Science funding policies: Meeting needs and opportunities for New Zealand's economic development

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Introduction

Over the period from 1976 to 1996 total exports from New Zealand's agricultural and horticultural sectors grew by an average of 5% per year in 1996 dollar terms. Total exported goods from New Zealand in the same period grew at about 9% per year. The consequence was that whereas the agricultural and horticultural sectors supplied 75% of the total goods exported by New Zealand in 1976 this percentage had fallen to 56% by 1996. One of the Government's strategic goals is to "maximise the direct contribution of science and technology to diverse social, economic and environmental goals" through the Public Good Science Fund (PGSF) (NZ Govt., 1996). Science is such an integral part of agricultural and horticultural development in New Zealand it is timely to examine whether the science funding policies are helping New Zealand's economic growth as much as possible in these sectors.

Table 1. 1995-96 Export Receipts (FOB $) for the land based primary industries of New Zealand - changes since 1975-76 adjusted to 1996 $ values ($ millions)..

	1975-76	1995-96	% change	Annual % change
Wool	1468.4	1098.6	-25	-1.2
Meat	1910.5	2708.1	42	2.1
Dairy	1279.9	4173.3	226	11.3
Total pastoral	5196.2	9060.9	74	3.7
Forestry	450.8	2455.0	445	22.2
Horticulture and arable	249.0	1887.2	658	32.9

Export Growth and Funding

Examination of the export receipts from the land based industries over the past 20 years shows that plant based products from the horticulture and arable sector, and from the forestry sector have far outperformed the animal sector in growth. The horticultural and arable sector has grown by 33% per year in export earnings over the past 20 years compared to 22% per year for forestry, 11% per year for dairying, 2% per year for meat and -1% per year for wool (Table 1). Irrespective of this performance the Science Priorities Review Panel (SPiR) recommended a 5% cut in the funding base of the horticultural and arable sectors, no change for the animal industries, and an increase of 8%, 14% and 23% in funding for forage, forestry, and dairying respectively in the five year period to 2001 (SPiR, 1995). Subsequent to these recommendations, the horticulture and arable sector funding was maintained at its previous funding level. The committee considered that the funding level for horticulture was disproportionately high relative to its strategic importance, particularly as indicated by its contribution to GDP. The committee went on to state that the previous funding situation appeared to reflect the view that New Zealand would develop new rapidly growing industries in the horticultural sector which would eventually match the size of the kiwifruit or pipfruit industries. They considered that the degree of sector development that actually occurred did not support that view(SPiR, 1995).

Funding Policy

PGSF funding policies have been in a state of evolution since their inception, and are now based on an interactive model of innovation focused on outcomes (Garden, 1997), principally the adoption and application of results by users (Buwalda, 1997). The Foundation for Research Science and Technology purchases, on behalf of Government, research to achieve the desired outcomes,

assessing research proposals on relevance and scientific or technological merit. Since 1995 relevance has been the primary criterion for assessment (FRST, 1997). Relevance is broken into two parts, strategic and tactical relevance. Strategic relevance is research which addresses specific strategic goals of government for each output (Williamson, 1997). Tactical relevance is more complex in that it relates to industry needs, with assessment of the linkages with end-users, end-user or industry leverage and the proposed technology transfer within an appropriate time frame (FfRST, not dated). Funding proposals are graded for scientific excellence and relevance by up to six referees, and then an assessment committee gives an overall grade to the programme and recommends fund allocation. If high grades are not received in both scientific merit and relevance the programme is unlikely to be fully funded or not funded at all. Relevance is graded into eight categories and scientific merit into four, with only the top two grades of each being assured of funding (FfRST, not dated). Since relevance is based on industry needs, the science funding system automatically favours established industries, as it is difficult to achieve high relevancy where there is little or no established industry structure. This seems to be a serious flaw in the funding system, in that it places the role of research in a follow-up position rather than a lead position. This approach of waiting until industries are established before funding research has also been highlighted as a negative feature of Government funding of fruit tree research in Israel (Misrahi 1995). Misrahi (1995) concluded that it would be more beneficial to provide research funds at the beginning of a developmental cycle when the crop was unproven, rather than waiting until it became established.

The Government strategy document, Research Science and Technology 2010 noted that the New Zealand research capabilities continued to be dominated by historical patterns rather than future challenges and opportunities (NZ Govt., 1996). A comparison of the export earnings from wool, deer, cereals, apples and kiwifruit with the current PGSF funding allocation, illustrates the high levels of funding going into industries such as wool which has declined by 25%, and cereals which declined by 72% in export earnings over the past 20 years and kiwifruit which has declined by 27% in the past six years (Fig. 1). In spite of these poor industry performances, high relevance of a programme is easier to demonstrate for such industries than where no industry structures occur. In addition, the science problems in established industries are often very well defined because of the previous scientific effort, and the consequence is that programmes can be written to score highly in relevance and scientific merit under the current ranking methods, and achieve funding. The dominance of the relevance assessment to achieve funding has led the Crown Research Institutes (CRIs) to focus most of their portfolios on well established crops rather than emerging industries to ensure funding. This is a direct response to the funding system, rather than leading the sectors they serve into new areas of economic growth.

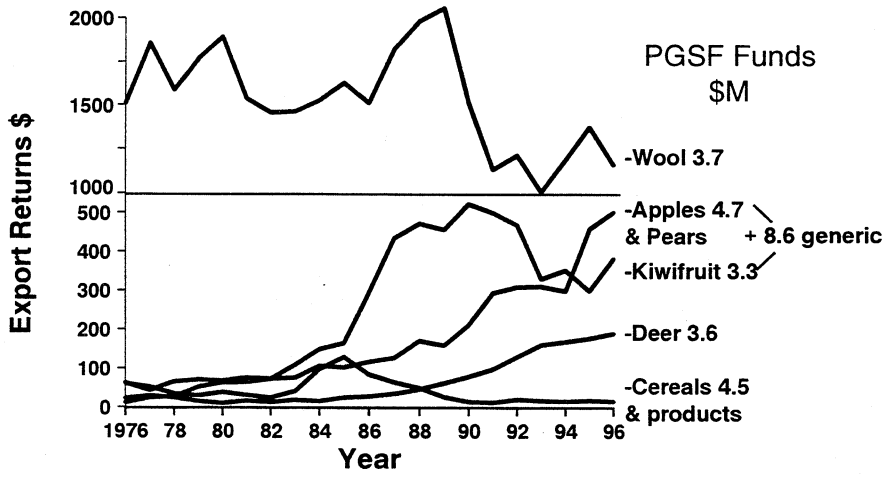

Figure 1. Inflation adjusted Export returns ($M) for 1976-96.

Market-led Research

The GATT Agreement is expected to have considerable long-term implications for New Zealand trade. Research and Development is seen as even more crucial in the post GATT era, with innovation and continued product development seen as a key to increasing New Zealand's share of global markets (Agricultural Development Steering Committee, 1994). The focus has shifted to the international rather than the domestic markets (Buwalda, 1997) with a need for strong market research of customer and market needs, and the ability to identify and produce new products to meet market demands (Bolger, 1994; Janes, 1994).

While development of new products within existing industries are an important way of maintaining market competitiveness, such as the successes of the dairy and apple industries over the past 20 years, the development of totally new industries is of equal importance to diversify the economy and make it less reliant on the fortunes of a single industry (Bolger, 1994). Almost all agricultural and horticultural exports from New Zealand come from introduced animals and plants, and we need a funding system which allows science to react to global changes in products and markets rather than being tied down to established domestic industries.

In the past 25 years in agriculture and horticulture only three new industries have developed into significant export earners of more than $50M, deer ($203M), squash ($55M) and cut flowers and bulbs ($57M). Deer farming began in 1970 and in ten years export earnings were still under $20M. Squash exports in the ten year period beginning in 1978 was double these earnings, indicating that it is much easier to achieve rapid development of a new industry based on plants, than animals which are restricted by multiplication rate. Both these industries have had strong research support since their beginning, and now as established industries they can offer strong relevance to research programmes and continue to receive PGSF funds. The unanswerable question is whether or not these industries would have received the same level of support under the current system if they were beginning today. The major focus on science funding towards industries which have established, rather than those which could be established, results from the relevance criterion being focused on industry needs rather than market opportunities. The shortcoming with following industry leadership is that it assumes there is an industry base ready to identify and exploit all new market opportunities. Commercial companies only deal with new opportunities within their expertise and capabilities, and new ideas outside their capabilities are usually ignored (Douglas, 1997). Market research has however been seen as an industry function rather than a science function, and this has left science in a void in regard to identifying and reacting to new market opportunities. Particularly for new market opportunities based on products not currently produced in New Zealand, there is a need for an integrated approach of using market analysts and biologists to critically assess new opportunities irrespective of industry involvement. To do this there is a need for market research to become part of PGSF funding so that science can undertake systematic analyses of new market opportunities rather than relying on uncoordinated industry feedback.

Case Studies of Market-led Research

We have followed a market-led, holistic approach to new industry development over the past ten years (Douglas, 1992, 1993) using an interactive approach similar to that proposed by Garden (1997). Our market investigations undertaken in the late 1980s (prior to the formation of the CRIs) highlighted a number of very large global markets which we believed offered a number of market opportunities for new products which could be produced in New Zealand. These markets were in Asian vegetables, phytomedicines, flavours and fragrances, ornamentals and edible fungi. These are huge international markets (Table 2) with some New Zealand development over the past 20 years in Asian vegetables and ornamentals, but with little development in phytomedicines, flavours and fragrances and edible fungi. The development of these industries in New Zealand has been constrained by a lack of technical knowledge to produce the marketable products.

(a) Asian medicinal plants

The annual sales of natural medicines in Asia are $7 billion per annum with an annual growth of 12-15%. New Zealand successfully exports $60M per annum of deer velvet into this market, but there is the opportunity to grow many of the Asian medicinal plant requirements, as there are appropriate environmental conditions to do so. A programme on Asian medicinal plants was begun in 1989 with research teams and TRADENZ forming a working group to develop the opportunity. At the time this programme was seen as a model for others to follow. Optimistic views suggested such an industry could be earning $50M by 2000 (Robertson, 1990). By 1996 a small industry has continued to develop, but it was considered insufficient progress had been made, and PGSF funding will be withdrawn from next year.

Table 2. Global Markets

Annual Trade - Mid 1990's	$ billions
Japanese wholesale vegetable market 1994	25
World phytomedicine sales	20+
World flavour and fragrance trade	15+
World ornamental trade	8
World edible fungi trade (wholesale)	25-30

(b) Edible fungi

New Zealand currently exports $1-2M of button mushrooms, which is insignificant in an estimated world trade in edible fungi of $25-30 billion per year. New Zealand has a huge opportunity to supply out of season, expensive mycorrhizal mushrooms to world markets, but the development of such an industry has been reliant on research developing techniques to make it possible. Research programmes began on Perigord black truffle in 1985 and the development of a successful inoculation technique led to the harvesting of the first truffles in the Southern Hemisphere in 1993. In 1997 truffle production in a truffiere in Gisborne gave an estimated return in excess of $40,000/ha. Such production suggests a bright future for the development of an edible fungi industry based on truffle and other mycorrhizal fungi. This now has to be viewed with uncertainty as PGSF funding will be withdrawn from this programme from next year.

Both these programmes were developed after market research defined large international market opportunities, and both industries were unlikely to proceed without a significant research input. They were well funded in their formative years but funds were increasingly whittled away until the final termination. Both programmes were leading commercial development rather than pure research, and both programmes had significant parts kept confidential to give New Zealand producers a commercial advantage. This action led to criticism of the lack of scientific output from these programmes, and subsequent science and relevance ratings were insufficient to maintain funding.

In simple terms these programmes did not meet the funding criteria of the PGSF funding committee. They did however begin new industries and they were underpinning these developing industries supplying new products to international markets. They highlight a serious disparity in the funding process in which developing industries are less able to compete against established industries within a rigid framework of funding criteria. It is such decisions which have driven the CRIs away from the new areas of development into safe science in established industries where funding is more assured. Such a process limits the scope of science to address new market opportunities, and is likely to slow down future economic development.

New Funding Policy

Recently the Minister of Research, Science and Technology announced a new policy to FfRST "to develop a strategic, far-sighted and proactive strategy for focusing on the achievement of outcomes", with the need to instil this philosophy into the scientific workforce (Williamson, 1997). The Minister believed the previous policy had resulted in a "strong focus on small scale purchasing of outputs, over relatively short time-frames and within a rather rigid framework of rules and procedures (Williamson, 1997). This change in policy is welcomed and it remains to be seen how it will be implemented. It is also clear from the current guidelines to applicants for the coming bidding round that funding will still be judged on relevance and scientific or technical merit. This system is, in a round-a-bout way, having a negative influence on new funding areas of possible high economic growth, and the criterion for funding need to be changed to address this. Firstly the CRIs have shifted their research focus into main stream industries to achieve high relevance when analysis of export growth indicates that new industries offer the highest export growth rates. Secondly high scientific merit has been equated to high-tech science and the CRIs have shifted their research emphasis into high-tech areas at the expense of more practical areas of applied science to be more assured of funding. Often, however, developing industries need answers to practical questions for their advancement rather than high-tech science.

The new directions in science funding policy seeking a globalised knowledge-based economy require the integration of a wide range of activities as well as research to achieve the desired outcomes (Buwalda, 1997; Garden, 1997). To deliver outcomes highlights the need to have good identification of the outcome requirements and good delivery systems to achieve the outcomes. In an economy focused on the marketplace (Janes, 1994) this requires a close integration of market information into science programmes, and an integrated technology transfer process to achieve adoption of the results. To provide end-users with appropriate recommendations requires specialised technical advisers competent in the interpretation of new information in

relation to budgetary and operational needs of the end user, rather than the simple transfer of information by scientists. The Agricultural Development Steering Committee (1994) have previously commented that the transfer of technology now lacks a coherent approach. The vacuum left by the demise of the MAF Advisory Services has not been filled by the CRIs. Unless an effective technology transfer system is put in place, the economic benefits of science are likely to remain unrealised. Integration of supply and delivery lines of information in and out of the science base would provide a powerful resource to deliver future outcomes, but to be effective it requires a stable, flexible funding system.

Science Funding in a market-led economy

The freeing up of the global economy through the GATT Agreement has been seen as a major step forward for the prospects for New Zealand trade. Similarly the past ten years has seen a huge change internally in New Zealand towards a free market economy as the way of the future. Along with these changes there is also the strong expectancy that science will play a key role in future economic development (Agricultural Development Steering Committee, 1994).

The dichotomy is that within this deregulated society, science is still working in an inflexible , highly regulated framework which does not allow it the flexibility and freedom to rapidly address changing market opportunities. We have seen the CRIs move research programmes back into established industries with emphasis on high-tech science to better meet the funding criteria, and be more assured of funding. This can only be bad for economic development. The emphasis on established industries puts the focus on yesterday's and today s innovation, rather than tomorrows opportunity. There is a need to change the funding focus from industry to the marketplace to identify new opportunities, and to encourage scientists to lead the research and development of new products for the economic growth of New Zealand. To achieve this requires a change in the science policies and a redirection away from traditional areas, so that the vision and lead position of science can be restored. It remains to be seen whether the recently announced changes in science policy go far enough.

Summary

- Over the past 20 years the plant based industries have out performed the animal-based industries in terms of growth in export earnings, with horticulture superior to forestry.
- Considerable PGSF funding is still going into well established industries which have shown little or no growth for many years.
- Funding policies have favoured established industries when the future global market opportunities for economic development will require a focus on new products and new industry development.
- The CRIs have intentionally shifted their research focus into mainstream industries to achieve high relevance, as a key criterion for funding, when the highest growth rates for economic growth are more likely to be achieved from research in new industries.
- The CRI's have shifted their research focus into high-tech science to be more assured of meeting the criterion of high scientific merit for funding with less emphasis on practical science often needed by developing industries.
- Science is currently being focused on industry by the funding system, when it would be better focused on the market place. By doing this, identifying new opportunities and leading their development, science will provide a leadership role to new industry development rather than dominantly being placed in a support role.
- The development of a strong market-led economy requires close integration of market information into science strategies to identify new market opportunities, and an integrated technology transfer process using technical advisers to achieve adoption of results by end-users.
- The new policies on science funding towards a holistic approach to achieve outcomes need a change in the fund allocation system away from the ranking system based on the narrow considerations of scientific merit and relevance, to one based on industry development and economic growth.
- Unless changes are made to the funding system of science, the speed of economic growth in the rural sector in the future will suffer.

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