Variable costs
     - Capital purchases
   - Sum across potential users
     - Adoption rate
     - Adoption ceiling

4. Adjust annual benefits to reflect possibility of obtaining the technology elsewhere → Determine research lead time

5. Adjust annual benefits to reflect the extent to which gains are captured by MRC stakeholders → Identify impact market
   - Australian beef market
   - Japanese beef market
   - US beef market
   - All beef markets
   - Sheep meat market
   - Domestic market
   - All markets

6. Adjust annual benefits to reflect probability of project success → Estimate success probabilities
   - Research phase
   - Developmental phase
   - Commercialisation phase

7. Estimate project pay off → Derive net present value and benefit cost ratio
   - On MRC investment
   - On total project cost

ESTIMATING MARKET POTENTIAL

MRC has developed guidelines to help applicants assess the likely market potential of proposed innovations. The guidelines provide a framework which can be used to derive estimates of the maximum adoption and the annual rate of adoption for individual innovations. While the use of the framework does not guarantee the market success of an innovation, it does provide a logical and consistent means of deriving estimates acceptable to the Corporation and applicants.

Adoption behaviour (or the decision to buy and use an innovation) is a function between:

* **the decision maker** - for example, a beef producer, processor or butcher;

* **the innovation itself** - its functionality, cost and quality for example; and

* **the social environment** - within which the decision maker operates. The effect of positive and negative word of mouth can have a major impact on the maximum adoption of the innovation.

These are briefly discussed below.

The decision-maker

The characteristics of the individual producer and the individual organisational situation play a key role in determining the maximum market potential of an innovation. Farmer perceptions of the value of an innovation will largely be determined by their own situation. In marketing literature, individuals are segmented into "innovators" and "imitators". The segmentation is based on attitudes towards innovation and risk, not on value judgements.

The marketing literature views innovators as having two distinguishing characteristics:

(i) they seek out information and,

(ii) they are prepared to make up their own minds as to whether or not to use a technology and do not necessarily wait until the new product or practice is well proven in the district before adopting/rejecting.

"Imitators" on the other hand, wait until a new product or practice is well proven in the district prior to adoption/rejection.

Generally, therefore, innovators are influenced externally (ie, by mass media communication) while imitators are influenced internally (ie, by word of mouth communication). As such, a critical factor on the rate of adoption is how the experience of these early users is communicated from the innovators to the imitators.

The innovation

The specific attributes of an innovation are central to how it will be perceived by potential users and, as such, play a key role in determining the ultimate success of the product. A large proportion (49%-87%) of the variance in the rate of adoption of different innovations is explained by individuals' perceptions of the innovation. These perceptions tend to be driven by the attributes of the innovation.

While we appreciate that it may be difficult for the researcher to precisely describe the new product at the early research stage, it has been found that the introduction of market information early in the stage of a product's development is a key factor influencing its success. By understanding the nature of specific attributes, and how they influence adoption decisions, the researcher can identify likely barriers to adoption and may be able to refine the product or process so as to overcome any shortcomings and hence increase the attractiveness of doing the research.

The marketing literature commonly identifies six key attributes that influence adoption decisions.

Relative advantage - Relative advantage relates the specific attributes of the innovation to the best available alternatives. That is, how does it compare to the current offerings? Does it save costs or reduce the time it takes to perform given tasks? Does its use lead to an increase in profits? Is it easier to use? Is it more effective at solving the given problem? What is the quality of the innovation in terms of reliability or back-up service? These are just some of the questions that should be asked of the innovation.

Compatibility - Compatibility refers to how easily the product fits in with the existing practices, behaviours and values of the target market.

New products that require farmers to make significant changes to their operations are less likely to be as well received than, say, a new drench which fits in well with their existing animal health program.

Divisibility/Trialability - The divisibility attribute relates to how easily the farmer can conduct a small scale test of the innovation on their farm. Trialability allows the farmer to experience the product before making a wide scale commitment to it - "seeing is believing". Trialability appears to have a greater impact on the rate of adoption than on the maximum level of adoption.

Communicability - Communicability relates to the ease with which the benefits can be identified and communicated to others. Is the innovation one that farmers can seek working "over the back fence" or are the benefits harder to identify?

Communicability is an important variable in the feedback loop, especially between different segments of farmers.

Complexity - Complexity relates to the extent to which the innovation is difficult to use or understand. This construct is negatively correlated with adoption.

Perceived risk - There is an inherent risk in trying anything new - both social and economic. Thus, any new product must overcome this barrier to adoption.

In adoption modelling, arguments have been put forward that relative advantage, compatibility, complexity and perceived risk (negatively correlated) have a direct impact on maximum adoption, while the remaining attributes - communicability, and divisibility - have a greater impact on the rate of adoption.

However, it is important to note that these attributes are not mutually exclusive and that indeed in some instances, there may be a high degree of correlation between the attributes. For example, where it is easy to conduct a small scale test of new product or practice, the risk associated with adoption can be reduced significantly.

Of the factors influencing maximum adoption, relative advantage and compatibility are consistently identified as the most critical.

The social environment

For a given innovation, a farmer must base his adoption/rejection decision on the information he receives. Two main sources of information exist - promotion and extension activities and word of mouth communications. This second source of information is particularly important for imitators. Given the different responses and behaviours of innovators and imitators it is worthwhile to identify and target innovators when a new practice is being promoted to industry. After initial trial use by innovators the appropriate marketing or extension techniques will be those that encourage positive word-of-mouth; such as local field trials, farmer discussion groups, testimonial advertising, etc.

These results also lend support to the importance of "search" and "experience" type communicability attributes of the new technology. For new products, the responses and attitudes of innovators and imitators do not differ as greatly as for more complex techniques.

Many new products are conceptually easy for producers to imagine working on their property, and generally have high "search" communicability attributes.

New practices, however, have high "experience" communicability attributes and do not generally lend themselves to word-of-mouth communication. Similarly, it is not easy for a producer to observe the benefits of these new practices by "looking over the fence". They have to trial the practice for themselves and "experience" the benefits. This has the effect of slowing the rate of adoption. It is difficult to demonstrate a track record for these practices with high "experience" communicability attributes.

Market Potential

In the cost-benefit assessments undertaken by the Corporation, it is not necessary to consider each and every potential decision maker. A representative operating unit can be chosen (see MRC's Data Compendium) and also be used to estimate market potential. However, further consideration will need to be given to other aspects of an innovation and the social environment within which it will be used.

Considerable time and resources are required to determine the impact on adoption behaviour of the interaction between the decision maker, the innovation and the social environment. Therefore the Corporation has developed some broad "rules of thumb" or guidelines. These guidelines consider the following:

* **Maximum Adoption** - or its ultimate take-up within a target group of users who could potentially benefit from the use of the innovation. That is, is it likely to be a major new product or practice, a niche product or somewhere in between?

* **Rate of Adoption** - or how quickly the innovation will be taken up within the target group of potential users on a year to year basis.

The Adoption Framework developed to assist applicants assess the likely maximum adoption and annual rate of adoption of proposed innovations is based on a consideration of the key physical attributes of potential innovations and users' perceptions regarding their complexity and observed value.

The strength of the approach does not rely on detailed market assessments but rather, a systematic framework within which maximum adoption and rate can be determined in a logical and consistent way. The model is based on six key product attributes:

* Relative advantage
* Compatibility
* Trialability
* Perceived risk
* Complexity, and
* Communicability.

Under each product attribute, such as relative advantage, a number of product features have been listed. The number of such features for each attribute provides a simple weighting for that attribute. This reflects that some attributes are more important than others as identified by research studies. For example, compatibility, with three features, is weighted more than complexity or perceived risk. The importance of relative advantage as an attribute is reflected in the way it is scored from 1-10, as opposed to a 1-5 score for all the other features and attributes. The listing of a range of features also draws attention to the many different factors that lead to consumer perceptions of the innovation which must be assessed in its evaluation. For example, a new product may have superior performance and lead to cost savings, but if it is not convenient to use, then its overall relative advantage will be lessened. Hence the

objective is to evaluate the innovation on a range of features and benefits rather than attempt to collapse the scoring into a single construct such as economic advantage or benefits.

The maximum adoption of an innovation is largely determined by:

* its relative advantage over current options, and
* its compatibility with current practices, values and habits.

The attributes of complexity and perceived risk also have a bearing on maximum adoption but to a lesser degree.

It is important that, prior to assigning scores for each of the attributes, the researcher identifies the specific target market to which the innovation is aimed. Once the target market has been identified, the scores for each of the attributes should be assigned bearing in mind the perceptions of the target market. It is the perceptions held by the target market (which do not necessarily reflect the physical attributes of the innovation) that will determine the scores awarded for each attribute.

The annual rate of adoption - how quickly the innovation is likely to reach its potential - is a function of the extent to which target users will adopt it (maximum adoption) and the extent to which it can be trialed by users and the benefits observed and communicated to others. It should be remembered that high maximum adoption does not necessarily imply that its rate of adoption will also be high.

The score for maximum adoption is calculated by adding together all the scores under relative advantage, compatibility, complexity and perceived risk. The derived score provides an indication as to what assumption should be used in the benefit cost assessment for maximum adoption.

If the score is less than 25 it is assumed that the innovation has *no maximum adoption*

> If the score is between 26 and 40, maximum adoption is assumed to be *low or 25%* of target end-users
>
> If the score is between 41 and 54, maximum adoption is assumed to be *medium or 45%* of target end-users
>
> If the score is greater than 55, maximum adoption is assumed to be *high or 65%* of target end-users

MAXIMUM ADOPTION

Relative Advantage	*Your Score*	*Score 1-10, where 1 is low and 10 is high*
Increased performance or reduction in the problem		How well will the innovation reduce the problem or increase performance relative to currently available options?
Increased profitability or cost savings		How great are the cost savings of the innovation relative to the current alternatives?
Product quality / reliability		How will the product quality and/or reliability be perceived by the target market compared with current options?
Increased convenience of use / time savings		How convenient to use is the product relative to current products? Does its use result in significant time savings?
Complexity	*Score*	*Score 1-5, where 1 is difficult and 5 is easy*
Technical complexity		How technically complex will the innovation be seen by the target market?
Difficult to learn to use		How difficult initially will it be for the target market to learn to use the product/service?
Compatibility	*Your Score*	*Score 1-5, where 1 is low and 5 is high*
With current practices		How compatible is the innovation with current practices?
With current technology		To what extent is the innovation compatible with current technology and used for similar tasks?
With social Values / norms		How compatible is the innovation with how potential users see themselves - with current social values and norms?
Perceived Risk	*Your Score*	*Score 1-5, where 1 is high and 5 is low*
Investment required		How great is the level of investment required to adopt the innovation relative to current options?
Product failure loss		How great will be the consequences of the innovation failing? (score 1 if major consequences)
Total Adoption Level		

The score for the rate of adoption is calculated by adding together all the scores under trialability and communicability then multiplying this value by the value calculated for maximum adoption. The derived score provides an indication as to what assumption should be used in the benefit cost assessment for the rate of adoption.

ANNUAL RATE OF ADOPTION

Trialability	*Your Score*	*Score 1-5, where 1 is difficult and 5 is easy*
Small scale trial feasibility		How easy will it be for the target market to trial the innovation and assess its performance before adopting on a widespread scale?
Adoption easily reversible		How easy would it be to revert back to current practices/products if the innovation does not perform to expectations after adoption?
Communicability	*Your Score*	*Score 1-5, where 1 is difficult and 5 is easy*
Benefits evaluated pre-use		How easy is it for potential users to evaluate the innovation before use - or do they have to try it in their own situation before making any assessment?
Benefits evaluated by others during use		How easy is it for potential adopters to assess the performance of the innovation by observing its use by others?
Sub Total		
Adoption Level Score		
Adoption Rate Score		Multiply Sub Total by Adoption Level Score

If the score is 700 or less, rate of adoption is assumed to be ***low***; (ie, 5% of target end-users will adopt the technology each year).

If the score is between 701 and 999, rate of adoption is assumed to be ***medium***; (ie, 12% of target end-users will adopt the technology each year).

If the score is 1000 or more, rate of adoption is assumed to be ***high*** (ie, 20% of target end-users will adopt the technology each year).

As could be seen from above, the framework prepared for the Meat Research Corporation is based on assigning one of three values (low, medium, high) to both market potential and rate of adoption.

The matrix below summarises the thresholds (cut-off points) developed for MRC. These thresholds have been based on a comprehensive analysis of the marketing literature and studies into the adoption of new technology for a number of products and practices for a range of industries. It should be noted, however, that there is a subjective element in the thresholds that could be modified in the light of further work.

Rate of Adoption (a)				
	High Range 700 or less	a_h, p_l	a_h, p_m	a_h, p_h
	Medium Range 701 - 999	a_m, p_l	a_m, p_m	a_m, p_h
	Low Range 1000 or more	a_l, p_l	a_l, p_m	a_l, p_h
		Low Range 26-40	Medium Range 41 - 54	High Range >55

Maximum Adoption (p)