RURAL INDUSTRIES RESEARCH
& DEVELOPMENT CORPORATION

DOOR in Australian Wildflowers & Native Plants

A report for the Rural Industries Research and Development Corporation

by Mal N.Hunter

July 2000

RIRDC Publication No. 00/103
RIRDC Project No. DAQ-236A

ISBN 0 642 0642 58133 9
ISSN 1440-6845

DOOR in the Australian Wildflower and Native Plants Industry
Publication No. 00/103
Project No DAQ-236A,

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Published in July 2000
Printed on environmentally friendly paper by Canprint

Foreword

With the increasing proliferation of 'new' rural industries on the Australian landscape comes an ever increasing demand for research. There is a limit to government's ability to meet this need and alternatives to the traditional institutional responsibility in meeting this demand needs to be evaluated.

The Do Our Own Research (DOOR) concept of much greater grower involvement and responsibility in the conduct of research was initiated, developed and evaluated in the Australian Nursery Industry. The program included workshopping as well as on the job training (action learning) for a group of growers and consultants in the conduct of research specific to the particular grower's needs. The concept has been adopted by the industry's peak body (NIAA) as a useful way to fine-tune new technology that is directly applicable to grower specific needs.

This publication reports on an evaluation of the DOOR process in the Australian wildflower and native plants industry with pilot assessments being conducted in Queensland and Western Australia.

This project was funded from RIRDC Core Funds which are provided by the Federal Government. Industry participants also contributed by paying for workshop attendance and through their provision of time, labour, resources and skills in the conduct of their various experimental projects.

This report, a new addition to RIRDC's diverse range of over 500 research publications, forms part of our Australian wildflower and native plants industry R&D program, which aims to improve the profitability and sustainability of the Australian wildflower and native plant industry.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- downloads at www.rirdc.gov.au/reports/Index.htm
- purchases at www.rirdc.gov.au/eshop

Peter Core
Managing Director
Rural Industries Research and Development Corporation

Acknowledgements

Many people have contributed significantly to the success of this project, in initial discussions, in project support and in the actual conduct of the project, as a participant, as a trainer or a reviewer or as a sounding board. Institutions that supported the project included the Queensland Department of Primary Industries, Agriculture Western Australia, Centre for Australian Plants, Western Australia Wildflowers Producers Association, Protea Producers Association of Western Australia, Gympie Flower Growers Association, Queensland Wax and Native Flowers Association and the Central Queensland Native Flower Association. The project was based at the Centre for Amenity and Environmental Horticulture, (Queensland Horticulture Institute, QDPI) Cleveland, Queensland. RIRDC provided financial support.

Grower Participants
Queensland-Southern Group: Ann Fitton, Max Lampo, Graham and Esther Cook, Nigel and Marian Dunche, David Shelton, David Wilderspin, Ken Young, Gloria and Neil Bale, David and Olive Hockings, George Hendricks, Kerry Cumner, Paul Blinco, Doug McCallum, Peter and Coralie Blackwood and Bob Grieve. *Central Group*: Bruce and Fay McCamley, Garry and Linda Scofield, Lloyd and Sandra Ingleton, Alenna and Doug McMah, Cecelia Parker.
Western Australia-Southern Protea Group: Jim Pollitt, John Daykin, Tom, Joan and Nick Antoine, Morris Cox, Wally Lewis, George Livingstone. *Northern Protea Group*: Ralph and Grace Sedgley, Peter and Joy Kelly, Ray Smith, Peter Cornock, Helen and Kevin Moore, Bruce and Claire. Robins.
Wildflower Group: Nina and Anton Foulkes-Taylor, Jackie and Ron Catto, Amy McCain, Gail Reading and Ida Southall.

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Western Australia-Chris Newell.

Government Consultants
Queensland-Garth Hayes, Peter Beal, Cynthia Carson, Lois Turnbull, Mal Hunter.
Western Australia-Mark Heap, Neville Burton, Lachlan Duncan, Digby Growns.

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Executive Summary

The DOOR approach to research
Following the success of the Do-Our-Own-Research in the Australian nursery industry (Hunter, 1997), the project leader was invited to conduct a similar exercise in the Australian Wildflower and Protea Industry. In essence, the concept promulgates a radical shift in the conduct of 'recipe' research, away from an institutional base to a grower base. In this mode, sound statistical research is initiated, controlled, led and conducted by growers themselves, with specialist and consultancy support on a needs basis.

This approach was found in the nursery industry to stimulate a much more critical approach to problem definition and problem solving in participants as well as ensuring that immediately relevant work was done. This latter aspect alone demolished the so called 'technology barrier' since the context of the work being done and the results produced applied directly to the problem on site. The DOOR solution to the problem did not have to be adapted from recommendations which had been developed elsewhere and were thus of doubtful relevance.

Wildflower production versus nursery production
The process applied in the wildflower industry was very similar to the one developed in the nursery industry, bearing in mind that the two industries differ significantly in a number of aspects. Wildflower culture is field based while most nursery production is conducted in pots of soilless media. Consequently, statistically sound research can be conducted much more easily and efficiently, in terms of labour, space, time and money in nurseries where the unit is a single pot plant, where medium variability can be virtually eliminated and where massive replication can be employed. The wildflower industry also faces a much greater logistical problem in being geographically dispersed.

The Process
The project was set up as a pilot, being restricted to Queensland and Western Australia. In a survey of industry members' appreciation of the research process, a questionnaire (and outline of the DOOR program) was distributed to all members of the industry in these two states. One of the questions elicited the respondent's interest in being involved in the project. Awareness presentations were then made at grower meetings to members of the wildflower and Protea industries. These presentations outlined the research process and how the DOOR program would be conducted.

A series of operators' and consultants' workshops were conducted in Western Australia in August 1997 and in Queensland in March 1998. These workshops provided the context of the DOOR program, some preliminary information on the research process and the opportunity for hands on experience with a classroom experiment. Groups were formed to discuss ideas in the development of group research projects to be carried between this workshop and the second in twelve months' time. Trainee DOOR consultants were allocated to each of these groups.

It was left up to these groups to organise on going meetings to finalise plans and commitments for the implementation of a research program. Trainee consultants were expected to act as facilitators rather than as leaders.

Mid term reviews were conducted in Western Australia in August 1998, and in Queensland in December 1998. The second series of operators' workshops were conducted in September 1998 in Western Australia and in July 1999 in Queensland. A survey was conducted on the participants engaged in trial work prior to the second workshop to assess how they had found the process.

Three groups implemented experiments in Western Australia, 3 of which were successfully reported. Five groups were formed in Queensland. One of these resigned from the program despite having put in experiments. Another group met on several occasions but did not proceed with an experimental program. Three other groups put in experiments, although by their completion participation in the groups had reduced to the couples who owned the trial site. Thus, from a total of 49 participants who

attended the initial workshops 27 actually established experiments, with only 18 (38%) of them actually being responsible for the collection of data that was statistically analysed.

Titles of experiments

Western Australia

The effect of application time and rate of nitrogen on the performance and economic productivity of mature *Leucadendron,* cv Safari Sunset. Southern Protea Group

The effect of nitrogen rates on the performance and economic productivity of young *Leucadendron,* cv Safari Sunset. Northern Protea Group

A comparison of organic and inorganic fertilisers on the production and economic performance of *Verticordia*. Wildflower Group

Queensland

The effect of foliar fertilisers on leaf colour, the retention of green leaves and the flower quality of two rice flower varieties. Esther and Graham Cook

Assessment of a number of soil bioconditioners/ameliorants on plant establishment and growth of wax flower. Ken Young

The effect of incorporated and unincorporated sawdust on the incidence of root nematode in Valentine Lace (*Platysace lanceolata*). David Hockings

Proposed experiments but not implemented

Effects of pruning techniques on NSW Christmas Bush (*Ceratopetalum gummiferrum*). Cooloola Group

Comparison of alternative organic fertilisers with chemical fertilisers in the performance of wax flower. Kerry Kumner

The effect of paclobutrazol on the early flowering of wax flower. Rex Grattidge

A comparison of the establishment, growth and persistence of 5 protea cultivars. David Shelton

Outcomes

The nitrogen work in Western Australia confirmed the economic value of additional nitogen application to *Leucadendron*. The recommendations based on these results have already been adopted by some growers.. Work on the *Verticordia* is still to be collated. The significant reduction in nematode galling in Valentine Lace has led to the recommendation of applications of sawdust to this new wildflower crop species. While leaf yellowing and leaf loss in rice flower could not be alleviated by a range of foliar fertiliser, the results provided important baseline information for future trial work. Significant positive responses were recorded in the early growth cycle of some wax flower cultivars to the addition of beneficial microorganisms.

More importantly, these experiments provided important experiential learning. At the second workshop those actively involved in this process were invited to identify 3 positive and 3 negative critical incidents that they had experienced during the course of the project. These data, together with a mid term review as well as operator responses to a mid term survey, contributed to the answers to the 4 questions that follow.

Morris Cox gave a paper at the 5th Australian Wildflower Conference on the Southern Protea Group's nitrogen work, while David Hocking gave an overview at the same conference on his DOOR work with a particular focus on his findings in nematode control.

Questions answered

Can growers maintain their commitment to research at a high enough level to ensure successful statistically sound experimentation?

Results in this project clearly indicate that quality data sets were collected from 2 groups, 2 family operations and 1 single operator. Analysis of these data showed significant effects of the various treatments examined at a number of sites. Of the 49 participants who attended the first series of

workshops in Western Australia and Queensland, 27 actually established experiments, as groups or individually. Of these, a total of 18 (38%) participants were involved in collecting data that could be statistically analysed.

Is the level of ownership and personal responsibility encouraged by the DOOR approach sufficient to generate that level of commitment needed for success?
'Members of all active groups in Western Australia said that they felt a strong ownership of the trial through their individual contributions towards its success. All have had an input to decisions through their meetings' Digby Growns, Mid-term Reviewer. Ownership and extreme satisfaction of the outputs created by the individuals involved in a successful research program was very high. Doing their own thing gave growers the opportunity to customise their investigations to the crop and the farm, with such a local focus that the results were directly applicable.

While ownership may be high, there is still substantial evidence of responsibility being more in the dependency mode (on the facilitator) in terms of meeting timelines, report writing and organising meetings. Indeed, one group indicated that it was quite critical to have the 'right' facilitator. Individuals working in a group were seen as less likely to give up on the research particularly when that group was drawn from the local community. One grower indicated the likelihood of diminished motivation in experiments where there was no evidence of any treatment effects.

What sort of training will the grower need to be confident enough to conduct effective research?
While some commented on the process as being rather complicated, growers may enter the DOOR program at a range of levels of training provided they are willing to learn on the job. However, such training must be kept simple and conducted at a pace appropriate to the group. Recipes have been developed that can be followed by those competent enough to run a small business and an ability to grow plants. "The DOOR process can be effective if motivated, established growers are involved". Initial input by a DOOR consultant would be very useful in the problem identification, project planning, design and statistical analyses phases. Group training (a maximum of 7 per group), with the resultant benefits of group dynamics, would be the preferred mode with the inclusion of the opportunity for individual activity. This approach could utilise the concept of Focal Research Sites with Satellite Sites designed to minimise the costs of engaging a consultant.

What sort (and cost) of 'consultant' support will be necessary and how is this likely to change over time in supporting an ongoing DOOR program?
The dependency mode of most participants seemed to be the norm, with much of their action reliant on 'prodding' by the consultant. One group that was very successful in its research program believed that their consultant's considerable input was crucial to the group's success. While the input and enthusiasm of group members had exceeded expectations, the amount of specialist consulting input needed to realise the planned outcomes for the group has been greater than originally outlined in the DOOR concept. Some groups achieved a lot with minimal consultant intervention.

Insights and learnings
Difficulties in communication were seen as the reason for breakdown between one grower group and their consultant. It is now clear that more attention needs to be given by all to developing the detail of the interdependency mode (roles and responsibilities), where the grower can succeed on their own account, seeking the input from other consultants if necessary. However, the dependency mode is attractive to the grower in the short term, but may not be viable in the long term as resources are withdrawn and officers (consultants) allocated elsewhere. The dependency mode still seems to be the norm in institutional led on farm research.

There were a few cases where growers actually took the initiative and succeeded with relatively little input from the consultant. In these cases, growers had had previous research experience, with the confidence to implement the experimental program without consultant input. They were strongly motivated with the additional experience of personally knowing that this sort of research works. Such experiences clearly indicate that with time and experience consultancy input may become relatively small.

The DOOR philosophy advocates continued experiential learning as a means of increasing confidence in the grower's own conduct of research, ultimately to the position where a facilitator may not be needed. It is clear that this goal is within the grasp of individuals of the wildflower industry.

It is increasingly unlikely that governments will provide enough funds to the wildflower industry to underwrite more than just a fraction of the necessary research program. But improvements in the cultural systems for current and newly emerging wildflowers will be dependent on appropriate research. The majority of such work is unlikely to be done by government in a site specific and therefore relevant way. Grower research will thus underpin such improvement. It is believed that the DOOR approach, supplemented with easy to follow Research Recipes and consultant support, is a cost effective option.

A participant's perspective

Finally, it is appropriate to reiterate the statement of David Hockings, an authority on new species development in the wildflower industry and a project participant, '*I urge other growers to investigate the DOOR concept and where a problem exists, to initiate a DOOR trial. The knowledge that can be gained from DOOR projects could be of immense benefit to individuals and, if approached on an open and co-operative basis, will be of further value to our industry generally.*'

1. Introduction

Wildflowers are grown commercially in all states. Exports of wildflowers and native plants amounted to about $30 in 1995-96. The industry, initially based on bush picked product, is developing a substantial need for better knowledge to optimise cultural practice. Because of the nature of the species being cultivated with a focus on flower quality and production, much of the information developed for other grain and forage industries is only of generic value. If the industry is to achieve its potential, mechanisms that foster the acquisition of relevant information on which to build an industry knowledge base need to be explored.

2. Review and Background

Technical knowledge resides in all communities and is evidence of a dynamic process of inquiry and experimentation (Farrington and Martin, 1988). In other words, research is a widespread activity that underpins human development. However, with the advent of modern agriculture, much of the responsibility for agriculture research has become institutionalised, most often being carried by the public sector, including government agencies and universities.

Some if not much of this devolution of responsibility has been due to the development of 'the scientific method' that has been accepted as central to good research. While the scientific method, with its focus on rigorous and repeatable methodology and statistical analyses, is able to separate treatment effects and their subtle interactions well beyond those that can be detected by eye, its application requires special training. Consequently, 'valid' agricultural research has largely become the domain of the trained scientist with the farmer as the dependent client for research information.

Unfortunately, the scientific support once available in government for horticultural research is declining due to the reallocation of resources. Furthermore, with the emergence of numerous 'new' industries the scientific resource has become so thinly spread that it is frequently unavailable. The diverse range of issues (species, cultivar, soil type, and climatic conditions) in industries such as the wildflower industry further exacerbates the perceived decline in support since there is often little widespread public benefit to be derived from the outcome of most specific research.

It is believed that a significant but unexploited resource for doing research resides in the growers themselves. It must be acknowledged that growers already conduct their own research but much of this is based on unrecorded observations, which as a consequence, cannot be subject to any objective statistical analysis. This observation is not intended to discount the value of such research, the results of which have been fundamental to the emergence of new industries, but rather to suggest that with a more statistical approach and not a great deal more effort, such information could be even more valuable. It is worth noting that in a survey of Queensland nursery growers we found that 68% do their own research, while 94% of respondents to the survey thought that 'inhouse' research was important to the success of their businesses.

The feasibility of enhancing the research skills of nursery people has recently been examined (Hunter Hayes and Chamala, 1996; Hunter, Hayes and Hickey, 1996). They concluded that '*the scientific and statistically sound way of doing research can be conducted successfully by nursery industry operators following some basic training in scientific methodology and the development of an ongoing interdependent relationship with a DOOR accredited consultant.'* While nursery people and wildflower growers are faced with common production issues, they differ importantly in their choice of medium (pots and soilless media versus inground) and length of growing period (often short with nursery crops and 2-3 years and more with inground flower crops). These differences alone impact on the differences between these industries in ease of experimentation and the length of individual commitment to the research process. Other differences undoubtedly exist. It would therefore be unwise to assume that the value of the DOOR approach will necessarily apply to the wildflower industry.

A group of Iowa farmers in the US (Practical Farmers of Iowa) decided in 1984, as a result of limited availability and lack of priority of government support, to conduct their own research as 'full partners in the control of research' (Rosman 1994). Their first goal was to provide farmers with information about environmentally sound, lower cost profitable farming techniques. The second goal was to encourage and guide research aimed at producing information about sustainable agriculture.

Membership of PFI stood at 450 in 1994, with it becoming well known for its involvement in sustainable agriculture and on farm research. From 1987-1992, 298 trials were conducted by 27 farmer cooperators including trials on cover crops, manure, nitrogen rates, phosphorus and

potassium placement and timing, starter fertiliser, tillage, weeds, intercropping, intensive grazing, with a further 79 unreplicated demonstrations. A field coordinator worked on behalf of the Extension Service and the PFI in a partnership that reflected a shared commitment to sustainable agriculture and the communication process.

It would seem that such growers with their greater field orientation have probably more in common with wildflower growers than do nursery people. Thus, the success of the Iowa group substantially raises the expectation that the DOOR concept will work for the Australian wildflower industry.

It is becoming recognised that adoption of new technology is greatly enhanced when the client is actually closely involved in its development. Such involvement is at the core of Chamala’s Participatory Action Model (Chamala 1995, 1996). This model provided the underlying theme of operator involvement in the DOOR feasibility study of the nursery industry.

PAM is a convergent organisational action model offering true partnership for all stakeholders who are organised into converging and energising groups, with the collective energy being redirected for participative activity. Groups and individuals are empowered to manage themselves but with assistance from skilled facilitators where necessary. The model provides guidelines on how to manage group emergence, group establishment and group action. PAM involves all stakeholders in developing a shared common vision in the planning, implementation, review and reflection processes. Thus, in this model the research process is seen as one of a number of integrated processes and not as an end in itself, which unfortunately appears to be the fate of some, if not many, institutional research projects.

The PAM philosophy has been successfully applied in Landcare, Catchment Management, Clean Up Australia and the World, youth employment and Greening Australia. However, Chamala (1995) points out that working together is not without problems since there is a limited personal capacity in working together for the common good. More appropriate ways that include appropriate incentives need to be developed. There is a need to understand the process of personal empowerment, and how to build effective developmental groups and empowering structures. More innovation is required in service delivery by institutions, the development of government policy frameworks, and in program implementation and monitoring.

It was thus in this environment that there developed the idea that some scientific research could be conducted in a different mode to that promoted by institutions without sacrificing its scientific integrity, but with a much greater emphasis on partnership, grower involvement and empowerment, as emphasised in the PAM model.

3. Objectives

Before the concept of self-help research is promoted in the wildflower and native plant industry some questions need to be answered:

- *Can growers maintain their commitment to research at a high enough level to ensure successful statistically sound experimentation?*
- *Is the level of ownership and personal responsibility encouraged by the DOOR approach sufficient to generate that level of commitment needed for success?*
- *What sort of training will the grower need to be confident enough to conduct effective research?*
- *What sort (and cost) of 'consultant' support will be is necessary and how is this likely to change over time in supporting an ongoing DOOR program?*

4. Methodology

This study was focussed around 4 principal and interlinked activities:

- *survey,*
- *awareness,*
- *training and hands-on research, and*
- *evaluation.*

4.1 Survey

The aim of the survey was to establish the context in which the industry currently conducts research, what sort of research is being conducted by growers, as well as aiding the selection of growers that have the appropriate profile for assessment purposes in this pilot phase. The survey questionnaire **(Appendix 1)** was based on that used in the nursery industry being slightly modified prior to its delivery to members of the Australian wildflower and native plants industry.

4.2 Grower Awareness

DOOR Awareness Presentations were given in Rockhampton, Gympie, Toowoomba in Queensland and in Perth and Busselton in Western Australia to wildflower growers in outlining the DOOR concept as developed in the nursery industry (**Appendix 2** for detailed outline).

4.3 Consultants' Training

Consultants who wished to service research activity within the industry were invited to undertake training in the DOOR approach (Appendix 2). This need occurred because of the fundamental shift from the current dependency model to the more participatory one in which the consultant is much more of a facilitator rather than being directly responsible for the conduct of the research itself. Getting professionals to let go of this 'leadership role' must be achieved if the DOOR approach is to flourish. Growers must be empowered to be actively engaged in the research process, accepting a high level of leadership and responsibility for their particular project.

A total of 8 Trainee DOOR consultants were involved in the project. Two were from private companies, 4 were government professionals, 1 from university and 1 from a grower organisation. Three resigned before the completion of the testing phase while a new appointment joined the project and replaced the role of one of them. All trainees, with the exception of 2, underwent the DOOR consultants' course, attended the participants workshops and attached themselves to grower groups or individuals. Their role was to facilitate grower group activity in a hands off mode.

4.4 Growers' Training

Four Growers' DOOR Operators' training workshops **(Appendix 2)** were conducted in Western Australia (July/August 1997,1998) and in Queensland (February 1998, July 1999)**.** The DOOR Implementation Cycle that appears in the *DOOR Manual for Plant Nurseries* provided the core to these workshops as well as being distributed to all participants for use as a reference material during the conduct of on site experiments. At the first workshop all growers participated in a workshop demonstration experiment developed to illustrate the concepts of replication, blocking and the value of statistical analysis. Growers worked in groups and with a trainee consultant developed group and complementary individual experiments that commenced in August 1997 for Western Australia, and during 1998 in

Queensland. Costs for experimentation in terms of land and labour were provided by industry.

4.5 Research

The scope of the research project and tentative outline was discussed during the afternoon of the first workshop. Assessment of information gleaned in the literature search (through GrowSearch Australia facilities) and its evaluation followed in subsequent group meetings. In a determined bid to break any government dependency mould, it was emphasised that the responsibility for organising site activity etc. be allocated to a grower member (in rotation if necessary) and not the trainee consultant.

Three Focal Research Sites and 1 Satellite Research Site were developed in Western Australia and 5 experiments initiated in Queensland **(**details appear in **Appendix 3).** While planning and design of experiments was provided by the consultants, the actual implementation, maintenance and data collection was left largely in the hands of the grower. Data analysis and interpretation was carried out by the consultant.

The group decided how the experiment was to be implemented who collected what data and when and how the site was managed. After collection, data sets were forwarded to the relevant trainee consultant for statistical analysis, preliminary evaluation, and comment and return. All participants were expected to keep a written record of their own experimental activity, with the Focal Research Site owner having the responsibility for records at this site. All participants were given a copy of the DOOR Manual for Nurseries.

4.6 Evaluation

Evaluation of grower response to the workshops was on the basis of a subsequent project development, implementation and completion. Success as a researcher (group or individually) was reflected in the sort of project report submitted by each trainee consultant **(Appendix 3)**. A mid project questionnaire was conducted with course participants to assess attitudes towards their research project. Each trainee consultant provided feedback on individual participation, group dynamics and the level of sustained commitment occurring in his/her group.

5. Results

5.1 Initial Grower Survey (Wildflower and Protea)

(See Appendix 1)

A total of 54 people responded, with 37 replies being received from Queensland and 17 from Western Australia growers. *Information appearing in italics applies to Western Australian responses.*

Respondents 32% from Western Australia, 28% from the Queensland Sunshine Coast, 11% from Brisbane and the Gold Coast, 11 %from Ipswich and Toowoomba and 17% from the rest of Queensland.

Involvement in Research 59% of respondent indicated that they often carried out on farm research, while 20% seldom conducted research. The remainder never carried out research. *Two thirds of the respondents indicated they often carried out research, while 3 out of 17 had never done research*.

Importance of Research 98% of growers felt that inhouse was either important or very important. *15 of the 17 respondents thought research was either important or very important.*

Types of Research In their first nominated topic 71% of respondents conducted variety testing, with just over 10% investigating fertility issues. In their second nomination 44% conducted nutrition work. Other types of research included pruning, non chemical options for nematode control, herbicides, pest and disease control, irrigation and water stress, vase life, bud and flower control, planting time and day length effects. *Research activities previously conducted by respondents included those on varieties, irrigation, organic fertiliser, weed mat, windbreak, nutrition, vermin, herbicides, pest and diseases, nematodes, pruning, drying, and vase life*.

Use of References 67% often read articles, while 28% read articles very infrequently. 6% rarely read articles. *6 of the 17 respondents used references regularly, 8 used them infrequently while 3 used them rarely*.

GrowSearch 46% reported accessing information from GrowSearch Australia. *Not one of the respondents from Western Australia knew about GrowSearch Information database.*

Success 15% of those who conducted experimental work considered their research work very successful, while 77% thought it successful. *13 out of the 14 respondents who answered this question believed that their research was either successful or very successful.*

Who conducts research? 86% of respondents did their own research. 10% used consultants while 5% worked with consultants. *Most respondents did their own research, with only 2 engaging consultants.*

Statistical Research 42% of respondents randomly distributed treatments, 11% did so occasionally, while 39% did not. The rest did not understand the question. 41% replicated treatments, 23% occasionally while 27% didn't. The remainder did not understand the question. 21% blocked their treatments, 9% sometimes, while 41% didn't do so. 29% didn't understand the question. 31% took objective measurements, 11% sometimes, while 56% didn't. 41% recorded the results, 24% sometimes, while 32% didn't record the results. 13% of those who conducted experiments had their data statistically analysed, while 74% didn't. The rest did not understand the question. 5% wrote written reports on their experiments, 8% sometimes and 84% never. *About half randomised and replicated their experiments, but rarely blocked their replicates. While about half took objective measurements and recorded*

the results, only a quarter had the data statistically analysed. Slightly less than one third of the respondents wrote reports on their experiments.

The six most important research topics identified by respondents for their farm (ex 52) (see Table 1 for full details) 58% of respondents listed nutrition in their list of 6 preferred issues, 44% for varieties, 39% for disease and pest control, 37% propagation, 29% herbicides, 27 % database resource base. *The Western Australia respondents indicated nutrition (59%), varieties (49%), propagation (47%), disease and pest control (41%), herbicides (41%), vase life (29%).*

Involvement 61% of respondents wished to be involved in the project and all agreed to pay their course costs. *One third of respondents wished to participate in the course, with all agreeing to pay.*

Information 98% of respondents wished to be kept informed. *All but one respondent wanted to be kept informed of progress.*

Age 11% of respondents were less than 35 years old, 54% were aged between 35 and 50, while 35% were more than 50 years old. *Just over half were aged between 35-50, while the rest were 50 and older.*

Associations Respondents were members of a total of 11 flower grower groups, 26% were members of WAPA, 17% of the Cooloola Native Flowers Group, 15% of the Central Queensland Native Flowers Growers Association, 11% of the Wax and Native flowers group. 41% or respondents were members of 2 or more groups, and 19% were members of 3 or more groups. *All were members of WAWPA, with individuals having membership of 6 other grower associations.*

Income from flowers as a proportion of total 38% of respondents were dependent on flower sales for at least 95% of their income, while 30% earned less than 10% of their income from flower sales. *Slightly less than half of the 17 respondents raised 95% or more of their income from the sale of flowers, while just under 20% earned 5% or less from flower sales.*

Flower enterprise expansion 76% of respondents expected to expand their flower enterprise. *One third of the respondents expected to expand their flower enterprises within the next 2 years.*

Core Business 63% were involved in commercial flower production, 24% involved in mixed farming operations (grazing, citrus and other horticulture). Other businesses included tea tree, hobby farming, painting and building. *Flower production (and/or associated activities) was the core business for 10 of the 17 respondents with others including mixed farming, wheat and sheep, organic fertiliser production, and hobby farming.*

Industry Description 68% of growers described their operation as production, 12% as production/ wholesale/ retail, 8% as wholesale/retail, 8% as production/wholesale, and 4% as only wholesale. *14 of the 17 respondents described their enterprises as production, 2 as a mix of wholesale and retail, while 1 included a 3 way mix of production, wholesale and retail.*

Staff numbers 44% of respondents employed no staff, 33% employed 1 full time equivalent, 7% employed 2, 2% employed 4, 4% employed 6, 2% employed 8, while 2% employed 12, and 4% employed 18 staff or more. *6 of the 17 respondents employed no other staff, 6 employed between 1 and 5 staff, 1 employed 6, while 2 employed 18 staff each.*

Items in Use Commonly used items included a rain gauge (93%), a tape measure (76%), a fax machine (71%), a measuring cylinder (66%), answering machine (60%), scales (60%) and thermometer (51%). 43% used computers for financial accounting and stock control, while 15% used computers to control irrigation etc., hand lens (43%), mobile phone (41%), pH meter (40%), EC meter (17%), and microscope 6%. *Fax machine, measuring cylinder, tape measure, and rain gauge were the most commonly quoted equipment on hand. While 6 people used computers for stock control, only 3 used them for irrigation scheduling etc.*

Table 1 Percentage of respondents (%) out of 52 questionnaire respondents in the Australian Wildflower and Protea Industry who indicated a particular research issue in their list of 6 most important topics needing research.

Research Issue	Queensland (%)	Western Australia (%)	Mean for both States (%)
Nutrition	57	59	58
Clonal, variety, selection criteria	38	49	44
IPM, pest control, disease	36	41	39
Propagation	26	47	37
Herbicides	17	41	29
Data resource base	29	24	27
Beneficial organisms	26	NR	26
Vase life	23	29	26
Post harvest	31	18	25
Cultural practice and production cost	20	18	19
Irrigation	11	24	18
Transport and engineering	20	12	16
Cash flow	14	NR	14
Transplanting	17	6	12
Farm layout	11	NR	11
Water recycling	14	6	10
Alternative to in-ground production	9	NR	9
Soil type	6	NR	6
Cool chain	6	6	6

NR = not included in list of options in the questionnaire presented to the Western Australian industry respondents.

5.2 Course Experiments (Emerald and Toowoomba)

(See Appendix 3)

Influence of moisture content of medium on germination and early growth of sorghum and radish

Summary

A hands on activity was conducted at grower workshops to provide an experience in experimental layout, data collection, the discussion of results and the formulation of recommendations. Germination test experiments were set up three and a half days prior to the workshop. The aim was to assess seedling response of two species to varying moisture status. Treatments included 2 species (sorghum and radish) sown into media, at 3 moisture levels contained within a closed transparent plastic container. After 4 days containers were placed on the floor of the workshop, opened up and used to illustrate the ideas of replication, randomisation and blocking, and statistical separation of effects. Participants then recorded germination, shoot and root length. Data were statistically analysed and results discussed at the workshop.

5.3 Participants' Responses to Questionnaire on 5.4 DOOR Presentations

(WA in August 1997. see Appendix 4)

DOOR Awareness Presentation
Time was just right, the **content** slightly on the light side and little bit too **serious.**

Clarity was a very mixed bag. A quarter of the respondents thought it was less than average, while half thought it was well above average or very clear.

Delivery and **group interaction** ranged from above average to excellent.

Overheads ranged from just above average to poor.

Workshop
While the majority thought that just the right amount of **time** was spent, 2 people (ex 9) thought there was too little, while 2 thought there was too much.
Most people thought the **content** was right, but 2 thought there was too much.
While feelings on **structure** ranged from slightly less than optimum to too much, the majority thought it was just right.
While to most the workshop was quite **clear**, a third thought it was only average or less.
Three people rated the **delivery** as excellent while the rest rated it as average or above.
The **conclusion** was assessed as average (44%) or well above average (44%) or excellent (11%).

The perception of **group interaction** ranged from less than average to excellent, while the **balance** of the workshop was seen as just right by the majority. Two people thought there was too much presentation while 2 thought there was too much discussion.

Specific comments from respondents

- Generally, I thought your presentation was quite good, but some things were too long considering in one case, you were preaching to the converted.
- Enjoying project
- I don't feel that there has been enough 'training' for consultants. I realise that most consultants have prior experience but being a new graduate I am finding that designing and executing this experiment for the growers is a huge responsibility.
- Enjoyed the day very much. Hope we can carry it out.
- Group interaction got better as the day progressed, finishing with enthusiasm. This has been maintained. Transparencies would have been better if they had related to the wild flower industry instead of the nursery industry. Nevertheless, they told the story.
- This was a good idea to start one evening and carry on the whole of the next day.
- It is a pity that Perth and Busselton are both doing only nitrogen trials. There should be a **longer term project** in at least one area.
- Jim Pollitt has been the backbone of the project and without his drive we may have had problems.
- Group responded well, already had a clear idea of first experiment. Good atmosphere, friendly mix of people. Time spent constructively.

Conclusions
As expected, perceptions varied considerably on many of the issues. On average it appears that both presentation and workshop were conducted satisfactorily. Overhead transparencies drew the most consistent negative comment with the suggestion that they should be made more relevant to the flower industry (and not to the nursery industry).

5.5 Summaries of Grower Experiments

(See Appendix 5 for complete experimental report)

Western Australia

A) The effect of application time and rate of nitrogen on the performance and economic productivity of mature Leucadendron, cv Safari Sunset in the Busselton area.

Summary
The effects of applied nitrogen (N) fertiliser rate and timing on harvested stem number, length and quality were investigated for *Leucadendron,* cv Safari Sunset on a grey, acidic, siliceous sand in the Busselton area. N was applied fortnightly to plants as calcium nitrate between August and December in 1997 and 1998. Four rates of N (0, 25, 50 and 100 g N/plant) were applied using three schedules; ‘early’ (August - October), ‘late’ (October - December) and ‘all’ (August - December).

Rate and timing of applied N did not significantly ($P<0.05$) influence the length of harvested stems for the harvest seasons in 1998 and 1999. The application of N significantly increased the number of stems harvested and financial return from treated plants compared with control plants in both years. There is no evidence at this stage of reduced stem quality as a result of applied nitrogen.

B1) The effect of nitrogen rates on the performance and economic productivity of young Leucadendron, cv Safari Sunset. Northern Protea DOOR Group (site 1)

B2) The effect of nitrogen rates on the performance and economic productivity of young Leucadendron, cv Safari Sunset. Northern Protea Group (site 2)

Summary
The results of the 1997 - 1998 nutrition trial showed some interesting and varied responses of the *Leucadendron*’s to applications of calcium nitrate. Increasing applications of calcium nitrate seemed to have little effect on plant growth. However, a late or continuous application of calcium nitrate seemed to yield longer stem lengths than an early application. By itself, this might have been a bit disheartening for the group. However, the plants at one Satellite Research Site on Grace and Ralph Sedgly’s property showed a significant increase in plant width as well as stem length in response to calcium nitrate. This highlighted the importance of having additional Satellite Research Sites as well as the main group Focus Research Sites.

C) A comparison of organic and inorganic fertilisers on the production and economic performance of Verticordia. Wildflower Group

Summary
No Summary available

Queensland

D) The effect of foliar fertilisers on leaf colour, the retention of green leaves and the flower quality of 2 rice flower varieties.

Summary
A range of foliar fertilisers were applied to rice flower to see whether the yellowing and shedding of the lower leaves noticed in the previous season could be prevented. Some of the

apparent differences between the treatment effects on stem numbers were large but because of the variability of the data was not significant (P<0.05). Neither leaf colour nor leaf retention was affected by foliar fertilisation. Baseline data will be very useful in planning future experiments.

E) The effect of incorporated and unincorporated sawdust on the incidence of root nematode in Valentine Lace (Platysace lanceolata).

Summary

Nematode damage occurs in many wildflower species. Chemicals being used to control nematodes are expensive and poisonous. Alternative control may be achieved with organic amendments. In this paper we assessed the value of composted hardwood sawdust (incorporated and unincorporated) in reducing nematode galling in *Platysace lanceolata* (cv Valentine Lace). Nine months after application of sawdust we rated roots for damage and found that surface applications significantly reduced galling (P<0.05).

F) Assessment of a number of soil bio conditioners/ameliorants on plant establishment and growth of wax flower.

Summary

Bioconditioners and soil ameliorants can improve plant performance. Such organisms are likely to interact with each other and are going to be site specific in their efficacy. The products Trichopel (a *Trichoderma spp* formulation), Vaminoc (an inoculum containing 4 species of *Glomus mycorrhizal* fungi) and Humilac (an extract of humic acid) were applied in factorial combination at the transplanting stage to 7 wax flower hybrids (*Chamaelaucium unicinatum X megapetalum*). Just prior to the first heavy prune, plant height and health were measured. Both Trichopel and Vaminoc had a highly significant (P<0.05) positive effect but only on 1 cultivar each. Humilac had a positive effect on 1 cultivar and a negative effect on another. These results must be regarded as only of preliminary significance. The experiment is continuing.

Experiments deferred

G) Effects of pruning techniques on NSW Christmas Bush (Ceratopetalum gumiferrum).

(see Appendix 5 for Preschedule)

H) The effect of paclobutrazol on the early flowering of wax flower. Rex Grattidge.

I) Comparison of alternative organic fertilisers with chemical fertilisers in the performance of wax flower. Kerry Kumner.

J) A comparison of the establishment, growth and persistence of 5 protea cultivars. David Shelton.

5.6 Paper Presentations-5th Australian Wildflower Conference

'New Flowers, Products and Technologies', 14-17 April 1999, p111-112.

DOOR Project: Nematode Control

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Abstract
Two DOOR projects are discussed outlining this grower's personal experiences in conducting on-farm research under the Do Our Own Research concept. The philosophy of DOOR is discussed along with the case for wide adoption and support of the concept by all grower organisations and individual growers.

Introduction
In 1997, an opportunity was presented via our local Sunshine Coast Branch of Queensland Nursery Association, to undertake a DOOR (Hunter and Hayes, 1996) project and my wife and daughter took up the challenge. DOOR stands for Do Our Own Research, a concept that is financially supported by HRDC and RIRDC in the 'new crops' area.

We had been battling with obscure recurrent disorders in one of our native cut flower crops - *Stenanthemum* - and suspected the problem could be related to phosphorus toxicity. We are growing flowers on a deep red volcanic soil - a krasnozem. In the long distant past, possibly 30 or more years ago, when the property was part of a dairy farm, it had been the practice to regularly apply superphosphate.

We were able to strengthen our suspicions of phosphorus toxicity by soil analysis, by tissue analysis and by comparing both soil and tissue from cultivated plants with samples of the same from a natural wild population of the plant.

Pot trial
Finally, with a DOOR pot trial and the help of our DOOR consultant, we were able to confirm the sensitivity of the plant and the expression and progression of symptoms. We intend to follow the first P trial with another to expand our findings. We will explore aspects of soil treatment, on the one hand to attempt to prevent toxicity symptoms appearing and on the other hand to combat the toxicity, after symptoms have been produced.

The future for research
It is quite apparent that help with farm and nursery problems from the traditional sources such as departments of primary industries or agriculture is now virtually non-existent or increasingly very difficult to access, even if you are prepared to fully fund the work. Industry has to look for alternatives that meet its own research requirements or go backwards. However, as we discovered, the DOOR concept offers limited but sufficient scientific guidance to enable growers to undertake sound and effective research themselves and it is relatively inexpensive. In fact, 1 believe that increasingly the only way growers will get answers to many of their problems in the future, is by doing their own research.

Practical implications
Nevertheless, a DOOR project should not be undertaken lightly. It involves both resources and time. It must have commitment.

To look at our own situation, the resources aspect is not a big deal, provided you tailor the trial to fit within the scope and function of your ordinary nursery or farm operations. In other words, keep it simple and keep it practical. Initially, we did find collection and preparation of the soils and treatments somewhat daunting, but once we made the decision to proceed, it went ahead quickly and easily. The planting and layout of the trial was simple.

We actually did this as a pot trial under the automatic watering system in the nursery, so it virtually looked after itself once it was laid out. Even so, we found the time component more difficult. We tended to put off recording observations and measurements because we were busy with other farm and nursery demands. We had to strictly discipline ourselves and really, the main part of DOOR is in making the commitment of time to see it through. During the run of the trial, we had to set aside 3 or 4 periods of several hours to measure, record and photograph.

The P toxicity trial convinced us that the DOOR concept has the potential to be an extremely useful and accurate way of seeking solutions to problems.

Field trial

When a further opportunity arose through the Wax and Native Flower Association to take on another DOOR trial, we jumped at it. We have developed a new native cut-flower, Valentine Lace, which is highly susceptible to root knot nematode infestation. This plant is not alone with this problem. Others, such as rice flower, are equally susceptible; therefore, successful research could bring wider benefits to the industry generally.

The usual methods of nematode control using crop rotation or nematicides, such as fenamiphos, vary in effectiveness or period before significant reinfestation. They offer poor long term prospects with a crop that should have a life of maybe 4 to 5 years. We undertook a DOOR project to seek a better long term solution.

There is evidence that maintaining higher levels of organic matter in soil reduces root damage by nematodes. The mode of action of organic amendments is apparently complex and could involve release of compounds toxic to nematodes or stimulation of organisms that are antagonistic to nematodes. Furthermore, improvement of soil structure and fertility by adding organic material could promote better plant health and vigour and tolerance of nematode damage. Some fungi and bacteria have been shown to be amongst the antagonists responsible for nematode suppression and these organisms can colonise organic material.

In our pre trial literature search, we found a paper by the nematologists Vawdrey and Stirling, (1997). They compared 5 different treatments, namely molasses, sawdust, filter press, green manure crop and fenamiphos in a field grown crop of tomatoes. Of these, the sawdust amendment was clearly superior, the roots being (and I quote) ‘almost free of galls and had the lowest population of root knot nematodes’.

In the Vawdrey and Stirling (1996) trials, sawdust composted with urea to prevent nitrogen draw down, was incorporated into soil prior to planting. As our new plant, Valentine Lace, has a cycle of 4 to 5 years, we were particularly interested in also treating existing plantings. Our trial, therefore, set out to compare the effectiveness of incorporated sawdust with surface application of sawdust.

Method

To digress for a few moments about this trial - we followed the Vawdrey and Stirling (1997) treatment and mixed hardwood sawdust with urea at the rate of 60gm urea per 15 litres of sawdust. We used a cement mixer and piled the mix on a large plastic sheet. The final heap was hosed and then the plastic folded over the top. The sawdust heated up and turned a dark

colour as well as smelling strongly of ammonia. A black smelly liquid seeped from the bottom of the heap. After 3 weeks or so, the heap was opened and after a couple of days to disperse the ammonia, the treated sawdust was applied to the relevant trial plots at 15 litres per square metre. We had also applied 3 litres per plot of mixed soil from around plants that had recently died from nematodes in an attempt to ensure nematodes were distributed throughout the trial. After the trial plants of Valentine Lace were in place the whole trial was oversown with tomato seed. The idea of the tomato plants was to enable us to bio sample the plots periodically without interfering with the trial plants.

Graham Stirling advises that the difference between using hardwood sawdust and softwood sawdust will only be in the frequency of application. Softwood sawdust will break down more rapidly and will probably need to be applied 2 or 3 times per year. Also, since their initial trials, Graham is recommending seeding the sawdust with a biological starter such as old composted poultry manure or old compost.

DOOR to the future

I believe all growers have some production problems, either major or minor, that could be solved by appropriate research. Certainly, in my work developing new plants, new and obscure problems are apt to occur. They may have little relevance to existing knowledge relating to traditional plants.

DOOR is a collaborative process, teamwork, between a skilled professional - the consultant - and the nursery or farm operator who will be assisted to become familiar with scientific methods and to carry out sound statistical research. Computers have made statistical analysis relatively simple for many operators.

DOOR is a move away from industry dependency on institutional research to industry self reliance. It can provide customised information specific to a particular species or an individual business.

I urge other growers to investigate the DOOR concept and where a problem exists, to initiate a DOOR trial. The knowledge that can be gained from DOOR projects could be of immense benefit to individuals and, if approached on an open and cooperative basis, will be of further value to our industry generally.

DOOR will have all the more relevance as the traditional institutional avenues of research cease to exist and particularly as little known and previously uncultivated native species of plants are developed as commercial crops.

Acknowledgments

The author thanks Dr Mal Hunter, Mr Peter Beal and Ms Vesna Popovic of QDP1 for their guidance and Sunshine Coast Branch of Qld Nursery Industry Assoc and Qld Wax & Native Flower Assoc for their support.

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5.7 Paper Presentations-5th Australian Wildflower Conference

'New Flowers, Products and Technologies', 14-17 April 1999.

Southern Protea Group's DOOR Project

Morris Cox,
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Introduction

The Southern Zone of the Protea Producers Association (PPA) was trying to get help from Agriculture Western Australia (AGWA) for research. It was realised that as a small industry there was not much hope in this, so Mal Hunter's DOOR (Do Our Own Research) program was a good opportunity for the organisation.

DOOR Workshop

In August 1997 Mal Hunter from the Queensland Department of Primary Industries held a meeting in Western Australia to discuss his DOOR project. From that meeting six Protea growers from the South Zone of the PPA decided to conduct a nitrogen trial on *Leucadendron* as nutrition was one of the research priorities for the growers. It was also thought that this would give some quick results which would give the growers more enthusiasm to tackle more difficult and long term research.

DOOR Project

Mark Heap from AGWA was at the DOOR workshop and agreed to be the consultant for the group of 6. Mark helped develop the program including the rates of nitrogen, the timing, etc.

As I had some *Leucadendron* Safari Sunset the group decided to do the trials on my farm. The group met several times to help with fertiliser application and to discuss the progress and results of soil and leaf tests, etc. From January to June 1998 suitable flowers were picked and the lengths and quantity from each plot were recorded. Returns were worked out for the various trial plots with a dollar value put on the different stem lengths. These figures showed noticeable differences. All felt it was very pleasing to see such dramatic results so quickly. The trials are being continued to determine the long term effects of increased rates of nitrogen.

Other Research

Another research priority was water rates required by Protea. Another simple trial was initiated for this.

Other Groups

The Northern Protea Group also started a DOOR project but were not very enthusiastic later on and it seemed they did not get the support from their consultant they had hoped for. The group's trials are progressing better with their new consultant.

Conclusion

In conclusion, the Southern Protea Group is very pleased with the way its version of DOOR is progressing. Although it must be emphasised that the group has received considerable technical help from Mark Heap of AGWA.

Future

As growers have many deaths from Sudden Death Syndrome (probably *Phytophthora cinnamomi*) the next project will be trials to determine if it can be controlled with help from Murdoch University and AGWA.

5.8 Mid course questionnaire

(See Appendix 6)

Collated returns of Mid-project Questionnaire distributed to Western Australian and Queensland participants.
An inter workshop survey was carried out with the WA growers in July 1988 and in March 1999 with Queensland growers. All growers registered with the project (13) were sent a questionnaire. The number of respondents in WA was little under half of the registered participants. Only 6 questionnaires were returned in Qld out of 15 sent. One may conclude that the non respondents felt that completing the questionnaire was not of sufficiently high priority among all the other activities. ***The Queensland responses appear below in italics.***

The responses to the questionnaire indicated:
Potential, confidence, enthusiasm
Most growers were still enthusiastic about the DOOR concept, rating its potential as high to very high. Most participants have also developed a high level of confidence in conducting their own research. *Four of the returns rated the potential of DOOR as high to very high, with almost all having a lot of confidence in conducting DOOR type experiments. Enthusiasm has been maintained with all except one agreeing that enough support had been provided.*

Support and completion
In most cases they stated that their project was on target and had gone as originally planned with an adequate amount of support being provided. While one grower has completed his/her project most will continue with theirs after the August workshop. *Half the growers were on target with their project, one has been completed and most will continue.*

Access to GrowSearch (information)
It was clear that most growers could find relatively little information from the traditional sources (GrowSearch Australia or libraries). What was available was of limited use. *The value of GrowSearch as a source of information for their project varied considerably; in 1 case highly, while in another case not at all, with others in the middle.*

Value
There was unanimous agreement that the results from the project work will be very valuable. This clearly establishes the need for this sort of approach. *One grower indicated that results will be very valuable, while 2 indicated that results would be of some value.*

5.9 Second WA Visit Report

(1-4th September, 1998). M.N.Hunter

Personnel
On my recent trip to Western Australia I was very pleased to meet up with a total of 12 DOOR participants and 3 consultants, 1 of whom was Lachlan Duncan, a Floriculture Officer recently appointed by WA Ag in response to the industry's support of the DOOR program. Chris Newell, the Industry development Officer of WAWPA, travelled with me in the north. I had meetings at 2 northern sites and ran a workshop with Mark Heap at Dunsborough with members of the Southern Protea Group. I was impressed with the research being undertaken and the obvious commitment from growers as well as the very enthusiastic support from the consultants involved.

Interest level
It is apparent to me that the interest in the DOOR concept remains high among the participants I met, even though there is some feeling that what is being currently developed is

really a hybrid between the Centre for Australian Plants Product Group approach and DOOR as originally intended.

What is DOOR
The hallmarks I see in DOOR are your
Active involvement in research itself, the development of individual skills
(Empowerment), to carry out that research, within an
Interdependent relationship with a consultant (extension officer, facilitator, specialist, etc.), which results in the individual having a high level of
Ownership of the work and the results and a good
Understanding of what the work means.

These **AEIOU** traits represent a major change in how growers in the established agricultural or horticultural industries were previously involved (there are exceptions) in the research process. With the DOOR approach the 'technology adoption barrier' will be virtually eliminated since the growers are themselves closely involved in generating the information themselves in their own environment. They would need no convincing of its relevance.

In my mind, provided these traits exist the DOOR philosophy will still apply whether the operation of DOOR is considered a hybrid or otherwise. As autonomous groups, the desire to 'rebadge' the project label to better reflect the hybrid is your choice and really up to you.

Self responsibility
A primary goal in DOOR is to get you and your group operating as autonomously as possible, but with appropriate links to other people or groups that allow you to achieve your goals. Our job as consultants and facilitators is to 'kick start' that process and continue our support at the level you need (and in time will probably have to pay for). I expect that need for support to decline with time due to your developing skill.

Bear in mind that there may be others who might be interested in being involved in your research program. If so, they should be prepared to share the pain (cost of research) in return for the gain (information and knowledge).

Government R&D funding agents, such as the Horticultural Research and Development Corporation are very interested in supporting grower led research on a $1:$1 upfront basis provided a sufficient amount of the research results can be made public property. A DOOR research consultant should be able to help you develop proposals to get you started down this track.

In control but interdependent
Part of the empowerment process is to instil in you a sense of personal control of the research being done, either individually or in groups, rather than you merely being a provider of resources for some one else’s research program (or not involved at all!). DOOR research is yours and shared with others on a negotiated basis, depending on their input and support. Whether you share or not is your decision. However, I believe that the more you share with others the more (often much more) others will be inclined to share with you. The process of sharing also has other important beneficial spinoffs (and some negatives, I admit). Sharing will substantially increase your knowledge base, and reduce the possibility of re inventing the wheel.

Action learning needs attention
In the current DOOR program we are relying heavily on the *Action Learning* approach and *Group Learning* as a basis for training. I feel this has been quite variable in its success so far, particularly when groups are comprised of only a few people some of whom find it difficult to make meetings regularly. We need to work out how to do this better.

The DOOR Manual
The DOOR Manual for Plant Nurseries (Hunter and Hayes, 1996) which all participants have should be a useful orientating document for the complete research process, even though the target group is obviously nursery operators. A major problem seems for people to be able to find the time (or the inclination) to read it, in an environment of information overload and other priorities. We have tried to make it as readable as possible and can only encourage you to persist.

Everyone doing any research should at least attempt to complete the experimental outline or preschedule that appears in Appendix 10 on page 89, a case study example of which appears on page 95. This preschedule should be shared with anyone else involved in the project, including your consultant, so that everyone involved knows what is intended and may put a point of view before things actually get underway. I cannot emphasise enough the need to attend to this paper work. Without these types of records the results you produce will be of somewhat limited anecdotal value and lose their real value with time as memories fade or become distorted.

'Recipe' versus 'creative' research
The results from the Southern Protea Group clearly establish how valuable appropriate N management in *Leucadendron* is. While I don't personally consider the tissue/soil testing (TST) project as a true DOOR project, the results from it show quite admirably how DOOR research and institutional research can complement one another. I would put the TST project into the 'creative' research category which is much less applicable to the DOOR concept than the N rates and dates (NRD) 'recipe' research.

The basis for this distinction is that the TST is being run and managed by researchers, has a substantial creative element, is subject to a relatively high risk of not succeeding, and is pretty costly in terms of nutrient testing. By contrast, NRD is managed completely by growers, has more of a recipe focus, is low risk in terms of its likely value to the grower and is not expensive in terms of specialist inputs. This is not intended to discount whatsoever the generic value of TST.

A real bonus of the close collaboration between researchers and growers in both experiments will be the enhanced likelihood of the acceptance of the TST (if successful), by the industry because of the context in which the testing was conducted and its links with the real world. This combined experimental approach is also a legitimate way of growers reducing consultancy costs.

DOOR recipes
There seems to be some interest in the development of specific stand alone project 'recipes' for particular experiments. A number of recipes which essentially outline the research steps taken for individual experiments could be developed for the current DOOR in Wildflowers and Proteas program. I would be seeking support from the other consultants in the development of these recipes with relevant grower input and critical appraisal and suggest that we consider a standard but simple format (template). The *Nursery Manual* could then be used as a general guide with each 'recipe' being the specific details for a particular sort of experiment. Because the 'recipes' stand alone they could be readily modified and updated and even customised for particular locations, activities etc. The analogy to the use of recipes in cooking and how they are modified to meet an individual's tastes is appropriate. For example, the ingredients of plant species, soil type, climatic zone may vary but the trial design, range in fertiliser application rates, when they are applied and forms used etc., and sort of data collected may be very similar for a particular experiment type. I could envisage that later on an additional suite of research recipes being commissioned by industry with possible corporation support.

Mid term DOOR review
I have enclosed a copy of the mid term ‘DOOR in Wildflowers and Proteas’ review conducted recently in WA by Digby Growns, Project Manager, Floriculture Industry Development with WA Ag. The report is very positive and suggests that the DOOR way may be one way to go, for WA at least (‘The DOOR way for WA’ has a certain ring to it!).

Note that the preliminary Southern Protea Group experiment report is not included as alluded to but will be available at a later date. I will be conducting a similar review of the Queensland DOOR activity probably in the second week of December. I will be finding out what research is actually underway (with attendant completed pre-schedules), the level of skill development in individuals, their relationship with their consultant and their understanding of the basic principles of sound research.

Both the WA and Qld reviews will form an important component of the final project report to be completed by the June next year.

DOOR in the West is alive and well
I have come back to Queensland enthused with what I learnt in the West. I was particularly impressed that so much has been achieved (on the ground and in the head) with virtually no intervention on my part and relatively little basic training being provided to either consultants or growers. The level of self confidence has developed to such an extent in the Southern Protea Group that I was told, *‘with respect Mal, we don’t really need your input anymore’*. I could take this in two ways but have been assured by the spokesperson for the group that it should be seen as an indication of their developing maturity, aided and abetted to a great extent, I have been advised, by Mark Heap, their DOOR WA Ag consultant.

The success of DOOR so far, despite my lack of appropriate input, reflects in part the robustness of the simple underlying philosophy that enhances, legitimises and formalises (and hence 'value adds') grower activity in the research process in which most are already active. The success also reflects the value of learning by doing (*Action Learning*) in Adult Education. But most importantly, the success reflects substantially on the nature of the participants themselves and their considerable commitment to a new but empowering way of doing business. Hopefully DOOR, or whatever you deem is the appropriate label, will be of value to you in your future success and not just another passing fad.

5.10 Mid term DOOR Project Review

A) Western Australia August 1998
A mid project term review was conducted in Western Australia by the Agriculture Western Australia Project Manager, Floriculture Industry Development, Mr Digby Growns. 10/8/1998

Groups
The DOOR project on wildflowers and proteas involves three areas; the Southern Protea, the Northern Protea and wildflowers. Feedback was sought from all players on the progress to date of the project. In all cases there has been strong recognition that the project is no longer purely following the DOOR principles and that it is now a Western Australian hybrid which has a large input from researchers from Agriculture Western Australia.

The establishment of the Myrtaceac and Proteaccae product groups under the Centre for Australian Plants (CAP) prior to the DOOR proposal is also highly significant in continuing this research. The straight DOOR activity did not, and could not work given industry

inexperience and an inability to complete scientific activity without continued input from experienced researchers. If not for the involvement of these researchers it is unlikely the original DOOR would have continued past the early stages.

The Northern Protea Group has a Focal Research Site and 2 Satellite Research Sites looking at N nutrition on *Leucodendron* Safari Sunset. The Southern Protea Group has a Focal Research Site researching nutrition of *Leucodendron*. However, no formal Satellite Research Sites have been established, although some early 'on farm' adoption of the promising treatments is already occurring.

The wildflower group has a Focal Research Site and 2 Satellite Research Sites and are researching nutrition of *Verticordia* species.

Level of activity
The Southern members have been very active. Meetings have been held about once a month since August 1997 and attendance has been high. All members have been involved in the decision making processes, although much (not all) of the actual trial labour has been carried out by Morris Cox. Group meetings have included 'on site' examinations of the trial and a summary of results for the first year has been circulated.

Northern meetings were held about fortnightly early on. However, this activity has declined severely. There has not been the level of cohesion among members of this group as there has with the Southern Group. This may be explained in part in that the Northern Group has stayed more closely with the DOOR principles regarding the involvement of the consultants than has the Southern Group, and hence the trials have not had the same impetus.

This group has not used an Agriculture WA consultant and are impressed with the achievements of the Southern Group. These 2 groups have decided to amalgamate and Agriculture WA will provide a consultant to the group who will replace the WAWPA industry development officer now he has resigned from his position.

Meetings of the *Verticordia* trial group have been held monthly when the nutrients are being applied to plants on the Focal Site. Activity on the Satellite Research Sites has not yet begun.

Empowerment
The members of all groups interviewed felt that they were in charge of the process and in control. The need for outside specialist help (statistical, plant nutrition etc.) was not viewed by the members as a loss of control or empowerment.

Relationship with consultant
The Northern Protea Group felt initially that the relationship was excellent. However, this later declined as did the level of activity. All of the Southern members interviewed feel that the relationship is excellent. One significant comment was that the good relationship has encouraged the group to tackle more complex work in the future.

The *Verticordia* group feels that there has been fairly minimal input by the consultant, except with the initial experimental design. Greater input was not at this stage deemed necessary. They felt that this input would increase as data manipulation of the trial results was needed.

Ownership
Members of all groups said that they felt a strong ownership of the trial through their individual contributions towards its success. All have had an input to decisions through their meetings.

Understanding of basic principles
The response to this issue was mixed. Whilst the members said that the DOOR process had improved their general knowledge of basic research principles, they are also aware that there are several 'holes' in knowledge (statistics, basic plant nutrition, quality report production) where outside help is very useful. A view was expressed that flower plantations have difficulty setting up experimental trials due to time and manpower constraints, even if they have the basic knowledge. Having someone with research expertise to oversee this activity so that it was done properly the first time would reduce the time wasted making mistakes and ensure that any results arising from the trial were valid.

There are 2 options here; train the members to a higher level on the basics of 'simple' research, or provide a higher level of outside (consultant) involvement. The Southern Protea Group and the Wildflower Group have operated well on the latter, on the understanding that the increased contribution of the consultant should not lead to loss of control for members or leading by the consultant.

Consultant's view
The Southern Protea members have been very positive about the process. Whilst the input and enthusiasm of group members has exceeded expectations, the amount of specialist consulting input needed to realise the planned outcomes for the group has been greater than outlined in the DOOR concept.

A large consulting input has been invested to produce valid trial designs (following group concepts), check the scientific literature, contact relevant plant nutrition researchers and add to the interpretation of trial results. This has been a common sense response to 'value add' to the great effort put in by the Southern Protea members.

The Northern Protea members have been less enthusiastic about the outcome of their trial, probably as they are a less cohesive group than the Southern Group. However, they still believe there is value in a grower led research activity and hence have decided to amalgamate with the Southern Group.

The Myrtaceae group had a slow start ostensibly because it was waiting for the season to break and plant growth to begin and to capitalise on rain to help disperse applied fertilisers. However, there is still a good deal of interest in the trial and it will likely continue next year.

B) Queensland December 1998
This review was conducted by Mal Hunter, the DOOR in Wildflowers Project Leader.

Groups
Five groups were formed following DOOR Workshops in Emerald and Toowoomba in March 1998. One Group was developed in Central Queensland, 1 on the Sunshine Coast hinterland (the Cooloola Group), 2 focused on flower farms in the Lockyer Valley (Ken Young’s property and Esther Cook’s property), and finally a single participating couple’s site at Maleny.

Despite earlier expectations of a larger group, the Central Queensland Group was finally made up of 2 grower couples, one in Moura and the other outside Rockhampton. Each couple decided to conduct their own Research Site, because of the distance factor, rather than focus on one Focal Research Site. Experiments were established to assess the fertiliser needs of native flower species.

Communications
Major communication difficulties developed between the CQ DOOR growers and their consultant. Experimental preschedules were not drawn up. Thus, clear responsibilities on who would do what, by when, or how were not established. It was apparent that the role and/or responsibilities of the consultant were not clearly established and understood. A heavy reliance was placed on the consultant with no fall back position identified when the consultant was unavailable.

As a consequence experiments that had commenced were not continued. Such were the misunderstandings and apparent lack of rapport between the growers and the consultant that the growers decided to resign from the program. Concern was attributed to the lack of sufficient consultant contact and expected direction and support. Moreover, the consultant took on this role in an already heavy and unpredictable work schedule, possibly further aggravating the communication difficulties.

Timing
Timing of the project seems to have been the stumbling block for many of the growers within the Cooloola Flower Growers. A follow up group meeting was held within a couple of weeks of the participants' workshop in March 1988 and action plans agreed. The aim of this group was to assess the pruning requirements of Christmas Bush.

Despite this and 2 subsequent meetings little further progress was made. The initial DOOR workshop was held towards the end of 'normal' preparation stage for the crop of this group's interest and once this stage had passed other more important priorities apparently took over. Those who did not proceed immediately seem to have been left behind. It may have been much better if this initial workshop had been held early in the group's preparation phase.

Self Review
The trainee DOOR consultant for this group suggested that a review procedure for group members to self evaluate their own progress needs be implemented. Members should also consider the relevance of their project, their desired outcomes and their perceptions on their progress and the program they are involved in. Such a feedback mechanism preferably in a written form should promote ownership and allow the growers to express their frustration and more importantly their level of confidence in their progress.

DOOR for Established Growers
Growers who are in the first stages of establishing their flower farms should consider their focus and priorities before committing to the DOOR approach. Indeed it may be argued that the DOOR approach is primarily relevant only to those growers that are already running an established production system and at a stage when operational fine tuning is economically justified.

A Focal Research Site was established at Esther and Graham Cook's property in the Lockyer Valley, with an experiment to look at the effect of foliar fertilisers on yellowing in rice flowers developed and implemented. Good data has been collected. However, other than very competent input, trial management and data collection by the Cooks themselves, participation by other members of the group has been very limited because of other priorities. One member of the group did establish a Satellite Research Site but because of labour pressures at harvest no data were collected.

At the time of this mid term review, the group with a focus on Ken Young's property had not planted an experiment but still had every intention to do so. They intend to assess the value of various soil amendments on the early growth of wax flower.

David and Olive Hockings' Research Site at Maleny was initiated in July 1998 with the experiment underway by August. The aim of this experiment is to assess the efficacy of sawdust in reducing nematode damage in a 'new' native flower species (*Platysace lauceolata*).

Door Consultants
Other DOOR consultants remarked on the level of inaction and lack of contact despite the very high level of enthusiasm apparent in participants at the conclusion of the March 1998 workshop in Toowoomba.

Activity
Most of the Queensland DOOR participants have not been very actively involved in DOOR research despite an almost unprecedented level of apparent enthusiasm at the conclusion of both initial DOOR workshops. Loss of enthusiasm and hence lack of action may be put down to timing of the research phase, more urgent tactical priorities in individual enterprise management, loss of commitment or diffidence in acknowledging the real value and relevance of the DOOR approach individual operations.

Empowerment
Those who initiated a research program did so with little problem and valued the process. They learnt what was involved in sound experimentation and the time it took. Their confidence in the conduct of similar activities grew.

Interdependency
The dependency mode of most participants seems to be the norm, with much of their action reliant on 'prodding' by the consultant. There were few cases where the grower actually took the initiative. There were exceptions to this general condition. Interdependency will only flourish when communication is good.

Ownership
Ownership and extreme satisfaction of the outputs created by the few individuals involved in a successful research program was very high. Ownership diminished when doubts were raised on the real commercial value of the DOOR approach.

Understanding
This is dependent on the level of understanding of the cultural system itself. Understanding of the research process requires an understanding of why the particular need for the research exists in the first place and then an understanding of how the research will resolve the problem. Without general grower participation it was very difficult to gauge how well participants understood the generalised research process or even the specific research topic.

Commitment
Commitment to the DOOR approach requires the research to be simple, with clear contingency plans, not costly, essentially risk free and of real value to the participant, as well as being rapidly resolved. The DOOR consultant has an important role in nurturing that commitment, but in a way that fosters the development of an interdependent operator rather than one who regresses into the dependency mode.

5.11 Critical Incident Report

At the second workshop in both states participants (growers and consultants) were invited to record the 3 most important highlights of their experiences with the DOOR project since it started, as well as recording the 3 issues that they felt most negative about. The raw data appears in Appendix 7. Comments, as actually written, have also been categorised in an attempt to elicit some common themes (see below).

Categorisation of Positive Perspectives of the DOOR Project

Value of the DOOR process

- Consultants becoming more aware of the real world.
- Results are very useful.
- Results can be used on your own property.
- Means of validating observations and assumptions.
- Realising the value of this style of research, especially given funding cut backs from R&D corporations and government agencies.
- We have learnt about the suitability of the DOOR process for industries in the early stages of their development.
- Suggested new lines of inquiry for me - eg. I think the results might have been different in a drier tougher year.
- Recognition of further outside influences (different water applications).

Research Process

- Gain some understanding of research methods.
- Setting up experiment and need for discipline.
- By discussing necessary resources and financial needs reduced the risk in the project.
- Greater awareness and understanding of experimental design.
- We have learnt about the suitability of the DOOR process for industries in the early stages of their development.
- The DOOR process can be effective if motivated, established growers are involved.
- It is gratifying to see interest in the concept expanding, eg. olives, DOOR Market Research for New Crops.
- This is probably the first time action learning principles have been applied to research training for non scientists.
- Proved what we had observed - good for self-esteem.

Empowerment

- Encourages me to improve my business.
- Learn a new way of working with grower groups.
- Stepping stone to other pieces of more basic research.
- Development of skill and confidence to apply methods to virtually any problem.
- Satisfaction and confidence in putting in place a trial that should yield valid results.
- DOOR members are willing to help themselves and are willing to work with AgWA.

Actual Results

- Trials were successful in longer stems being produced with certain fertiliser being added.
- Results showed that longer stems can be produced.
- Earlier flowering achieved.

Commitment

- By doing trials in a group less likely to give up.
- The fact that group members live close to each other and the experimental site meant that the trial was most likely to succeed in being completed.

Interdependence

- Meeting with advisors for technical help.
- Good cooperation between consultant and grower.
- As an extension officer being part of the DOOR process has taught me to listen more and to back off and let growers work through their own problems rather than trying to suggest immediate solutions.
- Interaction with consultants and specialists.

Facilitation

- The importance of the role of facilitator cannot be underestimated.
- Our facilitator has good people skills and a sound nutrition and statistics background.

Helping those who help themselves

- AgWA has been keen to help the Proteaceae Industry because of the involvement of DOOR members.
- AgWA are keen to help the Proteaceae Industry on a broader range of research topics because the industry is seen to be keen to help itself, ie. there have been 'big picture' advantages to the Protea Industry because of DOOR participation that were not anticipated originally.

Specific Value of Research

- Results can be used on your own property.
- Opportunities to customise investigations to crop and farm.
- Local focus that this style of research allows.

Interaction

- Opportunities to meet with others with similar interests.
- Discuss problems with others.
- Exchange of ideas.
- Exchange of information.
- Meeting with other growers for research.
- Working with people who are well known to each other meant a great rate of progress was possible.
- Meet and work with a positive group of people.
- Initial enthusiasm of group members for involvement in project.

Development of knowledge

- Better understanding of the plants.
- Better knowledge overall.
- Understand overall Protea Industry better.
- Got into areas of the culture of Australian native plant species.
- Experiments - something we needed to know.

Categorisation of negative perspectives of the DOOR project

(as written)

Problems

- There are problems with implementing the process with emerging industries.

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Preliminary information

- Some of the participants had not attended the preliminary briefing- this is an essential part of the process.

Questions

- Why should fertiliser be used?

Priority

- The interference the project has on the commercial routine, not being part of the normal production activity.
- Difficult to disentangle DOOR part of my responsibilities with my overall AgWA Protea responsibilities.
- Needed impetus to actually get to carry out measurements-time and priorities.
- Needed finalising at our busiest time of the year.
- Difficult to explain that more treatments means lots + lots of work - which was proposed to occur at harvest when commercial decisions will take over.

Commitment

- Remembering to do the job.
- We growers should have devoted more time to initial planning and aims of the trial.
- Hard to find the motivation to finish as there was no obvious differential result.
- People who dropped out may be turned off the whole process.
- Lack of commitment of some group members to respond to phone calls/faxes etc.
- I was disappointed with lack of uptake in Central Queensland.
- In some situations the process will only work because there is a committed consultant in place.
- Someone may need to act as a ‘transformer’ or ‘lightning rod’ in the process or else the momentum may not be sustained.

Time

- Time consuming.
- Time
- Time involved.
- Not having the time.
- Time to read information.
- Time for meeting.
- Time to conduct trials.
- Time taken for meetings and research.
- Great difficulty with finding time for trial.
- The imposition on time and labour - delays etc., additional costs.

Planning

- Should have planned what to measure and when better.
- Lack of convincing information on products being used in the trial.
- Distance problem.
- Uncertainty as to the direction to take-what was required.
- Trying to reduce the number of treatments.
- Unforeseen weather problems - (26ins).

Experimental Process

- Seems rather complicated.
- So far little feedback.
- No simple experimental booklet available.
- Keep the DOOR Manual simple.
- Fastback' nature of field trial left a few details unattended.
- Not easy to set up.
- Poor early understanding of 'internal (national)'DOOR objectives and procedures.
- Working in a group that has had very little experience.
- Fitting the research into a commercial operation-some growers need to develop an experimental area.

Consultant

- In some situations the process will only work because there is a committed consultant in place.
- Outside consultant offered conflicting advice.

Results

- The results may be seen as universal and taken as gospel even where different conditions (eg. water quality, weather, etc.) may give quite different results.
- Lack of results from experiments.
- Results are very slow in coming.

5.12 DOOR Presentations

Experiences in the initiation, development and promulgation of the DOOR concept have provided the basis for a total of 7 invited presentations by M.N.Hunter of a paper entitled '

The DOOR way to grower led research.
(Appendix 9).

Audiences included

- (3/11/1998) Staff at the Animal Research Institute, QDPI, Yeerongpilly
- (24/11/1998) Vegetable Team Workshop, NSWAg, Yanco
- (25/11/1998) Vegetable Team Workshop, NSW Ag, Richmond (Sydney Basin)
- (26/3/1999) Tick control strategy Workshop, ARI, Yeroongpilly
- (27/5/1999) Physiology Group Workshop, Queensland Horticultural Institute, QDPI
- (15/9/1999) Philippines Agricultural Extension Group
- (14/ 3/1999) Indian MANAGE Delegation (high level agricultural extension)

Synopsis
The paper acknowledges the range of people involved in the development of DOOR, outlines what DOOR is about, why it is of interest and what its role is. It comments on surveys of research awareness in the nursery and flower industries. It outlines what the focus of DOOR is and then makes a comparison between the transfer of technology model and the DOOR model. An introduction is given to the DOOR Manual, highlighting the practical use of the DOOR Implementation Cycle (the 10 steps of research). Examples are given of successful nursery DOOR projects. It introduces, with an example, the concept of using DOOR to piggyback creative research. It comments on how grower attitudes have changed as a result of their DOOR experience. An outline is given of DOOR training programs, what has been done and current activity. It closes with the DOOR mission statement:
'to enhance the capacity of individuals and groups within industry to conduct their own in house research by enabling the most efficient use of complementary skills of experienced industry operators and trained professional consultants.'

Invited paper

How does the grower do their own research?
Hunter, Mal and McPhee, Greg (1999). How does the grower do their own research? Nursery Industry Association of NSW State Conference, Ballina-10 April, pp 1-8.

Abstract
Seventy-five percent of growers already do their own research. Much of this is based on observation alone with relatively little rigour or recording. Through the ***DOOR®* in Nurseries*** collaborative project (QDPI, QNIA, UQ, HRDC, NIAA, Hunter, 1996) with growers, we have developed and tested a research approach involving growers themselves. Solutions are found to simple questions (how much fertiliser should I add, which potting mix should I use for a particular Australian native?), with rigorous experimentation and reporting. NIAA endorsed training courses involve 2 one day workshops, each separated by a period of 6 months during which the grower does their own (or group) research project, with support and guidance from a DOOR facilitator (consultant). At the end of the course, the grower will be able to initiate their own research program, involving the consultant less and less (and thus less cost), as their own skill and confidence increases. Participating growers will be **A**ctively involved, develop their own research skills (**E**mpowerment), work **I**nterdependently with a consultant and others, **O**wn and control all the action, and from the outset, **U**nderstand what is going on.

5.13 A Compendium of Research Recipes

It was originally proposed to compile a DOOR Manual for the wildflower industry with a format similar to that of the *DOOR Manual for Plant Nurseries* (Hunter and Hayes, 1996). Feedback from participants was not supportive, requesting a document less formal, much smaller and focussed on a practical issue without too much theoretical 'stuff'. Thus, the recipe idea emerged, with a close analogy to what is included in a food recipe; essentially a step by step guide to establishing and managing an experiment. Such recipes would be complemented by reference to the *DOOR Manual for Plant Nurseries.*

The adjective 'recipe' research has been coined to contrast with 'creative' research. Recipe research may be regarded as a low risk activity, concerned with fine tuning the level or type of an input factor such as cultivar, fertiliser (their elements and forms), irrigation, soil amendments, growth control agents, herbicides, etc. Creative research is more about solving problems where the causal factor is unknown or is difficult to define.

* Do Our Own Research®

Thus, there may be much more risk in arriving at a solution with creative research. Such research has been the preserve of institutions able to accommodate that risk. This is not to imply that such research cannot be done by the grower, but rather that returns to creative research investment are less assured and therefore less attractive to those unable to afford or are averse to risk. By contrast, the inputs of recipe research can be well defined and outputs should almost invariably produce information that leads to better management decisions as well as new understanding. For example, a nitrogen rates experiment should clearly establish whether the current nitrogen practice (on which the rates are based) is deficient, adequate, excessive or even toxic as well as providing the basis for a more appropriate rate being applied..

The format for these recipes was developed by the group attending the second Queensland Operators' DOOR workshop and is outlined in Appendix 9. Four recipes have been developed and their titles appear below.

Proposed Research Recipes for the Wildflower Industry:
(Appendix 10)
Evaluating the effects of organic soil amendments on flower production.
Native species/cultivar selection.
How much nitrogen to apply to a wildflower crop.
How much water to apply (at two levels of nitrogen) to a wildflower crop.

Should these recipes prove popular it would be a simple matter to commission the writing of more with possible government support. It would be desirable to include growers in this process. This first batch of recipes have not been 'road tested' and should be fine tuned as a result of operator experience and upgraded to take into account changing technology and knowledge of the species that is grown.

6. Discussion

6.1 Answers to the four questions (objectives)

Can growers maintain their commitment to research at a high enough level to ensure successful statistically sound experimentation?

Results from this project clearly indicate that quality data sets were collected from 2 groups, 2 family operations and a single operator. Analysis of these data showed significant effects of the various treatments examined at a number of sites. Research is continuing at these sites beyond the context of this project, again indicating that the original commitment is being maintained by a number of individuals. Of the 49 participants who attended the first series of workshops in Western Australia and Queensland, 27 actually established experiments, as groups or individually. Of these, a total of 18 (38%) participants were involved in collecting data that could be statistically analysed.

Is the level of ownership and personal responsibility encouraged by the DOOR approach sufficient to generate that level of commitment needed for success?

'Members of all active groups in Western Australia said that they felt a strong ownership of the trial through their individual contributions towards its success. All have had an input to decisions through their meetings.' Digby Growns. Ownership and extreme satisfaction of the outputs created by the individuals involved in a successful research program was very high. In 1 case, outcome of an experiment is now being promulgated to other members of the industry as the preferred cultural management for the particular species being examined. Doing their own thing gave growers the opportunity to customise their investigations to the crop and the farm, with such a local focus that the results were directly applicable. However ownership diminished when doubts were raised on the real commercial value of the DOOR approach.

While ownership may be high, there is still substantial evidence of responsibility being more in the dependency mode (on the facilitator) in terms of meeting timelines, report writing and organising meetings. Indeed, 1 group indicated that it was quite critical to have the 'right' facilitator. Individuals working in a group were seen as less likely to give up on the research particularly when that group was drawn from the local community. One grower indicated the likelihood of diminished motivation in experiments where there was no evidence of any treatment effect. Concern was expressed that those who had been initially involved, but did not continue in the DOOR project, may now be turned off by the whole process.

What sort of training will the grower need to be confident enough to conduct effective research?

While some commented on the process as being rather complicated, growers may enter the DOOR program at a range of levels of training provided they are willing to learn on the job. However, such training must be kept simple and conducted at a pace appropriate to the group. Recipes have been developed that can be followed by those competent enough to run a small business and an ability to grow plants. 'The DOOR process can be effective if motivated, established growers are involved'. Initial input by a DOOR consultant would be very useful in the problem identification, project planning design and statistical analyses phases. Group training (a maximum of 7 per group), with the resultant benefits of group dynamics, would be the preferred mode with the inclusion of the opportunity for individual activity. This approach could utilise the concept of Focal Research Sites with Satellite Sites designed to minimise the costs of engaging a consultant.

What sort (and cost) of 'consultant' support will be necessary and how is this likely to change over time in supporting an ongoing DOOR program?

The dependency mode of most participants seemed to be the norm, with much of their action reliant on 'prodding' by the consultant. Such prodding still proved ineffectual with 1 group in getting a research project established. One group that was very successful in its research program believed that their consultant's considerable input was crucial to the group's success. While the input and enthusiasm of group members had exceeded expectations, the amount of specialist consulting input needed to realise the planned outcomes for the group has been greater than originally outlined in the DOOR concept. A large consulting input was invested to produce valid trial designs (following group concepts), check the scientific literature, contact relevant plant nutrition researchers and add to the interpretation of trial results.

The success of the above relationship may be compared with the withdrawal of another group from the project because of the difficulties encountered in developing the appropriate rapport between the group and their consultant. Difficulties in communication were seen as the core of the problem exacerbated by insufficient emphasis being given to drawing up of preschedules and contingency plans. It is now clear that much more attention needs to be given to developing the detail of the interdependency mode (roles and responsibilities) where the grower will succeed on their own account, seeking the input from other consultants if necessary. However, the dependency mode is attractive to the grower in the short term, but may not be viable in the long term as resources are withdrawn and officers (consultants) allocated elsewhere. The dependency mode still seems to be the norm in institutional led, on farm research.

There were a few cases in this project where growers actually took the initiative and succeeded with relatively little input from the consultant. In these cases, growers had previous research experience, with the confidence to implement the experimental program without consultant input. They were strongly motivated with the additional experience of personally knowing that this sort of research works.

Such was the conviction of one of the successful growers of the value of DOOR that he said: '*DOOR is a collaborative process, teamwork, between a skilled professional - the consultant - and the nursery or farm operator who will be assisted to become familiar with scientific methods and to carry out sound statistical research. DOOR is a move away from industry dependency on institutional research to industry self-reliance. It can provide customised information specific to a particular species or an individual business.*

I urge other growers to investigate the DOOR concept and where a problem exists, to initiate a DOOR trial. The knowledge that can be gained from DOOR projects could be of immense benefit to individuals and if approached on an open and co-operative basis, will be of further value to our industry generally.' (David Hockings, 5th Australian Wildflower Conference, Melbourne, 1999).

The costs of consultancy support can be expected to fall rapidly once growers become familiar with the simple recipe research approach. Within the space of 2 or 3 experiments it is expected that the consultant would focus on a telephonic advisory role, analyse data and provide a report. This will be much cheaper than the current formal consultant's activities in research.

It is easy to appreciate that the DOOR concept of grower empowerment and active participation in their own research will not be readily embraced by consultants themselves. At face value, a consultant could expect his/her client to need less service with time. This in fact may not be the case since each grower will probably do more research following a shift into a much more research oriented mode. Thus, the consultant could expect to service many more trials and many more clients. What is very important is that grower will not be paying

for consultants travelling and accommodation costs or costs of those research activities that the grower is quite capable of looking after themselves.

6.2 Shift in thinking

The outcome of the DOOR approach will be (already occurring in the nursery industry) a major shift in how growers think about problems in their enterprise and how they can find solutions. Their research results will be locally applicable, thereby eliminating the adoption barrier that exists with much new technology, as well as being generated at a small fraction of the costs previously associated with such research. The interdependent relationship between consultants and researchers will mean that consultants become 'more aware of the real world' and also become aware of 'piggyback' creative research opportunities. The 'piggyback' research outcome was an important feature of the Southern Protea Group's trial and an important contribution to the protea industry itself.

'The Southern Protea Group is very pleased with the way its version of DOOR is progressing, although it must be emphasised that the group has received considerable technical help from Mark Heap of AGWA. As growers have many deaths from Sudden Death Syndrome (probably Phytophthora cinnamomi) the next project will be trials to determine if it can be controlled with help from Murdoch University and AGWA.' Morris Cox, 5th Australian Wildflower Conference, Melbourne, 1999.

6.3 Trainee DOOR Consultants

The project may have proved somewhat frustrating for some of the consultants, a number of whom had been previously involved in their own hands on research. This frustration reflected their involvement in the facilitation role rather than a direction or leadership role that they were more familiar with.

One of the consultants was more involved in group activity than just in facilitation, and also carried out a component of creative research. His role was more in the traditional on farm research mode and proved to be very successful in project completion. It was clear that the group had become somewhat dependent on his input. Comments from the group that he serviced indicated that 'the importance of the role of facilitator cannot be underestimated'.

Digby Growns in his mid-term review suggested that *'indications from this (above) and other group activity in WA suggest that there are 2 options here; train the members to a higher level on the basics of 'simple' research, or provide a higher level of outside (consultant) involvement. The Southern Protea Group and the WA Wildflower Group have operated well on the latter, on the understanding that the increased contribution of the consultant should not lead to loss of control for members or leading by the consultant.*

The amount of specialist consulting input needed to realise the planned outcomes for the group has been greater than outlined in the initial DOOR concept. A large consulting input has been invested to produce valid trial designs (following group concepts), check the scientific literature, contact relevant plant nutrition researchers and add to the interpretation of trial results.'

6.4 Comparison of DOOR in the Wildflower Industry with DOOR in the Nursery Industry

While both the wildflower industry and the nursery industry share many common interests and utilise similar skills important differences exist. It is worth comparing these similarities and differences to explain in part the issues that may have to be addressed in the promulgation of the DOOR process of self sufficiency in recipe research. In the wildflower DOOR project,

38% (18) of the participants who commenced the course were successful in collecting data that could be statistically analysed. Of the initial 14 participants in the nursery industry pilot, 11 completed the DOOR course (Hunter, 1997).

Both groups had been heavily into observational research and most thought that inhouse research was important to the success of their business (79% for wildflower growers and 75% for nursery people).

The proportion of respondents that used reference material was almost identical with 67% of growers in both industries often reading articles.

It was clear that the focus of their own on farm research varied markedly between the two groups. Seventy one percent of wildflower growers were engaged in variety testing contrasted to only 4% with nursery people. Forty nine percent of nursery people had conducted work on media or pot environment related research while the issue of the growing medium (soil factor) was not even mentioned by wildflower growers. By contrast, both groups had been heavily involved in nutritional work (44% in wildflower and 36% in nursery). Both industries rarely engaged a consultant to do their research (10%).

Members of both industries rated nutrition as their most important area of future research need (59% for nursery, 58% for wildflowers). Wildflower growers then rated 44% for varieties, 39% for disease and pest control, 37% for propagation, 29% for herbicides and 27% for data resource base. Likewise, nursery people then rated 49% for water recycling, 41% for the control of pests, 41% for integrated pest management, 39% for potting media, 33% for propagation and 30 % for specified fungal control. Clearly, the 2 industries have some similar research needs but also some that are quite different.

The DOOR in Nurseries project was largely based around Brisbane whereas the Wildflower DOOR project covered 2 States (Queensland and Western Australia). Wildflower growers were farm based and geographically and environmentally widely spread, whereas nursery people were located in or close to a major city. Furthermore, wildflower growers had to contend with the constraints of in ground culture and the attendant site variability. By contrast, multiple replication and appropriate blocking could be very easily achieved with uniform media and irrigation in nursery production at a fraction of the cost of similar work in the wildflower industry.

All nursery participants attended meetings held at the same place and met with each other and all the consultants. By contrast, 8 meeting venues were used for wildflower growers and contact between participants and consultants was limited. Furthermore, nursery participants did not pay for their training and indeed, were presented with $200 worth of experimental materials and books. Wildflower growers were required to pay $300 for their course work but much of this was able to be refunded from support from elsewhere.

The results of this project suggest that the DOOR concept ought to be endorsed by the industry. However, its actual adoption will be determined by the condition of the individual grower. Many new growers in this relatively young industry have still to develop their growing system. The operational dimension of DOOR only becomes relevant when the system is in place and needs fine-tuning. However, the self help philosophy (AEIOU) advocated by DOOR is relevant irrespective of the maturity of the growing system.

While the DOOR process has been endorsed by Nursery Industry Association of Australia its apparent uptake rate has been slow. Time will tell whether a similar endorsement emerges from the national flower industry. Meanwhile, the concept is being implemented in the Australian Macadamia Industry research program and the Australian Vegetable Industry research program.

6.5 The DOOR Logo

The DOOR logo has been Trade Marked by the Queensland Department of Primary Industries (QDPI), being registered in 2 classes under the trade marks' legislation to signify:

- the provision of training and education in agricultural practices and procedures;
- the provision of information on agricultural practice to agricultural and horticultural businesses.

It was intended to use this logo on experimental reports to signify that appropriate experimental protocols were applied in obtaining the results. Such a mark is unnecessary with experimental work that is published in a reputable journal, since the review process is expected to screen out material that is not scientifically sound. However, in the case of DOOR experiments, many of which will be conducted to fine tune operations for a particular environment, this avenue of publication will be unlikely. Use of the logo on such reports would thus differentiate between these, based on good science, and those that are observational in nature and often of anecdotal value only.

Use of the logo could also indicate that the grower and consultant involved in producing the report were reputable, and that relevant data was accessible (where the report was made freely available) for scrutiny. The logo would thus provide some sort of quality assurance.

How the administration of the logo by QDPI will actually be managed is still being discussed.

7. Conclusion

A significant number of the participants in this project successfully completed their project work, but not without commenting on how much more time they spent than they originally envisaged. This identified the need to budget time, as well as finances, particularly at harvest. Potential clashes in priority need to be resolved in the planning stage. Because of the long term nature of some experiments some work will continue. One group is already embarking on a new research program.

The outcomes of some of these projects are quite significant in terms of their value to crop husbandry. This was a real bonus for the project in which the emphasis was on the process rather than on what was achieved experimentally. In one instance new knowledge is already being promulgated as a component of best practice for a new crop.

It has become apparent that there is a fine line between the concepts of dependency and interdependency. Excessive intervention by the facilitator, especially if the facilitator does not charge for their service, may encourage the client group to readily move into the dependency mode. While such a service is offered, such dependency may not jeopardise outcomes, but when its nature changes in or is withdrawn the client could suffer substantially. The DOOR approach promotes the conscious move away from the dependency mode.

The DOOR philosophy advocates continued experiential learning as a means of increasing confidence in the grower's own conduct of research, ultimately to the position where a facilitator is not needed. Part of this learning includes the grower accepting total responsibility for completing the work. While governments are involved in the DOOR process at no cost to the grower, it is unlikely that this shift in responsibility will ever be complete. However, the necessary shift of growers into the interdependency mode could be greatly encouraged if governments were to charge appropriately for their 'facilitation' role.

It is increasingly unlikely that governments will provide enough funds to the wildflower industry to underwrite more than just a fraction of the necessary research program. But improvements in the cultural systems for current and newly emerging wildflowers will be dependent on appropriate research. It is clear that the majority of such work is unlikely to be done by government in a site specific, and therefore relevant way to the individual. Individual grower research will thus underpin such improvement. It is believed that the DOOR approach, supplemented with easy to follow Research Recipes and consultant support is a cost effective option.

Grower perspective

Finally, it is appropriate to reiterate the statement of David Hockings, an authority on new species development and a participant in this project, *'I urge other growers to investigate the DOOR concept and where a problem exists, to initiate a DOOR trial. The knowledge that can be gained from DOOR projects could be of immense benefit to individuals and if approached on an open and co-operative basis, will be of further value to our industry generally.'*

8. Recommendations

- *That grower associations endorse the DOOR process as a relevant approach in the generation of site specific information for wildflower growers.*
- *That grower associations organise DOOR training programs in response to grower expressions of interest.*
- *That grower associations support grower assessment of the four DOOR recipes, providing feedback as required for recipe update, as well as commissioning additional recipes in response to demand.*
- *That grower associations develop a system that compensates the grower's cost of DOOR research where the findings of that research is applicable and is made available to a significant component of the industry.*
- *That grower associations endorse the use of the DOOR logo (Trade Marked by the QDPI) on all DOOR reports made available to the public to signify: that associated information was developed using best research practices , that the people who collected the data are known to industry and that the original data may be sourced and scrutinised.*

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10. Appendices

Appendix 1 *'DO OUR OWN RESEARCH'* IN THE WILDFLOWER AND PROTEA INDUSTRIES

QUESTIONNAIRE

Please complete this questionnaire whether or not you wish to be an active participant in the project. It will help us gain a clearer picture of the wildflower and Protea industry's attitude toward 'Do Our Own Research'.

Indicate your response to each question by marking the appropriate boxes with a tick. Names and addresses are optional **except** for those applying to participate in the workshop program or those who wish to receive reports on the progress of the DOOR project.

NAME: ____________________

ADDRESS: ____________________

____

____

Phone Fax

BUSINESS NAME: ____________________

1. What is the postcode of your business? (Even if given above.)

☐

2. Would you like to be involved in the Do Our Own Research workshops described in the accompanying letter?

☐ Yes, please register my application for one of the available places.

☐ No, not at the present time

3. I am prepared to pay $300 for my participation in the project

☐ Yes, please register my application for one of the available places.

☐ No, not at the present time

4. Would you like to be kept informed of the DOOR project's progress?

- ☐ Yes
- ☐ No

5. Would you mind telling us the age group to which you belong?

- ☐ Up to 35 years
- ☐ 35-50 years
- ☐ Over 50 years

6. Please list the specialist groups to which you belong (eg Protea Producers' Association, WA)

- ☐
- ☐
- ☐
- ☐
- ☐
- ☐
- ☐

7. In very broad terms could you please indicate what proportion (%) of your annual farm income would be derived from wildflowers and or proteas?......................

8. Do you expect to significantly expand the wildflower or protea component within the next two years? (Y/N)....................

9. Is experimental work carried out on your farm?

- ☐ Often
- ☐ Seldom
- ☐ Never ....**if so, please go to**

question 14

10. If experimental work has been conducted on your farm over the last three years, could you very briefly describe it? (eg. nutrition trial, variety testing)

....

....

....

11. Overall, how successful do you consider such work to have been?

- ☐ Very successful
- ☐ Successful
- ☐ Not successful

12. Who mainly conducts these experiments?

- ☐ You and/or your staff
- ☐ Consultant

13. (Answer against the questions below either Yes(Y) or No(N), or Sometimes(S) If you don't understand the question record DU)

Do you randomly distribute your treatments? (Y/N/S)...............

Do you replicate your treatments (how many usually) (Y/N/S).............

Do you block your treatments? (Y/N/S).............

Do you take objective measurements (height,weight etc) (Y/N/S).....................

Do you record your results? (Y/N/S)...............

Do you get the results statistically analysed? (Y/N/S).................

Do you write a report about your experiment? (Y/N/S).................

14. Could you please tick the items that you currently use on your farm?

- ☐ pH meter
- ☐ Fax machine
- ☐ Conductivity meter
- ☐ Telephone answering machine
- ☐ Computer used for stock control, accounts and budgets
- ☐ Computer used for irrigation, fertigation, daylength control etc.
- ☐ Accurate scales for weighing chemicals (to the nearest gram)
- ☐ Accurate liquid measuring cylinder (to the nearest millilitre)
- ☐ Tape measure (for plant heights etc)
- ☐ Hand lens
- ☐ Microscope
- ☐ Thermometer
- ☐ Rain gauge

☐ Others

15. How often do you use reference articles to aid you in your enterprise?

☐ Often (at least once a week)
☐ Seldom (at least once every three months)
☐ Rarely (at least once a year)
☐ Never

Do you access information from GrowSearch Australia? (Y/N)

16 Could you describe your core business?(eg mixed farming)

17. How many full time staff (or full time equivalents i.e., two half time casuals = one full time equivalent) do you regularly employ? Please place number in box.

☐

18. What term best describes your operation?

☐ Production
☐ Wholesale
☐ Retail
☐ Wholesale/Retail
☐ Production/Wholesale/Retail

19. If you were in the position to be able to conduct 'in house' research or experimental work, how important would you consider it to be to the success of your business?

☐ Very important
☐ Important
☐ Not important

20. Please tick what you consider to be the six most important areas requiring research in the wildflower and protea industry on your farm.

☐ Transport
☐ Data resource base
☐ Clonal selection
☐ Alternatives to in-ground culture

- [ ] Transplanting
- [ ] Engineering and mechanisation systems
- [ ] Water recycling
- [ ] Herbicides
- [ ] Cultural practice and its relationship to plants
- [ ] Farm layout
- [ ] Planning for disease and hygiene control
- [ ] Integrated pest management/biological control
- [ ] Nutrition (including pH and conductivity)
- [ ] Varieties
- [ ] Soil type
- [ ] Spray damage
- [ ] Irrigation
- [ ] Beneficial soil organisms
- [ ] Disease control
- [ ] Pest control
- [ ] Propagation
- [ ] Cash flow
- [ ] Production costs
- [ ] Post-harvest
- [ ] Other - please specify ....

....

....

RETURNING YOUR QUESTIONNAIRE

Please return your completed questionnaire in the envelope provided. No postage stamp is required.

It would be appreciated if your completed form could be returned by...................................

Thank you for your time and cooperation. The results from this questionnaire will ensure that an appropriate group from the wildflower and protea ndustries are involved in developing the 'Do-Our-Own Research' concept.

Appendix 2 Details of DOOR courses

DOOR Awareness Seminar

This presentation commences with a graphic example of how growers can be convinced by a pseudo-scientific scam that ‘novel’ (but worthless) technology is worth adopting. This is followed by an examination of the need for research, outlining how different sorts of research are carried out, concluding with an overview of what statistically sound research entails.

A report is given on the HRDC supported feasibility study (NY 404) in the nursery industry and the success that a group of operators who participated in that study had in carrying out their own research. As an example, one of the experiments conducted in the feasibility phase is discussed in some detail. The participants are introduced to a simplified version of the DOOR implementation cycle and the DOOR Manual for Plant Nurseries. The content of the Operators Course is outlined and then participants are told about the likely future of DOOR, how actual consultancies will operate and what they achieve in becoming accredited DOOR operators or consultants.

DOOR Growers’ Course

This course introduces the participant to the philosophy of participative action management and action learning as a basis for the DOOR concept. The DOOR Manual for Plant Nurseries will be used as the reference text (Available GrowSearch Australia, Centre for Amenity Horticulture, Redlands Research, PO Box 327 Cleveland Q4163). The Manual provides the detail of the Implementation Cycle, in both full text as well as in dot point form. Appendices contain worked examples of experiments and blank experiment preschedule that can be photocopied and used in setting up experiments, as well as other useful information.

The course then proceeds to cover in a chronological way elements of the full DOOR Implementation Cycle. Group work, with one Trainee Consultant for every three growers will involve hands on experience with a simple course experiment as well as preliminary discussion about the experiment they will conduct in groups and by themselves following the first workshop.

At the second workshop (about twelve months after the first) participants and trainee consultants will report back to their group about their experiences. Outstanding elements of the DOOR Implementation Cycle will then be covered. A formal report, based on a proforma in the appendices with a worked example, will be completed for individual and group experiments (see Appendix 4).

DOOR Consultants’ Course

This course has been designed for tertiary qualified horticultural consultants eligible for membership to Australian Institute of Agricultural Science and Technology (AIAST) or equivalent and with proven research competence as outlined in an appropriate portfolio. The participant was introduced to the DOOR concept and the underlying PAM philosophy adopted in the generation and adaptation of research information, in contrast to the more familiar linear dependency mode. The DOOR Manual for Plant Nurseries will be used as the reference text (Available GrowSearch Australia, Centre for Amenity Horticulture, Redlands Research, PO Box 327 Cleveland Q4163).

The DOOR Implementation Cycle in the Manual and the consultants role in it are outlined. Statistical requirements in the conduct of DOOR experiments are discussed, with information on the availability and use of statistical computer packages being provided. The use of backup statistical consultancy support to the consultants themselves is highlighted. The first part of the course will conclude with discussions on how consultancies may be carried out,

what sort of charges should be applied and how consultants could facilitate research information flow within the wildflower industry.

Prior to full accreditation as DOOR consultants, participants were further required to attend the two days (two workshops about twelve months apart) of a DOOR Operators' Course as a *Trainee DOOR Consultants*. In an action learning mode, they will provide consultancy advice as related to the research process, input and guidance to participating growers.

Outline of DOOR Courses

A) DOOR AWARENESS PRESENTATION

- **Welcome and self Introduction**
- **A scenario-** *Michael McMaster markets Magic Muck*
- **What is DOOR-** self help research
- **Research questionnaire results**
- **What does DOOR involve-** a major shift in our thinking (a paradigim shift)
- **Why the need-**
  - decline in the research dollar
  - decline in institutional dollar
  - a focus on specific rather than generic
  - what do we mean by research-
  - definition
  - types
  - comparisons
- **Statistical research** the rules
- **The DOOR approach**
  - transfer of technology-the linear model
  - participative action management
  - action learning
  - the DOOR Manual
  - the DOOR implementation cycle
- **The sorts of experiments**
  - list of experiments
  - a case study -the Hickey Experiment
- **The impact of DOOR**
  - impact on one participant- an example
  - mid-project questionnaire
  - AEIOU
- **Application of DOOR to your industry**
- **Similarities and differences to the nursery environment**
  - experimental units (pot, inground, others)
  - plot size
  - simplicity of experimental design
  - environmental variation and control
  - generic versus specific information need
  - location of enterprise
  - availability of "DOOR"consultants

- **Our approach in the Wildflower Industry**
  - 2 workshops 12 15 months apart
  - 2 states (Qld and WA)
  - 2 training sites/state
  - 2 Focal Research Sites/training site (one major experiment)
  - 5 satelite research sites /training site (five integrated experiments)
  - 6 people /FRS, plus at least one trainee consultant /FRS

Thus there will be 4 major experiments per State with 20 complementary experiments per state.

Research Recipes specific to the industry will be published, to complement the DOOR Manual

B) Consultants' Course

- The Context of DOOR in Industry
- The DOOR concept-self help research
- PAM and Action Learning- the underpinnings of DOOR
- What sort of research?
- Examples of DOOR projects
- Problem/opportunity identification-brain storming and prioritisation
- The DOOR Manual
- The role and responsibilities of DOOR consultants
- Statistical packages
- Types of consultancies
- Role in Operators Workshop
- Reflection

C) First Operators' Workshop

- The DOOR concept
- The DOOR environment-active participation and action learning
- The DOOR Manual for Plant Nurseries- its value to, and use by nursery operators
- Benefits and costs of experimentation
- Demonstration experiment-hands on
- Your own experiments keywords
- Information gathering
- Accessing information from GrowSearch
- Experiment discussion
- Results of Demonstration Experiment
- Finalising commitments for future experimental activities

D) Second Operators' Workshop

- What is happening with DOOR around the traps.
- Critical incident report-3 positives and 3 negatives each, about DOORrelatedactivities in the last 12 months
- Presentation of experimental results and take home points
- The identification and development of Research Recipes
- Select from industry identified activities (eg):
  - Steps in problem solving;
  - Group participation (brain storming) etc;
  - Costs/benefits of research;
  - How to interpret results

Appendix 3 Course work experiments

Influence of moisture content of medium on germination and early growth of sorghum and radish.

Operators

Emerald Bruce and Fay McCauley, Garry and Linda Scofield, Lloyd and Sandra Ingleton, Alenna and Doug McMah,and Cecilia Parker.

Toowoomba Ann Fitton, Max Lampo, Esther Cook, Nigel and Marian Dunchue, David Sheiton, David Wilderspin, Ken Young, Gloria and Neil Bale, Olive and David Hockings, George Hendrick, Kerry Cumner, Paul Blinco, Doug McCallum, Peter and Coralie Blackwood,and Bob Grieve.

Trainee DOOR consultants

Emerald Bill Pumpa, Nora Brandli, David Midmore, Rex Grattidge,

Toowoomba Alison Fuss, Andrew Griffin, Peter Beal, Lois Turnbull, Peter Vance,

Trainers

Cynthia Carson and Mal Hunter.

Method

Aim

- to examine how the germination and growth of sorghum and radish in a potting media medium is affected by moisture level.
- compare the relative sensitivities of germination number, root and shoot growth to moisture level.
- to establish whether there was a detectable environmental gradient across blocks.

Design

Six treatments, that included a factorial combination of two species and 3 levels of moisture in two media, were examined at Emerald and Toowoomba.

Treatments

Treatments were replicated four times and randomly distributed in blocks. Water was added to the media to give moisture contents of 39, 72 and 84 % in the sand bark mixture (Emerald) and 11, 32, and 55% moisture content (Toowoomba) (oven dry basis).

Operation

100ml of each medium was placed in a 500ml round plastic container Twenty seeds of each species (Radish cv Radar and Sorghum cv.Forager) were placed about 5 mm deep in the layer of medium. The plastic containers with lids attached were placed in a controlled temperature (28C) with day/night lengths of 12 hours for three and a half days prior to being transported to the workshop venue and examined at the end of the 4 th day.

Duration of the Experiment

Start:Emerald 17.2.98 -21.2.98 Toowoomba 1.3.98 -6.3.98

Measurements

Number of germinated seedlings and length of shoot and root *Toowoomba - number of seedlings with root development above the medium (Popovic response).

Results Emerald

Germination

Saturated media (100% WHC=55%) significantly depressed germination in both species but significantly more so in sorghum than in radish (SPXM sig $P<0.05$) (Figure 1, Table 1). The middle moisture level (72%) tended to reduce germination in sorghum but not in radish. Mean germination was significantly less in sorghum than radish.

Shoot Length

Sorghum produced significantly longer shoots than radish (Figure 2). However, shoot length was not significantly affected by moisture content of the medium.

Root Length
Increasing moisture content significantly reduced root length in both species but much more so in radish than sorghum under saturated conditions (P for SPxM<0.01) (Figure 3, Table 1). Mean root lengths of sorghum exceeded those of radish (P<0.5).
Shoot: Root ratio
This ratio was increased by increasing media moisture content and in particular by the saturated conditions (P<0.01) (Figure 4, Table 1). The ratio did not differ significantly between species.
Coefficient of Variation
The shoot root ratio was the most variable, mean root length least variable and germination number and shoot lengths being similar and intermediate (Table 1).
Sensitivity to increasing moisture level
Shoot length was not affected by moistuire content. By contrast saturated media severely depressed germination especially in sorghum, as well as depressing root growth especially in radish.
Block effects
There appeared to be no significant block effects in any of the variables (Table 1) thus ruling out the presence of gradient effects or differences among operators in data collection.

Results Toowoomba

Germination
Other than a severe depression in sorghum in germination at the highest moisture level, germination was otherwise not affected significantly by varying moisture contents. On average germination in radish was significantly greater than in sorghum (Figure 5, Table 2).
Shoot length
Sorghum shoots were significantly longer than radish. Shoots were shortest in the driest medium and longest at the intermediate moisture level. Species did not vary in their response to increasing moisture (Figure 6, Table 2).
Root length Moisture
content significantly depressed root length in radish whereas only the wettest medium depressed root lengths in sorghum (Figure 7, Table 2).
Shoot: root ratio
This ratio was very low in radish in the driest medium increasing some 8 fold in the wettest medium. Similar trends but not so extreme occurred in the sorghum (Figure 8, Table 2).
Popovic response (PR)
Increasing moisture contents significantly increased the number of seedlings exhibiting root extension above the medium (PR) rather than within it. Radish seedlings appeared far more susceptible than sorghum to PR.
Sensitivities to increasing moisture
High moisture content depressed germination in sorghum and root length in radish.
Block effects
Replicate (block) values of all variables did not vary significantly.
Coefficient of variation
Variability of data (coefficient of variation) increased in the order S:R ratio < root length < germination < root length (Table 2).

Interpretation

Both experiments illustrated well that radish and sorghum vary considerably in their reaction to moisture content of the medium, in terms of germination (sorghum) and root growth (radish). These negative responses of either sorghum or radish to high moisture conditions may be interpreted in the toxicity test as a reaction to toxicity, rather than being caused by excessive moisture. Clearly in this case they are not.

Because the moisture status of media used in the standard toxicity test is poorly defined, it is conceivable that low germination in sorghum or poor root growth in radish may be due to high moisture content of the medium rather than implied toxicity. To ensure that media used in the test are not overly wet we suggest the mixing of equal parts of media, one part fully wet up (100% water holding capacity) and the other as received. This will give an intermediate moisture content more suitable for testing. Note that nutrients should be added in the process of wetting up the medium.

The shoot: root ratio increased in both species as moisture content of the medium rose, with the greatest range occurring in radish. This ratio may be useful as an indicator of excessive moisture content and hence establish the validity of the toxicity test. Thus a 'toxic response' maybe qualified on the basis of this index.

Proposed recommended action

When setting up the Toxicity Test mix equal parts of saturated media (no free water) and media as delivered, rather than using saturated media. Use the root/shoot index as an indicator of excessively wet conditions.

Further experimental work

The interaction of known toxicity, (salt, organic) moisture and species needs to be further studied.

Other reports

Handreck and Black (1 994) Growing Media for Ornamental Plants and turf. UNSWP pp 259-277.

Sunshine Coast DOOR class Experiment (27/11-10/12/97). Inter-action between added chemical and moisture level on the germination and 4 day growth of sorghum, cv Forager (DOOR course 1998 booklet).

Table 1. **Statistical information from the analysis of germination, shoot and root responses of radish and sorghum to increasing media moisture contents (Emerald DOOR class 21/2/98)**

	CV%	Factor	Prob-ability	LSD 0.05	M %	Species (SP)		$\bar{x}$
						Rad	Sorg	
Sum of shoot length (cm)	20.55	SP	42	NS	39	83.40	103.50	93.45
		M	00	14.88	72	100.30	94.20	97.25
		SPxM	.01	21.05	84	56.40	27.90	42.15
		R	.08	NS	$\bar{x}$	80.03	75.20	
Sum of root lengths	15.56	SP	.0001	15.22	39	197.20	171.30	184.25
		M	.000	18.66	72	186.80	130.40	158.60
		SPxM	.149	NS	84	54.70	31.20	42.95
		R	.73	NS	$\bar{x}$	146.23	110.97	
Germination No. (ex 20)	18.73	SP	.000	2.05	39	19.2	16.6	17.9
		M	.000	2.51	72	19.0	14.0	16.5
		SPxM	.046	3.55	84	13.2	4.2	8.7
		R	.40	NS	$\bar{x}$	17.13	11.60	
Mean shoot length (cm)	18.8	SP	.000	0.80	39	4.37	6.24	5.30
		M	.29	NS	72	5.30	6.72	6.01
		SPxM	.73	NS	84	4.35	6.51	5.43
		R	.55	NS	$\bar{x}$	4.67	6.49	
Mean root Length (cm)	11.42	SP	.03	0.74	39	10.28	10.36	10.32
		M	.000	0.91	72	9.85	9.35	9.59
		SPxM	.002	1.28	84	4.14	7.04	5.59
		R	.42	NS	x	8.09	8.91	
Shoot root ratio	29.6	SP	.36	NS	39	0.42	0.60	0.51
		M	.001	0.20	72	0.54	0.72	0.63
		SPxM	.19	NS	84	1.09	0.95	1.02
		R	.55	NS	$\bar{x}$	0.68	0.76	

CV% = Coefficient of variation
NS = not significant $P<0.05$; R = replicate effect

Table 2. **Statistical information from the analyses of germination, shoot and root responses of radish and sorghum to increasing moisture contents in a peat/sand/gravel medium (Toowoomba DOOR Class 6.3.98)**

	CV%	Factor	Probability	LSD 0.05	M %	Species (SP)		$\bar{x}$
						Rad	Sorg	
Germination No. (ex 20)	23.09	SP	.07	2.72	11	15.4	18.6	17.0
		M	.008	3.33	32	18.4	16.0	17.2
		SPxM	.006	4.71	55	16.4	8.0	12.2
		R	.95	NS	$\bar{x}$	16.7	14.2	
Mean shoot length (cm)	25.45	SP	.00	0.77	11	1.55	3.50	2.53
		M	.00	0.94	32	4.12	6.66	5.39
		SPxM	.81	NS	55	2.81	5.10	3.96
		R	.65	NS	$\bar{x}$	2.83	5.09	
Mean root length (cm)	19.77	SP	.00	0.88	11	7.36	7.91	7.64
		M	.00	1.08	32	4.10	8.84	6.47
		SPxM	.002	1.52	55	1.64	5.16	3.40
		R	.99	NS	$\bar{x}$	4.37	7.30	
Shoot: root ratio	19.46	SP	.000	0.127	*11*	0.20	0.44	0.32
		M	.000	0.156	*32*	1.03	0.76	0.89
		SPxM	.00	0.22	*55*	1.73	0.98	1.36
		R	.62	NS	$\bar{x}$	0.99	0.73	
'Popovic' germination	95.27	SP	.005	1.38	11	1.00	1.40	1.20
		M	.201	1.69	32	2.40	1.20	1.80
		SPxM	.005	2.39	55	5.40	0.0	2.70
		R	.616	NS	$\bar{x}$	2.93	0.87	
'Popovic' mean shoot length (cm)	70.42	SP	.329	0.728	11	0.04	0.30	0.17
		M	.000	0.892	32	2.47	3.25	2.56
		SPxM	.007	1.26	*55*	2.09	0.00	1.04
		R	.45	NS	$\bar{x}$	1.53	1.18	
'Popovic' mean root length (cm)	93.17	SP	.19	NS	11	1.36	4.38	2.87
		M	.05	2.18	32	2.49	4.85	3.67
		SPxM	0.56	3.08	55	1.95	0	0.97
		R	0.09	NS	$\bar{x}$	1.93	3.08	

CV% = coefficient of variation NS = not significant $P< 0.05$
R = replicate effect

EMERALD CLASS FEBRUARY 1998

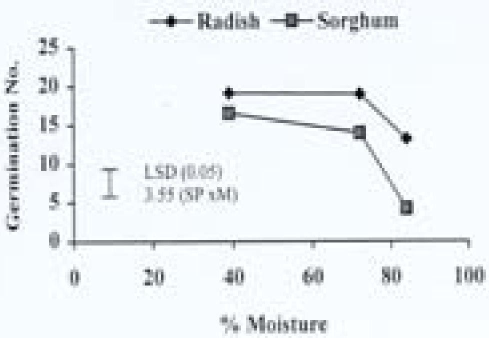

Figure 1
Effect of moisture content of a bark sand medium on germination of radish and sorghum.

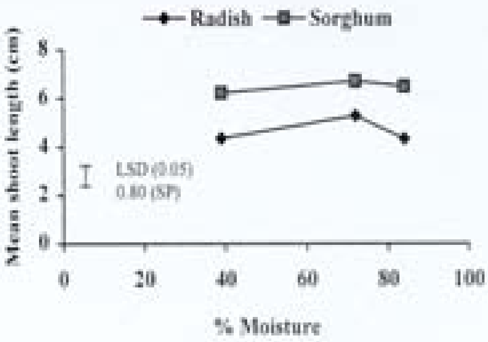

Figure 2
Effect of moisture content of a bark sand medium on mean bush of shoots of radish and sorghum after 4 days.

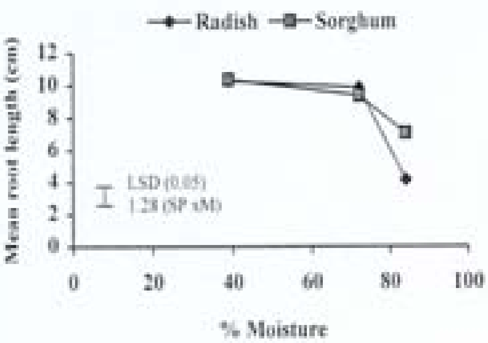

Figure 3
Effect of moisture content of a bark sand medium on mean length of roots of radish and sorghum after 4 days.

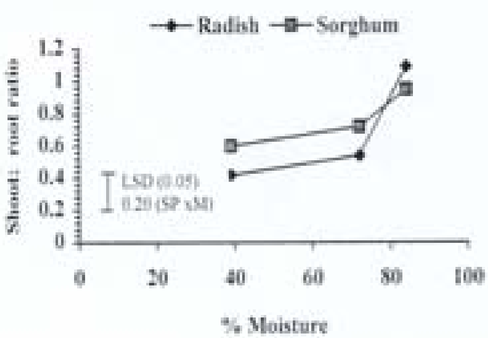

Figure 4
Effect of moisture content of a bark sand medium on shoot: root ratio after 4 days.

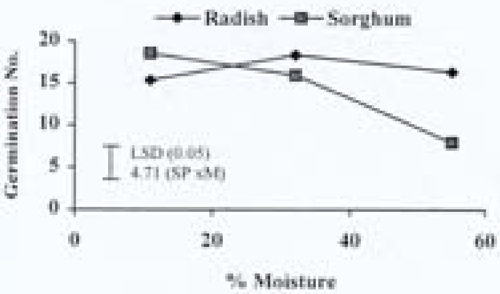

Figure 5
Effect of moisture content of a peat sand gravel medium on germination of radish and sorghum.

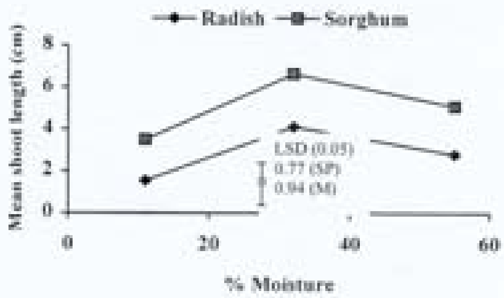

Figure 6
Effect of moisture content of a peat sand gravel medium on mean length of shoots of radish and sorghum after 4 days.

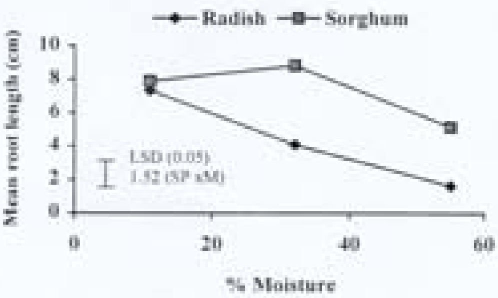

Figure 7
Effect of moisture content of a peat sand gravel medium on mean length of roots of radish and sorghum after 4 days.

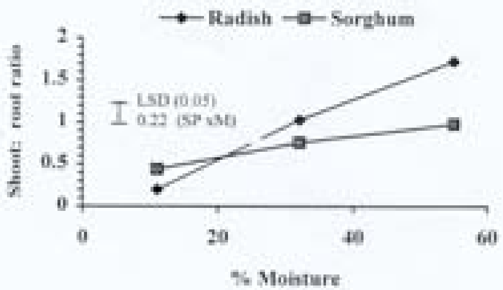

Figure 8
Effect of moisture content of a peat sand gravel medium on shoot: root ratio after 4 days.

Appendix 4 DOOR presentation and workshop evaluation

Scoring

Please place a circle around the value that you felt best described your impression on the particular aspect of the presentation. For example if you felt that too little time was spent on the presentation you would circle 1 against TIME, or 4 if it was about right and 7 if it was too long. Ring the intermediate values if your rating falls in between these descriptions. If you feel an alternative comment is applicable or you cannot remember enough to describe the aspect fill out the Comments column.

The Presentation on the Do Our Own Research approach.

Busselton or Perth (cross out inapplicable venue)

	Too little			**Just right**			**Too much**	**comment**
TIME	1	2	3	4	5	6	7	
CONTENT	1	2	3	4	5	6	7	
HUMOUR	1	2	3	4	5	6	7	
CLARITY	Confused			Average			Very Clear	
	1	2	3	4	5	6	7	
DELIVERY	Poor			Average			Excellent	
	1	2	3	4	5	6	7	
GROUP INTERACTION	1	2	3	4	5	6	7	
OVERHEAD TRANSPAREN CIESS	1	2	3	4	5	6	7	

Other Comments

Workshop on developing the DOOR experiment

Busselton or Perth (cross out inapplicable venue)

	Too little			Just right			Too much	comment
TIME	1	2	3	4	5	6	7	
CONTENT	1	2	3	4	5	6	7	
STRUCTURE	1	2	3	4	5	6	7	
CLARITY	Confused			Average			Very Clear	
	1	2	3	4	5	6	7	
DELIVERY	Poor			Average			Excellent	
	1	2	3	4	5	6	7	
CONCLUSION	1	2	3	4	5	6	7	
GROUP INTERACTION	1	2	3	4	5	6	7	
BALANCE	Too much presentatio n			Just right			To much discussion	
	1	2	3	4	5	6	7	

Other Comments

Appendix 5 Grower experiments

A) The effect of application time and rate of nitrogen on the performance and economic productivity of mature Leucadendron, cv Safari Sunset in the Busselton area.

Morris Cox's property

Participants

Jim Pollitt, John Daykin, Tom, Joan and Nick Antoine, Morris Cox, Wally Lewis, George Livingstone.

Trainee DOOR Consultant

Mark Heap

Summary

The effects of applied nitrogen (N) fertiliser rate and timing on harvested stem number, length and quality were investigated for ***Leucadendron*** cvv. Safari Sunset on a grey, acidic, siliceous sand in the Busselton area. N was applied fortnightly to plants as calcium nitrate between August and December in 1997 and 1998. Four rates of N (0, 25, 50 and 100 g N/plant) were applied using three schedules; "early" (August - October), "late" (October - December) and "all" (August - December).

Rate and timing of applied N did not significantly ($p<.05$) influence the length of harvested stems for the harvest seasons in 1998 and 1999. The application of N significantly increased the number of stems harvested and financial return from treated plants compared with control plants in both years. There is no evidence at this stage of reduced stem quality as a result of applied nitrogen.

Introduction

Commercial plantings of ***Leucadendron*** species have increased significantly in Western Australia, and are now the major source of income on many protea farms. Despite this, little reputable information is available to commercial producers on basic agronomic management. Plant nutrition, irrigation and pest and disease management strategies vary greatly between growers with a corresponding variation in plant performance.

The Southern Protea DOOR (Do Our Own Research) Group was formed in July 1997 to provide a framework for growers to plan and conduct their own research. The first project of the group commenced in August 1997, examining the effect of rate and timing of applied nitrogen on the growth and productivity of Leucadendron. This work followed anecdotal evidence from commercial growers of Leucadendron in the south west of Western Australia suggesting that improved productivity had been gained by the application of nitrogen fertiliser. An existing report of plant nutrition work on leucadendron in South Australia (Maier 1994) did not find significant responses to applied N, although the report notes that "For irrigated protea and leucadendron crops, annual applications of N and Ca up to 20 - 30 g/plant and Mg and K up to 10 - 15 g/plant should be considered on siliceous sands."

Materials and Methods

Site

The experimental site was located in a commercial protea plantation, owned and managed by Mr. Morris Cox at Metricup, about 20 k east of Dunsborough in the south west of Western Australia. The soil at the experimental site was an acid, siliceous sand. This soil type, commonly used for protea cultivation, is highly leached and infertile (Table 1). The climate at Metricup is Mediterranean, with cool wet winters and dry warm summers. Pest and disease control and irrigation management were provided by the grower. Irrigation was by drippers, two per plant, 60 cm apart, each dripper rated at 2

litres/hr. During the irrigation season (October to April) 4 litres per plant was normally applied each day from a nearby spring.

Table 1. Chemical characteristics of the soil at the Metricup trial site before treatment.

	Depth of sample	
Characteristic	0-10 cm	10-20 cm
nitrogen nitrate mg/kg ammonium mg/kg	3 8	1 3
phosphorus mg/kg (Colwell)	4	2
potassium mg/kg (Colwell)	50	19
sulphur mg/kg	12	4
organic carbon %	2.13	1.36
reactive iron	53	62
salt EC dS/m	.03	.01
pH 1:5 $CaCl_2$	3.8	3.7

Plants
Leucadendron cv. Safari Sunset plants planted in June 1995 were used. The plants, 1.2 m apart within rows and 3 m between rows, were two years old and in good health at the commencement of the trial.
Trial design and treatments
Ten treatments were replicated three times in a randomised complete block design. The treatments consisted of a Control (nil N) and three N rates (25, 50 and 100 g of N/plant) each applied over three periods ("Early" (E), "Late" (L) and "All" (A)).). The N was applied fortnightly between late August and late October for E, between late October and late December for L, and between late August and late December for A in 1997 and 1998.
Measurement
Measurements of the length of stems, number of stems and value of stems were recorded at a number of harvests between February and May in each year. In each year, average stem length, total number of stems and the total value of stems were examined using Analysis of Variance.

Nitrogen was applied as calcium nitrate (15.5% N, 20% Ca), the preferred choice of commercial growers in the area, who seek to avoid further acidification of the soil associated with other common forms of N fertiliser. The calcium nitrate was dissolved in water (100 g/l) and a measured volume applied around the trunk of the plants each fortnight to supply the amount of N for each treatment.

Cecil et al (1995) found that the major nutrients removed in harvested Leucadendron stems are N, Ca, K and Mg and suggested annual applications of Ca at 20 - 30 g/plant and Mg and K at 10 - 15 g/plant. Magnesium (magnesium sulphate, 30 g/plant), potassium (potassium sulphate, 30 g/plant) and a trace element mix (10 g/plant) were applied in August of 1997 and 1998.
Plant tissue, water and soil analysis
Leaf samples were collected from plants for nutrient analysis using the sampling procedure of Cecil et al (1995). The funds available did not allow for a comprehensive sampling program and treatments were selected for sampling to focus on areas of interest to the DOOR. Group. The samples were dried and sent for laboratory analysis.

A laboratory analysis was conducted in September, 1993, on the water from the spring used for irrigation of the trial (Table 2).

Table 2. Chemical analysis of water sampled from the property of Mr. Morris Cox (Metricup).

Characteristic	Value
pH	5.30
Conductivity @ 25 C (umho/cm)	280
Total dissolved solids (mg/l)	180
Potassium (mg/l)	1.8
Carbonate (mg/l)	Nil
Bicarbonate (mg/l)	5
Total Kjeldahl Nitrogen (mg/l)	0.65
Alkalinity as $CaCO_3$ (mg/l)	5
Ortho Phosphorus	<0.05

Soil samples were taken from the experimental site to examine changes in some soil characteristics for selected treatments

Results

Harvest data for the treatments

The effect of the various combinations of nitrogen rate and application time appear in Figure 1 (income/plant), in Figure 2 (stems/plant) and in Figure 3 (stem lengths) for 1998 and the same again in Figures 4, 5,and 6 for the same variables respectively in 1999.

Additional nitrogen was the only factor that had a significant positive effect ($P<0.05$) of increasing stem numbers and hence income per plant in both 1998 and 1999 (Table 3). Even though trends were evident, nitrogen rates above 25g/plant (50 and 100g/plant) did not consistently have large enough effects to meet the significance test ($P<0.05$). In 1998 the linear response to N rates almost had a significant effect ($P=0.10$) on the value of stems harvested. There is thus a trend for increasing value of stems with increasing rates of N.

There was no evidence to support the idea that a particular time of application (August-October, August-December, August-December) was the best option.

Table 3 Comparison of the effects of the all the nitrogen treated plots with the plots not treated with nitrogen on stem lengths, stem numbers and value in Leucadendron, cv Safari Sunset over two seasons.

Nitrogen addition	1998			1999		
	Av. Stem Length (cm)	Stem No. /plant	Value /plant ($)	Av. Stem Length(cm)	Stem No. /plant	Value /plant($)
Nil	53.4	35.7	5.67	61.2	49.7	8.97
N treatments	58.4	53.8	9.36	60.5	70.7	12.63
5% LSD[A]	7.3	16.2	3.3	5.2	16.3	3.28

[A]Least Significant Difference ($P=0.05$) is the value by which treatment effects need to differ to be deemed not due just to chance, at the one in twenty (or 5%)level of probability

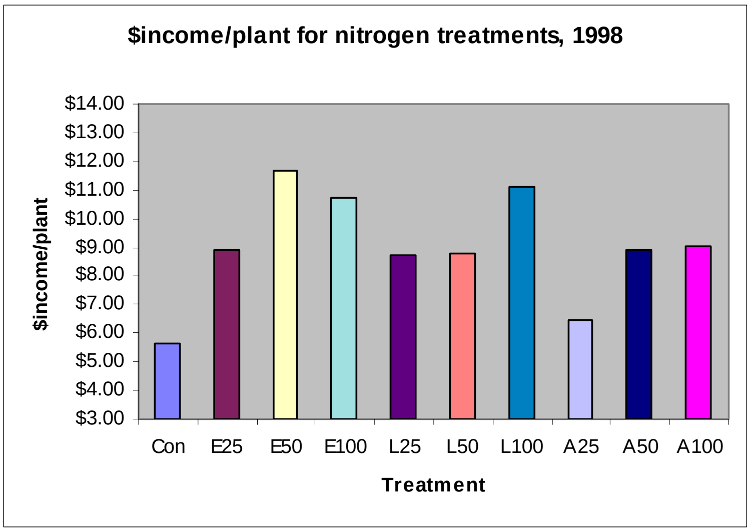

Figure 1 The effect of nitrogen rates (0, 25, 50 and 100g/plant) and application times (E=September-October, L=October to December, A=September to December) on the value of harvested stems in Leucadendron, cv. Safari sunset, in the 1998 season.

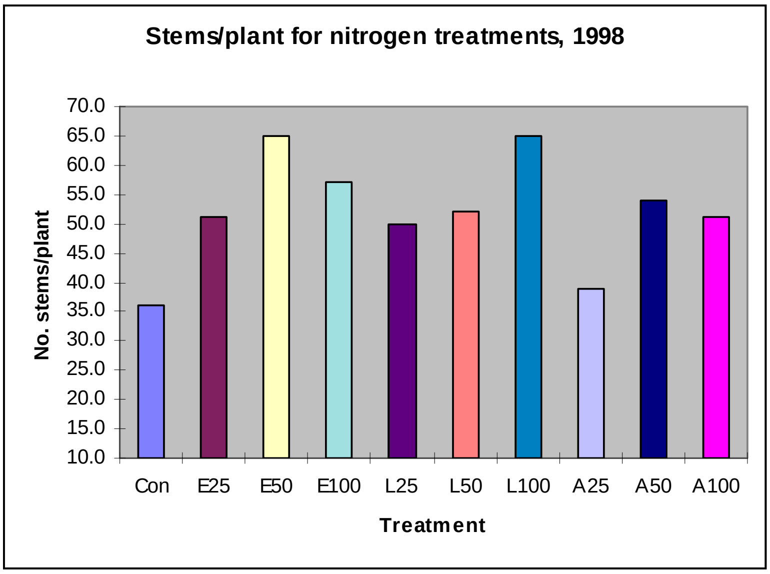

Figure 2 The effect of nitrogen rates (0, 25, 50 and 100g/plant) and application times (E=September-October, L=October to December, A=September to December) on the number of stems in Leucadendron, cv. Safari Sunset, in the 1998 season.

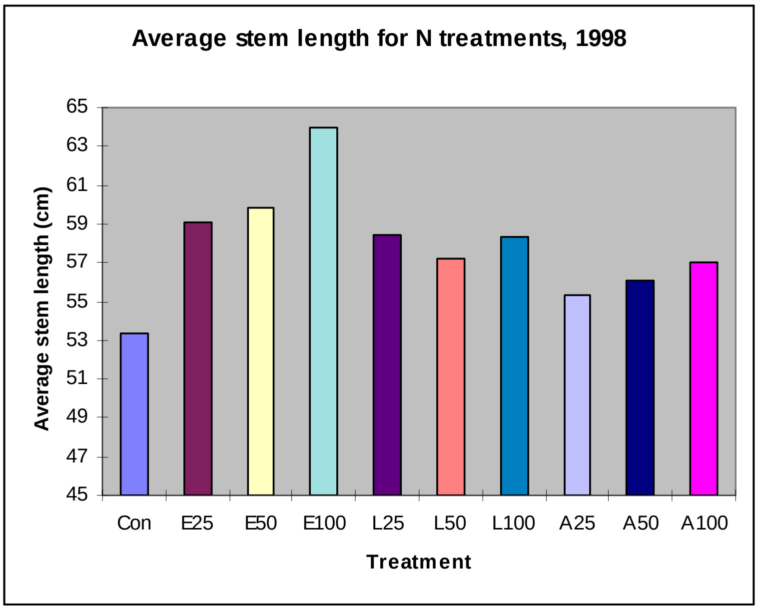

Figure 3 The effect of nitrogen rates (0, 25, 50 and 100g/plant) and application times (E=September-October, L=October to December, A=September to December) on the average stem length in Leucadendron, cv. Safari Sunset, 1998 season.

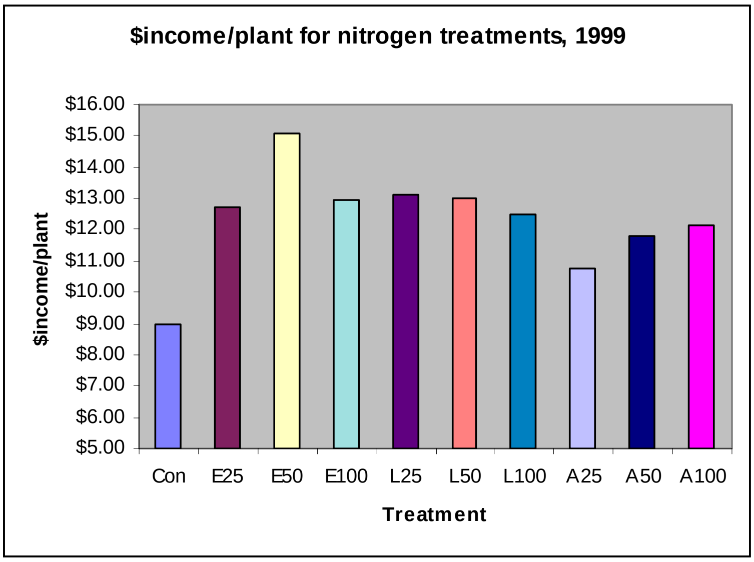

Figure 4 The effect of nitrogen rates (0, 25, 50 and 100g/plant) and application times (E=September-October, L=October to December, A=September to December) on the value of harvested stems in Leucadendron, cv. Safari Sunset, in the 1999 season.

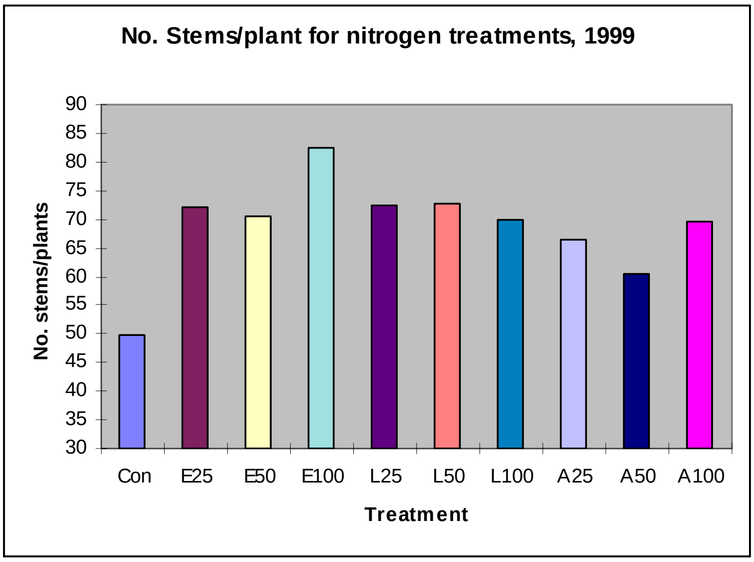

Figure 5 The effect of nitrogen rates (0, 25, 50 and 100g/plant) and application times (E=September-October, L=October to December, A=September to December) on the number of stem per plant in Leucadendron, cv. Safari sunset, in the 1999 season

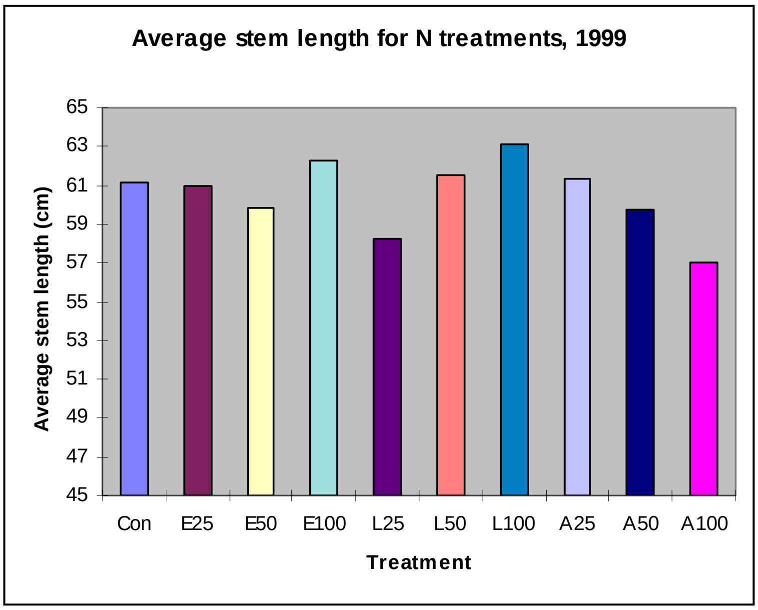

Figure 6 The effect of nitrogen rates (0, 25, 50 and 100g/plant) and application times (E=September-October, L=October to December, A=September to December) on the average stem length in Leucadendron, cv. Safari sunset, in the 1999 season.

Data on plant tissue (after Cecil et al., 1995). and soil analyses conducted on samples collected during the course of the experiment from a number of treatments appear in Tables 4-10.

Table 4. Plant nutrients measured in dry *Leucadendron* plant samples collected on 10/10/1997.

Trt.	N% total	NO_3 %	P %	K %	Ca %	Mg %	Na %	S %	B mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Zn mg/kg	Cl %
Con	1.19	<0.01	0.15	0.37	1.20	0.40	0.29	0.27	11	3.6	35	470	88	0.54
E25	1.27	<0.01	0.15	0.37	1.17	0.38	0.27	0.29	10	3.8	34	430	84	0.48
E50	1.44	<0.01	0.17	0.40	1.26	0.38	0.30	0.31	11	4.1	39	570	98	0.57
E100	1.42	<0.01	0.13	0.39	1.22	0.36	0.29	0.30	10	4.2	39	730	130	0.56

Table 5. Plant nutrients measured in dry *Leucadendron* plant samples collected on 28/11/1997.

Trt.	N% total	P %	K %	Ca %	Mg %	Na %	S %	B mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Zn mg/kg
Con	1.09	0.11	0.34	0.43	0.28	0.69	0.15	9	7.0	23	200	31
E50	1.36	0.12	0.35	0.50	0.26	0.57	0.14	7	5.1	21	250	33

Table 6. Total N measured in dry *Leucadendron* plant samples collected on 28/11/1997.

Trt.	Con	E25	E50	E100	L25	L50	L100	A50
N% total	1.09	1.24	1.36	1.35	1.20	1.12	1.34	1.29

Table 7. Plant nutrients measured in dry *Leucadendron* plant samples collected on 27/8/1998.

Trt.	N% total	P %	K %	Ca %	Mg %	Na %	S %	B mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Zn mg/kg
Con	1.02	0.09	0.29	0.70	0.26	0.33	0.18	10	2.8	44	200	30
E50	0.93	0.09	0.30	0.49	0.18	0.42	0.13	7	3.0	75	140	22
L50	0.95	0.10	0.28	0.41	0.16	0.42	0.12	7	3.7	42	110	20

Table 8. Chemical characteristics of the soil (0 – 20 cm) in samples collected on 10/10/97

Trt.	pH ($CaCl_2$)	K mg/kg (HCO_3)	NH_4 mg/kg	NO_3 mg/kg
Nil	3.6	110	10	6
E25	3.7	140	30	55
E50	3.8	80	32	100
E100	3.8	73	36	200

Table 9. Nitrogen measured in soil samples (0 – 20 cm) collected on 28/11/97

Trt	NH_4 mg/kg	NO_3 mg/kg
Con	26	2
E50	54	200
L50	34	96
A50	37	100

Table 10. Nitrogen measured in soil samples (0 – 20 & 20 – 40 cm) collected on 27/8/98

Trt	NH_4 mg/kg	NO_3 mg/kg
Con 0 - 20 cm	5	1
Con 20 – 40 cm	2	1
E50 0 – 20 cm	6	1
E50 20 – 40 cm	2	1
L50 0 – 20 cm	8	2
L50 20 – 40 cm	3	1

Discussion

This work was initiated following anecdotal reports (Pollitt, J. *pers. comm*. 1997) of yield increases for ***Leucadendron*** following the addition of N as fertiliser.

A literature search found that similar work had been conducted in South Australia by Maier et al. (1994), who examined the effect of N, Ca and K on the yield, chemical composition and nutrient removal by ***Protea*** and ***Leucadendron*** species. The field experiments were in commercial plantings in the Mt. Lofty Ranges and the lower South East of South Australia. The soil at these sites ranged from acid sands to loamy sand and silty loam and the climate is classified as Mediterranean.

This work in South Australia is in a similar environment to the work reported here. Maier et al. (1994) found that annual applications of N at 25 or 50 g per plant increased the total weight of stems harvested from King Proteas by 52 – 83% in 1992 and by 49 – 308% in 1993. They did not find a significant effect for N, K or Ca on the number or size of stems harvested for ***Leucadendron*** 'Silvan Red' or 'Safari Sunset'. Maier et al. (1994) applied the N as ammonium sulphate, an acidifying source, as a solid side-dressing under the plants in the August – October period.

In contrast to the report of Maier et al. (1994), this study found that stem number increased significantly ($P<0.05$) for plants treated with N. The treated plants also returned significantly more ($P<0.05$) income than the untreated controls. The average return of $9.36 in 1998 and $12.63 in 1999 for N treated plants compared with $5.67 in 1998 and $8.97 in 1999 for control plants translates to an increased return per hectare of $10,000 in each year. The study did not find a significant difference ($P<0.05$) between rates of N applied for stem number or income, although a trend for increasing income for increasing rate of N is apparent. The study did not find a significant effect for N and stem length.

Furthermore there was no evidence that nitrogen application time is critical. This suggests that the easiest of the three timing options be adopted.

The plant tissue sampling for nutrient analysis has provided valuable insight. Evidence of elevated levels of N were detected for treated plants compared with the control in October, two months after the start of treatments in 1997 (Table 4.). The level of total N in dry plant tissue recorded in this study (between 1.19 & 1.44%) are much higher than levels recorded by Cecil et al. (1995) in commercial plants in South Australia. Cecil et al (1995) obtained samples from ***Leucadendron*** over a 12 month

period and reported a range of 0.6 – 0.9% for N in samples taken in October, with a maximum value of 1.25% N recorded in November sampling.

A suggested annual cycle of nitrogen concentration in the leaves for Leucadendron at this site is compared with that of Cecil et al (1995) and appears in Figure 7. It is interesting to note that even the N levels recorded in untreated control plants (1.19% N in October, 1997, 1.09% N in November, 1997, 1.02% N in August, 1998) are high compared with the South Australian levels.

Whilst N levels rose in plant tissue following treatment in 1997 and 1998 (Tables 4, 5 & 6), the higher levels were not apparent in August 1998 before the commencement of the second year of N treatments. This suggests that the N treatments may not have a long-term effect in the leached sand. This idea is supported by measurements of soil nitrate. Tables 8 and 9 show much higher nitrate levels in the soil for treated plants (55 – 200 mg/kg) compared with the soil from control plants (6 mg/kg) in October and November 1997. However, sampling in August 1998, after winter rain and before second year treatments, found the soil nitrate level had fallen to 1 mg/kg for control and treated plants (Table 10).

The N levels recorded for the early (E50) treatment in October 1997 (Table 4) and November 1997 (Table 6) were as high as the E100 treatment on both occasions, despite much higher nitrate levels in the soil under plants in the E100 treatment (Tables 8 and 9). This may indicate that 100 g of N per plant, applied between August and October, is in excess of that required for maximum plant uptake of N.

This information on tissue nutrient concentrations and soil tests should be regarded as indicative only, since not enough material was sampled to allow any meaningful statistical analyses of these data.

Other nutrients measured in the samples did not show trends correlating with N treatment. In general, the macro and micro elements recorded at Metricup were at the high end of levels recorded by Cecil et al (1995) in South Australian crops. No serious nutrient deficiencies were evident.

Commercial ***Leucadendron*** crops should be productive for about 10 years, and are grown on a range of soil types in South West Western Australia. These results should be treated with some caution; since the trial plants are young, the treatments have been applied for only two years, and the effects may vary greatly with soil type. The long-term effect of applying N on ***Leucadendron*** plant longevity, health and stem quality is not clear from this study.

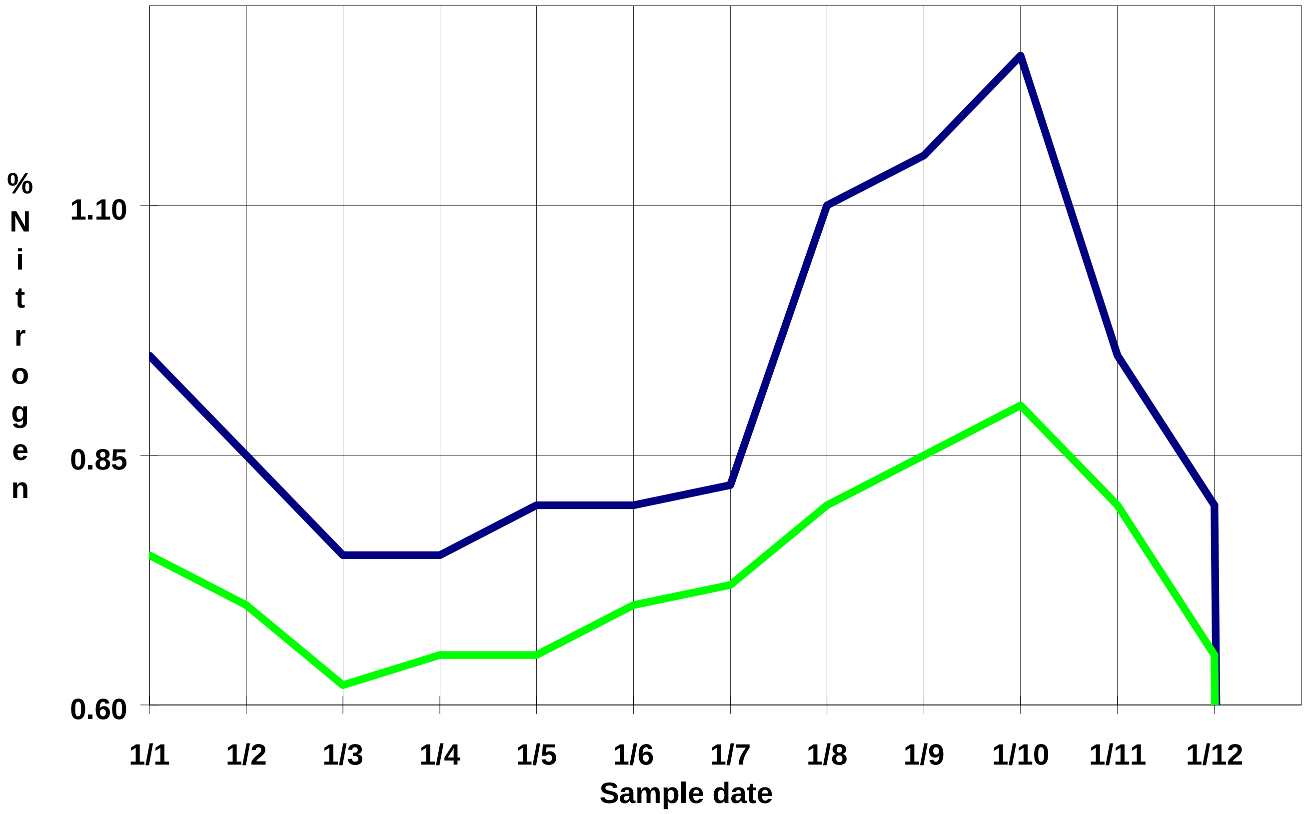

Figure 7. Suggested annual nitrogen concentration cycle in dry *Leucadendron* plant tissue samples for Metricup (upper line) compared with that proposed by Cecil et al., (1995).

References

Cecil, J.S., Barth G. E., Maier,N. A., Chvyl,W.L. and Bartetzko M.N. 1995. Leaf chemical composition and nutrient removal by stems of ***Leucadendron*** cvv. Silvan red and Safari Sunset. *Australian Journal of Experimental Agriculture* **35**, 547-555.

Maier, N.A. 1994. Development of nutrient management technology for improved quality, yield and post harvest life of Australian waxflowers (***Chamelaucium*** species), ***Protea*** 'Pink Ice' and ***Leucadendron*** 'Silvan red'. Final Report RIRDC # DAS 35A, Rural Industries Research and Development Corporation, Australia.

B1) The effect of nitrogen rates on the performance and economic productivity of young Leucadendron, cv Safari Sunset. Northern Protea DOOR Group (site 1)

Bruce and Claire Robin's Property- Robinbank

Participants

Ralph and Grace Sedgly, Bruce and Claire Robins, Helen and Kevin Moore, Ray Smith, Peter and Joy Kelly, Peter Cornock

Trainee DOOR Consultants

Chris Newell and Lachlan Duncan

Results and discussion

Plant Dimensions

The application of calcium nitrate did not significantly affect the height or width of the plants. No particular trends in plant growth seemed evident. It is possible the high degree of variation in the plants before the experiment would masked any possible effect of fertiliser application. .

Yield

Increased applications of calcium nitrate had no significant effect on the number of stems each plant produced. There seemed to be some trend of increasing stem number as applications of calcium nitrate increased, however there was a lot of variation associated with this data.

Increased application of calcium nitrate did not significantly increase the length of the stems yielded. There was no clear trend in the data that indicated some kind of non- significant response.

However, the timing of calcium nitrate application had a significant effect on stem length. A 'late or 'continual' (all) yielded a significantly greater stem length than just early applications. There was no significant difference between late or continual (all) applications of calcium nitrate.

This effect of timing of application was not evident in any other factors measured.

Comments

It is interesting that the increase in stem length due to late or continual applications of calcium nitrate was not also reflected in the height of the plants. It is likely that the high level of variation in plant height before the experiment might have 'masked' any growth response due to timing of fertiliser application.

B2) The effect of nitrogen rates on the performance and economic productivity of young Leucadendron, cv Safari Sunset. Northern Protea Group (site 2)

Grace and Ralph Sedgley's Property

Participants

Ralph & Grace Sedgly, Bruce and Claire Robins, Helen and Kevin Moore, Ray Smith Peter and Joy Kelly, Peter Cornock

Trainee DOOR Consultants

Chris Newell and Lachlan Duncan

Results and discussion

Plant Dimensions

An application of 100 grams of calcium nitrate significantly ($p < 0.05$) increased the girth of the Amarillo Proteas plants:

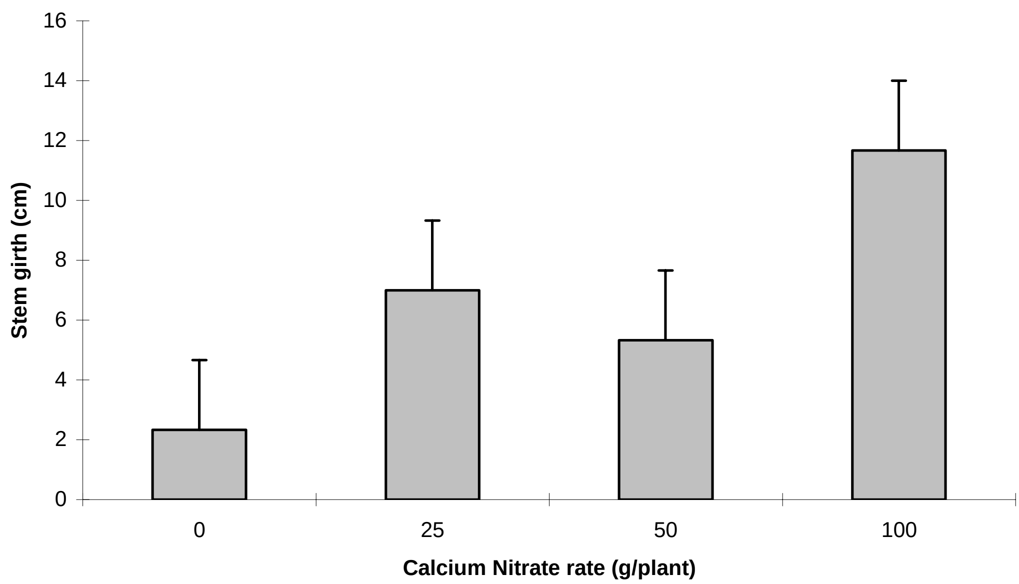

Figure 1 The effect of calcium nitrate application on stem girth of Amirillo Proteas.

This increase in plant girth did not mean there was a significantly greater number of shoots or stems (ie calcium nitrate did not significantly increase these factors). However, it is possible we might see a significant increase in stem numbers in subsequent years. However, this increase in girth possibly affected the length of the stems produced.

Yield

The application of calcium nitrate seemed to increase the length of stems plants produced. This can be expressed in a number of ways. An application of 100 grams of calcium nitrate per plant significantly increased the number of stems over 40cm. (saleable stems).

Calcium nitrate did not have a significant effect on the total number of stems on each plant. This would suggest the increase the number of saleable stems is due to an increase in stem length rather than number of stems.

Another way to look at it is the total length of stem obtained from each plant (ie add up the length of all stems). As might be expected, this measurement showed a similar trend: It was interesting that the width of the plants before the experiment had no significant affect on the results above.

Future

Encouraged by these results the group was eager to reapply the previous seasons treatments to the Focal Research Site. The method of fertiliser application was cited as a possible cause for the "noise" associated with last seasons Focal Research Site. More controlled methods for applying liquid fertiliser were explored by the group and summarised by me in the attached file. This is a good example of the group looking to continually improve the experimental method by using the ideas given to them by agricultural professionals and adapting them to their suit their own property.

The next round of treatments were applied efficiently and with little professional intervention - a testament to the enthusiasm and capability of the group. It should be noted that the Sedgly's did not reapply the fertiliser treatment as the plants were removed to make way for new varieties (this was unfortunate but a reminder of the realities of running a floriculture business).

When helping collect the latest results from the Focal Research Site at Bruce Robins property it became apparent that about one third of our trial plants were a different variety. The different structure of these plants will most likely mask any growth differences associated with the treatments. These differences were not so obvious to the eye in the first season of measurements although this might explain the great variation accompanied with this data. However, the same experiment was performed at Helen Moore's property and she reports that visually there would seem to be some substantial differences in plant growth. These data are yet to be statistically analysed and again it might show that the Satiellite Research Site gives the group the most useful results.

The group agreed it would be unproductive to reapply the same fertiliser treatments on Bruce Robins property although depending on the analysis of the latest results from Helen's property, the group might decide to make the focal site for this nutrition trial on Helen's property. Helen has expressed interest in having this sort of trial on her property.

Meanwhile the Northern Protea DOOR Group has expressed interest in joining with the Southern Protea DOOR Group in developing a project looking at the effect of mulch and soil treatments on the establishment and growth of new plants. It is encouraging that the Southern DOOR Group provided the stimulus for the development of this sort of trial, perhaps indicating their enthusiasm to be a part of the research process. The role that the Northern DOOR Group is to play in this trial is yet to be decided although they have all indicated their support for the concept.

Summary

The results of the 1997 - 1998 nutrition trial showed some interesting and varied responses of the *Leucadendron*'s to applications of calcium nitrate. Increasing applications of calcium nitrate seemed to have little effect on plant growth. However a late or continuous application of calcium nitrate seemed to yield longer stem lengths than an early application . By itself, this might have been a bit disheartening for the group however the plants at one Satellite Research Site on Grace and Ralph Sedgly's property showed a significant increase in plant width as well as stem length in response to calcium nitrate. This highlighted the importance of having additional Satellite Research Sites as well as the main group Focus Research Sites.

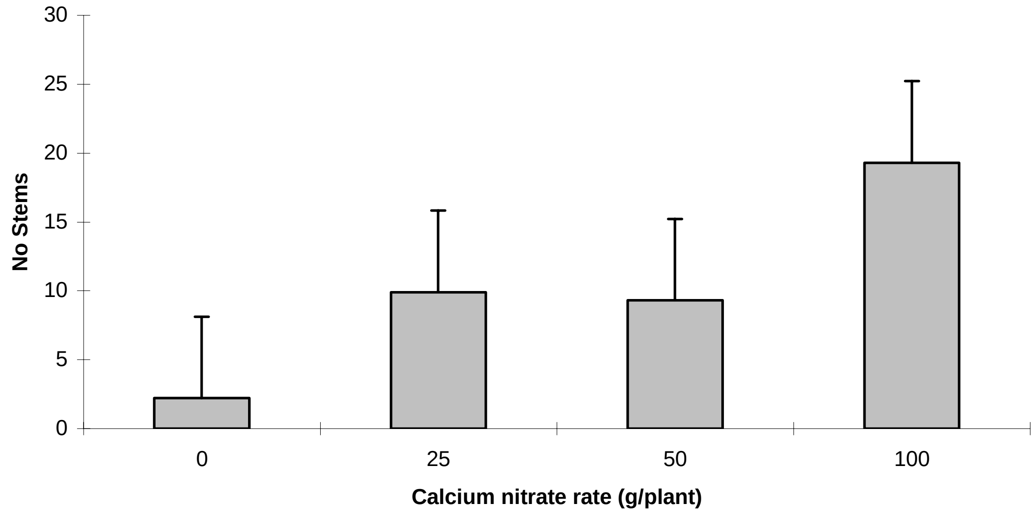

Figure 2 The effect of calcium nitrate application on the number of saleable (>40cm) stems of Amirillo Proteas.

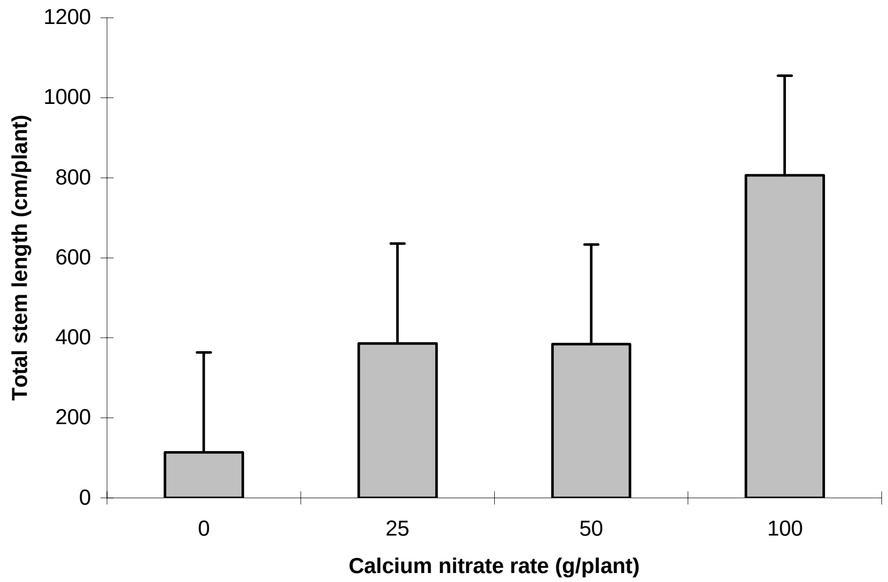

Figure 3 The effect of calcium nitrate application on the total length of stems per plant of Amirillo Proteas.

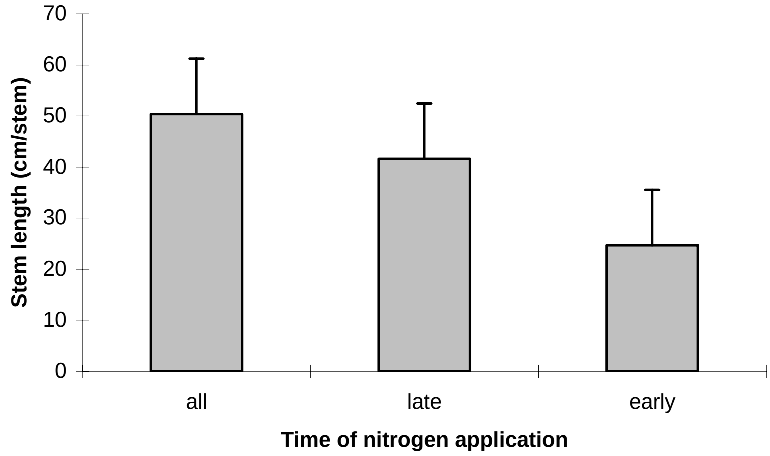

Figure 4 The effect of the timing of calcium nitrate application on stem length of Amirillo Protea.

C) A comparison of organic and inorganic fertilisers on the production and economic performance of Verticordia. Wildflower Group

Nina and Anton Foulkes- Taylor Property

Participants
Nina and Anton Foulkes-Taylor, Jackie and Ron Catto, Amy McCain, Gail Reading and Ida Southall

Trainee DOOR Consultants

Simone Cunneen, Neville Burton

Summary

D) The effect of foliar fertilisers on leaf colour, the retention of green leaves and the flower quality of two riceflower varieties

Esther and Graham Cook's property

Participants
Esther Cook, George Hendricks, David Wilderspin.

Trainee DOOR Consultant
Alison Fuss

Background.
The leaves of several riceflower (*Ozothamnus diosmifolius*) varieties, in particular Cook's Tall Pink, tend to go yellow just prior to flowering. This gives an unacceptable appearance of the stem when harvested and prepared for sale. In severe cases the leaves drop off which actually has the effect of improving the appearance of the former situation. It would however be preferable if green leaves were retained on the stem so that it appears fresh and healthy.

The pattern of yellowing (from the base up) suggests that it is the result of the mobilisation of nitrogen from the older leaves to the flower head. In riceflower iron deficiency shows up on the tips of shoots. Application of excessive nitrogen can lead to the development of growth through the main corymb resulting in a down grading of flower quality.

An experiment was conducted to see whether any of a range of proprietary foliar fertilisers could prevent the yellowing symptoms without reducing flower quality and enhance yields.

Method
Three propriety leaf sprays (Vital, Archem and Ca Dextro-lac) were applied to a mature riceflower crop as various times prior to harvest as outlined below. A urea solution was applied twice during the growing season. These seven treatments were compared with current farm practice as well as with a treatment where no spray was applied at all. Treatments were replicated six times and randomly allocated to six blocks. A single plant within each plot constituted the datum plant.

Treatments:
1=Vital (5ml/L) applied every 4 weeks;
2=Current farm practice PLUS Vital (5ml/L) weekly for the last 4 weeks;
3=Current farm practice PLUS Vital (5ml/L) weekly for the last 2 weeks;
4=Archem 750 (10ml/L) applied every 4 weeks;
5=Archem 750W (10ml/L) applied as in 4;
6= Ca Dextro-Lac (6ml/L) two-weekly;
7= Urea_ (7g/L) mid-March and mid-July;
8=No foliar fertiliser;
9= Current farm practice

Results.
Only one of the analyses indicated a significant treatment (Table 1). Without supporting results this could be put down to chance. Despite some probable limitation on datum size there does not seem to be any consistent positive and significant fertiliser effect from any treatment.

While averaged data suggests that there are big differences between some treatments the data is very variable and inconsistent. A goal in future work will be to minimise this variation.

A simple correlation matrix for each cultivar appears in Table 2. As expected Total Stem numbers are significantly related to the numbers in the various length categories. Plant heights are also related to total stem numbers and numbers in the various length categories. Growthru was significantly (P<0.05) negatively related to stem numbers of the 70-80cm category while being significantly (P<0.05) positively related to initial plant height. Leaf colour and leaf retention were highly (P>0.01) negatively related to each other, but only in the case of Snow White. Neither of these variables was related to any other variable.

Discussion.

This experiment has provided some very important base data on which to plan future experiments. Some of the differences between treatments were very large and although not significant should be examined further. Lack of significance when variances are high should not provide a basis on which to eliminate possible options particularly when their mean effects are large (eg Vital for total stems in Snow White, and Ca dextro-lac for total stems in Tall Pink.).

The very high coefficient of variation with many of the variables in the data is of some concern and may be reduced in future work by having two or more datum plants per plot, rather than just one (this observation is an important one in attempting to reduce variance). With both cultivars, data for stem numbers > 90cm long were skewed as was leaf colour, leaf retained and Growthru. Data transformations have not been conducted.

An appreciation of this comprehensive data set should allow the substantial reduction in data collection next time as well as a prioritisation on the variables themselves. Starting height was very useful as a covariate (significant reduction of error in 7 AOVs). Total marketable stems had relatively low cvs and was fairly sensitive to treatment effects. The scoring of Grow Through, Leaf Retention and Leaf Colour needs to be expanded, while acknowledging that they are difficult variables to score. With these subjective assessments there could be value in having the assessment conducted by 2 or more people. Corymb size was least responsive to treatment effects but required an inordinate amount of information. If essential, its collection should be limited to the most important stem category.

Unfortunately, this sort of data could lend itself to unscrupulous product promotion. For example in considering the Total Stems data set, 60 and 82% increases occurred for Snow White (SW) and Tall Pink (TP) respectively. Analyses were significant at the P<0.20 level for SW and at the P<0.10 level for TP. If these probability levels are accepted (a 'good' salesman would say that P<0.05 is far too conservative) then the seller of Vital could claim that for SW their product was significantly better than current farm practice (Trt 1 versus 9).

By contrast, the competitor who sells Ca Dextro-lac could claim that for TP their product (Tr 6) wipes the floor with Vital, 'significantly' out performing treatments 1, 2, and 3 , being treatments including Vital and best farm practice. In looking at the whole data set Tr 6 gave the highest value on five occasions (out of 21) and Tr 1 on four occasions. By contrast, Tr 3 didn’t score while Tr 9 scored the highest values only on one occasion. From the lowest value point of view in the whole data set, Tr 6 (Dextro-lac) was lowest on 5 occasions, while Tr 1 (Vital) was lowest only once. Couldn't the Vital and Dextro-lac salesmen have an interesting discussion.

This does raise the issue on who has unfettered access to this sort of data and its consequent 'use' or misuse. The owners of the information (the Cooks, RIRDC?) may place a restriction on its use (eg quoting out of context, selective reporting, reporting proprietal labels (eg Vital, Archem etc) and negotiate condition with those who want to use it. Ownership of and consequent entitlements to data use are an important questions and need to be thought through. Issues such as loss of competitive advantage and liberalisation of the 'facts' are two that spring to mind.

Summary
A range of foliar fertilizers were applied to rice flower to see whether the yellowing and shedding of the lower leaves noticed in the previous season could be prevented. Some of the apparent differences between the treatment effects on stem numbers was large but because of the variability of the data were not significant (P<0.05). Neither leaf colour nor leaf retention were affected by foliar fertilization. Baseline data will be very useful in planning future experiments.

Table 1 Effect of nine foliar fertility treatments on performance of riceflower cultivars Snow White(SW) and Tall Pink(TP) at Esther and Graham Cook's property in the Lockyer Valley, 1998.

Var	Cv.	Prb	Cv%	TREATMENT MEANS									LSD 0.05
				1	2	3	4	5	6	7	8	9	
H1	SW	0.35	8.5	108.0	108.8	104.5	**109.5**	106.5	**109.5**	107.2	108.0	96.8	10.6
H1	TP	0.40	6.3	**143.2**	141.8	141.2	142.2	136.3	132.7	136.2	134.7	136.5	10.0
H2	SW	No record											
H2	TP	0.21	3.77	204.8	204.6	202.7	208.7	200.3	205.6	205.7	**209.5**	197.6	8.99
M6	SW	0.55	46.5	**16.2**	10.5	10.8	11.8	10.5	10.2	12.0	12.8	9.2	6.3
M6	TP	0.07[c]	50.1	3.71	4.23	4.78	6.21	**9.47**	6.57	5.32	6.59	5.46	2.37
M7	SW	0.75	51.7	7.00	**8.67**	7.17	6.83	8.67	5.33	7.33	5.50	6.50	4.23
M7	TP	0.03[c]	42.8	4.63	3.48	3.68	4.30	5.60	**7.61**	6.10	6.68	4.58	1.80
M8	SW	0.43[c]	56.4	5.00	2.91	3.89	5.33	**5.50**	2.67	4.59	5.00	4.41	2.87
M8	TP	1.0	80.3	3.14	3.51	2.6	3.64	3.24	**4.07**	3.94	3.47	3.89	3.27
M9	SW	0.78[c]	109.4	1.57	1.18	1.47	1.13	1.17	0.30	**1.62**	0.90	1.16	1.49
M9	TP	0.22[c]	87.5	1.88	1.76	1.50	2.72	2.20	**4.96**	2.89	1.73	3.19	2.58
M1	SW	0.16	218.3	**0.83**	0.0	0.33	**0.83**	0.17	0.33	0.00	0.00	0.17	0.75
M1	TP	0.86[c]	135.8	0.98	**1.16**	0.53	0.48	0.59	0.59	0.43	0.50	0.58	1.02
TS	SW	0.18	28.8	**30.8**	23.7	23.3	26.5	26.0	19.3	25.7	24.5	19.7	8.2
TS	TP	0.09[c]	35.2	14.3	14.1	13.0	17.3	21.1	**23.8**	18.6	18.9	17.7	7.26
MC	SW	0.57	15.3	7.6	7.64	7.08	7.96	7.13	**8.56**	7.83	7.63	7.78	1.38
MC	TP	0.74	34.8	6.69	8.26	6.61	7.91	6.33	6.81	7.52	**8.54**	8.26	3.01
GT	SW	No record											
GT	TP	0.70	235.7	**0.83**	0.17	0.67	0.33	0.33	0.50	0.00	0.00	0.33	0.97
LR	SW	0.45	13.36	1.00	1.00	1.00	1.00	1.00	1.00	**1.17**	1.00	1.00	0.16
LR	TP	0.34	30.38	0.97	1.00	1.22	1.00	**1.38**	1.18	1.20	1.33	1.00	0.41
LC	SW	0.49	29.0	1.83	1.83	1.83	**2.00**	1.67	1.83	1.33	1.68	**2.00**	0.60
LC	TP	0.87	36.2	1.41	1.50	1.63	**1.83**	1.41	1.61	1.56	1.50	**1.83**	0.67

Highest values in each row are indicated in bold; [c] values presented are those after the covariate analysis of each variable with first plant height was found to significantly reduce error.
Var= variable; cult= cultivar; Prb= probability; Cv%= coefficient of variation; LSD= least significant difference(P=0.05).
H1= Height in March (cm); H2= Height in September (cm); M6= No of marketable stems(NMS) 60-70 cm; M7=NMS 70-80cm; M8= NMS 80-90cm; M9=NMS 90-100 cm; M1 = stems greater than 100cm. TS= total stem number; MC= mean corymb diameter (cm); GT= grow through (1=yes, 2=no); LR= leaf retention (1=yes, 2=no); LC= leaf colour 0= yellow, 1= light green, 2 = dark green.
Mean values should NOT be used to separate treatment effects unless the probability (Prb) statement is less than 0.05 (shaded row only). SW= Snow White; TP= Tall Pink.

Table 2a. Correlation matrix of growth and flower production variables for riceflower, cv. Snow White. PLTH is plant height (cm) in March, M60, 70, 80, 90, and 100 are marketable stems in the category 60-70cm up to >100 cm. SUMSTEM is the total marketable stem number, LEAFCOL is the green colour rating, LEAFRET is leaf retention and MEANCORYMB is the mean corymb diameter at harvest.

CORRELATIONS (PEARSON)

	PLTH1	M60	M70	M80	M90	M100	SUMSTEM
M60	0.1115						
P-VALUE	0.4222						
M70	-0.0507	-0.0185					
	0.7156	0.8943					
M80	0.3956	-0.0143	0.0289				
	0.0031	0.9184	0.8355				
M90	0.4134	-0.0758	-0.0322	0.4258			
	0.0019	0.5859	0.8171	0.0013			
M100	0.2574	-0.0857	-0.2230	0.2150	0.2886		
	0.0603	0.5376	0.1051	0.1185	0.0343		
SUMSTEM	0.3149	0.6963	0.4699	0.4820	0.3246	0.0664	
	0.0204	0.0000	0.0003	0.0002	0.0166	0.6334	
LEAFCOL	0.1788	0.0919	0.0850	0.0940	0.1011	-0.0233	0.1637
	0.1958	0.5084	0.5410	0.4990	0.4672	0.8671	0.2368
LEAFRET	-0.0688	0.0922	-0.0783	0.0876	-0.1086	-0.0573	0.0317
	0.6209	0.5075	0.5734	0.5288	0.4342	0.6808	0.8200
MEANCORY	-0.1104	0.0232	-0.1894	-0.0635	-0.0182	0.2861	-0.0760
	0.4269	0.8677	0.1702	0.6484	0.8960	0.0360	0.5847

	LEAFCOL	LEAFRET
LEAFRET	-0.4914	
P-VALUE	0.0002	
MEANCORY	-0.2320	0.0155
	0.0914	0.9117

CASES INCLUDED 54 MISSING CASES 0

Table 2b. Correlation matrix of growth and flower production variables for riceflower, cv. Tall Pink. PLTH1 andPLTH2 are plant heights (cm) in March and September respectively. M60, 70, 80, 90, and 100 are marketable stems in the category 60-70cm up to >100 cm. SUMSTEM is the total marketable stem number, LEAFCOL is the green colour rating, LEAFRET is leaf retention and MEANCORYMB is the mean corymb diameter at harvest.

	PLTHT1	PLTHT2	M60	M70	M80	M90	M100
PLTHT2	0.6353						
P-VALUE	0.0000						
M60	0.0135	0.1742					
	0.9229	0.2077					
M70	-0.0619	-0.0399	0.1918				
	0.6567	0.7747	0.1646				
M80	0.3954	0.2614	-0.0223	0.1597			
	0.0031	0.0562	0.8728	0.2487			
M90	0.3775	0.2923	-0.0965	0.1808	0.6245		
	0.0049	0.0320	0.4875	0.1907	0.0000		
M100	0.3650	0.4082	-0.0684	0.0182	0.4540	0.3045	
	0.0067	0.0022	0.6231	0.8964	0.0006	0.0252	
SUMSTEM	0.3318	0.3318	0.4490	0.5723	0.7392	0.6760	0.4177
	0.0142	0.0142	0.0007	0.0000	0.0000	0.0000	0.0017
MEANCORY	0.1167	0.0858	-0.2242	-0.0481	0.2671	0.0588	0.0514
	0.4007	0.5374	0.1031	0.7296	0.0509	0.6726	0.7122
GROWTHRU	0.2867	0.1220	-0.2087	-0.2713	0.1549	0.2296	0.1837
	0.0356	0.3796	0.1299	0.0472	0.2633	0.0949	0.1835

	SUMSTEM	MEANCORY
MEANCORY	0.0211	
P-VALUE	0.8795	
GROWTHRU	-0.0160	0.0900
	0.9088	0.5174

CASES INCLUDED 54   MISSING CASES 0

E) The effect of incorporated and unincorporated sawdust on the incidence of root nematode in Valentine Lace (*Platysace lanceolata*).

David and Olive Hockings' Property

Participants
David and Olive Hockings

Trainee Door Consultant
Peter Beal

Introduction
Root knot nematode infestations are a common and serious problem with a large range of vegetable, fruit and flower crops. Much research has been carried out over many years and past treatments included methyl bromide, ethylene dibromide, fenamiphos, cadusafos and ethoprophos. These chemicals are expensive and poisonous.

There is evidence that maintaining high levels of organic matter in soil reduces root damage by nematodes. The mode of action of organic amendements is apparently complex and could involve the release of compounds toxic to nematodes or the stimulation of organisms that are antagonistic to nematodes. Furthermore, improvement of soil structure and fertility by adding organic matter could promote better plant health and vigour and tolerance of nematode damage. Some fungi and bacteria have been shown to be amongst the antagonists responsible for nematode suppression and these organisms can colonise organic material.

Vawdrey and Stirling (1997) compared the efficacy of molasses, sawdust, filter press, green manure and feniphos in a field grown crop of tomatoes. The sawdust treatment was clearly superior with plants being treated with sawdust "almost free of galls and had the lowest population of root-knot nematodes.

This experiment attempted to find a practical and inexpensive method of control using easily available materials and simple resources and equipment normally available in any farming operation. We compared the efficacy of incorporated sawdust and surface applied sawdust with nil sawdust on the extent of nematode galling of roots of *Platysace lauceolata* cv Valentine Lace and tomato.

Method
Hard wood sawdust was mixed with urea (4kg/cubic metre) on a plastic sheet, wetted and composted for three weeks.

Treatments
Composted sawdust was applied to trial plots (15L/m^2) of and either incorporated into the surface soil with a garden fork or spread as a surface mulch. Each plot was 4.2m X 0.60m. Three litres of nematode infested soil was added at the same time to ensure nematode infestations were present in all plots. These three treatments were replicated five times and randomly allocated to five blocks.

Planting
Five 375mm tube grown Valentine Lace cuttings were transplanted into trial plots on 6/8/98. At the same time plots were oversown with tomato seeds to be used as an indicator of nematode damage.

Measurement
Valentine Lace and tomatoes were rated for the severity of galling on a 1-10 point scale (1=no galls, 10 = massive galling) in May 1999.

Results and Discussion

Galling occurred in both tomato and Valentine Lace in all plots (Table 1). While no difference in the extent of galling was observed in the tomato plants, a significant (P<0.05) reduction occurred in the Valentine Lace plants.

Table 1 Effect of surface or incorporated sawdust and nill application on the galling in tomato and Valentine Lace plants.

Treatments	Gall Rating (1-10)	
	Tomato	Valentine Lace
No sawdust	6.11a	6.21ab
Surface sawdust	5.31a	3.75b
Incorporated sawdust	6.35a	6.45a

Column values sharing common letters are not significantly at P<0.05

The effectiveness of incorporated sawdust on the suppression of nematodes in annual crops has been shown previously (Vawdrey and Stirling 1997). Other than at preplanting, incorporation of sawdust is not possible with perennial crops without damaging surface roots. These results indicate that sawdust incorporation is not effective in the case of Valentine Lace while surface sawdust mulching is effective. Surface applications of sawdust could thus be useful in reducing nematode galling for both new plantings as well as established perennial plants.

Future

Future work could look at the additional benefits of adding as an inoculum, small quantities of well matured compost or old poultry manure (presumably containing a host of beneficial micro-organisms) to the composting sawdust prior to its application. The rate of sawdust used in this study is equivalent to a rate of 150 tonnes/ha. Work needs to be done on optimum application rates and the frequency of application.

The possibility of growing healthy crops unaffected by nematodes without the hazards associated with the use of of expensive and toxic nematicides offers growers immense benefits.

Summary

Nematode damage occurs in many wildflower species. Chemicals being used to control nematodes are expensive and poisonous. Alternative control may be achieved with organic amendments. In this paper we assessed the value of composted hardwood sawdust (incorporated and unincorporated) in reducing nematode galling in *Platysace lanceolata(*cv Valentine Lace). Nine months after application of sawdust we rated roots for damage and found that surface applications significantly reduced galling (P<0.05).

References

Vawdrey,L.L. and Stirling G.R. (1997) Control of root-knot nematodes on tomato with molasses and other organic amendments. Australasian Plant Pathology 26: 179-187.

Graham Stirling. Nematode control following the withdrawal of EDB. Biological Crop Protection, Brisbane

F) Assessment of a number of soil bio-conditioners/ameliorants on plant establishment and growth of wax flower

Ken Young's Property

Participants
Ken Young and Kerry Cumner

Trainee DOOR Consultant
Lois Turnbull

DOOR Consultant
Mal Hunter

Introduction
Many soil organisms are known to be beneficial to plant performance. Some limit the activity of microbes that produce toxins (Hunter and Bodman 1999). Others can stimulate plant growth through the secretion of growth promoting hormones. Trichoderma species suppress plant disease organisms and their colonisation of the soil is claimed to assist plant growth and vigour.. Mycorrhizal fungi increase the uptake of nutrients such as phosphorus and increase the plant's tolerance of root diseases.. A liquid preparation of humic acid (Humilac) raises the organic matter level of the soil and stimulates the activity of soil micro-organisms which are claimed to accelerate plant growth and development.

Such beneficial organisms probably interact with each other as well as varying in their sensitivities to environmental conditions including applied chemicals (biocides and fertilisers). Their value is likely to be site specific and vary with growing conditions and crop species.

In this experiment we looked at the interacting effect of Trichoderma spp (Trichopel), a selection of mycorrhizal fungi (Glomus spp, Vamonoc) and a liquid preparation of humic acid (Humilac) on the growth and health of waxflower.

Method
Treatments
Tube stock (50ml) of six Waxflower hybrids (*Chamaelaucium uncinatum* X *megapetalum*) from Western Australia, were planted in blocks in beds 2.4 m with 2 m between plant. Within each block, consisting of one cultivar each (Table 1[B]), one row was treated prior to planting with Humilac (6L/ha) and the adjacent without. Each of these rows were subdivided into four sub blocks, each consisting of four plots of three plants each. At planting, two grams of Trichopel were placed with the three transplants in one of these four plots, one gram of Vaminoc was placed with the three transplants in another of these four plots, while both Trichopel and Vaminoc were added together to a third. The fourth plot was untreated. These four treatments were randomly distributed within each block.

In another area, four rows of the cultivar, Pink Whisper of the same cross, were each divided into 2 blocks (a total of eight blocks), each block consisting of 8 plots of three plants per plot. Factorial combinations of plus and minus Humilac, Trichopel and Vaminoc (8 treatments) were applied at transplanting as above to these eight plots.. Treatments were randomly distributed in each block. Transplanting in both areas was completed 10/5/1999.
Soil Information
The soil is a slowly draining sandy loam, with an organic matter content of 0.9%, an E.C. of 0.02 dS/m and a pH of 5.8.

Measurements
Plant heights (ground level to top bud) were measured on 17/11/1999 some four months after transplanting and just prior to the first heavy prune. Plants were rated at this time for apparent health (0=dead, 5=healthy)

Results
The quality of the data was satisfactory with overall coefficients of variation about 20% for both height and observed plant health, with a range from 10 to 27% across all experiments.
Full factorial-Pink Whisper
The Trichoderma treatment significantly increased height by 18% (P=0.0003), while the addition of Humilac increased height by 8% (P=0.07) (Table 1). Plant health was similarly improved by the two factors (P=0.0006 for Trichoderma and 0.002 for Humilac) (Table 2). The addition of Mycorrhiza had no significant effect at all. Replicates varied significantly (P=0.01 for height and 0.04 for plant health). Sixty-eight percent of the variation in plant height was accounted for by the health rating (Table 5). No interactions among these three factors were significant (P<0.05).

Partial factorial(Mycorrhiza and Trichoderma) –Humilac and 6 cultivars
Neither treatments with Mycorrhizal or Trichodermal inoculum had any significant effect on plant height (Table 1). Mycorrhizal inoculum improved plant health very significantly in the case of cv Jaspar (P=0.002), but had no effect in the other five cultivars (Table 2). Humilac had no positive effect whatsoever, with some evidence of a negative effect in two cultivars (inappropriate statistical design). Replicates varied significantly in only two cultivars (My Sweet 16 and Adi (Table3 and 4) for both height and health rating. The variation in height was significantly accounted for by the plant health rating, although the amount that could be accounted for varied considerably (27% to 65%) among the six cultivars. No interactions among these three factors were significant (P<0.05).

Discussion
The data examined must be considered only as of very preliminary significance. Indeed, the considerable effort expended in collecting these data was seen as an exercise in the DOOR mode rather than with the expectation of any revelation.

It was unexpected to find that the highly significant positive effect of Trichoderma inoculum in Pink Whisper was not at all evident in the other 6 cultivars. This may reflect real differences in cultivar response to beneficial organisms but this cannot be substantiated within the current statistical design. Likewise, the highly significant positive effect of mycorrhizal inoculum on plant health occurred only in the case of Jaspar. However the study of both factors was based on statistically sound design and should be used as preliminary evidence that both mycorrhiza and Trichoderma have beneficial effects in waxflower. Such a marked variation in response to these two factors among cultivars is a possibility. The effects of Humilac were both significantly positive (Pink Whisper) and negative (Blondie and Jaspar), but not as significantly effective as the other organisms. Thus evidence for the efficacy of Humilac is mucsh less compelling.

It appears that cultivars varied considerably both in height (31-52cm) and plant health (2.8-3.9) although this cannot be stated on any statistical basis. It will be interesting to see how this early cultivar variation changes over time.

The relationship between plant health and height is fairly strong in three of the seven cultivars but not in two. This may be an important growth distinction among cultivars in that health rating may be a suitable general growth indicator in some cultivars (eg. Pink Whisper, Blondie and Eric John) but not others (eg. Adi and Muchea Mauve).

Eight replicates were included in the Pink Whisper experiment. While the use of only four would have probably proved satisfactory the additional replicates may provide useful options as the experiment matures. To reduce the experimental workload it may be appropriate to intensively

monitor only four of these replicates, but include the other four when higher levels of precision are being sought. Obviously all eight replicates should receive the same management inputs. It is always best to err on the side of excessive replication when knowledge on plant variability is limited or unavailable.

Summary

Bioconditioners and soil ameliorants can improve plant performance. Such organisms are likely to interact with each other and are going to be site specific in their efficacy. The products Trichopel (a Trichoderma spp formulation), Vaminoc (an inoculum containing 4 species of Glomus mycorrhizal fungi) and Humilac (an extract of humic acid) were applied in factorial combination at the transplanting stage to 7 waxflower hybrids (Chamaelaucium unicinatum X megapetalum). Just prior to the first heavy prune plant height and health were measured. Both Trichopel and Vaminoc had a highly significant ($P<0.05$)positive effect but only on one cultivar each. Humilac had a positive effect on one cultivar and a negative effect on another. These results must be regarded as only of preliminary significance. The experiment is continuing.

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Table 1. Effect of the addition at transplanting, in factorial combination at two levels, of mycorrhizal and trichodermal inoculum and Humilac, on height of 7 waxflower (Chamaelaucium uncinatum X megapetalum) cultivars, four months after transplanting on 10/5/1999.

Cultivar	C.V. (%)	Plant Height (cm)						
		Mycorrhiza		Trichoderma		Humilac		Mean
		Minus	Plus	Minus	Plus	Minus	Plus	
Pink Whisper[A]	17.2	30.68	32.55	28.96	$34.27^{0.0003}$	30.37	$32.87^{0.07}$	31.62
My Sweet 16[B]	25.46	31.77	31.30	31.77	31.30	30.00	33.07	31.54
Blondie[B]	18.38	52.19	52.19	51.62	52.76	55.31	$49.06^{0.07}$	52.19
Eric John[B]	22.46	36.56	36.17	34.79	37.94	36.51	36.22	36.36
Muchea Mauve[B]	16.73	34.88	34.22	35.78	33.16	36.08	33.02	34.55
Adi[B]	16.39	40.21	40.33	40.73	39.79	43.44	$37.08^{0.01}$	40.26
Jaspar[B]	10.44	43.85	46.15	45.52	44.48	45.10	44.90	45.00
Mean	18.15	38.59	38.99	38.45	39.10	39.54	38.03	38.78

C.V. = coefficient of variation [A] Layout appropriate for all factors. [B] Layout appropriate only for Mycorrhizal and Trichodermal factors. Superscript is the Probability level that the difference between the plus and minus treatments are not different (only differences with a $P<0.10$ are shown).

Table 2. Effect of the addition at transplanting, in factorial combination at two levels, of mycorrhizal and trichodermal inoculum and Humilac, on plant health (0= dead, 5= healthy) of 7 waxflower (Chamaelaucium uncinatum X megapetalum) cultivars, four months after transplanting on 10/5/1999

Cultivar	C.V. (%)	Plant health rating (0=dead, 5=healthy)						
		Mycorrhiza		Trichoderma		Humilac		Mean
		Minus	Plus	Minus	Plus	Minus	Plus	
Pink[A] Whisper	15.80	3.84	4.02	3.65	4.22[0.0006]	3.75	4.11[0.02]	3.93
My Sweet 16[B]	24.14	2.81	3.01	2.99	2.83	2.88	2.95	2.91
Blondie[B]	16.78	3.65	3.63	3.53	3.74	3.88[0.04]	3.40	3.64
Eric John[B]	26.60	3.21	3.09	3.08	3.22	3.04	3.26	3.15
Muchea Mauve[B]	24.11	2.99	2.56	2.81	2.74	3.07	2.49	2.78
Adi[B]	25.15	3.44	2.91	3.27	3.07	3.30	3.04	3.17
Jaspar[B]	14.45	3.35	4.02[0.002]	3.81	3.56	3.85	3.52[0.09]	3.69
Mean	21.00	3.33	3.32	3.31	3.34	3.40	3.25	3.32

C.V. = coefficient of variation[A] Layout appropriate for all factors. [B] Layout appropriate only for Mycorrhizal and Trichodermal factors. Superscript is the Probability level that the difference between the plus and minus treatments are not different (only differences with a $P<0.10$ are shown).

Table 3. Average plant heights in each replicate following treatments as described in Table1, with Probability (Prob.)of significance as derived from the analysis of variance.

Cultivar	Prob	Rep1	Rep2	Rep3	Rep4	Rep5	Rep6	Rep7	Rep8
Pink[A] Whisper	0.01 (5.46)[C]	28.33	33.75	34.58	34.79	31.46	34.79	28.54	26.67
My Sweet 16[B]	0.08 (8.33)	36.46	33.96	29.58	26.15				
Blondie[B]	0.41 ns	54.90	51.67	47.60	54.58				
Eric John[B]	0.95 ns	36.39	36.88	35.00	37.19				
Muchea Mauve[B]	0.0000 (6.05)	24.69	32.47	36.67	44.38				
Adi[B]	0.77 ns	40.00	41.88	40.73	38.44				
Jaspar[B]	0.91 ns	44.17	45.21	44.79	45.83				

[A] Layout appropriate for all factors. [B] Layout appropriate only for Mycorrhizal and Trichodermal factors [C]WhereLeast Significant Difference (P=0.05) appears in parentheses. Ns= not significant.

Table 4. Average observed plant health rating (0= dead, 5=healthy) in each replicate following treatments as described in Table2, with Probability of Significance as derived from the analysis of variance.

Cultivar	Prob-ability	Rep1	Rep2	Rep3	Rep4	Rep5	Rep6	Rep7	Rep8
Pink[A] Whisper	0.04[C] (0.62)	3.29	4.17	3.92	4.04	4.29	4.25	3.79	3.71
My Sweet 16[B]	0.0004 (0.73)	3.75	3.29	2.54	2.06				
Blondie[B]	0.22 ns	3.56	3.63	3.35	4.00				
Eric John[B]	0.77 ns	3.04	2.96	3.33	3.27				
Muchea Mauve[B]	0.11 ns	2.27	3.07	3.00	2.77				
Adi[B]	0.01 (0.83)	3.92	3.38	2.90	2.50				
Jaspar[B]	0.13 ns	3.71	3.38	4.04	3.63				

[A] Layout appropriate for all factors. [B] Layout appropriate only for Mycorrhizal and Trichodermal factors [C]Where P<0.1 Least Significant Difference (P=0.05)appears in parentheses.

Table 5. Relationship between plant height and observed plant health for seven waxflower cultuvars.

Cultivar	Coeff. of Determination (R^2)	Relationship
Pink Whisper	0.68 n=64	Plant Height (cm) =7.47 X Plant health +2.25
My Sweet 16	0.42 n=32	Plant Height (cm) = 6.0 X Plant health +14.07
Blondie	0.65 n=32	Plant Height (cm) = 11.52 X Plant health + 10.29
Eric John	0.60 n=32	Plant Height (cm) = 8.50 X Plant health + 9.47
Muchea Mauve	0.28 n=29	Plant Height (cm) = 6.83 X Plant health + 16.08
Adi	0.27 n=32	Plant Height (cm) = 3.78 X Plant health + 28.26
Jaspar	0.34 n=32	Plant Height (cm) = 4.04 X Plant Health +30.11

All relationships are highly significant ($P<0.01$). n= no. of observations

G) Effects of pruning techniques on NSW Christmas Bush (Ceratopetalum gummiferrum).

Proposed Preschedule (the trial deferred)

Marian and Nigel Dunche Property

Participants
Nigel and Marian Dunche, Paul Blinco, Peter and Coralie Blackwood, Ann Fitton, Max Lampo, Gloria and Neil Bale

Trainee DOOR Consultant
Andrew Griffin

Aims/Objective
To determine the effects of differing pruning techniques/practices for *C. gummiferrum*, in relation to the number and length of flowering stems.
Timing

Project Start: March 1998
Experiment Start: November 1998
Experiment Finish: March 1999
Report: October 1999

Relevant Information

Cultural Notes - *"Ceratopetalum gummiferrum"* © Paul Daley, Mountain Nursery

Treatment Identification
Treatment applied to established 3 year old plants.
Sample within plantation of 250 plants.
All plants within sample chosen for equality of vigour and size.

- Soft Prune- Plants reduced to 50% @ 1.2 m after harvest
- Hard Prune-Plants reduced to 25% @ 0.45 m after harvest
- No prune-Plants reduced to harvest requirements

<u>NOTE</u> Plants may need to be "re-pruned" in March if excessive growth necessitates. This will be assessed as the project develops.

Experimental Design
✶ 3 treatments randomised within each block (replicates).
✶ 5 bushes per plot
✶ 8 replicates as blocks

Measurements
Stem numbers per plant placed into appropriate length categories (these data may be collected immediately prior to harvest or at harvest)

Appendix 6 Inter workshop participants' survey

QUESTIONS. Please circle the item that you most agree with. Please note that negative responses are just as valuable as positive. We need to get a good understanding of your personal perceptions of the project.

Since our first Workshop last year:

Question 1: How do you currently rank the potential value for Do-Our-Own-Research (DOOR) for your operation?

very high	*high*	*medium*	*low*	*very low*

Question2: How do you rate your own confidence in conducting DOOR.

very high	*high*	*medium*	*low*	*very low*

Question 3: If you are not confident about DOOR could you please specify what needs further attention (Use an extra page if necessary).

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4: Since the workshop, has your enthusiasm for the concept become -

more keen	*not changed*	*less keen*	*waned completely*

Question 5: In terms of support, have you had -

too much	*just enough*	*not quite enough*	*too little*

Question 6: In terms of being on target for your own DOOR project, are you -

ahead	*on target*	*behind*	*not started but will*	*unable to start*

Question 7: In terms of finishing your project, will you by August 1998 for WA,/ April 1999 for QLD -

complete	*continue*	*won't complete but discontinue*

Question 8: Has your project gone ahead as you thought it would before the workshop?

as planned	*slight modification*	*big modification*	*new project*

Question 9: If modified, was it changed because it was -

too time consuming	*too costly*	*not important enough*	*too complex*

other reasons (please specify:

Question 10: In terms of your DOOR project, how much did you value the information acquired from GrowSearch and other sources?

a lot	*some*	*a little*	*not at all*

Question 11: If your project is successful, how valuable will the results be to your operation?

very	*some*	*slight*	*not at all*

Question 12: Could you please place a number in the left hand column of boxes that indicates your wish for detailed information to be provided at the next workshop against the following topics. List in priority order, with 1 being the most important.

Priority		Topic
☐	Steps in problem solving	☐
☐	How to conduct an experiment	☐
☐	How to assess and record	☐
☐	How to interpret results	☐
☐	The value of photography in experimentation	☐
☐	How to communicate research information	☐
☐	Costs/benefits of research	☐
☐	Understanding the language of research	☐
☐	Group participation	☐

Question 13: For the topics above, could you please indicate in the right hand column of boxes whether you would like them handled in small groups (S), in two large groups (L) or told directly how it is with minimum interaction but maximum information (T). Place one of these letters (S, L or T) against the above topics.

COMMENTS

Please make any other comments that could be useful in the conduct of the DOOR project. Is there anything you would like us to do for the group before the next workshop that would enhance the capabilities of DOOR?

Thank you very much for your time and effort.

Appendix 7 Critical Incident Report

Table 1a Comments from WA growers and consultantson their experiences in the DOOR project. Each grower was asked to identify three positive aspects and three negative aspects.

Positive Aspects	Negative Aspects
1. Opportunities to meet with others with similar interests. 2. Gain some understanding of research methods. 3. Discuss problems with others	• Seems rather complicated. • So far little feedback • Time consuming
1. Setting up experiment and need for discipline. 2. Interaction with consultants and specialists. 3. Consultants becoming more aware of the real world.	• Time • The interference the project has on the commercial routine, not being part of the normal production activity. • Results are very slow in coming
4. Trials were successful in longer stems being produced with certain fertiliser being added. 5. Results showed that longer stems can be produced. 6. Earlier flowering achieved.	• Lack of results from experiments. • Why should fertiliser be used? • Time
7. Results are very useful. 8. Results can be used on your own property. 9. Exchange of ideas	• Time involved. • Remembering to do the job. • Not easy to set up.
10. The use of information for the industry to produce better quality a profitability. 11. Better understanding of the plants. 12. Better knowledge overall.	• Not having the time

13. Exchange of information. 14. Improve profitability of farm. 15. Encourages me to improve my business.	• Time to read information. • Time for meeting. • Time to conduct trials
16. Meeting with other growers for research. 17. Meeting with advisors for technical help. 18. By doing trials in a group less likely to give up.	• Time taken for meetings and research.
1. Working with people who are well known to each other meant a great rate of progress was possible. 2. Group members live close to each other and the experimental site. Meant that the trial was most likely to succeed in being completed. 3. The importance of the role of facilitator cannot be underestimated. Our facilitator has good people skills and a sound nutrition and statistics background. 4. AgWA has been keen to help the Proteaceae Industry because of the involvement of DOOR members. 5. DOOR members are willing to help themselves and are willing to work with AgWA. 6. AgWA are keen to help the Proteaceae Industry on a broader range of research topics **because** the Industry is seen to be keen to help itself, i.e. there have been "big picture" advantages to the Protea Industry because of DOOR participation that were not anticipated originally.	• No simple experimental booklet available. • Keep the DOOR Manual simple
7. Meet and work with a positive group of people. 8. Understand overall Protea Industry better. 9. Learn a new way way of working with grower groups.	• Poor early understanding of "internal (national)"DOOR objectives and procedures. • "Fasttrack" nature of field trial left a few details unattended. • Difficult to disentangle DOOR part of my responsibilities with my overall AgWA protea responsibilities.

Table 1b Comments from Qld growers and consultants on their experiences in the DOOR project. Each grower was asked to identify three positive aspects and three negative aspects.

POSITIVES	NEGATIVES
• By discussing necessary resources and financial needs reduced the risk in the project. • Got into areas of the culture of Australian native plant species. • Stepping stone to other pieces of more basic research.	• Working in a group that has had very little experience. • Distance problem. • Outside consultant offered conflicting advice.
• We saw promise of attaining better reliability and performance(production) in new nematode susceptible crops and the encouragement to be involved in the commitment of time and effort. • Good cooperation between consultant and grower. • Recognition of further outside influences (different water applications).	• We growers should have devoted more time to initial planning and aims of the trial. • Uncertainty as to the direction to take- what was required. • Great difficulty with finding time for trial.
• Means of validating observations and assumptions. • Opportunities to customise investigations to crop and farm. • Development of skill and confidence to apply methods to virtually any problem.	• Should have planned what to measure and when better. • Unforseen weather problem (26 ins). • Needed impetus to actually get to carry out measurements-time and priorities.
• More exact answers than previous ad hoc. Experiments- something we needed to know. • Proved what we had observed- good for self-esteem. • Suggested new lines of inquiry for me-eg. I think the results might have been different in a drier tougher year.	• Needed finalising at our busiest time of the year. • Hard to find the motivation to finish as there was no obvious differential result. • People who dropped out may be turned off the whole process. • The results may be seen as universal and taken as gospel even where different conditions (eg. water quality, weather, etc) may give quite different results.
• Initial enthusiasm of group members for involvement in project • Realising the value of this style of research, especially given funding cut backs from R&D corporations and government agencies. • Local focus that this style of research allows.	• Lack of commitment of some group members to respond to phone calls/faxes etc. • Trying to reduce the number of treatments. Difficult to explain that more treatments means lots + lots of work- which was proposed to occur at harvest when commercial decisions will take over. • Fitting the research into a commercial operation-some growers need to develop an experimental area.
• Greater awareness and understanding of experimental design. • Satisfaction and confidence in putting in place a trial that should yield valid results.	• Lack of convincing information on products being used in the trial. • The imposition on time and labour -delays etc., additional costs.
• We have learnt about the suitability of the DOOR process for industries in the early stages of their development.	• There are problems with implementing the process with emerging industries. • I was disappointed with lack of uptake in

• The DOOR process can be effective if motivated ,established growers are involved. • It is gratifying to see interest in the concept expanding, eg olives, DOOR market Research for new crops. This is probably the first time action learning principles have been applied to research training for non-scientists. • As an extension officer being part of the DOOR process has taught me to listen more and to back off and let growers work through their own problems rather than trying to suggest immediate solutions.	Central Queensland. Distance and communication problems with consultant and the newness of the industry were all contributing factors. Also some of the participants had not attended the preliminary briefing- this is an essential part of the process. • In some situations the process will only work because there is a committed consultant in place. Someone may need to act as a "transformer" or "lightning rod" in the process or else the momentum may not be sustained.

Appendix 8 DOOR presentations

Let's Do Our Own Research
The DOOR way to practical solutions

The DOOR way
to
Grower-led Research

Mal Hunter
Queensland Horticulture Institute
School of Land and Food
University of Queensland, St Lucia

ACKNOWLEDGEMENTS
(Stakeholders)

- grower members of the Qld Nursery industry,
- grower members of the Australian Wildflower and Protea industry
- members of the Industry Executive in both industries
- the Director of Training in NIAA, the peak industry body
- the Nursery Industry committee of HRDC
- the Wildflower and Protea Committee of RIRDC
- relevant managers in HRDC and RIRDC,
- private consultants
- journalists,
- the University of Queensland (esp.Shankariah Chamala)
- TAFE
- Central Queensland University
- colleagues in the QDPI (esp Garth Hayes) and WAAg (economist, biometrician, researchers, extension officers, editors, publisher, admin support)

WHAT IS DOOR?

Stands for Do Our Own Research (**note** started out as DYOR).

- Is essentially grower initiated
- grower led
- grower controlled
- involves the conduct of statistically sound research
- with specialist input and facilitation as needed

The emphasis of DOOR is on grower participation from day one

WHY THE INTEREST IN DOOR (DO OUR OWN RESEARCH)?

- declining availability of the research dollar
- information of generic rather than specific value
- greater industry involvement and hence ownership

THE ROLE OF DOOR

DOOR is the integration of the grower resource (site, labour, equipment, facilities, management, data collection) in rigorous scientific experimentation to provide relevant information on which the grower can make decisions.

SURVEY RESPONSES IN THE NURSERY AND FLOWER INDUSTRIES

- 94-98 % of questionnaire respondents in both industries believe that in-house research is important or very important
- 75-79 % of respondents already conduct some form of research
- Only 10% of such research is done by consultants

THE FOCUS OF DOOR.

On:

- ***reductionist*** research
- ***recipe*** research rather than ***creative*** research (but not instead of), results of which will always be of value (recipe research will always give a useful result)
- ***low-risk*** research
- ***how*** questions addressed rather than ***why***, but complementary to ***why*** experiments that may be conducted opportunistically by other agencies
- ***fine- tuning*** questions- eg fertiliser rate, potting media, spray concentrations
- those with ***limited*** resources (grower enterprises)-cannot afford consultants

ELIGIBILITY

- Anyone who is a competent producer.
- Someone who is seeking to enhance the productivity or effectiveness of an already established system.
- Not particularly useful for those just starting an enterprise requiring a lot of initial ‘hand-holding.’

CHARACTERISTICS OF PARTICIPANTS INVOLVED IN RESEARCH CONDUCTED UNDER THE TOT OR THE DOOR MODEL

"Transfer Of Technology" MODEL	***DOOR MODEL (AEIOU)***
• ***Bystander*** grower participation, with • ***No skills development*** and • ***Dependent*** *on institutional agencies for information resulting in* a • ***Lack ownership*** *of information* with • ***Little understanding*** of process and output or need for personal adoption.	• ***Active*** grower participation, • ***Empowered*** to conduct research, within an • ***Interdependent*** relationship with specialist providers (researchers, extension offocers, statisticians, pathologists, nutritionists, economists, etc), resulting in a very high • ***Ownership*** and • ***Understanding*** of process and output and likely adoption.

THE IMPLEMENTATION OF DOOR

The DOOR Cycle - the 10 steps of research
(see DOOR Manual for Implementation Cycle)

1. Identification of problem or opportunity
2. Review issue (collect information from many sources)
3. Evaluate information and decide whether or not to proceed
4. Design the experiment (size, treatments, layout, variables)
5. Access resources and conduct experiment
6. Collect data
7. Analyse and interpret data
8. Develop recommendations
9. Compile report
10. Validate

ADOPT!!

(**note** the *short circuit* between Evaluation and Recommendation and the r*eference* of the Issue to other agencies)

Titles of some DOOR projects

- **Production and shelf life of Lillipilli (*Syzygium*) in 6 soilless media**
  Aim*: To develop a mix that optimises production and has an improved tolerance to irregular watering at the customer level.*
  Result: *No significant difference between mixes early in growth, but one medium containing 20% sand, 10% peat, 45% standard pinebark and 25% fine pine bark was significantly better at 239 days. A post-production holding period of about 5 days was observed.*
- **Effect of water influencing additives on media characteristics and growth of an *Impatiens* hybrid in a sand bark mixture**
  Aim: *effects of wetting agent and 4 polyacrilimide polymers on media characteristics and growth of* Impatiens *hybrids in a bark sand mixture.*
  Result*: Little evidence that either wetter or polymer are of value under existing inconsistent irrigation distribution.*
- **Response of *Murraya* sp to container insulation**
  Aim: *to establish if there is a plant response to container insulation currently in use in the nursery.*
  Result: ***Use of insulation actually decreased shoot growth and root ball development during the March September growing period. This depression was related to the cooler soil temperatures .***
- **Effect of porosity and nutrition on container grown *Calatheas***
  Aim: *To examine the effect on the growth of Calathea, of adding coco peat with or without osmocote, and N or K with or without osmocote, to a standard potting mix.*
  Result: *While adding coco peat actually reduced air filled porosity and increased water content, it promoted better growth than treatments supplying additional N and K. Added osmocote had no significant effect.*
- **The relative susceptibility of two Basil (*Basilicum*) species to a potting medium infected with an organism causing wilting**
  Aim: *to trial species of Basil in 'wilt' contaminated soil and find a variety that is resistant to wilt.*
  Result: *Sweet Basil wilted and died before flowering (within 4 weeks) while the Sacred Basil went through its normal cycle without being affected.*

Piggy-backing on DOOR research.

The concept involves the conduct of ***creative*** research (institution) in the context of DOOR (industry) conducted ***recipe*** research

- Opportunist and dependent on good industry contacts
- Proposed creative research should be legitimate institutional activity
- Grower must welcome institutional involvement
- Grower must be prepared to share information in the public domain
- Costs are shared and thus lower for grower and scientist
- Substantial efficiencies
- Scientists involved in the real world

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Example Osmocote and Ureaform management in container grown Australian natives.

The **recipe** component included two rates of Osmocote (2, 4g/L) by four rates of Ureaform (0, 0.25, 0.5, 0.75g/L) applied to the potting media growing two eucalyptus species and one melaleuca species.

The **creative** component involved developing the relationship between stem perimeter and fresh weight to provide a useful non-destructive estimate of plant growth.

Graph 1 Fresh Weight and Stem Perimeter responses to interacting effects of osmocote and ureaform.

Graph 2 Relationship between shoot fresh weight and stem perimeter.

HOW THE GROWERS CHANGED

(Feedback from project participants as a result of their Action Learning experience in the DOOR in Nurseries Project)

Attitudinal changes

- more critical approach
- more questioning
- greater confidence

Growers now value

- existing information
- objective measurement
- more effort, but greater rewards
- need to prioritise research ($ and time)
- budget
- recognise the value of consultation
- small gains are important and additive
- simple approach
- cost benefit assessments

Outcome recognised

- no need to reinvent the wheel
- better informed decisions
- dependence on consultant will be minimised and may even be eliminated

THE DOOR AWARENESS AND TRAINING PROGRAM

Desirable because of the fundamental nature of the paradigm shift. However, the DOOR concept is robust enough for its implementation with very limited training- eg the current experience in the WA Wildflower industry. The sustainability of this training free approach is yet to be tested.

Courses

(Training is important- without it the necessary paradigm shift is unlikely to persist)

- **Awareness Presentation:** up to 2 hours introduction to DOOR
- **Operators' Course:** 2 workshops separated by a period of hands on experimentation (action learning) (3-9 months);
- **Consultants' Course:** 4 hour workshop (the role and responsibility of a consultant), with trainee consultants to provide consultancies to participants in Operators' Course.

WHAT HAVE WE DONE

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- given DOOR Awareness Course presentations to nursery and flower industry people in all states except Tasmania
- completed feasibility project on DOOR in the Queensland Nursery Industry with the training model we developed being adopted in principle by the peak industry body.
- published the DOOR Manual for nursery people,
- published the HRDC DOOR Project Report,
- presented one Conference Paper
- published numerous newsletter articles
- run one industry commissioned training course in Queensland.
- in Queensland now have 17 DOOR qualified Nursery Industry operators and 7 DOOR consultants/specialists

CURRENT ACTIVITY

We are currently assessing, through the sponsorship of RIRDC, the feasibility of establishing DOOR in the Australian Wildflower industry, using essentally the same training model that we developed with the nursery industry but including Focal Research and Satellite Research sites to minimise consultants' costs.

Initially involving two states, WA and Qld with the participation of **32 enterprises** (a number with both partners involved) and **10 trainee consultants**

Six months to go with results looking very promising, to the extent that on my last trip to the West a spokesman for the Southern Protea Group indicated that they were now sufficiently **confident to go it alone.**

As a direct result of the success of DOOR, the WA government are putting more resources into the Protea industry . Other groups are now wanting to be involved.

DOOR will be included as the Extension Strategy in the HRDC supported Root and Soil Health project to be conducted in the vegetable industry.

The value of the DOOR approach will be examined in a one year varietal testing program in the macadamia industry.

I have been invited to present an outline of the DOOR concept to the next National Meeting of the Lychee Industry.

Industries such as the olive, foliage and herb industries have expressed interest in the DOOR approach

CONCLUSION

The implementation of DOOR will yield a Win-Win result.

- Good for the grower with their specific questions answered.
- Good for industry with a culture shift into the interdependency mode
- Good for the consultant, requiring knowledge on process rather than content- not required to attain guru status before being effective.
- Good for piggyback research possibilities
- Good for government in the allocation of its research dollar into creative rather than recipe activities.
- Good for government in its transfer of technology

The thing that really excites me is the possibility of harnessing, through DOOR, the energies of the commercial growers of our horticultural and agricultural industries, in the production of substantial quantities of industry relevant information in a pretty short space of time. Such information will set up industry with the necessary competitive edge to prosper in the international market place in the coming millennium.

Finally, I would like to leave you with

THE DOOR MISSION STATEMENT

"***to enhance the capacity of individuals and groups within industry to conduct their own 'in-house' research by enabling the most efficient use of complementary skills of experienced industry operators and trained professional consultants".***

AND LOGO

LET'S **DO OUR OWN RESEARCH**
The DOOR way to practical Solutions

Appendix 9 Proposed framework for Research Recipes

- **Title**
- **Problem definition** and context (literature, etc)
- **Common opening statement** on the DOOR type of research. Seeking practical solutions to on-farm problems. Kept as simple as possible as warranted by the effort that can be committed. Simple analysis of likely benefits compared to the likely costs of research (especially time and time clashes). Questions that need to be answered to solve the problem (not necessarily to produce new knowledge)
- **Aim of experiment-** What solutions needs to be sought
- **Method** of carrying out experiments and equipment, and other resources needed
- **Design and layout** of experiment and statistical considerations.
- **Identification** of what measurements to take, how to take them and when
- **Benefits** likely in relation of costs
- **Time requirements** and likely clashes with other farming activities.
- **Environmental consequences** of the experiment and adoption of recommended practices
- **Data-collection-**proforma data sheets
- **Data analysis-**arithmetic, statistical, biometric
- **Results**
- **Discussion**
- **Recommendations**

Appendix 10 A Compendium of DOOR Research Recipes for the Australian Wildflower Industry

Foreword

The adjective ‘recipe’ research has been coined to contrast with ‘creative’ research. Recipe research may be regarded as a low risk activity, concerned with fine tuning the level or type of an input factor such as cultivar, fertiliser (their elements and forms), irrigation, soil amendment, growth control agent, herbicide, etc. Creative research is more about solving problems where the causal factor is unknown or poorly defined. Thus, there may be much more risk in arriving at a solution with creative research, traditionally the domain of institutional based research able to accommodate that risk. This is not to imply that such research cannot be done by the grower, but rather that returns to research investment are less assured and therefore less attractive in creative research. The output of recipe research should almost invariably produce information that leads to better decisions on aspects of management with resultant profitability.

With the recipes that follow there is an expectation of an understanding of the DOOR philosophy, the DOOR Implementation Cycle and the support role taken by a DOOR consultant (Hunter, Hayes and Chamala 1996, Hunter and Hayes, 1996). These projects should be grower initiated, grower led, and grower conducted with consultancy input if necessary to clarify the initial problem and to statistically analyse the data and report on the results.

The DOOR Manual was developed for the nursery industry but contains much information that is of general relevance to other horticultural and agricultural industries. It is referred to throughout these recipes as a source of further information that may clarify a particular issue.

Probably the single most important activity that underpins all recipe research is the preschedule or checklist of activities that should be completed before any hands-on work commences. A proforma of this preschedule appears as Appendix 10 on pages 89-93 in the DOOR Manual and is included with these recipes. Not only does it force the grower to critically think through the experiment and what it will entail, it produces a record of what sort of work will be done that is accessible to anyone else involved in the project. This will minimise misunderstanding.

Each of these recipes should stand alone. Consequently, much of the material is common to them all. This Compendium contains only four recipes. Others may be added at the industry request.
Mal Hunter. 22/05/2000

Evaluating the effects of organic soil amendments on flower production

Mal Hunter and Ken Young

The need for grower run research

With the declining availability of the government research dollar other resources must be developed. This is especially true for those new industries that have attracted only minor government support in the past and are finding more and more problems as their industry expands with less and less resources to solve them. Growers themselves may provide that needed resource.

Growers have always done their own research but it has generally been informal, observational and intuitive. Nonetheless, in many cases such research has been successful and the development of many industries, despite little in the way of formal research support, is testament to the observational skills of the growers involved.

Observational research is successful in the resolution of issues where differences in the effects of the various options are large and readily obvious. Economically viable cultural systems are developed in this way but as they mature and become increasingly dependent on fine tuning to maintain their competitive edge more critical research that can detect small differences becomes necessary. Observational research thus gives way to statistical research. The statistical research approach underpins the DOOR concept of grower responsibility and involvement in their own sound research (Hunter et al, 1996).

The following research project has been designed for the grower rather than the research scientist. However, it is expected that the grower will consult with a competent research consultant on a needs basis, as well as using the specific skills of a statistician in analysing the data. The methodology is based on the DOOR Manual for Plant Nurseries (1996) in which all elements of the research cycle are fully covered. Reference will be made throughout the Research Recipe to the DOOR Manual.

Problem definition and literature review (p 11 DOOR Manual)

Introduction

Many wildflower species will grow on a wide range of soils, many of which are at the ‘poor’ end of the scale when their suitability for arable farming is considered. The question arises “how to make these soils more productive with minimum inputs?”

Micro-organisms are an important component of any soil ecosystem. They are heavily involved in soil nutrient cycling, in plant nutrient uptake and water relations, in disease incidence as well as disease control. Soil biota stabilise soils and are critical to successful colonisation of sands by plants. It is thus not surprising to find that sellers of microbiological active “brews” with similar positive claims have tapped a receptive market. Enhancing bug activity by the addition of bug concoctions or liquors that stimulate bug populations seems like a good idea. Many products are available including fermented liquors, extracts from mushroom and waste composts, fish wastes and earthworm castings. Some materials specify the actual beneficial organism involved, such as *Trichoderma* or mycorrhizal fungi.

Folklore abounds in the use of a range of organic soil amendments and how they revitalise sick soils by kick-starting soil microbiological processes. The claims often have some scientific basis but unfortunately unreasonable licence is taken in converting these claims into unsubstantiated facts. Few of these “facts” are based on rigorous scientifically based testing and rarely if ever take into account the unique attributes of a particular location.

Literature review (see p15 DOOR Manual)

Much experimental work has been done on all forms of soil amendments and a lot published. This may be accessed from libraries and the Internet. Key words would include amendment,

soil improver, soil enhancer, soil additive, soil stimulator, soil micro-organism, beneficial micro-organisms, bio-control agent, mycorrhiza, trichoderma. The Web site of **http://www.barc.usda.gov/psi/bpdl/bioprod.html** lists a wide range of bio-control agents and their target pathogen. The Web site http://www.soilfoodweb.com is the site for Soil Foodweb Incorporated, a laboratory in Oregon, USA providing an information and analytical resource to biological farmers.

Aim of experiment

To compare the effect of adding five soil amendments, on growth and economic productivity of wildflower, with the existing system of crop management

The following Research Recipe guides you in setting up an experiment to evaluate a number of these products under you own environmental conditions. The methods you apply and the data you collect will allow you to assess which of these products work and whether any of them have in fact a deleterious effect on some aspect of your production system.

Method

Product

Obtain twice as much of the recommended amendment necessary to supply 60 plants used for each treatment in your experiment. Store each amendment carefully and critically observe any use-by dates. Liquors that contain live organisms have to be handled in a way that minimises organism death rates and have to be used before organism potency has diminished appreciably.

Directions for use

Follow recommendations on how to use the product to the letter making minor changes if absolutely necessary following consultation (preferably written form) with the supplier. Impractical requirements should also be discussed with the supplier and alternatives sought. There is no point in evaluating a product unless it can be incorporated into you system, following reasonable modification if warranted.

Planting material

Choose plants that you are familiar with but include those types that could benefit most from the amendment in question. Cultivars vary considerably in their ability to handle stresses, be they physical (eg. moisture), chemical (eg. nutrition) or biological (eg. pathogen). Many amendments focus on one (or as some claim even all!!) of these stressors.

Obtain the best stock you can of an appropriate age. Have the stock delivered after you have set up the trial site, particularly if this is the first experiment of this sort that you have conducted. Delays in planting out should be avoided and getting the field site organised is likely to take much longer than you first expect. If possible, find out how this stock was produced since the culture system and the inputs may impact on the claimed efficacy of the amendment. For example, tubestock produced in inoculated media are less likely to respond to the same inoculum placed in the planting hole.

Some amendments may be applied to already existing field plants rather than new plants, especially those that are considered long term perennials. Appropriate plant selection is critical. Establish replicates within which all the datum plants (the ones that are measured) are of similar form and health. Datum plants should be bounded on either end of their row with non-datum plants to provide a buffer against adjoining treatment effects (see Figure 1). Measurements must be carried out on these datum plants at or prior to treatment application to account for variation not attributable to the various amendment treatments. These data are used in data analysis to account for some of the plant to plant variation.

Site selection
Select an area that is representative of the area that you wish to apply the results to, preferably flat or with even slope and of the same soil type. This is often an impossible ask. At a minimum, ensure that the environmental conditions within each replicate (or block) are similar. Thus you may have 4 replicates all on slightly different soils or at different positions on the slope or on different depths. However, ensure that within the replicate, levels of these factors are similar. This will minimise any unfair advantage that any treatment will get simply because of its location.

Site characterisation
It is important that you know what your soil resource is. A good indicator of this is the native vegetation it once supported and their association with soil types (and their inherent productivity) in the district. Unfortunately, in many cases such vegetation has long since disappeared. Other information must be sought. Preferably, dig a soil pit at your experimental site and have a professional soil surveyor describe the soil profile. Additional pits may need to be dug if there are large differences among your blocks.

Samples of soil from the various horizons should be submitted to a reputable analytical laboratory for chemical and physical assays. Soil samples to 10 cm depth at least should be collected from each replicate (20 cores at random in each replicate which are bulked to make a one kg sample per replicate) and submitted for chemical assay. Soil profile characterisation needs to be done once only, while surface soil tests ought to be monitored, say on a two yearly basis.

The importance of this information to your management practices cannot be overstated, since they will allow you to critically assess what your soil resource is and how it should be managed.

Design and layout

Size and shape
You must first consider the size and shape of your experimental unit. To minimise interplot interference, each unit should include a minimum of three datum plants preferably bounded on either side by a row of five plants (guard plants), with an additional two plants (guard plants), one at either end of the row (Figure 1). The use of more than three datum plants is desirable and will improve precision but would require a greater area. Note that the minimum plant number that should be used will increase, the more variable your planting material. This could be substantial if your species is not genetically homogenous. The increased precision with larger plots will have to be traded off against greater costs for planting material, difficulty in finding a sufficiently large enough contiguous area of similar plants and increased time taken in collecting data. If plots become too large their value may also be compromised by spatial variation in soil conditions.

Guard plants may be omitted where spaces between plants are large with little or no interplant competition for light, nutrients and water, or where there is no influence from the adjoining treatment. Once the experimental unit has been determined, the next step is to arrange these units into blocks or replicates (a replicate is simply a repeat of a particular treatment, while a complete block contains one replicate of every treatment). The number of units in the block equals the number of treatments that are being investigated. In this present example, five amendments are being compared to a sixth treatment, which is representative of routine practice. If possible, arrange these six units in a square land area to minimise soil variation effects. Ensure that these units within each block are on roughly the same contour (Figure 1). A minimum of four replicates should be laid out, requiring a total of 24 units (ie.6 treatments by 4 replicates). Including more blocks (of six units each) will improve experimental precision. As a rule of thumb, blocks should be laid out down the gradient (with units within replicates across the gradient).

Thus, in a fully guarded experiment with the example above, a total of 360 plants (15 per unit by 6 treatments by 4 blocks (replicates)) would be required. In laying out each block as a quarter of a square, the experiment would occupy an area 44 m long by 43.2 m wide (2 m between plants in the row with rows 2.4 m apart, Figure 1). If guarding is unnecessary, the size may be reduced to an area 28 m long by 19.2 m wide, containing 72 plants.

Randomisation
The position of each treated unit within a block must be randomly allocated. Number six small squares of paper 1 to 6 (the six treatments above) scrunch up and place in a bowl. Take one bit of paper out of the bowl and write the number on the paper in the first unit of your field plan. Repeat the process until all units within a block one have been numbered. Return the bits of paper to the bowl, mix up, withdraw and repeat the numbering process on the other three blocks. This procedure called randomisation largely eliminates any pattern in the distribution of the treatments within a block, which consequently minimises any bias towards a particular treatment because of the particular position it occupies.

Field plan and notebook
Draw up a field plan to scale (Figure 1). Include all plants within the experimental area as well as indicating reference points which may be used by others independently visiting the site. Indicate what each treatment is. A laminated field plan is both sturdy and waterproof.

Every visit to the experimental site should be entered in you note book and entries with dates made on site. Include any observation or action that may impact on the subsequent performance of individual plants. This may become vital information when trying to account for the subsequent poor performance of plants.

Budgets

Funds
Research budgets for the proposed project must be drawn up. Funds ought to be identified for the research work and spent on research activities. Drawing research funds from a common pool always introduces some element of ongoing reluctance, particularly when the research results seem not to be going anywhere. This may jeopardise the completion of research commitments. Both cash and time needs for the research project need to be critically estimated, with some contingencies to account for initial inadequate estimates.

Time requirements
Research is a time consuming activity and time is by far the single most quoted factor identified by grower DOOR research trainees as a negative aspect of research. Good research is a painstaking activity and not consistent with corner cutting. Unless you have the experience, most time budgeted activities are likely to take two to three times longer than expected.

Priorities
Critical research activities are likely to clash with very high farm priorities particularly at harvest. The likelihood of immediate income to be gained from the farm operation is likely to reduce the priority given to any research activity that clashes with it, simply because the value of the research is not assured and will occur in the more distant future. In recognizing this in the planning stage, contingencies should be put in place (hiring labour specifically to carry out the research work) to minimise this dilemma.

Risk
Creative research is a much more risky activity than recipe research since creative research is often based on a hunch that does not necessarily include the missing key. By contrast, there is no missing key in this recipe research since the test is simply assessing whether or not the five amendments are better, worse or no different from your routine practice. In the present case, five organic amendments are being assessed for their efficacy in plant productivity. By the end of the project the results will indicate whether the products are worth applying or not. However, the work is not entirely risk free since the trial area could be wiped out (disease, insect, hailstorm, fire), the amendments may have lost their vitality before application, or

there be a fatal error in the conduct of the experiment. The likelihood of the last source of risk is minimised by having the work conducted by the owner/operator who has a huge vested interest in doing the job properly. Hired help should always be supervised.

Benefit cost considerations (P 25 DOOR Manual)
During the trial planning stage it is important to make some rough assessment on the likely value of the information generated by the proposed experiment. While the estimates may be rubbery they should provide a realistic ball park against which you should match the likely additional costs of running the experiment.

Five questions should be answered, in the first instance as a 'high' value or as a 'low' value (Table 1). If there are a lot of 'highs' in the Gains row and a lot of 'lows' in the Losses row then it is very likely that you should continue. However, if it is not so clear cut then putting in actual values into the various boxes may be necessary. The choice of the ratio of benefit to cost that determines whether the work should proceed or not is yours. The level of risk you are prepared to take in achieving your research goal should also be taken into account. However, if you do elect to proceed, do so with the aim of completing the project and not one of pulling out if results appear not to pan out as expected. The completion of a project will place you in a much better position to conduct the next one even if it doesn't provide the advantage you were after.

Pre-schedule (P 89 DOOR Manual)
This form is a checklist of all the activities that are to be carried out, with adjacent boxes to be filled out (Table 2). This is one of the must activities in your experimental diary. It is intended to encourage you to think everything through and find answers if the information is not available prior to starting any field operation. Some questions obviously cannot be answered until the experiment is completed. It becomes an invaluable aid to your subsequent operations and particularly so to any one else involved in the project. It forms one element of your permanent record.

Operation (P 39 DOOR Manual)

Grading stock
To reduce experimental variation, all plant stock should be graded prior to planting out. Divide up the graded stock into categories by the number of blocks, in this case four. The top category grade plants are allocated to block one, the second to block two and so on. This means that there should be minimum variation in plant size within a block of six treatments. On no account allocate a particular grade to a particular set of treatments.

Applying treatments
In the case of this example three of the amendments are applied as a 10 ml dose into the transplanting hole (using a disposable syringe), while two are applied as a spoonful of product into the hole. The sixth treatment is the nil amendment (sometimes referred to as the control). Dig the hole, add the amendment and transplant the tubestock preferably in a way that would mimic as closely as possible commercial practice. Complete treating and planting one of the experimental blocks before moving onto the next. Getting caught out in a rainstorm with two blocks partially planted creates much greater statistical problems than with one block if planting is delayed by 2-3 days.

Avoiding mistakes
It is very easy to make mistakes in a field operation, particularly if you are working on your own without additional checking going on. Record any mistakes but try to develop a fail safe system that minimises their occurrence. In the present case, before adding any amendment, place plot number and treatment detail (on a card) and the container of each amendment in the relevant plot, rather than carrying them all around in the same carryall. This discipline takes additional time but this is well spent if it reduces mistakes. Clearly mark your plot with a painted stake (UV stable plastic is preferred) and wrap fade resistant coloured material around one of you datum plants. A colour code can be developed that relates to the particular

treatment. Subsequent observational visits can be done quickly with out having to hunt around for plot stakes.

Measurements
Plant height (soil surface ti highest bud) and width (widest point, leaf tip to leaf tip) should be measured at 2-3 monthly intervals. The first measurement could be made just prior to the first pruning. In single stemmed species, the diameter of the stem just above ground level is often a good indicator of overall plant growth. In multi-stemmed species, mark 5 stems as representative of the rest on the individual bush and measure their heights as well as stem diameters one –two cm up the stem. Select stems by counting the total number on the plant, divide by 5 (quotient equals x) and then select each xth plant to give you a total of five stems per plant. These stems could be followed right through to harvest with their values expressed as a proportion of the total marketable stems on that plant.

Measuring total plant yields made up of many flowering stems presents quite a logistic problem particularly when stems are harvested over a period and not all at once. One approach may be to colour code stem bases with two colours of pressurised plastic paint; one colour indicating the block while the second (higher on the stem) indicates the treatment. These stems would be graded with others but identified and so recorded according to their colour combination. If this information is vital to the output of the experiment additional labour resources to carry out these measurements may have to be obtained.

Data collection
All measurements should be immediately entered into a record sheet (see Table 2) and then forwarded to your consultant for statistical analyses. To maintain analytical efficiency it is important that the data is entered in the designated order. Providing the data in an Excel spreadsheet would be preferred.

Meterological data
Rainfall on site is the minimum meterological data that should be collected, preferably on a daily basis, but at a minimum on a weekly basis. A crude system of a funnel sitting in a large capacity bottle as a rain gauge would suffice with a record being made of the volume of water accumulated each week. From the area of the funnel it is a simple matter to convert such volumes to a rainfall measurement. Summer storms are notoriously variable in their rainfall distribution and using home site rainfall to estimate experimental site rainfall may be quite misleading.

Daily maximum and minimum data should also be collected. If you are able to collect a month's worth of data from your site once in the peak of summer and again in the depths of winter you may be able to assess how accurately your values can be converted from your closest official weather station. You could then use the official site for your own site specific information.

Photoperiod or day length is another important variable that often determines the onset of flower initiation. This can be simply determined on the basis of latitude. However its value can be slightly modified by local topography and this can have a significant effect on sensitive species.

Data analyses (P47 DOOR Manual)

Means
After collecting the above data they are converted into plot means for plant height and diameter, stem number, stem length and total stem length per plot. Treatment means averaged over the four blocks on their own give some indication of the relative ranking of the effects of the five amendments and control (reference plot). However, these arithmetic means do not account for natural plant to plant variability or the variability caused by all sorts of gradients in the field environment (soil depth, soil water, nutrient supply, disease incidence, etc.). Thus, it is not possible to conclude whether the apparent difference among treatments are

likely to be real or due to genetic or site variability or other sources of variability including experimental error. This is less of a problem when the differences among treatments are large and the apparent variability slight.

Analysis of variance
To detect whether it is likely that differences are true, an analysis of the trial variances is conducted (ANOVA). Variances attributed to the blocks (replicates), the treatments and other sources (called error) are calculated. The blocks and treatment variances are then compared with the error variance to give the Variance Ratio (VR). If the ratio is one or less, we can conclude that there was no effect of these two factors on plant performance. However, the more these values exceed the error variance the more likely they have had a real effect. And we are able to attribute a probability statement to these values (or VRs) that indicate how likely the observed difference between error and the factor (in this case the amendments) is just due to chance. Thus a factor with a probability statement of P= 0.05 means that the result would likely to have occurred just by chance 1 in every 20 times the experiment was conducted rather than being in response to the treatment applied. A P= 0.01 indicates a probability of 1 in every 100 times.

Least significant difference (LSD)
In addition, the analysis of variance allows the calculation of the amount by which the effects of various levels of a factor need to differ in order to be deemed significantly (P=0.05) different (called the Least Significant Difference or LSD). Thus, in the present case, 4 of the amendments may not have differed from the control by this amount while a fifth may have. If so, then only the last amendment would be assessed as having had a significant effect on plant performance. If one had depressed growth compared with control by more than the LSD value then it would have been assessed as having had a significant ($P<0.05$) negative effect.

Coefficient of variation (CV)
Finally, the ANOVA allows the calculation of the experimental coefficient of variation (%CV). This value indicates how variable the data are and determines how much confidence to place in an experiment where no effects were significant. It is desirable to have as small a CV as possible. High CVs may be reduced by increasing the number of samples in the datum area and selecting less variable indicThe effect of high CVs in reducing precision can be also minimised by increasing the number of replicates.

Environmental consequences
It is important to examine how the conduct of the research, and indeed implementation of any of the recommendations that flow from it, could impact adversely on the local environment. For example in the present case, live organisms are going to be introduced and tested. Are they new to the area? If they are what is the likelihood of them adversely impacting on the local microbiological ecosystem?

Of course, some of these questions may be impossible to answer since it is quite likely that the sellers of the product don't really know themselves what their 'magic' potions contain. In applying the precautionary principle, it would be advisable to test only those that can be defined and do so after some professional advice from an ecologist. It would be unfortunate if the act of carrying out this research was to unwittingly introduce a potential microbiological 'weed' to the area.

Some sprays kill birds and bees and fish, and excessive fertiliser use may result in the contamination of ground water and river systems. 'Better' crop husbandry practices should only be implemented if they have nil or at the most only relatively little adverse effects on the environment. The introduction of new organisms into any area may be questionable on the one hand, but reduce the need to use destructive chemicals on the other.

By its very nature, the act of farming has a huge adverse impact on ecological systems. Doing nothing, however, on cleared and cropped land may allow bad weed problems and be

ecologically irresponsible. Farming wildflowers enhances survival of the species concerned, while generating income with which more sustainable and ecologically sound practices can be put in place.

Results

Caution and confidence

The results from an experiment of this type always have an element of doubt and should be adopted cautiously. Obviously, the lower the probability test (P) of this result just being due to chance, the more confidence you will have of the result being true. Confidence will be greatly enhanced if your results match what the seller claimed and what others have found. It is unlikely that the magnitude of your response will be identical to those observed by others, simply because your test is being conducted in a unique environment. Your unique environment also changes with season and year. Thus, this result will reflect the complex interaction of weather conditions that applied during the course of the experiment. Responses will vary from year to year. There is merit in repeating the experiment the following year to get some assessment of the effect of seasonal variation.

Farm scale

Bear in mind that the experimental size of the project does not necessarily take into account all relevant farm operational activities. It would be desirable to scale the new technology up to farm size and test the new technology under routine farm conditions before fully converting.

Benefit: cost assessment. (P 25 DOOR Manual)

The responses you observe need to be put into economic terms since in some cases a significant but small improvement will not necessarily match additional inputs. Repeat the B/C exercise above (Table 1).

The decision to implement the technology will be determined by how much the costs of implementation are exceeded by the benefits. Such benefits are not simply economic since they may involve lifestyle and even ethical issues. There is always an element of risk that such benefits will actually not occur, since unforseen circumstances can upset sound predictions. A rule of thumb that some use is to implement the recommendation when the B/C ratio exceeds 2. Of course the actual choice is yours.

Recommendations and report (P 61 DOOR Manual)

The work has been done, the data have been analysed and the results discussed from a variety of view points. Recommendations on how the new technology should be viewed can now be drawn up in terms of why, when, where, how and by whom. Such recommendations ought to involve all interested operational staff to ensure all relevant perspectives are accounted for.

Report

The whole project should be written up using the header format of *topic/title, operators, consultant, aim of work, treatments, start and completion dates, how the work was done, measurements, results, interpretation, recommended action, further experimental work, references to other papers and reports.* (P 100 DOOR Manual).This report should be securely filed in both electronic and hard copy form, together with the preschedule, the raw data and the analysed data.

Intellectual property

The new information that has been generated has cost you a considerable amount of time and effort and must be valued accordingly. The information should be seen as intellectual property that has direct relevance to the profitable operation of your enterprise. The value of this property should not be overlooked in the assessment of your operational assets for possible sale. Furthermore, such value should be taken into account if approached by sellers of the technology who are seeking to use data of this sort to support their claims.

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Native Species/Cultivar Selection

Graham & Esther Cook and Mal Hunter

The need for grower run research

With the declining availability of the government research dollar other resources must be developed. This is especially true for those new industries that have attracted only minor government support in the past and are finding more and more problems as their industry expands with less and less resources to solve them. Growers themselves may provide that needed resource.

Growers have always done their own research but it has generally been informal, observational and intuitive. Nonetheless, in many cases such research has been successful and the development of many industries, despite little in the way of formal research support, is testament to the observational skills of the growers involved.

Many primary producers are seeking ways to diversify into new areas of production, with flower growing one venture they may consider, including the cultivation of Australia's own unique native flowers. Because most of these species have been cultivated for such a relatively short time, it is difficult to find practical information that is valid for the wide range of conditions in Australia. In effect, commercial growers of native flowers must be prepared to do their own trials and make their own decisions.

Outline

This outline may help you select what to trial. It assumes that you have suitable land available, that you know the general seasonal patterns for the area, that you have tested the water and soil, and that you know, or are finding out, about farming in general, and growing flowers in particular. You will also need to consider how you will market your crop, and how you will get your crop to market (e.g. whether refrigerated transport is available).

Problem definition and literature review

One of the first difficulties faced in growing native flowers is deciding which species to plant. Even when a species is selected, it may be difficult to find or select the best cultivars to trial. Some, like waxflower, kangaroo paw and grevillea, have been in cultivation long enough to have a large number of cultivars from which to select. Others, like riceflower, have only a few cultivars on the open market. Very few native flowers can be grown commercially directly from seed because of the variability of seedlings. Ideally, you need to know something about the needs, problems and characteristics of any crop you plant. You may not have this information about native flowers until you have trialled different cultivars on your own site, under your specific seasonal conditions.

Which species will you trial?

Before you can decide which species to trial, you will need to gather as much information as possible.

Check out established flower growers in your area. Visit them if possible. You may be able to attend meetings of a regional flower growers' group.

- What are they growing?
- How did they choose?
- How do they market their flowers?
- Do they feel the market can cope with more of the same product?
- Does the species have any specific growing needs which might be hard to meet?
- Does it have known predators/pathogens?

- How are these problems treated?
- How are they marketed?
- What sort of post-harvest treatment is recommended? (See Appendix 1)

Growing native flowers may be far more labour intensive than you expected.

Contact exporters or wholesalers, check with them on the likely market prospects for the foreseeable future. Ask their advice on the most popular and most dependable cultivars of any species you are considering. They may know of a grower or nursery you could contact for more information.

Attend a Do Our Own Marketing Research (DOOR Marketing) course conducted by Dr Rob Fletcher, Senior Lecturer, University of Queensland Gatton College.

Contact relevant government and educational agencies and libraries, e.g. the Department of Primary Industries or University of Queensland, Gatton campus (Qld). Can "Growsearch" (at Redlands Research Station) or your local university or TAFE College provide any information?

Selecting cultivars

Decide which species you will try. For each species, list all the recommended or available cultivars.

There are two important aspects to consider in choosing which cultivars to plant:

- Different cultivars may flower at different times, so choosing early, medium and late varieties can lengthen the season.
- Cultivars with the same time slot or 'window' grown under the same conditions can be assessed for relative hardiness and market appeal.

Preliminary trial size

Decide how big a trial you want to run. If you are already growing flowers, or selling onto the domestic market, 10-20 bushes of a new cultivar can be added for a preliminary trial. However, if you are planning to export your first crop, you may need more bushes to make it worth your while to set up your shed, rent or build a cold room, and have enough flowers to pack boxes consistent in length and colour. For the export market, 100-200 bushes of each cultivar may be simpler to market than just a few.

The finances needed to complete a whole cycle of land preparation, irrigation, growing, spraying and marketing need to be carefully calculated before you start, including the time it takes to actually get paid after harvesting.

It is important to accept that there is always the chance of complete crop failure. As well, with a crop as new as growing many native flowers, there is no guarantee that any of the available cultivars will suit your conditions. A fair proposal is that you should not spend more than you can afford to lose!

Mark your cultivars clearly! If you have a number of cultivars or have replicated blocks, draw a plan for ready reference.

Records

Record your observations of how each cultivar performs. For example, some cultivars may appear to need more water, nitrogen or iron than others. Pests and diseases may affect different cultivars differently. Bush shape and growing habit can vary. Different cultivars will pack more easily than others, with straighter stems or less trimming needed. Above all, record the flowering times and quality, and any feedback from the market. Note the regrowth.

Will next year's harvest be as good? Will there be more stems? Will they be sturdy enough, or is regrowth too fine and wispy? See sample data sheet (Appendix 2).

Future program

If you decide to plant more in the future, select cultivars based on your notes.

- The prettiest plant may not be your most profitable one!
- Sturdiest cultivar/s (grow back after harvest/ease of propagation)
- Time of harvest (which week/s? how long before it is too mature?)
- Market feed-back
- Beware of short-lived fads when deciding how much to rely on a particularly popular new species.

Summary

To select cultivars that will do well under your conditions, you will need to trial as many as possible, and keep detailed notes to guide future selections. New cultivars are released from time to time, so setting some space aside for trials should be a permanent part of your management strategies.

Appendix 1 Factors to be considered in cultivar selection
Possible species/cultivars…………………………………………………………………………

Reasons for choice………………………………………………………………………………..

Markets……………………………………………………………………………………………...

Is the market likely to hold?……………………………………………………………………

Specific growing needs…………………………………………………………………………...

Predators/ pathogens and treatment……………………………………………………………

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Marketing prospects and options………………………………………………………………

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Post-harvest treatment…………………………………………………………………………

Refrigerated transport…………………………………………………………………………

Notes……………………………………………………………………………………….…
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Appendix 2 Observation data sheet

Name of cultivar……………………………………………………………………………………..

State of origin……………………………………………………………………………………..

Colour…………………………………………………………………………………………….

Characteristics……………………………………………………………………………………

Availability………………………………………………………………………………………

Special growing needs……………………………………………………………………………
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Vigour……………………………………………………………………………………………
Regrowth after harvest…………………………………………………………………………..
Market appeal……………………………………………………………………………………
Method/s of harvesting…………………………………………………………………………..
Equipment needed for harvest…………………………………………………………………...
Post-harvest treatment……………………………………………………………………………
Points in favour…………………………………………………………………………………..
Points against…………………………………………………………………………………….
Number to trial…………………………………………………………………………………..

Testing cultivars for economic performance

Observational research is successful in the selection of cultivars where differences are large and readily obvious. Economically viable cultural systems are developed in this way but as they mature and become increasingly dependent on fine-tuning to maintain their competitive edge, more critical research that can detect small differences becomes necessary. Observational research thus gives way to statistical research. The statistical research approach underpins the DOOR concept of grower responsibility and involvement in their own sound research (Hunter et al, 1996).

DOOR research projects are designed for the grower rather than the research scientist. However, it is expected that the grower will consult with a competent research consultant on a needs basis, as well as using the specific skills of a statistician in analysing the data. The methodology is based on the DOOR Manual for Plant Nurseries (1996) in which all elements of the research cycle are fully covered. Reference will be made throughout the Research Recipe to the DOOR Manual.

The following Research Recipe guides you in setting up an experiment to evaluate production characteristics of your new wildflower varieties under you own environmental conditions. The methods you apply and the data you collect will allow you to assess which varieties are best suited to your environment and your production system.

Aim

To compare the economic productivity of five new cultivars with an existing known cultivar (i.e. six treatments)

Method

Planting material

Obtain the best stock you can of an appropriate age. Have the stock delivered after you have set up the trial site (Figure 1), particularly if this is the first experiment of this sort that you have conducted. Delays in planting out should be avoided and getting the field site organised is likely to take much longer than you first expect. If possible, find out how this stock was produced since the culture system and the inputs may impact on the how the cultivars perform. For example, tubestock plants produced from well fertilised stock may perform better than cuttings taken from another stock plant growing under nutrient stress.

Site selection

Select an area that is representative of your farm, preferably flat or with even slope and of the same soil type. This is often an impossible ask. At a minimum, ensure that the environmental conditions within each replicate (or block) are similar. Thus you may have 4 replicates each on slightly different soils or at different positions on the slope or on different depths. However, ensure that within the replicate, levels of these factors are similar. This will minimise any unfair advantage that any treatment will get simply because of its location.

Site characterisation

It is important that you know what you soil resource is. A good indicator of this is the native vegetation it once supported and their association with soil types (and their inherent productivity) in the district. Unfortunately, in many cases such vegetation has long since disappeared. Other information must be sought. Preferably, dig a soil pit at your experimental site and have a professional soil surveyor describe the soil profile. Additional pits may need to be dug if there are large differences among your blocks.

Samples of soil from the various horizons should be submitted to a reputable analytical laboratory for chemical and physical assays. Soil samples to 10 cm depth at least should be collected from each replicate (20 cores at random in each replicate which are bulked to make one kg sample per replicate) and submitted for chemical assay. Soil profile characterisation needs to be done once only, while surface soil tests ought to be monitored, say on a two yearly basis.

The importance of this information to your management practices cannot be overstated, since they will allow you to critically assess what your soil resource is and how it should be managed.

Design and layout

Size and shape

You must first consider the size and shape of your experimental unit. To minimise interplot interference, each unit should include a minimum of three datum plants preferably bounded on either side by a row of five plants (guard plants), with an additional two plants (guard plants), one at either end of the row (Figure 1). The use of more than three datum plants is desirable and will improve precision but would require a greater area. Note that the minimum plant number that should be used will rise, the more variable your planting material. This could be substantial if your species is not genetically homogenous, which would be generally the case with wildflowers. The increased precision with larger plots will have to be traded off against greater costs for planting material, difficulty in finding a sufficiently large enough contiguous area of similar plants and increased time taken in collecting data. If plots become too large their value may also be compromised by spatial variation in soil conditions.

Guard plants may be omitted where spaces between plants is large with little or no interplant competition for light, nutrients and water, or where there is no influence from the adjoining treatment. Once the experimental unit has been determined, the next step is to arrange these units into blocks or replicates. The number of units in the block equals the number of cultivars that are being investigated. If possible, arrange these six units in a square land area to minimise soil variation effects. Ensure that these units within each block are on roughly the same contour down a slope (Figure 1). A minimum of four replicates should be laid out, requiring a total of 24 units (ie.6 treatments X 4 replicates). Including more blocks (of six units each) will improve experimental precision. As a rule of thumb blocks should be laid out down the gradient (with units within replicates across the gradient).

Thus, in a fully guarded experiment with the example above, a total of 360 plants (15 per unit by 6 cultivars by 4 blocks (replicates)) would be required. In laying out each block as a quarter of a square, the experiment would occupy an area 44 m long by 43.2 m wide (2 m between trees plants in the row and rows 2.4 m apart, Figure 1). If guarding is unnecessary, this is reduced to 72 plants (12 plants of 6 cultivars) in an area 28 m long by 19.2 m wide.

Randomisation

The position of each cultivar within a block must be randomly allocated . Number six small squares of paper one to six (the six cultivars above) scrunch up and place in a bowl. Take one bit of paper out of the bowl and write the number on the paper in the first unit of your field plan. Repeat the process until all units within a block one have been numbered. Return the bits of paper to the bowl, mix up, withdraw and repeat the numbering process on the other three blocks. This procedure largely eliminates any pattern in the distribution of the treatments (varieties) within a block, which consequently minimises any bias towards a particular cultivar because of the particular position it occupies.

Field plan and notebook

Draw up a field plan to scale (Figure 1). Include all plants within the experimental area as well as reference points which may be used by others independently visiting the site. Indicate what each treatment is. A laminated field plan is both sturdy and waterproof.

Every visit to the experimental site should be entered in you note book and entries with dates made on site. Include any observation or action that may impact on the subsequent performance of individual plants. This may become vital information when trying to account for the subsequent poor performance of plants.

Budgets

Funds

Research budgets for the proposed project must be drawn up. Funds ought to be identified for the research work and spent on research activities. Drawing research funds from a common pool always introduces some element of ongoing reluctance, particularly when the research results seem not to be going anywhere. This may jeopardise the completion of research commitments. Both cash and time needs for the research project need to be critically estimated, with some contingencies to account for initial inadequate estimates.

Time requirements

Research is a time consuming activity and time is by far the single most quoted factor identified by grower DOOR research trainees as a negative aspect of research. Good research is a painstaking activity and not consistent with corner cutting. Unless you have the experience, most time budgeted activities are likely to take two to three times longer than expected.

Priorities

Critical research activities are likely to clash with very high farm priorities particularly at harvest. The likelihood of immediate income to be gained from the farm operation is likely to reduce the priority given to any research activity that clashes with it, simply because the value of the research is not assured and will occur in the more distant future. In recognizing this in the planning stage, contingencies should be put in place (hiring labour specifically to carry out the research work) to minimise this dilemma.

Risk

Creative research is a much more risky activity than recipe research because some of the former type of research is often based on a hunch that does not necessarily include the missing key. By contrast, there is no missing key in this recipe research since the test is simply assessing whether or not the varieties are better, worse or no different from industry standard varieties. However, the work is not entirely risk free since the trial area could be wiped out (disease, insect, hailstorm, fire), or there be a fatal error in the conduct of the experiment such as inadvertently getting your labelling wrong or unknowingly mixing up your cultivars at the start.. The likelihood of the latter sources of risk is minimised by having the work conducted by the owner/operator who has a huge vested interest in doing the job properly. Hired help should always be supervised.

Benefit cost considerations

During the trial planning stage it is important to make some rough assessment on the likely value of the information generated by the proposed experiment. While the estimates may be rubbery they should provide a realistic ball park against which you should match the likely additional costs of running the experiment.

Five questions should be answered (Table 1), in the first instance as a ‘high’ value or as a ‘low’ value. If there are a lot of ‘highs’ in the Gains row and a lot of ‘lows’ in the Losses row then it is very likely that you should continue. However, if it is not so clear cut then putting in actual values into the various boxes may be necessary. The choice of the ratio of benefit to cost that determines whether the work should proceed or not is yours. The level of risk you are prepared to take in achieving your research goal should also be taken into account. However, if you do elect to proceed, do so with the aim of completing the project and not one of pulling out if results appear not to pan out as expected. The completion of a project will place you in a much better position to conduct the next one, even if it doesn’t provide the advantage you were after.

Pre-schedule (P 89 DOOR Manual).

This form is a listing of all the activities that are to be carried out, with adjacent boxes to be filled out (Table 2). This is one of the ‘must’ activities in your experimental diary. It is intended to encourage you to think everything through and find answers if the information is not available prior to starting any field operation. Some questions obviously cannot be answered until the experiment is completed. It becomes an invaluable aid to your subsequent operations and particularly so to any one else involved in the project. It forms one element of your permanent record.

Operation (P 39 DOOR Manual)

Grading stock

To reduce experimental variation, all plant stock should be graded prior to planting out. Divide up the graded stock into categories by the number of blocks, in this case four. The top category grade plants are allocated to block one, the second to block two and so on. This means that there should be minimum variation in plant size within a block of six treatments.

Planting

Dig a hole and transplant the tubestock preferably in a way that would mimic as closely as possible commercial practice. Complete the planting of one block before moving onto the next. Getting caught out in a rainstorm with two blocks partially planted creates much greater statistical problems than with one block if planting is delayed by 2-3 days.

Avoiding mistakes

It is very easy to make mistakes in a field operation, particularly if you are working on your own without additional checking going on. Record any mistakes but try to develop a fail-safe system that minimises their occurrence. In the present case, place plot number and treatment detail (on a card) on relevant plants, rather than carrying them all around in the same carryall. This discipline takes additional time but this is well spent if it eliminates mistakes. Clearly mark your plot with a painted stake (UV stable plastic is preferred) and wrap fade resistant coloured material around one of you datum plants. A colour code can be developed that relates to the particular cultivar. Subsequent observational visits can be done quickly without having to hunt around for plot stakes.

Measurements

Plant height (soil surface to highest bud) and width (widest point, leaf tip to leaf tip) should be measured at 2-3 monthly intervals. The first measurement could be made just prior to the first pruning. In single stemmed species, the diameter (girth) of the stem 30cm above ground level (avoiding the graft union) is often a good indicator of overall plant growth. Mark the trunk where girth measurements are taken with white acrylic paint to ensure consistency of measurement from year to year. When the trunks get bigger, a galvanised clout hammered half way into the trunk wood provides a permanent measurement marker.

In multi-stemmed species, mark 5 stems as representative of the rest on the individual bush and measure their heights as well as stem diameters one –two cm up the stem. Select stems by counting the total number on the plant, divide by 5 (quotient equals x) and then select each xth plant to give you a total of five stems per plant. These stems could be followed right through to harvest with their values expressed as a proportion of the total marketable stems on that plant. Measuring total plant yields made up of many flowering stems presents quite a logistic problem particularly when stems are harvested over a period and not all at once. One approach may be to colour code stem bases with two colours of pressurised plastic paint; one colour indicating the block while the second (higher on the stem) indicates the treatment. These stems would be graded with others but identified and so recorded according to their colour combination. If this information is vital to the output of the experiment additional labour resources to carry out these measurements may have to be obtained.

Data collection

All measurements should be immediately entered into a record sheet (see Table 2) and then forwarded to your consultant for statistical analyses. To maintain analytical efficiency it is important that the data is entered in the designated order. Providing the data in an Excel spreadsheet would be preferred.

Meterological data

Rainfall on site is the minimum meterological data that should be collected, preferably on a daily basis, but at a minimum on a weekly basis. A crude system of a funnel sitting in a large capacity bottle as a rain gauge would suffice with a record being made of the volume of water accumulated each week. From the area of the funnel it is a simple matter to convert such volumes to a rainfall measurement. Summer storms are notoriously variable in their rainfall distribution and using home site rainfall to estimate experimental site rainfall may be quite misleading.

Daily maximum and minimum temperature data should also be collected. If you are able to collect a month's worth of data from your site once in the peak of summer and again in the depths of winter you would be able to assess how your values can be converted from your closest official weather station. You may then be able to use the official site for your own site-specific information.

Data analyses (P 47 DOOR Manual)

Means

After collecting the above data, they are converted into plot means for plant height and diameter, stem number, stem length and total stem length per plot. Cultivar means averaged over the four blocks on their own give some indication of their relative ranking . However, these arithmetic means do not account for plant-to-plant variability or the variability caused by all sorts of gradients in the field environment (soil depth, soil water, nutrient supply, disease incidence, etc.). Thus, it is not possible to conclude whether the apparent difference among cultivars are likely to be real or due to genetic or site variability or even experimental error. This is less of a problem when the differences among varieties are large and the apparent variability slight, but this is rarely the case with wildflower species.

Analysis of variance

To detect whether it is likely that differences are true, an analysis of the trial variances is conducted (ANOVA). Your consultant, rather than the grower may carry out this procedure themselves. Variances attributed to the blocks (replicates), the cultivars and other sources (called error) are calculated. The blocks and treatment variances are then compared with the error variance to give the Variance Ratio (VR). If the ratio is one or less, we can conclude that there was no effect of these two factors on plant performance. However, the more these values exceed the error variance the more likely cultivar performance is really different. And we are able to attribute a probability statement to these values (or VRs) that indicate how likely the observed difference between error and the factor (in this case the varieties) is just due to chance. Thus a factor with a probability statement of $P<0.05$ means that the result would likely to have occurred by chance 1 in every 20 time the experiment was conducted. A $P<0.01$ indicates a probability of 1 in every 100 times.

Least significant difference (LSD)

In addition, the analysis of variance allows the calculation of the amount by which cultivars need to differ in order to be deemed significantly ($P=0.05$) different (called the Least Significant Difference or LSD). Thus, in the present case, four of the varieties may not have differed from the standard by this amount while a fifth may have. If so, then only the last cultivar would be assessed as being significantly better than the control (industry standard cultivar). If the yield of one cultivar for example was lower than the industry standard variety (control) by more than the LSD value, then it would have been assessed as being significantly lower yielding.

Coefficient of variation (CV)

Finally, the ANOVA allows the calculation of the experimental coefficient of variation (%CV). This value indicates how variable the data are and determines how much confidence to place in an experiment where no effects were significant. It is desirable to have as small a CV as possible. Increasing the number of samples in the datum and selecting less variable indices may reduce high CVs. The effect of high CVs in reducing precision can be also minimised by increasing the number of replicates.

Results

Caution and confidence.

The results from an experiment of this type always have an element of doubt and should be adopted cautiously, particularly annual results that are heavily influenced by environmental and seasonal conditions. Obviously the lower the probability test (P) of this result just being due to chance, the more confidence you will have of the result being an indication of a real difference. Confidence will be greatly enhanced if your results match what other growers have found. It is unlikely that the magnitude of your response will be identical to those observed by others, simply because your test is being conducted in a unique environment. Your unique environment also changes with season and year. Thus, this result will reflect the complex interaction of weather conditions that applied during

the course of the experiment. Responses will vary from year to year. There is merit in repeating the experiment for at least 3 years to get some assessment of the effect of seasonal variation.

Farm scale
Bear in mind that the experimental size of the project does not necessarily take into account all relevant farm operational activities. It would be desirable to scale the new cultivars up to farm size and assess them under routine farm conditions before fully converting.

Benefit: cost assessment. (P 25 Door Manual)
The differences among cultivars need to be put into economic terms since in some cases a significant but small improvement in yield may not necessarily match additional or more costly inputs. Repeat the BC exercise above (Table 1).

The decision to plant new cultivars will be determined by how much the costs of implementation are exceeded by the additional benefits. Such benefits are not simply economic since they may involve lifestyle (peak work clash with a holiday period) and even ethical issues. There is always an element of risk that such benefits will actually not occur, since unforseen circumstances can upset sound predictions. A rule of thumb that some use is to implement the recommendation when the B/C ratio exceeds 2. This may be a lot less in the case of cultivar selection where the level of inputs are often identical with the current cultivar. Of course the actual choice is yours.

Recommendations and report (P61 DOOR Manual)
The work has been done, the data have been analysed and the results discussed from a variety of viewpoints. Recommendations on the new varieties can now be drawn up in terms of why, when, where, how and by whom. Such recommendations ought to involve all interested operational staff to ensure all relevant perspectives are accounted for.

Report
The whole project should be written up using the header format of *topic/title, operators, consultant, aim of work, treatments, start and completion dates, how the work was done, measurements, results, interpretation, recommended action, further experimental work, references to other papers and reports* (P100 DOOR Manual). This report should be securely filed in both electronic and hard copy form, together with the preschedule, the raw data and the analysed data.

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The new information that has been generated has cost you a considerable amount of time and effort and must be valued accordingly. The information should be seen as intellectual property that has direct relevance to the profitable operation of your enterprise. The value of this property should not be overlooked in the assessment of your operational assets for possible sale. Furthermore, such value should be taken into account if approached by others seeking to use data in any way.

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How much nitrogen to apply to a wildflower crop

Mal Hunter

The need for grower run research

With the declining availability of the government research dollar other resources must be developed. This is especially true for those new industries that have attracted only minor government support in the past and are finding more and more problems as their industry expands with less and less resources to solve them. Growers themselves may provide that needed resource

Growers have always done their own research but it has generally been informal, intuitive and observational. Nonetheless, in many cases such research has been successful and the development of many industries, despite little in the way of formal research support, is testament to the observational skills of the growers involved.

Observational research is successful in the resolution of issues where differences in the effects of the various options are large and readily obvious. Economically viable cultural systems are developed in this way but, as they mature and become increasingly dependent on fine tuning to maintain their competitive edge, more critical research that can detect small differences becomes necessary. Observational research thus gives way to statistical research. The statistical research approach underpins the DOOR concept of grower responsibility and involvement in their own sound research (Hunter et al, 1996).

The following research project has been designed for the grower rather than the research scientist. However, it is expected that the grower will consult with a competent research consultant on a needs basis, as well as using the specific skills of a statistician in analysing the data. The methodology is based on the DOOR Manual for Plant Nurseries (1996) in which all elements of the research cycle are fully covered. Reference will be made throughout the Research Recipe to the DOOR Manual.

Problem definition and literature review (P 11 DOOR Manual)

Introduction

Many wildflower species will grow on a wide range of soils, many of which are at the ‘poor’ end of the scale when their suitability for arable farming is considered. The question arises “how to make these soils more productive while minimising inputs?”

Soils vary greatly in their inherent nutrient status, ranging from well structured fertile clays through to leached sands almost devoid of nutrient. In the case of the former little added nutrient will be needed, while in the latter a complete balanced nutrient regime will be needed until the organic fraction has been sufficiently built up and nutrient cycling (rather than leaching) predominates.

Background

Nitrogen, the nutrient in most demand by the crop, is often the first nutrient to run out. It can be replaced with inorganic forms singly, as ammonium nitrate or urea, in forms combined with other nutrients such as ammonium sulphate, calcium nitrate, or potassium nitrate or as ammoniated phosphorus forms. Slow release synthesised forms include ureaformaldehyde, isobutylidene diurea (IBDU) and crotonylidene diurea (Crotodur). Legume mulches (lucerne hay), manures and abattoir wastes are all sources of slow release nitrogen.

Responses to added nutrients over a wide set of conditions in Australian plant species has been often recorded. Kriedemann and Cromer (1966) demonstrated growth responses to phosphorus and nitrogen in eucalyptus species in wood production. Reed (1993) discussed the effects of trace elements, nitrogen, phosphorus and potassium on Geraldton Wax, while Maier et al (1996) reports on the effects of nitrogen and potassium on stem growth and yield of waxflower spp.

Barth and Maier (1996) found that effective nitrogen strategies in Australian waxflower had to take soil type, variety flushing characteristics and harvest period into account. Recent work by Heap et al

(see DOOR in Wildflowers RIRDC Report) showed that N application (25 g N applied per tree fortnightly during period late August and late October) significantly increased the number of stems and financial returns of *Leucadendron*, cv. Safari Sunset growing in grey acid sand of the south west region of Western Australia. This supports the suggestion from South Australia (Maier 1994) that annual applications of 20-30g/plant of N should be considered for irrigated Protea and *Leucadendron* crops.

Aim of experiment

To compare the effect of adding five levels of N on growth and economic productivity of wildflower with the existing system of crop management (which may already include some nitrogen).

The following Research Recipe guides you in setting up an experiment to evaluate the effects of these nitrogen rates on plant performance under you own environmental conditions. The methods you apply and the data you collect will allow you to assess whether additional nitrogen is useful and whether it has a deleterious effect on some aspect of your production system such as rank growth or poor flower quality.

Method

Selection of treatments
Water only will be applied to one treatment (referred to as the control). Five nitrogen treatments will include 5, 10, 20, 40, and 80 g of N applied annually per plant.. With sands these should be split applied at 2 weekly intervals over a 10 week period, i.e. 1, 2, 4, 8, and 16g N / plant per application five times. With heavy soils this may be split into 3 applications, 3 weeks apart of 1.7, 3.3, 6.7,13.3 and 26.7 g N / plant. Treatments will be applied to coincide with the start of the vegetative flush period when maximum demand for N could be expected.

Nitrogen source
For the sake of this recipe ammonium nitrate will be used. The main advantage of using this source for experimental purposes is that it is not combined with any other plant nutrient. Plant nutrients combined with nitrogen such as calcium in calcium nitrate or sulphur in ammonium sulphate may confound the real effect of nitrogen if these associated elements are in marginal supply. In other words, increasing the levels of nitrogen in the form of these compounds would also mean increasing levels of the associated nutrient. This can be accounted for by balancing these nutrient levels throughout the experiment but this is quite a fiddly process.

Use of ammonium nitrate will have a slight acidifying effect. So its potential effect in making some trace elements more available needs to be considered. Since ammonium nitrate contains 35% N, the above treatment rates will convert into total compound equivalents of ammonium nitrate of 14.3, 28.6, 57.1, 114.3, and 228.6g / plant.

Planting material
Obtain the best stock you can of an appropriate age. Have the stock delivered after you have set up the trial site, particularly if this is the first experiment of this sort that you have conducted. Delays in planting out should be avoided and getting the field site organised is likely to take much longer than you first expect. If possible, find out how this stock was produced since the culture system and the inputs may impact on the how the plants perform. For example, tubestock produced from well fertilised stock may perform better than cuttings taken from another stock plant growing under nutrient stress.

Site selection
Select an area that is representative of the area that you wish to apply the results to, preferably flat or with even slope and of the same soil type. This is often an impossible ask. At a minimum, ensure that the environmental conditions within each replicate (or block) are similar. Thus, you may have 4 replicates all on slightly different soils or at different positions on the slope or on different depths.

However, ensure that within the replicate, levels of these factors are similar. This will minimise any unfair advantage that any treatment will get simply because of its location.

Site characterisation
It is important that you know what you soil resource is. A good indicator of this is the native vegetation it once supported and their association with soil types (and their inherent productivity) in the district. Unfortunately, in many cases such vegetation has long since disappeared. Other information must be sought. Preferably, dig a soil pit at your experimental site and have a professional soil surveyor describe the soil profile. Additional pits may need to be dug if there are large differences among your blocks.

Samples of soil from the various horizons should be submitted to a reputable analytical laboratory for chemical and physical assays. Soil samples to 10 cm depth at least should be collected from each replicate (20 cores at random in each replicate which are bulked to make one kg sample per replicate) and submitted for chemical assay. Soil profile characterisation needs to be done once only, while surface soil tests ought to be monitored, say on a two yearly basis and even more often for nitrogen, particularly if removal rates as vegetation are large.

The importance of this information to your management practices cannot be overstated, since they will allow you to critically assess what your soil resource is and how it should be managed.

Design and layout

Size and shape
You must first consider the size and shape of your experimental unit. To minimise interplot interference, each unit should include a minimum of three datum plants preferably bounded on either side by a row of five plants (guard plants), with an additional two plants (guard plants), one at either end of the row (Figure 1). The use of more than three datum plants is desirable and will improve precision but would require a greater area. Note that the minimum plant number that should be used will increase the more variable your planting material. This could be substantial if your species is not genetically homogenous. The increased precision with larger plots will have to be traded off against greater costs for planting material, difficulty in finding a sufficiently large enough contiguous area of similar plants and increased time taken in collecting data. If plots become too large their value may also be compromised by spatial variation in soil conditions.

Guard plants may be omitted where spaces between plants are large with little or no interplant competition for light, nutrients and water, or where there is no influence from the adjoining treatment. Once the experimental unit has been determined, the next step is to arrange these units into blocks (or replicates). The number of units in each block equals the number of treatments including the control that are being investigated. In this present example five nitrogen rates are being compared with a sixth treatment, which is representative of routine nitrogen practice. If possible, arrange these six units in a square land area to minimise soil variation effects. Ensure that these units within each block are on roughly the same contour down a slope (Figure 1). A minimum of four blocks or replicates should be laid out, requiring a total of 24 units (ie.6 treatments by 4 replicates). Including more blocks (of six units each) will improve experimental precision. As a rule of thumb, where possible blocks should be laid out down the major gradient (with units within replicates across the gradient).

Thus, in a fully guarded experiment with the example above, a total of 360 plants (15 per unit by 6 treatments by 4 blocks (replicates)) would be required. In laying out each block as a quarter of a square, the experiment would occupy an area 44 m long by 43.2 m wide (2 m between plants in the row and rows 2.4 m apart, Figure 1). If guarding is unnecessary, this is reduced to 72 plants in an area 28 m long by 19.2 m wide.

Randomisation
The position of each unit within a block must be randomly allocated . Number six small squares of paper 1 to 6 (the six treatments above) scrunch up and place in a bowl. Take one bit of paper out of the bowl and write the number on the paper in the first unit of your field plan. Repeat the process until

all units within a block one have been numbered. Return the bits of paper to the bowl, mix up, withdraw and repeat the numbering process on the other three blocks. This procedure essentially eliminates any pattern in the distribution of the treatments within a block, which consequently minimises any bias towards a particular treatment because of the particular position it occupies.

Field plan and notebook
Draw up a field plan to scale (Figure 1). Include all plants within the experimental area and include reference points which may be used by others independently visiting the site. Indicate what each treatment is. A laminated field plan is both sturdy and waterproof.

Every visit to the experimental site should be entered in you note book and entries with dates made on site. Include any observation or action that may impact on the subsequent performance of individual plants. This may become vital information when trying to account for the subsequent unusual performance of plants.

Budgets

Funds
Research budgets for the proposed project must be drawn up. Funds ought to be identified for the research work and spent on research activities. Drawing research funds from a common pool always introduces some element of ongoing reluctance, particularly when the research results seem not to be going anywhere. This may jeopardise the completion of research commitments. Both cash and time needs for the research project need to be critically estimated, with some contingencies to account for initial inadequate estimates.

Time requirements
Research is a time consuming activity and time is by far the single most quoted factor identified by grower DOOR research trainees as a negative aspect of research. Good research is a painstaking activity and not consistent with corner cutting. Unless you have the experience, most time budgeted activities are likely to take two to three times longer than initially estimated.

Priorities
Critical research activities are likely to clash with very high farm priorities particularly at harvest. The much greater likelihood of immediate income to be gained from the farm operation is likely to reduce the priority given to any research activity that clashes with it, simply because the value of the research is not assured and will occur in the more distant future. In recognizing this in the planning stage, contingencies should be put in place (hiring labour specifically to carry out the research work) to minimise this dilemma.

Risk
Creative research is a much more risky activity than recipe research because some of the former type of research is often based on a hunch that does not necessarily include the missing key. By contrast, there is no missing key in this present recipe research since the test is simply assessing whether or not additional nitrogen is better, worse or no different from your routine fertiliser practice that already probably contains some nitrogen. In the present case, five nitrogen rates are being assessed for their efficacy in plant productivity. By the end of the project the results will indicate whether additional nitrogen is worth applying and at what level. However, the work is not entirely risk free since the trial area could be wiped out (disease, insect, hailstorm, fire), or there may have been a fatal error in the conduct of the experiment (mixing up and applying solutions, recording data). The likelihood of the last source of risk is minimised by having the work conducted by the owner/operator who has a huge vested interest in doing the job properly. Hired help should always be supervised.

Benefit:cost considerations (P 25 DOOR Manual)
During the trial planning stage it is important to make some rough assessment on the likely value of the information generated by the proposed experiment. While the estimates may be rubbery they should provide a realistic ball park against which you should match the likely additional costs of running the experiment (Table 1).

Five questions should be answered, in the first instance as a 'high' value or as a 'low' value. If there are a lot of 'highs' in the Gains row and a lot of 'lows' in the Losses row then it is very likely that you should continue. However, if it is not so clear-cut then putting in actual values into the various boxes may be necessary. The choice of the ratio of benefit to cost that determines whether the work should proceed or not is yours. The level of risk you are prepared to take in achieving your research goal should also be taken into account. However, if you do elect to proceed, do so with the aim of completing the project and not one of pulling out if results appear not to pan out as expected. The completion of a project will place you in a much better position to conduct the next one even if it doesn't provide the advantage you were after.

Pre-schedule (P 89 DOOR Manual)
This form is a listing of all the activities that are to be carried out, with adjacent boxes to be filled out (Table 2). This is one of the must activities in your experimental diary. It is intended to force you to think everything through and find answers if the information is not available prior to starting any field operation. Some questions obviously cannot be answered until the experiment is completed. It becomes an invaluable aid to your subsequent operations and particularly so to any one else involved in the project. It forms one element of your permanent record.

Operation (P 39 DOOR Manual)

Planting material
Obtain the best stock you can of an appropriate age. Have the stock delivered after you have set up the trial site, particularly if this is the first experiment of this sort that you have conducted. Delays in planting out should be avoided and getting the field site organised is likely to take much longer than you first expect. If possible, find out how this stock was produced since the culture system and the inputs particularly nitrogen may impact on the level of nitrogen response

Grading stock
To reduce experimental variation, all plant stock should be graded prior to planting out. Divide up the graded stock into categories by the number of blocks, in this case four. The top category grade plants are allocated to block one, the second to block two and so on. This means that there should be minimum variation in plant size within a block of six treatments. On no account allocate a particular grade to a particular treatment.

Nitrogen may be applied to already existing field plants rather than new plants, especially those that are considered long term perennials. Appropriate plant selection is critical. Establish replicates within which all the datum plants (the ones that are measured) are of similar form and health. Datum plants should be bounded on either end of their row with non-datum plants to provide a buffer against adjoining treatment effects (see Figure 1).

Nitrogen delivery
While nitrogen can be applied as a solid or in solution, the choice is to apply it here as a solution to simulate its routine application via drippers. The required amount of solution will be injected by syringe into the soil (say 10cm deep) directly beneath the dripper outlet. If each tree has two drippers the amount will be divided equally. Alternative delivery approaches with, for example, slowly dripping containers or inverted bottles, containing the required amount of solution (more dilute than in the syringe), stuck into the ground ought to be considered. Any experimental delivery system should closely simulate the ultimate practical delivery system to be used, be cheap to acquire and be implemented with minimum time spent. Note that these experimental costs, especially time, may be high and need to be carefully weighed against ultimate benefits. Bear in mind that reliable staff may be able to look after some of these somewhat protracted application procedures.

Complete treating and planting one block before moving onto the next. Getting caught out in a rainstorm with two blocks partially treated creates much greater statistical problems than with one block if treatment application is delayed by 2-3 days.

Avoiding mistakes
It is very easy to make mistakes in a field operation, particularly if you are working on your own without additional checking going on. Record any mistakes but try to develop a fail safe system that minimises their occurrence. In the present case, before adding any nitrogen, place plot number and treatment detail (on a card) and the container of each nitrogen solution in the relevant plot, rather than carrying them all around in the same carryall. This discipline takes additional time but this is well spent if it eliminates mistakes. Clearly mark your plot with a painted stake (UV stable plastic is preferred) and wrap fade resistant coloured material around one of you datum plants. A colour code can be developed that relates to the particular treatment. Subsequent observational visits can be done quickly with out having to hunt around for plot stakes.

Measurements
Measurements (height from soil surface to topmost bud, and width as the widest part, leaf tip to leaf tip) must be carried out on datum plants at or prior to treatment application to account for variation not attributable to the various amendment treatments. These data are used in data analysis to reduce plant to plant variation. In single stemmed species, the diameter (girth) of the stem 30cm above ground level (avoiding the graft union) is often a good indicator of overall plant growth. Mark the trunk where girth measurements are taken with white acrilic paint to ensure consistency of measurement from year to year. When the trunks get bigger, a galvanised clout hammered half way into the trunk wood provides a permanent measurement marker.

In multi-stemmed species, mark 5 stems as representative of the rest on the individual bush and measure their heights as well as stem diameters one –two cm up the stem. Select stems by counting the total number on the plant, divide by 5 (quotient equals x) and then select each xth plant to give you a total of five stems per plant. These stems could be followed right through to harvest with their values expressed as a proportion of the total marketable stems on that plant.

Measuring total plant yields made up of many flowering stems presents quite a logistic problem particularly when stems are harvested over a period and not all at once. One approach may be to colour code stem bases with two colours of pressurised plastic paint; one colour indicating the block while the second (higher on the stem) indicates the treatment. These stems would be graded with others but identified and so recorded according to their colour combination. If this information is vital to the output of the experiment additional labour resources to carry out these measurements may have to be obtained.

Data collection
All measurements should be immediately be entered into a record sheet (see Table 3) and then forwarded to your consultant for statistical analyses. To maintain analytical efficiency it is important that the data is entered in the designated order. Providing the data in an Excel spreadsheet would be preferred. Do not include information on guard plants.

Meterological data
Rainfall on site is the minimum meterological data that should be collected, preferably on a daily basis, but at a minimum on a weekly basis. A crude accumulating rain gauge may consist of a funnel sitting in a large capacity bottle with a record being made of the volume of water accumulated each week. From the horizontal area of the funnel it is a simple matter to convert such volumes to a rainfall measurement. Summer storms are notoriously variable in their rainfall distribution and using home site rainfall to estimate experimental site rainfall may be quite misleading.

Daily maximum and minimum data should also be collected. If you are able to collect a month's worth of data from your site once in the peak of summer and again in the depths of winter you may be able to assess how your values may be converted from your closest official weather station. You could then use the official site for your own site specific information.

Photoperiod or day length is another important variable that often determines the onset of flower initiation. This is normally simply determined on the basis of latitude. However its value can be slightly modified by local topography and this can have a significant effect on sensitive species.

Data analyses **(P 47 DOOR Manual)**

Means

After collecting the above data they are converted into plot means for plant height and diameter, stem number, stem length and total stem length per plot. Treatment means averaged over the four blocks on their own give some indication of the relative ranking of the five amendments and control. However, these arithmetic means do not account for plant to plant variability or the variability caused by all sorts of gradients in the field environment (soil depth, soil water, nutrient supply, disease incidence, etc.). Thus, it is not possible to conclude whether the apparent difference among treatments are likely to be real or due to genetic or site variability. This is less of a problem when the differences among treatments are large and the apparent variability slight.

Analysis of variance

To detect whether it is likely that differences are true, an analysis of the trial variances is conducted (ANOVA). Variances attributed to the blocks (replicates), the treatments and other sources (called error) are calculated. The blocks and treatment variances are then compared with the error variance to give the Variance Ratio (VR). If the ratio is one or less, we can conclude that there was no effect of these two factors on plant performance. However, the more these values exceed the error variance the more likely they have had a real effect. And we are able to attribute a probability statement to these values (or VRs) that indicate how likely the observed difference between error and the factor (in this case the nitrogen rates) is just due to chance. Thus, a factor with a probability statement of $P = 0.05$ means that the result would likely to have occurred by chance 1 in every 20 time the experiment was conducted. A $P = 0.01$ indicates a probability of 1 in every 100 times.

Least significant difference (LSD)

In addition, the analysis of variance allows the calculation of the amount by which levels of a factor need to differ in order to be deemed significantly ($P=0.05$) different (called the Least Significant Difference or LSD). Thus, in the present case, five of the nitrogen rates may have differed from the control but not have been different among themselves. If so, then only the first level (5g of N /plant) would be assessed as having had a significant effect on plant performance. If the heaviest rate of nitrogen had depressed growth by more than the LSD value then it would have been assessed as having had a significant negative effect on plant performance.

Coefficient of variation (CV)

Finally, the ANOVA allows the calculation of the experimental coefficient of variation (%CV). This value indicates how variable the data are and determines how much confidence to place in an experiment where no effects were significant. It is desirable to have as small a CV as possible. High CVs may be reduced by increasing the number of samples in the datum and selecting indices that are less variable. The effect of high CVs in reducing precision can be also minimised by increasing the number of replicates.

Environmental consequences

It is important to examine how the conduct of the research, and indeed implementation of any of the recommendations that flow from it, could impact adversely on the local environment. For example, in the present case excessive nitrogen, even if some of it is beneficial, may be contaminating the local watercourses and generating excessive algal growth. Can such an impact be minimised to acceptable levels or even eliminated by preventing the water entering the watercourse? 'Better' crop husbandry practices should only be implemented if they have nil or at the most only relatively little adverse effects on the environment.

By its very nature, the act of farming has a huge adverse impact on ecological systems. Doing nothing, however, on cleared and cropped land may generate bad weed problems and be ecologically

irresponsible. Farming wildflowers enhances survival of the species concerned, while generating income with which more sustainable and ecologically sound practices can be put in place.

Results

Caution and confidence

The results from an experiment of this type always have an element of doubt and should be adopted cautiously. Obviously the lower the probability test (P) of this result just being due to chance, the more confidence you will have of the result being true. Confidence will be greatly enhanced if your results match what others have found. It is unlikely that the magnitude of your response will be identical to those observed by others, simply because your test is being conducted in a unique environment. Your unique environment also changes with season and year as does the plant age. Thus, this result will reflect the complex interaction of weather conditions that applied during the course of the experiment and the responsiveness of you species at this age to additional nitrogen. Responses will vary from year to year. There is merit in repeating the experiment the following year to get some assessment of the effect of seasonal and age effects.

Farm scale

Bear in mind that the experimental size of the project does not necessarily take into account all relevant farm operational activities. It would be desirable to scale the new technology up to farm size and test the new technology under actual farm conditions before fully converting.

Benefit: cost assessment

The responses you observe need to be put into economic terms since in some cases a significant but small improvement will not necessarily match additional inputs. Repeat the B/C exercise above (Table 1).

The decision to implement the technology will be determined by how much the costs of implementation are exceeded by the benefits. Such benefits are not simply economic since they may involve lifestyle and even ethical issues. There is always an element of risk that such benefits will actually not occur, since unforseen circumstances can upset sound predictions. A rule of thumb, that some use is to implement the recommendation when the B/C ratio exceeds 2. Of course the actual choice is yours.

Recommendations and report (P61 DOOR Manual)

The work has been done , the data have been analysed and the results discussed from a variety of viewpoints. Recommendations on how the new technology should be viewed can now be drawn up in terms of why, when, where, how and by whom. Such recommendations ought to involve all interested operational staff to ensure that all relevant perspectives are accounted for.

Report

The whole project should be written up using the header format of topic/title, operators, consultant, aim of work, treatments, start and completion dates, how the work was done, measurements, results, interpretation, recommended action, further experimental work, references to other papers and reports (P100 DOOR Manual). This report should be securely filed in both electronic and hard copy form, together with the preschedule, the raw data and the analysed data.

Intellectual property

The new information that has been generated has cost you a considerable amount of time and effort and must be valued accordingly. The information should be seen as intellectual property that has direct relevance to the profitable operation of your enterprise. The value of this property should not be overlooked in the assessment of your operational assets for possible sale. Furthermore, such value should be taken into account if approached by sellers of the technology who are seeking to use data of this sort to support their claims.

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How much water to add to a wildflower crop

Mal Hunter

The need for grower run research

With the declining availability of the government research dollar other resources must be developed. This is especially true for those new industries that have attracted only minor government support in the past and are finding more and more problems as their industry expands with less and less resources to solve them. Growers themselves may provide that needed resource

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Observational research is successful in the resolution of issues where differences in the effects of applying the various options are large and readily obvious. Economically viable cultural systems are developed in this way but as they mature and become increasingly dependent on fine tuning to maintain their competitive edge, more critical research that can detect small differences becomes necessary. Observational research thus gives way to statistical research. The statistical research approach underpins the DOOR concept of grower responsibility and involvement in their own sound research (Hunter et al., 1996).

The following research project has been designed for the grower rather than the research scientist. However, it is expected that the grower will consult with a competent research consultant on a needs basis, as well as using the specific skills of a statistician (or skilled researcher) in analysing the data. The methodology outlined below is based on the DOOR Manual for Plant Nurseries (1996) in which all elements of the research cycle are fully covered. Reference will be made throughout the Research Recipe to the DOOR Manual.

Problem definition and literature review (P 11 DOOR Manual)

Introduction

Many wildflower species grow on a wide range of soils, many of which are at the ‘poor’ end of the scale when their suitability for arable farming is considered. While such species are adapted to moisture stress their growth and flower production may be enhanced by increasing the supply of water.

Soils vary greatly in their inherent water holding characteristics, ranging from well structured high water holding capacity clays through to coarse sands which hold relatively little water. In the case of the former little additional water may be needed in high rainfall areas, while in the latter economic production may be impossible without irrigation.

Irrigation

As pointed out by Stephenson (1986), irrigation is also involved in nutrient supply, pesticide applications, frost control, temperature and humidity control. Irrigation can be used to control plant size and flower drop. Irrigation thus has many uses. For the sake of this recipe, trickle irrigation frequency will be considered at two levels of nitrogen applied in the water.

The trigger for switching on irrigation is an important issue varying from the crude one of ‘gut’ feel to the sophistication of monitoring of moisture tensions within the plant itself. Developing a crude water balance that accounts for daily loss (evaporation Class A pan, Slater (1997) and transpiration (dependent on plant size) and inputs from rain may be used (Keefer, 1986). Soil moisture around the root system may be monitored with tensiometers (Yiasoumi, 1994) at 30 and 50 cm deep half way out from the butt to the plant’s dripline (Stephenson, pers. comm.). Alternatively, domain capacitance probes (Malcolm Durham, Horticultural Crop Monitoring, pers. comm.) may provide real time moisture information of the soil profile that can be used to automatically trigger an irrigation event when a predetermined state has been reached.

Assuming that the amount of irrigation water is finite (and costs money), some consideration needs to be given to the period of its most effective use. Seaton (1996) has developed a water budget for wildflowers that identifies month, water per plant, frequency of watering, duration of application through emitters and daily start times. Timing of water application to distribute more evenly throughout the day saves water, reduces drainage and nutrient loss. Yiasoumi (1994) outlines, in his paper on cutflower irrigation, different irrigation systems including low pressure emitters, low pressure/low throw sprinklers, micro-irrigation systems, mini-sprinklers and drip irrigation emitters.

Lantzke (1995) surveyed the rate, frequency and application methods of nutrients and water to ten flower properties in Western Australia. Seven out of the ten growers fertigated, with another two considering switching to fertigation. Recommended water application rates varied from 1-2L/plant/day in June-November, 4-6L/plant/day in December-March, 2-4L/plant/day in April to May. Frequency ranged from once per week to three times a day, presumably reflecting the storage capacity of the soil.

Aim of experiment

To establish whether variations in the amount of water currently applied have an impact on flower production and quality under two levels of nitrogen supply.

The following Research Recipe guides you in setting up an experiment to test such variations under you own environmental conditions. The methods you apply and the data you collect will allow you to assess whether variations on your current irrigation system have an effect (positive or negative or no effect) on your economic production.

Method

Selection of treatments

Choose irrigation rates that are half the usual farm rate, one and a half times the rate and twice the rate. Together with the farm practice rate this give a total of 4 irrigation treatments. For the nitrogen rates choose the farm practice nitrogen rate and one that is double this rate. Thus, if the farm practice rate is 25gN/plant/year (Treatment 1 or 1G in Figure 1b) then the second rate will be 50 g N/plant/year (Treatment 2 or 2G in Figure1b). Add the nitrogen as an ammonium nitrate (35%N) solution to the appropriate plants whenever nitrogen is added via fertigation as part of normal practice. Rather than going to the trouble of setting up a second fertigation system, slowly adding this solution close to the dripper outlet next to the plant would be an acceptable compromise. This can be achieved by placing the required amount of the solution in a container with a slow leak at the dripper outlet.

Planting material

Obtain the best stock you can of an appropriate age. Have the stock delivered after you have set up the trial site, particularly if this is the first experiment of this sort that you have conducted. Delays in planting out should be avoided and getting the field site organised is likely to take much longer than you first expect. If possible, find out how this stock was produced since the culture system and the inputs may impact on the how the plants perform. For example, tubestock produced from well fertilised stock may perform better than cuttings taken from another stock plant growing under nutrient stress.

Irrigation experiments may be conducted on existing field plants rather than new plants, especially those that are considered long term perennials. However, appropriate plant selection is critical. Establish replicates within which all the datum plants (the ones that are measured) are of similar form and health. Datum plants should be bounded on either end of their row with non-datum plants to provide a buffer against adjoining treatment effects (see Figure 1b).

Site selection

Select an area that is representative of the area that you wish to apply the results to, preferably flat or with even slope and of the same soil type. This is often an impossible ask. At a minimum, ensure that the environmental conditions within each replicate (or block) are similar. Thus you may have 4

replicates all on slightly different soils or at different positions on the slope or on different depths. However, ensure that within the replicate, levels of these factors are similar. This will minimise any unfair advantage that any treatment will get simply because of its location.

Site characterisation
It is important that you know what you soil resource is. A good indicator of this is the native vegetation it once supported and their association with soil types (and their inherent productivity) in the district. Unfortunately, in many cases such vegetation has long since disappeared. Other information must be sought. Preferably, dig a soil pit at your experimental site and have a professional soil surveyor describe the soil profile. Additional pits may need to be dug if there are large differences among your blocks.

Samples of soil from the various horizons should be submitted to a reputable analytical laboratory for chemical and physical assays. Soil samples to 10 cm depth at least should be collected from each replicate (20 cores at random in each replicate which are bulked to make one kg sample per replicate) and submitted for chemical assay. Soil profile characterisation needs to be done once only, while surface soil tests ought to be monitored, say on a two yearly basis.

The importance of this information to your management practices cannot be overstated, since they will allow you to critically assess what your soil resource is and how it should be managed.

Design and layout

Size and shape
You must first consider the size and shape of your experimental unit. To minimise interplot interference, each unit should include a minimum of three datum plants preferably bounded on either side by a row of five plants (guard plants), with an additional two plants (guard plants), one at either end of the row (Figure 1, without the guard rows). The use of more than three datum plants is desirable and will improve precision but would require a greater area. Note that the minimum plant number that should be used will increase the more variable your planting material. This could be substantial if your species is not genetically homogenous and this is often the case with wildflower species. The increased precision with larger plots should be traded off against greater costs for planting material, difficulty in finding a sufficiently large enough contiguous area of similar plants and increased time taken in collecting data. If plots become too large their value may also be compromised by spatial variation in soil conditions.

Guard plants may be omitted where spaces between plants is large with little or no interplant competition for light, nutrients and water, or where there is no influence from the adjoining treatment. Once the experimental unit has been determined, the next step is to arrange these units into blocks or replicates. The number of units in the block equals the number of treatments that are being investigated. In this present example four irrigation treatments are being assessed, with each irrigation treatment split into two sub units of two levels of nitrogen. If possible, arrange these six units in a square land area to minimise soil variation effects. Ensure that these units within each block are on roughly the same contour .(Figure 1b). A minimum of four blocks should be laid out, requiring a total of 32 units (8 treatments i.e. 4 irrigation treatments X 2 levels of nitrogen X 4 replicates) each of 5 plants, to give a total of 160 plants. Including more blocks (of eight units each) will improve experimental precision. As a rule of thumb blocks should be laid out down the gradient (with units within replicates across the gradient).

If this site was laid out as a fully guarded experiment, each unit would consist of 15 plants to give a total number of 480 (15plants by 32 plots). The unguarded experiment (Figure1b) would be 24 m wide and 44m long, while a fully guarded experiment would be 62.4m wide and 44m long.

Randomisation
The position of each main plot within a block must be randomly allocated. Number four small squares of paper 1 to 4 scrunch up and place in a bowl. Take one bit of paper out of the bowl and write the number on the paper in the first unit of your field plan. Repeat the process until all units within a

block have been numbered. Return the bits of paper to the bowl, mix up, withdraw and repeat the numbering process on the other three blocks. Repeat this exercise with 2 pieces of paper marked 1 and 2 to allocate the nitrogen sub plots within each main plot This procedure largely eliminates any pattern in the distribution of the treatments within a block, which consequently minimises any bias towards a particular treatment because of the particular position it occupies.

Field plan and notebook
Draw up a field plan to scale (Figure 1b). Include all plants within the experimental area as well as any reference points which may be used by others independently visiting the site. Indicate what each treatment is. A laminated field plan is both sturdy and waterproof.

Every visit to the experimental site should be entered in you note book and entries with dates made on site. Include any observation or action that may impact on the subsequent performance of individual plants. This may become vital information when trying to account for the subsequent poor performance of plants.

Budgets

Funds
Research budgets for the proposed project must be drawn up. Funds ought to be identified for the research work and spent on research activities. Drawing research funds from a common pool always introduces some element of ongoing reluctance, particularly when the research results seem not to be going anywhere. This may jeopardise the completion of research commitments. Both cash and time needs for the research project need to be critically estimated, with some contingencies to account for initial inadequate estimates.

Time requirements
Research is a time consuming activity and time is by far the single most quoted factor identified by grower DOOR research trainees as a negative aspect of research. Good research is a painstaking activity and not consistent with corner cutting. Unless you have the experience, most time budgeted activities are likely to take two to three times longer than expected.

Priorities
Critical research activities are likely to clash with very high farm priorities particularly at harvest. The likelihood of immediate income to be gained from the farm operation is likely to reduce the priority given to any research activity that clashes with it, simply because the value of the research is not assured and will occur in the more distant future. In recognising this in the planning stage, contingencies should be put in place (hiring labour specifically to carry out the research work) to minimise this dilemma.

Risk
Creative research is a much more risky activity than recipe research because some of the former type of research is often based on a hunch that does not necessarily include the missing key. By contrast, there is no missing key in this recipe research since the test is simply assessing whether or not the irrigation and nitrogen treatments are better, worse or no different from your routine practice. By the end of the project the results will indicate whether changes in your nitrogen and/or irrigation management should be considered. However, the work is not entirely risk free since the trial area could be wiped out (disease, insect, hailstorm, fire), the amendments may have lost their vitality before application, or there be a fatal error in the conduct of the experiment. The likelihood of the last source of risk is minimised by having the work conducted by the owner/operator who has a huge vested interest in doing the job properly. Hired help should always be supervised.

Benefit cost considerations
During the trial planning stage it is important to make some rough assessment on the likely value of the information generated by the proposed experiment. While the estimates may be rubbery they

should provide a realistic ball park against which you should match the likely additional costs of running the experiment.

Five questions should be answered, in the first instance as a ‘high’ value or as a ‘low’ value (Table 1). If there are a lot of ‘highs’ in the Gains row and a lot of ‘lows’ in the Losses row then it is very likely that you should continue. However, if it is not so clear cut then putting in actual values into the various boxes may be necessary. The choice of the ratio of benefit to cost that determines whether the work should proceed or not is yours. The level of risk you are prepared to take in achieving your research goal should also be taken into account. However, if you do elect to proceed do so with the aim of completing the project and not one of pulling out if results appear not to pan out as expected. The completion of a project will place you in a much better position to conduct the next one even if it doesn’t provide the advantage you were after.

Pre-schedule (P 89 DOOR Manual)
This form is a listing of all the activities that are to be carried out, with adjacent boxes to be filled out (Table 2). This is one of the must activities in your experimental diary. It is intended to force you to think everything through and find answers if the information is not available prior to starting any field operation. Some questions obviously cannot be answered until the experiment is completed. It becomes an invaluable aid to your subsequent operations and particularly so to any one else involved in the project. It forms one element of your permanent record.

Operation (P 39 DOOR Manual)

Grading stock
To reduce experimental variation, all plant stock should be graded prior to planting out. Divide up the graded stock into categories by the number of blocks, in this case four. The top category grade plants are allocated to block one, the second to block two and so on. This means that there should be minimum variation in plant size within a block of six treatments. On no account allocate a particular grade to a particular treatment.

Applying treatments
In the case of this example the four irrigation treatments will all commence together following a predetermined interval (based on the balance of rainfall and pan evaporation). Each treatment will then be switched off after a designated time calculated to deliver the specified quantity of water. While nitrogen can be applied as a solid or in solution, the choice is to apply it here as a solution to simulate its routine application via drippers. The required amount of solution will be injected by syringe into the soil (say 10cm deep) directly beneath the dripper outlet. If each tree has two drippers the amount will be divided equally. Alternative delivery approaches with, for example, slowly dripping containers or inverted bottles, containing the required amount of solution (more dilute than in the syringe), stuck into the ground ought to be considered. Any experimental delivery system should closely simulate the ultimate practical delivery system to be used, be cheap to acquire and be implemented with minimum time spent. Complete treating one block before moving onto the next. Getting caught out in a rainstorm with two blocks partially treated creates much greater statistical problems than with one block if treatment is delayed by 2-3 days.

Avoiding mistakes
It is very easy to make mistakes in a field operation, particularly if you are working on your own without additional checking going on. Record any mistakes but try to develop a fail safe system that minimises their occurrence. In the present case, before adding any amendment, place plot number and treatment detail (on a card) and the container of each amendment in the relevant plot, rather than carrying them all around in the same carryall. This discipline takes additional time but this is well spent if it eliminates mistakes. Clearly mark your plot with a painted stake (UV stable plastic is preferred) and wrap fade resistant coloured material around one of you datum plants. A colour code can be developed that relates to the particular treatment. Subsequent observational visits can be done quickly with out having to hunt around for plot stakes.

Measurements
Plant height (soil surface to highest bud) and width (widest point, leaf to leaf tip) should be measured at 2-3 monthly intervals. In single stemmed species, the diameter (girth) of the stem 30cm above ground level (avoiding the graft union) is often a good indicator of overall plant growth. Mark the trunk where girth measurements are taken with white acrilic paint to ensure consistency of measurement from year to year. When the trunks get bigger, a galvanised clout hammered half way into the trunk wood provides a permanent measurement marker.

In multi-stemmed species, mark 5 stems as representative of the rest on the individual bush and measure their heights as well as stem diameters one –two cm up the stem. Select stems by counting the total number on the plant, divide by 5 (quotient equals x) and then select each xth plant to give you a total of five stems per plant. These stems could be followed right through to harvest with their values expressed as a proportion of the total marketable stems on that plant.

Measuring total plant yields made up of many flowering stems presents quite a logistic problem particularly when stems are harvested over a period and not all at once. One approach may be to colour code stem bases with two colours of pressurised plastic paint; one colour indicating the block while the second (higher on the stem) indicates the treatment. These stems would be graded with others but identified and so recorded according to their colour combination. If this information is vital to the output of the experiment additional labour resources to carry out these measurements may have to be obtained.

Data collection
All measurements should be immediately entered into a record sheet (eg. see Table 2) and then forwarded to your consultant for statistical analysis. To maintain analytical efficiency it is important that the data is entered in the designated order. Providing the data in an Excel spreadsheet would be preferred.

Meterological data
Rainfall on site is the minimum meterological data that should be collected, preferably on a daily basis, but at a minimum on a weekly basis. A crude system of a funnel sitting in a large capacity bottle would suffice as a rain gauge with a record being made of the volume of water accumulated each week. From the area of the funnel it is a simple matter to convert such volumes to a rainfall measurement. Summer storms are notoriously variable in their rainfall distribution and using home site rainfall to estimate experimental site rainfall may be quite misleading. An appropriately located Class A evaporation pan should be used to measure evaporative water losses. Local weather stations may also provide this information.

Daily maximum and minimum data should also be collected. If you are able to collect a month's worth of data from your site once in the peak of summer and again in the depths of winter you would be able to assess how your values can be converted from your closest official weather station. You could then use the official site for your own site specific information.

Photoperiod is another important variable that often determines the onset of flower initiation. This is normally simply determined on the basis of latitude. However its value can be slightly modified by local topography and this can have a significant effect on sensitive species.

Data analyses **(P 47 DOOR Manual)**

Means
After collecting the above data they are converted into plot means for plant height and diameter, stem number, stem length and total stem length per plot. Treatment means averaged over the four blocks on their own give some indication of the relative ranking of the five amendments and control. However, these arithmetic means do not account for plant to plant variability or the variability caused by all sorts of gradients in the field environment (soil depth, soil water, nutrient supply, disease incidence, etc.). Thus, it is not possible to conclude whether the apparent difference among treatments are likely to be

real or due to genetic or site variability. This is less of a problem when the differences among treatments are large and the apparent variability slight.

Analysis of variance
To detect whether it is likely that differences are true, an analysis of the trial variances is conducted (ANOVA). Variances attributed to the blocks (replicates), the treatments and other sources (called error) are calculated. The blocks and treatment variances are then compared with the error variance to give the Variance Ratio (VR). If the ratio is one or less, we can conclude that there was no effect of these two factors on plant performance. However, the more these values exceed the error variance the more likely they have had a real effect. And we are able to attribute a probability statement to these values (or VRs) that indicate how likely the observed difference between error and the factor (in this case the amendments) is just due to chance. Thus a factor with a probability statement of $P<0.05$ means that the result would likely to have occurred by chance 1 in every 20 time the experiment was conducted. A $P<0.01$ indicates a probability of 1 in every 100 times.

Least Significant Difference (LSD)
In addition, the analysis of variance allows the calculation of the amount by which levels of a factor need to differ in order to be deemed significantly ($P=0.05$) different (called the Least Significant Difference or LSD). Thus, in the present case, 2 of the irrigation rates may not have differed from the farm practice result by this amount while the third did. If so, then only the last rate would be assessed as having had a significant effect on plant performance. If one had depressed growth by more than the LSD value then it would have been assessed as having had a significant negative effect.

Coefficient of Variation (CV)
Finally, the ANOVA allows the calculation of the experimental coefficient of variation (%CV). This value indicates how variable the data are and determines how much confidence to place in an experiment where no effects were significant. It is desirable to have as small a CV as possible. Increasing the number of samples in the datum area and selecting less variable indices may reduce high CVs. The effect of high CVs in reducing precision can be also minimised by increasing the number of replicates.

Environmental consequences

It is important to examine how the conduct of the research, and indeed implementation of any of the recommendations that flow from it, could impact adversely on the local environment. For example in the present case, additional nitrogen is to be added. While the recommended rate might be suitable in optimising plant growth is any of it leaching into the environment, and if so how much? Further work may be necessary or at least some ground water monitoring carried out. ‘Better’ crop husbandry practices should only be implemented if they have nil or at the most only relatively little adverse effects on the environment.

By its very nature, the act of farming has a huge adverse impact on ecological systems. Doing nothing, however, on cleared and cropped land may generate bad weed problems and be ecologically irresponsible. Farming wildflowers enhances survival of the species concerned, while generating income with which more sustainable and ecologically sound practices can be put in place.

Results

Caution and confidence
The results from an experiment of this type always have an element of doubt and should be adopted cautiously. Obviously the lower the probability test (P) of this result just being due to chance, the more confidence you will have of the result being true. Confidence will be greatly enhanced if your results match what the seller claimed and what others have found. It is unlikely that the magnitude of your response will be identical to those observed by others, simply because your test is being conducted in a unique environment. Your unique environment also changes with season and year. Thus, this result will reflect the complex interaction of weather conditions that applied during the course of the experiment. Responses will vary from year to year. There is merit in repeating the experiment the following year to get some assessment of the effect of seasonal variation.

Farm scale
Bear in mind that the experimental size of the project does not necessarily take into account all relevant farm operational activities. It would be desirable to scale the new technology up to farm relevance and test the new technology under actual routine farm conditions before fully converting.

Benefit: cost assessment
The responses you observe need to be put into economic terms since in some cases a significant but small improvement will not necessarily match additional inputs. Repeat the B/C exercise above (Table 1).

The decision to implement the technology will be determined by how much the costs of implementation are exceeded by the benefits. Such benefits are not simply economic since they may involve lifestyle and even ethical issues. There is always an element of risk that such benefits will actually not occur, since unforseen circumstances can upset sound predictions. A rule of thumb, that some use is to implement the recommendation when the B/C ratio exceeds 2. Of course the actual choice is yours.

Recommendations and report (P 61 DOOR Manual)
The work has been done , the data have been analysed and the results discussed from a variety of viewpoints. Recommendations on how the new technology should be viewed can now be drawn up in terms of why, when, where, how and by whom. Such recommendations ought to involve all interested operational staff to ensure all relevant perspectives are accounted for.

Report
The whole project should be written up using the header format of *topic/title, operators, consultant, aim of work, treatments, start and completion dates, how the work was done, measurements, results, interpretation, recommended action, further experimental work, references to other papers and reports* (P 100 DOOR Manual). This report should be securely filed in both electronic and hard copy form, together with the preschedule, the raw data and the analysed data.

Intellectual property
The new information that has been generated has cost you a considerable amount of time and effort and must be valued accordingly. The information should be seen as intellectual property that has direct relevance to the profitable operation of your enterprise. The value of this property should not be overlooked in the assessment of your operational assets for possible sale. Furthermore, such value should be taken into account if approached by sellers of the technology who are seeking to use data of this sort to support their claims.

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Table 1 A simple Benefit: Cost proforma[A] for assessing economic viability (J.Page, pers comm.)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Q1	If you solve the issue how much extra income will be earned each year?							
Q2	If you solve the issue what costs will be saved each year?							
Q3	What is the value of any other derived benefits							
	Total Annual Gain (Q1+Q2+Q3)							
Q4[A]	How much will it cost to carry out the research (labour, land, materials, consultancy, lost opportunity costs)							
Q5	How much will production and marketing costs increase if research findings are implemented?							
	Total Annual Losses							
	Net Annual Gain or Loss *(Gains-Losses)*							

[A]Research costs may be tax dedeuctable

Table 2. Experimental preschedule checklist

TITLE	

AIM/OBJECTIVES
λ
λ
λ
λ
λ

TIMING			
Project Start		**Experiment Start**	
Experiment Finish		**Report Complete**	

RELEVANT INFORMATION ʕ

ʕ **attach additional items**

TREATMENT IDENTIFICATION ς		
1.	**2.**	**3.**
4.	**5.**	**6.**
7.	**8.**	**9.**
10.	**11.**	**12.**
13.	**14.**	**15.**
16.	**17.**	**18.**
19.	**20.**	**21.**

ς **attach additional treatments if necessary**

EXPERIMENTAL DESIGN		
Randomisation Scheme	**Samples Per Rep.**	**No. of Replicates (or Blocks)**
Layout (Overview) (Dimensions) ς		

ς **Attach full Layout (with plot details and treatment identification)**

MATERIALS - (Quantity, types, rates)			
Species, Variety		Humidity	
Soil Type/Profile		Monitoring Equipment	
Fertilisers		Labels	
Amendments		Bags	
Fungicides		Measuring tape	
Insecticides		Scales (range)	
Herbicides		Record Sheets	
Nematicides		Random numbers	
Irrigation - type frequency		Specialist equipment	
Daylength		pH meter	
Temperature		EC meter	
Others		Calipers	

ς

MEASUREMENTS		
Dependent Variables To Be Measured[A]	**How**	**When (Times, Frequency)**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		

[A]Dependent variables are expected to be affected differently by the treatments, eg. plant height

MEASUREMENTS		
Independent Variables To Be Measured[A]	**How**	**When** **(Times, Frequency)**
1.		
2.		
3.		
4.		

[A] Independent variables are not expected to be affected by the treatments, eg daily temperature

STAFF INVOLVED	
Activity	**Names**
Planning	
Laying out	
Measuring	
Maintenance	
Interpreting	

	LABOUR (additional to what would be normally expended)														
	Month														
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th
Number Of Hours*															

* indicate your valuation of the hourly rate e.g. a superscript of ^{1} = standard rate, ^{2} =x 2 standard rate,^{3} = x 3 standard rate. Qualify hours by type of work e.g. 3^{1}M = 3 hours, at the standard rate on Measurements; L = laying out experiment; O = overall observations; M = Measurements; W = Weeding; S= Spraying; I = Irrigating by hand; E = Organising stock plants, labelling and planting, soil collection.

COST OF ITEMS (additional to what would be normally expended)					
Item	**$**	**Item**	**$**	**Item**	**$**

ς

Table 3. One example of a data sheet. Plant heights, stem numbers and stem lengths as affected by 6 treatments in 4 randomised blocks (=replicates). Date:

Rep Block	**Treat -ment**	**Plant height (cm)**			**St. no. P1**	**Stem Length (cm)**					**St. no P2**	**Stem Length (cm)**					**St. no P3**	**StemLgth (cm)**				
		P1	**P2**	**P3**		**P1S1**	**P1S2**	**P1S3**	**P1S4**	**P1S5**		**P2S1**	**P2S2**	**P2S3**	**P2S4**	**P2S5**		**P3S1**	**P3S2**	**P3S3**	**P3S4**	**P3S5**
1	1																					
1	2																					
1	3																					
1	4																					
1	5																					
1	6																					
2	1																					
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4	1																					
4	2																					
4	3																					
4	4																					
4	5																					
4	6																					

P1=datum plant 1, P2 =datum plant 2, P3= datum plant 3; S1-S5 = 5 stems as a representative sample of all stems on plant.

Figure 1a Field layout of an experiment consisting of 6 randomly allocated treatments (G^1-G^6) within 4 replicates/blocks (R1-R4). Each letter indicates a single plant. B = border plants; G = guard plants that are treated identically to D= datum plants that they surround.

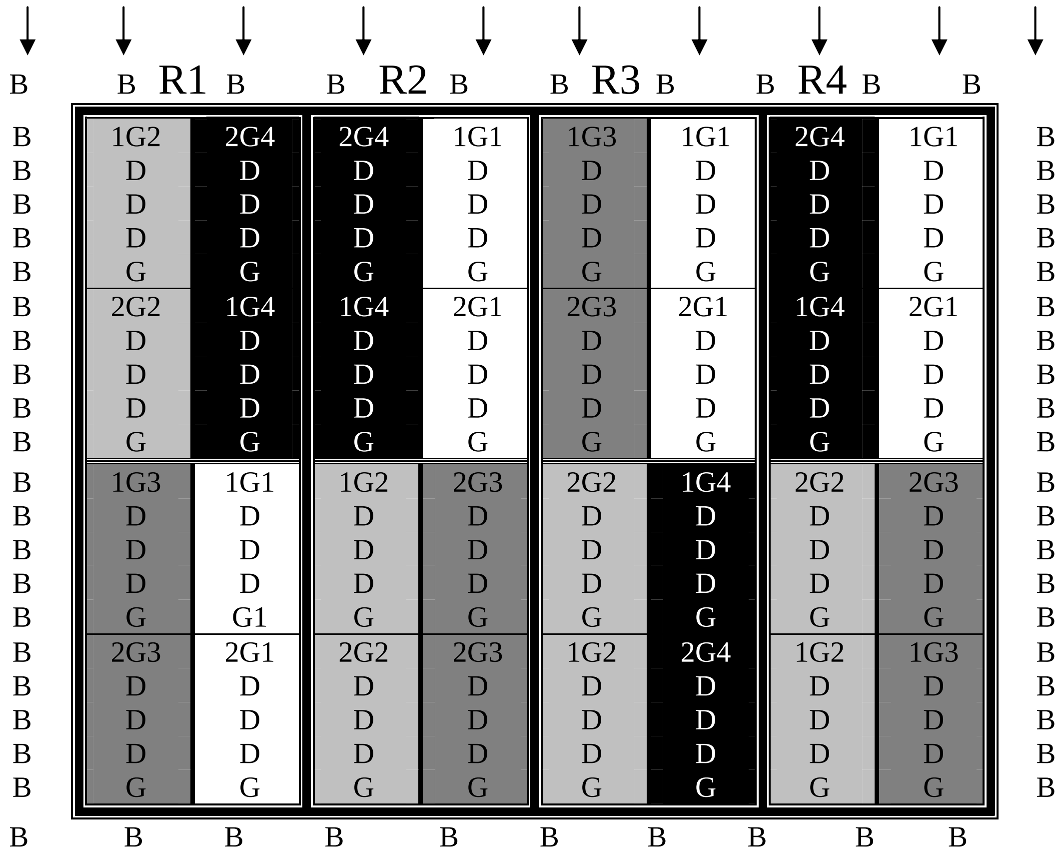
Rows

↓ ↓ ↓ ↓

B	**R**	B	B	B	B	B	B	B	R1	R2	B	B	B	B	B	B	B	**R**	B
R1	**G**^{1}	G	G	**G**^{4}	G	G	**G**^{6}	G	G	**G**^{4}	G	G	**G**^{2}	G	G	**G**^{5}	G	G	R2
	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	B
B	**G**^{5}	G	G	**G**^{2}	G	G	**G**^{3}	G	G	**G**^{1}	G	G	**G**^{6}	G	G	**G**^{3}	G	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
R1	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	R2
R3	**G**^{5}	G	G	**G**^{1}	G	G	**G**^{3}	G	G	**G**^{6}	G	G	**G**^{1}	G	G	**G**^{2}	G	G	R4
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	B
B	**G**^{6}	G	G	**G**^{4}	G	G	**G**^{2}	G	G	**G**^{3}	G	G	**G**^{5}	G	G	**G**^{4}	G	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
B	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	G	D	G	B
R3	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	R4
B	**R**	B	B	B	B	B	B	B	R3	R4	B	B	B	B	B	B	B	**R**	B

Dimensions: 18 (vertical) rows (plus 2 border rows), with 20 plants/row (plus 2 border plants).

Figure 1b. Field layout of an irrigation experiment comprised of 4 blocks (or replicates R1-R4) each block comprised of 4 main plots (4 irrigation treatments, labelled G1-G4 and four levels of shading), each plot containing 2 sub-plots (2 nitrogen treatments 1G-2G). Each letter indicates a single plant. B = border plants; G = guard plants that are treated identically to D= datum plants that they surround. Arrows indicate rows.



11. Photos

DOOR Participants in Western Australia

DOOR Participants in Queensland

DOOR Stars

David Hockings presenting his DOOR paper at the 5th Australian Wildflower Conference

Morris Cox presenting his DOOR paper at the 5th Australian Wildflower Conference