DOES RESEARCH AND DEVELOPMENT PAY - THE CASE FOR PROTEACEAE

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This paper reports on the socio-economic impact of the Proteaceae technology development and transfer programme. Farm level data were collected from the major role players in the industry, including cultivators, harvesters, agents and nurseries. The five major production regions were the Western Cape, South Western Cape, Southern Cape, Cape Peninsula and Eastern Cape, but other small regions in the Republic of South Africa (RSA) were also included in the study. Standard pretested mail questionnaires, supplemented with personal interviews, were used. This paper reports the socio-economic impacts over the period 1974-2005. Results show that the rate of return for the financial and economic analyses ranged between seven and twelve percent, showing that the research programme is a profitable investment to society. The Proteaceae programme contributed to the conservation of biodiversity, had institutional impact in terms of training and technology transfer, while the social impact was indicated by employment generation through R&D activities.

1. INTRODUCTION

The trend to reduce public funding of research programmes and a new political dispensation in the Republic of South Africa (RSA), intensify competition for the available public funds. This necessitates increased emphasis on the tangible demonstration of the socio-economic benefits of research. The debate on the allocation of scarce public resources could be aided by evidence of the net gain from research to society. Thus, the concept of research impact assessment is becoming increasingly important (Van Rooyen, Carstens & Nortjé, 1996). All countries, but particularly developing countries, are faced with the basic economic problem of allocating limited resources (Squire & Van der Tak, 1992). Choices need to be made regarding

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the allocation of scarce resources for optimal use to assist the particular country in achieving its fundamental objectives.

2. BACKGROUND TO THE RESEARCH PROBLEM

The Proteaceae flower industry originated in the harvesting and marketing of floral material collected from their natural habitat. These flowers were sold by small scale vendors on the market and streets of Cape Town. Dried flowers were exported to Europe as early as the previous century. This business flourished and has since become one of the major horticultural export products of the RSA. The monetary value of the fynbos industry is currently valued at R81,7 million. During 1995, an estimated 2 860 metric tons of fresh flowers were exported; which represents a 15.5 percent increase over the previous year. The industry also shows promising signs of growth. However, several aspects would have to be addressed to realize this potential.

Aspects regarding the cultivation and marketability of flowers were seen as the major limitations for growth in the fynbos industry (Wessels, 1998). The objectives of the Proteaceae breeding programme are aimed at addressing limitations of time, form and place utility (Table 1). It was visualized that successful implementation of technology research and development (R&D) will support the continued growth of the fynbos cut flower industry. Apart from the monetary gains, a social or equity dimension could further be added by the employment opportunities created amongst the poor. This was due to the labour intensive nature of this industry (Wessels, 1998).

3. ANALYTICAL FRAMEWORK

A comprehensive approach (Anandajayasekeram *et. al.*, 1996) was taken to evaluate the impact of the Proteaceae R&D programme. The effectiveness, i.e. what was achieved viz-a-viz what was planned, was assessed through the application of a Logical Framework Analysis (LFA) (ABOS, 1996; Farrington & Nelson, 1997). The socio-economic impact of the Proteaceae R&D activities was estimated using the cost-benefit variation of the surplus approach. The advantage of the method is that it does not require elasticities (Anandajayasekeram *et al.*, 1996); especially since these were not available for wildflowers at the time of the study. Only the costs and benefits accruing to domestic producers and consumers were included in the analysis. Primary data on the current production and marketing practices of the industry were collected by means of a mail questionnaire, supplemented with personal interviews. The industry is perceived to consist of veld harvesters, cultivators, agents and nurseries. All these stakeholders were considered in the study. The five primary production regions included were the Western Cape (WC), South Western Cape (SWC), Southern Cape (SC), and Cape Peninsula (CP) in the winter rainfall area, as well as the constant rainfall area of the Eastern Cape (EC). Proteas are also produced to a smaller extent in the summer rainfall area of Gauteng, Mpumalanga and the highlands of Kwazulu-Natal (Wessels *et. al.*, 1997). Secondary data were collected from the ARC-Fynbos Unit and appropriate published sources.

Table 1: Objectives of the breeding programme for selected Proteaceae genera

Breeding Objective	Protea	Leucospermum	Leucadendron	Serruria
Unique Appearance of the Flower	X	X	X	
Intense Flower Colour	X	X		
Long Stems Without Pruning	X	X	X	X
Strong Vigour in Cultivation	X	X	X	X
High Single Stem Yield	X	X	X	
Out of Season Flowering	X			
Floriferousness	X	X	X	X
Resistance to Root Rot		X		
Flowering Time and Duration	X	X	X	
Adaptability to Different Climates and Soil Types	X	X	X	X
Ability to Manipulate Flowering Time by Pruning/Disbudding	X	X		
Long Vase Life	X	X	X	X
Suitability for Pot Culture				X

Source: Wessels *et al.*, 1997

4. THE PROTEACEAE PRODUCTION SYSTEM

The industry consists of nurseries, cultivators, harvesters and agents (who could also be exporters). All these role players produce Proteaceae material; which is sold to consumers in the end. The ARC-Fynbos Unit produces potted plants and cuttings and also disseminates information on Proteaceae production to the industry. The South African Protea Producers and Exporters Association (SAPPEX) fulfills a further supporting role.

Most cultivators started producing Proteaceae during the period 1990-1997. Of the sample cultivators, 19 percent not only cultivated, but also harvested products from the wild. Five different Proteaceae products were at stake, including *Protea*, *Leucospermum*, *Leucadendron*, Cape Greens and dried products. These could be produced in three different ways, i.e. by broadcast seeding or by cultivation in plantations using either seedlings or cuttings for establishment. According to the farmers, the importance of seedling and cutting establishment methods for Proteaceae was increasing. The veld harvesters can be defined as those producers who utilize the natural veld as a source for their products. Ninety-two percent of the sample farmers started harvesting after 1970, with the majority (38 percent) starting during the 1990 - 1996 period. Sixty-three percent of the sample harvesters owned land (Wessels *et al.*, 1997).

Agents/exporters not only played the role of "middle man" in the industry, but were also cultivating or harvesting Proteaceae products themselves. Their most important service comprised the provision of market outlets and marketing information to producers. Four commercial nurseries were servicing the fynbos industry. Most of the nurseries were founded in the 1990's with the exception of one that started business in 1968. These nurseries provide fynbos planting material to the cultivators.

5. IMPACT OF THE PROTEACEAE RESEARCH DEVELOPMENT AND TRANSFER PROGRAMME

A typical agricultural research and development programme has several impacts on society. These not only relate to the direct product of research, but also considers economic, institutional and social impacts. The performance of the Proteaceae R&D programme in relation to its intended direct product was assessed using an effectiveness analysis. The efficiency of the programme was assessed in both financial and economic terms. Social, environmental and institutional impact were evaluated by means of qualitative and quantative statements. Institutional impact refers to changes in institutions and the enabling environment, while social impact refers to economic, financial, social and environmental factors (Anandajayasekeram *et al.*, 1997).

5.1. Effectiveness analysis

Effectiveness analysis measures the degree to which the project has achieved the intended objectives. Firstly, the performance of the research programme was conceptualized using a LFA. The main problem, derived from the LFA, was that of a sub optimal income due to production and marketing systems which did not fully exploit time, form and place utilities. The study suggested that the Proteaceae R&D programme was effective in addressing these problems.

5.2. Financial analysis

The objective of this analysis is to assess the financial position of stakeholders involved in the project, as well as the overall costs and affordability of a project. A financial analysis was conducted for both individual farmers and for the industry. The financial rate of return (ROR) for individual farmers was estimated using partial budgets. All costs and benefits were included on a per hectare basis for those farmers who adopted the new Proteaceae technologies. A real discount rate of seven percent was applied. The analysis clearly indicated that the use of clonal material was profitable for individual farmers. The estimated ROR varied between 29 and 45 percent for the three different products (*Protea*, *Leucospermum* and *Leucadendron*) at the farm level.

The industry analysis included the total area established under clonal material of Proteaceae products. The costs and benefits incurred by research activities were also included. The area under individual Proteaceae production systems (i.e. broadcast seed, seedling or cutting establishment) were not available at the time. It was therefore decided to use the distributed cuttings as the basis for estimating the area under improved cultivars. Figure 1 shows the cumulative establishment of *Protea*, *Leucospermum* and *Leucadendron* products estimated in this manner. The discount rate (7%) was the same as used for the financial analysis for farmers.

Apart from the distribution of cuttings, the programme has also released several cultivars and agronomic recommendations. However, the only clearly measurable impact was that associated with the development and dissemination of clonal materials. These were therefore the only benefits included in the analysis. In contrast, the entire cost of the research programme was included. Appropriate data and records were not available to permit the joint cost allocation procedures usually needed in such a case (Wessels *et. al.*, 1997, Gittinger, 1982). Thus the costs are over estimated and the benefits

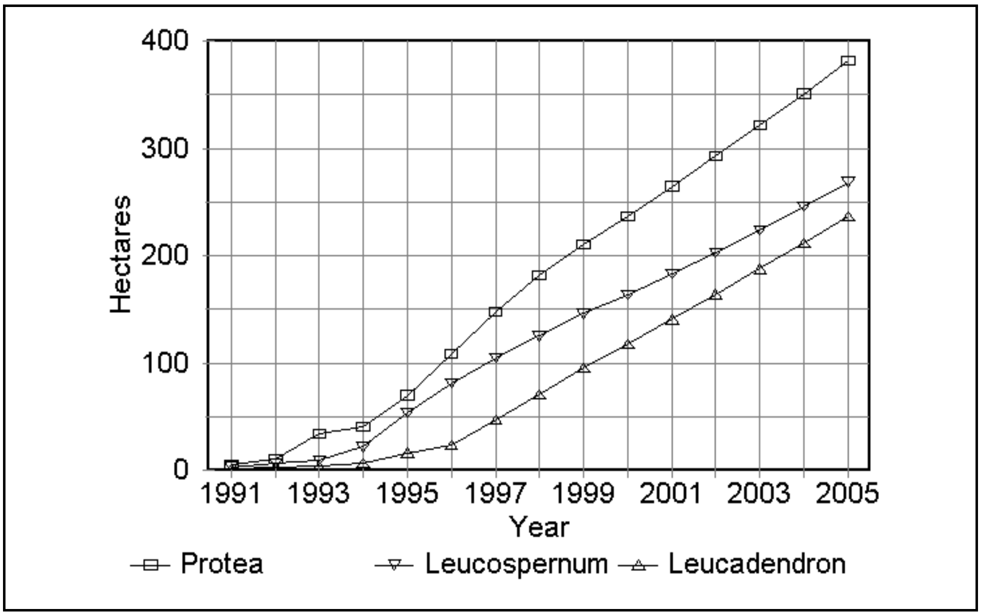

Figure 1. Cumulative establishment of *Protea*, *Leucospermum* and *Leucadendron* (1991-2005)
Source: Wessels *et al.*, 1997

under estimated in this study. The financial ROR of the Proteaceae R&D investment to the industry was 7.7 percent. The net present value (NPV) at a seven percent real discount rate was R4 million in 1997 constant values. The estimated financial ROR is larger than the financial opportunity cost of capital of seven percent. The NPV was also positive; which indicated that the R&D investment is financially profitable (Wessels, 1998). Several sensitivity tests were conducted to incorporate the over and under estimation of costs and benefits. For example, the area under Proteaceae cultivation was increased, the overhead and administration costs reduced, the total research costs reduced, the gross revenue from *Protea* increased and the area and gross revenue simultaneously increased. These analyses clearly indicated positive investment figures for the more likely scenarios.

5.3. Economic impact

This measures the effects on economic efficiency associated with a set of R&D activities. The real costs are systematically compared with the real benefits of the project, valued at economic shadow prices. Certain adjustments are required when market prices do not reflect the true economic value of a commodity or service. In the case of Proteaceae, the costs of cultivation inputs and irrigation water, as well as the value of land were adjusted for distortions to reflect the true economic value. The costs of cultivation inputs were distorted due to the tariff charged on these products and were adjusted with the tariff protection rate (Bradfield, 1993). The economic value of land was expressed in terms of the opportunity cost of producing alternative crops. This could be translated to the rental value of the land to produce these alternatives. The value of grazing land was found to be the most realistic measure of alternative land use. This also represented the "without" project value, since most farmers introduced Proteaceae on grazing land (i.e. mountainous areas). The market price of irrigation water also does not reflect the opportunity cost due to current and historical levels of subsidization. Three different approaches were considered to determine the economic value for irrigation water and included the production cost value, the alternative land use and the marginal value product approaches. In the case of Proteaceae cultivation, these shadow prices were not found to have a significant influence on the investment decision.

The long-term bond rate in the RSA, adjusted for inflation, represents society's time preference for money. This was estimated at five percent and was used as the social discount rate in the economic analysis. The estimated economic ROR was 7.5 percent and the NPV, at a five percent real discount rate, amounted to R22.5 million. The real bond rate of five percent is lower than the ROR of 7.5 percent; which indicates that the public investment in the Proteaceae R&D was profitable.

5.4. Environmental impact

When fynbos was recognized as a commercial enterprise, there was a concern that these practices would, in the long-term, affect the remaining natural fynbos vegetation on private land. Some of the issues raised, included that the shift from veld harvesting to orchard cultivation will result in more natural and fynbos vegetation being removed for production purposes, that the present land use pattern will change, that the establishment of Proteaceae cultivar material will result in the genetic contamination of the natural vegetation and that the use of pesticides in fynbos cultivation will pose a threat to natural insects and bird fauna. Several mitigation proposals have been put forward by the Cape Nature Conservation to minimize these effects and to conserve the natural ecology and biodiversity (Wessels *et. al.*, 1997).

It was interesting to note that the majority of the sample harvesters (59%) did not notice any decrease in the number of flowers harvested per year from the same unit of land, neither was any specific plant types noticed to disappear over the years. An important environmental contribution of the Proteaceae research programme related to the conservation of biodiversity in terms of gene bank accessions. The number of these accessions increased from 139 in 1974 to 1,774 in 1996. About 44 of these species have been classified as rare, endangered or vulnerable (Wessels *et. al.*, 1997).

5.5. Socio-economic impact

This was estimated in terms of the contribution to employment creation and income distribution. During 1996, the additional employment created through these activities amounted to 858 full time and 309 part time jobs. This number is expected to increase given the labour intensive nature of the fynbos industry. All indications are that Proteaceae R&D activities contribute substantially to the economy of the Western Cape. Eckert, Liebenberg and Troskie (1997) found that the fynbos industry ranked ninth out of 48 sectors in the Western Cape according to its contribution to development.

5.6. Institutional impact

Institutional impact resulted from the Proteaceae R&D programme in the form of training and technology transfer. A total of 65 participants have been trained through the two day courses, and another 152 through the four day courses over the period 1994 - 1996. The entire group of cultivators indicated that this short term training should continue. Apart from these initiatives, 38 percent of the harvesters received some form of extension advice on their production practices, while 85 percent of the cultivators received consultancy services from the ARC-Fynbos Unit.

6. CONCLUSIONS

The study clearly indicated an evolution of technology development and transfer (TDT) with respect to Proteaceae. Increased cultivation of improved varieties was promoted to address the issues of time, form and place utility. The R&D programme was shown to have a definite financial, social, economic, institutional and environmental impact. The ROR was over 7% for all scenarios considered and indicated that the research programme was profitable to both farmers and society. The ARC-Fynbos Unit has also contributed significantly to human capital development and technology transfer through the multiplication and distribution of propagation materials, formal and informal training, publications and consultation services.

The number of harvesters involved in the industry has grown substantially over the years. The harvesters were able to participate in the industry because Proteaceae products could be harvested from the wild. Establishment costs were therefore not needed. However, the increased competition in the export market and the growing demand for improved quality products indicated the need to move towards organized orchards. This could work against the harvesters in future. If corrective action is not taken in time, the fynbos industry might soon be in the hands of cultivators with access to capital and land only. The same harvesters who were the backbone of the industry in the sixties and seventies, may then disappear. About 54% of the sample harvesters indicated that they would change from harvesting to cultivation if they owned their land. Policy action might be required to provide access to land and credit facilities to support the emerging cultivators.

Though the economic ROR of the Proteaceae research programme indicated a profitable investment to society, it was not as high as the estimated returns to public sector agricultural research (44 %) (Khatri *et. al.*, 1996) or those estimated in similar technology studies for crops grown on wider areas (35-49%) (Marasas *et. al.*, 1997). The lower ROR for Proteaceae could be ascribed to the long research gestation period required. This was confirmed in another study on wildflower research (Niederwieser *et. al.*, 1997). In the case of Proteaceae, the long gestation period is explained by the perennial nature of the crop and the time needed (19 - 33 years) to develop a cultivar from the initial seed collection to cultivar acceptance. This placed the gross benefits realized by the programme at a disadvantage to the total cost. The benefits were further underestimated in this study for various reasons. Lack of data allowed only the benefits associated with clonal materials to be included, while the entire cost of the R&D programme was, however, accounted for. The cost-benefit variation of the economic surplus approach further tends to under estimate the benefits of R&D activities (Anandajayasekeram *et. al.*, 1997). In the presence of more dependable data, the ROR and other benefits would undoubtedly improve positively.

The estimated ROR was very sensitive to increases in the gross revenue of Proteaceae cultivation; which related to productivity gains and cost reducing management techniques. This indicated that the ARC-Fynbos Unit should, in addition to cultivar development, also focus more attention to agronomic research to increase the productivity, quality and economic viability of existing cultivars.

The current funding arrangements within the ARC tend to drive the research agenda towards shorter term activities that will lead to commercialization. This may negate funding support for the basic research needed and will move away from technologies with public goods characteristics. Given the uniqueness of Proteaceae products, the maintenance and conservation of biodiversity should be a public responsibility.

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