THE FUTURE OF WILDFLOWER RESEARCH AND DEVELOPMENT IN SOUTH AFRICA - THE LACHENALIA CASE STUDY

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This paper reports the socio-economic impact of the lachenalia research program of the ARC-Roodeplaat Vegetable and Ornamental Plant Institute (ARC-Roodeplaat) over the period 1965-2010. Data were collected from researchers, the local propagator and the market agent in Holland, using guidelines and questionnaires. A financial and economic analysis were conducted. The results of both were negative, unless increased productivity, early entry into all potential markets and a decreased research gestation period were assumed. Additional impacts were qualitatively assessed. The program contributed to employment creation, the preservation of biodiversity, capacity building and beneficial institutional linkages. The management information generated by the study was used in planning and priority setting at the institute.

1. INTRODUCTION

The lachenalia research program started at the ARC-Roodeplaat Vegetable and Ornamental Plant Institute (ARC-Roodeplaat) in 1965. Realizing the importance of impact assessment in the mobilization and allocation of resources, the institute decided to undertake this evaluation in 1996. The information was to be used in future decision-making (Niederwieser *et al*., 1997). The assessment covered the period 1965-2010. The study comprised a financial and economic analysis, as well as qualitative statements on employment creation, the environment and institutional capacity building. The paper concludes with the implications of the study in planning and priority setting.

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2. BACKGROUND TO THE RESEARCH PROBLEM

South Africa (SA) is exceptionally rich in unique indigenous flowers. However, relatively little domestic effort has been made to commercialize these natural resources. South African flower production initially focussed on local market supply. After the lifting of sanctions, the emphasis became increasingly export orientated and several new growers entered the industry. The value of the South African flower industry increased from R100 million (1985/6) to R332 million (1995/6). The nominal export value was estimated at R70 million in 1995/6 (Niederwieser *et al*., 1997). Lachenalia is an indigenous flower bulb of the Southern and South Western Cape and Namaqualand, but species are currently grown by specialist growers throughout SA and also in Israel, Holland and the United States of America (USA).

Research and development (R&D) activities were initiated at ARC-Roodeplaat in 1965. The program developed through various stages until product commercialization started in 1997. Several hybrids and varieties were developed and a trade name filed in SA and the benelux countries. Evaluation trials were conducted in SA, Holland and the USA. ARC-Roodeplaat is responsible for the breeding and selection of new varieties, maintaining the nuclear source of disease free, true to type bulbs of each variety, developing supporting cultivation technology and to supply propagation stock to the industry. Arrangements to market a small number of bulbs in SA are also in progress. Agreements were signed with the chief licensee (Langberg); which was the only commercial lachenalia propagator at the time of the study. It was, however, anticipated that sub-licensees from Langberg will also start propagating lachenalia in future. Two agencies (Royalty Administration International and Hobaho) assist with the sale of products in the export market and are respectively responsible for royalty management, as well as marketing and co-ordination of evaluation trials in Holland.

3. METHODOLOGY

The impact of the lachenalia research program was analysed comprehensively. This includes both the direct research product and the people level impact. The latter refers to the actual adoption of the research output and its effects on the target population (Anandajayasekeram *et al*., 1996; Anderson & Herdt, 1990) and society at large (Alston *et al*., 1995; Gittinger, 1982). The study comprised a financial and economic analysis. The benefit cost derivative of the surplus approach to economic analysis was used (Figure 1). The model assumes perfectly elastic demand and a perfectly

inelastic supply curve (Anandajayasekeram *et al.*, 1996). The advantage of the method is that elasticity estimates are not needed, especially since these measures were not available for wildflowers at the time. Qualitative assessments were made of the social, environmental and institutional impact of the R&D program. Primary data were collected from the researchers, the domestic propagator (Langberg) and the market agent in Holland (Hobaho) through interviews, using guidelines and questionnaires. Secondary data were obtained from the institute and from published sources. The analysis comprised four different scenarios:

Figure 1: The benefit cost derivative of the surplus approach to rate of return estimates
Source: Anandajayasekeram *et al.*, 1996

3.1 Meeting the domestic demand at either 50% or 100%.

3.2 Meeting the export demand, in terms of either the European market only or for all three potential markets, including Europe, USA and Japan.

3.3 Increased productivity and marketing, under the following assumptions: Annual production increased from 0.65 to one million bulbs/ha, the maximum propagation capacity reached within two in

stead of three years and early entry into the Japanese and USA markets in the year 2000 in stead of 2005.

3.4 A decreased research gestation period to 15 in stead of the actual 32 years[1].

4. RESULTS AND DISCUSSION

4.1. The market demand for lachenalia bulbs

The impact of R&D initiatives depends on the realized market potential. For lachenalia, the potential markets comprised the domestic market, as well as export markets in Europe, Japan and the USA. The actual uptake was, however, difficult to estimate due to the novelty of the product. Estimates had to be obtained from researchers, the propagator and the market agent (Table 1). The domestic market demand was expected to increase with 1.6 million bulbs. For exports to Europe, the propagator gave the most optimistic estimate, while that of the researchers was the most conservative. The estimates for 2010 ranged between 10 to 20 million bulbs. The market agent also identified the USA and Japan as important export markets that could potentially absorb 11 million bulbs by the year 2010. The share of the three export markets was estimated at 55% (Europe), 25% (USA) and 20% (Japan).

Table 1: The market potential for lachenalia bulbs (1997-2010)

Year	Domestic market (Million bulbs)	Export market (Million bulbs)			
		Europe			USA & Japan
		Researchers	Propagator	Market agent	Market agent
1997	0.01	0.05	0.04	0.04	-
2001	0.3	2.0	1.5	1.0	-
2005	0.9	6.0	9.3	3.7	1.9
2010	1.6	10.0	20.3	13.7	11.2

At the time of the study, there was only one local propagator, who produced bulbs for both the domestic and export markets. The sales of this grower (Langberg) amounted to 40,000 bulbs in 1997. This could only be increased to five million under the current production potential. Langberg was cultivating one hectare at the time of the study, but the maximum production of this firm was estimated at six hectares. Once this capacity is realized, Langberg plans to sub contract other bulb producers to meet the market demand. Based on the experience of this grower, an economically viable unit for bulb production is

two hectares with a production capacity of 1.2 million bulbs per annum. The average cost curves for this type of operation are shown in Figure 2. The assumptions stated here were used in the analysis.

Figure 2: **Average cost curves for the South African lachenalia industry**
Source: Niederwieser *et al*., 1997.

4.2 Financial analysis

This was conducted from the viewpoint of ARC-Roodeplaat to evaluate the commercial viability and cost recovery of the program. Market prices and the actual costs accruing to the institute were used. At the time of the study, the ongoing market interest rate was 8.3% after adjusting for inflation. The rate of return (ROR) and net present value (NPV) were negative for all scenarios considered. This was largely due to the long research gestation period of 32 years.

The cost recovery rate is an important priority setting criterion at ARC-Roodeplaat. This aspect of the lachenalia research program was therefore projected on an annual basis over the period 1997-2015. The funding policy of the Agricultural Research Council (ARC) implicitly requires 30% of the research cost to be funded by industry or geared towards developing new knowledge. Only the most conservative scenarios were considered. Improved productivity and a decreased research period were therefore not assumed.

Before 1997, the institute received no returns on the financial investment. Cost recovery through product sales and royalties only started after 1997 at a rate of 5% (Table 2). Depending on the scenario realized, this could increase to at least 84%, but generally to around 106-209% after 2010. If all three export markets could be realized, the cost recovery rate was at its maximum.

Table 2: **Cost recovery percentage of the lachenalia research program for different scenarios (1997-2015)**

Year	European market only			European, USA and Japanese markets		
	Researchers	Exporter	Propagator	Researchers	Exporter	Propagator
1997	5	5	5	5	5	5
2001	35	32	29	35	32	29
2005	60	79	46	71	91	57
2010	82	140	103	146	204	167
2015	84	144	106	149	209	171

4.3. Economic analysis

This differs from the financial analysis in that the research program was analysed as a public rather than a private investment. The calculation of research benefits has several components, but is largely determined by the market potential of the product. Each product has its own life cycle and involves different impacts at various stages of evolution. This requires different balances of *ex ante* and *ex post* assessment (Alston *et al*., 1995). Because lachenalia is a new product in all the potential markets, the evaluation was largely conducted within an *ex ante* framework. Only the costs and benefits accruing to the South African society were included. The major cost components of the analysis comprised those relating to research, propagation, commercialization and marketing. Benefits pertained to the sale of propagation material, bulbs and potted plants, as well as royalties from domestic and export sales.

Where appropriate, market prices were adjusted to reflect economic values (Gittinger, 1982). The selling price of flowers is market related. However, the domestic price was adjusted for marketing cost, while the export parity price was used for export sales. Cognisance was taken of price distortions due to historical government intervention, but the analysis focussed on those issues most likely to bear a critical influence on the investment decision. Though water is subsidized in South African farming, appropriate shadow prices for

the use of this input in lachenalia production were not readily available at the time. Market prices were considered more reliable in the specific case. The other inputs used in the cultivation process should ideally have been adjusted with the tariff protection rate. However, the level of distortion and the effect on the management issues at stake were not considered significant enough to warrant elaborate shadow pricing. This notion was confirmed by the findings of a similar study on commercial wildflower production in which these issues were addressed (Wessels, 1998).

The major cost component of the analysis related to the R&D conducted since 1965. This was appropriately accounted for in a comprehensive cost analysis. It was found that staff salaries and benefits accounted for approximately 60% of the total budget in 1993. This component was expected to decline to 45% towards the year 2010. The cost breakdown accommodated the post level, medical and housing subsidies and salary increases of personnel. Staff working hours attributable to the lachenalia program were multiplied by the applicable salary estimate per post level to estimate the total personnel costs (Niederwieser *et al*., 1997).

The choice of discount rate is subject to considerable debate in the literature. The real interest rate is, however, generally considered most appropriate (Alston *et al*., 1995). In this study, a real rate of 6.7% was used for the economic analysis. This was derived from the long term government bond rate adjusted for inflation. Because of the uncertainties involved in choosing the discount rate, a sensitivity estimate of 5% was included. This could be considered conservative in view of even lower public investment rates proposed for SA (Van Rooyen, 1983).

As for the financial analysis, the economic impact was negative unless increased productivity and marketing could be realized and a shortened research gestation period was assumed (Table 3). Under conditions of improved productivity and marketing, a ROR of 7-8% was realized. This increased to 9-12% if a decreased research gestation period was assumed. The NPV ranged between 2-13 million Rands. The analysis was not sensitive to changes in the domestic market at either 50% or 100% saturation.

4.4. Social impact

Employment generation is an important social benefit of the research program. This is due to the labour intensive nature of lachenalia cultivation. Although the employment created through auxiliary services and related

industries are recognized, the study was confined to the direct opportunities generated by the South African lachenalia bulb industry. Job creation was considered at ARC-Roodeplaat, as well as by the commercial production operations. At the institute, technicians and labour are required for *in vitro* maintenance of genetic resources and the propagation of disease free bulbs. In terms of annual full time equivalents (FTE), one technician, three assistants and seven labourers will be employed from 1999 onwards.

Table 3: Economic rate of return and net present value of the lachenalia research program (1965-2015)

Scenario	Economic analysis (5% discount rate)	
	Rate of return range (%)	Net present value range (R million)
European export market only	0-3	(2.1)- (4.4)
European, USA and Japanese export markets	2-4	(0.7) - (2.5)
Improved productivity and marketing	7-8	2.0 - 4.9
Decreased research gestation period	9-12	7.2-13.3

Notes:
1. Rate of return and net present value ranges accommodate the variation in researchers, propagators and exporters estimates of the lachenalia market demand.
2. Net present value estimates are presented for the 5% discount rate.
3. All scenarios assumed 100% realization of the domestic market.

Job creation by the lachenalia industry was based on the propagator's estimate of the labour force employed in bulb production, the exporter's estimate of the market demand for these products and the anticipated expansion plan for commercial bulb production. Assuming that only the domestic and European markets are realized and that the maximum area (26 ha) under commercial production is reached by the year 2008, a total of 416 FTE of labour can be employed (Table 4). This could increase to 704 FTE if improved productivity and marketing were assumed. A certain number of managers and team leaders are further needed in the commercial production process.

4.5 Environmental impact

One of the important environmental consequences of the lachenalia R&D program is the preservation of biodiversity in terms of gene bank accessions

of endemic genera. At the outstart of the program, the gene bank consisted of 17 accessions; which increased to the approximate 1,000 at present. Around

Table 4: Labour requirements for commercial lachenalia bulb propagation (1997-2010)

Year	Domestic and European markets only							
	Area (ha)	Full time equivalents of labour			Area (ha)	Full time equivalents of labour		
		Full time labour	Casual labour	Total		Full time labour	Casual labour	Total
1997	0.5	5	3	8	0.5	5	3	8
2001	6.0	60	36	96	6.0	60	36	96
2005	16	160	96	256	28.0	280	168	448
2010	26	260	156	416	44.0	440	264	704

Notes:
1. Estimates were based on the exporter's projection of the lachenalia market demand. This was the most conservative estimate.
2. Labour requirements were based on the information provided by the local propagator.
3. It was assumed that the propagator will sub-contract two bulb growers with two hectares each by the year 2000.

250 crosses per year are additionally being made. The alternative to lachenalia cultivation is the production of chrysanthemum cuttings; which uses comparatively more fertilizer, pesticides, artificial temperature stabilization and lighting. When considered that lachenalia bulb production does not require environmental control and uses relatively small quantities of petro-chemicals, a positive environmental impact is implied.

4.6 Institutional impact

This refers to the changes in the research organization and the enabling environment which may affect the technology development and transfer process at large (Anandajayasekeram *et al*., 1996). The lachenalia program contributed to beneficial institutional linkages. The vision of the institute has shifted beyond the research arena towards improved team work with the roleplayers in the industry. Research priorities are demand driven and based on market signals. Domestic capacity was developed in the commercialization of indigenous wildflowers; which was previously confined to countries such as Holland, Israel and France.

A semi commercial tissue culture facility was established at ARC-Roodeplaat to mass propagate virus free stock plants. This contributed to income

generation and dissemination of experience to the private sector through contracts, consultations, training and commercialization activities. The capacity of this laboratory is partially devoted to the genetic resource conservation of other important food crops, such as potato, sweet potato and cassava. In terms of scientific training and capacity building, the program has resulted in various postgraduate qualifications, publications and conference papers. Although difficult to value in monetary terms, society eventually benefits through direct and indirect effects on the technical change in agriculture emanating from this capacity developed. This should be taken into account when assessing the productivity of research efforts.

5. CONCLUSIONS

Lachenalia is a new product and the analysis was based on several assumptions. However, very conservative estimates were used. Should the market potential be more optimistic than assumed, the results will certainly change in favour of the research investment. The analysis provided ARC-Roodeplaat with tentative guidelines to current resource allocation priorities and the planning of similar new product developments in future. In view of the growing global demand for flower bulbs (Rabo Bank, 1992), a constantly expanding flower range will be needed to meet the changing wishes of consumers. The rich variety of South African indigenous flowers and the existing capacity developed at the institute suggested the continued development of new varieties. The study indicated that an effective research program can be maintained at ARC-Roodeplaat with a moderate level of resource investments. Even under the most conservative scenario, the program will recover at least 30% of its costs around the year 2001.

The ROR on the lachenalia investment was lower than the estimates for aggregate public research (Khatri *et al.*, 1996) and for similar technology studies on crops comprising larger production areas (Marasas *et al.*, 1997). The results of the more optimistic assumptions, however, corresponded with the findings of another study on wildflowers. In the latter case, a ROR of 7-12% was estimated for proteaceae products (Wessels, 1998; Wessels *et al.*, 1997). The low ROR for the lachenalia research program can be ascribed to several factors. At present, the entire market supply of products depends on only one propagator. Healthy competition should be established by bringing additional producers into the industry. Although the market response is positive, the overall size is relatively small and may not change substantially over time. Marketing and commercialization issues should be carefully considered when planning research programs involving new product developments. The long

research gestation period of 32 years was the major factor explaining the low social benefit of the program. Market analysis, continuity and a constant relationship between technological and market development are preconditions for undertaking such investments in future. The analysis was not sensitive to the domestic demand for lachenalia, but was significantly influenced by increased productivity and expanded export marketing opportunities. Researchers should closely co-operate with the propagator and the market agent to realize the potential export demand.

Critical decisions had to be made regarding future lachenalia research. Considerable expertise, infrastructure and gene bank accessions have been accumulated to date. If the institute could assist the industry to reach its maximum potential, the revenue flow from royalties will continue. The propagators will then be able to take over the responsibilities of virus free bulb multiplication. A certain amount of agronomic research should continue to increase bulb productivity, but should be closely related to the royalty revenue. It did not seem viable to close down the research program at the time it was starting to generate income to the institute. In terms of current management decisions, these social costs could well be considered as "sunk costs". However, this kind of argument obviously creates a dilemma to research managers.

The issues of conservation and biodiversity should be addressed. These are the responsibility of society. Unless the research system has access to genetic materials, exploitation of the natural diversity in producing commercial product lines is not possible. The flower industry should be sensitized regarding the socio-economic impacts of research. Both public and private resources are becoming increasingly limited and the process of technology development and transfer should be rendered as efficiently as possible. This study constitutes a milestone in the application of *ex ante* impact assessment to planning and priority setting within the agricultural research arena. Continued emphasis on this approach would undoubtedly contribute to improved understanding, commitment and active participation of all stakeholders in the process.

NOTES:

1. *Lachenalia research was initiated in 1965 at ARC-Roodeplaat. Researchers reckon that, given the breeding cycle of three years, a reasonable time frame for cultivar development and commercialization comprises fifteen years. This implies that commercialization of the lachenalia products could have been actively initiated*

around 1980, when applications were made for plant breeders rights. The slow progress could be ascribed to several reasons. The major explaining factor was the assumption that the bulb growers in SA and Holland had enough expertise to develop suitable cultivation practices. Hindsight experience, however, revealed that the institute would have to take a strong lead in the commercialization process. The industry should be supported with a constant supply of appropriate production technology. If active commercialization of the product could have been realized in the early 1980s, the entire net benefit stream of the investment would have been shifted to the right. Therefore, the analysis was repeated to assess the sensitivity to a reduction in the gestation period by decreasing this period to 15 in stead of the actual 32 years.

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