

The role of agricultural extension in improving the health and resilience of the Great Barrier Reef

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Abstract. Australia's iconic Great Barrier Reef (GBR) is internationally recognised for its unique values. Although numerous pressures are threatening the health and resilience of the GBR, a priority is to reduce diffuse pollutant loads emanating from agricultural land uses in the catchments adjoining the GBR. To address this issue, a collective of governments, industry and community organisations came together under the auspices of the Reef Water Quality Protection Plan 2009 (Reef Plan) to increase the adoption of agricultural land management practices that reduce nutrient, sediment and pesticide exports to the GBR. Agricultural extension is recognised as having an important role in facilitating land management change by rural landholders and this is a key action in Reef Plan. An Extension and Education Strategy was developed and piloted to enhance extension coordination and delivery to accelerate the rate of change. The pilot project was undertaken with the sugarcane, beef cattle grazing, banana, other crops, dairy and forestry industries in two catchments of North-East Queensland. The key objectives were to improve extension services to producers, increase coordination and communication between stakeholders, and build the capacity of practitioners to enable change. Extension efforts were targeted to achieve agronomic, economic and water quality benefits. There were significant capacity gains reported by producers, with evidence of land management changes with the potential to reduce nutrient, sediment or pesticide runoff from 42,000 hectares of land. Stakeholder networks were established leading to significant improvements in communication and collaboration between allied programs. The lessons and recommendations from the project are being used to guide future delivery of extension services in GBR catchments under the auspices of Reef Plan 2013.

Keywords: extension, agriculture, Great Barrier Reef, water quality, coordination.

Introduction

The Great Barrier Reef (GBR) is a World Heritage Area, internationally recognised for its outstanding values. To maintain these values, the GBR needs to be resilient in order to recover from cyclones and floods and adapt to a changing climate. A decline in water quality has been identified as a significant threat to this resilience (Great Barrier Reef Marine Park Authority 2009) and the Australian and Queensland Governments have partnered with key industry, natural resource management (NRM) and conservation organisations to address this threat through the Reef Water Quality Protection Plan (Reef Plan). The aim of Reef Plan is to reduce the loads of nutrients, sediments and pesticides entering the GBR lagoon from adjoining catchments, with a focus on improving agricultural land management practices. Reef Plan incorporates a variety of mechanisms to better understand threats and solutions (i.e. research), increase adoption of improved land management practices (i.e. incentives, extension and policy) and monitor and evaluate progress (i.e. biophysical and management practice monitoring and reporting).

Reef Plan 2009 recognised that agricultural extension has a role in supporting adoption of improved management practices by producers. It acknowledged that extension services need to be enhanced and coordinated to meet the challenge of accelerating the rate of uptake of land management practices that reduce losses of nutrients, sediments and pesticides. The Queensland Department of Agriculture, Fisheries and Forestry (DAFF) was lead agency for this component of Reef Plan and undertook a review of extension services, developed the Reef Plan Extension and Education Strategy (E&E Strategy) and implemented the E&E Strategy as a pilot project. This paper presents key outcomes and lessons from the pilot project and future direction for extension delivery to contribute towards improving water quality entering the GBR.

Project objectives

The E&E Strategy pilot project had four overarching objectives:

1. To pilot and evaluate the E&E Strategy and provide recommendations for GBR-wide implementation.
2. To enhance extension delivery to increase the capacity of agricultural landholders, resulting in the adoption of management practices that improve water quality and agricultural business outcomes.

3. To improve coordination and communication between stakeholders leading to efficient, integrated service delivery.
4. To build the capacity of practitioners (including extension officers, NRM officers, agribusiness resellers and consultants) to enable change.

The approach

The E&E Strategy was released in 2010, outlining 26 actions to enhance extension service delivery and coordination to accelerate the uptake of land management practices that maximise water quality improvements (Stockwell 2010). To trial the principles of the E&E Strategy prior to GBR-wide implementation, a pilot project was undertaken between February 2011 and June 2012, focusing on the two largest catchments in the Wet Tropics region of far north Queensland (Figure 1). The Herbert and Johnstone River catchments were chosen as priorities for the pilot project due to:

- Having a variety of agricultural industries in a comparatively small geographic area, including sugarcane, beef cattle grazing, bananas, other horticulture, dairy and forestry.
- The high rainfall environment (annual average 1500-4000mm (Reef Plan First Report 2009 Baseline)) increasing the risk of nutrient, chemical and sediment export impacting sensitive coral communities which are close to the coast in this part of Queensland.
- A range of allied projects and initiatives operating in these catchments concurrently, increasing the need and opportunity for collaboration and communication.

While these catchments were the initial focus of the project, the project also sought opportunities to enhance extension service delivery and coordination in other GBR catchments in the Burdekin Dry Tropics and Mackay Whitsunday regions.

Figure 1. Map of NRM regions in Queensland



Source: Waterwatch Queensland 2012 and Geoscience Australia 2005.

DAFF led the pilot with funding from the Queensland Government. The E&E Strategy was implemented by reviewing existing extension programs operating in the region, engaging key stakeholders and identifying opportunities to enhance extension service delivery and coordination, building upon existing projects and networks. Partnerships with agricultural industry peak bodies and other industry groups, NRM organisations and other government agencies were a priority to foster local participation and ownership to reflect specific industry issues and priorities in each catchment. This meant that extension delivery was tailored to each industry in each catchment, with dedicated extension officers aligned to each industry. There were eight extension officers, an economist and project leader aligned to this project.

A structured monitoring and evaluation program was developed at the start of the project to capture the outcomes and assess the success of the E&E Strategy to inform its GBR-wide

rollout. The monitoring and evaluation was implemented under the guidance of Coutts J&R Pty Ltd and was designed to capture gains in knowledge and skills, intention to change and actual practice adoption by producers. The monitoring and evaluation program also sought to identify the impact on coordination and communication between stakeholders and changes in practitioners' capacity. Data was collected through tailored feedback sheets from extension activities, narratives of observed changes, informed persons surveys and structured stakeholder debriefs. An online database established and operated by Coutts J&R Pty Ltd collated the data in a centralised place, which was necessary given that project staff worked in different locations.

It is acknowledged that the capacity gains and on-ground change reported in this project would have been influenced by the range of other Reef Plan and industry programs that were working towards improved agricultural land management before and during the pilot project.

Results

Producer engagement

During the almost 18 month project, over 430 extension, coordination and practitioner capacity building activities were delivered. Over 200 individual producers were engaged in extension activities. It is estimated that the project reached an additional 2,500 producers through media (based on media distribution figures divided by four to account for the fact not all recipients would have read the articles). Other producers are likely to have been indirectly influenced through involvement in allied projects and through increasing the capacity of other extension providers, agribusiness resellers and consultants.

Consistent with a participatory action learning approach used, around half the extension activities involved on-farm demonstrations/small-scale trials, farm visits and one-on-one extension support. Structured group activities through grower and grazer groups, farm walks and formal workshops comprised the other half of extension activities (Figure 2). Extension focused on practices that reduce the risk of nutrient, sediment or pesticide loss and improved agricultural business performance (i.e. production and profitability). Over a third of the extension activities targeted improved nutrient management, 20% soil management (ground cover, tillage, fallow management) and 15% better pesticide, primarily herbicide, management. Ten per cent of extension activities supported producers to improve their business management and record keeping.

Figure 2. Field demonstration of new herbicide application technology to cane farmers in the wet tropics region



Source: DAFF 2012.

The E&E Strategy identifies a need for extension to engage with the '*middle 60%*' of producers more overtly rather than rely on the process of diffusion from the '*early adopters*' or '*innovators*' who are usually involved in extension activities. Therefore extension officers specifically contacted producers that they (or colleagues) had not worked with before, to ask if they would be interested in participating in a farm demonstration. This was a successful approach with only 10% of producers declining due to having other work commitments. At the end of the project, extension officers were surveyed to identify what proportion of the producers engaged could be considered '*new*' to DAFF extension, that is, classed as '*never*' or '*only occasionally*' engaged in previous DAFF extension activities. This showed that an average of 60% of the producers engaged in project activities could be classed as in the target '*middle 60%*' audience.

Coordination and communication

A network of producer groups, industry-specific coordination groups and multi-industry stakeholder groups was established in the Herbert and Johnstone River catchments, building

upon and enhancing existing groups and partnerships. Networks were also enhanced in the Burdekin Dry Tropics and Mackay Whitsunday NRM regions. These networks, comprising a total of 20 groups, brought together government, industry, NRM organisations, researchers and producers working on a variety of Reef Plan, industry and NRM projects. 87 stakeholder meetings were undertaken, 75% of which can be directly attributed to the project. Feedback from stakeholders through the informed persons survey and debriefs verified the project had:

- increased coordination and communication between extension providers
- increased information sharing between agricultural industries
- facilitated the use of water quality information to target extension delivery.

Practitioner capacity building

Over 100 formal training and professional development opportunities were provided to extension officers, NRM practitioners and agribusiness resellers and consultants. The project specifically aimed to engage resellers and consultants to increase the opportunity for best practice information to be extended to a broader producer base. The participants surveyed after the training reported that the training had increased their knowledge and skills in the areas of:

- soil fertility and nutrient management
- erosion management
- economic decision support tools, record keeping and business management
- eExtension techniques and new technologies.

Over 75% of the participants surveyed in the eExtension workshops indicated that as a result of the workshop they would use eExtension in their work and at least five started using these technologies in their extension activities shortly afterwards.

Impact of extension

To understand whether the extension activities had any impact on producers' capacity and intention to change, producers participating in workshops and grower groups were asked to complete a brief evaluation. This had mixed success, in some events over 70% of producers completed evaluations whilst in other, larger events only 1% completed the evaluation. Those producers who completed the evaluations reported a moderate (average 6.5/10) increase in knowledge and skills as a result of project activities. Average ratings varied significantly, from 4/10 to 10/10, depending on the event and topic. The bulk of capacity gains were in the areas of nutrient, pesticide and soil management, overall farm management and record keeping in sugarcane and horticulture crops. In the dairy and beef grazing systems in high rainfall areas, producers reported capacity gains in pasture management through using legumes and improved fertiliser management. An average of 75% of producers surveyed stated that they intended to make a change to their enterprise management as a result of the activity.

The project has also led to demonstrable practice change. Of the 200 producers actively engaged in the project at least 20% (40 properties covering over 42,000 hectares) made an on-ground change during the 18 month project. Changes were recorded by extension officers through narratives which describe the farming enterprise, extension activity delivered and resulting practice change. Examples of practice changes reported include:

- Moving to band spraying herbicides in sugarcane, reducing the use of residual herbicides by 50%.
- Planting a legume fallow crop and subsequently reducing the amount of nitrogen fertiliser applied in the following sugarcane crop
- Soil testing and advice leading to better nutrient management throughout the banana crop.
- Using a fallow crop instead of nematicides to control nematodes and establishing permanent beds thereby minimising cultivation in bananas.
- Improved pasture management through planting legumes and reducing fertiliser applications in high rainfall grazing systems (beef and dairy).
- Implementing wet season spelling to improve ground cover in the low rainfall, extensive grazing systems.

The short timeframe associated with the project limited the capacity to quantify practice change occurring since June 2012 and track adoption throughout the properties. However, if the above changes were implemented in full throughout the 40 properties (i.e. in all blocks/paddocks) it is estimated that there could be water quality improvements in the order of:

- 1,400 t/yr less sediment
- 1,500 kg/yr less nitrogen runoff and 400 kg/yr less phosphorous runoff

- 35 kg/yr less runoff of photosystem II inhibiting herbicides.

In addition it is estimated that if the cane and banana enterprises implemented these changes in full they could collectively improve their economic performance by over A\$1 million.

These are estimates and not actual figures as they are not calculated by undertaking water quality monitoring or economic analyses on individual properties and do not account for different soil types. The practice adoption figures will be included in the broader Reef Plan Paddock to Reef monitoring and modelling program, which will provide a more robust and aggregated estimate of progress towards Reef Plan targets.

Lessons learnt

A number of lessons have emerged from this project that will inform future Reef Plan extension delivery and program coordination. These lessons also have broader relevance for other extension and rural development projects.

Extension delivery

The E&E Strategy pilot project demonstrated that agricultural extension can increase producers' knowledge and skills and result in on-farm management changes that contribute to reducing nutrient, sediment and pesticide losses from agricultural land.

Extension officers had an important role in supporting producers to trial and adopt new management practices on their property. As financial drivers have a significant bearing on adoption, extension should focus on supporting enterprise production and profitability, while also improving water quality outcomes. Embedding agricultural economics into extension programs is essential to validate the financial costs and benefits of the management practices being promoted.

All of the reported practice changes were as a result of one-on-one extension or small producer groups. This form of extension delivery allows the extension officer to identify the producer's priorities and potential practice improvements and then assist the producer in testing or adopting the practice. Workshops and producer groups increased knowledge, skills and the intention to adopt and producers stated (in post-event surveys or debriefs) that they found the interaction with other producers and extension officers as valuable to share experiences and knowledge. Media, case studies, short grower videos and field days can also play a role in increasing awareness of different management practices and their costs and benefits.

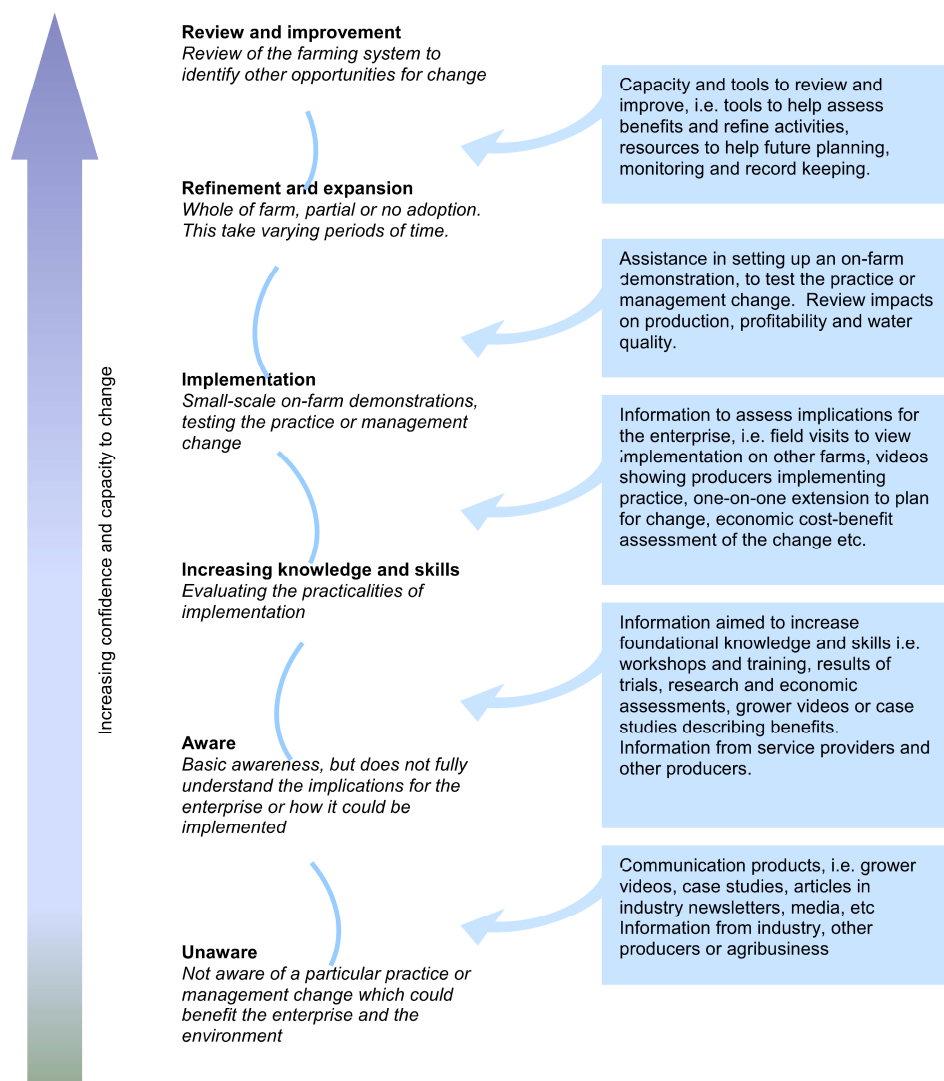
This illustrates that in order to build capacity and enable change, a range of delivery mechanisms are required to assist producers at different stages of adoption. Pannell et al. (2006) describes the process of adoption as starting with awareness, then developing knowledge and skills before trialling the practice or innovation. If the trial is successful, the practice may be gradually implemented throughout the production area. The range of different extension delivery mechanisms suited to each step in adoption is illustrated in Figure 3.

Extension projects should therefore have multiple delivery mechanisms and also be targeted where the greatest gains can be achieved. To make best use of available resources, extension effort should be targeted at areas with the highest risk of nutrient, sediment or pesticide export and where there is the greatest potential for mitigating these risks. Similarly working collaboratively with other extension providers, resellers and consultants increases the overall capacity to engender on-ground change.

Coordination and communication

The E&E Strategy proposes a governance network involving local, regional and GBR-wide groups to improve coordination, collaboration and communication between government, NRM and industry stakeholders. Stakeholder feedback confirmed that the 20 groups involved in the project had an important role in increasing communication between organisations and coordinating extension activities. Coordination groups were considered particularly valuable in the sugarcane industry where there are multiple extension providers operating at the catchment scale. Stakeholders emphasised the need to work with existing groups and networks, so flexibility is needed when implementing the governance network proposed in the E&E Strategy.

Figure 3. Illustration of the role of different extension delivery mechanisms in building capacity for change at different stages of adoption



In the Herbert River catchment, a stakeholder group was established with representatives from the key agricultural industries in the catchment, the regional NRM organisation, state and local government and researchers. This aimed to bring together different projects in the catchment, promote information sharing between agricultural industries and facilitate a whole of catchment approach to managing water quality in the catchment (Figure 4). Members stated that they believed the strength of the group was in having a clear purpose, core group of members to facilitate meetings and the ability to use water quality data to target extension delivery and inform local management decisions.

It took time, in some instances six months, to establish functional stakeholder groups. Once established, groups required continual review and refinement, responding to changes in projects, personnel and the expectations of the group. Overarching governance at a GBR-wide scale will be vital in the future to align Reef Plan and allied industry programs to provide the foundation for effective coordination at a regional or catchment level.

Practitioner capacity building

Training, mentoring and professional development for extension officers and other service providers improved knowledge and skills of practitioners. Training in the use of eExtension tools, resulted in the use of new technologies to broaden and improve extension delivery. Mentoring of new and young officers, by experienced practitioners had multiple benefits in fast-tracking a new officer’s knowledge and skills and inclusion in local networks while introducing new ideas and technologies, such as eExtension, to the team.

Figure 4. Herbert River multi-industry stakeholder meeting held on a grazing property



Source: DAFF 2011.

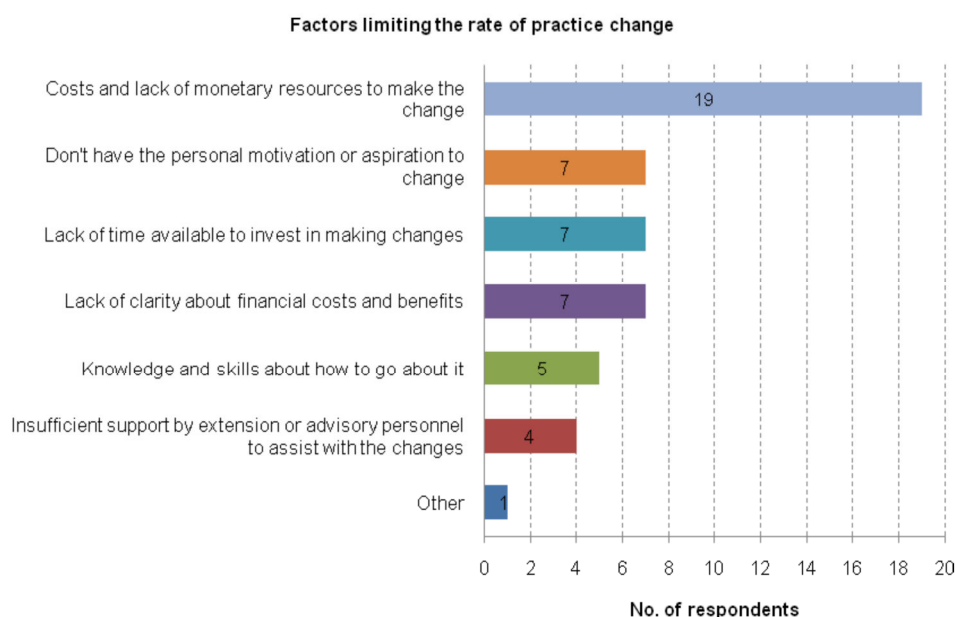
Challenges and barriers

Through the informed persons survey the project identified barriers (Figure 5) that could constrain the ability for extension, and potentially other voluntary mechanisms, to engender the level of practice change required to achieve Reef Plan water quality targets. The major barriers identified by stakeholders include:

- The large number of small production enterprises that are not economically viable and rely on off-farm income. These often do not have the financial or time capacity to invest in implementing change.
- Market forces and weather events have a major bearing on business and farm management. Within the 18 month project a severe tropical cyclone decimated banana and forestry crops, above-average rainfall impacted cane production and prices for milk and bananas slumped to very low levels. This affects morale and the capacity to invest time and money into new equipment and technologies.
- Agriculture has a large proportion of older growers, for instance over half of cane growers are aged 56 or older (Brunton 2010). This could impact their desire to invest in changes and new technologies that take a longer time to produce production or profitability benefits.

These barriers highlight the need for extension to be cognisant of and tailored to respond to local industry priorities and enterprise needs.

Figure 5. Results from an informed persons’ survey (stakeholders and producers) showing factors thought to be limiting the rate of practice change by producers



Conclusions

Future direction

The project demonstrated that the Reef Plan E&E Strategy provides a sound framework for extension delivery and coordination in GBR catchments and that implementation must be tailored to industry and catchment needs and contemporary agricultural business drivers. Lessons and recommendations from the pilot project were used to develop actions and deliverables for the next phase of Reef Plan (2013-2018), which was endorsed by the Australian and Queensland Governments in July 2013. Over the next five years there will be a greater emphasis on extension as a mechanism to increase adoption of improved agricultural management that minimises pollutant losses while maintaining and enhancing agricultural business performance and resilience. Reef Plan 2013 states that extension, incentives and industry-led projects need to be coordinated and targeted at the highest risk pollutants in the highest risk areas to maximise GBR water quality improvement. In planning extension activities, water quality data from Paddock to Reef will be used to identify these high-risk areas and pollutants and the practices that have significant pollution mitigation potential.

Lessons for other extension programs

The lessons from the pilot project can help inform the development and delivery of other extension and rural development programs. Key principles ascertained from the project include:

- A variety of extension methods are needed to support producers at different stages of adoption. Although resource intensive, one-on-one extension is effective in leading to practice change.
- Extension needs to be targeted at sub-catchments and demographics with the greatest potential for enabling practice change that will achieve the desired outcomes (such as water quality improvement).
- Extension should focus on practices that improve business performance as well as environmental outcomes as financial costs and benefits are key factors influencing adoption.
- Synergies can be developed by proactive collaboration and coordination of extension activities across service providers.
- Communication across the spectrum of research, development and extension providers increases knowledge sharing, leading to more effective programs.
- Developing capacity in delivery personnel (public and private) maximises effectiveness and efficiency. Mentoring is a vital part of capacity building.
- Establishing a monitoring and evaluation program at the start of an extension project ensures that project activities and evaluation tools can be planned and tailored, to ensure the impact and benefits of the project can be measured and reported.

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