Appendix 4: An Impact Assessment of USQ4: 'Innovative drought and climate variability RD&E to enhance business resilience and build producer capacity to manage climate risk across the northern Australian red meat industry (NACP Phase 2)' (Project USQ4)

Final Report

To

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Acknowledgments

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Abbreviations

BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
CRRDC	Council of Rural Research and Development Corporations
DAF	Department of Agriculture and Fisheries – Queensland
IRR	Internal Rate of Return
MIRR	Modified Internal Rate of Return
MLA	Meat and Livestock Australia
NPV	Net Present Value
PVB	Present Value of Benefits
PVC	Present Value of Costs
QLD	Queensland
R&D	Research and Development
RD&E	Research, Development and Extension
RDC	Research and Development Corporation

Glossary of Economic Terms

Benefit-cost ratio (BCR)	The ratio of the present value of investment benefits to the present value of investment costs.
Cost-benefit analysis (CBA)	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Internal Rate of Return (IRR)	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits is equal to present value of costs.
Investment criteria	Measures of the economic worth of an investment such as Net Present Value, Benefit Cost Ratio, and Internal Rate of Return.
Modified Internal Rate of Return (MIRR)	The MIRR is a modified IRR estimated so that any cash inflows from an investment are re-invested at the rate of the cost of capital (a designated re-investment rate).
Net Present Value (NPV)	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present Value of Benefits (PVB)	The discounted value of benefits.
Present Value of Costs (PVC)	The discounted value of investment costs.

Executive Summary

This report presents the results of an impact assessment of a still current investment in a project within Phase Two of the Queensland Drought and Climate Adaptation Program (DCAP2). The assessment addresses investment in Project USQ4.

The project is described qualitatively using a logical framework that included project objectives, activities and outputs to date, and prospective outcomes and impacts. Potential impacts are categorised into a triple bottom line framework. Principal potential impacts were then estimated in dollar terms.

Potential benefits were estimated for a range of time frames up to 30 years from the last year of investment in the project (2021/22). Past and future cash flows in 2019/20 dollar terms were discounted to the year 2019/20 using a discount rate of 5% to estimate the investment criteria.

The cost-benefit analysis (CBA) was conducted according to the Impact Assessment Guidelines of the Council of Rural Research and Development Corporations (CRRDC) (CRRDC, 2018).

In brief, the investment in NACP Phase Two addresses:

- Research into multi-week, seasonal and longer term forecasting
- Development of targeted decision tools for managing drought to assist producers, as well as policy makers
- Integration of climate forecasting information into existing northern Australia extension and adoption initiatives.

The principal impact identified and valued was improved management decision making by producers in northern Australia leading to increased productivity and profitability of some Queensland pastoral managers. Further impacts delivered and valued were an improved social licence for grazing activities in pastoral Queensland and some contribution to reduced government costs in delivering drought policy and support.

Total funding from all sources over the project duration was approximately $15.91 million (present value terms). Of this total funding, 51% was in cash and 49% was in-kind. Of the in-kind contributions, approximately one third emanated from organisations outside Queensland.

The value of total benefits estimated from the information delivered by the project was estimated at $83.66 million (present value terms). This result generated an estimated net present value of $67.74 million and a benefit-cost ratio of 5.26 to 1.

There were several potential impacts identified that were not valued in monetary terms. These included the benefits from reduced producer income variability, the regional community spillovers from the producer gains emanating from the investment, and the scientific (climate modelling) capability and future capacity built by the investment. Further, the impacts valued for the Queensland beef industry would be a substantial component of all impacts delivered via improved pastoral management as well as via the contribution to social licence maintenance. However, mixed grazing enterprises have not been included nor have the benefits to beef producers in the Northern Territory and the north of Western Australia. The investment criteria reported therefore are likely to have undervalued the full value of benefits delivered by the investment.

1. Evaluation Methods

The evaluation approach follows general evaluation guidelines that now are well entrenched within the Australian primary industry research sector including Research and Development Corporations (RDCs), Cooperative Research Centres, State Departments of Agriculture, and some Universities. This impact assessment uses Cost-Benefit Analysis (CBA) as its principal tool. The approach includes both qualitative and quantitative descriptions that are in accord with the Impact Assessment Guidelines of the Council of Rural Research and Development Corporations (CRRDC) (CRRDC, 2018).

The evaluation process involved identifying and briefly describing project objectives, activities and outputs to date, and actual and potential outcomes and impacts. The principal economic, environmental and social impacts were then summarised in a triple bottom line framework.

Some, but not all, of the impacts identified were then valued in monetary terms. The decision not to value certain impacts was due either to a shortage of necessary evidence/data, or the limited time and resources available to the evaluation. The potential impacts valued are still deemed to represent the principal benefits delivered by the project investment.

2. Background & Rationale

Background
Phase 1 of the Northern Australia Climate Program (NACP) was undertaken in the year ended June 2017 and addressed the planning of the project undertaken in Phase 2. The NACP included a number of partners including, but not limited to: DCAP (DAF), the Meat Donor Company (MDC) managed by Meat and Livestock Australia (MLA), and the University of Southern Queensland (USQ). The project set out to assist producers in Northern Australia to better manage drought and climate risk.

Previous Project
Phase 1 of NACP identified key reasons why producers were wary of using climate forecasts. Key reasons were:

- A number of regions currently experience low and variable forecast skill,
- There was a low relevance of existing forecast systems and technologies to key management decisions,
- There was a lack of understanding on how to use climate resources and the associated technologies,
- There was a lack of support from climate experts, and
- Proof of value was lacking.

What was Needed
The reasons for the lack of uptake by producers of the forecasts then available were addressed by the funding of NACP Phase 2 via DCAP, including the skill of forecasting in some regions, the type of information produced by forecasts and how such information might be used beneficially by producers in their land management decision making.

3. Project Details

Summary of Investment Details
The investment in NACP Phase 2 refers to the years ending June 2018 to June 2022. USQ was the lead research agency with the base contribution by DCAP and financial contributions from the Bureau of Meteorology (BoM), and the MDC. The DCAP project code, title, Project Leader, Team Personnel and the funding period are summarised in Table 1.

Table 1: Summary Details for the Investment in Phase Two of NACP (USQ4)

Project Code	Title	Project Leader and Team Personnel	Funding Period
USQ4	Innovative drought and climate variability RD&E to enhance business resilience and build producer capacity to manage climate risk across the northern Australian red meat industry.	David Cobon and Chelsea Jarvis, University of Southern Queensland	Years ending June 2018 to June 2022

Logical Framework
Table 2 provides a description of USQ4 in a logical framework format.

Table 2: Logical Framework for USQ4: Innovative Drought and Climate Variability RD&E

Overall Objective	The overall objective of the project is to deliver innovative research, development and extension outcomes to improve the capacity of the red meat industry to manage drought and climate risk across northern Australia.
Specific Objectives	• To improve the basic science and operational skill of seasonal, sub-seasonal (multi-week) and multi-year climate forecasting systems of direct relevance to the Northern Australia red meat industry. • To develop innovative and targeted products for use in drought monitoring, planning and prediction for producers and policy makers. • To integrate and embed climate forecast information into Northern Australia grazing industry networks to improve producer resilience to drought and climate variability.
Activities and Outputs	**Objective 1: Basic science and skill** • Gap analyses regarding influence of key climate/weather systems impacting on Northern Australia climate. • Identification of existing/potential frameworks and data sources, including the developing ACCESS-S forecasting system by BoM. • Work plans and agreements reviewed between USQ, the UK Met Office, and BoM. • Reporting on improvements to BoM's ACCESS-S model for seasonal forecasting that have been due to the Phase 2 NACP funding. • Assessment of value of multi-week /seasonal/decadal/multi-year modelling and predictions including recommendations for operational use and their linkages to pasture modelling systems that could be considered a result of the Phase 2 NACP funding. • Identification and assessment of value of new forecast products due to NACP funding (e.g. quick onset of severe droughts, Madden Julian Oscillation forecasts, wet season onset and breaks, and links to extreme events).

	• Enhancement of spatial drought monitoring and associated management products provided more prominently than currently. • Enhanced data feed for various management applications. **Objective 2: Product development** • Various drought indicators identified and provided online. • A drought monitor product provided on-line. • A monthly targeted climate outlook based on a suite of models, and communicated to extension officers, advisors and producers. • New generation tools and apps developed and provided on-line and via YouTube. The tools and apps are being promoted via extension programs including Grazing BMP, Business Mentoring, Grazing Land Management (GLM Edge) and MLA's Profitable Grazing Systems (PGS) and included managing for climate variability workshops. • Queensland Drought Mitigation Centre (QDMC) online provided drought indices, forecasts and interpretation, onset and length of wet season, and included forecast skill. • Case studies of improved producer decision making regarding drought planning and management, disseminated via networks and workshops. • Demonstration of impacts on forecast skill with use of additional climate variables (temperature etc) in herd modelling with regard to regional pasture growth, liveweight gain, business profit etc, disseminated online at ClimateARM. • Integration of climate management tools and management practices into extension and adoption programs. **Objective 3: Integration of management products and extension** • Delivery of monitoring and communication plans showing various targets across the hierarchy as well as Key Performance Indicators for various activity and outcome measures such as attendances at various workshops (e.g. extent of knowledge and skills gained, practice change etc). • Delivery of climate variability workshops, many of which involved BoM personnel; already 14 climate workshops have been delivered as well as 62 presentations at various workshops and field days, webinars and other extension processes. • Integration of climate risk tools into industry extension programs. • Development of a climate risk communication network for the northern grazing industry. • Development of the Climate Mates program where selected graziers and beef industry leaders have been trained by USQ and extension personnel and then return to their regions to share the increased understanding gained with others. • Development of regional case studies of climate information used in decisions affecting grazing management improvements.
Outcomes	• The basic science and skill activities and outputs of the project are expected to improve the reliability of climate forecasts for some regions in Northern Australia. • These improvements are expected to be very significant for the multi-year forecasts, and significant for the seasonal and multi-week forecasts.

	• Due to the increased coverage and reliability of the climate models, and the extension effort by the project, it has been observed that producer awareness and knowledge of the availability, interpretation and value of climate forecasting and the associated decision aids available has already increased. • This increase is supported by the second DCAP Benchmarking Survey (Coutts, 2019) where it was reported that both awareness and usage of six of eight climate tools nominated in the second survey had increased between the first benchmarking survey in 2017 and the second survey in 2019. In particular, a large increase in awareness and use of the Long Paddock website and Will it Rain booklet were reported. While both surveys were not specific to just beef producers in the north, the comparison is likely to be valid also for beef producers. • It is likely that those producers already using some form of climate based management aids will increase their confidence in using risk-based management decisions and hence improve their decision making due to the information and decision aids produced by the project. * • It is also likely that additional producers (producers who had not previously used climate forecasting aids) will commence using one or more of the climate based management aids promoted by the project investment. • Furthermore, the improved understanding of historical climate patterns and the improvements to climate forecasts (Drought Monitor development) are likely to add value and consistency to local drought committees on drought declarations and on state government policy on drought assistance (e.g. the QLD Drought Relief Assistance Scheme).
Impacts	• Increased average annual productivity and profitability for some Northern Australia pastoral managers from three sources: o new users of seasonal climate forecasting aids o an increase in the value of seasonal forecasting impacts for those decision makers who already use climate forecasting. o decisions by producers before and during a drought made with greater certainty due to the improved multi-year forecasts. • Any productivity and profitability gains will be shared along the supply chains with transporters, processors, exporters etc. • Reduced variability of annual net income for some Northern Australia red meat producers from improved management decision making (e.g. destocking, restocking) that takes into account seasonal and multi-year climate forecasts. • Improved government policy development regarding drought assistance. • Improved environmental management for some Northern Australia beef producers. • Increased scientific and extension capability and capacity. • Reduced personal and community trauma and improved wellbeing. • Maintained social licence for grazing activities in pastoral Queensland. • Impacts of improved climate forecasts to a wider set of businesses and individuals in Northern Australia outside of the red meat industry.

Note: DCAP Phase 2 projects were ongoing at the time of evaluation. Information was current as at 31 May 2020

4. Project Investment

Nominal Investment

Table 3 shows the annual investment in the project by a range of organisations. The large component of external funding in Table 3 should be noted (e.g. 25% of total funding from the Meat Donor Company (MLA) and 14% of total funding from the BOM and UK Met Office).

Table 3: Annual Investment ($) in USQ4 for Years ended June (nominal $)

Contributing Partners	2018	2019	2020	2021	2022	Total
DCAP (Cash)	391,390	481,223	706,098	905,530	536,702	3,020,943
Meat Donor Company (MLA) (Cash)	514,987	633,188	929,076	1,191,487	706,188	3,974,926
USQ (Cash)	123,596	151,965	222,978	285,957	169,485	953,981
USQ (in kind)	1,414,391	1,306,013	1,350,257	1,090,294	0	5,160,955
Bureau of Meteorology (BoM) (in kind) (a)	245,032	250,159	253,128	260,722	0	1,009,041
UK Met Office (in kind) (a)	270,000	275,000	280,000	285,000	0	1,110,000
NT DPIR (in kind)	8,000	8,000	8,000	8,000	2,000	34,000
WA DPIRD (in kind)	8,000	8,000	8,000	8,000	2,000	34,000
Rangelands NRM (WA) (in kind)	34,800	34,800	34,800	34,800	34,800	174,000
Northern Gulf NRM (in kind)	0	0	40,000	40,000	6,000	86,000
TOTAL	3,010,196	3,148,348	3,832,337	4,109,790	1,457,175	15,557,846

(a) BoM and UK Met Office in kind estimates are taken from the project proposal data but the actual in kind is much greater – the value of using their equipment, algorithms, models, scientific IP etc, having direct access to world leading scientists etc is potentially magnitudes greater than estimated here.

Source: David Cobon, USQ, pers comm., 2020

Program Management Costs

For all financial contributions including in-kind, any management and administration costs for the project are assumed already built into the nominal $ amounts appearing in Table 3. An exception is a 12% Meat Donor Company (MDC) administration fee; this was later added to the figures for MDC appearing in Table 3.

Real Investment and Extension Costs

For the purposes of the investment analysis, the investment costs of all parties were expressed in 2019/20 $ terms using the Implicit Gross Domestic Product Deflator index (ABS, 2020).

5. Impacts

An overview of impacts in a triple bottom line categorisation is shown in Table 4.

Table 4: Preliminary Categories of Impacts from the Investment

Economic	Environmental	Social
Increased average annual productivity and profitability for some Northern Australia red meat producers (QLD, NT, and WA) from at least three sources: • new users of seasonal climate forecasting aids. • an increase in the value of seasonal forecasting impacts for those who already use seasonal climate forecasting. • decisions by producers before and during a drought made with greater certainty due to the improved multi-year forecasts. Any productivity and profitability gains will be shared along the supply chains with transporters, processors, exporters etc. Reduced variability of annual net income for some Northern Australia red meat producers from improved management decision making (e.g. destocking, restocking) that takes into account seasonal and multi-year climate forecasts. Improved government policy development regarding drought assistance. Maintained social licence for the Northern Australia red meat industries. Improved management of businesses in Northern Australia, other than red meat.	Improved environmental management for some Northern Australia red meat producers.	Spillovers to regional communities from increased and less variable incomes for QLD livestock producers and their associated supply chain businesses. Increased scientific and extension capability and capacity. Reduced personal and community trauma and improved wellbeing.

Public versus Private Impacts
The impacts identified from the investment are expected to be predominantly private including red meat producers as well as other businesses in Northern Australia who can benefit from improved seasonal climate forecasts. Some public benefits are likely to be captured by improved policy development by government agencies, improved environmental management by producers, as well as via spillovers to regional communities from red meat producers.

Impacts Overseas
It is unlikely that there will be any significant impacts overseas.

Match with National and State Priorities
The Australian Government's Science and Research Priorities and Rural Research, Development and Extension (RD&E) Priorities are reproduced in Table 5. The investment is relevant to Rural RD&E Priorities 1, 3 and 4 and to Science and Research Priorities 1 and 2.

Table 5: Australian Government Research Priorities

Australian Government	
Rural RD&E Priorities[(a)] (est. 2015)	**Science and Research Priorities[(b)] (est. 2016)**
1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D	1. Food 2. Soil and Water 3. Transport 4. Cybersecurity 5. Energy and Resources 6. Manufacturing 7. Environmental Change 8. Health

(a) Source: Commonwealth of Australia (2015)
(b) Source: Office of the Chief Scientist (2016)

The QLD Government's Science and Research Priorities, together with the four decision rules for investment that guide evaluation, prioritisation and decision-making around future investment are reproduced in Table 6.

The investment addressed QLD Science and Research Priority 1,2 and 6. In terms of the guides to investment, the investment is likely to have a real future impact through improved management of red meat producers in Northern Australia. The project was well supported and funded by a range of organisations, many external to the QLD Government and had a distinctive angle as QLD communities will be a major recipient of the impacts.

Table 6: QLD Government Research Priorities

QLD Government	
Science and Research Priorities (est. 2015)	**Investment Decision Rule Guides (est. 2015)**
1. Delivering productivity growth 2. Growing knowledge intensive services 3. Protecting biodiversity and heritage, both marine and terrestrial 4. Cleaner and renewable energy technologies 5. Ensuring sustainability of physical and especially digital infrastructure critical for research 6. Building resilience and managing climate risk 7. Supporting the translation of health and biotechnology research 8. Improving health data management and services delivery 9. Ensuring sustainable water use and delivering quality water and water security 10. The development and application of digitally-enabled technologies.	1. Real Future Impact 2. External Commitment 3. Distinctive Angle 4. Scaling towards Critical Mass

Source: Office of the Chief Scientist Queensland (2015)

6. Valuation of Impacts

Impacts not Valued in Monetary Terms

The impacts identified but not valued included:

- The impact of reduced income variability was not valued as measures of the current level of income variability were not readily available; furthermore, it is difficult to convert any reduced variability into simple $ terms without knowledge, for example, of interest rates that may apply to surplus investment in good years versus increased loans in poor years.
- The improved management of businesses in Northern Australia other than red meat was not valued due to the difficulty of making credible assumptions on business category and impact levels.
- The increased spillovers to regional communities from sustained or increased income and decreased income variability was not valued as any increased economic activity and employment along the product supply chain would be difficult to value, given the number and spread of production systems, subregions, and the availability of time and resources for valuation.
- The impact of a reduction in environmental damage would be difficult to value given the differences in regional ecosystems, the sometimes localised nature of drought, and the fate of the soil and nutrient losses off-farm. Further elements of this impact are included in the valuation of the maintenance of the social contract.
- Maintained/increased QLD scientific and applied climate forecasting capacity would be difficult to value but some of the new capacity built will be accounted for in the improved climate modelling and tools already developed and valued in the existing analysis.
- The reduced trauma and improved well-being were not valued due to the lack of data on the extent and severity of such impacts and the extent to which they may be reduced by reduced income variability and improved preparedness.

Impacts Valued in Monetary Terms

The three impacts valued in the quantitative analysis are:

- The average annual net economic gain for Queensland beef producers from increased use of improved climate risk assessments and their impact on management decisions.
- Contribution to the maintenance of a social licence for Queensland beef producers.
- Contribution to a more efficient and effective Queensland government drought policy.

The USQ4 project evaluation forms part of a broader assessment of the DCAP Phase 2 investment. Two of the impacts identified above (increased productivity/profitability and decreased risk of a loss of social licence for the QLD grazing industry) were valued at a DCAP Program level. Six DCAP Phase 2 projects (DES1, DES3, USQ4, DAF6, DAF8 and DAF9) contributed to these two impacts. The estimated benefits then were shared between the six contributing DCAP projects.

Valuation of such shared impacts was restricted to the QLD beef industry. This was because:

i. Though some benefits from the six contributing projects would accrue to graziers in the NT and the north of Western Australia (WA), the main emphasis of the DCAP projects was in QLD,
ii. The QLD beef industry was made up of approximately 11.2 million head of cattle in 2018/19 comprising 49.8% of the national heard of 22.4 million head (ABS, 2020). On the other hand, the QLD sheep industry is relatively small, making up only 3.1% of the national flock at approximately 2.2 million head (MLA pers. comm., based on ABS data, 2020), and

iii. The scope of the DCAP Program evaluation (assessment across nine DCAP Phase 2 project investments) meant that time and resources were necessarily limited.

It should be noted that the impacts valued for the Queensland beef industry would be a substantial component of all impacts delivered by the improved climate risk management and the contribution to social licence maintenance. However, mixed grazing enterprises have not been included nor have the benefits to beef producers in the Northern Territory and the north of Western Australia.

The third impact identified above for USQ4 has been valued jointly in the quantitative analysis with two other projects including DES3 and DES1.

A summary of all assumptions is presented in Table 7.

Table 7: Summary of Assumptions for Valuing Benefits

Variable	**Assumption**	**Source**
IMPACT 1: Increased profitability/ productivity for QLD beef grazing enterprises (increased net farm income for QLD beef producers)		
Without DCAP Phase 2 Investment		
Average farm cash income for QLD beef producers	$163,645 per farm	5yr average based on AgSurf farm cash income data for QLD beef (2015 to 2019) (ABARES, 2020)
Average number of beef cattle enterprises in QLD	7,069	5yr average based on AgSurf population data for QLD beef (2015 to 2019) (ABARES, 2020)
Current proportion of primary producers in QLD utilising climate forecasting, models, decision support tools etc. for farm decision making	40% Midpoint of most recent estimate: Cobon (2017)	Seasonal climate forecasts are used by 30 to 50% of agricultural producers in decision-making (Keogh et al., 2005; Keogh et al., 2004a; Australian Government Department of Agriculture Fisheries and Forestry, 2004) The uptake of SCF by agricultural producers in decision-making range from 30 to 50% (Cobon et al. 2017)
With DCAP Phase 2 Investment		
Part 1 (existing users): Proportion of existing users (primary producers) of climate forecasting, models, decision support tools who have improved their decision making specifically due to DCAP Phase 2 investment	25%	¼ of existing users in QLD, conservative analyst assumption
Part 1 (existing users): Increase in net farm cash income due to improved decisions for producers who were already utilising climate forecasting, models, decision support tools etc.	5%	Conservative estimate based on a minimum profitability/ productivity improvement of 10% for new adopters. Seasonal forecasts can increase productivity and profitability by 10-26% (Ash et al. 2000; McKeon et al. 2000; Stafford

		Smith et al. 2000; O'Reagain et al. 2011; Brown et al. 2019, Anh Vo et al 2019, Cobon et al 2020). These studies have shown that using the current SOI to adjust stock numbers can increase profit by 10% and a perfect forecast of pasture growth by 26% (Brown et al. 2019).
Part 2 (new users): Proportion QLD beef producers newly adopting the use of climate forecasting, models, decision support tools etc. to improve on-farm decision making	15% (increasing proportion of total QLD users from 40% to 55%)	Given a base assumption of 40% of producers currently using climate forecasting etc. (see above), this is a conservative assumption supported by evidence that in regions with access to local champions and specialists in seasonal climate systems, adoption of seasonal forecasts into management decisions is increased to 75% (Cobon et al. 2008; Cliffe et al. 2016).
Part 2 (new users): Attribution of practice change to DCAP2 investment for new users	50%	Acknowledges contribution of other drought resilience investments and previous investment in DCAP1
Part 2 (new users): Increase in net farm cash income due to improved decisions for producers who were already utilising climate forecasting, models, decision support tools etc.	10%	Conservative estimate. Seasonal forecasts can increase productivity and profitability by 10-26% (Ash et al. 2000; McKeon et al. 2000; Stafford Smith et al. 2000; O'Reagain et al. 2011; Brown et al. 2019 , Anh Vo et al 2019 Cobon et al 2020). These studies have shown that using the current SOI to adjust stock numbers can increase profit by 10% and a perfect forecast of pasture growth by 26% (Brown et al. 2019).
First year of impact	2020/21	Third year of DCAP2 investments – allows time for outputs and extension to create practice change on farm
Year of maximum impact	2024/25	Five years from first year of impact
Risk factors		
Probability of output.	100%	Outputs have already been delivered
Probability of outcome	100%	Already allowed for in the 33% of QLD beef enterprises implementing practice changes on farm
Probability of impact	80%	Analyst assumption – allows for exogenous factors that may affect realisation of impacts and also that the benefits estimated may not persist into the future

Contribution to relevant DCAP projects from USQ4		
Specific attribution to USQ4	45.2%	USQ4 investment as % of total investment in DES1, DES3, USQ4, DAF6, DAF8 and DAF9
IMPACT 2: Maintained social licence to operate for some QLD grazing enterprises (QLD beef producers)		
Baseline data		
Average annual gross value of production (GVP) of QLD beef cattle	$5,206.2 million	5yr average based on ABS value of agricultural commodities data (2014 to 2018) (ABS, 2015 to 2019)
With investment in DCAP projects DES1, DES3, USQ4, DAF6, DAF8 and DAF9		
Profit as a proportion of GVP	10%	Analyst assumption, based on average profit as a proportion of total cash receipts for QLD beef producers (ABARES farm financial performance data 2017 to 2019) (Australian Bureau of Agricultural and Resource Economics and Sciences, 2020)
Proportion of QLD beef industry at risk of loss of profitability without DCAP2 investment	10%	Analyst assumption
Estimated reduction in risk of loss of social licence attributable to DCAP2 investment	1.0%	Conservative estimate, analyst assumption
First year of impact	2020/21	Third year of DCAP2 investments – allows time for outputs and extension to create practice change on farm
Year of maximum impact	2024/25	Five years from first year of impact
Risk factors		
Probability of output	100%	Outputs have already been delivered
Probability of outcome	100%	Already allowed for in the 10% of QLD beef enterprises at risk
Probability of impact	80%	Analyst assumption – allows for exogenous factors that may affect realisation of impacts and also that the benefits estimated may not persist into the future
Contribution to relevant DCAP projects from USQ4		
Specific attribution to USQ4	45.2%	USQ4 investment as % of total investment in DES1, DES3, USQ4, DAF6, DAF8 and DAF9
IMPACT 3: Contribution to reduced cost to Queensland government for drought support		
Average QLD drought support costs	$27 million per annum	Based on Wade and Burke (2019)
Reduction drought support costs due to DCAP investment	9%	Analyst assumption, based on combined impact of DES1 (4%), DES3 (1%), and USQ4 (4%)
First year of reduction	Year ending June 2022	Analyst assumption

Year of maximum reduction	Year ending June 2026	Analyst assumption
Risk and attribution factors		
Probability of relevant output	100%	Analyst assumptions
Probability of outcomes occurring given information generated	75%	
Probability of impact given outcomes	75%	
Specific attribution to Project USQ4	4%	

Counterfactual

The counterfactual Includes a scenario that some climate knowledge and seasonal forecasting tools would have been utilised by graziers without the investment in USQ4. This scenario is allowed for in the valuation by considering only the improvements in such tools as well as their increased availability and promotion through activities in USQ4 and its associated projects, including delivery projects.

7. Results

All past costs were expressed in 2019/20 dollar terms using the Implicit Price Deflator for Gross Domestic Product (GDP) (ABS, 2020). All costs and benefits were discounted to 2019/20 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the Modified Internal Rate of Return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the investment period plus 30 years from the last year of investment (2021/22).

Investment Criteria

Tables 8 and 9 show the investment criteria estimated for different periods of benefits for the total investment and the DAF investment respectively. The present value of benefits (PVB) attributable to DAF investment only, shown in Table 9, has been estimated by multiplying the total PVB by the DAF proportion of real investment (19.3%).

Table 8: Investment Criteria for Total Investment in Project USQ4

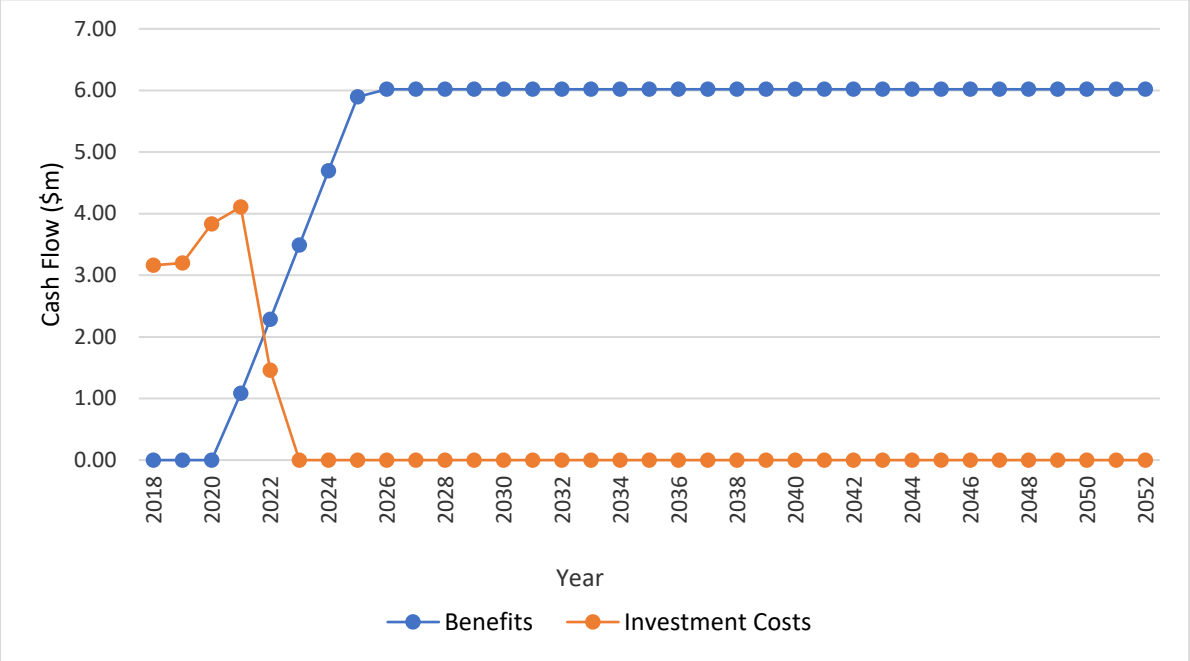
Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	3.10	23.37	41.89	56.40	67.77	76.68	83.66
Present value of costs ($m)	15.91	15.91	15.91	15.91	15.91	15.91	15.91
Net present value ($m)	-12.81	7.46	25.98	40.49	51.86	60.76	67.74
Benefit-cost ratio	0.20	1.47	2.63	3.54	4.26	4.82	5.26
Internal rate of return (IRR) (%)	negative	13.62	21.36	23.08	23.58	23.74	23.79
Modified IRR (%)	negative	14.87	18.55	16.72	14.97	13.59	12.32

Table 9: Investment Criteria for DAF Investment in Project USQ4

Investment criteria	**Number of years from year of last investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present value of benefits ($m)	0.60	4.52	8.10	10.91	13.11	14.83	16.18
Present value of costs ($m)	3.02	3.02	3.02	3.02	3.02	3.02	3.02
Net present value ($m)	-2.42	1.50	5.08	7.89	10.09	11.81	13.16
Benefit-cost ratio	0.20	1.50	2.68	3.61	4.34	4.91	5.35
Internal rate of return (IRR) (%)	negative	14.84	22.87	24.57	25.03	25.17	25.22
Modified IRR (%)	negative	9.37	15.42	14.59	13.36	12.31	11.29

The annual undiscounted benefit and cost cash flows for the total investment for the duration of investment period plus 30 years from the last year of investment are shown in Figure 1.

Figure 1: Cash Flow of Undiscounted Total Net Benefits and Total Investment Costs



Source of Benefits

Estimates of the relative contribution of each benefit valued, given the assumptions made, are shown in Table 10. It should be noted that over 87% of the total benefits estimated was derived from producer action taken as a result of improved seasonal and multi-year forecasting produced by USQ4.

Table 10: Contribution to Total Benefits from Each Source

Source of Benefit	Contribution to PVB ($m)	Share of benefits (%)
Increased beef producer profitability	73.05	87%
Maintenance of social licence	2.63	3%
Reduced cost of QLD Government drought support	7.97	10%
Total	83.66	100%

Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 11 presents the results that showed a moderate sensitivity to the discount rate.

Table 11: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5% (base)	10%
Present value of benefits ($m)	179.96	83.66	46.88
Present value of costs ($m)	15.76	15.91	16.12
Net present value ($m)	164.20	67.74	30.77
Benefit-cost ratio	11.42	5.26	2.91

Other sensitivity analyses including the sensitivity of assumptions for valuing Impacts 1, 2 and 3 are carried out at the Program level due to the valuation frameworks being extended to cover multiple DCAP Phase 2 projects. This was driven by the pathways to impact being common to each of the three impacts.

Confidence Ratings

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made for the benefit valued, including the linkage between the research and the assumed outcomes and impacts.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 12). The rating categories used are High, Medium and Low, where:

High:	denotes a good coverage of benefits or reasonable confidence in the assumptions made
Medium:	denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
Low:	denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 12: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium	Medium-Low

Coverage of benefits was assessed as Medium. While there were several benefits identified but not valued, the principal economic impacts from the project were valued.

Confidence in assumptions for the valuation also was rated as Medium as several of the assumptions associated with each of the three impacts valued were not well supported by verifiable information.

8. Conclusion

The investment in NACP Phase Two over the years ending June 2018 to June 2022 is likely to be successful and is on track to provide impacts for north Australia red meat producers, the environment and government.

The principal benefits delivered by the project will accrue to beef producers in north Australia from improved on-farm decision making and avoidance of some potential loss in social licence to operate. Some of these benefits are likely to be shared along the product supply chain due to increased economic activity in product transporting and processing. Some public benefits will be delivered via community spillovers from increased, or at least maintained, producer incomes.

The total value of Investment costs included both cash (51%) and in-kind contributions (49%) from a range of organisations. Of the in-kind contributions, approximately one third emanated from organisations outside Queensland.

In summary, the total investment in the project of $15.91 million (present value terms) has been estimated to produce total gross benefits of $83.66 million (present value terms) providing a net present value of $67.74 million, a benefit-cost ratio of 5.26 to 1 (using a 5% discount rate), an internal rate of return of 23.8% and a modified internal rate of return of 12.3%. Using a different approach another study produced a benefit-cost ratio of 7.7 to 1 (Pudmenzky et al, 2017).

The investment criteria reported are likely to have undervalued the full set of impacts delivered by the investment because several impacts identified were not valued in quantitative terms. These included a reduction in producer income variability, benefits to mixed grazing enterprises, benefits to beef producers in the Northern Territory and Western Australia, businesses outside the red meat industry, the spillovers to rural communities, and improvements to scientific and extension capability and capacity.

Also, as with any quantitative impact assessment of an investment that is not yet completed, the investment criteria are based on a number of assumptions that necessarily have to be made, but where supporting data are not available.

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