

Applying behavioural science to the Queensland sugar cane industry and its relationship to the Great Barrier Reef

JA Pickering¹, J Hong¹, D Hong¹ & M Kealley²

¹ Behaviour Innovation Pty Ltd. 315 Brunswick St, Fortitude Valley, QLD 4006

² Queensland Cane Growers Organisation Ltd. Level 6, 100 Edward St, Brisbane, QLD 4000
Email: john@behaviourinnovation.com

Abstract. The decline of the health of the Great Barrier Reef (GBR) has motivated efforts to modify the farming practices of landholders connected to the Reef—especially cane growers. Despite knowledge of the importance of human behaviour in protecting the GBR, a focus on the science of how to change human behaviour has not featured prominently in discussions about water quality. This paper outlines the empirical basis for an evidence-based behaviour change program targeting Queensland's population of sugar cane growers. The paper reviews the evidence of behaviour change in the context of the sugar cane industry and outlines the key considerations in designing a program of change at scale. It is concluded that a population-level approach to behavioural change is a potentially pivotal means for accelerating the adoption of new farming practices across the sugar cane industry.

Keywords: psychology, behavioural science, great barrier reef, practice change, sugar cane

Introduction

A major focus of improving the health of the Great Barrier Reef (GBR) is to target the factors that improve Reef water quality. In particular, excess nutrients (i.e. Nitrogen) in water running into the GBR is detrimental as it promotes outbreaks of Crown of Thorns starfish and impacts negatively on the growth of sea plants (Queensland Government 2016)

A major contributor to Nitrogen in the GBR is the agricultural run-off from surrounding farms, including the sugar cane farms of Queensland (Queensland Government 2016). Significant investment has been made to improve the specific farming practices that contribute to nutrients entering the GBR catchments. A common example is reducing rates of fertiliser application by Queensland cane farmers (Queensland Government 2016). An industry lead program called Smartcane BMP provides a framework for these farming practices to support cane production, water quality and continuous improvement (Kealley & Quirk 2016).

To promote such change, many industry bodies from a wide range of disciplines have been engaged. Water quality scientists, marine scientists, agronomists and many other experts in agriculture and water science have attempted to inform growers of more sustainable farming practices. However, environmental problems often have their origins in patterns of human behaviour, and the solutions ultimately rely on changing certain elements of their behaviour (Schultz 2014). Thus, focussing research towards understanding the science of human behaviour (i.e. behavioural science and psychology) is a potentially powerful method for better understanding the antecedents of specific farming behaviours and how to best change them. In support of this idea, the World Bank (2015) declared that for any major global or environmental challenge to be addressed (e.g. climate change, energy access, environmental management, poverty reduction), a comprehensive and scientific understanding of human behaviour, and the context in which people make decisions, must be included at the core of any planned solution.

The empirical literature is rich with examples of how the science of behaviour change has been used to combat major questions of health and wellbeing such as poor eating habits (Irvine et al. 2004), smoking cessation (Cooper & Clayton 1989), reducing the usage of excess electricity (Thaler & Sunstein 2008), and increasing pro-environmental behaviours (Moloney, Horne & Fien 2010). Behavioural interventions have proven useful because they take the established principles of behavioural science and use them to change or prevent maladaptive behaviours (Atkins & Michie 2015). The challenge is to design and implement behaviour change interventions at scale.

No single approach has propriety over the science of behaviour change. As outlined by the House of Lords (2011) report, a wide variety of sub-disciplines of psychology, economics, cognitive science and sociology contribute to the theory and evidence of behavioural change. The challenge for modern behavioural scientists and policy makers is working out how best to draw on these findings in order to design programs that positively influence human behaviour.

The available evidence affirms the view that human behaviour is the product of many interrelated factors. Significant theoretical and empirical influences on behaviour include learning theory (reward, reinforcement and punishment), social cognitive theory, social identity theory (interaction within and between groups), social networks, social norms, messaging and framing, and many more.

Beyond specific influences on human behaviour, it is important to consider how populations of people change, not just the individuals within them. In the context of understanding and modifying behaviour that affects Reef water quality, it is important to appraise the evidence that is relevant to both individual and collective behavioural change.

To adequately address this, the first section of the review provides an appraisal of how specific theories of behavioural change relate to the sugar industry of Queensland. The second section examines the theory and evidence supporting programs for behavioural change across entire communities. The final section of this review paper proposes eight recommendations for designing behaviour change programs in the context of the cane industry and water quality entering the GBR.

Section One – Understanding the factors that influence cane farmer behaviour

There are a multitude of psychological factors that are likely to influence the behaviour of cane farmers. Described below are some of the major theories addressing potential influences and why they are relevant to understanding behaviour in the cane industry.

Learning Theory (Pavlov 1927; Thorndike 1898; Skinner 1953)

Two of the most prominent theories of human behaviour are Classical Conditioning and Operant Conditioning (Thorndike 1898; Skinner 1953). Although conceived over 100 years ago, these theories remain among the most influential and useful in understanding human behaviour—and how to change it.

Classical Conditioning Classical Conditioning describes the phenomenon where an unconditioned stimulus becomes associated with a conditioned stimulus to elicit a certain response. In Pavlov's early trials, the unconditioned stimulus was food, and the conditioned stimulus was a bell (that Pavlov sounded in association with the food). After several pairing trials, Pavlov identified the response was salivation in his dogs. The result was that ultimately the bell by itself, in the absence of food, elicited the same salivation response.

The reason Classical Conditioning remains so important is that behavioural change can be achieved by introducing new associations or extinguishing existing ones. Applied to the sugar cane industry in Queensland, there are likely to be a number of associations that growers draw between conditioned stimuli and specific outcomes. For example, some growers may have come to associate Best Management Practices (BMP), used to grow sugar cane, with government regulation, thus decreasing their inclination to adopt change.

Operant Conditioning Operant Conditioning states that behaviours are more or less likely to occur depending on the consequences of that behaviour.

Two of the main components of Operant Conditioning are reinforcement and punishment. Reinforcement can be either positive or negative – both of which are designed to promote more of the behaviour occurring. Positive reinforcement refers to the presentation of a positive (desirable) stimulus following certain behaviour. In the cane industry, a grower receiving public praise and acknowledgement for becoming accredited in BMP would be an example of positive reinforcement.

Negative reinforcement refers to the removal of an aversive stimulus following the behaviour. An example of negative reinforcement in the cane industry would be a reduction of the threat of further regulation being imposed upon growers as a result of increasing rates of BMP adoption.

Punishment is different to reinforcement as it is designed to reduce rates of behaviour, not increase it. Like reinforcement, punishment can be either positive or negative. An example of positive punishment would be to impose a fine on growers who fail to adopt BMP. Negative punishment would be to remove the choice growers have in determining how much Nitrogen they can apply in fertilising their cane fields as a result of failing to be accredited in BMP.

Social Cognitive Theory (Bandura 1977; Bandura 2004)

Bandura extended the thinking of learning theory by showing that not only do people learn through the consequences of their actions, but also through direct observation and modelling of the behaviour of others. Social Cognitive Theory states that a significant portion of human behaviour is learned purely by observing others. Once an individual observes a behaviour they then use these observations to form their own ideas about how to perform new behaviours, and then use this information to produce a new behavioural repertoire.

Social Cognitive Theory highlights the important distinction between the process of learning a new behaviour (observation and modelling) and putting that newly learned behaviour into

practice. Social Cognitive Theory stipulates there are four motivational elements that are crucial precursors to any behavioural change.

Self-efficacy, self-control and personal agency The extent to which an individual believes they have the capacity to exert control over their actions, and the consequences of those actions, is the foundation of human motivation. According to Social Cognitive Theory, the reason self-efficacy is so important is that when contemplating whether to adopt a new behaviour, an individual will generally be faced with competing priorities and dissuading complexities. Thus, unless an individual believes in their ability to produce effects by his actions, the individual will be very unlikely to act. Self-efficacy can be enhanced through multiple ways. For example, when an individual sets an aspirational goal for achievement and successfully masters a goal they are able to experience an increase in perceived self-efficacy.

Self-control is also reassuring. In the face of a threatening or fear-laden event, such as harm to the GBR through poor water quality, perceptions of control can be a key psychological resource that stimulates constructive behavioural responses (see Hornsey et al. 2016). Experimental research demonstrates that providing people with a sense of control allows people to respond to threat without defensiveness (Greenaway et al. 2014).

The health and wellbeing of the Reef is ultimately determined by a complex set of interdependencies (climate change, water quality, sedimentation, pesticides, warmer water temperatures). Such complexity means that individual growers might wonder to what extent their own individual efforts can positively influence outcomes. Thus, measures to enhance self-control should be given careful consideration in designing a behavioural change program that links changing the behaviour of cane growers to environmental outcomes in the Reef.

An important benefit of enhancing self-efficacy is that the more people report having control of their lives, the healthier, happier, and more productive they are (Knight & Haslam 2010). A behaviour change program that targets improving self-efficacy is likely to not only benefit the Reef, but also the general health and well-being of growers.

Collective efficacy Some problems and challenges require groups of people to work together with a collective voice to improve their circumstances. In this way, collective efficacy refers to people's belief that they can work in a unified manner to bring improvement in their collective circumstance. The theory of collective efficacy acknowledges that behavioural change often requires people to work against dated traditions and normative constraints. Thus, improving collective efficacy typically involves changing sociocultural norms and practices at the social system level. When groups of people are unified behind a common purpose they can experience a greater sense of control over their environment than what might otherwise be possible if an individual within that group was acting alone.

Goals and aspirations Goals, aspirations and challenges people set for themselves are fundamental drivers of human behaviour. It is important for individuals to have both long- and short-term goals. Long-term goals are instrumental in setting a course for change, but are typically too far removed to provide immediate guidance for incremental improvement. Short-term goals act as immediate precursors to behaviour to bring about more immediate change. Most importantly, goals must be translated into specific plans and strategies if they are to be effective. Crucial to this is the availability of specific monitoring and feedback protocols for the specific goals and behaviours in question. For the cane grower, this means having clear, realistic and achievable targets for change they can work towards that are enveloped in an ordered and structured way.

Outcome expectations The outcomes individuals anticipate their behaviours to create have a large influence over their desire to perform that particular behaviour. Individuals are fundamentally motivated to enact behaviours that bring about a positive change for themselves, their social system, environment or some other material benefit.

An example of Social Cognitive theory in action within the cane industry is as follows:

1. A grower observes another grower implementing a new farming practice and forms an understanding of how that practice works and how to do it (**social modelling**).
2. The grower who observed the new practice has a belief in his ability to control his farming practices, and that by doing so, it will likely result in some positive consequence (**self-efficacy**).
3. The grower lives in a broader social context that believes in the importance of adopting new practices and how a unified approach is necessary for any kind of meaningful change in the industry to occur (**collective efficacy**).

4. The grower sets himself clear short- and long-term goals that are operationalised into specific plans and strategies such as the Smartcane BMP process (**goals and aspirations**).
5. The grower has an understanding that his new farming practices (behaviours) will produce positive outcomes at either a personal (e.g. feeling good about doing something new), environmental (e.g. Reef), material (e.g. lowered production costs), or social (e.g. I am being acknowledged by my peers for adopting new ideas) level (**outcome expectations**).
6. The grower introduces new farming practices to achieve the expected outcomes, signalling that a change in behaviour has taken place (**behavioural change**).

Theory of Reasoned Action (Fishbein & Ajzen 1975)

The Theory of Reasoned Action, the precursor to the Theory of Planned Behaviour (Fishbein & Ajzen 1975), states that an individual's behavioural intention is derived from the internal belief that performing a specific behaviour (or set of behaviours) will result in a specific and desirable outcome. Thus, one way of changing behaviour is to influence the expected benefits an individual perceives will flow once the required behaviour is performed.

Applied to the sugar cane industry, the Theory of Reasoned Action could be used to better understand what growers understand the benefits of BMP are and thus, what they expect to achieve from doing it. It could be argued that a potential barrier to change is that growers do not behave positively towards BMP (accreditation) because they do not believe that it brings about any beneficial outcome. The Theory of Reasoned Action could be used to justify giving priority to shifting the expectations growers have relating to the beneficial effects of BMP. Significant improvements in rates of adoption might be experienced simply by articulating that greater BMP adoption leads to a better outcome (e.g. higher chance of positive future for cane).

Social Identity Theory (Turner 1975; Haslam, Reicher & Reynolds 2012)

The social identity approach is a collection of theories that provide an integrated analysis of the role of self-conception in group membership related behaviours. Tajfel (1972, p. 292) defined social identity as 'the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of this group membership.'

The reason social identity is a relevant scientific underpinning to behavioural change program development is that it deals with group membership. Groups are one of the most central facets to human existence—they provide us with a sense of security, a sense of meaning and a sense of identity. Recent research has also shown that an individual's social identity and group membership can serve an important function for improving general health, wellbeing and a sense of feeling capable and in control of their lives (Greenaway et al. 2015). For the purposes of behavioural change, group identity is a powerful mechanism for defining how 'we' should behave, and separates 'us' as in-group members from 'them' as out-group members.

It is possible for an individual to have multiple group identities, with different identities proving more salient in specific situations. Recent evidence shows that social identity can be used to understand environmental beliefs and behaviours and how identities can prompt individuals to behave in more (or less) environmentally friendly ways (Fielding & Hornsey 2016). For example, a cane grower might identify as a member of the overarching cane industry. In this instance, being a cane grower is meaningfully distinct and unique compared to being a grazier. A grower may also identify with being from a particular region or district within the industry – for example, he may identify as a Tully cane grower, which is meaningful, distinct and unique when compared to being a grower from Innisfail.

Two motivational factors within the social identity literature are highly relevant to the science of behavioural change. These motivations are known as self-enhancement and uncertainty-reduction.

Self-enhancement surrounds the belief that 'we' are better than 'them', reflecting the need for a group to maximise its status, prestige, and social valence. The self-enhancement motive, therefore, guides the need for positive social identity and represents a powerful driver of behaviour. The Tully grower, for example, may respond favourably to performing behaviours that demonstrate his district is superior to Innisfail.

The uncertainty-reduction motive rests on the premise that group identification is one of the most effective ways of reducing uncertainty about oneself. Group identification, therefore, furnishes clear group prototypes that prescribe how we ought to behave and, as result, is one of the most powerful methods of modifying behaviours of individuals.

Applied to the cane industry, targeting group membership and identity could prove a powerful method of promoting behavioural change. For example, self-enhancement may provide an

important target for bolstering growers' desire to adopt change in order to preserve that their group (e.g. the Tully area) is better than another group (e.g. the Innisfail area). Constructing a mechanism for promoting positive competition among socially identifiable groups to become better than one another may reduce uncertainty and promote positive behavioural change.

Social networks

Recent research has shed significant light on the various ways in which social networks can be applied to the task of changing behaviour and disseminating new knowledge. Corner and Randall (2011) conducted a study to demonstrate that behaviour change programs focusing on pro-environmental behaviour benefit from including an approach based on activating social networks. Participants indicated that a key driver for changing behaviour was the mutual learning and the support provided by their social networks. Behaviour change programs in the health domain indicate that positive behaviours are more likely to occur within groups of individuals who trust each other and pay attention to each other's behaviour.

Incorporating social networks into the design of behaviour change programs may also have the added benefit of boosting social capital within the community. As described by Thoyre (2011), social capital refers to the productive benefits associated with social relations and is a potentially critical predictor of pro-environmental behaviour.

Hall et al. (2013) conducted a study examining a behaviour change program for increasing energy conservation behaviours. The study found that participating in a behaviour change program increased energy-saving actions, increased control over energy consumption, and that new knowledge was primarily spread through social networks. Findings identified the importance of group discussion within demographic groups for information uptake and adoption of new energy behaviours.

Social norms

A wealth of research indicates that social norms influence intentions and behaviour (Fishbein & Ajzen 1975). Social norms are best understood as existing within an individual's social identity groups and networks. Social norms refer to people's perceptions of how others behave in the relevant social context. Thus, many of the decisions an individual is likely to make on any given day are at least partially contingent upon what norms exist within the social group that individual belongs to. Put simply, people tend to behave based on what they think others are doing and what is socially desirable.

In the case of the sugar cane industry, a decision a grower makes about what farming practices to adopt might be influenced by the norms of the social group the grower belongs to.

Messaging and framing

One potentially powerful method of modifying or promulgating social norms is to construct carefully curated messages about the target behaviour or group. Years of experimental research indicate that people's judgements and decisions are strongly influenced by the way a problem is framed. The same message delivered in different ways can yield sometimes completely different responses—a pattern of results known as framing effects.

There have been numerous demonstrations of the power of persuasive messages that are couched in terms of social norms to influence behaviour. For example, a normative message about average neighbourhood energy consumption has been shown to reduce energy use amongst households with above-average consumption. Persuasive messages that make social norms salient have also been shown to influence littering, recycling, and environmental conservation amongst hotel guests.

The Queensland Water Commission Target 140 campaign, implemented in South East Queensland in 2007 is a high quality, local example of a behaviour change campaign that included a focus on social norms. The project was successful in securing the region's water supply in response to the worst draught on record (Walton & Hume 2011). The 8-month campaign targeted household users, aiming to change the water use habits of SEQ residents and was ultimately achieved, with water use consumption dropping from 180 litres per person per day to an average of 126 litres per person per day. In 2009, despite the drought being broken, residents continued to consume water on average less than 140 litres per person per day. Driving attitudinal change, goal setting and providing feedback were all key components of the change program, with the Queensland Water Commission using techniques to personalise the problem ('this is not someone else's problem'), and individualising the solution ('everyone can play a part').

A landmark study by Bain and colleagues (2012) examined the effects of different messaging frames on people's motivations to deny climate change. The conclusion of the study was that to motivate deniers' pro-environmental actions, communication should focus on how mitigation efforts can promote a better society, rather than focusing on the reality of climate change and averting its risks. The research demonstrated that people intended to act more pro-environmentally where they thought climate change action would create a society where people are more considerate and caring. In other words, a behaviour change messaging campaign showing that framing climate change action as increasing consideration for others, or improving economic/technological development, led to greater pro-environmental action intentions than a frame emphasising avoiding the risks of climate change.

These findings from Project 140, as well as Bain et al. (2012), are corroborated by other studies (e.g. Hurlstone et al. 2014) that have shown that framing messages as a foregone-gain (i.e. something that is relinquished) is likely to be better received than framing something as a loss. For example, Kahneman, Knetsch and Thaler (1986) found that when a group of participants was asked to decide whether the addition of a surcharge on a brand of car that was in short supply—perceived as a loss—was fair or unacceptable, most people (71%) deemed such an economic action to be unacceptable. By contrast, when a second group of participants was presented with an objectively equivalent scenario in which the surcharge was replaced by the removal of a \$200 discount—perceived as a foregone gain—most people (58%) deemed such an economic action to be fair. In other words, keeping messages as positively and upwardly framed as possible is likely to have a significant bearing on behaviour in the target community.

Negative or fear-based messages can be overwhelming and dispiriting, encouraging people to respond negatively (e.g. Feinberg & Willer 2011; Feldman & Hart 2016). Negative messages may also significantly impair an individual's sense of control, efficacy and agency which are crucial to unlocking behavioural change.

Thus, behaviour change interventions that have at their core an aspirational and positive outlook, not negativity and despair, hold considerable promise in reducing behaviours that may result in negative environmental outcomes.

Nudge theory (Thaler & Sunstein 2008)

Nudge theory is built on the premise that the application of subtle, indirect, and non-forced (i.e. regulatory) principles of behavioural and economic science (e.g. positive reinforcement, social comparisons) are powerful tools in influencing human behaviour. As the term suggests, nudges are designed to be brief, low-cost, and simple prompts and reinforcers that seek to modify the behaviour of individuals and groups. Nudges can be embedded in social marketing approaches and other techniques of behavioural change.

The concept of choice architecture is at the core of nudge theory. Choice architecture is a relatively simple concept that refers to the broader personal, physical, social, political and contextual environment in which an individual makes choices. What this means is that changing the way options are presented, or altering the context in which decisions are made, can make certain decisions more (or less) likely than others.

Putting the concepts of nudge theory and choice architecture together provides a fascinating perspective on a potentially useful method for altering human behaviour. The process is best summarised by Thaler and Sunstein (2008, p. 6) who defined the concept as follows:

A nudge, as we will use the term, is any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. Putting fruit at eye level counts as a nudge. Banning junk food does not.

Importantly, the House of Lords (2011) report into the effectiveness of nudges in modifying behaviour within the UK policy environment found that non-regulatory measures used in isolation, including nudges, are not likely to be as effective as interventions that draw on a range of strategies and techniques. For the cane industry, an application of nudges would be to provide real-time feedback to growers relating to the environmental benefits of their modified farming practices. For example, growers could be supplied with a summary statement indicating the positive effects of their lowered rates of chemical usage.

A case study in agricultural behavioural change

The National Landcare Program undertaken by the UK Department for Environment, Food and Rural Affairs (2006) is an excellent example of a behavioural change techniques that assisted landholders to overcome these barriers to change. A range of evaluation reports on the National

Landcare Program concluded that the program was an excellent example of a successful behavioural change program. Described below is an interpretation of the key techniques contained within the program and how they relate to the evidence presented in this review.

- **Target innovators and early adopters first.** The program targeted the landholders most ready for action in the first instance. Targeting these groups helped create a critical mass of momentum for the change process.
- **Improve self-efficacy.** The program was able to increase landholders' self-efficacy by providing them with the skills and knowledge to adopt natural resource management measures. Feedback, ongoing advice and assistance for those in the process of adopting new techniques was based on 'farmers teaching farmers'.
- **Think of context and involve constituents when designing the program.** The bottom-up, local nature of the project allowed for a broader understanding of the context landholders operate in and also gave them a strong sense of ownership of projects.
- **Reduce risk and uncertainty through social modelling.** The program was able to reduce the risk of adopting new methods because landholders could observe if the new methods worked in their local conditions by visiting and observing other members who have already adopted the new methods.
- **Social networks and diffusions of innovation.** The project utilised peer pressure and peer support to influence members to adopt natural resource management measures.
- **Provide financial incentives.** The program provided funding incentives for landholders, particularly groups of landholders, to undertake natural resource management measures.

Section Two – Key considerations in modifying behaviour across entire populations

This section focuses on the methods for achieving change at a population-level. The population-level approach emphasises the universal relevance of the behaviour change program as such that the larger community is able to embrace and support being involved. From a population-level perspective, intervention developers must consider how their program fits with local needs and policy, and be mindful of the cost-effectiveness of their proposed solution.

The rationale behind a population-level approach to behavioural change is that all members of a community must be included in the change process for significant change to occur. Moreover, there are natural variations across individuals in the community and each member may have different needs and preferences regarding the type, intensity and mode of change they may require.

An example of a population approach to behavioural change is The Triple P-Positive Parenting Program (Triple P; Sanders 2012). Triple P was developed at The University of Queensland and is a system of parenting support and intervention that seeks to increase parents' confidence and skill in raising their children, thereby enhancing children's developmental outcomes.

What makes Triple P especially relevant to the current review is that it seeks to modify behaviours of entire communities simultaneously, not just individuals. In this way, it is an exemplar of a population-level approach to behaviour change.

In examining the logic behind Triple P, in combination with other research that has examined behaviour change, there are four key ingredients to making a population-level approach to behaviour change work. Each of these ingredients is discussed below.

1. Community Engagement Engaging the community when designing behaviour change programs is an important component in the design of behaviour change programs (Pickering & Sanders 2013). Engagement is about involving "consumers" of the intervention in program design as well as communicating with those same consumers about the benefits of changing their practices. The key outcome is better adoption of change within the community.

The main goal of applying a consumer approach to behaviour change is to enhance the ecological fit between programs and farmers' needs. Improving the fit enhances the effectiveness of the outcomes of intervention across both the individual and community level. Consumer engagement seeks to maximise the effectiveness of the intervention at the individual farm or farmer level (e.g. the extent to which an intervention lowers problematic agricultural practices), but also to maximise the likelihood that it will be widely adopted and disseminated well beyond the project period. Crucially, involvement of stakeholders must commence at the very outset and, ideally, be instigated by the major stakeholder itself (i.e. the cane growers). Involving the consumers of the behaviour change program in its design will improve its applicability, utility, and ultimately its effectiveness and sustainability.

2. Self-regulation A second key ingredient within a population-level approach to behavioural change is a self-regulatory framework. Self-regulation is a process whereby individuals acquire the skills they need to change their own behaviour and become independent problem solvers and controllers of their own destiny (Sanders & Mazzucchelli 2013). In so doing, they only ever acquire the skills they need, to the extent that they need them, and to the minimally sufficient amount. Not only does attainment of enhanced self-regulation skills enable individuals to gain a greater sense of personal control and mastery over their life deficits (Moffitt et al. 2011), it is important to the ongoing maintenance of behavioural change.

3. Flexibility and Tailoring The third ingredient is flexibility and tailoring. When a population-level approach is adopted, support needs to be flexible with respect to delivery formats to meet the needs of the community. Programs should not exist under a 'one-size-fits-all-banner'. Thus, multiple delivery formats are required that cover the spectrum of possibilities from intensive, face-to-face formats, through to light-touch, web-based or self-help formats.

In relation to the cane industry, this means that having a suite of behaviour change program components that can be flexibly applied to different constituent groups within the industry is important. Not all growers are the same, and the context in which growers work and live, varies. A multilevel suite of strategies is required in order to ensure sensitivity to the different needs, wants and preferences of the cane growing community.

4. Destigmatisation The fourth ingredient is that behaviour change programs need to be delivered in a non-stigmatising way. An important mechanism for achieving destigmatisation is for researchers to actively engage with the community through the media about the importance of the science behind their work. Pickering and Sanders (2015) demonstrate how a simultaneous media and communications strategy supporting the development of a parenting program can create a shift in community attitudes.

Within the cane industry, the same risks apply in terms of a behaviour change program being seen for either the wayward or "cowboy" farmers, or the top tier elite farmers. To be effective, the program must apply equally across the industry and not single out any particular group or sub-population of growers.

Section three – A behaviour change program for the Queensland sugar cane industry

The theories and literature discussed in the sections preceding can be summarised into the following eight components, all of which are key ingredients to unlocking widespread behaviour change in the context of the Queensland sugar cane industry.

1. **Positivity trumps negativity** - The evidence clearly supports the view that behaviour change strategies that are positive, aspirational and enabling are more effective than those based on negativity. Behaviour change works best when desirable behaviours are reinforced, rather than punishing undesirable behaviours.
2. **Self-control and personal agency are crucial** - The extent to which an individual believes he or she has influence over the outcomes of their actions, and believes they can perform the required action, are significant precursors to behavioural change.
3. **Social systems are important** - An individual's social identity (group membership) and their social networks are powerful targets for behavioural change. Moreover, shifting social norms is a highly effective method of bringing about change in individuals' behaviour.
4. **Context matters** - People do not live in isolation. Behaviour unfolds in a broad ranging system of contextual influences that affect individuals' lives. Thus, an effective behaviour change program must consider each layer of influence in order to produce sustainable change.
5. **The need for an integrated, population-level approach** - In order to achieve a significant change in the prevalence and incidence of particular behaviours, a population-level approach to behavioural change must be adopted. Targeting individuals or small groups in isolation is unlikely to result in significant reductions (or increases) in target behaviours. Multiple projects orchestrated by multiple stakeholders are also unlikely to achieve the same outcomes as a high quality integrated project that targets all members of a community.
6. **A tailorable, multi-level system of behaviour change components is required** - When it comes to behavioural change, one size does not fit all. Human behaviour unfolds in a complex interplay across an individual's personal, social, environmental, cultural, and material circumstances. These circumstances can vary widely within a particular population. Thus, an effective behaviour change strategy must have multiple components that can be tailored and personalised to the needs of specific sub-populations within the broader target population.

7. **Self-regulation is a priority** - Although guidelines, targets and regulations can be effective augmentations to a behaviour change strategy, they are rarely fully effective in their own right. For sustained behavioural change to occur, the process of change must be driven by the individuals making the change that illuminates their internal capability, efficacy and confidence.
8. **End-user engagement is crucial across all aspects of program development, testing, and dissemination** - To be effective, behaviour change programs must have, at their core, a deep and sustained involvement of the very constituents that will interact with them. This commences with involving all members of the target population in the earliest stages of designing behavioural change programs.

Summary and conclusion

The goal of this review was to establish what the scientific evidence says in terms of how to change behaviour at a population level. Emphasis is given to applying the science of behavioural change to the agricultural practices of cane farmers that affect water quality outcomes for the GBR.

Investment in a population-level behaviour change strategy for the Queensland cane industry would enable every farmer in the community to have access to evidence-based behaviour change strategies regardless of their circumstances. Under a population approach, the vast majority of farmers would be able to engage with the program through the multilevel suite of strategies contained within systems of intervention. The end result will be a more innovative industry that commits to the ongoing adoption of new practices that benefit the Reef and the community.

Combined, the evidence outlined in this review provides the basis for the *theory of change* that will inform all aspects of an innovative population-level approach to modifying the farming practices of Queensland sugar cane farmers. The evidence shows that the utility of behavioural science in helping solve major problems within the community—especially those facing governments—has never been more relevant and important than it is today.

References

- Atkins, L & Michie, S 2015, 'Designing interventions to change eating behaviours', *Proceedings of the Nutrition Society*, vol. 74, pp. 164-170.
- Bain, PG, Hornsey, MJ, Bongiorno, R & Jeffries, C 2012, 'Promoting pro-environmental action in climate change skeptics', *Nature Climate Change*, vol. 2, pp. 600-603.
- Bandura, A 1977, *Social learning theory*, Prentice Hall, Englewood Cliffs.
- Bandura, A 2004, 'Social cognitive theory for personal and social change by enabling media', in *Entertainment-education and social change: History, research, and practice*, eds A Singhal, MJ Cody, EM Rogers, M Sabido, Lawrence Erlbaum, Mahwah, pp. 75-96.
- Cooper, T & Clayton, R 1989, 'Stop-smoking program using nicotine reduction therapy and behavior modification for heavy smokers', *Journal of the American Dental Association*, vol. 118, pp. 47-51.
- Corner, A & Randall, A 2011, 'Selling climate change? The limitations of social marketing as a strategy for climate change public engagement', *Global Environmental Change*, vol. 21, pp. 1005-1014.
- Department for Environment, Food and Rural Affairs 2006, *Enhancing Sustainability at Farm Level*, United Kingdom. Available from: <randd.defra.gov.uk/>. [16 June 2017].
- Feinberg, M & Willer, R 2011, 'Apocalypse soon? Dire messages reduce belief in global warming by contradicting just-world beliefs', *Psychological Science*, vol. 22, pp. 34-38.
- Feldman, L & Hart, PS 2016, 'Using political efficacy messages to increase climate activism: The mediating role of emotions', *Science Communication*, vol. 38, pp. 99-127.
- Fielding, KS & Hornsey, MJ 2016, 'A social identity analysis of climate change and environmental attitudes and behaviours: Insights and opportunities', *Frontline Psychology*, vol. 7, pp. 121.
- Fishbein, M & Ajzen, I 1975, *Belief, attitude, intention, and behaviour*, Addison-Wesley, Massachusetts.
- Greenaway, KH, Louis, WR, Hornsey, MJ & Jones, JM 2014, 'Perceived control qualifies the effects of threat on prejudice', *British Journal of Social Psychology*, vol. 53, pp. 422-442.
- Greenaway, KH, Haslam, SA, Cruwys, T, Branscombe, NR, Ysseldyk, R & Heldreth, C 2015, 'From "we" to "me": Group identification enhances perceived personal control with consequences for health and well-being', *Journal of Personality and Social Psychology*, vol. 109, pp. 53-74.
- Hall, NL, & Romanach, LM, Cook, S & Meikle, S 2013, 'Increasing energy-saving in low income households to achieve sustainability', *Sustainability*, vol. 5, pp. 4561-4577.
- Haslam, SA, Reicher, SD & Reynolds, KJ 2012, 'Identity, influence, and change: Rediscovering John Turner's vision for social psychology', *British Journal of Social Psychology*, vol. 5, pp. 201-218.
- Hornsey, MJ, Harris, EA, Bain, PG & Fielding, KS 2016, 'Meta-analyses of the determinants and outcomes of belief in climate change', *Nature Climate Change*, vol. 6, pp. 622-626.
- House of Lords, Science and Technology Select Committee 2011, *Behaviour change*, The Stationery Office Ltd, London.
- Hurlstone, MJ, Lewandowsky, S, Newell, BR & Sewell, B 2014, 'The effect of framing and normative messages in building support for climate policies', *Plos One*, vol. 9, e114335.

- Irvine, AB, Ary, DV, Grove, DA & Gilfillan-Morton, L 2004, 'The effectiveness of an interactive multimedia program to influence eating habits', *Health Education Research*, vol. 19, pp. 290-305.
- Kahneman, D, Knetsch, JL & Thaler, R 1986, 'Fairness as a constraint on profit seeking: Entitlements in the market', *American Economic Review*, vol. 76, pp. 728-741.
- Kealley, MJ & Quirk, MF 2016, 'Smartcane BMP – understanding drivers and building momentum for best management practice uptake in the Queensland sugarcane industry', *Proceedings of the International Society of Sugar Cane Technologists*, vol. 29.
- Knight, C & Haslam, SA 2010, 'The relative merits of lean, enriched, and empowered offices: An experimental examination of the impact of workspace management strategies on well-being and productivity', *Journal of Experimental Psychology: Applied*, vol. 16, pp. 158- 172.
- Moffitt, TE, Areseneault, L, Belsky D, Dickson, N, Hancox, RJ, Harrington, H, Houts, R, Poulton, R, Roberts, BW, Ross, S, Sears, MR, Thomson, WM & Caspi, A 2011, 'A gradient of self-control predicts health, wealth, and public safety', *Proceedings of the National Academy of Sciences in the United States of America*, vol. 108, pp. 2693-2698.
- Moloney, SE, Horne, R & Fien, J 2010, 'Transitioning to low carbon communities. From behaviour change to systematic change: Lessons from Australia', *Energy Policy*, vol. 38, pp. 7614-7623.
- Pavlov, IP 1927, *Conditional Reflexes*, Dover Publications, New York.
- Pickering, JA & Sanders, MR 2015, 'The Triple P-positive parenting program: An example of a public health approach to evidence-based parenting support', *Family Matters*, vol. 96, pp.53-63.
- Pickering, JA & Sanders, MR 2013, 'Enhancing communities through the design and development of positive parenting intervention', *Journal of Applied Research on Children: Informing Policy for Children at Risk*, vol. 4. no. 2. Available from: <http://digitalcommons.library.tmc.edu/childrenatrisk/vol4/iss2/18>. [24 July 2017].
- Queensland Government 2016, *Great barrier reef report card 2015 results*, Queensland Government. Available from: < <http://www.reefplan.qld.gov.au/>>, [5 May 2017].
- Sanders, MR 2012, 'The development, evaluation and multinational dissemination of the Triple P-Positive Parenting Program', *Annual Review of Clinical Psychology*, vol. 8, pp. 349-375.
- Sanders, MR & Mazzucchelli, T 2013, 'The promotion of self-regulation through parenting interventions', *Clinical Child and Family Psychology Review*, vol. 16, pp. 1-17.
- Schultz, PW 2014, 'Strategies for promoting proenvironmental behaviour', *European Psychologist*, vol. 19, pp. 107-117.
- Skinner BF 1953, *Science and human behaviour*, Macmillan, New York.
- Tajfel, H 1972, 'La categorisation sociale (English trans.)', in ed. S Moscovici, 'Introduction a' la psychologie sociale', vol. 1, pp. 272-302.
- Thaler, R & Sunstein, C 2008, *Nudge*, Yale University Press, New Haven.
- Thorndike, EL 1898, 'Animal intelligence: An experimental study of the associative processes in animals', *The Psychological Review: Monograph Supplements*, vol. 2, pp. i-109.
- Thoyre, A 2011, 'Social capital as a facilitator of pro-environmental actions in the USA: A preliminary examination of mechanisms', *Local Environment*, vol. 16, pp. 37-49.
- Turner, JC 1975, 'Social comparison and social identity: Some prospects for intergroup behaviour', *European Journal of Social Psychology*, vol. 5, pp. 5-34.
- Walton, A & Hume, M 2011, 'Creating positive habits in water conservation: the case of the Queensland water commission and the target 140 campaign', *International Journal of Nonprofit and Voluntary Sector Marketing*, vol. 16, pp. 215-224.
- World Bank 2015, *Mind, society and behaviour*, The World Bank. Available from: <<http://www.worldbank.org/>> , [5 May 2017].