Review of the Climate Variability in Agriculture R&D Program

Prepared for:

Land and Water Australia

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Executive Summary

Introduction

The Climate Variability in Agriculture R&D Program (CVAP) represents the third and latest round of explicit public investment in climate variability research and development (R&D) with a specific focus on the agriculture sector. It has as its goal:

> *to work with the Australian agricultural sector to develop and implement profitable and sustainable management strategies which prepare it to respond to the major opportunities and risks arising from climate variability.*

CVAP has been funded through the Agriculture - Advancing Australia (AAA) package, to the extent of $3.5 million from 1997 to 2001 and is administered by Land and Water Australia, as an R&D program.

This final impact (ex-post) review has addressed fundamental issues associated with the nature and extent of the outcomes achieved thus far and potential future directions for a climate variability program. The review has developed a framework, based on Program Logic, to define and assess the outcomes. Available performance information has been collated, which has meant drawing heavily on the perspectives of key stakeholders. Two national workshops have been conducted involving funders, users, beneficiaries and research providers: one focusing on potential future directions and the other on evaluation issues.

Appropriateness

CVAP's current objectives and past activities have aligned well with the AAA objectives, with the emphasis on promoting a more profitable and sustainable agricultural sector through assisting farmers and other resource managers to better manage risks relating to climate variability. Implicit in the activities supported by CVAP has been the desire to promote higher degrees of self-reliance and resilience at the farm enterprise level. This has been a theme of government policy, particularly since the launch of the National Drought Policy in 1992.

The lack of knowledge and tools related to the agricultural sector at the commencement of the CVAP has necessitated a strong and quite appropriate focus on R&D related activities since the inception of the program.

The national focus of the program has also been appropriate given the significance of climate to managing agricultural activity in the Australian context and the range of cross-regional, cross-industry and cross-jurisdictional issues involved. Because of these considerations, Commonwealth financial support for the operation of the program through its formative years has been of crucial importance.

The support for the CVAP program amongst stakeholders has been very high, which acts as a further indicator of the level of appropriateness of the program. For example, the National Farmers Federation has shown a continued level of support and has written to the Minister for Agriculture Fisheries & Forests encouraging continuance of the program. In addition, five R&D Corporations have also actively contributed to the current phase of CVAP (Dairy Research & Development

Corporation, Grains Research & Development Corporation, Land & Water Australia, Sugar Research & Development Corporation and Rural Industries Research & Development Corporation). State governments have also heavily invested in some CVAP projects.

Based on these considerations, Hassall & Associates considers that the overall objectives of the program are highly appropriate and relevant. Continuing to involve stakeholders in the design of a future program is also likely to enhance its appropriateness. Appropriateness could be further enhanced through improving wider adoption, natural resource management outcomes and further integration of activities and investment with related programs.

Effectiveness

The objectives and outcomes established for CVAP are quite ambitious, especially given the scale of investment involved. Climate variability is still a relatively young research area. Outcomes sought for the program have not been well defined in terms of time and feasibility, and the determination of effectiveness has been hampered by the lack of a rigorous monitoring and evaluation framework.

It is clear that the program has made considerable progress in relation to developing improved understandings of climate variability and developing specific products that are relevant to the agricultural sector. CVAP has effectively put agriculture on the map, as far as climate service providers are concerned. It has also been effective in promoting an extremely high level of collaboration amongst researchers in different disciplines and increasing research capacity. This is likely to lead to future pay-offs for the present investment in climate variability R&D.

Even though the objectives are ambitious and ill defined, CVAP has partly achieved its objectives. Full achievement would rely on a significant expansion in the uptake of its outputs. The need to focus more on adoption was a persistent theme by stakeholders, throughout this review. An increased level of integration with other programs also offers the prospect of enhancing the program's overall effectiveness.

Efficiency

The Annual Report and Six-Monthly reports submitted by LWA to AFFA demonstrate a systematic and effective approach to program management. The reports outline for each project funded: its objectives, performance against the objectives, issues raised and further funding recommendations. Progress payments to projects are based on meeting their internal milestones. Hassall & Associates has confidence in the project management systems used. Responses from researchers during the consultation demonstrated that they were aware of the high expectations as to performance, project reporting and management.

Only a small number of projects reported delays in their original milestones due particularly to staffing and recruitment issues. Similarly, only a small number of projects reported changes to the milestones, as well as the overall scope of the project, during the establishment of the project. The CVAP coordinator approved all of these changes and there do not appear to be any outstanding issues of concern to the reviewers.

Some issues were raised by researchers about the timeframe for their respective projects, as well as the exploratory nature of some of the projects, which means that it is difficult to see adoption of results during the project or even the progression to next stages. Few of the projects appeared to have mechanisms to formally track what happens after the project has been completed, which should be of concern at the program level in order to assess the efficiency (and effectiveness) of the program.

Hassall & Associates has not been required to investigate the process for selection of projects nor the financial management of the program, but has no reason to believe that there are any deficiencies in these areas.

Integration

Resource managers at all levels should be looking for approaches that are capable of addressing the broad range of NRM and commercial challenges they are confronting. This presents particular challenges for programs, such as CVAP, both in their design and implementation. Within the constraints of available resources, CVAP management, through the coordinator, has already gone to considerable lengths to develop effective collaboration with other organisations and projects.

There is now the opportunity for a higher level of interaction and collaborative activity with LWA programs that have potential areas of common interest and with other national programs dealing with priority natural resource and environmental management issues.

Stakeholders support and acknowledge that program/project integration is a strategic priority for the Program. It is important that the need for improved integration is given some prominence at the program design level.

Where CVAP makes a difference

It is suggested that without a program such as CVAP:

- There would have been a lack of coordination of climate variability R&D;
- Agriculture would not have been recognised as a client for provision of climate services, and the agricultural sector and policy makers would rely on understandings that were not geared towards agriculture;
- There would have been no central focus for climate risk management;
- Agencies would have less incentive to interact, that is, there would be more 'silos';
- Research agendas would then, by implication, be driven by internal organisational priorities rather than to a national agenda;
- Fewer products would have been available for use;
- Farmers would not have the necessary tools and understanding in order to become more self-reliant and better managers of climate risks (and opportunities); and
- The level of networking between researchers in climate and agriculture would not have been as advanced as it is now.

These points indicate that CVAP has been an important program in providing a focus for agriculture and climate variability R&D to progress.

Summary of evaluation

CVAP has been well managed and individual projects have, in the main, been successfully implemented. It has provided a base to develop and foster supporting science skills and capacity, which should contribute longer-term benefits. There has been a commendable level of integration at the project level. However, the program should now be sufficiently mature to achieve a higher level of integration at the program level in order to achieve greater adoption and industry outcomes

On balance, CVAP has achieved well, considering the level of investment provided and the ambitious objectives. The program has also achieved well in relation to developing improved understandings of climate variability and developing products. However, a concerted effort to expand the level of uptake of CVAP information and tools will be required to achieve the higher level outcomes.

Recommendations

The primary recommendation is that funding an extension of the Climate Variability in Agriculture Program with a focus on adoption is warranted.

This recommendation is based on our assessment that:

- While progress has been made, there is a continuing need for coordinated and well targeted activity to further enhance the capacity of farmers and other resource managers to better manage climate variability;
- CVAP has made considerable advances in the development of our collective understanding of climate variability in relation to the agricultural sector and scientific capacity in this field;
- Without an additional phase concentrating on further refining and promoting the adoption of current CVAP tools there is the prospect that the returns on those funds already invested in this process will not be fully realised; and
- An appropriate and effective program management framework has already been established in support of CVAP.

However, there are substantial modifications recommended for the direction of the program and its integration with other activities. These are outlined below.

Future Program Design

Any future climate variability program should build on the successes of CVAP in providing a national focus for R&D and supporting the development of climate information and support tools. Giving prominence to addressing any significant impediments to further use or adoption of current and future CVAP products is fundamental to achieving the desired outcomes. Products developed to-date have the potential for wider adoption within the agricultural sector as well as in related rural industries and communities. They also have the prospect of promoting enhanced natural resource management outcomes. This offers the prospect of considerably expanding the benefits derived from the public investment in CVAP while retaining the current primary focus on the agricultural sector.

Based on these considerations the goal of a successor program could be:

> *To contribute to more profitable, competitive and sustainable rural industries and communities…*
> *…by equipping Australian rural industries and resource managers to respond more effectively to the major production and natural resource management opportunities and risks associated with climate variability.*

Primary Characteristics – what would be different?

The main change suggested relates to a shift in emphasis to a program with a greater emphasis on adoption of climate risk management and CVAP products in all primary production sectors. This change would involve giving greater priority to extension and communication activities, as well as to promoting the application and adoption of existing information and tools. Research would continue to be a significant element of the program but would not be the principal focus.

The suggested changes would be achieved by:

- Promoting adoption by more specifically targeting the needs of particular primary production and food sectors - where appropriate, at a regional level;
- Promoting strategic alliances and the further integration of its activities with complementary programs and activities;
- Continuing to provide leadership and catalytic support to research specifically intended to fill identified needs and priorities, as well as providing a multi-disciplinary research network that is even more responsive to user needs; and
- Identifying and developing applications with potential to contribute to the sustainable use and management of natural resources and improved biodiversity outcomes.

Should the basic concept of the future program be accepted, then a further planning process to prioritise additional work will be required to develop a suitably detailed strategic plan and to refine its method of operation, particularly in relation to its management and governance arrangements. Stakeholders have recognised that the outcomes need to be prioritised and consideration given to the level of respective investment. The process will need to determine an appropriate level of funding consistent with the objectives. As part of this process, priority will need to be given to establishing detailed performance goals and associated performance indicators and reporting procedures. These matters are beyond the scope and capacity of this review.

Hassall & Associates has made specific recommendations that apply to two of the important projects of CVAP, Aussie Grass and StreamFlow, which are contained in Chapter 3.

1. Introduction

The Commonwealth Government has continued to invest explicitly in climate variability research and development (R&D), over the past nine years, in recognition of the threats and opportunities that climate variability presents to farmers and resource managers. There has also been substantial investment by State governments, industry organisations and other R&D Corporations.

The Climate Variability in Agriculture R&D Program (CVAP) represents the third and latest round of investment. It has as its goal:

> *to work with the Australian agricultural sector to develop and implement profitable and sustainable management strategies which prepare it to respond to the major opportunities and risks arising from climate variability.*

CVAP is part of a larger and ongoing national R&D effort in climate research. CVAP activities have a primary focus on providing support to those aspects of climate variability with particular implications for the agricultural sector. More details on CVAP are available via the website: www.cvap.gov.au .

CVAP is currently funded through the Agriculture - Advancing Australia (AAA) package, to the extent of $3.5 million from 1997 to 2001 (not including contributions from other R&D Corporations). The aim of the AAA package is to help the rural sector to be more competitive, sustainable and profitable by:

- helping farmers profit from change;
- giving farmers access to an effective welfare safety net;
- providing incentives for ongoing farm adjustment; and
- encouraging social and economic development in rural areas.

CVAP fits well under the AAA banner because of its emphasis on managing risks relating to the climate, promoting self-reliance and sustainable management of resources (constant themes dating back to 1992 with the National Drought Policy).

Five R&D Corporations have also contributed to the current phase of CVAP (Dairy Research & Development Corporation, Grains Research & Development Corporation, Land & Water Australia, Sugar Research & Development Corporation and Rural Industries Research & Development Corporation)[1].

The program's funding is administered by Land and Water Australia, as a R&D program. Four main objectives of Land and Water Australia are addressed:

- increasing the environmental or social benefits to members of primary industries and to the community in general by improving the production, processing, storage, transport or marketing of the products of primary industries;
- achieving the sustainable use and management of natural resources;

[1] The Australian Centre for International Agricultural Research also contributed funding for an international workshop.

- making more effective use of the resources and skills of the community in general and the scientific community in particular; and
- improving accountability for expenditure on R&D activities in relation to primary industries.

A review of the previous rounds of investment determined that the program was sound and that continuing investment was warranted - albeit, with some changes in emphases, particularly to marketing and communication and also to include Natural Resource Management (NRM) (Hassall & Associates 1997). A planning workshop was held in 1997 to design CVAP (which is the third phase of investment), involving a range of stakeholders including researchers, investors, agency staff and industry representatives.

A mid point review of CVAP reported achievements of the program to date and identified opportunities to strengthen information sharing and networking between the researchers (CapitalAg 2001). The mid-point review found that in general CVAP is achieving, or has potential to achieve, its objectives as set out in the management strategy. The mid-point review also noted that CVAP had taken action to address many of the gaps identified in the review of previous phases.

The interest of this final impact (ex-post) review is to address more fundamental questions about the outcomes achieved thus far and future directions for a climate variability program. As at December, 2001, all funded projects have been completed with the exception of four final project reports that needed minor changes before acceptance and final payment.

The Terms of Reference for the review are included in Appendix 1. The ex-post review covers particularly the appropriateness and effectiveness of the program.

The appropriateness element considers the extent to which the program's objectives meets societal and government needs. Appropriateness also is relevant for discussing the future design of a climate variability program.

The effectiveness element of the review considers the extent to which the desired outcomes are achieved of the program as a whole. It is acknowledged that there are some difficulties in evaluating programs and projects that have been set-up prior to this convention being widely adopted and incorporated in project design. Part of the review task needed to define the intended outcomes and consider indicators of performance in achieving the outcomes (see Section 2 Approach).

The efficiency of the program is addressed through assessing whether the standard management practices of Land and Water Australia have been followed.

The issues addressed by CVAP have the potential to impact on, and be influenced by other research and development activities undertaken by Land & Water Australia as well as a range of related R&D Corporations, Cooperative Research Centres and individual research institutions. With this in mind, consideration is given to the current extent of research integration as well as to the potential to promote improved outcomes by identifying and harnessing synergies with other relevant R&D activity.

Intended Outcomes of the Program

Hassall & Associates has considered the program documentation and developed a framework to consider the intended outcomes of the program. This framework more explicitly considers what the program is trying to achieve, as well as establish the means by which performance can be assessed. The outcomes ascribed for each of the objectives, along with their significance or importance, include:

Outputs

Improved climate prediction and the monitoring of the impacts of climate variability through increased understanding of climate variability [Objective 1].

> This output is important because such understanding is seen as fundamental to the credibility and the confidence that users have in the prediction and monitoring of impacts (a persistent theme from users). An increased understanding is also a fundamental input into climate variability information and tools.

New farming systems developed that are better adapted to climate variability [Objective 2].

> This output is important because it is evident that many current farming systems have deficiencies and that new farming systems are needed that are better aligned to Australia's climate variability. Drivers for this also include climate change and a broader range of NRM challenges such as dryland salinity. The emphasis is also on 'systems' and a bigger picture, rather than on individual decisions or projects.

Managers' needs met for climate information based on improved knowledge of their needs [Objective 3].

> This is important because improved knowledge of needs is fundamental to achieving the program goals and to ensure that the information provided is predominately demand/user driven rather than solely supply/researcher driven (the former is thought to improve adoption, although it is also evident that user demand needs to be informed, as "you don't know what you don't know").

Managers provided with information on the value of seasonal climate forecasts in supporting decisions for specific applications [Objective 4].

> The wording of the objective could be refined to emphasise supporting decisions rather than providing information. This output is needed to translate the better understanding into tools and products that can be used (and hence obtain a return on the investment in improving understandings). Knowing the value of forecasts is needed to indicate which decisions can be supported.

Short term outcomes

Improved researcher capability.

> This outcome is needed to build human/intellectual capacity to deliver future returns. An improved capability can lead to short term pay-offs through better "integrated" and comprehensive products.

Improved climate variability information available and a better predictive capacity & understanding of impacts.

As noted with output 1, improved information is crucial for credibility and future uptake.

Improved awareness of climate variability information - By farmers, agri-sector, policy.

Awareness is necessary to achieve longer term outcomes.

Intermediate term outcomes

Improved capability to understand and use climate variability information [including the willingness or acceptance to use?]- By farmers, agri-sector, policy.

Capacity to use climate variability information is necessary.

Improved use of climate variability information; information is incorporated into decision making- By farmers, agri-sector, policy.

Information must be used in order for research to have its pay-offs.

Longer term outcomes

Management strategies developed and implemented (profitable & sustainable): - By farmers, agri- sector and policy.

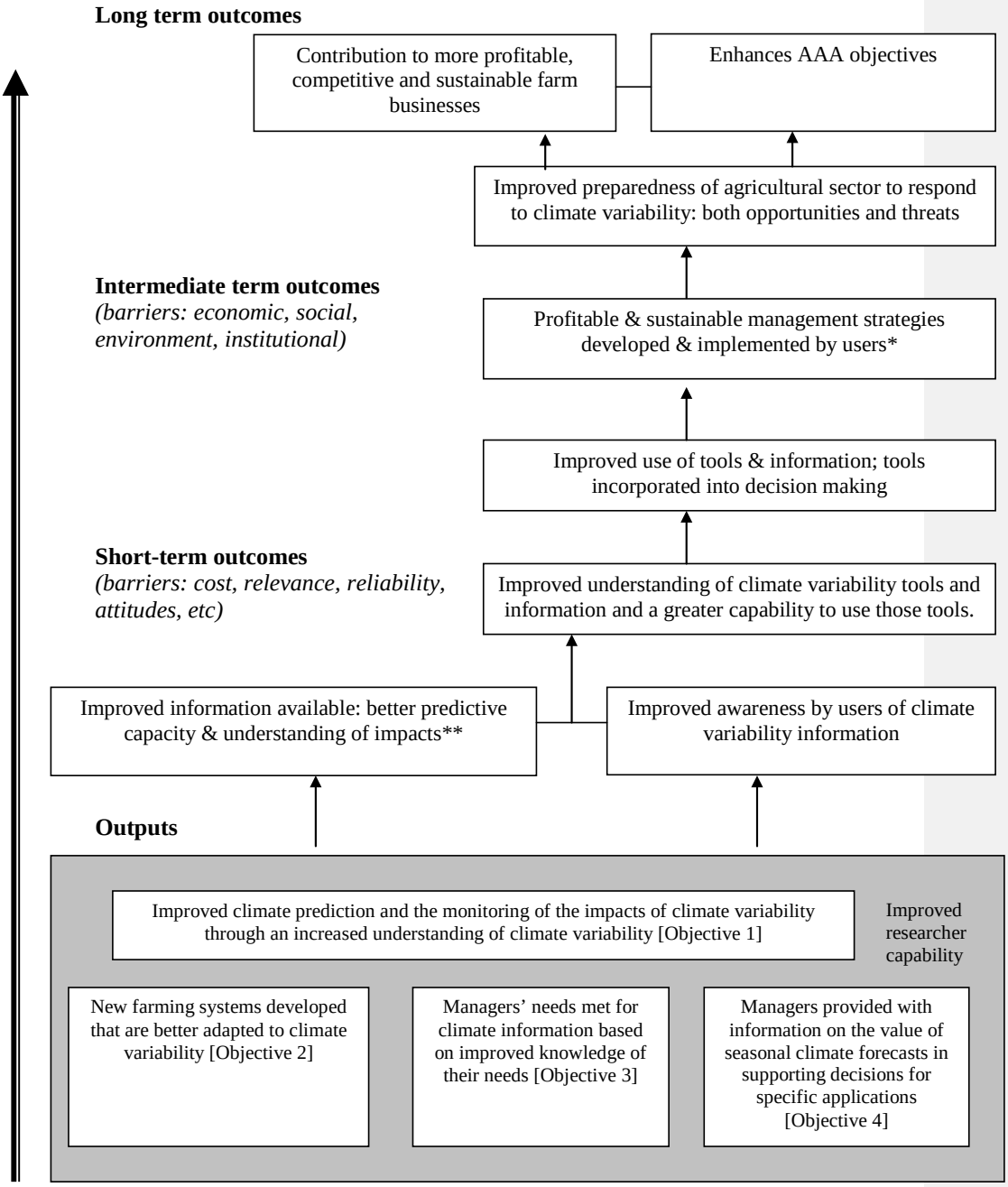
Improved preparedness of the Agricultural sector to respond to climate variability: both opportunities and threats.

This would show: a more prepared and responsive sector, an increased acceptance of risk management, lower reliance on government 'rescues' and potentially higher overall profitability over climate variability periods.

AAA program goals are enhanced; and a more profitable, competitive and sustainable agricultural sector results.

The intended outcomes are shown diagrammatically in Figure 1. The outcomes have been ascribed for the purpose of conducting the review. It must be acknowledged that these are not outcomes that have been designed or signed off by the management committee. Without ascribing outcomes, the only other path is to consider whether the actual outputs are the same as the planned outputs, and trust that the planned outputs will lead to the necessary outcomes. There was prior agreement from stakeholders that the four CVAP strategies are desirable, as shown by the 1997 planning workshop, and therefore this assumption may be reasonable. However, defining outcomes and tracking through different levels has more rigour and, we argue, more utility for designing a future program.

Figure 1: Attributed Outcomes of the Current Climate Variability in Agriculture Program (CVAP)



* Users include: farmers, agri-sector and policy

** Improved tools availability may be a long term outcome, especially given lead times and nested research projects (e.g. output of one project may feed into another).

The program and the projects undertaken

Australia's primary production systems are subject to extremely variable climatic conditions. Farmers therefore have to make awareness of this variability an integral component of managing their farming systems. To assist them in addressing this challenge, projects funded within CVAP have been targeted at anticipating and reducing the impact of climatic extremes on the productivity, sustainability and financial viability of Australia's broad range of agricultural systems.
A focus of the program has been on anticipating future climatic trends and events, particularly through improved seasonal outlooks. This has been made possible through establishing a strong national network involving researchers in agriculture, climatology and oceanography.

Forecasting tools have included empirical statistical models, based on the Southern Oscillation Index (SOI) and Sea Surface Temperatures (SST) **(BOM4[2] and BOM5)** and on more process-oriented General Circulation (Global Climate) Models (GCMs), with particular attention being paid to ocean-atmosphere interactions and the implications for Australian farming **(CTC16)**.

Attention has also been focused on Decadal Variability, using the Interdecadal Pacific Oscillation as another significant determinant of seasonal outlooks and climate trends **(QPI44)**. This project, directed at northern cropping systems, has gone some way in demonstrating the importance of runs of wet and dry years and how they might be managed. For example, correlations between the Murray River flow and the SOI are very low when the IPO is positive, compared to higher values when the IPO is negative. It has also been recognised that the Indian Ocean as well as the Pacific Ocean affects the climate of eastern Australia **(UWA23)**, in the former case via the influence of north-west cloudbands on eastern Australia rainfall.

A strategic project has been *From oceans to farms: integrated management of climate variability* (**CTC16**). This has used statistical indices (e.g. SST) and coupled ocean-atmosphere models in association with farm production/economics models for the extensive grazing, dryland grains and sugar industries. A major achievement was the development of a statistical forecasting system that relates SSTs from the Indian, Pacific and Southern Oceans directly to an index of plant growth (or any other index including rainfall) in a target region.

The direct impact of past and anticipated climate events on Australian grasslands has been examined through the Aussie GRASS program, in which the innovative systems developed in Queensland are now being trialled in most other States and the Northern Territory (**QNR9**). Aussie GRASS has provided considerable assistance in Queensland at the State and Commonwealth level in drought monitoring and assessment. Seasonal forecasting is now being used to mitigate land and pasture degradation events (**QNR14**). Historical evidence indicates that where conservative stocking policies have been adopted, or where rapid reduction in stock numbers occurred in response to the onset of drought, such degradation appears to have been

[2] Project reference codes are used – please refer to Appendix 2 for a description of the project title and researcher for each project.

minimal. Decadal information was shown to have value in anticipating and mitigating against such degradation events.

Reliable seasonal outlooks are important aids to successful farming, but so too is the ability for agricultural and other natural resource managers to manage climate variability *per se*. This is an essential pre-requisite to having profitable and sustainable management strategies developed and made use of by producers. The projects on *Searching for innovative adaptations to climate variability* (**CIC3**) and *Promotion of Masters of the Climate case studies* (**CIC5**) were important in identifying how different ways that farmers themselves reduce climate impacts.

The fact that there were only two projects targeting Objective 2, developing new farming systems, is not reflective of the importance of the objective nor the considerable policy, political, economic, climatic and technological changes that impact on global and particularly Australian agriculture. Further projects were not funded under this objective because there was a lack of suitable research proposals that could deliver the outcomes required.

An important step in managing climate variability so as to reduce climate risk involves accessing historical climate data, including SOI and SST data, this being facilitated through the Australian Rainman CD-Rom (**RDC9**) and the ongoing development of SILO (**BOM6**; **QNR3**), enabling on-line access to detailed historical climate data through the Bureau of Meteorology's web site. There has also been on-going digitising of pre-1958 climate archives providing a valuable benchmark to assist in identifying significant regional shifts in our climate, and placing more recent climate perturbations in perspective.

With data, a good progression for managing climate variability *per se* is to determine and implement the optimal long-term strategy for the farm. This includes determining optimal dates for sowing crops, and the lambing and calving down of flocks and herds respectively. Livestock producers also need to determine their long-term stocking rates, and associated buying and selling activities, since these have a major impact on overall farm profitability, and the impact of grazing activities on vegetation and soil structure, with implications for limiting land degradation.

Reasons for the adoption or otherwise of new technologies can be identified through farmer surveys, model-based analysis of farming systems, and through studying farmer motivations and behaviour. All three approaches provide a different and often complementary perspective and insight into the decision making process.

Use of seasonal outlooks is lower in Victoria than in north-eastern Australia. From a systems viewpoint this is hardly surprising for a number of reasons. Firstly, the relationship between spring rainfall and winter indicators such as the Southern Oscillation Index is still significantly less than the relationship between summer rainfall and comparable spring indicators in north-eastern Australia. Secondly, the marginal value of the additional information provided by three-monthly seasonal outlooks over other information such as recent rainfall, soil moisture and available pasture or crop biomass is often low, particularly in areas with a long (autumn-winter-spring) growing season, typical of southern and western Victoria. On the other hand, climate variability is much higher and growing seasons significantly shorter in areas

of Victoria that are north of the Great Dividing Range. In addition, many farms are stocked well under optimal stocking rates, with flocks lambing down in autumn thereby minimising the number of ewes bearing twins, further reducing their exposure to climate variability and their need for outlook information. This is also characteristic of grazing properties in areas of New South Wales (e.g. Simpson et al. 1999).[3]

URS3 surveyed stakeholders within the southern New South Wales and Victorian grain belts to establish the degree to which seasonal forecasts are used and to determine the key factors constraining the use of seasonal forecasting information in this region. Unlike the systems studies, the possible reasons focussed more on the reliability of information, with stakeholders suggesting that there was not enough assistance available, some land managers perceiving little value in changing their management practices, and the information not being seen as a useful management tool. Subsequent workshops helped focus on the need for a longer lead time, and the fact that many stakeholders have little idea of how to incorporate the information into their management planning. Here again, systems studies can assist in addressing both these issues. Three projects have addressed southern Australia and helped to broaden the geographical coverage of the program.

The mid-term review of CVAP (CapitalAg 2001) recommended that there is a need for more research on the psychology of farmer attitudes to risk and the influence this has on their decision making. The University of Queensland consequently addressed the need for better communication with respect to climate forecasts (**UQL20**). This led to changes in the way the Bureau of Meteorology presents its Seasonal Climate Outlook, so that it is better understood.

It is important that research program development is based in part on what R&D has taken place before. A survey of agricultural climate research, development and services in Australia was therefore undertaken, complemented by an update of the compendium of Drought Research in Progress (**DAN12**). Updating this database regularly, e.g. annually, is expected to enhance its use and value.

There is now a better appreciation that government policy can have a major impact on whether new technologies are adopted, and the extent of structural adjustment and farm improvement. Project **CWE23** (under Objective 3) examines whether government policy instruments support sustainable grazing on-farm. This recognises that taxation and other policy instruments have often provided significant disincentives to responsible management, whereas properly targeted policy instruments can foster farm management practices that are both profitable and

[3] This demonstrates why targeting adaptive farming is important. A useful starting point would be the systems studies of Morley (1994), Vizard (1998), Bowman et al. (1995) and Simpson *et al*. (2000), all of which have highlighted the difficulty of obtaining economic responses to such information. Work in western Victoria by Austen and Clark (1999) (VCE14) concluded that "The SOI is not as useful at predicting south-eastern Australia as it is in eastern and northern Australia. Low mean winter SOI values do, however, indicate below average spring growth. This is particularly so if soil moisture levels at the end of winter are low". They showed that the value of the SOI will be limited to years when there is a strong signal, but this will include years when there is a much increased drought risk. The value of other statistical indicators of climatic extremes now needs to be investigated, along with work aimed at extending the lead time well beyond the current three months. Many producers, given limited options to take appropriate trading and other actions without incurring severe financial penalties, seek lead times in excess of a year.

environmentally sound. In particular, the project has done pioneering comparisons of alternatives for valuing livestock and how these influence profits and sustainability. Policy makers now have a tool which can be used to assess new instruments before they are applied.

Australian Rainman has been adapted to provide seasonal streamflow and runoff forecasts in order to improve management of often scarce water resources has resulted in a CD-Rom now being available (**QPI39**). This has potential to give irrigators a better basis for planning and to seek more information from water agencies about the implications of local rules governing water allocations. It may also assist those responsible for maintaining environmental flows to support wetlands and other significant ecological habitats.

The current phase of CVAP has much more emphasis on the marketing of climate data and related information (Objective 3), consistent with the recommendations of the Phase 2 review (Hassall & Associates 1997). There has been considerable attention to better understanding what influences farmer decision making, and hence their needs with respect to better managing their farms. CVAP has also been characterised by a much closer focus on addressing the needs of specific industries and agribusiness, again consistent with earlier recommendations. During project **VIR5** it was concluded that a demand-side emphasis was essential to better equip Victorian dairy farmers to handle climate information as part of a broader risk management. Accordingly the project was extended and revised, with emphasis on material for inclusion in existing extension programs aimed at improved risk management. The value of seasonal climate forecasting in improving the competitiveness of the sugar industry by canegrowers, marketers and millers has been investigated. Early industry support has been favourable, with stakeholders in the production-marketing chain actively involved, including making considerable use of the aforementioned SILO datasets.

A number of extension projects were supported, including the production of best practice manuals for the summer and winter grain areas, based in part on active involvement by prominent consultants and farm advisers in the participating States. (**HRM1**). Harvest risk was identified as a major manageable risk in northern areas. However, seasonal forecasts were found to be of limited value in many cropping situations unless there was a strong signal, as with a significant ENSO event.

The role of seasonal climate forecasting in influencing key cropping systems decisions, including crop choice and cropping sequence, was also investigated (**QPI38**). The decision support program 'Whopper Cropper was developed, giving advisers a powerful and easy-to-use tool to compare simulated crop yields and returns for a range of crops and seasonal forecasts. The Agricultural Production Systems Research Unit (APSRU) at Toowoomba has incorporated a seasonal forecast facility into the APSIM software framework for use by a range of simulation tools, covering a wide range of crops. This should facilitate further studies into the value of such forecasts and when they can best aid the decision making process.

APSRU has also been collaborating with agribusiness partners to develop the role for seasonal climate forecasts and simulation models for marketing, financial lending and insurance institutions (**CTC18**). Case studies were developed with firms in insurance

(loss assessment), fertiliser companies and banking. It is important to engage with the agri-business sector in order to enhance the effectiveness of the program.

Associated with Phase 3 of CVAP has been specific extension activities, including a planned workshop on *A century's perspective on climate variability and impacts on agriculture*, which evolved into the very successful CLI-MANAGE 2000 Conference at Albury (**BOM3**), and an International workshop on farm management decisions jointly funded by ACIAR, held in Toowoomba in April 2000 (**QPI42**). The latter helped consolidate the experience of a number of Australian and overseas experts. Recognising that much of the reasoning behind CVAP is based on policy concerns about the need to increase the self-reliance and risk management skills of farmers, workshops were also held in the southern States to aid farmers, advisers and students address both price and climate variability (**UWA21**). The project has had good support from FarmBis, with a general purpose training package for risk management being developed.

CVAP and its predecessors (e.g. NCVP) have provided policy makers assistance in assessing the current state of Australian agriculture, including determining whether drought and/or other events have been so exceptional as to qualify regions for financial assistance from the Commonwealth government. Current work within BRS **(BRR7)** has included the development of a Rainfall Reliability Wizard to operationally analyse and map rainfall variability and reliability at different timescales. An Integrated Toolset has also been developed for spatially integrating scientific evidence with respect to the severity and impact of extreme events. Of course, effectiveness of rainfall in terms of pasture and crop growth is critical in assessing whether such events are exceptional, requiring outputs of agronomic models and remote sensing to be integrated with other information.

CVAP has provided many useful outputs, in terms of climate data and information and both specialist and user understanding of climatic systems, scientific and extension-oriented publications, workshops and decision tools and recommendations for improved farm management. There is little doubt that CVAP incorporates thinking of a paradigm shift in terms of enabling researchers from disparate fields to work together to meet rural goals, and to make the rural community in particular much more aware of the climate phenomena that affect Australian agriculture, as well as how such understanding can lead to better strategies and farming systems.

A list of the projects undertaken is provided in Appendix 2.

2. Approach

Evaluation framework

The goals and the strategies of the program are articulated in the CVAP Management Strategy, which is available on the website: www.cvap.gov.au . The review has been guided by a framework based on *Program Logic*, which concentrates on describing the program in terms of its intended outcomes. This in turn allows the selection of appropriate performance indicators. Individual projects are analysed in the context of the program, rather than stand alone (the final project reports should indicate whether the project has been successful in meeting its own objectives).

The outcomes hierarchy for CVAP, adopted by Hassall & Associates for the review, is shown in Figure 1 in the previous section. An outcomes hierarchy can specify intermediate as well as long term outcomes, select appropriate performance indicators, describe the impact of projects in relation to the program's objectives and look to quantify the impact where possible. It is necessary to define intermediate outcomes because the overall goal of the program is very long term and there is a lack of data available to say whether it has been achieved.

Further detail as to the attributes of success for each outcome, possible comparisons, factors inside and outside of the influence of the program, potential performance indicators and comments about assumptions used are contained in the matrix in Appendix 3. This then sets the framework for making assessments about the performance of the program.

Methods and data

Two workshops have been conducted, corresponding to the terms of reference:

- The first aimed to scope possible future directions for a Climate Variability Program. This workshop was conducted in May 2001 and involved a range of stakeholders in agriculture and natural resource management[4].
- The second aimed to support the evaluation and develop recommendations. Participants included Project Leaders as well as a range of stakeholders drawn primarily from the first workshop. The workshop was conducted in November, 2001.

Whilst the scoping of future directions normally happens after an evaluation has been conducted, the process enabled the consideration of the funding of a new program (or phase of program) to commence in July 2002. It also recognised that various CVAP projects would not be completed until June 2001. The timing allowed some iterations and refining of the outcomes, outputs and strategies. An interim report on the new directions has been available on the website, however, has not drawn any unsolicited comments.

[4] A list of the participants can be provided, if important.

Consultation with key stakeholders occurred during the workshop processes, and this forms one of the main data sources for the review. Questionnaires were sent to a range of *users* and *researchers* before the first workshop, particularly to identify current use and demand for research outputs and issues relevant to future directions. Other data sources included the Program Evaluation 2000 (AAA survey), progress and final project reports, other products and tools/models that have resulted from the projects, records kept by Land and Water Australia and general literature pertaining to climate variability.

Additional tasks included considering the integration of CVAP and its projects with other projects in the Land and Water Australia portfolio and also more broadly across other R&D activity. Two projects have been chosen for further investigation, based on the supplementary activities described below. The unintended outcomes of CVAP and the "without program" scenarios were also canvassed.

Two supplementary activities at an individual project level have been undertaken:

- a product launch of StreamFlow, designed to engage the attention of water managers in South Eastern Australia in the products from the QNRM project. The StreamFlow product was officially launched on 29 November, 2001, by Mr Don Blackmore, Chief Executive of the Murray Darling Basin Commission, as well as released by the Queensland Minister for Primary Industries.
- a scientific and merit review of the Aussie GRASS project, via an independent review panel chaired by Professor Henry Nix.

The two supplementary activities are included as self-contained reports (Appendices 4 and 5) and relevant lessons included in the discussions in the main report.

3. Evaluation findings

The findings address:

- AAA survey results;
- Assessment of performance;
- Gaps between actual and planned achievement;
- Lessons from the program;
- Unintended consequences;
- Additional lessons from StreamFlow and Aussie GRASS examinations;
- Integration with other projects and programs;
- Quantification of benefits; and
- 'Without program' scenarios.

The results of the consultations and project level investigation have been incorporated into the categories of findings above.

AAA Program Evaluation 2000 (AAA survey)

The following data is contained within the AAA survey:

- About CVAP:
  - Awareness of CVAP
  - Knowledge of CVAP
  - Used or benefited from CVAP
  - Expect to utilise CVAP in the future
- About farmers' plans and records:
  - Farmers with a farm plan that will help them in a drought
  - Farmers keeping long term rainfall records
- About Seasonal Climate Forecasts (SCF):
  - Awareness of SCF
  - Use of SCF
  - Types of decisions that use SCF
  - Reasons why SCF are not taken into account
  - How are SCF accessed
  - How can SCF be improved
  - Would you undertake training to make better use of SCF

The detailed data available for each of these points is contained in Appendix 6. Not all of the comparable questions were asked in the 1998 AAA Survey and hence time-trend information is limited.

The main findings follow, along with interpretations.

About CVAP

Of respondents, 10% have heard of CVAP. Of these, 43% know what it is about. Of these, 19% have used or benefited from the program and 33% expect to use the program in the future. That is, less than 1% of the rural farming population had used and just over 1% intended to use CVAP in the future.

In terms of States and industries:

- Awareness was higher in Queensland and Tasmania, and lower in Victoria.
- Awareness was highest for Sugar Cane and Cotton; and lowest for Sheep and Beef, Dairy and Horticulture.

Overall, the awareness of CVAP is low, however, this does not account for farmers that have heard of Rainman, for example, but would not necessarily associate it with the program. In addition, there are questions about whether it is necessary to have a recognisable brand name in the sense that it is more important to achieve outcomes. Many farmers have also expressed to the reviewers that they do not care which particular bucket the money or project or product comes from, rather they concentrate on its utility. However, it is difficult to attribute the outcomes and achievements without this recognition. It also impacts on the political awareness and the level of support for the program.

About farmers' plans and records

The proportion of the total population that believed their farm plan would help with drought is 36%. [48% of the population had a farm plan]. 63% of respondents kept long term rainfall records. These data provide a limited baseline of farmer behaviour. If it is associated with capacity to understand and use climate variability information, which is tenuous, then it suggests that CVAP will not reach 100% of the audience, in any case.

About Seasonal Climate Forecasts (SCF)

72% of the sample was aware of SCF. This was highest in Qld and WA and lowest in NT and Vic. By industry, it was highest in sugar, cotton and cereal industries and lowest for fruit and vegetable.

51% of these farmers (37% of total) take the SCF into account when making decisions on the farm. The results also have a strong geographical and industry basis, as did the previous result. A high proportion made decisions for cropping and livestock inputs, a reasonable proportion for output decisions, and less for finance decisions (e.g. water allocations). For the people that do not take SCF into account, most respond that the forecasts are not accurate enough. A small number stated that weather/climate is not a constraint for their operations.

SCF are one component to managing climate variability. There are other climate risk management decisions for which there is often no available data.

If 1989 can be taken as the provision of the first "official" SCF, by the Bureau of Meteorology, then the increase has been marked. The real value of the AAA data will come in 2002 when the next series of data points is available, so that CVAP can see if it is making any difference to farmer behaviour.

Assessment of performance

The assessment of performance is provided below. Comments specifically arising from the Evaluation Workshop are labelled "workshop participants' comments". "Hassall & Associates' assessment" refers to our views about the achievement of each outcome, drawing on data from a range of sources, including the workshop(s), pre workshop consultation and project reports.

Outputs

1. Improved climate prediction and the monitoring of the impacts of climate variability through increased understanding of climate variability [Objective 1]

Workshop participants' comments:

- Forecasts and tools have been developed that include improved understanding. Participants felt that there was now a higher level of confidence in the underlying climate science.
- New forecasts are being used and experimental systems are being developed (which may in turn become operational if their skill is higher). GCM's are continuing development and have a lot of potential in the medium to long term.
- A large number of impact tools are available, such as AussieGRASS (& APSIM, GRASP), RiskHerd, Rainman, SILO and others, that have been contributed to by CVAP funding.
- Tools are being used by Government agencies, particularly AFFA/BRS, QNR&M.
- One project from a previous phase of CVAP is now at next stage (experimental system). Projects have led to other projects (e.g. decadal research).
- More data sets are now available for use in tools (e.g. Rainman, StreamFlow, Climarc, Aussie GRASS pasture yields).
- Users always seek longer lead time, increased accuracy, and more regional climate variability information – this is not always possible in the short term.
- Queries from participants include: do we need better forecasts vs better using existing information? Left out social impacts? Improved understanding doesn't apply to all industries?
- -Gaps include: Critical mass in staffing; data gaps and use of data (e.g. remote sensing); gaps in understanding (of processes and driving mechanisms of climate); industry gaps; and managing the media.

Hassall & Associates' assessment:

There is an impressive array of products and publications, although an implemented way of assessing skill and value levels is essential. It is difficult to determine if the prediction and monitoring have actually improved, although there is a strong likelihood that this is the case. The investment in GCM's has followed previous recommendations (Hassall & Associates 1997) although their potential has not been realised. One encouraging achievement is that during projects, other research questions have been identified. In turn, these have been preliminarily investigated (e.g. decadal oscillations, etc.).

2. New farming systems developed that are better adapted to climate variability [Objective 2]

Workshop participants' comments:

- In the workshop objectives 2 and 4 were discussed together. Attention focused on two projects regarding "Masters of the Climate".
- "Masters" of the Climate are a minority and not typical of most farmers.
- Query: did we get best use out of Masters of Climate? [this was examined for potential inclusion in R&D program].

Hassall & Associates' assessment:

This output was not obtained, although the Masters of the Climate was a very useful exercise for profiling the program and issues of managing climate risk (and information). The case study approach has contributed to more climate variability (CV) information being available (a higher level outcome). It is noted that a call for applications in this area did not lead to any suitable projects for funding and that as a consequence the Master's project was commissioned. The output is still important, although it is also noted that the Redesigning Australian Agricultural Landscapes (Futures) program has been active in this area and this may have diminished the imperative for CVAP to address this issue.

In the long term, systems level changes appear to be necessary to achieve the ultimate outcomes and, to some extent, are included in the discussion of the future directions of the program (chapter 5).

3. Managers' needs met for climate information based on improved knowledge of their needs [Objective 3]

Workshop participants' comments:

- There is an increased awareness of client information and use of climate variability information by researchers.
- Other CVAP and related projects have been developed and modified based on this changed awareness, including those targeted at better land management and degradation.
- There is an improved presentation of data; without CVAP client demand and solutions this would not have been identified.
- There is an improved availability of data (including new data sets – see obj 1)
- Can consider 4 market segments: farmer, agribusiness, policy and other researchers. All segments have a patchy awareness (some very high and most low) and achievement.
  -For the farmer segment: CVAP has attempted to address the psychology of decision making to understand needs.
  - For the agribusiness segment: CVAP has attempted to address: considered improved understanding of limits to present systems.
  - For the policy segment: CVAP has attempted to address more transparent and objective discussions (e.g. EC)
  - For the other researcher segment: CVAP has attempted to address links between strategic, applied and then to users (end-to-end projects, however these are only patchy in NRM issues).

- Queries include: demand vs supply driven? some producers do not need forecasts/info? Need to go beyond case studies?
- Gaps include: NRM, all parts of R&D&E, link with existing extension, sufficient consultation with users, scale, and too much policy and not enough farmer level effort.

AAA:
37% of farmers surveyed take SCF into account - there are few baselines or targets to aid the interpretation.

Hassall & Associates' assessment:
The AAA results indicate that 37% of farmers surveyed take SCF into account. If information is being used, then it can be assumed that it is likely to be useful. Some websites have high level of use which also suggest the information is useful. Stakeholder representatives throughout the review have indicated that use of products, not just SCF, appears to be low.

Individual projects may have assessed managers' needs, through their consultations with users. Assessing needs is an important part of then being able to meet needs and ensure that the information provided is predominately demand/user driven rather than solely supply/researcher driven. The segmentation of client groups undertaken by workshop participants was encouraging as it showed an understanding that different clients have different needs. At a program level, the AAA survey has filled a gap in assessing needs that can then be used to direct activity.

4. Managers provided with information on the value of seasonal climate forecasts in supporting decisions for specific applications [Objective 4]

Workshop participants' comments:
- Capacity building has occurred within research organisations/extension/producers/policy.
- Workshops/extension activities have been conducted.
- There is a range of products available (e.g. climate variability information kits and publications).
- There is an improved knowledge base and climate variability is recognised as part of Agriculture (more at a policy and other researcher level, rather than producer and agribusiness).
- Demand for climate variability information is very poor in some regions (information is perceived as being not reliable or useful enough).
- Case studies have been conducted (sugar, grains, etc, which show evidence of increased profit through using SCF).
- Queries include: models are supply vs demand driven? Gaps in linking different forecasts? Individual rather than large-scale successes? Attribution difficult – some of the successes may have been outside of CVAP?
- Gaps: farmer understanding is a limitation, new forecasts have potential that has not been fully realised, spatial and temporal data are still missing, demonstration of economic value, patchy uptake, technical support is constraining uptake, consultants are not engaged.

Hassall & Associates' assessment:
Information has been provided for several industries and regions, although there are some gaps. The concern of some participants that the information has been supply rather than user driven has been included in the scoping of future directions of the program, although this criticism relates to a range of R&D programs and not just CVAP. CVAP has also attempted to engage with its users. The capacity to support decisions has not been fully demonstrated, although some of the tools could play a useful part and case studies have been conducted for selected industries that show evidence of increased profit through using SCF.

Outcomes

5. Improved researcher capability

Workshop participants' comments:

- There have been multi-discipline projects, including the incorporation of new disciplines (e.g. psychology).
- There has been very high cooperation nationally and internationally.
- Researchers claim to have more capacity as a result of CVAP.
- Agriculture has been included as a working partner in climate science and prediction (cf. agriculture now on climate science map).

Hassall & Associates' assessment:
This outcome has been achieved beyond expectation and can be highlighted as an example to which other AAA and LWA programs can aspire. There are risks that need to be managed to ensure that a balance can be maintained between capacity, delivery of outputs and meeting user needs.

6. Improved climate variability information available: better predictive capacity & understanding of impacts

Workshop participants' comments:

- Improved information is available & easily accessible (e.g. websites, conferences, publications, products – see previous outputs).

Hassall & Associates' assessment:
CVAP has resulted in considerably more climate variability information being made available. On this basis good progress has been made towards achieving this outcome.

7. Improved awareness of climate variability information
By farmers, agri-sector, policy

Workshop participants' comments:

- Media articles (e.g. farming journals, etc)
- Invited conference papers
- Web-sites: high number of hits.

AAA:
Awareness of SCF is 72%, which appears very high even if there are few baselines or targets to aid the interpretation.

Hassall & Associates' assessment:
The outcome has been achieved, with the qualification that climate variability information goes beyond SCF. Comments were raised in the workshop about CVAP's role in addressing broader climate risk management information needs other than SCF, especially where the value of a forecast for strategic or tactical decisions can be quite low. An additional qualification is that the awareness amongst agri-sector and policy is not expected to be as high as farmers (cf. AAA survey).

8. Improved capability to understand and use climate variability information [including the willingness or acceptance to use?]
By farmers, agri-sector, policy

Workshop participants' comments:

- There is perceived to be some market confusion possible between different forecasts and products? Media can give a misunderstanding.
- There is a need to go beyond case studies to improve the capability to use climate variability information.
- A manager's needs can change over time – it is thus important to focus on building capacity.
- Some tools are close to self-funding (AussieGRASS, SILO, Rainman), which demonstrates use and acceptance.
- Funding from other organisations has been leveraged (possibly demonstrating acceptance).
- Some producers have been closely involved in the research projects and, as a result, have a very high capability.
- Surveys in Queensland show 93 uses of climate variability information.

Hassall & Associates' assessment:
For some producers, within some industries and regions, there is undoubtedly a higher capability to understand and use climate information. Success clearly requires considerable support from a network of committed researchers, extension officers and consultants, this being much more established in Queensland than elsewhere. It is uncertain whether other audiences, e.g. policy, are more or less willing to use information. As a generalisation, and while good progress has been made within the constraints of available resources, there is still some way to go before this outcome is fully achieved.

9. Improved use of climate variability information; information is incorporated into decision making. By farmers, agri-sector, policy.

AAA:

- Nationally, 37% of farmers are using forecasts (51% of the 72% that are aware of the forecasts).
- There is a strong perception that the forecasts are still not accurate or reliable enough (the majority of the remaining 49%).

Workshop participants' comments:

- Demand by researchers for climate variability information has been high.
- An adoption rate of 37%, as shown by AAA, is good for agriculture if it is compared to other innovations.
- There has been an improved discourse in policy.
- There is not much evidence available as to changed behaviours (cannot just rely on anecdotes).

Hassall & Associates' assessment:
As above, for some producers, within some industries and regions, there is undoubtedly a higher use and incorporation into decisions. The argument that 37% use is sufficient to say that the outcome has been achieved depends on baselines and targets, which have not been defined. On balance, it appears that substantive progress towards achieving the outcomes has occurred, but there is still some way to go before this outcome is achieved.

10. Management strategies developed and implemented (profitable & sustainable): - farmers, agri- sector and policy.

Workshop participants' comments:

- Clearly some farmers have implemented better strategies, but the coverage is patchy and not general.
- Problem of attribution to CVAP (some would happen anyway).

Hassall & Associates' assessment:
Some progress towards achieving this outcome is apparent, however the coverage of regions and industries is very patchy and uptake appears to be low. There is a question as to how far this outcome can be achieved given the catalytic nature of the program as well as its scope and available resources.

11. Improved preparedness of Agricultural sector to respond to climate variability: both opportunities and threats

Workshop participants' comments:

- Continuing trend towards self-reliance and education that cannot be achieved in time frame.
- May only be apparent during the next significant El Niño event, when it can be seen whether farmers have really become more self-reliant, or actively seek Government intervention and financial support.

Hassall & Associates' assessment:
There are no direct measures available to comment on whether preparedness has been improved. The extent of improvement possible is likely to be limited by the program's duration and resources. Indications from the review are that CVAP projects are likely to have contributed to an improved preparedness of the agriculture sector to respond to climate variability.

12. AAA program goals are enhanced; and a more profitable, competitive and sustainable agricultural sector results

Workshop participants' comments:

- (as above)

Hassall & Associates' assessment:

The CVAP program has been an important part of the AAA program. Even though this outcome is beyond the scope of a 3 year program, the level of resourcing is also not sufficient to enable a better result than 'progress towards achieving the outcome' of obtaining a more profitable, competitive and sustainable agricultural sector.

Other benefits from the program

Workshop participants identified a range of other beneficial outcomes, which may be at least partly attributable to the direct outputs of the program or the impact that CVAP has had of raising the profile of climate variability issues. These included:

- Investment by other R&D funders in traditional CVAP activities (e.g. AWI, etc) and leveraging has occurred;
- Investment of government in climate variability information has continued;
- Wording of SCF has changed to better reflect client interpretations;
- NSW Agriculture's climate applications unit has been established;
- Collaborative research with the World Meteorological Organisation and new international initiatives have occurred;
- Hammer *et al* (2000) publication has been released;
- Some greenhouse & climate change collaborative efforts;
- There is a move to more robust agricultural systems [queried within the workshop];
- Networking, collaboration has been higher than expected (and more multi-disciplinary);
- Identification and research of (basic mechanisms) like the decadal factor has occurred;
- Deficiencies in the knowledge of Advisory officers has been identified;
- CVAP projects have modified other CVAP projects (and enhanced the output); and
- (some) Catchment managers have used SCF in their approach.

A negative unintended outcomes that workshop participants identified is the extent to which there is now some confusion in the market place at the number of climate forecasts.

The extent of attribution to CVAP is problematic, however, the broader impacts seem to be quite significant and should be taken into account in the design of future programs.

Gaps between actual and intended achievement identified by workshop

Workshop participants identified the following issues that contributed to some of the shortfalls between intended and actual achievements:

- Critical mass in staffing is not available.
- Data gaps and use of data (e.g. remote sensing).
- Gaps in understanding are apparent (of processes & basic mechanisms etc).
- Industry gaps in coverage and adoption.
- NRM is not fully incorporated.
- Links with existing extension has not been realised.
- Consultation with users has not been sufficient.
- Scale (which way)?
- Too much policy and not enough farmer level effort (this is hard to interpret)?
- Farmer understanding is a limitation.
- New forecasts have potential not fully realised.
- Spatial and temporal data availability.
- Demonstration of economic value.
- Patchy uptake.
- Technical support is constraining uptake.

These issues are symptomatic of stakeholder concerns with CVAP, and together with the "lessons" from the program, provide support for the design of a future climate variability program (Chapter 5).

Lessons from the program

The nine years of CVAP investment provide insights into

- Program design;
- R&D issues;
- Institutional frameworks; and
- Client engagement and communication.

Participants at the workshop directly addressed the issue of lessons that have arisen from CVAP. Other stakeholders during the review process have also offered suggestions about the lessons that they see as being relevant.

Comments relating to performance of the program, particularly the effectiveness, have been included in other sections of the report and are not repeated here.

Program design

Participants felt that applications and knowledge from certain regions do not transfer easily to other regions. Further, that it was essential to explore the relationship further between climate risk management, seasonal climate forecast (SCF) and general risk management. Some participants felt that too much emphasis had been given to SCF, whilst others felt that they needed to be improved to increase credibility and adoption.

Some participants expressed that too much emphasis had been placed to date on production, whereas there were a range of potential clients including NRM, insurance, marketing and fire managers.

For CVAP, there will be benefits from undertaking a tighter planning phase. There is a need to have clear measurable targets and performance indicators.

R&D issues

Participants recognised that validation of forecasts is difficult and it was important to distinguish between skill (accuracy) and value (utility) of forecasts. Some forecasts might not be all that useful. Knowledge that a forecast has a low skill is useful knowledge, and that skill varies from year to year. In some systems a rule of thumb may give better or similar results to SCFs. Some SCF do add value (e.g. opportunity cropping) and some do not (e.g. frost probabilities when all actions are taken). A value added product (e.g. number of growth days) can be more useful than a forecast alone. Increasing awareness of client's exposure to climate variability might add value to their consideration of management options. One participant claimed that forecasts have helped focus attention on critical decision points and risks. A better understanding of climate variability was seen to help with other farm management skills and decisions, although this probably cannot be generalised.

There is a strong need to understand physical mechanisms in regions where there is little skill. Some researchers expressed that they are now finding out how much more there is to discover about basic climate mechanisms and drivers, presumably before skill levels can increase too much further. A further examination of forecast failures may assist in the process.

Although CVAP has contributed new datasets, it was postulated that further (regularly updated) datasets are needed.

The necessity of undertaking a systems approach was also identified. This included the need for multi-disciplinary collaboration, and incorporation of new disciplines such as psychology.
A final R&D lesson was that there was seen as a strong place for both strategic and applied research within the program. This related also to vertical integration and the desirability of a systems approach, discussed above.

Institutional frameworks

Participants commented on the lack of a national climate agenda, which means that CVAP is filling a coordination role that perhaps it is not designed to do. Comments were also made that it was necessary to look at the broader institutional framework and not just focus on the R&D. Presumably this meant the full range of integration issues (see below) as well as policy responses such as Exceptional Circumstances.

A further institutional lesson from CVAP regarded the capacity of researchers and a lack of a critical mass (most of the delays in projects, for example, are attributable to staffing issues).

Client engagement and communication

The issue of adoption was highlighted throughout the workshop and the review process. Adoption means engagement and communication with users, which can be distinguished from information provision. Participants expressed that projects included adequate involvement of user groups, but did not link in with broader extension activities. The presence of local champions was seen as vital for encouraging uptake.

One of the main barriers to adoption, which has been evident for some time rather than being a lesson from CVAP *per se*, is that adoption is also linked to the credibility and accuracy of forecasts. Again, it probably is useful to distinguish between SCF and managing climate variability *per se* as adoption covers a full range of climate variability products and not just SCF.

One lesson that researchers in particular highlighted was that the demand for climate information itself is uneven, and the demand is subject to the same variability as with the climate. This implied different ways of working with users rather than trying to achieve a blanket adoption (not that many projects have tried for blanket adoption). Pessimistically, it implied that a "severe" climate event was needed in order to focus attention on climate variability again.

Additional lessons from case studies: StreamFlow and Aussie GRASS examinations

The full details of the supplementary examinations/activities are provided in Appendices 4 and 5.

The **Aussie GRASS** project was found to have set a high standard for an operational system of regional and national monitoring. It has heightened awareness of the major climate drivers and the influence of the surrounding oceans on agricultural productivity and the health of natural ecosystems. Aussie GRASS has provided considerable assistance in Queensland at the State and Commonwealth level in drought monitoring and assessment. Seasonal forecasting is now being used to mitigate land degradation events.

The whole team deserves commendation for their unflagging determination to put modelling concepts to work for real-world and real-time applications. The reviewers feel strongly that further investment (and policy support through the Natural resource Management Ministerial Council) would have high pay-offs, considering the strong foundation and the functioning of the interdisciplinary team assembled for the project.

One of the great achievements of the project has been legitimising the use of pasture modelling within agencies. There is a need to enhance the interpretation capabilities of Aussie GRASS, and to link the tool to a knowledge base in order to provide end-users with easier and direct access to management options and strategies. The stakeholder base needs to be expanded well beyond pastoral and public service managers. Stakeholders need ownership and embedded participation through being involved in improving the interpretation capabilities and developing the knowledge base, including advising on management implications and providing records, including stock numbers.

We advocate the use of a specialist to advise on a detailed stakeholder analysis and to determine and highlight future directions on how to maximise the usefulness of Aussie GRASS as an assessment and interpretation tool.

Essentially this is a solid and well-designed R&D program that has not yet achieved widespread adoption outside Queensland. Emphasis has been on achieving awareness rather than adoption, and on the necessary developing and testing of their system.

A wide range of potential uses were anticipated, including: drought monitoring, rangelands monitoring, land degradation monitoring (including overstocking, vegetation change, vegetation/degradation thresholds), grazing pressure and carrying capacity, identifying appropriate land uses, pastoral management including leasehold monitoring, monitoring of land use change, monitoring and control of woody weeds, fire monitoring and control, estimating greenhouse gas emissions from the rural sector, carbon accounting, climate change impacts, epidemiological models, auditing statistical data, need for government financial intervention, biodiversity modelling (though this would require model adaptation), and monitoring and management of flora and fauna (for example the survival and population dynamics of certain migrating birds is dependent on grassland seed production).

With regards to **StreamFlow**, the launch conducted was successful however, as pointed out by various speakers, this is only the first step in encouraging better decision making through the use of available tools. Thus, there needs to be strong steps taken towards encouraging the use of the StreamFlow product.

StreamFlow developers need to conduct a full market assessment to determine the awareness, capabilities, potential use and desirable tactics to reach the market. The main focus initially should be on State water and NRM authorities and irrigator groups. Contact will need to be made with the target audiences in the main irrigation regions. At some stage, dedicated time with potential users will then be essential to demonstrate the product and improve capabilities, perhaps in the form of focus groups.

The possibility of applications for urban uses should also be investigated.

Clarification should be made about the capacity of the program, particularly in relation to regulated streams.

User-friendliness should be maximised should a future version be considered. An ethic of continuous improvement in functionality, capability and data included is appropriate.

At a broader scale, on the basis of the StreamFlow experience, two other activities have been shown to be desirable. CVAP, LWA and AFFA should consider merit of promoting the availability of State data, perhaps in conjunction with the National Land and Water Resources Audit and the Natural Resources Management Ministerial Council. Also, CVAP, LWA and AFFA should consider the merit promoting better risk management within the water authorities and full use of all available information when making decisions about allocations.

Integration

As more is understood about the complexities and range of biophysical interactions in our natural resource systems, the utility of single issue/focused research and development activity is increasingly being challenged. At the same time, resource managers at all levels should be looking for approaches that are capable of more comprehensively addressing the broad range of NRM and commercial challenges they are confronting. This presents particular challenges for programs such as CVAP both in their design and implementation. These challenges have been acknowledged by LWA through the establishment of a unit dedicated to promoting an enhanced level of integration across its programs.

At the program level improved integration offers the prospect of promoting:

- a more comprehensive assessment of user needs and designing products/outputs that address those needs;
- alignment with other programs/activities with complementary R&D goals;
- the achievement of multiple (environmental, economic and social) goals;
- a broader R&D portfolio through shared (leveraged) investment;
- access to data and knowledge accumulated by other programs;
- communication synergies; and
- extension and training synergies.

At the project level, these prospects can translate to the achievement of:

- improved project design in terms of its coverage and responsiveness to user needs;
- projects that are informed by, and build on related R&D projects and activities;
- higher levels of collaboration as well as the sharing of knowledge and resources with those individuals, organizations and institutions operating in related fields;
- lower levels of duplication and unproductive overlap; and ultimately
- products and output that have higher credibility with users and hence greater prospect for adoption and use.

It is also evident that, within the constraints of available resources, CVAP management, through the coordinator, has already gone to considerable lengths to develop effective collaboration with other organisations and projects. The supplementary work with the StreamFlow and Aussie GRASS projects shows that at the project level there is an exceptional level of collaboration between different organisations. In addition, obtaining joint funding from other RDC's is a good achievement.

There is now the opportunity for CVAP to promote a higher level of interaction and collaborative activity with LWA programs that have potential areas of common interest (such as in the Rivers Arena and Sustainable Primary Industries Arena programs) as well as with other national programs dealing with priority natural resource and environmental management issues, including those associated with climate change. To date, linkages in these areas appear to be largely limited to opportunistic rather than systematic contact by principal investigators, or team members, working on other and/or related projects.

Pursuing a high level of integration at the formative stages of new programs can add a degree of complexity that might limit and/or unduly delay the commencement of program activity. It can also be difficult to promote cross program integration when the products from the program are not well developed and/or defined. However, CVAP has now effectively passed this phase of potential delays and the parameters of the program as well as its direction and potential outputs have been well established.

For the benefits of integration to be realised it would seem important that the need for improved integration is given some prominence at the program design level. This will be vital in order to ensure that:

- stakeholders support and acknowledge that program/project integration is a strategic priority for the Program; and that
- dedicated resources will be devoted to this activity.

In the absence of a program level focus the prospect of integration will be limited by the vision of the individual project managers and the resources available to them. In addition it will not be possible for individual project managers to consider issues associated with achieving program level integration, especially where institutional issues such as the development of inter-agency/program agreements and or the establishment of national networks are involved.

At the project design and development level it will be important that those areas where integration is expected are clearly identified and built into project planning and implementation.

Areas where integration could be further advanced include not only the broad range of programs in the L&WA portfolio but could also include:

- Natural Heritage Trust Programs managed by AFFA and EA;
- Greenhouse Programs managed by the Australian Greenhouse Office;
- Agriculture Advancing Australia Programs managed by AFFA;
- Activities across a range of potentially related Cooperative Research Centres and Research Institutions; and
- Related State and Territory based programs and activities.

Potential benefits and their quantification

Since its inception in 1992, the Commonwealth Government has provided over $11 million of public funds to support CVAP activities. These funds are in addition to support for related activities by a range of publicly supported R&D institutions as well as complementary government and industry financed R&D activity. Through this investment, programs such as CVAP offer the prospect of generating a wide range of potential public and private benefits, including:

Private:

- Improved profitability of agriculture enterprises (reduced costs of production and improved market performance). Improved profitability is not uniform and in some cases can be negated by other institutional factors;
- Reduced financial risk; and
- Reduced resource (asset) degradation.

Public:

- More resilient and self-reliant rural industries and communities;
- Reduced dependence on Government assistance programs (e.g. Exceptional Circumstances)5;
- Reduced off-site impacts of degradation associated with extreme climatic events;
- Improved performance of resource management and conservation agencies;
- Reduced public risk associated with extreme climatic events (e.g. floods, fires);
- Improved performance of government research expenditure through establishment of scientific networks; and
- Improved general levels of awareness and understanding in rural of communities about climate variability.

The benefits are also likely to be continuous rather than one off, should changes in behaviour occur, with returns being realised into the future. The importance of adoption and use of tools therefore becomes critical to determining the quantum of benefits.

We are not aware of any systematic attempts to quantify these costs and benefits or to attribute any observed changes in these areas to the possible impacts of climate variability, or more specifically to CVAP. This would be a complex and resource intensive task, particularly in the absence of established systems to determine baseline data sets as well as identify and collect the relevant supporting data needed to monitor changes over time. However, we postulate that should the benefits be able to be quantified, then they would outweigh the costs of the program.

Some data (such as through the AAA Survey) is being collected and other data sets are available (such as aggregate government expenditure on support programs). In addition, some systems may be in place to collect performance data that relate to projects and potential increases in profitability due to incorporation of climate risk management, but presently do not provide for the compilation, analysis and subsequent use of performance information at the program management level.

In the event of CVAP being extended beyond its current term, consideration must be given to establishing a supporting monitoring and evaluation framework incorporating agreed performance indicators and expectations. This would provide the basis to develop and implement the systems and approaches necessary to establish appropriate baseline data sets as well as collect and analyse data on the overall impact of the program. Care would need to be taken to establishing indicators that were not only relevant but were capable of being monitored in a timely and cost-effective manner.

[5] For example between 1992 and November 2001, Government expenditure in support of Exceptional Circumstances has been about $760 million. This has obviously varied according to timing of major events. Should only 1.4% of these payments have been avoidable, perhaps due to better risk management, then the CVAP program would have well and truly returned a positive return on its investment. This does not take into account the private costs associated with droughts and climate variability, which if estimated would be considerable.

Without program scenario

Managing agricultural activity in a variable climate has been a consistent challenge since European settlement. The problems are not new. It is in this context that it is necessary to assess scenarios that might have eventuated without the program.

Stakeholders have postulated that without CVAP, the implications for the agriculture sector would have been:

- Lack of coordination of climate variability R&D;
- Agriculture would not be recognised as a client for provision of climate services, and the agricultural sector and policy makers would rely on understandings that were not geared towards agriculture;
- There would be no central focus for climate risk management;
- Agencies have less incentive to interact, that is, there would be more 'silos';
- Research agendas would then driven by internal organisational priorities rather than to a national agenda;
- Fewer products would be available for use;
- Farmers would not have the necessary tools and understandings in order to become more self reliant and better managers of climate risks (and opportunities); and
- The level of networking between researchers in climate and agriculture would not be as advanced as it is now.

There is some evidence RDCs are now more aware of the issues associated with climate variability, so there may have been more activity focused at a sector level without a national CVAP program. Even though this might lead to more demand driven products, the leveraging effect of CVAP and collaboration between researchers might not have been as high. The non-program scenario is really one where management of climate variability does not have as much opportunity to progress.

4. Discussion & evaluation conclusions

This component of the review considers the appropriateness, effectiveness and efficiency of the program, namely:

- **Appropriateness** - How well are the program's outcomes designed to meeting societal needs and government objectives, in particular for a sustainable and profitable agricultural sector?
- **Effectiveness** - How well is the program meeting planned program outcomes, that is the realised and potential impact on climate-related risk management by farmers?
- **Efficiency** - How well is the program meeting program objectives, that is how well is the program providing outputs from R&D in relation to the input resources used?

Overall conclusions have been drawn, which support the future directions developed in consultation with a broad range of stakeholders during the scoping exercise, and through subsequent consultation. The detailed results of this process and our interpretations are outlined in Chapter 5.

Appropriateness

The objectives have reflected the continuing trend for government to promote self-reliance and better risk management, and to attempt to facilitate the development of the tools to do so. The alignment towards the AAA objectives has been appropriate. The alternative to this process is the prospect of more direct Commonwealth government intervention and support being required. The lack of available tools at the commencement of the CVAP meant that the focus on R&D that has been evident to date has been appropriate.

The national focus of the program is appropriate given that the issues cross industries and jurisdictions. On this basis it would seem appropriate that the Commonwealth financially supports the operation of the program through its formative years.

The support for the CVAP program amongst stakeholders has been very high. The National Farmers Federation, for example, have shown a continued support and have recently written a letter to the Minister encouraging continuance to a climate variability program. The design of the CVAP program in 1997 saw input from major stakeholder groups, through a planning workshop, and various representatives of funding organisations and the NFF, all of whom hold positions on the CVAP management Committee.

On this basis, Hassall & Associates considers that the broad objectives were highly appropriate at the beginning of the program and are still reasonably so given the continuing support for the program by its key stakeholders. While this may be the case it is evident that the objectives for the program need to be modified to reflect the current expectations of CVAP stakeholders and the need for more clarity in their expression (see Chapter 5).

In summary, the program when judged in its historical context has been very appropriate. The continuation of involving stakeholders in the design of a future program is also likely to enhance its appropriateness, as would the further integration of activities and investment with related programs.

Effectiveness

The objectives and outcomes established for CVAP are quite ambitious, especially given their national scope and the scale of investment involved. Climate variability is still a relatively young research area. There are inevitable time delays between the development of R&D outputs and their adoption. Outcomes sought for the program have not been well defined in terms of time and feasibility, and the determination of effectiveness has been hampered by the lack of a rigorous monitoring and evaluation framework.

It is clear that the program has made considerable progress in relation to developing improved understandings of climate variability and developing specific products that are relevant to the agricultural sector. CVAP has effectively put agriculture on the map, as far as climate service providers are concerned. It has also been effective in promoting an extremely high level of collaboration amongst researchers and increasing research capacity. This is likely to lead to for future pay-offs for the present investment in climate variability R&D.

Even though the objectives are ambitious and lack clear definition, CVAP has made good progress towards their achievement. This is particularly the case in relation to the development of "strategies which prepare [the Australian agricultural sector] to respond to the major opportunities and risks arising from climate variability". A more full-some achievement of the Program's objectives would require a significant expansion in the uptake of its outputs. This and the need for any future program to focus more extensively on adoption was a persistent theme by stakeholders throughout this review. An increased level of integration with other programs also offers the prospect of enhancing the program's overall effectiveness.

Efficiency

The activities for all projects have been completed and reports have been lodged. There are currently 4 projects that are undertaking final changes before their report is accepted and the project is officially finalised.

The Annual Report and Six-Monthly reports submitted by LWA to AFFA demonstrates a systematic approach to program management. The reports outline for each project funded the objectives, performance against the objectives, issues raised and further funding recommendations. Hassall & Associates has confidence in the project management systems used and the responses from researchers during the consultation demonstrated that they were aware of the high expectations.

A small number of projects reported delays in their original milestones due particularly to staffing and recruitment issues and four are yet to be completed. In these cases it was usual for new milestone dates to be negotiated and approved by the Coordinator. The number of projects involved was within the range of expectations.

A small number of projects reported changes to the milestones, as well as the overall scope of the project, during the establishment of the project. This included incorporating advice from project steering committees as well as new information on climate processes, as relevant. The CVAP coordinator approved all of these changes and there do not appear to be any outstanding issues of concern to the reviewers.

Some issues were raised by researchers about the timeframe for the project, as well as the exploratory nature of some of the projects, which means that it is difficult to see adoption of results during the project or even the progression to next stages. Not many of the projects appeared to have mechanisms of formally tracking what happens after the project has been completed, which should be of concern at the program level.

Hassall & Associates has not been required to investigate the process for selection of projects nor the financial management of the program, but have no reason to believe that there are any deficiencies[6]. Although outside of the scope of the examination of efficiency, the efforts of the CVAP coordinator are particularly commendable.

Summary of the evaluation

The program is well aligned with AAA goals/objectives and has provided a focus for the development of knowledge and tools of direct relevance/application to the farm sector. CVAP has potential to contribute to a range of NRM/environmental outcomes as well as promote social outcomes through more resilient and self-reliant rural industries.

CVAP has been well managed and individual projects have in the main been successfully implemented. It has provided a base to develop and foster supporting science skills and capacity, which should contribute longer-term benefits. There has been a high level of integration at the project level but CVAP can do better at the program level in order to achieve greater adoption and industry outcomes. The program should now be sufficiently mature to achieve this.

On balance, CVAP has achieved well, considering the level of investment provided and its ambitious objectives. The program has made good progress in relation to developing improved understandings of climate variability and developing specific products, but has not demonstrated that it will be effective in achieving the higher-level outcomes without a concerted effort to expand the level of uptake of CVAP information and tools.

There is wide support for a future program, with a further emphasis on greater adoption of CVAP products. This is detailed in the next chapter.

[6] An increased commissioning of projects rather than relying on general calls may be appropriate in future programs. This should aid in targeting projects and enhancing attention to achieving higher-level outcomes and being able to demonstrate these.

5. Future Program Design

Introduction

Possible directions for a future climate variability applications (CV) program are outlined in this chapter. These directions are based on results from widespread consultation, an issues paper and a scoping workshop undertaken by Hassall & Associates. In undertaking this task the intention has been to build on the current program, which was initially developed as part of the National Drought Policy (1992). That policy aimed to prepare the agricultural sector to better manage climate variability through implementing strategies based on self-reliance.

The chapter, as an interim report, has been distributed to workshop participants as well as other stakeholders to elicit further input to this process and ensure that a broad cross-section of interest is reflected in the final report. All comments on the draft have been analysed and every effort has been made to incorporate those comments.

This chapter addresses the broad scope and direction of a possible successor climate variability applications program. If it is decided that the development and implementation of such a program is warranted, additional work will be required to develop a suitably detailed strategic plan and to refine its method of operation, particularly in relation to its management and governance arrangements. Stakeholders have recognised that the outcomes need to be prioritised and consideration given to the level of respective investment. As part of this process, priority will need to be given to establishing detailed performance goals and associated performance indicators and reporting procedures. These matters are beyond the scope and capacity of this review.

Any future climate variability program should build on the successes of CVAP in providing a national focus for R&D and supporting the development of climate information and support tools. Well designed and conducted research effort will continue to be required to develop relevant and credible products that respond to changing user needs. While good science and support tools are fundamental prerequisites to any program of this nature, investment in these areas will not achieve the desired outcomes unless the products are effectively and more broadly adopted by the agricultural sector. Any future climate variability program should therefore give prominence to addressing any significant impediments to further use or adoption of current and future CVAP products.

Impediments identified at the Scoping Workshop included:

- a lack of a common language across scientists, media and producers;
- users may not see the benefits of climate information (lack of scenario planning, size of benefit compared to costs or risks, skills and motivation, and access to information);
- potential users may not have the skills, ability, confidence or financial capacity to use the information and to integrate CVAP products within their operations;
- producers may not have a risk management framework that is able to readily accommodate climate variability information;

- scientists are not always certain as to who can benefit, and how;
- Government policy (e.g. Exceptional Circumstances) might not adequately emphasise or engender a risk management ethos;
- science and forecasting skills (and lead times) are often inadequate to give sufficient confidence in the use of CVAP products; and
- a lack of champions for CVAP products.

Since its inception, CVAP has evolved in a new R&D area where climate variability products did not previously exist. The products developed to-date have the potential for wider adoption within the agricultural sector as well as in related rural industries and communities. This offers the prospect of considerably expanding the benefits derived from the public investment in CVAP while retaining the current primary focus on the agricultural sector.

Based on these considerations the goal of any successor climate variability program could be:

> *To contribute to more profitable, competitive and sustainable rural industries and communities…*
> *…by equipping Australian rural industries and resource managers to respond more effectively to the major production and natural resource management opportunities and risks associated with climate variability.*

Current climate variability products

Current climate variability products include improved scientific understanding of climate variability, forecasting tools, decisions support tools, analyses of risk and climate variability impacts, publications and production of internet sites. A small selection of specific climate variability products include:

- Improved climate forecasting, which includes coupling of atmospheric and oceanic models.
- Drought and grassland condition assessment models.
- Seasonal streamflow forecasts.
- Examination of climate variability impacts, risk and management decisions in cropping, rangeland grazing, sugar, dairy and agribusiness sectors.
- Masters of the Climate case studies.
- Publication – Hammer *et al.* (2000) Applications of Seasonal Climate Forecasting in Agriculture and Natural Ecosystems – The Australian Experience.
- Enhancement of the SILO website. Other relevant websites include the "Long Paddock" web site.
- Amended formats of Bureau of Meteorology's forecasts.
- Workshops and conferences, to aid communication and networking amongst stakeholders.

CVAP has contributed to the development of these products and this has been assessed in Chapter 3.

Primary Characteristics – what would be different?

The main change anticipated between the current CVAP and future climate variability program is a shift in the balance and a broadening from a program with a significant research orientation to one with a greater emphasis on adoption of climate risk management in all primary production sectors. This would include the forestry and possibly fisheries sectors and could involve extending or adapting products developed to other potential users in rural and regional Australia.

This change would involve giving further emphasis to extension and communication activities as well as to promoting the application and adoption of existing information and tools. Research would continue to be a significant element of the program but would not be the principal focus. The broadening would include giving a greater priority to achieving improvements in the sustainable utilisation and management of our natural resources.

Such a change in emphasis would acknowledge:

- the considerable advances that have been made by CVAP in supporting and guiding the development of improved climate management tools;
- that ultimately the program's objectives will only be promoted by achieving increased adoption and use of its products;
- better informed commercial decisions by the agriculture sector based on the greater adoption and use of CVAP products have the prospect of achieving improved social outcomes by fostering more resilient and self-reliant rural and regional economies;
- there are significant linkages between the fundamental objectives of the program and the achievement of improved natural resource management outcomes; and
- there is the potential for others to benefit from the products already developed through CVAP, and for the development of productive partnerships to further develop and improve those products.

This change would be achieved by:

1. More specifically targeting the needs of particular primary production and food sectors - where appropriate, at a regional level. The focus would be on addressing impediments and better positioning those sectors to anticipate and respond to both the threats and opportunities associated with climate variability. Linking the needs of particular primary production and food sectors to available sources of climate information should be a priority.
2. Promoting strategic alliances and the further integration of climate variability activities with complementary programs and activities. This could involve developing a prospectus (investment guide) to encourage agricultural and other climate sensitive industries to invest in integrating climate variability dimensions into their management strategies and to contribute to further development of climate variability capacities and tools;
3. Identifying and developing applications that have the potential to contribute to the sustainable use and management of natural resources and improved biodiversity outcomes; and

4. Continuing to provide leadership and catalytic support to research specifically intended to fill identified needs and priorities, as well as providing a multi-disciplinary research network that is even more responsive to user needs.

Possible Name Change

The suitability of the current name of the program has been raised in the light of its potential to influence management decisions in a far broader spectrum of activities than currently implied by its title, such as NRM. In particular, the question has been raised about whether the term "Agriculture" continues to remain appropriate and whether a more generic term might more correctly convey the program's range of activities and help to attract a broader range of stakeholders.

Arguments against any change include:

- the program has been operating under the current name since 1997. The level of concern may not be sufficient to risk creating confusion/uncertainty;
- the name of the program is not a critical issue as the main focus should be on raising awareness of its products;
- the primary focus of the program is (and remains) on the agriculture sector;
- broadening the title risks implying a far greater role than may be intended or acceptable to key stakeholders.

In the light of these comments there would appear to be three options:

Option 1: No change.

Option 2: Introduce a sub-text into the title to indicate a broader level of activity, for example: *Climate Variability in Agriculture Program: Assisting rural industries and resource managers to respond to climate variability.*

Option 3: Imply a broader application, for example: *Rural Industries Climate Variability Program.*

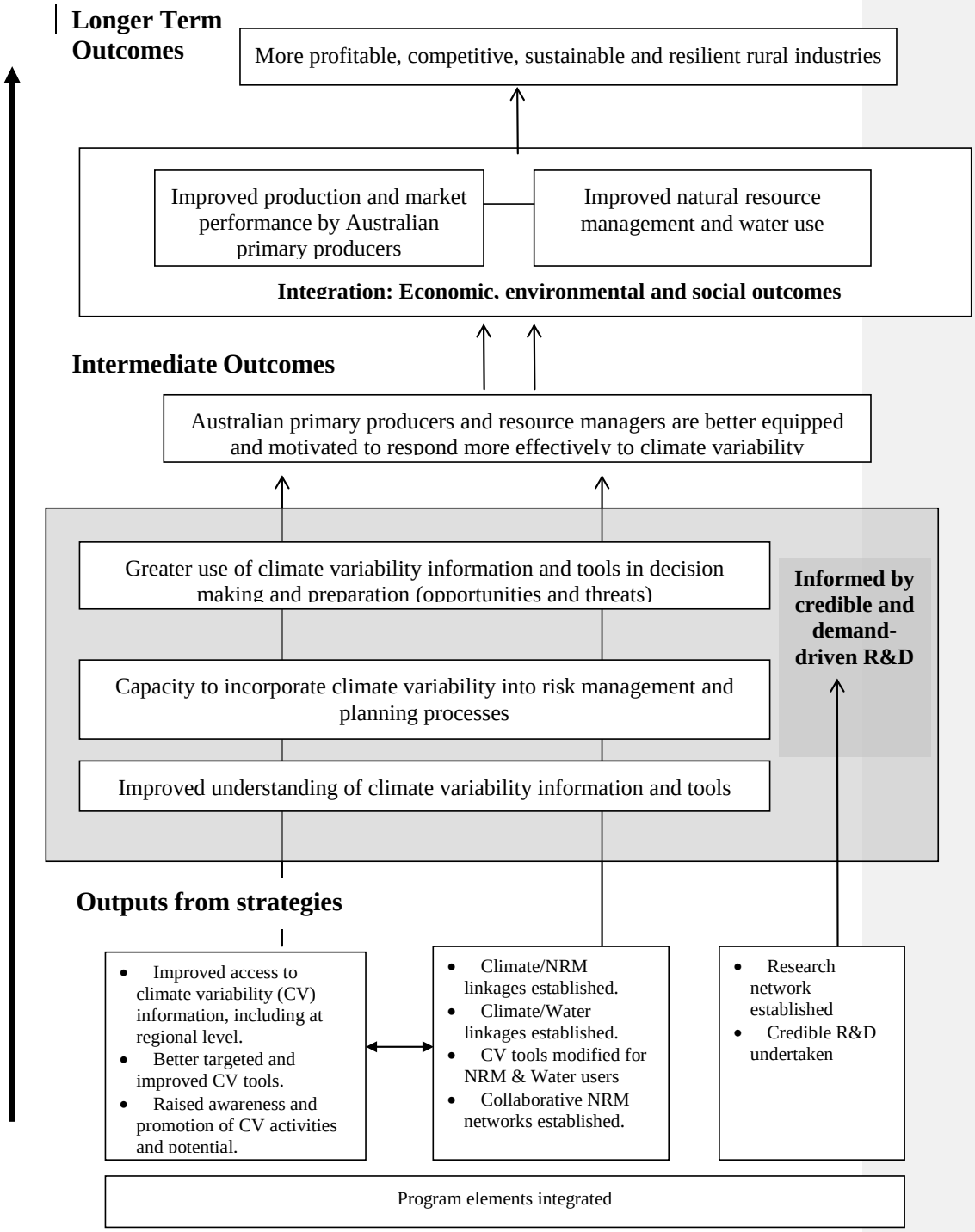
Program Elements

A diagrammatic representation of a possible future program is shown in Figure 2. It is suggested that the program would comprise the following four elements:

1. Enhanced Adoption - Australian Agriculture, Fisheries, Forestry and Food Production Sectors;
2. Promoting Better NRM and Environmental Outcomes;
3. Supporting Research Activities; and
4. Program Management & Integration.

While the main emphasis would continue to be on supporting improved outcomes in the agriculture, fisheries, forestry and food sectors, it is expected that Elements 1 and 2 will be highly complementary. Improved enterprise level management of climate variability should result in improved natural resource management outcomes (through the more sustainable use of land and water resources). Similarly, providing resource managers with improved climate management tools should result in the development and adoption of more effective approaches to land and water management with consequential benefits for the agriculture, fisheries, forestry and food sectors.

Figure 2: Map of a future Climate Variability Applications program



Program Element 1: Enhanced Adoption - Australian Agriculture, Fisheries, Forestry and Food Production Sectors.

Primary Objectives/Outcomes

A. Primary Production

- *Improved profitability, competitiveness and sustainability through enabling Australian primary producers to anticipate and respond to threats and opportunities associated with climate variability.*

Secondary Objectives/Outcomes

B. Trade

- *Improved international trade performance through integration of climate forecasts (informing assessments of international demand and supply conditions) into management/commerce decisions both at a domestic (production) and international (trade) level.*

C. Whole of Food and Fibre Chain Applications

- *Improvements in quality and availability of food products marketed to consumers; and*
- *Improved profitability through reduced wastage.*

D. Non-agricultural sectors

- *Improved profitability, competitiveness and sustainability of non-agricultural sectors through an enhanced capacity to anticipate and respond to the threats and opportunities associated with climate variability.*

E. Social Outcomes

- *More resilient and self-reliant rural and regional communities as a consequence of promoting Outcomes A to D above.*

Rationale:

A well-targeted and executed climate variability program offers considerable potential to assist a wide range of climate sensitive rural industries to approach climate management in a more deliberate and informed manner. Such an approach offers the clear prospect of achieving more self-reliant, profitable, sustainable and competitive industries. On this basis, the objective of supporting a more informed approach to enterprise planning and risk management should continue to be a primary thrust of any new climate variability program.

However, in order to avoid finite resources being dissipated to the extent that the desired outcomes are not achieved, it may be necessary to give priority to those regions and industries where the prospects for improved management are greatest. This would also require institutional support within the relevant States and Territories.

The inclusion of trade and whole of chain considerations reflects the context in which farming takes place; that agriculture is more than production and includes processing, transport and marketing, both locally and overseas.

There has been considerable public investment in CVAP and related climate variability research and development focussed on the agricultural sector. This work may have utility in other industries and applications, with the prospect of a more self-reliant approach to enterprise planning and risk management in those industries. This could have beneficial flow-back effects to agriculture, particularly through the further development of climate information and tools. There may also be merit in exploring the prospect of promoting the commercialisation of selected CVAP products.

There is also a range of climate-sensitive industries, particularly in rural and regional locations, whose performance has considerable potential to impact on primary producers and who could benefit from integrating climate variability into their business planning processes. These industries include those involved in water storage and distribution, as well as rural suppliers and the finance and insurance sectors.

Further, it may be possible for other climate-sensitive industries such as tourism, sports and outdoor entertainment to also benefit from the public investment in CVAP through the adaptation of existing services and capacities.

The profitability and sustainability of the agricultural sector and related industries has significant implications for Australia's rural and regional communities. How well the agricultural sector manages climate variability will inevitably have both short and long term implications for those communities. These communities may be able to directly access CVAP products to help them to better anticipate extreme climatic events and to develop risk management approaches that enable them to better respond to such occurrences. This is pertinent considering that the next major drought is clearly a matter of "when" not "if" and concern has been expressed about our ability to respond effectively to these events.

Similarly, a more informed approach to managing climate variability offers the prospect of more sustainable decisions about the use of the land and water resources available to landholders. For example improved crop management and water utilisation could benefit both the riverine environment and impact on significant NRM issues such as dryland salinity.

Strategies:

1. Improve access to current climate information and tools by individual enterprises as well as priority regions and industries, including:
   - north – rangelands/grazing;
   - northeast – mixed summer/winter cropping, sugar and viticulture;
   - southeast – winter cropping, livestock, dairy and horticulture (incl. grazing, mixed farming, viticulture, berries, vegetables and orchards);
   - southwest – winter cropping, livestock, dairy, horticulture.
2. Identify and respond to any specific requirements for improved forecasting information at a regional level;
3. Further promote the opportunities (including threat abatement) that could be associated with a better appreciation of climate variability in priority regions and industries;

4. Conduct studies to further estimate the benefits and marginal value of using climate information in production and trading decisions, targeted at specific regions and farming systems;
5. As appropriate, explore the prospect of promoting the commercialisation of selected CVAP products;
6. Work with relevant training, extension and education programs (such as FarmBis), institutions (such as agricultural colleges and universities), the agribusiness sector and related programs (such as those dealing with risk management and climate change) to promote the products available or being developed;
7. Consider opportunities to link with other risk management programs and initiatives, including those dealing with financial and marketing risk management as well as greenhouse related climate change;
8. Identify and support "champions" at a regional level (modeling, extension);
9. Develop improved forecast capacity/information systems for domestic and international trade decisions;
10. Promote a heightened awareness of the merits of adopting of risk management techniques and tools in agriculture and the whole of the production, processing, transport and marketing chain (this may include reducing impediments to greater adoption of risk management strategies incorporating climate variability products and establishing links to other programs);
11. Commission an assessment of the potential application of existing CVAP products to non-agricultural applications to determine the opportunity for mutually advantageous collaboration; and
12. Give consideration to engaging relevant Commonwealth and State community/social service agencies to ensure they are aware of the range of CVAP products and ascertain their interest in collaborating to further develop products where there is a shared interest. This may also include the development of projects involving shared investment.

Program Element 2: Promoting Better Natural Resource Management (NRM) and Environmental Outcomes

Objectives/Outcomes:

- *Improved NRM and environmental outcomes through a better appreciation of the potential implications and applications of climate variability forecasting and management tools to NRM related programs and activities.*
    - *Improved agricultural and NRM outcomes by enabling the water users and providers to more accurately project water requirements and availability.*

Rationale:

Prospects of adverse NRM outcomes are heightened in times of climatic extremes. This involves maintaining adequate vegetation cover and soil stability as well as changes in the level of accessions to water tables, weed seed dispersal and a range of potential impacts on bio-diversity.

A better appreciation of the full range of climate variability tools therefore offers the potential for improvements in water, soil and vegetation management as a result of better managing the threats and opportunities associated with extreme climatic events. This would have particular application to:

- salinity (dryland and irrigation) management;
- catchment management (soil conservation);
- water quality and availability, including environmental flows;
- fire management (eucalypt forests, northern savannas);
- park and native vegetation management;
- protection of wildlife corridors;
- disease epidemiology (plants, livestock, human); and
- weed management.

These outcomes are in addition to the NRM benefits that are likely to result from the improved alignment of production decisions and climatic conditions by enterprise managers.

Existing research and resource management agencies have the capacity to further explore and identify the potential of current and future climate variability products to achieve improved NRM outcomes. This could include assessing how climate impacts could be incorporated into current initiatives, such as the range of NHT programs and the National Action Plan for Salinity and Water Quality. In particular, there may be potential for climate variability products to better inform and guide the development of regional and catchment based approaches to achieving enhanced NRM and environmental outcomes. Care would need to be taken to ensure that any climate related activities complemented rather than duplicated efforts currently underway in a number of Commonwealth and State jurisdictions.

In addition, the strategies in program elements 1 and 2 can provide products that enable water managers, regulators and distributors to better match the level of consumptive and environmental requirements with the likely availability of water. This could result in a range of benefits including reduced levels of wastage in the system, lower operating costs (charges), reduced environmental impacts and longer term increases in the availability of water for consumptive purposes. This will provide beneficial outcomes from both an agricultural production and NRM/environmental perspective. Similarly, there is also the prospect for well targeted climate variability products to have similar applications and benefits for the energy sector.

Strategies:

1. Form strategic alliances with stakeholders to establish priority areas of potential application (initially at the Commonwealth/State level) and areas of common interest;
2. Identify current tools that are relevant to requirements;
3. Identify other products/tools that involve either the modification of existing products/tools or the development of new capabilities;
4. Establish and quantify the nature and extent of linkages between climate variability and NRM/environmental management especially at a catchment and landscape level - priority areas could include:
   - salinity management (dryland and irrigation);
   - wind and water erosion (drought and flood are major drivers);
   - water availability and quality;
   - energy management;
   - reduce deep drainage (leaking ecosystems) e.g. through opportunity cropping in response to (wet) forecasts;
   - environmental flows;
   - vegetation and biodiversity management;
   - weed management; and
   - climate variability and climate change.
5. Develop and maintain mechanisms to promote collaboration between stakeholders and to avoid duplicating or prejudicing the work in support of a wide range of NRM initiatives currently in progress (possibly using the National Dryland Salinity Program model).

Program Element 3: Supporting Research Activities

Objective/Outcome:

- *Development of climate variability tools and applications are user/needs driven, as well as underpinned and supported by timely, relevant and credible science.*

Rationale:

climate variability science requires a solid R&D base to ensure a core of products that are of the highest credibility and utility. For example, users have indicated that significant impediments to greater adoption are the reliability, timing and coverage of existing forecasting services. The need to foster strategic research in areas such as these has been highlighted on a number of occasions. Relevant expertise to address this may be found in the atmospheric, oceanic, agricultural, environmental, biomathematical/systems and social sciences.

More specifically, is apparent that more needs to be done to:

a) make climate information and tools relevant to a regional level (with particular emphasis on gaps and regions not well serviced by current information and tools);
b) extend the lead time and accuracy of forecasts (e.g. through studies of the southern ocean and circumpolar currents);
c) determine the marginal value of forecasts for key decisions in different environments and farming systems; and
d) examine possible linkages between climate variability and climate change.

The CVAP program has made considerable progress in providing national leadership and encouraging synergies between research agencies, thereby ensuring that agriculture is included in the consideration of climate information needs. The establishment of an effective, working national network for researchers operating in this field will build on this progress and help to ensure that scientific effort is conducted in the most efficient and effective manner possible by avoiding duplication, maximising opportunities for synergies to be identified and exploited as well as being informed by the successes and failures of others. In particular, it should be possible through this process to promote improved networking between scientists operating in related NRM fields such as dryland salinity and catchment management.

The establishment of a more formalised scientific network may also provide the basis for developing a more cohesive national climate change agenda. It would also establish a capacity to link progress in this area to the considerable level of activity now evident in relation to developing a better understanding of climate change and establishing the most effective strategic responses to climate change at the national, regional and enterprise level.

It is inevitable that the program will identify areas requiring research, development and/or innovation activity to progress the further adoption of a more considered and informed approach to managing climate variability. In these circumstances direct financial support from the program might be necessary to ensure the required work is

completed in a timely and acceptable manner. In providing financial support to such activities there may be merit in the following broad principles:

- the program should be mindful of the operating charter of R&D agencies active in the field of climate forecasting and management, and avoid the potential for duplication of effort and cost-shifting;
- to the extent possible, funding should be catalytic (that is, it should be directed towards bringing forward/re-prioritising, reshaping or supplementing research activities to better meet the program's specific requirement rather than sponsoring fundamental research effort, particularly where it is within the area of responsibility of established research programs or institutions); and
- to the extent possible the program should seek to identify and engage other beneficiaries in the research activity and to form strategic alliances and/or funding consortia as appropriate.

Strategies:

1. Establish and actively support the operations of a climate variability research network to facilitate the effective conduct of strategic applied research by agencies active in this and related fields and across projects/disciplines.
2. Once established priority should be on establishing linkages with colleagues active in the field of climate change.
3. Identify user requirements (by region and farming system) and scope/prioritise research required to support those requirements. Actively promote user engagement in R&D projects to the maximum extent possible.
4. Identify skills and capacity building requirements necessary to support continuous improvement in the area of managing climate variability. Work with relevant agencies/institutions to fill this need.
5. Work with other stakeholders (from industry as well as Commonwealth and State agencies/institutions involved in related research) to provide catalytic/strategic support to promote the conduct of research essential to achieve improved products/tools and generate increased use/adoption (particularly in relation to research intended to predict climatic extremes with more lead-time and accuracy and deliver products that are regionally focused).
6. Develop project specifications for integrated projects to enable commissioning of projects to target priority areas.
7. Foster undergraduate and postgraduate training in relevant (multi-) disciplines.
8. Endeavour to maintain and promote the standing and credibility of Australia's climate variability research effort internationally by maintaining contact with overseas counterparts and promoting scientific exchanges with other countries exposed to high climate variability (e.g. south-east Asia and southern Africa).
9. Increase awareness of networking tools, such as the agricultural meteorology and agricultural modelling mailing lists (internet discussion groups), and relevant web sites (for scientists, advisers, producers, schools, and community).

Program Element 4: Program Management & Integration.

Objective/Outcome:

- *To ensure each of the program elements are designed and implemented to promote the collective achievement of beneficial production (economic), natural resource management and social outcomes in the most effective and efficient manner possible; and*
- *Provide a focal point to develop complementary relationships (at the program level) with others active in related fields.*

Rationale:

Without due emphasis being given to the development and delivery of integrated climate variability products there is the risk that the range of opportunities and imperatives identified in Chapter 3 will not be effectively addressed and that each of the elements of the program will be progressed in isolation. The establishment of a program element dedicated to promoting program management and integration is intended to avoid this prospect.

An integration element will be particularly important in ensuring that any R&D and extension effort is designed to achieve broadly based objectives and needs identified by each of the other program elements. It will also be important in ensuring that secondary objectives relating to the achievement of more broadly based environmental and social outcomes are not inadvertently overlooked.

A management and integration program element will provide the vehicle to ensure that the program's activities are well integrated with complementary activities being supported by other related R&D and industry development and extension programs – examples include current efforts to address a wide range of NRM challenges, including dryland salinity, water management and climate change.

While it will be important for any future climate variability projects to establish supporting extension strategies there is a clear need for the program to have the capacity to integrate the full range of its products with those of other programs. For example, industry RDC's are now giving greater emphasis to the development of improved farming systems and to providing farmers with improved capacity to manage risk. It will be important to have the capacity to inform and influence those activities. This cannot be readily achieved at the project level and thus will require a program level focus.

Strategies:

1. Establish a Management and Integration Program Element within the program's governance/management framework.
2. Develop linkages with programs/agencies active in related/complementary areas (for example the development of more sustainable farm systems, NRM, climate change, farm risk management as well as the commercial sector including those involved in insurance and weather derivatives etc).

3. For any new proposed activity, evaluate the degree to which it has the potential to achieve more broadly based outcomes and the merit of pursuing collaborative partnerships with other programs/agencies;
4. Develop an integrated communication and extension strategy to progress the outcomes sought for each Program Element consistent with the Program's overall objectives; and
5. Develop an integrated set of performance monitoring indicators and a complementary monitoring, evaluation and reporting framework – this should include determining the level of performance expected for each project before its commencement..

Stakeholder Engagement & Involvement

Stakeholder engagement is a fundamental part of a new climate variability program. This section is presented in the same way as other program elements, that is, outlining the objectives and outcomes desired, rationale and strategies to achieve the outcomes.

Objectives/Outcomes:

- *To ensure the program fully responds to stakeholder requirements and expectations through their effective involvement in the direction and management of the program; and*
- *To promote effective collaboration on issues of mutual interest.*

Rationale:

A range of agricultural and related industries as well as NRM management agencies and community groups have a keen interest in managing climate variability in a more deliberate and informed manner. At the same time a range of research and development corporations, cooperative research centres and research institutes are actively engaged in progressing our understanding of climate and developing improved management tools. If effectively managed and directed, this program has the potential to simultaneously promote the interests of these stakeholders.

Strategies:

1. When the scope and direction of a future climate variability program is confirmed catalogue the range of potential stakeholders and canvas the nature and extent of their particular interests.
2. For each stakeholder, determine the most appropriate mechanism to ensure their effective and ongoing involvement in the program.
3. Establish appropriate governance arrangements, which would be expected to include the formation of a Steering Committee to represent stakeholder interests in the management of the program.

Potential Stakeholders include:

- Government agricultural and NRM agencies including AFFA, Environment Australia and their State/Territory and international counterparts;
- Farmer and industry organisations representing climate-sensitive rural industries (including the National Farmers Federation);
- Related rural industries (including those involved in the transport, marketing and processing of agricultural produce, agribusiness, insurance, stock & station agents, banking);
- Water and energy management, regulation and distribution enterprises and agencies (including the Murray Darling Basin Commission and their State/Territory counterparts);
- Regional and catchment management agencies and community groups;

- Relevant Research & Development Corporations (including the Dairy Research & Development Corporation, Grains Research & Development Corporation, Land & Water Australia, Sugar Research & Development Corporation, Rural Industries Research & Development Corporation);
- Cooperative Research Centres (CRCs) (such as the CRCs for: Australian Sheep Industry; Australian Weed Management; Plant-based Management of Dryland Salinity; Tropical Savannas Management; Water Quality and Treatment; Sustainable Production Forestry; Tropical Plant Protection; Viticulture; Aquaculture; Sustainable Aquaculture of Fin Fish; Australian Cotton; Food Industry Innovation; Sustainable Sugar Production; Sustainable Rice Production; Southern Hemisphere Meteorology; Catchment Hydrology; Freshwater Ecology; Tropical Rainfall Ecology and Management; Sustainable Tourism; and Greenhouse Accounting);
- Research institutes and agencies including CSIRO, the Bureau of Meteorology, the Bureau of Rural Sciences, State agencies, Universities, Agriculture Colleges and individual researchers; and
- Private and Government training and extension services providers, including consultants.

6. Recommendations

The primary recommendation is that funding an extension of the Climate Variability in Agriculture Program with a focus on adoption is warranted. It is expected that stakeholders would support such an extension.

This recommendation is based on our assessment that:

- While progress has been made, there is a continuing need for coordinated and well targeted activity to further enhance the capacity of farmers and other resource managers to better manage climate variability;
- CVAP has made considerable advances in the development of our collective understanding of climate variability in relation to the agricultural sector and scientific capacity in this field;
- Without an additional phase concentrating on further refining and promoting the adoption of current CVAP tools, there is the prospect that the returns on those funds already invested in this process will not be fully realised; and
- An appropriate and effective program management framework has already been established in support of CVAP.

However, there are substantial modifications recommended for the direction of the program and its integration with other activities. These have been outlined in Chapter 5.

Should the basic concept of the future program be accepted, then a further planning process to prioritise additional work will be required to develop a suitably detailed strategic plan and to refine its method of operation, particularly in relation to its management and governance arrangements. Stakeholders have recognised that the outcomes need to be prioritised and consideration given to the level of respective investment. The process will need to determine an appropriate level of funding consistent with the objectives and the relative contributions to be made by the range of potential stakeholders. As part of this process, priority will need to be given to establishing detailed performance goals and associated performance indicators and reporting procedures. These matters are beyond the scope and capacity of this review.

Hassall & Associates has made specific recommendations that apply to two of the important projects of CVAP, Aussie Grass and StreamFlow, which are contained in Chapter 3.

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Appendix 1: Terms of Reference

A Stakeholders Report (Interim). Based on a stakeholder workshop and consultation with other agencies, identify the most promising opportunities to contribute to improved management of climate-related risks. A preliminary evaluation of the achievements of the current phase of CVAP will provide a starting point to identify opportunities. The working report will inform the broad direction for any future phase of the program, as well as contributing to planning by other agencies. The report is to cover:

- the most promising avenues to capitalise on outputs from the concluding Phase 3 projects,
- opportunities which arise from major developments in climate science and in applications research,
- opportunities to change the balance of the program to overcome any key constraints identified, for example in research capacity, communication, user skills, or the range of stakeholders involved,
- opportunities to extend applications in particular regions, industries and for broader applications in natural resource management, and
- the process and outline for the November Evaluation Workshop including relevant evaluation frameworks and perspectives.

The Workshop is to be held in Canberra from 24/25 May 2001. The Consultant is responsible for all workshop costs other than for participants travel and accommodation. The participant list is to be approved by the LWRRDC contact. Participants are to be sent a scoping report with relevant position papers one week prior to the Workshop.

B Program Evaluation Report. Based on a second workshop with selected researchers and stakeholders, finalise an overall Program Evaluation Report incorporating updated information from the interim Stakeholder Report. The Report will also consolidate the lessons and implications from Phase 3 projects, based on their Final Reports as they become available. The scope of the program and its research priorities will be included together with research planning and management processes. The plan for the Final Report will be reviewed at the second workshop. The workshop is to be held in Canberra from 5-6 November, 2001.

Evaluation Issues

The program evaluation is to be consistent with general government requirements, and also reflect any specific stakeholder perspectives. The evaluation framework will therefore include the hierarchy:

Appropriateness - How well are the program's outcomes designed to meeting societal needs and government objectives, in particular for a sustainable and profitable agricultural sector?

Effectiveness - How well is the program meeting planned program outcomes, that is the realised and potential impact on climate-related risk management by farmers?

Efficiency - How well is the program meeting program objectives, that is how well is the program providing outputs from R&D in relation to the input resources used?

The Management Strategy for the current Phase 3 of CVAP was developed during 1997-98. As such, the Strategy may not fully reflect contemporary requirements in implementing an accountability framework at the program level. The consultancy will need to take into account the current accountability requirements to the extent that is practical in an *ex post* evaluation.

The degree of emphasis to be placed on the components of the above hierarchy is a matter of judgement, informed by an awareness of the data available and the value of lessons to be learnt and applied to any further programs.

The three components of the accountability hierarchy may warrant different emphasis in the first and second parts of the consultancy. More information will be available for the second part. For example, there may be aspects of efficiency and program management, which are better evaluated in the second part. There is also scope for the first workshop to define priorities for the second part of the consultancy. In addition to studies undertaken within the consultancy, there may be scope as recommended by the workshop, for CVAP to fund some short, more technical studies during mid 2001. Technical reviews, surveys and position papers are examples.

The remaining issue which will influence the approach adopted is in attribution of benefits. Availability of data will constrain the extent to which a quantitative approach can be adopted. Where it is difficult to directly relate outputs to outcomes, there may be intermediate indicators which show that outputs are contributing to outcomes. Nevertheless, the consultants approach will need to recognise three particular aspects:

- The joint or partnership basis of most project funding with research agencies,
- The accrual of benefits and costs over time and the difficulty in attributing realised and potential benefits to a specific phase of the program, and
- The extent to which a 'without the program' situation can be conceptualised to provide some qualitative assessment of how CVAP has made a significant difference, for example in accelerating the development of complimentary programs by other agencies.

Appendix 2: List of CVAP projects by objective

Objective 1 - Climate Forecasting and Impacts

BOM4 *Improved climate prediction during El Nino events*.
Bureau of Meteorology (Vic) W. Wright

BOM5 *Effective implementation, adoption & utilisation of new climate model results.*
Bureau of Meteorology (Vic) —Scott Power

COR5 *Extended seasonal climate predictions using a dynamic climate model*
G Meyers (CSIRO Marine) / Neville Smith (BoM)

CTC16 *From oceans to farms: integrated management of climate variability*.
CSIRO Division of Tropical Agriculture — Andrew Ash

QNR9 (Phase 2) *Australian grassland & rangeland assessment by spatial simulation — "Aussie Grass"*.
Qld Dpmt of Natural Resources — Wayne Hall

QPI44 *Can decadal climate variability (DCV) impact on cropping systems management?*
Qld Dpmt of Primary Industries — Holger Meinke

RDC7 (Phase 2) *Further development & application of Australian Rainman to improve management of climate variability*.(joint RIRDC/CVAP)— QDPI - Jeff Clewett

UWA23 *The influence of north-west cloud bands on eastern Australia rainfall.*
A/Prof Charitha Pattiaratchi, University of Western Australia

Objective 2 - Adaptive farming systems

CIC3 *Search for innovative adaptations to climate variability*. Cox Inall Communications —Tim Powell

CIC5 *Promotion of Masters of the Climate case studies.* Cox Inall Communications

Objective 3 - Marketing Climate Information

BRR7 *Framework for analysing climate variability for policy*.
Bureau of Rural Sciences — Gregory Laughlin

CTC18 *Better management of climate variability within the agribusiness service sector*.
CSIRO Division of Tropical Agriculture — Peter Carberry

CWE23 *Do government policy instruments support sustainable grazing on-farm?*.
CSIRO Division of Wildlife & Ecology —Mark Stafford-Smith

DAN12 *Survey of agricultural climate research, development & services in Australia*.
NSW Agriculture —Graeme Tupper

QNR3 (Phase 2) *The Australian On-Line agrometeorological information service-SILO* (joint CVAP/RIRDC). Qld Dpmt of Natural Resources — Alan Beswick.

VIR5 *Improving the communication of climate information to dairy farmers*.
VCG Australia (with DRDC) — Greg Hayes

QPI43 *CLIMARC — Computerising the Australian climate archives*
Qld Dpmt of Primary Industries — Nick Clarkson

UQL20 *Seasonal climate information & farmers' risk assessment & decision-making*.
University of Queensland — Len Dalgleish

BOM6 *SILO tailored to users location and preferences for presentation*
Dr Scott Power, National Climate Centre, Bureau of Meteorology

QNR24 *SILO II - Extension, Marketing and Industry Focused Product Development*.
Alan Beswick, Queensland Department of Natural Resources

WORKSHOPS

BOM3 *A century's perspective on climate variability & impacts on agriculture.*
Bureau of Meteorology — Scott Power/Bill Wright

QPI42 *International workshop on farm management decisions with climatic risk* (workshop jointly funded with ACIAR). Qld Dpmt of Primary Industries — Rod Saal

UWA21 *Innovative workshops to improve understanding of price & climate variability*.
University of WA — Ross Kingwell

Objective 4 - Industry and Extension

QNR14 *Can seasonal climate forecasting prevent degradation of Australia's grazing lands?*
Qld Dpmt of Natural Resources — Greg McKeon

SRC6 *Improving sugar industry competitiveness using seasonal climate forecasting.*
CSIRO Tropical Agriculture (with SRDC) — Russell Muchow

HRM1 *Improved management of climate variability on Australian grain farms.*
Horizon Rural Management — Peter Wylie

QPI38 (Phase 2) *Evaluating the role of seasonal climate forecasting in tactical management of cropping systems in north-east Australia* (with GRDC and RIRDC). Qld Dpmt of Primary Industries — Roger Stone

QPI39 (Phase 2) *Seasonal streamflow forecasts to improve management of water resources — Rainman Streamflow project*. Qld Dpmt of Primary Industries — Nick Clarkson

VCE14 *Strategies to cope with climate variability in the perennial pasture zone of south-eastern Australia*.
Dpmt of Natural Resources & Environment —Stephen Clark

Appendix 3: Matrix of outcomes, attributes and possible performance indicators

Outcome/output	**Attributes of success** more precisely what was to be achieved, with whom, where, when / by when as appropriate	Possible Comparisons	Factors within the control of the program	Factors outside control of the program	Possible performance indicators	Comments/ assumptions
OUTPUTS						
Improved climate prediction and the monitoring of the impacts of climate variability through increased understanding of climate variability [Objective 1]	-The projects undertaken provide advances in the science and knowledge of climate prediction for the scientific community. -Meets priority needs identified. -Completed to desired quality. -Funding fully utilised and all projects completed within agreed time frames	-Against priorities [Nil] -Scientific standards -Scientific/ knowledge increases over time (before & after) -Projects that lead on to other projects	-Choice of projects and resources allocated meet priorities and needs. -Efficiency & effectiveness of project management	-Lead times -The extreme difficulty in accurately forecasting long term weather and climate. - Availability of researchers and extension pathways.	-Stakeholder opinion as to improvements -Number of projects from previous rounds that lead on to other projects in current round. -Projects are completed and monitored via LWA processes within the agreed time frames.	-Need a better way of measuring improvements in science and forecasting skills. -Measuring skill for forecasts is hard and GCMs will be harder to measure than statistical approaches! -Communication with research users sufficient? -LWA processes appear adequate and projects not paid unless meet milestones. Most delays caused by problems with locating staff.
New farming systems developed that are better adapted to climate variability [Objective 2]	Projects undertaken are identified, promoted and assessed to develop production systems that are better adapted to climate variability. -Funding fully utilised and all projects completed within agreed time frames	Changes over time	-Choice of projects and resources allocated meet priorities and needs. -Efficiency & effectiveness of project management	-Lead times -The extreme difficulty in accurately forecasting long term weather and climate. - The availability of researchers and extension pathways.	-Projects funded adequately contribute to the development/ improvement of production systems better adapted to climate variability. -Projects are completed and monitored via LWA processes within agreed time frames.	Availability of suitable tools and information. Communication with research users sufficient? Need attention on managing CV per se.
Managers' needs met for climate information based on improved knowledge of their needs [Objective 3]	-Products meet manager's climate information needs. -Funding fully utilised and all projects completed within agreed time frames. .	-Meeting needs [identified?] -Scientific/ knowledge increases over time (before & after). -Changes in needs.	-Choice of projects and resources allocated meet priorities and needs. -Efficiency & effectiveness of project management	Culture that discourages/ does not appreciate the value of risk management planning?	-Projects funded adequately contribute products and information that meet manager's climate information needs. --Projects are completed and monitored via LWA processes within agreed time frames.	Communication with research users sufficient? Managers' needs can met based on improved knowledge

Outcome/output	**Attributes of success** more precisely what was to be achieved, with whom, where, when / by when as appropriate	**Possible Comparisons**	**Factors within the control of the program**	**Factors outside control of the program**	**Possible performance indicators**	**Comments/ assumptions**
Managers provided with information on the value of seasonal climate forecasts in supporting decisions for specific applications [Objective 4]	- provided through extension programs & other channels - information used -training available and used -Funding fully utilised and all projects completed within agreed time frames	-Meeting needs [identified?] -Scientific/ knowledge increases over time (before & after) -Changes in needs	Choice of projects and resources allocated meet priorities and needs. -Efficiency & effectiveness of project management		-Projects provide information on the value and use of SCF -Projects are completed and monitored via LWA processes	-AAA survey, only 29% would consider training (in seasonal climate forecasts) -Communication with research users sufficient?
OUTCOMES						
Improved researcher capability	-Researchers improve CV understanding. -Networks between research groups improve CV research capability.	-Collaboration of researchers for CV projects.	-Networking through conference -Joint projects	Availability of researchers and extension pathways.	-Improved skill level of researchers for CV. - Number of collaborations between research groups specifically for CV.	
Improved CV information available: better predictive capacity & understanding of impacts	-Higher skill & accuracy of forecasts (timeliness of forecasts, format can be understood). -Impacts built into further DSS or quantified (agronomic and ecological) -Tools are promoted or users are aware of tools	-Increase over time (before & after) R&D expectations/ Scientific standards/ Peer review -Satisfaction of users	Networking through conference Joint projects	- Lead times -The extreme difficulty in accurately forecasting long term weather and climate.	-see output 1 (Higher skill) -Availability of tools and information (including number, quality). -Usability of tools and information: stakeholder satisfaction.	
Improved awareness of CV information	-Tools are readily available and promoted	-Increased awareness over time.	-Promotion (successful case studies). - marketing and communication. -coordination of effort	Competing priorities for media	-Awareness of CV information	-Awareness of CVAP important?
Improved capability to understand and use CV information [including the willingness or acceptance to use?]	-Improved understanding of what CV means for users and the knowledge of what tools are available. -Users are confident in using CV tools and information (training?)	-Increased capability and understanding of the uses of CV information and tools over time.	-CV comm. and training activities are undertaken. -Awareness and access to information and tools.	-There is a general lack of skill/confidence regarding the use of risk management tools.	-User satisfaction with R&D findings (quality, credibility and timeliness) -To what extent did the R&D lead to increased understanding of climate variability & impacts?	

Outcome/output	**Attributes of success** more precisely what was to be achieved, with whom, where, when / by when as appropriate	**Possible Comparisons**	**Factors within the control of the program**	**Factors outside control of the program**	**Possible performance indicators**	**Comments/ assumptions**
Improved use of CV information; information is incorporated into decision making -farmers, agri-sector, policy.	- Tools are used for production, marketing financial planning decisions	-Increase use of CV information over time	Promotion (successful case studies). - marketing and communication activities are undertaken.	-A culture that discourages/ does not appreciate the value of risk management planning. - general lack of skill/confidence regarding risk management tools.	- Number of producers using seasonal forecasts at the start and end of the program (AFFA measure to show effectiveness of activities). -Number of people across different sectors using CV information	AAA – concentrates on SCF
Management strategies developed and implemented (profitable & sustainable): - farmers, agri- sector and policy.	Developed [by farmers] & built into farm plan. Implemented, with some sort of monitoring to gauge effectiveness	Changes over time	--	Seasonal conditions, markets, general economics	-No of strategies developed as a result of information from CVAP. -No of strategies implemented as a result of information from CVAP. -Stakeholder indications of an acceptance of need for management strategies to include CV information	
Improved preparedness of Ag sector to respond to climate variability: both opportunities and threats	Increased acceptance of risk management More prepared and responsive sector Lower reliance on government 'rescues' Higher overall profitability over CV periods?	-	-	Seasonal conditions, markets, general economics	-Have changes in strategies lead to behavioural changes (see previous indicators). -Stakeholder views of whether the sector is more prepared	-Reduced reliance on EC payments – but a timing issue and event-dependent -Preparedness of States and producers to handle severe droughts? -Self-reliance in rural sector, given inappropriate political signals?
AAA program goals are enhanced; and a more profitable, competitive and sustainable agricultural sector results	A more profitable, competitive and sustainable agricultural sector. More self-reliant sector with better risk management (of which climate is a part)	-	-	Seasonal conditions, markets, general economics, Other programs	No precise measures, rather an amalgamation of performance information from other PI	CVAP goals are consistent with AAA.

Appendix 4: StreamFlow Launch

StreamFlow

StreamFlow has been developed by the Queensland Centre for Climate Applications (QCCA) as part of a major collaborative effort around Australia. The project was part of the Climate Variability and Agriculture Program (CVAP), a Commonwealth Government funded research and development program. The program is supported by Agriculture, Fisheries and Forestry- Australia and administered by Land and Water Australia. More details of the program can be found on the website (www.cvap.gov.au).

StreamFlow includes data for more than 400 gauging stations throughout Australia and allows users to:

- Examine historical records of streamflow;
- Analyse monthly and daily stream flow[7]; and input your own data;
- Forecast seasonal streamflow based on the Southern Oscillation Index (SOI), Indian Ocean Sea Surface Temperature and other predictors; and
- Assess water availability under pumping licence conditions – when, how often and how much.

StreamFlow works as a supplement to Australian RAINMAN, which aims to provide rainfall information for better management of climate information. The Rainman package provides rainfall data for 3700 locations across Australia, as well as uses SOI and SST to forecast seasonal rain, droughts and rainfall events. Over 2000 copies of the Rainman package have been sold to primary producers, business, agencies, policy makers and educational institutions.

Launch and workshop

A launch and a workshop was held in order to demonstrate potential applications with influential water resource managers in mainly south-eastern Australia, and also to indicate future directions for promotional activities based on an evaluation of the workshop.

The specific aims of the workshop were:

- Marketing: to launch the StreamFlow product and provide an awareness of its capabilities;
- Training: to provide a training session in using the product; and
- Evaluation: to provide feedback for the developers and funders and indicate other potential uses/clients.

The launch and workshop was held at The Boathouse, in Canberra, on Thursday 29 November, 2001. The launch was conducted by Mr. Don Blackmore, Chief Executive, Murray Darling Basin Commission.

[7] Note this is for unregulated streams.

Media activity generated

Media activity was coordinated by Capital Public Affairs. Two publicity events resulted. An article appeared in The Weekly Times, 30/11/01 [attach in final report]. In addition, interviews were conducted by ABC Radio in Sydney.

Evaluating the launch and workshop

The emphasis of Hassall & Associates' evaluation, as agreed with the CVAP coordinator, is not so much on what was done, which is covered to some extent by QNR&M's exit survey, but rather addressing the question of where to from here. There was also the opportunity to collect data on the project that might help in the overall review of CVAP, such as whether the products are (going to be) used and to how to best assist in their adoption.

A follow up survey to workshop participants that returned evaluation forms was conducted via email and some were contacted by telephone to enhance the response rate. 19 out of 22 responded and an agency representative that could not participate on the day due to other commitments gave an extra set of comments.

Results of the evaluation

There was a very positive and enthusiastic response to the launch and associated training workshop. The launch and workshop were seen as a very successful in presenting Streamflow to a diverse audience and providing training to those with a requirement for more comprehensive knowledge of the product. 90% of participants at the workshop stated that they would recommend the product to others. Most ranked the workshop as being useful and relevant. The location of the day at a prestige venue was seen as positive.

While complimentary of the launch and workshop, the suggestion was made by some of the attendees that it could have been improved by providing more background briefing on hydrology, how the StreamFlow "engine works" and how to interpret the data. However, it was also recognised that there was a lot of material to present in a short period of time and that generating competency in using the package may take more than 2 hours.

StreamFlow was generally seen as having considerable potential across a broad range of possible applications. Specific areas of potential application identified by attendees included:

- Drought response planning;
- Managing environmental flows;
- Managing storages; and
- Promoting a higher ethos of risk management amongst irrigators.

One participant mentioned that the enhancement of Rainman by adding *persistence* was a real plus for the package.

Nevertheless, respondents identified a range of areas where they considered StreamFlow have deficiencies and/or where improvements could be made, including:

- Its use is significantly limited by covering only unregulated streams (which reduces its relevance for NSW irrigators, in particular);
- It is based on historic data and does not help in predicting events such as 10 year droughts;
- Some reservations about IQQM data;
- Need more background knowledge of hydrology and how to interpret the data to be able to use the product;
- NSW data seems pretty "hollow" – but as more data is incorporated it will have vast potential uses;
- Would be useful to have a capacity to analyse state wide rather than having to look at individual stations; and
- Need to involve agronomists.

There was an overall sense that the use and application of StreamFlow would improve over time as it became more widely known and further data was incorporated in the model. Many felt they needed to have time to "play" with it before they would be confident about its worth. Based on these responses and statements made by several key speakers at the launch, the challenge is now to promote awareness and adoption.

Amongst attendees there was a mixed level of prior knowledge about the product. Understandably those that had some involvement in the development of the product were quite familiar with it whereas this was not the case for many potential users. This response suggests the need for a clear communications strategy targeted at potential users. Comment made by one agency attendee suggests there may be merit in organising presentations tailored to key State NRM agencies. There was a strong preference expressed to engage with key agencies and irrigators in the regions rather than from a central base.

Overall, congratulations were given to the project team for obtaining data from the States and there was general support for continuing efforts to obtain and collate further data.

In terms of future training/extension there was general support for a group training format as it provided the opportunity for greater interaction and learning from the questions of others. There was also some support for improved manuals. Additionally, enhanced user-friendliness would be beneficial, such as using buttons rather than having to scroll through many menus, improving the display, easy to find help and strong manuals.

The package needs to clarify the capacity of the model and clearly state that it covers unregulated rivers and inflows into storages. Otherwise there is potential for disappointment, as with a few of the irrigators at the workshop who operate on regulated streams, when it is discovered that the package may not provide all the answers/assistance that they would like.

Recommendations for StreamFlow

StreamFlow developers need to conduct a full market assessment to determine the awareness, capabilities, potential use and desirable tactics to reach the market[8]. The main focus initially should be on State water and NRM authorities and irrigator groups. Contact will then need to be made with the target audiences in the main irrigation regions. At some stage, dedicated time with potential users will be essential to demonstrate the product and improve capabilities, perhaps in the form of focus groups.

The possibility of applications for urban uses should also be investigated.

Clarification should be made about the capacity of the program, particularly in relation to regulated streams.

User-friendliness should be maximised should a future version be considered. An ethic of continuous improvement in functionality, capability and data included is appropriate.

Broader recommendations

CVAP, LWA and AFFA should consider the merit of further promoting the availability of State data, perhaps in conjunction with the National Land and Water Resources Audit and the Natural Resources Management Ministerial Council. The availability of data will influence the usability of the products.

CVAP, LWA and AFFA should consider the merit of further promoting better risk management within the water authorities and full use of all available information when making decisions about allocations.

Attachments

Survey questions

The survey covered the following issues:

- What motivated you to attend/not-attend the launch?
- Before the launch and workshop, did you consider yourself to be adequately aware of the potential impact of Climate Variability on your operations/activities?
- Before your invite to the workshop, were you aware that a STREAMFLOW forecast product was being developed?
- Before the workshop were you aware of how RAINMAN was used in seasonal forecasts of RAINFALL?

[8] The main issue is to determine whether audience has awareness of the product and capabilities to use the product. We estimate that the awareness is still probably quite low. Once aware, then the next stage is to encourage take-up. Three main tactics seem apparent:

- Roadshow and direct presentation to users (including establishing alliances with organisations and key influencers within a select number of regions (say 10);
- Direct mail to potential users (again using alliances and their mailing lists – e.g. NFF, irrigation groups, etc); and
- Media push – provide case studies of how people are using it and what are the benefits.

- What uses do you see for the product, both for:
  - your organisation; and
  - others (e.g. irrigators, water resource managers)?
- Do you think you will be using the product in six months time to help with the management of climate variability and streamflow? Yes / No / Don't Know
- How would you rate your knowledge/skill level to use the StreamFlow tool:
  - High – could pass-on training to others;
  - Adequate - for current purposes;
  - Inadequate - for current purposes (e.g. because need further support/assistance).
- Do you (or your staff) need any further support/training to achieve the level of proficiency you feel you need? Yes / No / Don't know
  If yes nominate:
  - StreamFlow Instruction/training
    - Group (e.g. with other irrigators/water managers etc); or
    - One-on-one.
  - Instruction/training in other related CVAP products; e.g.
    - Rainman;
    - General training on implications of climate variability.
  - Support (to answer particular problems as they arise)
    - Telephone; or
    - Email.
  - Manuals
    - Simplified; or
    - More detailed.
- Have you looked further at the product since the launch?
- Do you have any other comments you have on the day or product?
- Would you be prepared to participate in a follow-up survey on StreamFlow in 6 months?

Department of Queensland Natural Resources & Mines' Exit Survey Results

30 participants, 22 responses.

Mix of industries and occupations represented:

R&D: 11%
Lambs/wool: 6%
Beef Cattle & dairy: 9%
Sugar: 3%
Irrigated crops: 20%
Field crops: 9%
Veg: 11%
Water resource management 17%
Consultancy: 6%
Ag extension: 3%
Env rehab: 3%
Policy: 3%

Session impressions:

Clearly presented: 3.4 out of 5, where 1 is low and 5 is high
Relevant: 4.1
Useful: 4.1
Met needs: 4.0
Recommend: 90% (20) Y

Achieved QNR&M objectives:

One [understand how water users, etc can use package to enhance decisions about water resources]: **3.7**
Two [access data from 400 locations]: **4.0** [incl one score of 1/5]
Three [evaluate impacts of climate variability on streamflow]: **4.0**
Four [argue the value of seasonal streamflow forecasts in managing water shortages and envt flows]: **3.7**
Five [use streamflow forecasts to assess water diversions and pumping]: **3.4**

What will be done as a result of the session:

Examine software & tutorials (several comments)
As above, for better farm decisions
As above, for sustainable diversion limits & env flows
As above, for clients
Use for s/flow and economic impacts
Learn about CV
Use SOI and persistence in River forecasts
Use in farmer education workshops
Discuss package with other people
Tell people about benefits

*additional comment: data limitations need to be better understood

Invitation to participate

The Climate Variability and Agriculture Program (CVAP) is pleased to invite you to the launch, followed by a hands-on workshop for:

StreamFlow

Supplement to Australian ***RAINMAN***

StreamFlow is a decision support tool for irrigators, advisers and water managers.

29 November 2001

The Boat House, Menindee Drive, Canberra

Australia's all-too-variable climate has shaped the development and use of our water resources. With StreamFlow you can now easily determine how current climate features like El Niño can influence likely water availability in the coming season and improve management decisions.

StreamFlow has been developed by the Queensland Centre for Climate Applications (QCCA) as part of a major collaborative effort around Australia. The project was part of the Climate Variability and Agriculture Program (CVAP), a Commonwealth Government funded research and development program. The program is supported by Agriculture, Fisheries and Forestry- Australia and administered by Land and Water Australia. More details of the program can be found on the website (www.cvap.gov.au).

StreamFlow includes data for more than 400 gauging stations throughout Australia and allows users to:

- Examine historical records of streamflow;
- Analyse monthly and daily stream flow; and input your own data
- Forecast seasonal streamflow based on the Southern Oscillation Index (SOI), Indian Ocean Sea Surface Temperature and other predictors; and
- Assess water availability under pumping licence conditions – when, how often and how much.

QCCA is a Queensland Government imitative which includes the Departments of Primary Industries and Natural Resources and Mines. StreamFlow was developed with contributions from major water agencies, the Bureau of Meteorology, and the CRC for Catchment Hydrology.

AGENDA
29 November 2001
The Boat House, Menindee Drive, Canberra

10am	- Welcome morning tea
10.30am	- Introduction and background to StreamFlow
12pm	**- Official StreamFlow Launch**
	Don Blackmore, Chief Executive - Murray-Darling Basin Commission
12.30pm	- Lunch
1.30pm	- StreamFlow Workshop
4.00pm	- Close

StreamFlow Workshop

It is recommended that water managers, irrigators and resource managers attend the workshop as it will better enable users to:

- Understand how water users, agencies and managers could use the RAINMAN STREAMFLOW package to enhance decisions about water resources;
- Access streamflow data from over 400 locations throughout Australia;
- Evaluate the impacts of climate variability and ENSO (El Niño / Southern Oscillation) on streamflow;
- Assess the value of seasonal streamflow forecasts in managing water shortages and environmental flows; and
- Use seasonal streamflow forecasts to assess water diversions available for licensed pumping.

RSVP by 20 November 2001
FAX 02 9241 5684

Name _____Organisation_____
Address_____ PH_____
FAX_____ EMAIL_____
I will attend the

Introduction and Launch		**StreamFlow Workshop**		*(NB: spaces are limited)*
YES	NO	YES	NO	

I can not attend but would like to nominate: _____.

For further information please contact Vicki Manson, Hassall & Associates
Ph 02 9241 5655 or vmanson@hassyd.aust.com

Places are limited so RSVP early to ensure you can participate in this free workshop and launch. A copy of the RAINMAN StreamFlow package will also be provided to workshop participants free of charge.

Appendix 5: Aussie GRASS Scientific & Merit Review

Aussie GRASS

Aussie GRASS stands for the Australian Grassland and Rangeland Assessment by Spatial Simulation. Aussie GRASS is a national pasture growth model that seeks to provide an objective assessment of seasonal conditions for drought analysis. Its role and scope has been greatly extended, including undertaking spatial/temporal simulations of pasture growth right across Australia, assisting with identifying areas that are likely to be vulnerable to overgrazing, and other areas that are also prone to land degradation, and aiding bushfire monitoring. Being incorporated into a Geographic Information System, the output can be readily integrated with other spatial data sets.

This can help to prevent degradation of Australia's grazing lands. In total, 280,000 grid cells are linked to a spatial climate database that covers daily rainfall, temperature and evaporation surfaces dating back to 1890. This historical climate data combined with current climate prediction (rainfall, temperature, radiation, evaporation and humidity), satellite data (soils, pasture type, stocking rate and tree cover) and animal numbers, produce an "environmental calculator" which can then alert users to possible areas of degradation. The outputs of Aussie GRASS can be used to influence policy and decision making.

Over the past decade many organisations have contributed to the development of the Aussie GRASS project. These include NSW Agriculture, Agriculture Western Australia, AFFA through CVAP, Land & Water Australia, CSIRO, S.A. Primary Industries & Resources, N.T. Department of Primary Industry & Fisheries, , NSW Department of Land ad Water Conservation, Queensland Department of Primary Industries and Queensland Natural Resources and Mines. The program covers issues that directly relate to environmental degradation such as droughts, grass fire risk, climate change impacts, hydrological impacts, agistment and industry conditions, greenhouse issues, and assessment of "safe" carrying capacity. The project had its genesis as a National Drought Alert Strategic Information System.

More details about the project can be seen on the website [www.nrm.qld.gov.au].

The project has received $750,000 funding from CVAP over the several phases. There has been a substantial in-kind contribution from the agencies involved, which provide leverage to the CVAP funds. The project thus forms a major component of CVAP and was chosen as the focus for a 'scientific and merit' review. The review process is a normal part of Land and Water Australia's research program management. The review was conducted as a supplementary activity to the overall review of the program. Findings relating to the contribution of the project to the intended outcomes of the program have also been included as data for the overall review of CVAP.

A closely related project is the QNR14 project 'Can seasonal climate forecasting prevent degradation of Australia's grazing lands' (final report submitted). This was also presented in the introductory seminar, discussed below.

Review process

Steps included:

- Organisation of the process and one-day session;
- Introductory seminar and overview of the project given by the Aussie GRASS project team. Potentially interested organisations and personnel were invited;
- Detailed presentations by the project to the review panel;
- Questions from the review panel;
- Assessment by review panel; and
- Reporting.

A LWA Scientific Review form was used as a proforma, which was modified prior to the review to capture the objectives and relevant issues (see next section).

The Review Panel consisted of:

- Chair: Prof. Henry Nix, Australian National University.
- Secretariat: Dr. David White, ASIT Consulting (sub-contracting to Hassall & Associates).
- Panel: Prof. Ockie Bosch, University of Southern Queensland; Dr. Tim McVicar, CSIRO; Prof. Craig Pearson, Greenwich Consulting (formerly Bureau of Rural Sciences).
- Observers: Dr. Barry White, CVAP Coordinator and Dr. David McClintock, Hassall & Associates.

Review findings

{recorded as a completed Scientific Review Form}

QNR9

PROJECT REVIEW FORM

1. PROJECT DETAILS

(to be filled out prior to review: Project Schedule and Application Form must be attached)

Project Title: **Australian Grassland and Rangeland Assessment by Spatial Simulation** (Aussie GRASS)

Project No: QNR9 Project Location: Indooroopilly, Qld

Research Area: Climate Variability in Agriculture Program

Principal Investigator(s): Dr Wayne Hall

Organisation: Queensland Department of Natural Resources & Mines (QNR&M)

Last Achieved Milestone (date and details): Final reports submitted in April 2001

2. REVIEWER'S COMMENTS

2(a) Reason for review: Project has been completed

2(b) Were all project objectives met? Yes ( ) No (√)
If No, explain divergence and reasons:

Objective 6 was not met, since this was superseded by Earth Observation activities performed by CSIRO. The Project Steering Committee agreed to this change early in the life of the project; the review committee endorsed this decision.

Objective 1: Further technical development and operationalisation of 'Aussie GRASS'

State or Territory Ecoclimatic Zone	Done	Evidence	Applications	Future work required
NT & Kimberley Western Australia South Australia Western NSW Eastern NSW	Yes	Data collection, model calibration and validation	Absolute and decile products of rainfall, pasture growth and standing dry matter	Move from awareness to adoption by stakeholders. Broaden definition of stakeholders

There is a need for a brief document that describes Aussie GRASS components to the R&D community, and potential expert users. Likewise, different versions of GRASP need to be properly documented.

Objective 2: Facilitating a nationally co-ordinated effort of spatial grazing modelling

State or Territory Ecoclimatic Zone	Done	Evidence	Applications	Future work required
Queensland*		Development of team culture that crosses State and Territory boundaries. Extended Aussie GRASS models and data sets to other regions of Australia		Need better linkages with Commonwealth agencies, MLA and Australian Wool Innovation P/L
NT & Kimberley South Australia	Yes	Limited increase in climate applications knowledge and awareness	Generation of electronic and printed products	Concept needs to be institutionalised within each State.
Western Australia Western NSW Eastern NSW	Yes	Significant increase in climate applications knowledge and awareness	Generation of electronic and printed products	Concept needs to be institutionalised within each State.

* Queensland included where relevant comments need to be cited

Objective 3: Development of a nationally integrated extension program

State or Territory Ecoclimatic Zone	Done	Evidence	Applications	Future work required
NT & Kimberley Western Australia South Australia Western NSW Eastern NSW	Yes	Numerous electronic and printed products, displays workshops	State and Territory products for State & Territory agencies. Legitimised use of pasture modelling within agencies	Need detailed analysis and involvement of stakeholders.

One of the great achievements of the program has been legitimising the use of pasture modelling within agencies. There is a need to enhance the interpretation capabilities of Aussie GRASS, and to link the tool to a knowledge base in order to provide end-users with easier and direct access to management options and strategies. The stakeholder base needs to be expanded well beyond pastoral and public service managers. Stakeholders need system ownership and embedded participation through being involved in improving the interpretation capabilities and developing the knowledge base, including advising on management implications and providing records, including stock numbers. We advocate the use of a consultant to advise on a detailed stakeholder analysis and to determine and highlight future directions on how to maximise the usefulness of Aussie GRASS as an assessment and interpretation tool. Current discussions with Wesfarmers are a step in the right direction.

Consistent with our recommendation to broaden the stakeholder base, and improve the marketing of Aussie GRASS and its products, we advocate developing climate, pasture and ecosystem condition products with overlays that are focussed towards specific client groups – e.g. agroclimatic/ecoclimatic zones, soil and vegetation classes, local government areas, catchments, and electoral zones.

Developing partnerships with Commonwealth agencies and all States and the Northern Territory has been difficult, but this is an essential prerequisite to Aussie GRASS becoming a national system. Linkage with a key Commonwealth agency will strengthen the likelihood of another round of funding. The review panel suggests that QNR&M consider linkages – perhaps a joint venture agreement – with CSIRO Land & Water, CSIRO Sustainable Ecosystems, BRS and ABARE.

The remaining States, Tasmania and Victoria, will need particular attention if they are to be involved in a national system

Objective 4: Development, calibration and validation of the best pasture models for different ecoclimatic zones

State/Territory Ecoclimatic Zone	Done	Evidence	Applications	Future work required
Queensland*				Ongoing upgrading of GRASP
NT & Kimberley	Yes	Natural extension of GRASP/Aussie GRASS to northern rangelands	Extensive/valuable spider mapping	
Western NSW South Australia Western Australia	Yes	Calibrated GRASP favoured on southern rangelands relative to alternative models	Spider mapping	
Eastern NSW	Yes	Calibrated GRASP favoured in the High Rainfall Zone relative to alternative model	Spider mapping	

* Queensland included in case relevant comments need to be cited

We commend the team and its collaborators on their innovative ground truthing through the spider mapping program. This involved collecting large amounts of vegetation data across substantial areas of outback Australia. Building on the spider mapping, it is felt that it is now timely to test other less expensive but effective strategies that involve collecting more temporal data at fewer sites through purposeful sampling and along gradient transects.

Management during drought is critical to achieving sustainability. Aussie GRASS has substantial capacity at the State and national level in helping to avert major land degradation events. More attention could be given to identifying vegetation thresholds associated with botanical composition and land degradation., These could then be incorporated as information to aid interpretation of land assessments. Users can then be linked to strategies for averting irreversible degradation.

Objective 5: Further calibration and validation of the GRASP pasture model in the Northern Territory and Kimberley, as well as integrating the extent of savanna burning in the NT and WA

State/Territory Ecoclimatic Zone	Done	Evidence	Applications	Future work required
NT and Kimberley	Yes	Vegetation/fire load Curing index	Estimating fire risk and extent. Involvement with DOLA, Tropical Savannas CRC, NT Bushfire Council	Succession planning of key staff. Train a cohort of competent people. Dynamic modelling*
NT – integrating extent of savanna burning	Yes	As above	As above	As above
WA – integrating extent of savanna burning	Yes	As above	As above	As above

* Dynamic modelling of shrubs, trees and grasslands with respect to estimating likely fire severity.

The GRASP model was calibrated for 21 sites in the Victoria River District. Generic parameters were determined for major ecosystems.

Objective 6: Facilitate the development of a national distribution system that provides at a continental scale, both a standardised archive of historical NOAA imagery, and a standardised regular feed of newly acquired imagery, that have been processed, navigated, radiometrically corrected and mosaiced to an agreed national standard

Development steps	Done	Evidence	Applications	Future work required
Standardised NOAA archive	No	Refer note below*	Availability of archive	AVHRR transforms to NDVI and NDTI
Standardised regular feed of new imagery – processed, navigated, radiometrically corrected & mosaiced	No	CAPS – Aussie GRASS team active participants	Using CSIRO's CAPS (Common AVHRR Processing Software)	Closer alliance needed with CSIRO to make processed data more readily available, including through an internet-based system.

* The Aussie GRASS team clearly identified these products as a major requirement. At an early state they consulted with CSIRO and COSSA. The bulk of this task was taken on by CSIRO (COSSA/EOC, a CSIRO unit managed by CSIRO Atmospheric Research).

Potential linkage of NDVI (vegetation index) and NDTI (thermal index) to GROWEST. Additionally, lags between the local maxima of NDTI and subsequent local maxima of NDVI could possibly be used to assess and differentiate between climatic and anthropogenic sources of variability.

Objective 7: Explore how to interface with new seasonal forecasting systems (SSTs, GCMs)

Forecasting system	Done	1. Evidence	Applications	Future work required
SSTs (including SST-phase and Interdecadal Pacific Oscillation)	Yes	Explorative only	Forecasts of rainfall and pasture growth	Concentrate on SSTs for now.
GCMs	Yes	Explorative only	Reliability of GCMs is still an issue	Scaling down from GCMs for regional applications

Anticipating linkages to CVAP's 'Ocean to Farms' project (Andrew Ash/Peter McIntosh)

There is an ongoing need to determine the best forecasting system available, and how it can be applied. The use of remotely sensed measurements of SSTs appears to offer more promise, at least in the short- to medium-term, than down-scaled GCM outputs.

Objective 8: Explore ways to develop synergies with other relevant research projects, and supplement the funding base. In the final year, the States and NT will make their own assessments about the long-term nature of the project and start to self-fund the operation.

Research project	Done	Evidence	Applications	Future work required
Aussie GRASS	Yes	Valuable synergies developed with other users. Products in public domain. CVAP put in $759K, QNR&M $824K, and other agencies put in $930K	Need fee for service from public and commercial clients.	Establish long-term funding base through determining significant potential stakeholders

If detailed stakeholder analysis and marketing was done, then this should fall into place. Stakeholders should, at a minimum, include financial institutions and pastoral companies/stock and station agents.

2(c) Has the original methodology been followed? Yes (√) No ( )
If No, explain divergence and reasons:

Methodology	Done	Evidence	Future work required
Data acquisition	Yes	Spider mapping	Ongoing data acquisition, fewer sites, gradient transacts
Database development	Yes	Databases for validation and calibration	Ongoing validation and calibration
Model development	Yes	All final reports	
Model comparisons	Yes	Final reports – HRZ and Southern Pastures	Publish in say *Aust.J.Agric Res* or *Agric.Systems*
Validation, calibration	Yes	All final reports	
Model application	Yes	Maps of rainfall and pasture deciles	

Differences between model outputs and field data, and between the models, which are all modelling the water balance and plant growth, may primarily be due to minor differences in parameterising Potential Evapotranspiration (Pot_ET). Methods for estimating Pot_ET need to be assessed.

2(d) Are there any problems foreshadowed in the future? Yes (√) No ( )
If Yes, explain reasons:

Major problems foreseen in maintaining necessary funding without significant input from private and public sector clients.

Need for succession planning of key staff, maintenance of relevant corporate knowledge, and training of a cohort of competent people.

Ongoing upgrading and validation of GRASP model.

2(e) Was the scientific rigour of the project acceptable? Yes (√) No ( )
If No, explain reasons:

Scientific rigour was acceptable within the context of the team's objectives. The reviewers considered that Error mapping (eg confidence limits) in both spatial and temporal dimensions is desirable to enable users to get a better perspective on model outputs. Other models have suffered from inadequate parameterisation and lack of sensitivity analyses.

2(f) What were the principal outputs achieved for the project?

Electronic and hard copy products including maps of amounts and percentiles of rainfall, pasture growth and total standing dry matter, along with seasonal forecasts. Information available through a password-protected area within QNR&M's Long Paddock web site.

A substantial database of field observations achieved through the spider mapping program.

SILO – patched point datasets and data drill.

Extension products also included numerous training workshops and public displays.

The reviewers note the comprehensive range of outputs being very provided. However, there is now a need to focus more on the marginal value of the information provided (compared with other information available to users).

2(g) What were the major impacts of the project in terms of sustainability of land/water/vegetation?

The Aussie GRASS project has set a high standard for an operational system of regional and national monitoring. It has heightened awareness of the major climate drivers and the influence of the surrounding oceans on agricultural productivity and the health of natural ecosystems. Aussie GRASS has provided considerable assistance in Queensland at the State and Commonwealth level in drought monitoring and assessment. Seasonal forecasting is now being used to mitigate land degradation events (Hall and McKeon).

2(h) How has the project contributed to the various outcomes anticipated for the CVAP program [refer to Attachment A Map of Intended Outcomes for the CVAP program]?

Aussie GRASS is a well-balanced good system that provides outcomes a a range of levels (short-, medium- and long-term outcomes) set out in the Map of Intended Outcomes – viz. better predictive capacity, improved user awareness and tools for decision making, and significantly improving the preparedness of the agricultural sector to respond to climate variability.

2(i) Potential future applications of Aussie GRASS:

Drought monitoring, rangelands monitoring, land degradation monitoring (including overstocking, vegetation change, vegetation/degradation thresholds), grazing pressure and carrying capacity, identifying appropriate land uses, pastoral management including leasehold monitoring, monitoring of land use change, monitoring and control of woody weeds, fire monitoring and control, estimating greenhouse gas emissions from the rural sector, carbon accounting, climate change impacts, epidemiological models, auditing statistical data, need for government financial intervention, biodiversity modelling (though this would require model adaptation). Monitoring and management of flora and fauna, for example the survival and population dynamics of certain migrating birds is dependent on grassland seed production.

2(j) Who are the potential users of the products?

Aussie GRASS provides a sound foundation for significant improvement in natural resource management across Australia. Relevant Commonwealth and State/Territory Departments; CSIRO, BRS, ABARE, EA, AGO, ACRES, ERIN and Geoscience Australia have a wide range of potential uses. The monitoring, burning and control of woody weeds is just one example. But States must contribute to data collection and to financing their share of the system. This will involve SCARM and ARMCANZ.

The reviewers suggest that educational and training workshops be provided for the whole range of users, as well as staff support to address their specific requirements. There should be an even greater focus on producing deliverables, addressing problems of scale, and on locking in the private sector, who must be actively involved.

Overall, users are seen to include:
- Policy makers and natural resource managers at all levels of government.
- Research, development and extension agencies involved with agricultural and natural resource management.
- Conservation users
- Private consultants
- Universities and colleges – particularly agricultural and other natural resource faculties
- Land and water managers
- Financial institutions
- Pastoral companies/stock and station agents
- Media

2(k) What can be recommended by the review team to enhance these potential outcomes and what steps would be involved to reach the potential users of the products (including low or no-cost promotions with other agencies)?

Broaden the stakeholder and funding base, recognising that commercial clients will recognise a high level of service. This would require significant additional resourcing over an intensive 3 to 5 year period.

2(l) Was adoption of outputs rapid? Yes ( ) No (√)

Were clear adoption pathways identified? Yes ( ) No (√)

Was adoption process thought through/implemented? Yes ( ) No (√)

If No, explain reasons:

We are not criticising the considerable amount of extension work that was undertaken. We do recognise that output adoption has not been the primary focus of the project and so we distinguish between planned and potential adoption. A great deal was achieved within the limits of the available funding. Essentially this is a solid and well-designed R&D program that has not yet achieved widespread adoption outside Queensland. Emphasis has been on achieving awareness rather than adoption, and on the necessary developing and testing of their system. However, it is noted that successful adoption has been achieved in significant areas of Queensland by pastoralists, resource managers and policy makers, where the system has a much longer history of development and testing, and has been backed up by State extension resources.

A successful monitoring and information tool:
- assesses accurately
- helps interpret the information/maps
- helps decision making
- links the user directly and easily to strategies/options (what to do)
- feedback loops to enhance the models and knowledge are in place (ongoing knowledge building).

Such a tool will become institutionalised only through increasing ownership of the concept such that benefits to all relevant stakeholders are maximised. For a tool to become institutionalised we also need
- detailed stakeholder analysis
- involving all stakeholders in the next phase
- developing an interpretation module
- developing a knowledge base with options and strategies WITH the end-users

- help in developing and establishing processes for sending in records and other information for input to the Aussie GRASS model (ongoing refinement of the interpretation capability and management strategies)
- making available a timeslot on TV, eg Weather Channel, with maps, interpretations, management implications

Future activities should include greater emphasis on the adoption of outputs, and the consequent translation of these into outcomes.

2(m) Was project management (financial/personnel) satisfactory? Yes (√) No ( )

The project appeared to be well managed at all levels – within Land and Water Australia, within CVAP, and by the Aussie GRASS project team.

2(n) Was project coordination with other work/organisations satisfactory? Yes (√) No ( )
If No, explain reasons:

There was a great deal of collaboration and coordination involving the Aussie GRASS team and the assigned State and Territory collaborators. There is scope for improved collaboration with Commonwealth agencies such as the CSIRO and BRS, who have their own agenda and priorities.

2(o) Ideas for future R&D:

Carbon accounting

Epidemiological modelling

Pasture management (with NLWRA)

Lead a National Modelling Consortium for assessing climate impacts, including biophysical evaluation of Exceptional Circumstances and consequences of climate extremes and climate change.

2(p) Other issues/recommendations:

The whole team deserves commendation for their unflagging determination to put modelling concepts to work for real-world and real-time applications. The reviewers feel strongly that further investment (and policy support through SCARM and ARMCANZ) would have high pay-offs, considering the strong foundation and the functioning of the interdisciplinary team assembled for the project. Not to capitalise on their tremendous achievement, through continued funding and policy support, would be yet another Australian tragedy of failing to follow through on what is a major breakthrough. Yes, the models can be improved and yes, better data inputs can be derived and improved field validation developed, but the essential foundation is there. Most importantly, the interdisciplinary team assembled for this project should be allowed to continue their great work.

3. PROJECT RATING (rate each out of 10)

PROGRESS (b-d)	SCIENTIFIC RIGOUR (e)	IMPACT (f-j)	ADOPTION (k)	PROJECT MANAGEMENT (l-m)	TOTAL
9	6**	8	5*	9	37/50

The above needs to be viewed relative to the scoring system:

Thus 9 = excellent progress being made

6 = satisfactory, but recommendations likely, and

5 = marginal, recommendations likely.

* adoption was not a 1° objective with respect to this project. To the extent that it involved partner State agencies supporting self-funding then adoption could be considered satisfactory in terms of what was planned.

** With respect to scientific rigour, it was not the underlying empirical (phenomenological or deductive) model that was of concern, so much as the need to address and display spatial and temporal uncertainties in at least some of Aussie GRASS's products, particularly those associated with seasonal forecasts. A higher score than 6 could not be provided because recommendations were being made.

4. REVIEWERS' NAMES AND SIGNATURES: .....

Chair: Professor Henry Nix.
Secretariat: Dr. David White.
Members: Associate Professor Ockie Bosch, Professor Craig Pearson, Dr. Tim McVicar.
Observers: Dr Barry White, Dr. David McClintock.

DATE REVIEWED: 16 November 2001

SUMMARY GUIDELINES FOR THE REVIEW OF INDIVIDUAL R&D PROJECTS

Review Objectives

1. To provide feedback to the Board on the progress of research, whether objectives are being met through the meeting of milestones and whether project management is sound.
2. To ensure the maintenance of scientific rigour and relevance in research being conducted.
3. To ensure the technology transfer is integral to the project, and that the research outcomes are likely to have favourable impact on the improved use and management of natural resources.

Projects to be Reviewed

All three-year projects should be reviewed at least once in their lifetime, either individually or as part of a topic review or part of the commissioning process.

The criteria for deciding which projects should be reviewed in any one year include -

- relevance to other current Corporation activities, eg. commissioning of programs
- stage of progress reached in the project
- availability of Directors or others to carry out the review
- relevance to Corporation's R&D priorities
- potential of the research for technology transfer or communication

A timetable for review of projects by each Program Committee in the coming year should be approved by the Board.

The Review Committee

The responsibility for project reviews lies with each Program Committee which is able to take whichever approach is considered most appropriate.

The review committee should consist of one or two Directors and a member of the Executive, plus the option of an expert in the area concerned. Alternatively, reviews can be carried out by outside personnel or agencies with no director involvement by the Corporation. This latter approach may be useful or review of groups of projects in given areas.

Industry representation is encouraged where feasible. Directors on review committees can appoint an outside member with the Chairman's approval. External members will be paid expenses and travel as set out by the Remuneration Tribunal.

The Review Process

Each review should aim to establish some basic summary information to be entered on the form by the head of the review committee. Detailed information should be attached.

Each project review is expected to take at least one hour to complete. This time may be extended dependent upon the project and whether a field site/laboratory visit is warranted.

Use of Project Review Results

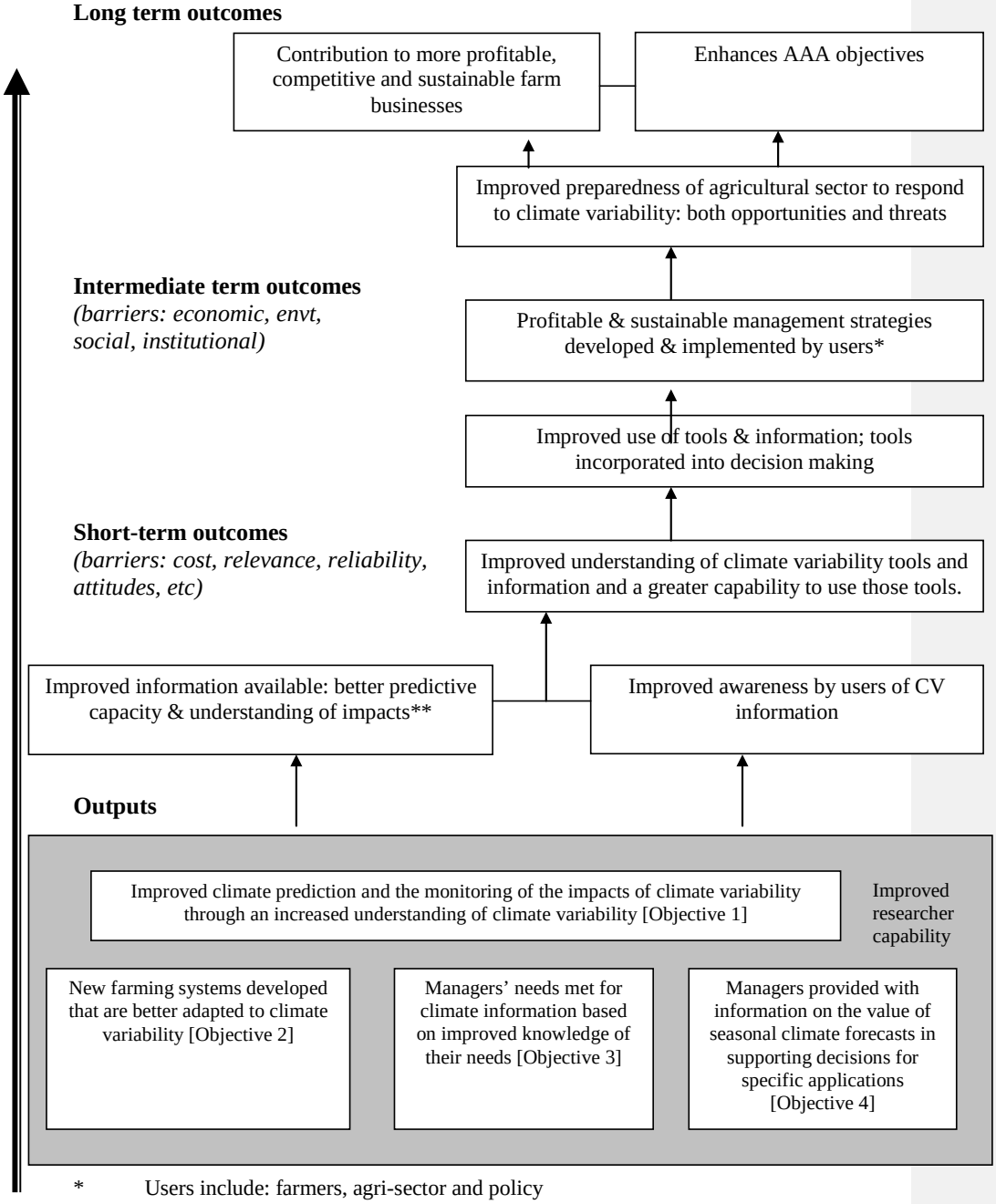
Where significant action is recommended by the review committee, the review papers will be forwarded by the Executive Director to the Chair of the relevant Program Committee who may elect to have it circulated to all members before a decision is made.

Scoring System

This form asks you to rate the project out of 10 in each of five categories, plus an overall rating. The following gives a guide to the meaning of scores.

0. Totally unacceptable situation, cut funds.
1. Very major reform, or cut funds.
2. Very poor, major reforms required.
3. Poor, moderate reforms required.
4. Poor, some reforms to be recommended.
5. Marginal, recommendations likely.
6. Satisfactory, but recommendations likely.
7. Satisfactory, no changes required.
8. Good.
9. Excellent progress being made.
10. Reserved for exceptional performance.

Attachment A: Intended Outcomes of the Climate Variability in Agriculture Program (CVAP)[9]



* Users include: farmers, agri-sector and policy

** Improved tools availability may be a long term outcome, especially given lead times and nested research projects (e.g. output of one project may feed into another).

[9] Ascribed by Hassall & Associates for the purpose of reviewing the program.

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Glossary of Acronyms

ABARE	Australian Bureau of Agricultural & Resource Economics
ACRES	Australian Centre for Remote Sensing
AFFA	Agriculture, Fisheries & Forestry Australia
AGO	Australian Greenhouse Office
ARMCANZ	Agricultural and Resource Management Council of Australia and New Zealand
Aussie GRASS	Australian Grassland and Rangeland Assessment by Spatial Simulation
AVHRR	Advanced Very High Resolution Radiometer
BRS	Bureau of Rural Sciences
CAPS	Common AVHRR Processing Software
COSSA	CSIRO Office of Space Science & Applications
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CVAP	Climate Variability in Agriculture R&D Program
DOLA	Department of Land Administration (Western Australia)
EA	Environment Australia
EOC	Earth Observation Centre (CSIRO)
ERIN	Environmental Resources Information Network
GCMs	General Circulation (Global Climate) Models
GRASP	GRASs Production
GROWEST	GROWth ESTimator
HRZ	High Rainfall Zone
MLA	Meat & Livestock Australia
NDTI	Normalised Difference Thermal Index
NDVI	Normalised Difference Vegetation Index
NLWRA	National Land and Water Resources Audit
NSW	New South Wales
NT	Northern Territory
Pot_ET	Potential Evapotranspiration
QNR&M	Queensland Department of Natural Resources & Mines
R&D	Research and development
SILO	http://www.bom.gov.au/silo (meteorology and agricultural information website)
SSTs	Sea Surface Temperatures
WA	Western Australia

Appendix 6: AAA Program Evaluation 2000 findings

About CVAP

HEARD OF CLIMATE VARIABILITY IN AGRICULTURE PROGRAM?
YES 10%
NO 90%

Of the 10% who were aware of CVAP….

Heard from:		Know what the program is about	Used or directly benefited from CVAP	Expect to utilise CVAP in the future
State Ag Department	5%	YES 43%	YES 19%	YES 33%
Country Link	0%	NO 57%	NO 81%	NO 48%
Other	82%			Don't know 19%
Don't know	13%			

In terms of States and industries:

- Awareness was higher in Queensland and Tasmania, and lower in Victoria.
- Awareness was highest for Sugar Cane and Cotton; and lowest for Sheep and Beef, Dairy and Horticulture.

About farmers' plans and records

DO YOU BELIEVE YOUR FARM PLAN WILL HELP YOU IN TIMES OF DROUGHT ? (SEC2 Q3)
YES 75%
NO 24%
Don't Know 1%

This result is of the 48% of the population that have a yearly farm plan. This was down from 1998, where 56% indicated that they had a farm plan. That is, the proportion of the total population that believed a farm plan would help with drought is 36%.

DO YOU KEEP LONG-TERM RAINFALL RECORDS? (SEC2 Q13-1A)
YES 63%
NO 37%

About Seasonal Climate Forecasts (SCF)

AWARE OF SEASONAL CLIMATE FORECASTS THAT PREDICT THE CHANCE OF RAIN OVER THE NEXT FEW MONTHS ? (SEC2 Q14a-1A)
YES 72%
NO 28%

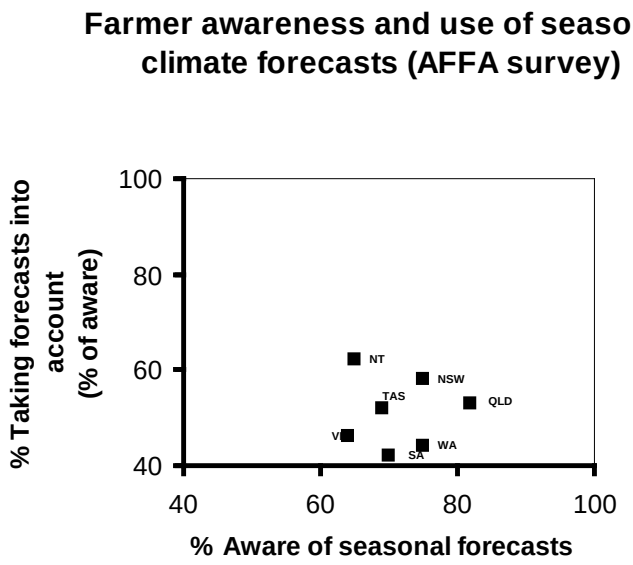
- Highest in Qld and WA. Lowest in NT and Vic.
- Highest in sugar, cotton and cereal industries. Lowest in Fruit and Vegetable.

DO YOU TAKE THESE SEASONAL CLIMATE FORECASTS INTO ACCOUNT WHEN MAKING DECISIONS ON THE FARM? (SEC2 Q14b-1A)

YES 51%
NO 49%

Figure 1 shows the awareness and use of SCF, by State.

FIGURE 1



WHAT TYPES OF DECISIONS DO YOU USE SEASONAL CLIMATE FORECASTS FOR ? (SEC2 Q14c)

Crop input decisions (crop variety, planting times, rotations, fertiliser rates)	56%
Crop output decisions (crop selling, marketing, storage)	20%
Livestock input decisions (stocking rates, species choice, feed decisions, shearing times, other tasks)	42%
Livestock output decisions (slaughter times, marketing)	24%
Farm finance decisions irrigation/water	11%
Policy – decisions	5%
Burning off timing / decisions	0%
Planning/rosters/ job allocation	2%
Machinery/equipment usage	0%
Other	2%
Don't know	1%

WHY AREN'T SEASONAL CLIMATE FORECASTS TAKEN INTO ACCOUNT IN MAKING DECISIONS ON THE FARM? (SEC2 Q14d)

Forecasting is not accurate/reliable	63%
Rely on personal experience	3%
Long term forecasting less relevant than short term	2%
Forecasts are not specific/too general	1%
Weather not a priority/essential for my farming operations	14%
Consistent, reliable, climate/irrigation/drainage	8%
In my region weather patterns are impossible to predict	4%
Farming practices/ management techniques allow/ facilitate flexible	2%
Record keeping/ database historically incomplete/not comprehensive enough	1%
Seasonal climate forecasts not available/accessible	1%
Don't know	3%

HOW DO YOU ACCESS SEASONAL CLIMATE FORECASTS ? (SEC2 Q14e)

Fax	18%
Internet	31%
Rural press	37%
TV	35%
Radio	16%
Personal	5%
Communication	15%
Rural govt agency(state/federal)	0%
Post	1%
Computer software	1%
Other	0%
Don't know	1%

Note: Detailed breakdown of these groups is available.

HOW COULD SEASONAL CLIMATE FORECASTS BE IMPROVED? (SEC2 Q15a)

More accuracy	28%
More detail/ specific/regional/ localised data	5%
Improved technology/ research/data & record gathering	4%
Satisfied that they are good enough impossible to	3%
Improve/weather unpredictable/ voliatile	7%
No need/don't rely on/not applicable	1%
Concentrate on short term forecasting/more accurate	1%
Simplified, easier to understand	0%
Easier more widespread access/ availability of information/ internet access	3%
More reliance on local/historical/ anecdotal evidence/ rely on farmers expertise/bom should employ farmers	0%
Increase govt (all) funding	0%
Require longer term forecasting	1%
Don't know	50%

WOULD YOU CONSIDER UNDERTAKING TRAINING TO MAKE BETTER USE OF SEASONAL CLIMATE FORECASTS? (SEC2 Q15b)

YES 29%
NO 71%
Don’t Know 1%