EVALUATION OF COLLABORATIVE RESEARCH AND DEVELOPMENT: INSIGHTS FROM A SURVEY OF SUGAR INDUSTRY RESEARCHERS

Contributed paper to the 47th Annual Conference of the Australian Agricultural and Resource Economics Society, Esplanade Hotel, Freemantle, 12 – 14 February 2003.

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ABSTRACT

The Australian agricultural research and development (R&D) sector faces many challenges associated with the trend to increased collaborative research as promoted by the Cooperative Research Centre Program. Analysis of the results of an electronic survey of researchers involved in the sugar industry highlights economic, managerial, and sociological challenges associated with collaborative research. Researchers' perceptions of the usefulness of a range of economic and non-economic evaluation techniques are also highlighted. It is shown that economic evaluation is appropriate for resource allocation and impact assessment purposes but is of limited value in monitoring and improving the process of collaborative research. A systems-based approach to the evaluation of collaborative R&D incorporating principles from economics, management, and sociology is promoted as an appropriate alternative that could contribute to improved efficiency and effectiveness of collaborative research activities.

KEYWORDS

evaluation, collaborative research, sugar, systems approach

INTRODUCTION

Collaborative R&D is a relatively recent development, particularly in the Australian sugar industry, and has been actively promoted by government over recent decades. Of particular interest is the researcher-stakeholder form of collaborative R&D, as promoted by the Cooperative Research Centre (CRC) Program established in 1990, and the CRC for Sustainable Sugar Production (CRC Sugar), established in 1995.

Little is known of the characteristics of collaborative R&D, the motivation for researcher involvement in collaborative research, or the value of collaborative R&D activities (Kaplan and Norton, 1996; Katz and Martin, 1997). Efficiency, effectiveness, and appropriateness of collaborative R&D in the Australian sugar industry may be restricted by the current limited knowledge base and, in particular, limited knowledge and application of appropriate evaluation activities (Henderson, 2001, Henderson, 2002).

This paper reports the key findings of an electronic survey of the population of researchers involved in sugar R&D. Findings provide insight into the perceived value of various forms of collaborative R&D, motivation for researcher involvement in collaborative R&D, the use of key forms of evaluation, and potential for improvement in the conduct and management of collaborative R&D in the sugar industry. The expected benefits and challenges of applying a systems approach to the evaluation of collaborative R&D activities in the Australian sugar industry are highlighted.

ELECTRONIC SURVEY

An electronic survey of the population of researchers involved in sugar R&D was undertaken in July 2002. A web-based survey form was developed and responses received and coded for statistical analysis using the Surveysaid software (Marketing Masters, 1999). Complete questionnaire responses were received from 129 individuals representing a response rate of 85 per cent, which is considered very good (Babbie, 1990). Fifty-four per cent of survey respondents indicated they had been involved in research projects funded by CRC Sugar.

The electronic survey method was demonstrated to be an efficient, effective, and appropriate means of collecting data from the population of researchers. Pilot testing of the questionnaire, support of the survey by the major R&D providers, personal telephone contact with each researcher in the sample prior to email notification of the questionnaire web-site, and the use of reminder emails, were important factors contributing to the high response rate. The questionnaire was received anonymously from respondents, which may also have contributed to the high response rate and quality of responses.

THE DYNAMIC NATURE OF COLLABORATIVE R&D ACTIVITY IN THE AUSTRALIAN SUGAR INDUSTRY

There are several forms of collaborative R&D (Bond and Thompson, 1996; Coombs, et al.; 1996, Smith, 2001). Five key forms of R&D activity conducted at the project level in Australian sugar R&D include:

- working alone;
- working with other researchers from the same discipline;
- working with other researchers from a range of disciplines;
- working with other researchers and advisory service people; and
- working with researchers, industry, advisory service people, community, government and/or others (researcher-stakeholder collaborative R&D) (Henderson, 2001).

A significant group of respondents (47.3 per cent) indicated that the majority of their research activities from mid-2000 to mid-2002 involved collaborations with other researchers, industry, advisory service people, community, government and/or others. Of those researchers who received CRC Sugar funding, 50.7 per cent indicated the majority of their research involved collaboration with non-researchers. A lower proportion of non-CRC Sugar funded researchers (43.3 per cent) indicated the majority of their research activities involved non-researchers. There was no significant difference in the nature of the research activities conducted over the past two years by CRC funded researchers and non-CRC funded researchers. This was confirmed by the Pearson chi-squared value (calculated to be 4.556, less than the critical value of 9.49 at 5% probability value). This result indicates that from mid-2000 to mid-2002, CRC funding had limited impact on the major types of research activity undertaken in the Australian sugar industry.

Table 1. Respondent characteristics categorised by involvement with CRC Sugar funded research

CRC funded	Nature of the majority of research activities over the past two years					Total
	Alone	Same discipline	Range of disciplines	Researchers and advisory	Researchers and non-researchers	
CRC funded	5 (7.2)	3 (4.3)	19 (27.5)	7 (10.1)	35 (50.7)	69 (99.8)
Not CRC funded	3 (5.0)	9 (15.0)	16 (26.7)	6 (10.0)	26 (43.3)	60 (100.0)
All respondents	8 (6.2)	12 (9.3)	35 (27.1)	13 (10.1)	61 (47.3)	129 (100.0)

The number of respondents is reported, with the percentage of respondents by row reported in parenthesis. Totals may not add to 100.0 per cent due to rounding errors.

Changes in the nature of relationships between collaborators over time

The nature of relationships with other researchers and with non-researchers over the past 15 years was investigated. Between the five-year period ending 1992 and the five-year period ending 1997 there was no significant difference in the median ranking by respondents of the closeness of these relationships. However, between the five year period ending 1997 and the five year period ending 2002, the median

ranking describing the closeness of relationships indicated relationships between researchers and both other researchers and non-researchers tended to become close and more like partnership relationships. See Tables 2 and 3 for details.

Table 2. Nature of relationship with other researchers (ranking)

Year	Nature of relationship with other researchers in collaborative research							Non-respondent	Total
	Distant, arms length -3	-2	-1	0	1	2	Close, partner-ship 3		
1992	4 (3.1)	8 (6.2)	10 (7.8)	5 (3.9)	21* (16.3)	16 (12.4)	8 (6.2)	57 (44.2)	129 (100.1)
1997	4 (3.1)	3 (2.3)	8 (6.2)	10 (7.8)	31* (24.0)	25 (19.4)	15 (11.6)	33 (25.6)	129 (100.0)
2002	2 (1.6)	3 (2.3)	6 (4.7)	6 (4.7)	29 (22.5)	53* (41.1)	29 (22.5)	1 (0.8)	129 (100.0)

The number of respondents is reported, with the percentage of respondents by row reported in parenthesis. Totals may not add to 100.0 per cent due to rounding errors.
* denotes median category by row and was calculated excluding non-respondents.

Table 3. Nature of relationship with non-researchers (ranking)

Year	Nature of relationship with non-researchers in collaborative research							Non-respondent	Total
	Distant, arms length -3	-2	-1	0	1	2	Close, partner-ship 3		
1992	6 (4.7)	4 (3.1)	4 (3.1)	17 (13.2)	13* (10.1)	13 (10.1)	13 (10.1)	59 (45.7)	129 (100.1)
1997	3 (2.3)	8 (6.2)	8 (6.2)	18 (14.0)	22* (17.1)	16 (12.4)	18 (14.0)	36 (27.9)	129 (100.1)
2002	4 (3.1)	5 (3.9)	6 (4.7)	12 (9.3)	30 (23.3)	38* (29.5)	32 (24.8)	2 (1.6)	129 (100.2)

The number of respondents is reported, with the percentage of respondents by row reported in parenthesis. Totals may not add to 100.0 per cent due to rounding errors.
* denotes median category by row and was calculated excluding non-respondents.

Motivation for collaboration/Drivers of collaboration

The survey results indicate the primary reason why the majority of researchers currently collaborate with researchers and/or non-researchers is that collaborative R&D is perceived as a beneficial means of addressing research problems. Only a small proportion of researchers indicated that the primary reason they are involved in collaborative R&D is because this form of research is encouraged by employer organisations and/or research fund providers. See Figures 1 and 2 for details.

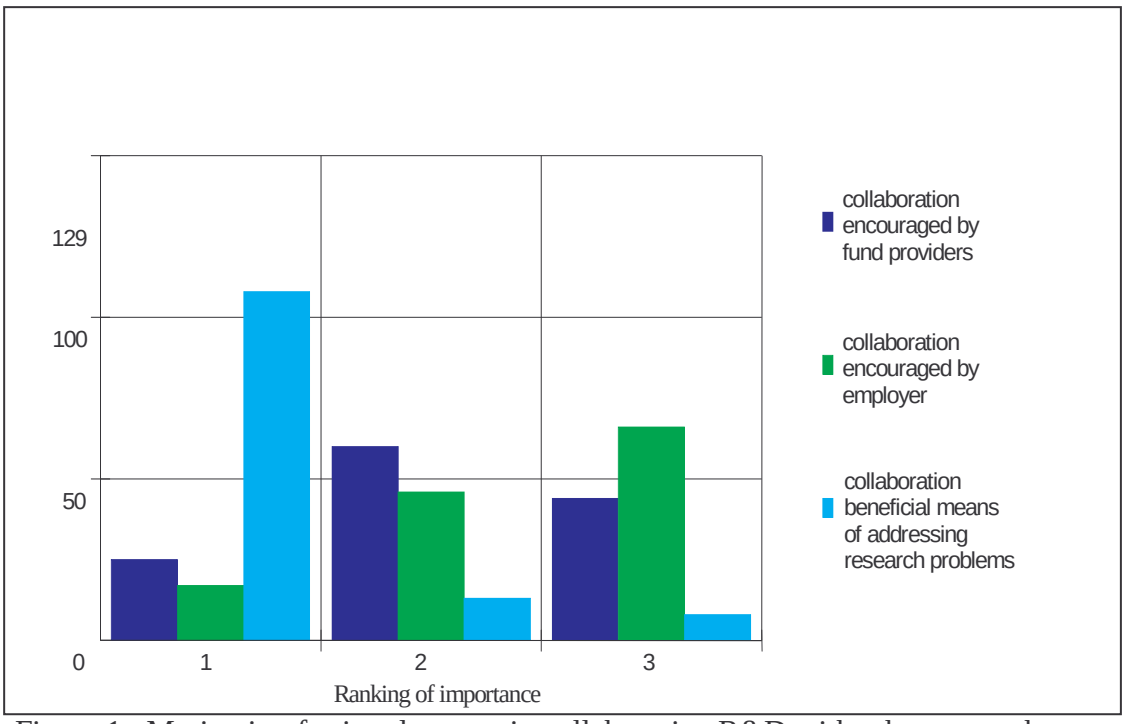

Figure 1. Motivation for involvement in collaborative R&D with other researchers

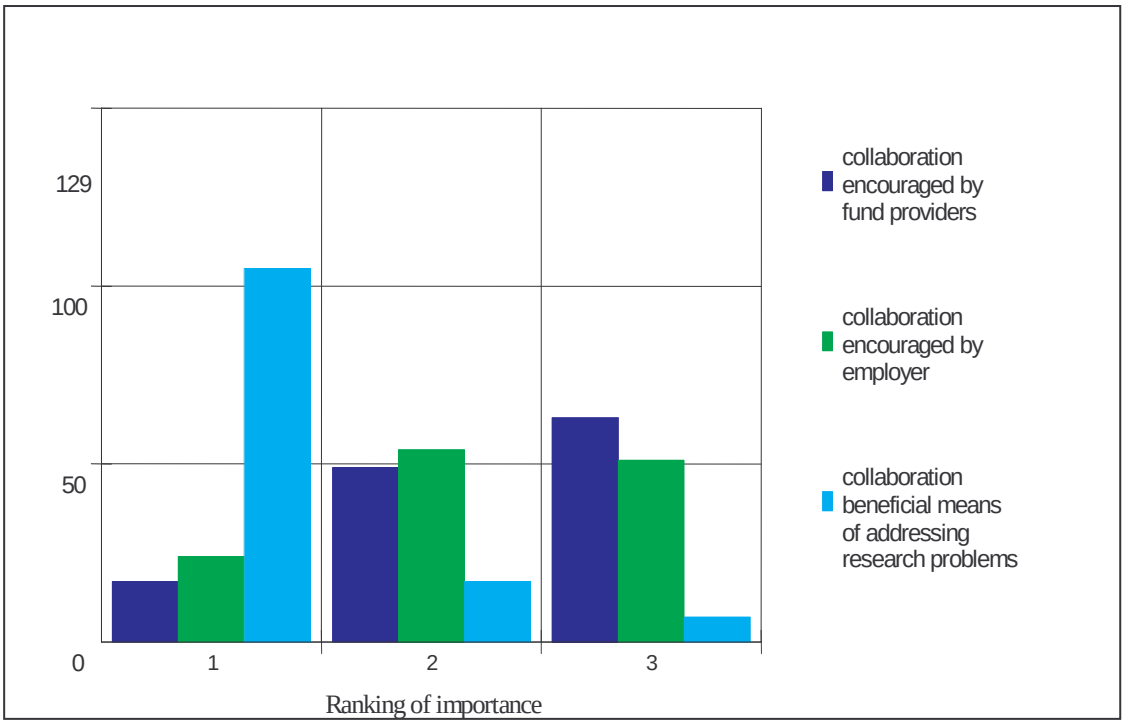

Figure 2. Motivation for involvement in collaborative R&D with non-researchers

Government policy to encourage collaborative R&D was extended to the Australian sugar industry firstly in 1987 when the Sugar Research Council (predecessor to the Sugar Research and Development Corporation) was formed, and secondly in 1995 when CRC Sugar was formed. Figures 1 and 2 indicate the majority of researchers appear to support policies encouraging collaborative R&D.

POSITIVE AND NEGATIVE FEATURES OF COLLABORATIVE R&D

A range of positive and negative features of collaborative R&D are identified in the literature, and these were explored using case study analysis of two CRC Sugar funded collaborative R&D activities, as reported in previous papers (Henderson, 2001; Henderson, 2002). The electronic survey enabled the compilation of quantitative and statistically significant data regarding the perceived value of collaborative R&D by researchers in the sugar industry.

Respondents indicated their level of agreement with 24 statements about the attributes of collaborative research activities. Statements were grouped into three categories relevant to the following aspects of collaborative R&D at the project level:

- administration and management;
- process; and
- inputs, outputs and outcomes.

Respondents indicated wide variation in their perceptions of key attributes of collaborative R&D.

Administration and management of collaborative R&D

The majority (60.6 per cent) of respondents indicated that intellectual property for collaborative research projects is frequently difficult to manage, and that clear goals are frequently specified for collaborative research projects (57.4 per cent). More than half (51.2 per cent) of respondents also indicated decisions influencing the direction and management of collaborative research projects were frequently made on the basis of unequal input from researchers and non-researchers. Respondents held mixed views on the effectiveness of the management structure of collaborative research, the presence of performance criteria, and the difficulties associated with authorship of scientific papers resulting from collaborative R&D. These mixed views indicate diversity in the administration of individual collaborative R&D activities. Further details are reported in Table 3.

Table 3. Perceptions of administration and management attributes of collaborative R&D

Statement	Proportion of respondents (per cent)		
	Agree	Neutral or uncertain	Disagree
Collaborative research projects frequently have an effective management structure able to cope with the operation of the research and changes in the project	30.1	30.1	38.6
Decisions influencing the direction and management of collaborative research projects are frequently made based on equal input from researchers and non-researchers	21.7	27.1	51.2
Intellectual property is frequently difficult to manage in collaborative research projects	60.6	24.4	15.0
Clear goals are frequently lacking in collaborative research projects	24.0	17.8	57.4
There is frequently a lack of effective and measurable performance criteria for collaborative research projects	28.7	24.0	47.3
Authorship of scientific papers is frequently difficult to manage for collaborative research projects	24.8	31.8	43.4

Process of collaborative R&D

A large majority of respondents (82.2 per cent) perceive the process of collaborative R&D is frequently stimulating and energising, and that continuous progress and momentum is critical to the success of a collaborative research project (82.0 per cent). Furthermore, 76.4 per cent of respondents believe the process of collaborative research improves over time as the people involved become familiar with this form of research but 57.5 per cent believe that it is frequently difficult to achieve a consensus among all people involved in collaborative research.

Respondents were divided in their opinion on other aspects associated with the process of collaborative R&D. In particular, respondents did not provide a consistent view as to whether the process of collaborative R&D is frustrating and draining, or whether it is difficult to maintain the interest and involvement of non-researchers in the collaborative R&D process. Respondents were also divided and did not necessarily agree with the statement that differences between researchers and non-researchers hinders the process of collaborative research. The comment that differences between researchers of different disciplines and/or organisations frequently hinders the process of collaborative research received a similar response. Divided opinion was also evident among respondents regarding the ability of researchers to fulfil a honest broker role in collaborative research. Perceptions held by researchers on a wide range of attributes relevant to the process of collaborative R&D appear to differ significantly. See Table 4 for further details.

Table 4. Perceptions of process attributes of collaborative R&D

Statement	Proportion of respondents (per cent)		
	Agree	Neutral or uncertain	Disagree
The process of collaborative research is frequently stimulating and energising	82.2	11.6	6.2
The process of collaborative research is frequently frustrating and draining	46.5	18.6	34.9
Continuous progress and momentum is critical to the success of a collaborative research project	82.0	11.7	7.0
It is frequently difficult to maintain the interest and involvement of non-researchers in collaborative research projects	42.2	27.3	30.5
It is frequently difficult to achieve an consensus among all people involved in collaborative research activities	57.5	18.1	24.4
Differences between researchers and non-researchers hinders the process of collaborative research	30.7	31.5	38.0
Differences between researchers of different disciplines and/or organisations frequently hinders the process of collaborative research	43.0	25.0	32.0
The process of collaborative research improves over time as the people involved become familiar with this form of research	76.4	18.9	4.7
It is difficult for researchers to fulfil honest broker role when involved in collaborative research with non-researchers	22.8	39.4	37.8

Inputs, outputs and outcomes of collaborative R&D

The majority of respondents agreed that the cost of collaborative research is frequently underestimated (70.3 per cent), that collaborative research incurs high transaction costs (76.6 per cent) and that the technical skills of people involved in collaborative research are frequently excellent (75.8 per cent). The majority of respondents (75.0 per cent) also agreed that collaborative R&D featuring a close, partnership relationship between researchers and non-researchers delivers outputs of greater relevance to non-researchers more frequently than collaborative research featuring a distant, arms length relationship between researchers and non-researchers. The majority of researchers (82.7 per cent) agreed collaborative research frequently results in improved awareness and understanding by researchers of the needs of industry, community, and others, and results in improved awareness and understanding by non-researchers of the capabilities and complexities of researchers. Most respondents (81.9 per cent) agree that collaborative research frequently results in changes in knowledge, attitudes, skills and aspirations of participants in the research process. There was no majority opinion as to whether collaborative research results in the development of generalist rather than specialist researcher skills, or whether collaborative research has reduced any duplication in research effort. See Table 5 for details.

Table 5. Perceptions of input, output, and outcome attributes of collaborative R&D

Statement	Proportion of respondents (per cent)		
	Agree	Neutral or uncertain	Disagree
The costs of collaborative research are frequently underestimated	70.3	21.1	8.6
Collaborative research incurs high transaction costs, or costs of doing business (eg travel costs, difficulties in arranging meeting times to suit all collaborators)	76.6	12.5	10.9
The technical skills of people involved in collaborative research are frequently excellent	75.8	16.4	7.8
Collaborative research featuring a close, partnership relationship between researchers and non-researchers frequently delivers outputs of greater relevance to non-researchers than collaborative research featuring a distant, arms length relationship between researchers and non-researchers	75.0	20.3	4.7
Collaborative research frequently results in improved awareness and understanding by researchers of the needs of industry, community, and others	82.7	14.2	3.1
Collaborative research frequently results in improved awareness and understanding by non-researchers of the capabilities and complexities of researchers	80.3	16.5	3.2
Collaborative research frequently results in changes in knowledge, attitudes, skills and aspirations of participants in the research process	81.9	15.0	3.2
Researchers involved in collaborative research frequently develop generalist skills rather than specialist skills	30.2	31.8	38.0
Collaborative research has reduced duplication of research activity in my area of interest	35.2	42.2	22.7

Analysis of the perceptions held by researchers on a range of attributes of collaborative R&D activities reveals variation and diversity in responses. This finding supports the view reported in the literature on collaborative R&D, that collaborative R&D is an intrinsically social process and there may be at least as many attributes of collaborative R&D as there are individuals involved (Bond and Thompson, 1996; Katz and Martin, 1997).

Feedback from researchers on their perceptions of a range of attributes of collaborative R&D indicates collaborative R&D is complex, with considerable diversity between perceived attributes at the project level.

PERCEIVED VALUE OF COLLABORATIVE RESEARCH

The majority of respondents (86.9 per cent) indicated that the positive aspects of undertaking collaborative research frequently or always outweighed the negative aspects. Furthermore, the majority (72.9 per cent) of respondents indicated collaborative research projects have frequently or always met researcher expectations about what this form of research would deliver. These findings indicate collaborative R&D is perceived favourably among researchers within the Australian sugar industry.

However, despite respondents expressing a favourable opinion of collaborative R&D, the majority of respondents (84.5 per cent) believe that action should be taken to

improve the efficiency and effectiveness of collaborative R&D. The majority of respondents indicated their support for actions likely to improve the efficiency and effectiveness of collaborative R&D:

- 85.3 per cent of respondents agree linkages and relations between researchers of different disciplines and organisations should be improved;
- 82.2 per cent of respondents agree linkages and relations between researchers and non-researchers should be improved;
- 67.4 per cent of respondents agree the people involved in collaborative R&D should improve project management skills and knowledge;
- 59.7 per cent of respondents agree that the reward and incentive system for researchers should be improved; and
- 54.3 per cent of respondents agree that the people involved in collaborative R&D should increase their knowledge of appropriate evaluation techniques.

Details are provided in Table 6.

Table 6. Perceptions of how the efficiency and effectiveness of collaborative research could be improved

Statement	Proportion of respondents (per cent)		
	Agree	Uncertain or neutral	Disagree
To improve the efficiency and effectiveness of collaborative research, linkages and relations between researchers of different disciplines and organisations needs to be improved	85.3	13.2	1.6
To improve the efficiency and effectiveness of collaborative research, linkages and relations between researchers and non-researchers needs to be improved	82.2	14.7	3.1
To improve the efficiency and effectiveness of collaborative research, the reward and incentive system for researchers needs to be improved	59.7	29.7	10.2
To improve the efficiency and effectiveness of collaborative research, the people involved in collaborative research need to improve project management skills and knowledge	67.4	23.4	8.6
To improve the efficiency and effectiveness of collaborative research, the people involved in collaborative research need to increase their knowledge of appropriate evaluation techniques	54.3	34.4	10.9
Nothing needs to be done to improve the efficiency and effectiveness of collaborative research	2.3	13.2	85.0

In summary, the majority of respondents perceive the efficiency and effectiveness of collaborative R&D could be improved through a range of actions. For some of these, approximately one third of all respondents indicated their view was uncertain or neutral which may imply researchers have insufficient knowledge of particular actions to form a view whether that action will improve the efficiency and effectiveness of collaborative research or not, eg. increased knowledge of appropriate evaluation techniques.

USE AND PERCEIVED VALUE OF EVALUATION

Use of evaluation techniques

The use of evaluation techniques by researchers during the two-year period ending July 2002 was also investigated. Respondents differed considerably in the frequency with which various techniques were used to evaluate research. The most frequently implemented evaluation technique was the process of checking research progress against milestones (median category of >75% of all research projects). The less frequently used evaluation techniques (median category of <25% of all research projects) nominated by researchers included:

- ex-ante benefit-cost analysis;
- action learning cycle; and
- ex-post benefit-cost analysis.

CRC Sugar funded researchers indicated they only occasionally (<25% of projects) did they develop an evaluation strategy at the initial stage of the research project, compared with a median category of frequently (25 – 75% of projects) for other researchers. There were no other significant differences in the median response from CRC Sugar funded respondents when compared to non-CRC Sugar funded respondents.

Perceived importance of evaluation

A useful system of categorising evaluation approaches by purpose was developed by (Owen and Rogers, 1999) as outlined in Table 7.

Respondents indicated the importance of each of Owens five forms of evaluation. The median category of importance did not differ between CRC Sugar funded and other respondents and the majority of respondents indicated the following forms of evaluation as “very important”:

- Form 1 - evaluation to develop project objectives before a project begins;
- Form 3 - monitoring and evaluation to improve the process of research throughout the project; and
- Form 5 - evaluation to demonstrate the impact of the project after project completion.

Respondents also indicated the following forms of evaluation were “important”:

- Form 2 - evaluation to clarify the purpose of the project continuing throughout the duration of the project; and
- Form 4 - evaluation to monitor the performance of the project throughout the duration of the project to provide accountability information.

See Table 8 for further details.

Table 7. Owen's forms of evaluation

Form	Orientation	Brief overview
1: Evaluation for program development	Synthesis	This form of evaluation is typically undertaken *ex-ante*, or prior to the commencement of a program, to identify the needs of stakeholders, and focus on defining the program context, including objectives. Commonly referred to as a needs assessment or setting a benchmark.
2: Evaluation for design clarification	Clarification	This form of evaluation is ongoing during the development of a program and focuses on all aspects of the program. Key findings of a clarificative evaluation include a program plan and implications for stakeholders in the program.
3: Process Evaluation	Improvement	This form of evaluation is ongoing during the development state of a program, and focuses on delivery and improving the program as it progresses.
4: Evaluation for program management (monitoring)	Accountability /Finetuning	This form of evaluation is typically undertaken during the program, and is useful to justify and/or fine-tune the program to improve delivery and outcomes.
5: Evaluation for impact assessment	Justification	This form of evaluation is undertaken *ex-post* or following the completion of a program, to assess the impact of a program for justification or accountability. Assessment of whether the objectives of the program have been met.

Source: Owen and Rogers, 1999, p.53.

Table 8. Perceived importance of Owen's five forms of evaluation

Owen's form of evaluation	Proportion of respondents (per cent)				
	Very important	Important	Uncertain or neutral	Not important	Not very important
1. synthesis	57.4*	33.3	6.2	1.6	1.6
2. clarification	40.9	44.1*	9.4	5.5	0.0
3. improvement	51.2*	40.3	7.8	0.8	0.0
4. accountability/finetuning	34.4	49.2*	14.1	1.6	0.8
5. justification	54.7*	38.3	4.7	0.8	1.6

The number of respondents is reported, with the percentage of respondents by row reported in parenthesis. Totals may not add to 100.0 per cent due to rounding errors.
* denotes median category by row and was calculated excluding non-respondents.

Researcher interest in learning about evaluation

The majority of respondents (78 per cent) believed it would be useful to learn more about how to improve the efficiency and effectiveness of collaborative research using appropriate evaluation tools.

IMPLICATIONS

The survey of researchers involved in the sugar industry provided insight into many of the challenges faced by researchers involved in collaborative R&D activities and, in particular, provided insight to address the problem of improving the efficiency and effectiveness of collaborative R&D at the project level.

Analysis of the questionnaire responses reveals *diversity* in opinion among researchers in the Australian sugar industry regarding key attributes of collaborative R&D, as illustrated in Tables 3, 4 and 5. In particular, it appears there are frequently diverse and competing perspectives held by researchers involved in collaborative R&D. This was evidenced by the fact that 58 per cent of survey respondents agreed that it is frequently difficult to achieve consensus among all people involved in collaborative research activities (Table 4). Diversity in the opinions held by researchers reflects variation in the experience of individual researchers involved in collaborative R&D, as well as the *complexities* associated with collaborative R&D. Perceptions of a range of attributes of collaborative R&D highlight this complexity at the project level.

Collaborative R&D is perceived as a *dynamic* process by researchers highlighted by the fact that 76 per cent of respondents agreed that the process of collaborative research improves over time as the people involved become familiar with this form of research (Table 4). This feature also highlights the *learning* aspects of collaborative R&D and implies the presence of *feedback loops* within the process of collaboration.

A potentially important approach for accommodating the diversity, complexity and dynamism exhibited by collaborative R&D activities in the Australian sugar industry is the application of a systems approach. The issue of improving the efficiency and effectiveness of collaborative R&D may be addressed by applying systems principles, and incorporating aspects from Owen's five forms of evaluation into the process. A systems approach to the evaluation of collaborative R&D is theoretically sound, and recently published literature has provided a basis for systems thinking in an evaluative context (Rogers and Williams, 2002; Flood, 1999). Support for the application of a systems approach to the problem of improving the efficiency and effectiveness of collaborative R&D is provided in the literature.

> "*…the world has become far more complex and far less certain. Traditional management strategies that seemed sufficient as recently as a generation ago are found wanting today.*" (Flood, 1999, p.1.)
>
> "*Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static "snapshots". It is a set of general principles – distilled over the course of the twentieth century, spanning fields as diverse as the physical and social sciences, engineering, and management. It is also a set of specific tools and techniques, originating in two threads: in "feedback" concepts of cybernetics and in "servo-mechanism" engineering theory dating back to the nineteenth century. During the last thirty years, these tools have been applied to understand a wide range of corporate, urban, regional, economic, political, ecological, and even physiological systems. And systems thinking is a*

sensibility – for the subtle interconnectedness that gives living systems their unique character." (Senge, 1990, p.68.)

Over the past decade, there has been a surge in the application of systems approaches to research problems in the sugar industry as evidenced by research activities in the CRC Sugar "Systems Analysis and Modelling" Cross-Program, and the move by the Sugar R&D Corporation (SRDC) toward a systems-based R&D portfolio structure (Sugar Research and Development Corporation, 2002, p.52). Furthermore, an independent assessment of the sugar industry in 2002 recommended a whole-of-value-chain or systems approach to many aspects of operations in the Australian sugar industry be adopted to address current challenges faced by the industry (Hildebrand, 2002, p.46).

Despite the promotion of a systems approach to the conduct of research and other operations of the sugar industry value chain, the survey results indicated there is no evidence of a parallel trend to a systems approach in the evaluation of sugar R&D. Survey results reveal relatively low levels of application of the major forms of evaluation at the project level by researchers, despite their recognition that evaluation as a valuable tool, and indicating a desire to learn more about appropriate evaluation techniques.

The literature highlights the value of a systems approach in an evaluative context (Rogers and Williams, 2002; Jackson, 2000; Chamala et.al, 1999; Flood, 1999; Owen and Rogers, 1999; Greene and Caracelli, 1997; Checkland, 1990). Based upon the theory of the systems approach, and the findings of the survey of sugar researchers, it appears the application of appropriate systems approaches to the evaluation of collaborative R&D will improve knowledge, and potentially provide insight to improve the efficiency and effectiveness of collaborative R&D in the Australian sugar industry.

OVERVIEW AND CONCLUSIONS

The survey of researchers involved in sugar R&D provided insight into the activities of researchers, the perceived value of collaborative R&D and the use and perceived value of evaluation approaches. The quantitative and qualitative data and information produced as a result of the survey was not previously available, and a benchmark has been set regarding current actions and perceptions of sugar researchers regarding collaborative R&D and evaluation of collaborative R&D. The electronic survey technique was shown to be an efficient and effective method of collecting quantitative and qualitative data from researchers involved in the sugar industry, as demonstrated by the survey response rate of 85 per cent.

Survey results illustrate researcher-stakeholder collaborative R&D is a predominant form of research activity in the Australian sugar industry. Furthermore, the survey results indicate collaborative R&D presents many challenges to researchers as there are a wide range of positive and negative attributes of this form of research. Overall, collaborative R&D is perceived by sugar researchers to be a beneficial means of addressing particular research problems. However, the majority of respondents perceive a need to improve the efficiency and effectiveness of collaborative R&D

activities. In particular, Owen's five forms of evaluation, based upon purpose, are considered important and researchers indicated their interest in learning about evaluation and its application to collaborative R&D. Survey results further support the argument put forward in earlier papers that improved project management and evaluation is critical to the improvement in efficiency, effectiveness, and appropriateness of collaborative R&D at the project level. Furthermore, the survey results together with analysis of the literature on systems approaches to complex, dynamic problems, highlight the potential value of developing a systems approach to the evaluation of collaborative R&D in the Australian sugar industry.

ACKNOWLEDGMENTS

This paper draws on research conducted within the first two years of the author's post-graduate studies at the School of Natural and Rural Systems Management at The University of Queensland funded by the Cooperative Research Centre for Sustainable Sugar Production. The title of the final thesis is 'Evaluating the performance of collaborative agricultural research and development activities in the Australian sugar industry'. Support and guidance provided by supervisors Dr Mal Wegener, Dr Lisa Brennan, and Dr Thilak Mallawaarachchi is gratefully acknowledged.

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