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DOOR For Quandong Production

A feasibility study

A report for the Rural Industries Research and Development Corporation

by Ben Lethbridge

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Foreword

Development of the native Australian quandong to a managed orchard tree still requires much research. With restrictive funding for institutionalised research for new industry a greater reliance on grower run research will be required. The Do Our Own Research (DOOR) protocol has been developed for this purpose.

This report details the introduction of DOOR to the Australian Quandong Industry Association with emphasis on the suitability of the technique to the psychology of the new industry participant.

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This report is an addition to RIRDC's diverse range of over 1000 research publications, forms part of our New Plant Products R&D program, which aims to facilitate the development of new industries based on plants or plant products that have commercial potential in Australia.

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Simon Hearn
Managing Director
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Abbreviations

ANOVA	ANalysis Of VAriance
AQIA	Australian Quandong Industry Association
CSIRO	Commonwealth Scientific Industry Research Organization
DOOR	Do Our Own Research
RIRDC	Rural Industries Research and Development Corporation
SVBF	Southern Vales Bushfood

Contents

Executive Summary

Do Our Own Research (DOOR) is a protocol developed for growers to conduct statistically sound research on site, a technique pioneered by Hunter (2000).

This report should be considered an adjunct and introduction to the DOOR method. The report describes a field ready, ‘distribution free’ statistical approach to quandong production. It highlights the use of the five senses in evaluating observations whilst still retaining the basic concepts of randomisation and replication with simple statistical analysis. The psychological barrier of accepting complex continuous variable parametric statistics and computer analysis is initially avoided for the generally capricious but opportunistic members of the Australian Quandong Industry Association. Principles rather than sensitivity of analysis were considered more important as an introductory step to DOOR.

Application of this technique to other Native food Industry associations should be possible but other research topics such as marketing and mechanisation would appear to have higher priority for crops with simpler growth patterns. The method would still be useful for highlighting the general applicability of statistical principles.

Introduction.

1.1 The quandong and DOOR

The fruit of the quandong tree (*Santalum acuminatum*) is a significant component of the native food industry (Graham and Hart 1997). The quandong is a small (2 to 8 metres) Australian native tree occurring predominantly in the semi arid areas of Southern Australia. The usually dry textured, tart tasting, red skinned fruit (2 to 3 cms in diameter) is harvested from orchards and the wild between August and December depending on local weather conditions. The research history on this partially root parasitic, horticulturally unique tree has been well reviewed by Gordon Mills (2001and later versions) and limitations to production highlighted by Hele (2001). Impediments to industry development have been show cased by Mckinna (2002) in the recently updated industry development plan.

The purpose of this report is to document the introduction of the Do Our Own Research (DOOR) protocol developed by Hunter (1996, 2002) to the Australian Quandong Industry Association (AQIA). AQIA was formed at a meeting in Adelaide in December 1993 and was incorporated on January 31st 1995. Membership numbers of about 50 to 60 have been maintained to this day. The association holds annual conferences and produces quarterly newsletters, allowing significant opportunities for networking and exchange of information. This avenue formed the basis for introducing the DOOR methodology to the association.

The DOOR process came into being for several interconnected reasons.
(1) funding for institutionalised research was becoming scarcer
(2) The generic information produced is rarely specific enough for local considerations such as the effect of cultivar, soil type and climate on production.
(3) The grower resource is very much under utilised.

DOOR is about conducting statistically sound research on site. Most growers conduct informal research themselves, based usually on unrecorded observation, which cannot be subjected to objective statistical analysis. Whilst this information is still valuable with improved methods this information could be even more useful. The DOOR process was developed for this purpose (Hunter 1996, 2000).

1.2 References.

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Introducing DOOR

2.1 Statistics in context

The DOOR protocol authored by Hunter (1996,2002) has been developed in what can best be described as established industries (eg the Nursery) or emerging industries (eg the wild flower industry) where scale of production allow for 10% improvements in production potential to be considered significant. This is the realm of statistically sound research. For new industry, which includes the quandong, scale of production is just one of many limitations that allow an industry to progress from novelty status, others include

(1) New industries offer a plethora of production systems, refinement of inefficient techniques may be counter productive, entrenching this inefficiency.
(2) Improved efficiencies in production may not show improved economies if a similar improvement in market penetration does not occur.
(3) Genuine and biased results. The human nature component of industries. Inappropriate application of statistics can lead new producers to become inoculated against further involvement if forecasts due not match reality. (Coster 2002)

On this final point, Roberts (1974) succinctly expressed some limitations of statistical interpretation. "I like to think of statistics as common sense disciplined by calculation". It is better to rely on common sense than to accept second hand an unsatisfactory analysis. This could relate to the competency or vested interests of the individual. People also tend to do statistics as a mechanical exercise in calculation according to cook book rules and often fall into gross violations of common sense as result.

Roberts (1974) also provided this sage advice " First, you need to see the application of statistics to your problem or opportunity. Secondly, you need to see applications of statistics to problems outside your own areas of greatest interest. In that way you can gain an understanding and perspective about the statistical approach and its fundamental universality". This underlying philosophy forms the basis of the initial approach adopted to introduce DOOR to AQIA.

The following summary on the introduction of DOOR to AQIA is best understood if read in conjunction with a good basic statistics book. Several options are provided in the general reference section, Norman and Streiner (2000), Motulsky(1995) are just two examples. For spreadsheet computational methods, Neufeld(1997) is an excellent introduction and for those who wish to expand on the factorial ANOVA approach of Hunter (2000), Edwards (1968) offers a very good description of the topic.

2.2 Application of parametric statistics.

Prior to the commencement of this project (August 2002) industry participants had been primed with the DOOR process. At the previous conference (August 2001) several projects were outlined with a coordinator for each topic. Telephone polling of these individuals indicated that only about 10 percent of those coordinators had performed any relevant work. None of the projects were performed in a statistically relevant fashion, it was obvious from this point that significant guidance would be required to achieve any significant results. At the 2002 conference (Swan Hill) the statistical approach to research was introduced by reviewing the recipe approach to grower run research. This was achieved by analysing in a step by step fashion the recipe entitled "How much water to add to a wildflower crop"(Hunter 2000). This presentation generated little original thought. A survey form distributed at the conference still rated the concept as excellent. The first newsletter article summarised the project, developed the observational approach of DOOR with some simple relevant quandong projects and developed the intuitive description of parametric statistical inference with computational techniques. A survey form was included which yielded a negligible response. At a general meeting of AQIA (November 2nd 2002), the general consensus was that the essentials were understood but it was beyond their capabilities to actually apply it to problem solving. More direction and a simpler DOOR procedure will be required.

2.3 Non Parametric statistics.

It is obvious from the responses of the members of AQIA that a simplified version of DOOR was required before it can become acceptable as a generally useful technique to new industry participants. Rather than induce variation by experimental means, we could use and measure the natural variation in the orchard to our advantage. The set up of the experiment would thus be simplified to a simple randomisation process, the data could be analysed as a correlation coefficient. (Pearson). It then occurred to me that to be generally useful it should be able to handle data that lacked a Guassian distribution. (eg. distance along a dripper line.) A non parametric correlation coefficient was required. Spearmans correlation coefficient would be handy but its calculation is as tedious as Pearsons. Kendalls rank correlation coefficient (Kendall 1956, Norman and Streiner 2000) would be simple to understand and calculate. Non parametric techniques which are based on ordinal (rank) and nominal (categorical) variables offer many advantages over parametric techniques as an introductory method to statistics for new industry members. Siegel and Castellan (1988) identified six important features, which are summarised and combined below.

1. Non parametric statistical tests are typically much easier to learn and to apply than are parametric tests. In addition, these interpretations often are more direct than the interpretations of parametric tests.
2. Non parametric tests typically make fewer assumptions about the data and may be more relevant to a particular situation.
3. There are suitable non parametric statistical tests for treating samples made up of observations form several different populations
4. If the sample size is very small, there may be no alternative to using a non parametric statistical test unless the nature of the population distribution is known exactly.
5. The handling of data on a ranked scale, which are easy to handle with non parametric methods may be more convenient for variables that are difficult or two expensive to define as a continuous variable. For categorical scales, no parametric methods are available.

The simplicity and ease of use make non parametric statistical techniques the method of choice for new industry participants. For example an experiment set up to compare quandong yield per tree and leaf colour is easy when leaf colour is simply ranked on greenness, but is far more complex to analyse as a continuous variable, where leaf chlorophyll, cumbersome colour charts, or nutritional status may need to be measured. Parametric methods can also require long set up times, patience is a not an attribute in large supply for capricious individuals wanting quick results.

The observational skills of the individual need not be limited to colour perception , sweetness, sourness, roughness, smoothness, in fact any of the five senses make ideal sources for which to compare samples and which are much easier than the equivalent piece of scientific equipment. (eg nasal appraisal vs. gas chromatograph.). Conference discussion groups, usually rely on sensual comparisons (eg. sweet, sour etc.) for quick and easy descriptions of fruit quality and other attributes.

Language is based on categorical classifications, so it should not be surprising that this method of data collection should have a sound psychological basis. Further to this a dichotomous nature of classification, because of its simplicity has added appeal. Success or failure is an often used as a dichotomous variable. A Broken Hill correspondent nicely highlighted such a system when describing which seed were good for germination and which were not. On cracking the shell, seeds that went ‘pop’ were good, but those that didn’t ‘pop’ were not. Such two category systems are best handled by chi-square 2 by 2 contingency tables , whose statistic may be calculated with a simple equation (appendix 1) and a calculator. The data may also be manipulated as a binomially distributed variable which allows for some simple look up tables to be produced (see appendix 1). The chi square (2 by 2 contingency table) statistic is used for the statistical analysis at the field grafting workshop which appears in the next section.

DOOR Workshop Field grafting of quandong.

Figure 1. A few DOOR participants (from a total of seven) discussing quandong grafting techniques at the Blue Bush café at the Arid Land Botanic Gardens, Port Augusta. (19/07/03)

3.1 Introduction

The late Dick Bentley pioneered the technique of field grafting of quandong with a low percentage of successes. With the prevalence of seedling quandong orchards in the industry at the moment, with variable quantity and quality of fruit per tree, development of a technique for reliable grafting of quality scion material onto established rootstock would be a valuable technique. The workshop at the Arid Land Botanic Gardens is an initial attempt to develop and master the technique.

3.2 Materials and Methods.

In the research area at the Arid Land Botanic Gardens research Area is a trial planting of quandongs associated with different wattle seed species. (project AQI-1A , RIRDC) 17 quandong plants of 2 years of age (stem diameter at 10 cms, 17.82 +/- 1.59 , average +/- standard error)) growing near Acacia argyrophylla (aged 3 years) were chosen as the root stock. On the 19th 0f July 2003, eight specimens were randomly selected and a lateral branch of about 3-4 mm diameter on the south side was top wedge grafted with Powell 1 scion material selected from trees growing in the same orchard. All cut surfaces were covered with parafilm. The scion material was covered with a small self sealing plastic bag which was then covered with a pocket of 70% shade cloth. The remaining quandong trees were grafted with a few nodes of stem directly opposite the grafting point (ie self grafted). The plants will be scored at 1 month of age for evidence of significant bud growth on the scion.(August 22nd and early November 2003)

Statistics
The results will be analysed with a Chi-square, test for independence, 2 by 2 contingency table.

3.3 Results and Discussion

Scion / Graft	success	failure
Powell 1.	0	9
Self (control)	0	8

Table 1. 2 by 2 contingency table testing scion quality. (Chi square calculations are not relevant.)

None of the grafts proved successful. Although the grafts appeared healthy one month after top working, examination of grafts approximately 3months from commencement of the experiment showed that all scions had desiccated, with significant wind damage and dust abrasion. It would appear that the protection provided for the graft was insufficient to prevent drying out of the scion before significant healing of the graft had occurred. Timing of grafting and temperatures (Southwick (1979) and Mc Ewin Alexander (1998)) are significant features in grafting success. A pilot study using Hodge's mummy graft(Moody 1999) in late August 2003 in two significantly different environments does provide some insights into the lack of success of the above experiment.
The mummy graft seems to be particularly applicable in low humidity environs.(Moody 1999) . Eight self mummy grafts were performed on quandong plants (Acacia hemiteles as host) at Pt Augusta. and six quandongs with various hosts were self mummy grafted at Clarendon (Adelaide Hills) . Although none of the grafts survived at Pt Augusta, Five of six grafts showed significant bud growth at Clarendon.,(Fishers exact test ,p=0.0030) figure 2 shows the best of these. It is evident that the milder temperatures at Clarendon had a significant effect on graft success. Insect damage was also quite significant on the newly expanded buds on the scion. Improved protection of the graft could serve two purposes, protection from insect damage and desiccation from wind and sun from nearly emerged shoots.
This pilot study highlights quite clearly the need for the application of DOOR to field grafting techniques. It would be suggested that the field grafting of the evergreen quandong at Pt. Augusta should be performed in late Autumn.

Figure 2 Self mummy graft of quandong
Clarendon S.A. (28/8/03 to 20/11/03)
The growing shoot is about 50 mm in length

3.4 References

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Application of the adopted approach to other Native food Industries.

The purpose of this section is try to ascertain whether for any reason, quandong growers or native food growers in general should differ in their learning ability from other individuals in the general agricultural community. Fulton (2003) summarised the barriers to farmer's participation in learning opportunities. The reasons are many and varied but relate to education levels, 'social distance' between farmers and scientists, who should be setting the agenda, credibility of learning providers, content of activities and relative income levels. Perhaps the most interesting aspect of all; an inability of research organisations and extension agencies "to acknowledge that farming is a social and cultural activity is responsible for the limited success of extension". Native foods have been part of the cultural landscape of Australia for many thousands of years. Indeed part of the charm of native foods is the luddite nature of the product. Provided DOOR is not seen as too bureaucratic or esoteric in nature it will probably succeed. The simplicity of non parametric statistical methods would therefore not seem to far out of place. A survey of the Southern Bales Bushfood Inc. committee would indicate that research on marketing and mechanisation issues are probably of more importance at the present time for crops with simpler growth patterns (eg lemon myrtle, muntries).

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Implications and recommendations.

The implications of this research in a new industry environment, as opposed to an emerging industry, is that DOOR is an evolutionary rather than a revolutionary process. An important point to consider is that specialisation of most industry participants has not occurred. The growers, grow, process and market the product they produce leaving little time to concentrate on any aspect of production. The scale of production, percentage of wild harvest or time available may not warrant the fine tuning of orchard production techniques as a high priority. Statistical techniques should be as simple as possible.

Recommend that DOOR (statistically sound research) be pursued at a more holistic level as practical and relevant regional workshops (ie include business management, marketing topics) emphasising the fundamental universality of statistical techniques to industry development. It may take some time to convince new industry participants that DOOR is a necessity rather than a nicety and it should be pursued at a level suited to the current status of industry development or business management capabilities.

Appendix

Appendix 1. At least one success calculator

Look up table for estimating the number of replicates per site or tree that are required to give at least one success. The left hand column is the probability of obtaining a successful result (obtained from a trial). The top row is the expected number of sites with at least one successful application. The body of the table indicates how many attempts at each site are required to achieve the indicated success rate (at least one) in the field. Useful for calculating number of seed required, or field grafting successes.
The second table below is an example of a 2 by 2 contingency table and chi square statistic.

liklehood probability of success	% 97.5	% 95	% 90	% 75	% 50
0.1	36	29	22	14	7
0.2	17	14	11	7	4
0.3	11	9	7	4	2
0.4	8	6	5	3	2
0.5	6	5	4	2	1
0.6	5	4	3	2	1
0.7	4	3	2	2	1
0.8	3	2	2	1	1
0.9	2	2	1	1	1
1	1	1	1	1	1

2 by 2	success	failure	
method 1.	a	b	a+b
method 2.	c	d	c+d
	a+c	b+d	N

Chi square=

$$\frac{(ad-bc)^2 \times N}{(a+b)(a+c)(b+d)(c+d)}$$

critical value = 3.841