ISSUES RELATED
TO THE FUNDING OF PRIMARY PROCESSING RESEARCH
THROUGH RESEARCH ASSOCIATIONS

N. BLYTH and A.C. BECK

Views expressed in Agricultural Economics Research Unit Discussion Papers are those of the authors and do not necessarily reflect the views of the Director, other members of the staff, or members of the Policy or Advisory Committee.

DISCUSSION PAPER NO. 73
OCTOBER 1983

AGRICULTURAL ECONOMICS RESEARCH UNIT
LINCOLN COLLEGE
CANTERBURY
NEW ZEALAND

ISSN 0110-7720
THE AGRICULTURAL ECONOMICS RESEARCH UNIT
Lincoln College, Canterbury, N.Z.

The Agricultural Economics Research Unit (AERU) was established in 1962 at Lincoln College, University of Canterbury. The aims of the Unit are to assist by way of economic research those groups involved in the many aspects of New Zealand primary production and product processing, distribution and marketing.

Major sources of funding have been annual grants from the Department of Scientific and Industrial Research and the College. However, a substantial proportion of the Unit's budget is derived from specific project research under contract to government departments, producer boards, farmer organisations and to commercial and industrial groups.

The Unit is involved in a wide spectrum of agricultural economics and management research, with some concentration on production economics, natural resource economics, marketing, processing and transportation. The results of research projects are published as Research Reports or Discussion Papers. (For further information regarding the Unit's publications see the inside back cover). The Unit also sponsors periodic conferences and seminars on topics of regional and national interest, often in conjunction with other organisations.

The Unit is guided in policy formation by an Advisory Committee first established in 1982.

The AERU, the Department of Agricultural Economics and Marketing, and the Department of Farm Management and Rural Valuation maintain a close working relationship on research and associated matters. The heads of these two Departments are represented on the Advisory Committee, and together with the Director, constitute an AERU Policy Committee.

UNIT ADVISORY COMMITTEE

G.W. Butler, M.Sc., F.l.d., F.R.S.N.Z.
(Administrative Director-General, Department of Scientific & Industrial Research)

B.D. Chamberlain
(Junior Vice-President, Federated Farmers of New Zealand Inc.)

P.D. Chudleigh, B.Sc. (Hons), Ph.D.
(Director, Agricultural Economics Research Unit, Lincoln College) (ex officio)

J. Clarke, C.M.G.
(Member, New Zealand Planning Council)

J.B. Dent, B.Sc., M.Agr.Sc., Ph.D.
(Professor & Head of Department of Farm Management & Rural Valuation, Lincoln College)

(Lincoln College Council)

B.J. Ross, M.Agr.Sc.
(Professor & Head of Department of Agricultural Economics & Marketing, Lincoln College)

P. Shirtcliffe, B.Com., ACA
(Nominee of Advisory Committee)

Professor Sir James Stewart, M.A., Ph.D., Dip. V.F.M., F.N.Z.I.A.S., F.N.Z.S.F.M.
(Principal of Lincoln College)

E.J. Stonyer, B.Agr.Sc.
(Director, Economics Division, Ministry of Agriculture and Fisheries)

UNIT RESEARCH STAFF: 1983

Director

P.D. Chudleigh, B.Sc. (Hons), Ph.D.

Research Fellow in Agricultural Policy

J.G. Pryde, O.B.E., M.A., F.N.Z.I.M.

Senior Research Economists


R.L. Sheppard, B.Agr.Sc. (Hons), B.B.S.

Research Economist


Assistant Research Economists

J.B. Bain, B.Agr. LL.B.


G. Greer, B.Agr.Sc. (Hons) (DSIR Secondment)

S.A. Hughes, B.Sc. (Hons), D.B.A.

G.N. Kerr, B.A., M.A. (Hons)

M.T. Laing, B.Com. (Agr), M.Com. (Agr) (Hons)


P.R. McCrea, B.Com. (Agr)

J.P. Rathbun, B.Sc., M.Com. (Hons)

Post Graduate Fellows

C.K.G. Darkey, B.Sc., M.Sc.

Secretary

G.W. Butler, M.Sc., F.l.d., F.R.S.N.Z.
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PREFACE</strong></td>
<td></td>
<td>(v)</td>
</tr>
<tr>
<td><strong>CHAPTER 1</strong></td>
<td><strong>INTRODUCTION</strong></td>
<td>1</td>
</tr>
<tr>
<td><strong>CHAPTER 2</strong></td>
<td><strong>RESEARCH ASSOCIATIONS</strong></td>
<td>3</td>
</tr>
<tr>
<td>2.1</td>
<td>The Research Associations</td>
<td>3</td>
</tr>
<tr>
<td>2.2</td>
<td>Funding of Research Associations</td>
<td>4</td>
</tr>
<tr>
<td>2.3</td>
<td>Criteria for Funding Research Associations</td>
<td>6</td>
</tr>
<tr>
<td><strong>CHAPTER 3</strong></td>
<td><strong>FACTORS AFFECTING GOVERNMENT ASSISTANCE TO PRIMARY PROCESSING RESEARCH</strong></td>
<td>11</td>
</tr>
<tr>
<td>3.1</td>
<td>The Profitability of Agricultural Research</td>
<td>11</td>
</tr>
<tr>
<td>3.1.1</td>
<td>Industry Size and Growth</td>
<td>13</td>
</tr>
<tr>
<td>3.1.2</td>
<td>The Cost of Research</td>
<td>13</td>
</tr>
<tr>
<td>3.1.3</td>
<td>The Adoption Rate of Research</td>
<td>14</td>
</tr>
<tr>
<td>3.1.4</td>
<td>The Responsiveness of New Zealand Production to Changes in Price</td>
<td>14</td>
</tr>
<tr>
<td>3.1.5</td>
<td>The Responsiveness of Quantity Demanded to Changes in Price</td>
<td>14</td>
</tr>
<tr>
<td>3.1.6</td>
<td>The Level of Domestic Consumption</td>
<td>15</td>
</tr>
<tr>
<td>3.2</td>
<td>Factors Reducing Investment in Primary Processing Research</td>
<td>15</td>
</tr>
<tr>
<td>3.2.1</td>
<td>External Benefits</td>
<td>15</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Distortions in the Economy</td>
<td>16</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Time Preferences, Costs and Risk</td>
<td>16</td>
</tr>
<tr>
<td>3.2.4</td>
<td>Maintaining International Competitiveness</td>
<td>17</td>
</tr>
<tr>
<td>3.3</td>
<td>Factors Affecting The Type of Research Undertaken</td>
<td>17</td>
</tr>
<tr>
<td>3.3.1</td>
<td>Basic Versus Applied Research</td>
<td>17</td>
</tr>
<tr>
<td>3.3.2</td>
<td>Research to Assist Particular Industries</td>
<td>18</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Conservation and Environmental Research</td>
<td>18</td>
</tr>
<tr>
<td>3.3.4</td>
<td>Research Facilitating Adjustment to Change</td>
<td>19</td>
</tr>
<tr>
<td>3.3.5</td>
<td>Overseas Versus Domestic Research</td>
<td>20</td>
</tr>
<tr>
<td>3.3.6</td>
<td>Other Reasons for Government Involvement in R.A.s</td>
<td>21</td>
</tr>
<tr>
<td>3.4</td>
<td>Conclusion</td>
<td>22</td>
</tr>
</tbody>
</table>
CHAPTER 4 Benefits and Costs of Primary Processing Research

4.1 The Distribution of Research Gains 23

4.2 The Distribution of Research Costs 25

4.3 The Distribution of Costs and Benefits of Demand-Shifting Research 25

4.4 Issues Related to Industry Funding of Research
   4.4.1 Levies 26
   4.4.2 Patents 28
   4.4.3 Other Methods of Encouraging Industry Funding 28

CHAPTER 5 Conclusions 31

5.1 Further Research 32

References 35

Appendix 1 Summary of Studies of Aggregate Agricultural Research Productivity 39

Appendix 2 Distribution of Costs and Benefits of Research 41
The last few years have seen a higher inflation rate in New Zealand compared with the country's trading partners, a price decline for the country's unprocessed export products, and increasing overseas access problems for these products. Hence more concern is currently being expressed for the reduction in processing and marketing costs as well as support for the concept of added value to traditional export products. Research undertaken by New Zealand R.A.s can be viewed as invaluable given this situation.

On the other hand, the pressure to reduce government spending is leading to the questioning of the level of government support for R.A.s (as opposed to industry support).

This Discussion Paper is concerned with this issue of government assistance to R.A.s. A review of the relevant arguments for continued government assistance is presented, further questions posed, and research useful in deciding how to resolve some of the arguments is suggested.
CHAPTER 1

INTRODUCTION

There has recently been some discussion on New Zealand Government involvement in funding of agricultural research (see, for example, National Business Review, 17/1/83). The arguments become more heated as economic pressures force both cuts in government expenditure and closer monitoring of the efficient use of remaining expenditure. It has been advocated that there be less reliance on public research and development (R & D) spending through bodies such as the Department of Scientific and Industrial Research (D.S.I.R.) and more private sector commitment.

This paper reviews some of the issues related to the funding of agricultural processing research, in particular the funding of one type of research organisation - the Research Association. Research Associations (R.A.s) are partnerships of government and particular industries, some of which undertake processing oriented agricultural research.

Chapter 2 of this paper provides some background to R.A.s and an overview of the current sources of their funds. The current formula for determining the level of government funding to R.A.s also is described.

In Chapter 3 some of the issues involved in government and industry funding of primary processing research are discussed. The question of the profitability of primary processing research is addressed in an attempt to find evidence of market failure. Various factors are described which affect the profitability of research but hard evidence of the profitability of processing research or the existence of market failure is shown to be lacking.

Despite this lack of data it is argued on a priori grounds that the characteristics of research and the nature of social objectives are likely to lead to a misallocation of research resources from a community point of view if funding decisions are left only to private interests. The factors leading to this misallocation, both in respect to the amount and type of research undertaken, are described in the second half of Chapter 3. The need to overcome the effect of these factors provides the rationale for government involvement in research organisation and funding.

While some government involvement in processing research appears justified a large proportion of processing research will be carried out efficiently by private interests, either through in-house research or through involvement with R.A.s. In Chapter 4 of this report the distribution of the direct benefits and costs of this important component of processing research is considered. In addition some issues related to the private funding of such research through the use of levies and patents are discussed.
Finally, in Chapter 5 some conclusions are drawn with respect to the role of government in R.A.s, and the need for further research.
CHAPTER 2

RESEARCH ASSOCIATIONS

2.1 The Research Associations

There are currently twelve R.A.s. These were formed as partnerships between the government and various industries, and are the:-

- Building Research Association (BRANZ)
- Coal Research Association (CRANZ)
- Concrete Research Association (CONRANZ)
- Dairy Research Institute (DRINZ)
- Fertiliser Manufacturers Research Association (FMRA)
- Heavy Engineering Research Association (HERA)
- Leather & Shoe Research Association (LSRA)
- Logging Industry Research Association (LIRANZ)
- Meat Industry Research Institute (MIRINZ)
- Pottery and Ceramics Research Association (PCRA)
- Res. Inst. of Textile Services (RITS)
- Wool Research Organisation (WRONZ)

The R.A.s were established at different times, though the government has been involved in them from the start. For example, a Dairy Research Organisation was formed in 1928, with the Dairy Produce Board contributing $1 for $1 to match a grant made by the DSIR. In 1947 the Institute was incorporated and was subsequently financed by the New Zealand Dairy Board and government.

The Meat Industry Research Institute and the Wool Research Organisation were established in 1955 and 1960 respectively.

The R.A.s are generally involved in research on conversion and processing of New Zealand's primary commodities into export products. The objectives of R.A.s are to stimulate the use of new technologies and technical expertise within industry, to encourage the use of local materials and the development of new products and processes, and to provide testing services. In practice Research Association research tends to fall into three main categories. These are cost-reducing innovations, development of new products from existing commodities and development of new processes which can be used by overseas processors to expand/maintain demand for New Zealand's raw materials.

Thus R.A.s deal mainly with the processing sector, whereas government departments such as DSIR and Ministry of Agriculture and Fisheries (MAF) generally concentrate their research efforts on the production sector. The allocation of public funding (i.e. to DSIR, MAF, R.A.s and universities) for production and processing research has been estimated at approximately 83% and 17% respectively (Sorrenson, 1977).
estimated at approximately 83% and 17% respectively (Sorrenson, 1977). While this ignores research undertaken in the private sector, it indicates that processing research attracts a relatively small proportion of public expenditure.

The three main R.A.s undertaking agriculturally related processing research are DRINZ, MIRINZ and WRONZ. Although several of the other R.A.s have undertaken projects which indirectly affect the agricultural sector (e.g. BRANZ's work on the serviceability of available flooring materials for freezing works; LSRA's split deliming process for production of pickled pelts) they are not directly involved in agricultural processing research and are therefore not dealt with in detail in this report.

The Boards of Directors of Research Associations comprise representatives of each of the sectors which contribute funds (i.e. Producer Boards, Industry and government), as well as other technical professional people such as University and R.A. staff. Research and development programmes are guided by various sub-committees of the Boards (e.g. the Technical Advisory Committee of DRINZ).

Because of their involvement in funding and decision making producers and processors can have a major influence on the type of research undertaken, and thereby ensure that it is closely allied to their needs. In addition, the R.A.s benefit through close contact with industry (liaison, co-ordination, communication) and through being subject to external review.

The system of funding R.A.s is, to some extent, an application of the customer/contractor principle (Rothschild, 1971). Under the concept the customer says what he wants; the contractor does it (if he can); and the customer pays. The customer may be the actual user of the research results such as a company, or a government department representing the user of the product or process. The contractor is, in this case, the R.A. A major advantage of this type of system is that "accountability and responsibility in the setting of research priorities (and the use of research funds) are likely to be encouraged if those benefiting from research have to pay for that research" (IAC, 1976).

2.2 Funding of Research Associations

Government expenditure on R.A.s is detailed in Table 1. It comprises approximately 3 per cent of the government science budget expenditure and around 60 per cent of DSIR grants to scientific organisations in NZ and overseas (e.g. universities, the Royal Society, the Commonwealth Agricultural Bureaux). Thus, the amount of government expenditure on R.A.s is small, compared to both total government R & D expenditure, and to the government budget. Government funding of agricultural research was around 1.2 per cent of the gross domestic product derived from the agricultural sector in 1980 (Bushnell, 1982). It has been estimated by the National Research Advisory Council that, in addition to government research, the private sector contributed around 20 per cent of the funds for agricultural research in New Zealand in
TABLE 1
NZ Government (DSIR) Expenditure on R.A.'s

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>BRANZ</td>
<td>413</td>
<td>597</td>
<td>689</td>
<td>766</td>
</tr>
<tr>
<td>CRANZ</td>
<td>242</td>
<td>288</td>
<td>297</td>
<td>358</td>
</tr>
<tr>
<td>CONRANZ</td>
<td>98</td>
<td>117</td>
<td>316</td>
<td>284</td>
</tr>
<tr>
<td>DRINZ</td>
<td>1055</td>
<td>1193</td>
<td>1355</td>
<td>1438</td>
</tr>
<tr>
<td>FMRA</td>
<td>195</td>
<td>288</td>
<td>267</td>
<td>339</td>
</tr>
<tr>
<td>HERA</td>
<td>21</td>
<td>128</td>
<td>172</td>
<td>316</td>
</tr>
<tr>
<td>LSRA</td>
<td>136</td>
<td>122</td>
<td>189</td>
<td>227</td>
</tr>
<tr>
<td>LIRANZ</td>
<td>94</td>
<td>165</td>
<td>135</td>
<td>229</td>
</tr>
<tr>
<td>MIRINZ</td>
<td>720</td>
<td>1141</td>
<td>1091</td>
<td>1299</td>
</tr>
<tr>
<td>PCRA</td>
<td>128</td>
<td>115</td>
<td>126</td>
<td>109</td>
</tr>
<tr>
<td>RITS</td>
<td>54</td>
<td>71</td>
<td>55</td>
<td>79</td>
</tr>
<tr>
<td>WRONZ</td>
<td>658</td>
<td>782</td>
<td>893</td>
<td>958</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3814</strong></td>
<td><strong>5007</strong></td>
<td><strong>5585</strong></td>
<td><strong>6402</strong></td>
</tr>
</tbody>
</table>

---

*a Annual operating costs excludes contributions to new buildings.

b Estimates

**SOURCE:** Annual Report of the Department of Scientific and Industrial Research (various issues)
per cent of sectoral GDP, and Bushnell (1982) suggests that this is lower than many other OECD countries.

In Tables 2 to 4 sources of funds for the three main Research Associations which undertake agriculturally related processing research (MIRINZ, DRINZ, WRONZ) are detailed. It can be seen that their funds derive partly from government sources and partly from producer bodies. Only a small proportion comes directly from private sources but funds provided by the producer boards (N.Z. Meat Producers Board (NZMPB), N.Z. Dairy Board (NZDB), N.Z. Wool Board (NZWB)) generally are indirectly obtained via levies on product sales.

It appears that there has been a change in sources of funds over time, with an increasing proportion of R.A. funds coming from producers and processors. This lessening dependence on government funding is intentional government policy as over time the industries become better organised and able to self-fund research. The shift from government to industry financing has been necessary to maintain or increase research funds, which suggests some willingness by producers and processors to increase their support for research. It should be noted, though, that whilst the proportion of government funds has declined, the total sum contributed by government in real terms has been maintained or increased marginally. Thus, R.A.s are still heavily supported by government, and a considerable amount of government funded research in the three primary processing sectors (meat, wool and dairy) is effected through R.A.s.

2.3 Criteria for Funding Research Associations

The current allocation of government funds to R.A.s is based on the concept of an 'ultimate size' for each R.A. This places a ceiling on government contributions at a level of activity considered appropriate for that industry. Ultimate size was determined by the National Research Advisory Council based on:

(i) the national importance and potential of the industry;

(ii) the effectiveness of the R.A.;

(iii) the receptiveness of the industry in applying research results;

(iv) the potential contribution of science and technology to the expansion, efficiency and diversification of the industry; and

(v) the influence which the R.A. has within the industry (DSIR, pers. comm.).

---

1 Government contributions to Dairy Research Institute for example, declined from over 40% of total DRI funds in 1973-80, to around 28% in 1983. Similarly, government contributions to wool research formed 45% of WRONZ budget in 1979/80, but only 36% in 1981/82.
### TABLE 2
Sources of Research Funds for DRINZ

<table>
<thead>
<tr>
<th>Year</th>
<th>1980-81</th>
<th>1981-82</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
<td>$1,836,434</td>
<td>$4,187,000</td>
</tr>
<tr>
<td>NZ Dairy Board</td>
<td>60%</td>
<td>74%</td>
</tr>
<tr>
<td>DSIR</td>
<td>$1,200,000</td>
<td>$1,504,923</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td>26%</td>
</tr>
<tr>
<td>Total</td>
<td>$3,036,434</td>
<td>$5,691,923</td>
</tr>
<tr>
<td>Less Capital Grants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plus Sundry Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- interest, royalties, fees, sales, etc.</td>
<td>$132,205</td>
<td>$241,644</td>
</tr>
<tr>
<td>Total</td>
<td>$3,030,539</td>
<td>$3,864,567</td>
</tr>
</tbody>
</table>

a Year ended 31st March

SOURCE: Department of Scientific and Industrial Research
### TABLE 3

**Sources of Research Funds for MIRINZ**

<table>
<thead>
<tr>
<th>Income</th>
<th>1980-81</th>
<th>%</th>
<th>1981-82</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DSIR</strong></td>
<td>$889,640</td>
<td>36</td>
<td>$1,111,382</td>
<td>43</td>
</tr>
<tr>
<td><strong>NZ Freezing Co. Assn.</strong></td>
<td>$770,979</td>
<td>31</td>
<td>$720,658</td>
<td>28</td>
</tr>
<tr>
<td><strong>NZ Meat Producers Board</strong></td>
<td>$770,979</td>
<td>31</td>
<td>$720,658</td>
<td>28</td>
</tr>
<tr>
<td><strong>Bacon Curers &amp; Meat Processors</strong></td>
<td>$2,980</td>
<td></td>
<td>$3,720</td>
<td></td>
</tr>
<tr>
<td><strong>Independent Meat Exporters</strong></td>
<td>$3,320</td>
<td></td>
<td>$5,200</td>
<td></td>
</tr>
<tr>
<td><strong>Meat Export Devp. Co (NZ) Ltd.</strong></td>
<td>$830</td>
<td></td>
<td>$1,040</td>
<td></td>
</tr>
<tr>
<td><strong>Defiance Processors Ltd.</strong></td>
<td>$830</td>
<td></td>
<td>$1,040</td>
<td></td>
</tr>
<tr>
<td><strong>Others</strong></td>
<td>$208</td>
<td></td>
<td>$3,640</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$2,439,766</td>
<td>100</td>
<td>$2,567,338</td>
<td>100</td>
</tr>
</tbody>
</table>

**Plus**

<table>
<thead>
<tr>
<th>Sundry Income</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Interest, fees, etc</td>
<td>$113,033</td>
<td></td>
<td>$241,137</td>
<td></td>
</tr>
<tr>
<td><strong>Building A/C Interest</strong></td>
<td>$2,042</td>
<td></td>
<td>$841</td>
<td></td>
</tr>
<tr>
<td><strong>Development Projects A/C</strong></td>
<td>$356,603</td>
<td></td>
<td>$185,669</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$2,911,444</td>
<td></td>
<td>$2,994,982</td>
<td></td>
</tr>
</tbody>
</table>

**SOURCE:** Department of Scientific and Industrial Research
### TABLE 4

**Sources of Research Funds for WRONZ**

<table>
<thead>
<tr>
<th>Year</th>
<th>1980-81</th>
<th>1981-82</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Income</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NZ Wool Board</td>
<td>807,000</td>
<td>1,344,310</td>
</tr>
<tr>
<td>DSIR</td>
<td>771,034</td>
<td>890,400</td>
</tr>
<tr>
<td>Industrial Members</td>
<td>337,474</td>
<td>413,364</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$</th>
<th>%</th>
<th>$</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>1,915,508</td>
<td>100</td>
<td>2,648,074</td>
<td>100</td>
</tr>
</tbody>
</table>

**Other**

<table>
<thead>
<tr>
<th></th>
<th>1980-81</th>
<th>1981-82</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>3,859</td>
<td>7,365</td>
</tr>
<tr>
<td>Rent</td>
<td>5,037</td>
<td>5,156</td>
</tr>
<tr>
<td>Sundry</td>
<td>86,772</td>
<td>112,272</td>
</tr>
</tbody>
</table>

|               | 2,011,176 |         | 2,772,867 |         |

**Source:** Department of Scientific and Industrial Research
For example, the 'ultimate size' of funds considered appropriate for DRINZ and MIRINZ was $3.7 million per annum, and for WRONZ was $2.47 million for 1982/83. The government pays a $1 for $1 subsidy, up to a limit on net expenditure equivalent to 40 per cent of the ultimate size of the R.A., then $1 for $2 above 40 per cent up to a limit of 100 per cent. In effect, this means that government support is limited to a maximum of 40 per cent of the specified 'ultimate size' of the R.A. No government contribution is made above this, and as the main R.A.s have already reached the 'ultimate size', all additional funding is expected to come from industry. Automatic adjustment to the limits is provided for based on the Consumer Price Index.

Industry contributions to R.A.s are supplied mainly through the Producer Boards from funds obtained via levies on product sales. The Boards tend to make a lump-sum payment to the R.A.s, which is only indirectly related to either the volume or value of product sold. It appears that no specific criteria are utilised in determining the contribution, but, rather an ad hoc decision is made dependent upon factors such as ability to pay and R.A. requirements.

Other industry contributions come from private processing companies and organisations (such as the wool scourers, brokers and buyers, meat processors, etc.) also on an ad hoc basis.
Government assistance to primary processing research can be justified largely on the grounds of market failure, national profitability and efficiency of resource use. However, there may be other important reasons (such as facilitating adjustment to change, and environmental conservation) why primary processing research should not be wholly funded and administered by the private sector. These will be discussed later in this Chapter. First, though, the basic question of whether such research is profitable is addressed.

3.1 The Profitability of Agricultural Research

The profitability of research is of interest because it can provide evidence, albeit circumstantial, of under or over-investment in research. In theory in a competitive market economy investment funds should flow into various investment alternatives until the marginal returns from those alternatives are equalised. In an imperfectly competitive world this tendency can be severely dampened; however, if marginal returns on investment in research are significantly higher than alternative investment yields then market failure may be indicated and government involvement may be justified.

Economic analyses of both specific research projects and agricultural research in aggregate have been undertaken in a number of countries. While these studies relate mainly to agricultural production research they are relevant to this discussion on processing research because, in many cases, the nature and distribution of the benefits are similar. The studies indicate that agricultural research is generally highly profitable and has a significant effect on the rate of increase in productivity (Arndt and Ruttan, 1977. See Appendix 1 for a summary of analyses). If this is the case in New Zealand, then market failure may be indicated. This may provide a case for considering the need for government intervention to foster a more efficient level of research.

Unfortunately, however, few analyses of profitability of either agricultural production research or processing research are available for either New Zealand or Australia. There have been studies of technical change which are reviewed by Powell and Bushnell (1981). These studies include Hussey (1969), Johnson (1970) and Longmire and Powell (1973). Powell and Bushnell (1981) calculated a technical change index, and suggest that in both New Zealand and Australia "technological change is a major contributor to economic growth and
through the implicit increase in productivity, is a major vehicle through which farmers can increase their incomes". The most recent aggregate study in Australia (Hastings, 1981) confirms these results.

The Australian IAC attempted to evaluate the returns to a large segment of rural research undertaken by the CSIRO's Division of Entomology (IAC/CSIRO, 1980). While the study indicated the value of the research, it still only provided a limited indication of the overall profitability of research. However, the study concluded from the available evidence that agricultural research is, and will continue to be, highly valuable both to producers and to the community. There is no reason to believe that this conclusion cannot be applied to the New Zealand case equally, though the shortage of specific analyses especially in the processing area, should be highlighted.

The opinion that agricultural research in New Zealand is profitable is supported by Sorrenson (1977) in his review of resource allocation in New Zealand agricultural research. He pointed out that a general conclusion reached in overseas studies is that the absolute value of the related output of the research effort has the most significant bearing on the profitability of the research. Given the significance of agriculture in the New Zealand economy it seems reasonable to assume that, on an aggregate basis, agricultural research has been, and will continue to be, profitable.

Sorrenson's work related mainly to agricultural production research; however, with respect to processing research he suggested that more government involvement in processing research was justified given the contribution that processing makes to national income and the value of gross exports.2

Sorrenson found that, in general, production activities were significantly better served with research than processing activities. He indicated that returns (in terms of foreign exchange and local employment) from additional research in the processing sector were likely to be considerably greater than in the production sector. However, given that the benefits from many processing developments can be satisfactorily appropriated by private companies undertaking their own research, it would appear that, by only considering government and R.A. expenditure on research, Sorrenson may have seriously underestimated the level of processing research expenditure. Private research expenditure by companies is difficult to quantify, but could be considerable, especially in horticultural and crop processing areas, not served by R.A.s.

2 In arriving at this conclusion Sorrenson took agricultural expenditure and manpower data for the DSIR, MAF, agricultural Research Associations and the universities for the years 1968/69 - 1975/76 and classified them into 15 NRAC agricultural activity areas. He then compared this research expenditure for each activity area with the contribution the area made to national income and gross export earnings.
With respect to processing research there seems to have been some highly profitable processing research undertaken by the Research Associations and others, but no studies are available to assess the economics of the total R.A. research programmes. Examples often cited of profitable R.A. research include the development by the Dairy Research Institute of "anhydrous milk fat" products for the South East Asian market, and cheese products acceptable to the Japanese market. Also, the concept of carcass electrical stimulation developed by the Meat Industry Research Institute and wool scouring technology developed by the Wool Research Organisation are examples of worthwhile processing research.

As mentioned above, agricultural production research has been found to be profitable in many situations. It can probably be inferred from this that agricultural processing research is also likely to be profitable. This assertion is supported by Freebairn et al (1982) who showed that there is no reason to argue that research opportunities are greater or research costs are less at one stage in the production and marketing chain than another.

Although there is little information available to assess the profitability of processing research in New Zealand it is possible to list some factors which will affect that profitability. These factors which are discussed in more detail by McLeigh and Wonder (1982), are outlined below.

3.1.1 Industry size and growth.

Industry size and growth directly affect the nation's returns from research, and in general, more will be gained from research which reduces costs by a given amount in a large industry than from the same unit cost reduction in a small industry.

The growth rate of industries also needs to be taken into account, as this will affect their size in future years.

3.1.2 The cost of research.

The costs of undertaking research are likely to vary significantly across different industries. It may be more difficult to achieve a given cost reduction in a large industry because it has historically attracted a large proportion of research funds and may have fewer opportunities for cost savings than smaller industries elsewhere in the economy. On the other hand, a large industry is likely to have much of the infra-structure necessary to undertake further research. These well-established industries may face lower costs of conducting further research than would those which have no existing investment in research. As noted earlier diminishing proportion subsidies paid by government to R.A.s recognise this cost-of-establishment factor.
3.1.3 The adoption rate of research.

The more widely and quickly the results from research are implemented, the greater will be society's gain from an innovation. It is difficult to identify factors responsible for variations in adoption rates, but differences do exist across industries which affect the magnitude of returns to research and must therefore be accounted for in the allocation of research funds.

The adoption rate of new technology overseas can be equally important, in cases such as the wool industry, where the intention is to expand overall demand for New Zealand commodities by supplying overseas processors with lower cost technology.

3.1.4 The responsiveness of New Zealand production to changes in price

The social gains from research will be greater the more production expands (or, the more production is prevented from falling) following implementation of primary processing research results. However, production in New Zealand may not expand if the research results are also implemented in the rest of the world, and world prices fall following expansion in total world production, or if increased New Zealand production would depress the world price (i.e. if the export demand elasticity facing New Zealand is small). Moreover, there may be reasons why reductions in processing costs as a result of research are not transmitted back to the producer. This may be because the processing companies have some monopoly power and can retain additional profits, or because the elasticity of substitution of marketing inputs for farm products is large. In the latter case, benefits to producers from processing research can be small, zero or they may even suffer a loss, depending on the elasticity of demand (Alston and Scobie, 1983).

3.1.5 The responsiveness of quantity demanded to changes in price

For a commodity which is mainly exported, research will benefit New Zealand producers and processors more, the greater the responsiveness of foreign demand to changes in price of New Zealand exports. The degree of responsiveness of foreign demand to price changes in New Zealand exports increases as New Zealand's share of world production declines; as world demand elasticities increase; as supply responses in the rest of the world decline, and as the degree of trade protection decreases (i.e. the price transmission elasticity approaches unity). Thus, cost-reducing research into commodities which have a small share of the world market or face few barriers to trade, will be of most benefit to New Zealand.
3.1.6 The level of domestic consumption.

Finally, the smaller the domestic consumption of a product, the smaller will tend to be New Zealand's benefit from research into the processing of that product.

In conclusion, while some general observations can be made on aspects of profitability, the lack of detailed studies on the profitability of primary processing research in New Zealand means that no empirical evidence can be provided as to the existence or otherwise of market failure. Nevertheless, it can be argued on a priori grounds that, in some cases, because of the characteristics of research and the nature of social objectives, a misallocation of research resources from society's point of view may occur. Such misallocation may occur as an underinvestment in research or with respect to the type of research undertaken. Factors leading to these effects are discussed in Sections 3.2 and 3.3.

3.2 Factors Reducing Investment in Primary Processing Research

A number of factors, which tend to reduce investment in primary processing research are described below.

3.2.1 External benefits.

It is a feature of some types of research that the private researcher is unable to prevent others from utilising his findings. The more the research is "information" or "management" based, rather than "process" or "product" based, the more difficult it becomes to prevent others from using it and benefitting from it. Similarly, external benefits tend to be greater for more basic types of research.

It can be argued that if all the benefits accrue to those who bear the cost of the research, then profit oriented firms under competition would arrive at a general optimum (private and social) by equating marginal costs and marginal returns. If, however, not all of these benefits accrue to these firms (i.e. if all the external benefits cannot be internalised), they would equate marginal costs only to the point where the returns that they can capture are equalised (Fishel, 1973). Under these circumstances it is possible that companies would undertake less research than is desirable from the community's point of view.

Patents and Breeders' Rights legislation is a method of internalising some of the externalities associated with research. Facts and natural laws are excluded from patents and patents may be difficult to apply to information that cannot be translated into a product or process. However as the research undertaken by the R.A.S is generally process oriented, many of the new developments would appear to be patentable. There seems, therefore, to be potential for industry to
reap directly many of the benefits of processing research. It could thus be argued that, because the extent of external benefits can be limited, industry should undertake a significant level of processing research without government subsidies.

The existence of external benefits may also be a factor discouraging companies from co-operating in R.A. research and realising the significant economies of scale that can result. Research benefits must be shared amongst all participating parties and thus, from an individual company's point of view, substantial external benefits may exist for competitors. Under these circumstances the 'carrot' of government matching industry contributions provides a strong incentive to them to contribute to R.A.s.

3.2.2 Distortions in the economy.

It is possible that some distortions in the economy may discourage processing research. One form of distortion which is relevant in New Zealand relates to the over-valued exchange rate. This represents a tax on exporters and may reduce the funds available for processing research. In other cases the structure of the processing industry may not encourage research. For example, where a processing industry is protected and competition between companies is limited, companies may have little incentive to undertake research to improve profitability.

3.2.3 Time preferences, costs and risk.

Research typically requires the outlay of substantial resources over long periods before a financial return can be expected. Further, more than most other investment activities, research is inherently uncertain, with a high risk that any one research project may not lead to results of economic significance. These features of research may lead to an underinvestment in research by private firms, particularly where firms in an industry are small. Underwood (1973), for example, has argued that without government involvement, industry will concentrate too heavily on short-run projects which offer quick and relatively certain returns, and neglect long term studies and basic research, to the detriment of the overall industry and the nation.

In principle, a case can be established for government involvement to counter private underinvestment in profitable but risky investments (see Hirshleifer, 1966; Arrow and Linds, 1970). Financial risks borne by a government are spread across a large number of taxpayers and can be pooled for a large number of investments. Consequently, the total cost of risk-bearing is insignificant and, therefore, governments can afford to ignore uncertainty to a large extent in evaluating public investments. In practice, the difficulties of determining the extent of underinvestment due to risk and establishing an appropriate policy to counter it are likely to be substantial.
3.2.4 Maintaining international competitiveness.

A common argument raised in support of continued government funding of research is that most of New Zealand's competitors in overseas markets spend massive sums on research. (It was noted for example, in Chapter 2 that New Zealand's funding of agricultural research at 1.5% of sectoral GDP is lower than that of many OECD countries). If New Zealand is to be internationally competitive, it may be necessary to subsidise research at levels similar to other countries, if industry is not prepared or able to do so. The difficulties in actually demonstrating market failure in this area are recognised, though it should be noted that the proportion of private funding appears to be low in New Zealand compared to other countries. This possibly results from a weaker corporation structure in New Zealand, with fewer large companies willing and able to undertake private research.

3.3 Factors Affecting The Type of Research Undertaken

In the previous section it was shown how some factors may tend to reduce the level of research being undertaken by private interests. In this section the type of the research is considered. Because of the characteristics of research, and the importance of certain social objectives in the community, the type of research undertaken by private interests may be different from that which is socially optimal. Some factors which may lead to this situation are outlined below.

3.3.1 Basic versus applied research.

It has been argued that there may be private underinvestment in 'basic' research, because the external benefits of such research are large. It would appear that primary processing research is rarely, if ever, truly basic - all research done by primary processing research agencies ultimately has the objective of commercial utilisation, but such research may still yield external benefits. External benefits are likely to diminish (i.e. become internalised) as research moves from the more basic to the more 'applied' end of the research spectrum.

---

3 'Basic' research is that which has no specific application in view, but is necessary to ensure the advancement of knowledge.

4 'Applied' research covers both strategic and tactical research and provides a broad basis of knowledge for, or may be entirely directed at, the solution of specific problems.
3.3.2 Research to assist particular industries.

It has been shown (Scobie, 1979) that an industrial protection policy, such as New Zealand’s, using tariffs against imported manufactured goods can lead to considerable bias against the agricultural sector. The effects are firstly to raise the price of manufactured inputs, and secondly to encourage investment in the manufacturing sector. Availability of resources to agriculture is thereby reduced, making the generally unprotected agricultural sector less competitive. Finally, and most important, the price of foreign exchange tends to be maintained artificially low (Scobie and Johnson, 1974) making the export of products less attractive. To compensate for this bias, assistance to the agricultural sector could be justified, perhaps in the form of a research subsidy.

Within the primary sector government may wish to assist or encourage a particular sub-sector. Some factors affecting the returns to research funds allocated to particular sectors were discussed in Section 3.1 and more or less weight can be given to these factors according to government objectives. For example, although the costs of research are likely to be higher in a new industry, government may allocate more funds to research in that industry to encourage diversification of total production.

Also new industries usually have no strong producer base to provide research funds during establishment and may suffer from inadequate research. Government assistance may be justified in such cases, particularly in the short term, to co-ordinate and supplement producer funds and to ensure that the long term potential of the industry is realised.

3.3.3 Conservation and environmental research.

Concern for conservation of the environment has been stated as an example of the different valuation which the community, on the one hand, and individuals, on the other hand, place on the use of certain resources (IAC, 1976).

Certain types of research are therefore likely to receive public preference because of their environmental impact, or because of the benefits which extend into future generations. With regard to the processing sector, government intervention in areas such as research on low-cost waste treatment systems, may be one way to ensure that effluent disposal and other pollution externalities are reduced.

---

5 This differs from the time preference argument proffered earlier, which tends to be a shorter term issue.
3.3.4 Research facilitating adjustment to change.

(a) Market Conditions

The question of producers' inability to adjust to changes in the physical and economic environment is closely linked to market failure in optimising the allocation of resources, and is relevant to New Zealand at the current time.

The whole rural sector would be able to cope more easily with physical and economic change if the resources at the disposal of farmers and processors could be made more mobile and/or used more efficiently. In this respect the government may wish to enhance the productivity and mobility of resources through fostering research and innovation. For example, processors and exporters would benefit from research to provide the flexibility to adapt to changing world market conditions and to develop new products for new markets, using the existing supply of raw commodities in New Zealand.

Research may also play a role in moderating the continuing cost-price squeeze by facilitating structural adjustment. Without research many of the long term adjustments would still take place under the pressure to maintain incomes, but the changes would possibly be more disruptive or be made more slowly.

(b) Labour and Incomes

Research, sponsored or directed by government, may also provide a tool for labour and income policies. For example, research to expedite structural change may moderate the adverse effects on the employment of labour both on farms and in the industrial sector. The effect of research on the size of the labour force is determined by two factors. These are firstly, how much the reductions in cost expand output or throughput and thus increase the need for labour. This, in turn, depends on the elasticity of product supply and demand, and the extent to which costs are reduced by research. Secondly, research may facilitate the substitution of capital for labour, and any increase in output induced by research might be undertaken by a smaller, but more highly mechanised labour force.

The IAC (1976) concluded that most agricultural production research in Australia has been land saving rather than labour saving, and that, in any case, labour saving innovations reduce costs and indirectly expand opportunities for employment. It is not possible to generalise on labour/capital substitution in the processing sector, as each case depends on the specific industry or process involved. However, overall employment opportunities are likely to increase in the long run if, through research, costs are reduced, and 'value-adding' opportunities in the processing sector are exploited.
Another factor relating to employment effects is the relatively high elasticity of factor substitution of marketing services for raw commodities that is likely to exist in some processing industries. Many processing and marketing services are labour-intensive so that processing research is likely to expand overall employment opportunities. Whilst there may be a net national gain from research and subsequent substitution, primary producers may not gain anything or may actually lose out if the use of raw commodities is diminished in favour of additional processing and marketing services.

In addition to existing patterns of processing the government may see "further processing" as a valuable source of employment opportunities in industries where unemployment is high. Under these circumstances government involvement may be justified on employment generation grounds, if not economic efficiency grounds.

Finally, research can contribute to the stability of an industry (and hence, producer) income, by reducing market price variability, and maintaining or stabilising overseas demand (through, for example, diversifying the product range and end-use of raw commodities).

3.3.5 Overseas versus domestic research.

Due to the high cost of undertaking research there is some question as to whether some types of research should be carried out in New Zealand, or research results imported from overseas and merely applied to the New Zealand situation. For example, it has been argued that New Zealand may not have a comparative advantage in basic research, and that this can be accessed from overseas at a very low cost (Teece, 1983). More emphasis could then be placed on applying that overseas basic research to New Zealand's industrial sector.

Whilst these arguments appear sensible, the practicalities of the situation make them less sound. Firstly, New Zealand has a unique set of problems and characteristics which research must attempt to resolve. For example, a certain amount of basic research in pasture and grazing-animal production must be undertaken here, as few other regions have sufficient interest to devote substantial research resources to the area. Similarly, with 'new' crops such as kiwifruit, basic research has to be done here, if New Zealand wishes to remain a world-leader in production.

Secondly, a considerable amount of basic and applied research from overseas is already utilised within New Zealand, after having been adapted to specific New Zealand situations by the various R.A.s. (For example, mechanical de-pelting machines which were invented overseas have been introduced to New Zealand freezing works).

Thirdly, basic research in New Zealand may lead to innovations and technology which, themselves, may have considerable export potential, in addition to aiding the domestic industries. Examples of such innovations from the past include wool scouring technology, shrink-wrapping of meat and the manufacture of anhydrous milk fat.
Fourthly, there is a need to maintain a body of scientists within New Zealand who are capable of monitoring and utilising overseas innovations.

Fifthly, it is questionable as to how long and how often New Zealand can obtain 'low-cost' research from overseas. Such research frequently comes from international organisations to which New Zealand's contributions appear to have been declining. Thus, importing 'low-cost' research, effectively subsidized by other countries, makes New Zealand a "free-rider". In the short term New Zealand may reap the benefits without bearing the costs. However, in the longer term access to such research results may be made more difficult by overseas research organisations.

Finally, there are problems associated with obtaining overseas technology (Johnson, 1981; Kolm, 1981). The reality is that much of the useful processing research is done by large, multi-national companies. Access to this technology usually means relying on the multi-nationals, and co-operating closely on product and market control. In turn, this may mean a loss of freedom and restricted market access for New Zealand companies. Also, there may be other costs associated with attracting multi-nationals to invest in, or co-operate with, the processing sector. For example, government grants may be needed as an incentive to multi-nationals, especially in a country such as New Zealand, with a relatively small domestic economy (The Economist, 19/2/83).

Thus, in order to ensure that appropriate basic research is done within New Zealand, that a body of scientists is supported to undertake this research and that undue dependence on multi-national companies be avoided, some government assistance to research may be desirable.

3.3.6 Other reasons for government involvement in R.A.s.

A number of other reasons for government involvement in primary processing research can be advanced which include the following.

Research Associations perform a number of functions for which producers and processors could not be expected to pay. These include liaison and co-operation in education, training of staff, staff secondment to overseas and other New Zealand institutions and sharing of equipment. The transfer of technology through visits, conferences and secondments increases interaction and integration of research effort, and reduces New Zealand industry insularity. Whilst this has no immediately obvious 'pay-offs', there are long term benefits to both industry and the nation.

Another argument for maintaining government involvement has been that they ensure that R.A.s remain independent and impartial organisations. Such autonomy is equally important for research scientists and for holding sector interests and competitors together as one unified group.
Finally, it may be more acceptable internationally and internally for New Zealand to support the agricultural sector indirectly, through funding production and processing research, than to pay direct price and income subsidies.

3.4 Conclusion

While little evidence can be cited to indicate market failure in the provision of primary processing research, a number of factors can be specified which may lead to such failure in some circumstances. These factors relate mainly to the characteristics of research and to the nature of the government's social objectives.

Where a significant divergence between private research performance and public research objectives is likely to occur government involvement may be justified to increase the amount of research undertaken to a more socially optimal level. (This involvement may be of either a legislative or a financial nature). However, government intervention to compensate for market failure or to achieve government objectives should not take place unless the social costs of intervention are less than the social benefits. The appropriate level of government involvement cannot be determined without more information on the nature and extent of market failure.
In Chapter 3 a number of factors related to market failure were presented which together form the basis of the case for government involvement in the funding of processing research through R.A.s. While some government involvement appears justified, a substantial proportion of processing research will be adequately handled and funded by private interests (perhaps through R.A.s), with the direct benefits and costs being distributed via the price mechanism. The distribution of the direct costs and benefits of research is of interest because it has implications for the structure of funding arrangements. The distribution processes are described and discussed in this Chapter, together with a discussion of issues related to industry funding of research.

The direct benefits of research and the distribution of those benefits between producers, processors and consumers depends on several factors. These include where the research applies in the system, the nature and extent of the shifts in the supply and demand functions due to research, elasticities of factor supply and product demand, factor cost shares, and the elasticities of substitution between inputs (Alston and Scobie, 1982).

On the grounds of both equity and efficiency, it may be reasonable to assume that those who directly benefit from research should bear the costs of such research. In line with this principle, it is sometimes argued that government should bear some of the cost of agricultural production and processing research because some of the benefits flow on to consumers. The tax-payer is seen as a proxy for the consumer in this argument. However, the case is not that simple, as it ignores the fact that a large proportion of New Zealand's product is consumed overseas. It also ignores the process by which costs and benefits are passed between sectors via the price mechanism.

This process is described in the following sections. In the final section (4.4), issues related to the use of levies and other methods of raising industry funds for research are discussed.

4.1 The Distribution of Research Gains

The direct benefits of much research (i.e. leaving aside external effects on other sectors) occur in the form of lower per unit production or processing costs. Greater cost efficiency at either the production or the processing stage will cause a downward shift in the supply curve, which has implications for prices and quantities exchanged at all stages of the system (Freebairn et al, 1982).
While it is not possible to estimate precisely the proportion of direct benefits of agricultural research accruing to producers and processors in the industry, and to domestic and foreign consumers, a broad indication can be given of likely shares by examining the Australian situation. The estimated shares with respect to Australian agriculture are shown in Appendix 2.4, but it must be emphasised that for New Zealand these should be regarded as rough orders of magnitude only as the proportion of output exported from New Zealand is considerably greater than from Australia.

Because much of New Zealand's agricultural output is exported, prices for most New Zealand products are determined on the world market (and world prices may or may not be affected by New Zealand supply levels). Hence, increased productivity in New Zealand will only have an impact on domestic prices if overseas market prices are affected, and domestic consumers will only gain from agricultural research in the form of lower prices to that extent. As is shown in Appendix 2 though, the benefits from agricultural research are passed on to overseas consumers only to the extent that export demand is not perfectly elastic.

In the most simple case, the distribution of the research benefits is the same whether the cost reductions occur at either the production or processing stage (Freebairn et al, 1982. For more detail, see Appendix 2.) The relative distribution between sectors depends on the elasticity of final demand and the supply elasticities at each stage of the production chain. In general, the more inelastic a sector's supply is, relative to that of other sectors, the greater will be the share of research benefits going to that sector.

These results are modified, but not overturned, when the assumption of perfect competition is relaxed. The share going to the

---

6 Domestic consumers may be affected if demand for exports is not perfectly elastic or if pricing schemes discriminate between the domestic and the export market or if little of the commodity is exported. They may also benefit from the availability of new products, which have generally been developed for diversification on overseas markets.

In addition, consumers benefit partly from the government subsidy to research (in the same ratio as the costs of research are distributed). On the other hand, a government research subsidy is a transfer of income from tax-payers to farmers and processors.

7 This result is based on a specific set of assumptions. Relaxation of the assumptions may modify the results (see, for example Alston and Scobie (1982); these authors explore the effects of differing values of the elasticity of factor substitution between marketing services and raw farm products in the processing sector).
innovating sector increases with monopoly power. According to Freebairn et al (1982), with a pure monopoly about half of the cost reduction is passed on in lower prices to other sectors. Uncertainty as to methods of price setting in imperfectly competitive industries make this result difficult to prove but it would appear that, in the long run, a high proportion of research-induced cost reductions are passed on.

4.2 The Distribution of Research Costs

Private funding of research usually takes the form of in-house research expenditure or payment of a levy or contribution to a Research Association. It is useful to determine who ultimately bears the burden of such costs. Research expenditure, like any other variable cost, increases per unit output costs (i.e. it is an upward shift of the supply curve of the sector paying for the research (Freebairn et al, 1982)). The increase will induce changes in prices in the other sectors. Thus, the costs of research will tend to be distributed in the same way as the benefits from research (represented as a downward supply curve shift), (for more detail, see Appendix 2). Therefore, to the extent that world export demand curves are elastic, the burden of research costs will be borne by both producers and processors. Moreover, as the elasticity of farm supply is likely to be lower than that of the processing sector, a large proportion of the cost of research is likely to be funded by producers rather than processors. (In light of recent research, some qualification of these results is in order and the issue is dealt with in Section 4.4.1.)

The benefits and costs of research incurred at any one stage are distributed between the different production stages and consumers in a similar way, regardless of the stage at which the research is done. Thus, the argument for government intervention in research funding because some of the benefits from research at one stage go to other stages is not warranted (Freebairn et al, 1982).

4.3 The Distribution of Costs and Benefits of Demand-Shifting Research

Analogous to the above case of cost-reducing research, the distribution of costs and benefits of demand-shifting research can be assessed (see Appendix 2 for more detail). In this case the aim of the research is to shift the demand curve upwards. This can be done by developing a new, higher-value product from existing supply, or by developing a new process which can be marketed overseas to increase overall demand.

8 Exact symmetry of benefits and costs depends on the existence of market competition, linear supply and demand curves, parallel research induced shifts in curves, and zero elasticity of factor substitution.
Briefly, the benefits of such research will be distributed between producers, processors and consumers. As demand becomes more inelastic producers and processors are more likely to benefit from demand-increasing research than from cost-reducing research. With respect to world demand for New Zealand products, less than perfectly elastic demand curves is not an unreasonable assumption. The sizeable share of many export markets held by New Zealand, and the growing number of barriers to free trade, both serve to reduce the elasticity of export demand. Even so, the elasticity of export demand is still likely to be large, relative to New Zealand's supply elasticity, so as with the previous case, the major proportion of benefits of demand-creating research will accrue to producers and processors.

On the other hand, producers and processors will only be able to pass on to consumers the costs of funding such research to the extent that demand is less than perfectly elastic. In turn, producers and processors will share the burden of the costs in proportion to the supply elasticity of each sector's output. (The more inelastic a sector's supply is relative to other sectors, the greater will be the research costs borne by that sector, as outlined previously). However, knowledge of the magnitudes of these elasticities may not be important if research is funded via product levies, as benefits tend to be distributed in a way similar to the distribution of costs. (This symmetry depends on the assumption of zero elasticity of substitution between processing services and raw farm products. Alston and Scobie (1983) have shown that producers will obtain a lower proportion of the total benefits from research which shifts the demand curve, than from research at the farm level, if the elasticity of factor substitution is greater than zero).

4.4 Issues Related to Industry Funding of Research

Earlier in this Chapter it was noted that levies on industry can be utilised to finance research. Issues related to levies and other methods of inducing industry to fund research are covered here briefly.

4.4.1 Levies.

The theoretical advantage of funding research from levies on production is that the financial costs of the levy tend to be borne in the same proportion as the benefits of research are distributed. It should be noted, however, that recent research (Alston and Scobie, 1982) has shown that only under a specific set of assumptions will the distribution of costs and benefits be symmetrical. Generally, if the research applies to the stage being levied or if a fixed proportion of inputs (raw commodities and marketing services) is assumed, then the distribution is likely to be symmetrical. If, however, research at the processing or marketing stage is financed by a levy on farm output, and the elasticity of substitution is not zero, the benefits may be distributed differently from the costs.
In this case, producers will bear a disproportionate share of the levy and consumers will reap a disproportionate share of the benefits, and this represents a transfer from producers to consumers. If the production sector is financing research in the processing sector, both farmers and processors may underinvest in research due to this distortion. Each group will find it comparatively profitable to support research relating to its own technology.

With respect to the size of national benefits from research financed via production levies, the result is unclear, and will depend on the ownership of the processing and marketing services. This is because a large proportion of New Zealand's raw commodities are exported, and much further processing is done overseas, sometimes using machinery and techniques developed by Research Associations within New Zealand.

Whilst it is perhaps not feasible to levy an industry in a more equitable manner than directly via the product, on the assumption that the costs and benefits tend to be distributed symmetrically, the above qualifications may serve as a note of warning. Producers should not, perhaps, be indifferent about which stage of production pays a per unit levy to finance processing research.

Another issue related to levies is the problem of maintaining an adequate level of funding. As was outlined in Chapter 2, industry funding for New Zealand Research Associations is largely obtained through Producer Boards from levies on production. A similar system operates in Australia (Underwood, 1974) whereby Trust funds are established from production levies (generally matched, on a 1:1 basis by Federal Government) for financing agricultural research.

Both in New Zealand and Australia such funds have permitted a considerable amount of research to be undertaken; however, there can be problems with a levy system, and these have become apparent in Australia. In Australia, it was found that despite periodic increases in the levels of the levies, funds did not keep pace with rapidly rising research costs as a result of inflation and the increasing sophistication of much of this research.

"The funds available are also subject to seasonal and market fluctuations due to changes in the volume of production and prices obtained. The consequent insecurity of income poses difficulties in the management and planning of research programmes" (Underwood, 1974).

---

9 Levies paid by producers for research and promotion are often tax deductible. This could be interpreted as amounting to a subsidy, but it is important to distinguish between normal tax deductions and concessional deductions. Deduction of research levies is not necessarily a concession (IAC, 1976). Such expenses are incurred in the earning of income, and as such are legitimate deductions, regardless of who carries out the research. Moreover, in the absence of research expenditure, taxable income, and hence tax payable, would presumably be lower.
An alternative solution offered by IAC (1976) to the problems of fluctuations in levy collection and the research-cost squeeze, is to use a value-of-output rather than a unit-of-output base, since value usually increases faster than production. They also recommend that the levy rate be reviewed at regular intervals. Such problems are likely to increase in New Zealand if R.A.s become more reliant on industry funding than at present, as the stabilizing influence from the large proportion of government funding would decline. Overall, though, the problems are not as significant in New Zealand, as funds are collected and monitored by Producer Boards, not collected directly by R.A.s from levies on output. Producer Boards then pay a lump sum to the R.A.s, which tends to stabilise their contribution.

4.4.2 **Patents.**

Freebairn et al (1982) have suggested that government intervention should be directed at establishing institutional arrangements to internalise externalities within each stage of the production process, and thereby encourage private funding of research. As many forms of technology at the processing stage are likely to be patentable this would appear to be an important method of achieving the objective. By patenting a product or process the research costs can be passed on to the users (i.e. in this case, other processing companies). The cost of the patent can then be incorporated into the industry's production costs and, to varying degrees, be passed on to the consumer.

Significant moves have already been made by R.A.s in the direction of patenting. MIRINZ, for example, patents and licences its own innovations and those of the collective industry. This procedure is quicker and easier than working through third parties, and it is also a way of exploiting the technology overseas. WRONZ has also moved towards patenting, forming partnerships in agreements with industry, to develop and commercialise patented technologies. Royalties could not be seen as a major potential source of funding for R.A.s but they do provide useful finance for some large scale development work. The royalties that can be earned by an R.A. are sizeable (see Tables 2 to 4, Chapter 2) at up to $100,000 per annum, but this would provide only 3-5% of the annual running costs of a Research Association.

4.4.3 **Other methods of encouraging industry funding.**

Other methods of encouraging more funding of research by industry should be mentioned briefly. These methods relate to ensuring adequate funds are available to industry to undertake the research.

One such method operating in the US is a venture capital market, however, such a market has not become highly developed in New Zealand despite the obvious benefits of coupling the right resources and skills. This shortage of capital could explain the inertia observed in the private sector towards research funding (Teece, 1983).
Another method would be for R.A.s to undertake more short term commercial contract research for individual companies. Any profits could be used to subsidise longer term basic research to benefit both the overall industry and the nation. R.A.s could be seen to be competing with private researchers, but it is more likely that R.A.s would work on large scale projects (because of better facilities and equipment and long term, co-ordinated funding).
CHAPTER 5

CONCLUSIONS

A number of issues related to government funding of R&As have been discussed in this paper. It was suggested that research in the primary processing sector could be profitable to New Zealand as a whole, though the lack of quantitative assessment of this is stressed. In view of the fact that the main direct beneficiaries of research are probably the producers and processors, it seems reasonable that they should bear a significant proportion of the costs of the research. However, a number of other arguments were advanced in Chapter 3 which suggested that continued government involvement in the funding of primary processing research may be justified in a number of cases. It seems likely that, in the absence of a subsidy, some worthwhile research would not be undertaken by industry.

This market failure, which may lead to a less than optimal amount of research, is due partly to the nature of research. There may be external benefits from which people other than the innovator can gain, and for which the innovator cannot be expected to pay. In addition, there may be distortions in the rest of the economy which make it desirable or necessary to compensate the less protected sectors, perhaps through subsidising their research programmes. Similarly, if other countries have government assistance to research, it may be necessary for New Zealand’s Government to assist its processing sector in order to maintain international competitiveness. Thus, by contributing some funds to the R&As, the government can ensure that an amount of research closer to the optimal is undertaken in New Zealand’s primary processing sector.

Government assistance to research may also be justified to ensure that appropriate types of research are undertaken. For instance, government funding of ‘basic’ research is widely accepted, but funding of ‘applied’ research may also be justified because of substantial external benefits, and because of the problems in accessing it from overseas. Funding of research in certain sectors may also be justified if government wishes to encourage new industries, further processing, product diversification, or structural adjustment. Other types of research which might not be undertaken if there were no government intervention include conservation and environmental research and projects which are highly risky, have high costs or have costs and benefits which extend over a long time horizon.

As stated by the I.A.C. (1976) "An essential distinction to be drawn in determining the government's share of research costs is not the distribution of benefits between producers and consumers, but rather the relative magnitude of direct private benefits distributed by the market system and the external benefits for which the government must assume responsibility." With private funding of research, including funding via
a research levy, producers, processors and consumers tend to bear the costs of research in direct proportion to the direct financial benefits which they gain. This is generally true, regardless of the stage of industry at which the research is directed or the degree of competition at each stage. Hence, the current system of R.A.s undertaking agricultural research in New Zealand appears rational; since private interests (i.e. producers and processors as well as both domestic and foreign consumers) gain the majority of the direct benefits, they pay the majority of the costs, while a proportion of funding is paid by government to cover the external benefits. It is concluded therefore that some continued government intervention in primary processing research is required to ensure that the substantial direct benefits to the industry and indirect ones to the general community are realised.

5.1 Further Research

However, before the optimal amount of government funds to research can be determined, several points need to be considered.

Firstly, there is a need to assess the profitability of processing research in New Zealand. Secondly, the amount and type of research currently undertaken by both the private sector (companies) and government should be determined. From such an analysis it could be determined whether underinvestment exists, either in general or with respect to particular sectors. Social costs and benefits would need to be accounted for in determining the reasons and remedies for any possible underinvestment in research.

If it was found that there is less research being done than is nationally desirable, and that government assistance is justified, there are several further issues to resolve. These concern the nature and extent of government assistance; the criteria used for allocation of government funds to research, and the organisational efficiency of research structures. The choice of government intervention rests between research by government departments or research agencies, government subsidisation of other research agencies, or a mix of both. Some mixture of the two exists at present, with the emphasis on the former. However, the effectiveness of the present system needs to be evaluated, and comparisons made with alternative research structures and forms of funding. This would lead to more efficient decision making and ensure the optimal use of primary processing research funds in New Zealand.

There is also a need for further development of the theory related to the distribution of costs and benefits from processing research, especially in the case of demand shifting technology. Similarly, the theoretical results outlined in Sections 4.1 to 4.3 need to be re-evaluated with the underlying simplifications relaxed. Quantification of some of the parameters would be useful in this respect, both of supply and demand elasticities and of elasticities of substitution (utilising the methodology of Gardner, 1975) and price transmissions. An assessment of the market power of processing firms would also be useful.
Finally, in view of the above comments, it would appear that government involvement in R.A.s should continue. However, the appropriate mix of government and private funding is not clear and requires further investigation along the lines suggested.
REFERENCES


IAC/CSIRO (1980) Returns on Australian Agricultural Research. CSIRO, Division of Entomology, Canberra


## APPENDIX 1

### SUMMARY OF STUDIES OF AGGREGATE AGRICULTURAL RESEARCH PRODUCTIVITY

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Time</th>
<th>Annual internal rate of return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Griliches (1964)</td>
<td>US</td>
<td>1949-59</td>
<td>35-40</td>
</tr>
<tr>
<td>Latimore</td>
<td>US</td>
<td>1949-59</td>
<td>not significant</td>
</tr>
<tr>
<td>Evenson</td>
<td>US</td>
<td>1949-59</td>
<td>47</td>
</tr>
<tr>
<td>Tang</td>
<td>Japan</td>
<td>1880-1938</td>
<td>35</td>
</tr>
<tr>
<td>Jha &amp; Evenson</td>
<td>India</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>Khalon et al</td>
<td>India</td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>Peterson &amp; Fitzharris</td>
<td>US</td>
<td>1967-72</td>
<td>34</td>
</tr>
</tbody>
</table>

Source: Arndt and Ruttan, 1975

Own Compilation

See Also:

- Hastings
  - Aust.
  - 1947-75
  - Technological Change Indices.

- Powell and Bushnell
  - NZ & Aust.
  - 1945-78
  - Technological Change Indices.
APPENDIX 2

DISTRIBUTION OF COSTS AND BENEFITS OF RESEARCH

A2.1 Introduction

In this appendix a method of measuring the distribution of costs and benefits of agricultural research between producers, processors and domestic and overseas consumers is discussed.

Firstly, the distribution of gains from cost reducing research is analysed, with respect to the domestic industry and to overseas consumers. The analysis is then extended to cover the gains to specific sectors of the industry (ie. producers and processors). Secondly, the parallel question of who bears the costs of such research is considered within the same framework. Finally, the effects of research which shift the demand curve by creating a new product, are considered, and a theoretical framework is developed for assessing costs and benefits of such research.

From this assessment it can be shown that in theory, product levies to raise funds for research are an equitable method, as the "user pays" in direct proportion to the gains accruing to him from such research.

A2.2 Methodology

A2.2.1 Case 1: Cost-reducing research.

(a) The Distribution of Gains

The objective of undertaking some types of agricultural research is to achieve a reduction in unit production or processing costs (or equivalently, an increase in unit input or throughput yields). The benefits of such changes accrue to domestic producers, processors and consumers, and to overseas consumers. The distribution of benefits between producers and consumers depends upon how much of the fall in unit costs is actually transmitted through to the final price of the product. This transmission is influenced by both the elasticity of supply of producers and the elasticity of demand of consumers, as well as the degree of protection between domestic and world market prices.

The distribution of the benefits from production research can be illustrated graphically (I.A.C., 1976). In Figure 1 demand is perfectly elastic (ie. the case where production sold internationally has no effect on price Po). An increase in productivity will reduce costs of production and shift the supply curve So to S1, increasing the quantity...
sold from \( Q_0 \) to \( Q_1 \). (A parallel shift is assumed here: for convergent/divergent/pivotal shifts, see Rose, 1980). The gain accruing to producers is equivalent to the hatched area. No benefits accrue to consumers.

If product demand is not perfectly elastic, as in Figure 2, an increase in productivity \( (S_0 \) to \( S_1 \)) will lower the price from \( P_0 \) to \( P_1 \). In this case the total benefits are distributed between consumers and producers. The consumers gain by the fall in price from \( P_0 \) to \( P_1 \); the producers' gain is represented by the hatched area. If some of the consumers are overseas not all the benefits from the productivity increase accrue to New Zealand.

Where production is consumed both domestically and overseas, and given no distortions in pricing in either market, domestic prices will be determined by export prices. Thus, the elasticity of world demand for New Zealand products, rather than the elasticity of domestic demand, is the relevant elasticity\(^{10}\); under this assumption the change in product price resulting from a reduction in unit costs can be estimated as:

\[
\frac{E_{S_{nz}}}{ED - E_{S_{nz}}} \quad \text{where } ED \text{ is the elasticity of world demand,} \\
\text{and } E_{S_{nz}} \text{ is the elasticity of supply} \\
\text{with respect to New Zealand products.}
\]

The degree of market competition in export markets is an important factor determining the proportion of benefits accruing to domestic producers and consumers. Market protection can be explicitly accounted for, using price transmission elasticities, in measures of world export demand elasticities. Since consumers benefit only through a fall in prices (ignoring quality changes), the proportion of benefits flowing from the reduction in unit costs is the percentage fall in product prices,

i.e.

\[
\frac{E_{S_{nz}} x 100}{ED - E_{S_{nz}}} 
\]

Domestic producers and processors, given the previous assumptions, are the only other beneficiaries, and hence their proportion is 100 minus the percentage accruing to consumers. The proportion of the total benefit accruing to consumers can be apportioned between New Zealand and overseas consumers on the basis of the proportion of total production consumed by each.

\(^{10}\) Definition and calculation of export demand elasticities can be found elsewhere (eg. IAC, 1976; Bredahl, 1979; Cronin, 1980).
This theory has been extended by Freebairn et al. (1982) to determine whether it is the processors or producers who gain from research, and the distribution of gains from research at different levels of the system. Their results are summarised here:

(i) Technological change resulting in cost reductions gives benefits to producers, processors and consumers.

(ii) A reduction in costs at any stage of the system (input costs, farm production or marketing) gives the same pattern of benefits to producers, processors and consumers.

(iii) This pattern of benefits is determined by the elasticity of supply and demand at each stage. The gain to producers is greater than the gain to consumers if the supply curve is relatively less elastic than the demand curve.

(iv) Aggregate benefits are proportional to the cost reductions and the initial level of output. (While the elasticities of the supply and demand curves have a significant effect on the distribution of gains, they have only a small effect on aggregate gains).

(v) A research advance in any one sector will provide benefits (or, at least, convey no costs) to those in other sectors. In the case where a particular sector's supply curve is horizontal, the sector will gain no additional economic surplus (the downward shift of the supply curve will be exactly offset by the downward shift of the price received).

(vi) The share of the benefits to any one sector will be greater, the more inelastic the supply curve for its output relative to that for other sectors.

(vii) The distribution of benefits between final consumers and all production sectors favours consumers only to the extent that retail demand (or export demand in the national case) is not perfectly elastic.

(b) Distribution of Costs of Cost-Reducing Research

If research is financed by a levy on production and demand is perfectly elastic this can be illustrated by a movement leftwards of the supply curve from S1 to S0 in Figure 1.11 In this case the producers bear the full impact of the levy.

---

11 Figures 1 and 2 are used again here in order to avoid duplication of diagrams. No relationship is implied with respect to the effect of research gains illustrated in the previous section.
If demand is less than perfectly elastic, as in Figure 2, and the supply curve shifts from $S_1$ to $S_0$ due to a research levy, producers do not bear all the cost of the levy. Part of the levy is passed on to consumers in the form of a price rise ($P_1$ to $P_0$).

Again, in this second case, if some of the consumers are overseas and if the research is financed by a levy, overseas consumers will also bear the costs of research in the same proportion as they share in the benefits, i.e. on the basis of the proportion of New Zealand production exported.

Thus, based on this theory, the relative distribution of the costs of research financed by a levy depends on the proportion of the commodity exported, the elasticity of export demand and the supply elasticities of value added at each stage of the production sector. The more inelastic a sector’s supply is relative to other sectors, the greater will be the share of research costs borne by that sector.

A2.2.2 Case 2: Demand-increasing research.

The distribution of research benefits and costs can also be illustrated for the case where the research is undertaken to increase demand (and hence price) by developing a new product from existing raw material (e.g. a new cheese) or a new process to expand overall demand (e.g. a new needle for making tufted wool carpets).

The allocation of the benefits of such research can be demonstrated with the use of Figure 3. If research is undertaken which shifts demand from $D_0$ to $D_1$, quantity demanded increases to $Q_1$, and price paid also increases, from $P_0$ to $P_1$. As in Case 1, the total benefits are distributed between producers, processors and consumers. Here, though, producers and processors benefit from higher prices. Their gains are represented by the hatched area in Figure 3.

Consumers, on the other hand, pay higher prices, but gain from the increased utility afforded by the new product. The gains to the consumer will be greater, and the gains to the producer smaller, the more elastic the supply curve is, relative to the demand curve. Since it can be assumed that the export demand elasticity for many New Zealand products is quite large and the supply elasticity quite low, a large proportion of the benefits of demand creating research will accrue to New Zealand producers and processors.

A similar effect would be seen from research at the marketing stage; changes in the marketing margin would be reflected as shifts in the demand curve, the direction depending upon the nature of the research. The distribution of benefits would be as outlined above, according to the elasticity of the particular sector’s demand curve, relative to those of other sectors.

By extending the theory, the issue of who bears the costs of research to shift the demand for an export product can be assessed. In Figure 4 if the research was financed by a levy on exports, the supply
FIGURE 3
schedule effectively shifts from $S$ to $(S + L)$. A new market equilibrium would be reached at a greater export volume $Q_1$ and a higher export price $P_1$ if the research and development were successful. The increase in national welfare would be the hatched area in Figure 4.

Figure 5 shows the effect if the same research were undertaken, but paid for by government rather than producers. The demand schedule shifts as before, but the supply schedule remains at $S$. A new equilibrium is reached at quantity $Q_2$ (greater than both $Q_0$ and $Q_1$) and at a price $P_2$ which would be intermediate between $P_0$ and $P_1$. The increase in national welfare is the hatched areas less the area marked "a". It can be shown mathematically (I.A.C. 1976a) that this national welfare gain is less than when producers fund research through a levy.

A2.3 Imperfect Competition

Whilst it may be reasonable to treat consumers and farmers as perfect competitors, there are grounds for challenging the assumption for the input supply, marketing and processing sectors (Freebairn et al, 1982). To some extent when there is imperfect competition in these sectors, technology-induced, production-cost changes will not be passed on in lower output prices, or passed back as higher returns to farmers. Thus, the results obtained in previous sections are modified (but not overturned) when the perfect competition assumption is relaxed. Monopolistic behaviour in the innovating sector increases the share going to that sector. It has been suggested that with a pure monopoly about half the cost reduction is passed on in lower prices to other sectors (Freebairn et al, 1982).

Whilst imperfect competition is recognised to exist, it is difficult to measure the extent of company-concentration, the levels of company profits, or the price formation process in agricultural industries. Thus, assessing monopoly power, whilst important in determining the allocation of research costs and benefits, is not feasible without more intensive study. Studies of the U.S. market (eg. George and King, 1971) indicate that a large part of farm price changes are passed on to retail within one quarter. They thus concluded that the competitive model may be a reasonable approximation, particularly in the longer term. Therefore, in New Zealand over the long term market price changes may be passed on by the processing sector, but the short to medium-term situation is unclear.

A2.4 Discussion

An application of the above method to rural research in Australia can be found in IAC (1976), and the results are summarised in Table 5. No attempt is made here to measure the allocation of benefits from research within New Zealand, but appropriate data would be available from various sources.
FIGURE 4

FIGURE 5
TABLE 5
Distribution of the Direct Benefits of Rural Research in Australia

<table>
<thead>
<tr>
<th></th>
<th>Australian producer</th>
<th>Consumer</th>
<th>Nature of export market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Wool</td>
<td>85 to 88</td>
<td>s</td>
<td>11 to 15</td>
</tr>
<tr>
<td>Beef and Veal</td>
<td>74 to 88</td>
<td>6 to 13</td>
<td>6 to 13</td>
</tr>
<tr>
<td>Wheat*</td>
<td>67 to 90</td>
<td>s</td>
<td>8 to 28</td>
</tr>
<tr>
<td>Coarse grains</td>
<td>94 to 99</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>Rice</td>
<td>99</td>
<td>s</td>
<td>s</td>
</tr>
<tr>
<td>Mutton and lamb</td>
<td>58 to 68</td>
<td>25 to 32</td>
<td>7 to 10</td>
</tr>
<tr>
<td>Pigmeat</td>
<td>83</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Manufactured dairy*</td>
<td>97 to 98</td>
<td>1 to 3</td>
<td>s</td>
</tr>
<tr>
<td>products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar*</td>
<td>91 to 93</td>
<td>s</td>
<td>5 to 7</td>
</tr>
</tbody>
</table>

s - small (less than 5%)

* - Ignores effect of two price schemes.

The IAC study shows that most of the benefits of rural research in Australia accrue to producers, as a large proportion of primary commodities is exported, and faces a relatively elastic demand.

An extension of the theory suggests that a large proportion of demand-shifting research benefits also accrues to producers, in the case where export demand is relatively elastic - it is not possible to determine exactly the shares of benefits accruing to each sector of production without further detailed measurement of sector supply responses. On the basis of estimates given in Table 5, it would appear that in New Zealand a large proportion of benefits could accrue to the farming sector, however, this potential will be reduced to the extent that there is monopoly power in certain processing sectors in New Zealand.

If funds for research are raised via a product levy, measurement of the distribution of benefits becomes less important, because, as was shown above, the costs of research tend to be borne in the same proportion as the benefits are distributed. This argument, of course, relates only to direct financial costs and benefits of research and ignores the externality issues raised in Chapter 3 as justification for additional assistance to research from government. The question of measurement of such social costs and benefits and hence, government or tax-payer contributions, is not addressed in this paper. It is, though, an issue of crucial importance and needs further research.

---

12 It has been pointed out (by A.G. Lloyd, in Edwards and Freebairn, 1982) that this analysis is static, while in fact the market adjusts gradually to a production levy and to a (subsequent) cost reduction. This delay between raising a levy and increasing productivity increases the producers' share (in present value terms) of both the levy and the benefits from research. Thus, the symmetry discussed in the text is retained.
RECENT PUBLICATIONS

RESEARCH REPORTS


115. A Socio-Economic Study of Farm Workers and Farm Managers, G.T. Harris, 1980.


DISCUSSION PAPERS


68. Energy Use in New Zealand Agricultural Production, P.D. Chudleigh, Glen Greer, 1983.

69. Farm Finance Data: Availability and Requirements, Glen Greer, 1983.

70. The Pastoral Livestock Sector and the Supplementary Minimum Price Policy, M.T. Laing, A.C. Zwart, 1983.

