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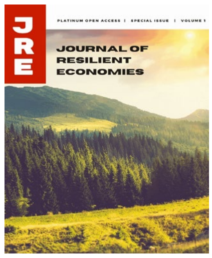

Influences on Stakeholder Attitudes towards Government's Great Barrier Reef Regulations: A Scoping Review for the Case of Sugar Cane Farmers in Queensland

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Abstract

The Great Barrier Reef (GBR) off Australia's east coast is a globally significant marine environment under threat from polluted runoff resulting from adjacent sugarcane farming (Waterhouse et al., 2017). Sustained efforts and investment by all levels of Government over 20 years have challenged the Queensland Sugar Industry to transition towards more sustainable farming practices and reduce non-point source (NPS) pollutant levels from reaching the GBR. In light of the issues outlined by UNESCO concerning the protection of the GBR in its 2011 and 2012 reports (UNESCO, 2011, 2012) and existing government regulations, a scoping review was undertaken to identify the conceptualisation of farmer attitudes to environmental protection, specifically the attitudes to protecting the GBR. It revealed that predominant policy mechanisms across countries are focused on voluntary adoption instruments to mitigate NPS pollution. The review showed that no policy or policy combinations are universally effective in reducing NPS pollution across farmer populations within given geographical locations. It identified behavioural theories that underpin factors influencing the adoption of pro-environmental practices. Additionally, it was found that farmers are heterogeneous in beliefs and attitudes, responding differently to different incentive options and challenging policy framing. Reviewing existing factors surrounding best management practice (BMP) adoption mechanisms exposes additional behavioural concepts, which could lead to improved approaches. Therefore, it is argued for the importance of conducting further research that will advance innovative strategies for achieving balances between the actions of farmers and the sustainability of the environment.

Keywords: Environmental Protection, Great Barrier Reef, Attitudes, Sugarcane Farmers, Runoff, Heuristic Decision-Making

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1. Introduction

In the tradition of "The Tragedy of the Commons" (Ostrom, 2016), will history show that one farmer (humanity), acting selfishly, exploited the Commons (the biosphere) for its single species gain at the expense of all other farmers (and other plant and animal species) in the Commons? On the one hand, the human species has been highly successful at maximising the return derived from the environment by employing agriculture intensification methods to keep pace with demand, while on the other, incrementally degrading the environment for which that success depends upon (Garcia, 2020). A primary cause of the degradation is the consequences of NPS pollution from agricultural practices reaching waterways and marine ecosystems (Ribaudo & Shortle, 2019). Internationally, regulatory authorities have struggled to reach a balance in weighing up the pressure to maximise ecosystem benefits from farming against threats to the environment posed by agricultural practices (Bennett et al., 2009). In Australia, this challenge of balancing benefits derived from agriculture whilst protecting the environment from adverse effects is evidenced by the case of the sugar cane industry in Queensland and the Great Barrier Reef (GBR).

The sugar cane industry directly generates 2.5 billion from export earnings (CGA, 2021), while providing in excess of 22,000 jobs over 26 mill sites, 3800 farms and 10,000 businesses across multiple coastal communities (Behrens & Tunny, 2019). The GBR contributes $6.4 billion per year in ecosystem services to the Australian economy, primarily from tourism (Deloitte's, 2019), but more significantly, it has been a globally prominent ecosystem inscribed on UNESCO's World Heritage List since 1981 (UNESCO, 2020). As a signatory to the World Heritage Convention, the Federal Government is obligated to ensure the identification, protection, conservation, presentation, and transmission of the GBR for current and future generations.

This leads to the crux of the problem for the Government because both Federal and State Governments have invested a staggering $667 million on NPS pollution mitigation strategies since 2017 (RWQRC, 2021), but are still struggling to gain traction with farming populations that show a lack of enthusiasm to embrace pollution mitigation policies (Eberhard et al., 2021). With less than 30% of cane farmers actively involved in a "Best Management Practice" scheme and uptake showing notable slowing trends (TRA, 2020), the latest water quality report released in February 2021 states that, "Overall marine condition remained poor" (RWQRC, 2021, p. 2).

Therefore, it is important to understand the current status quo to conduct research that will advance innovative strategies for achieving balances between the actions of farmers and the sustainability of the environment. Conducting a scoping review to synthesise existing knowledge from studies conducted by other researchers globally can assist in better understanding how different countries and cultures are addressing this 'wicked problem' (Peters et al., 2015). Results of the scoping review will lend insight into whether Australia's domestic policy mix is consistent with 'world's best practice' and potentially uncover untried mechanisms to employ.

This review is divided into three parts. The first part provides a background to the phenomenon of environmental protection, the threats from agricultural production, and the policies adopted by governments to manage those threats. The second part covers the scoping review process and results, while the third part presents recommendations and conclusions.

2. Background

Climate change is the greatest threat to the GBR (GBRMPA, 2022). In anticipation of more favourable temperature trajectories resulting from global efforts to reach net-zero carbon emissions (UN, 2015), and developments in heat-tolerant coral species (Buerger et al., 2020), controlling other stressors becomes vital to support the GBR's future (Wolff et al., 2018).

Runoff is a key contributor to the multiple stressor interactions (pollution, sedimentation, ocean warming, and acidification) in coral reef ecosystems (Ban et al., 2014), resulting from the polluted surface and groundwater flow that reaches marine environments via creeks and rivers (Brodie et al., 2019). With 35 major catchments draining into the GBR lagoon, large runoff volumes are unavoidable during cyclone season (GBRMPA, 2020). Water pollution sources are split into two categories: point source, which is easily controlled by directly enforcing regulation on the polluter, and NPS pollution, which cannot be traced back to a singular polluter, making it very difficult for authorities to regulate and control (Wang et al., 2018).

Agriculture's primary chemicals in runoff are nitrogen and phosphorous but include pesticides, herbicides, insecticides and fungicides (GBRMPA, 2020). Runoff from sugarcane farming chemicals and sediment, particularly nitrogen, is identified as the primary source of the degraded water quality entering the GBR lagoon (Eberhard et al., 2021; Taylor & Eberhard, 2020). Excess nitrogen reaching the GBR lagoon has an adverse effect on coral growth; not only does it increase corals' vulnerability to temperature stress, but it also benefits coral predators such as Acanthaster planci (Crown of Thorns starfish) (Bell et al., 2020) and promotes eutrophication (algae blooms) (Gruber & Galloway, 2008) in the reef lagoon inhibiting photosynthesis for seagrasses.

3. Government Regulations

The challenge faced is choosing from a range of policy and regulatory instruments to achieve governments' environmental and economic objectives (Taylor et al., 2013). One of the most important strategies for Government to protect the environment is the use of mandatory and incentive-based policies. However, Gunningham and Sinclair (1999) highlight that single regulatory instruments applied to address environmental protection lack sufficient flexibility to address all issues in all contexts across all stakeholders. The alternate approach is applying a cocktail of policies (Hamilton & Macintosh, 2008), harnessing the strengths of different regulatory approaches to achieve the best environmental protection outcome at the least cost to taxpayers without diminishing the value derived from ecosystem services.

The policy options for governance fall into the following categories (Hamilton & Macintosh, 2008): (1) Regulatory Instruments; (2) Economic Instruments (Market Based Instrument); (3) Voluntary Approaches (Best Management Practices); (4) Information and Education Instruments (Information Education Instruments)

4. This Study

The ability of policymakers to shape policy to create appropriate levels of engagement requires an understanding of the drivers and factors that impact them (Pannell & Claassen, 2020). In Australia, as elsewhere in the world, change in practice has proven challenging for regulators to improve pro-environmental behaviour within the agricultural sector. An embedded culture focused on productivism (Burton & Paragahawewa, 2011) and difficulties and costs in enforcing regulatory compliance mechanisms (Bohman, 2018) restrict choices of policy instruments and resultant outcomes. In addition, social psychological theories link personal engagement beliefs with behavioural outcomes (Eaton et al., 2021).

Several studies identify that shifting farmers' attitudes is pivotal to gaining the engagement of farmers in BMP mechanisms (Piñeiro et al., 2020). There is clear evidence that the Queensland Government needs to reduce NPS pollution (Deane et al., 2017). It is also known that the primary cause of nitrogen pollution originates from cane farming in the catchment on land adjusted to the GBR (QLDGov, 2022). Extensive investment has taken place over the years to mitigate causes of pollution (GBRMPA, 2020), primarily by targeting the behaviour of cane farmers (Eberhard et al., 2021) to change farming practices for improved environmental outcomes. To date, this has produced limited results (Eberhard et al., 2021), with current projections resulting in a pessimistic view of success based on the current uptake of pollutant reduction programs (RWQRC, 2021).

To better understand stakeholders' attitudes to government regulations, this scoping review, a first in combining these two concepts, will provide an understanding of current research in this space and the gap in research, allowing for the positioning of future research. As part of the scoping review, the data was mapped to determine participants, contexts of the studies, and concepts utilised in the studies, with a view to identifying any existing gaps. The scoping review looked for parameters that defined the topic area, the key stakeholders relating to the phenomena, what factors are relevant to the topic, and what actions stakeholders engage in. From this base, recommendations for future research are made.

5. Methodology

This scoping review is based on the guidelines of Arksey and O'Malley (2005) and Levac et al. (2010). It follows two components (Figure 1), reflecting adapted stages of Arksey and O'Malley (2005): (1) stages one, two, and three (accessing and filtering the data); and (2) stage four and five (synthesising the data to present meaningful results). Figure 1 also shows how thematic analysis (TA), adopting Braun and Clarke (2021) protocol, was used to identify key themes, patterns, and meaning.

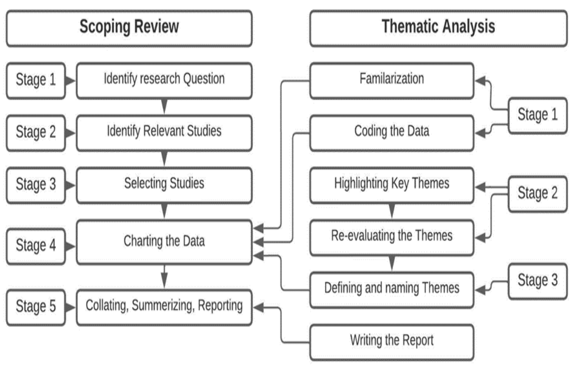

Figure 1- Flowchart showing Scoping review protocol and TA stages.

Stage One – identify the research question

The scoping review is guided by the following research objective: To identify the conceptualisation of farmer attitudes to environmental protection, specifically attitudes to protecting the GBR and in light of government regulations. The table below identifies ideas and questions that framed the scoping review.

Table 1- Key elements to identify relating to the research question

Key elements to Identify with scoping review	Participants	Concepts	Context
Phenomena		Farmers' attitudes toward Environmental Protection	Global Great Barrier Reef Sugar cane farms (Queensland)
Stakeholders	Farmers	Attitudes, values, beliefs, decision-making	Practices relating to the environment
	Government	Regulations	Adoption/non-adoption of regulations
Location	Farmers Government The study		Global Australia / Queensland Great Barrier Reef
Threats	Farmer	NPS pollution	On Farm practices
Mitigation strategies	Government	Regulation options Incentives / Enforcement	Adoption / non adoption

Table 1 highlights that the scoping review sought to capture studies addressing the phenomenon of farmers' attitudes toward environmental protection and related aspects such as participants, concepts, and context.

Stage Two – Identifying relevant studies

Search Strategy

Articles were sourced from Google Scholar because it's known for having the largest coverage of data (Gusenbauer, 2019). Figure 1 (above) presents the strategy to identify relevant studies. The inclusion/exclusion process was executed in stages (levels 1-5), outlined in Figure 2 (below).

An explanation for the selection of Year Ranges

The year 2011 was chosen for the commencement of the scoping review as significant because of the report findings by UNESCO putting the 'State' on notice to demonstrate clear action in protecting the GBR (UNESCO, 2011). In response, the 'State' documented its policies for reef protection via an integrated plan of land and marine use, including legislative changes, increased funding, and the introduction of the Water Quality Report (Commonwealth of Australia, 2012).

2017 was the year chosen to reduce the scoping study range (Level 4, Figure 2) because of the release that year of two significant reports. The first is the '2017 Scientific Consensus Statement' outlining land use impacts on the GBR and the second is the 'Reef 2050 Water Quality Improvement Plan 2017-2022' which focuses on improving water quality flowing from the catchments adjacent to the GBR (Waterhouse et al., 2017) and (Government, 2017). The release of both reports clearly demonstrates an elevated concern for the protection of the GBR at all levels of Government.

Stage Three – Study selection

Selection of Sources of Evidence

Identification of relevant studies began with an iterative process of word combinations (Table 2) to achieve the best possible combination of words and the most succinct results consistent with the project title, rationale, and research question. The word combination process acted to map concepts and terminologies concerning the phenomenon (farmer attitudes toward environmental protection) in the context of relevant stakeholders (i.e., farmers, governments), regulations and their respective environments (e.g., GBR).

Table 2- Iterative search word string combination

Option	Exact phrase	Word string
1	Great Barrier Reef	attitudes farmer
2	Great Barrier Reef	regulation farmer water quality
3	Great Barrier Reef	attitudes farmer marine regulation
4	Great Barrier Reef	attitudes farmer population regulation BMP
5	Environmental protection	attitude farming marine BMP GBR
6	Environmental protection	stakeholder attitude nutrient, marine nitrogen stakeholder
7	Environmental protection	attitudes stakeholder farmer runoff nitrogen marine GBR
8	Environmental protection	attitude farmer marine regulation runoff nitrogen GBR
9	Environmental protection	attitude farmer regulation runoff nitrogen
10	Environmental protection	attitude farmer runoff nitrogen

The final combination of words was chosen because they supported the largest number of associated words discovered during the word selection iteration process and reduced possible errors from using Google Scholar. A total of 5957 studies dating from 2011-2021 were retrieved from Google Scholar that reported having the key phrase of 'environmental protection' and keywords (attitude, farmer, runoff, nitrogen), identified as Option 10 in Table 2. After extraction, the initial studies were subjected to an eligibility criteria process (Figure 2), which resulted in a five-level process for concentrating studies' relevance to the research topic. The extraction process resulted in 86 studies for review.

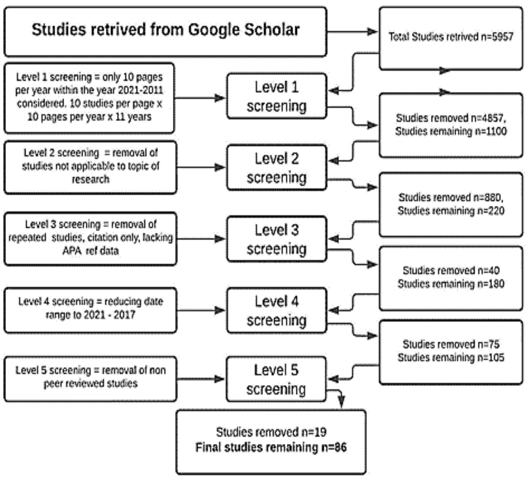

Figure 2- The flowchart shows the data screening process

Eligibility Criteria

The eligibility criteria were determined by the rationale for conducting the scoping study in line with academic standards and the resources available to conduct the search (Levac et al., 2010) and are detailed in Table 3.

Table 3- Eligibility Criteria

	Criteria for inclusion	Criteria for exclusion
1	Published within 2011-2021. Reason for this range: to reflect current governance for environmental protection.	Study published outside the date range at level two 2011-2021.
2	Following appears anywhere in the study: 'environmental protection' as an exact phrase and 'attitudes, farmer, run-off, and nitrogen' as individual words.	The exact phrase and keywords are not appearing in the study.
3	Search results in English.	Not written in English.
4	Eligible: book, journal article, working document, report, or thesis.	Non written information source
5	The study will have traceable evidence of being peer-reviewed prior to submission.	The study does not have any traceable evidence of being peer-reviewed prior to submission.
6		Results with citation only

Screening Process

Table 4 shows the initial numbers of studies extracted by year and the reduction in the number of studies after the application of the screening process by levels one to five.

Table 4- Reductive screening process of extracted Google Scholar studies

Action	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	Totals
Google search	452	452	534	630	555	586	568	571	572	539	498	5957
Level 1 screening	352	352	434	530	455	486	468	471	472	439	398	4857
Outcome	100	100	100	100	100	100	100	100	100	100	100	1100
Level 2 screening	63	78	79	83	80	80	81	77	84	86	89	880
Outcome	37	22	21	17	20	20	19	23	16	14	11	220
Level 3 screening	11	0	0	0	0	0	8	13	5	0	3	40
Outcome	26	22	21	17	20	20	11	10	11	14	8	180
Level 4 screening						20	11	11	11	14	8	75
Outcome	26	22	21	17	19							105
Level 5 screening	3	7	6	1	2							19
Final reviewed	23	15	15	16	17							86

Stage Four - Charting the data

An initial data charting form was developed, which was used to filter studies from level 1 screening to level 3 screening. From this step, a coding approach was adopted to segment areas of study focus based on study title, abstract, and keywords, resulting in 27 specific codes. From this process, consolidation of the data led to the second data charting process (Figure 9). The authors worked to confirm suitability and accuracy and filter data from level four to level five screening, allocating studies into themes along the way. This process was iterative and dependent on what data was revealed in the scoping process and how that aligned with the objectives of the review. The results are divided into two parts: (1) *descriptive results*, which primarily focus on the profiling of the studies; and (2) *substantive results,* which apply Braun and Clarke's (2005) protocol.

Descriptive results

The following descriptive data were extracted from the studies reviewed:

- Total studies per year – for level one (2011 – 2021), level 4 (2017-2021), and Australian-specific studies 2017-2021
- Location of study – Country, region
- Industry – Total studies, Australia.

- Study method – Total studies.
- Theories and Models
- Themes

Total Studies Per Year

Trends in the total number of studies were examined to determine if there is an increasing/decreasing or stable rate of interest in the research topic (Figure 3).

Figure 3 shows the integration of four sets of data: the yellow line (Y) represents the total number of studies for 2011-2021, and the grey line (G) represents studies for 2017-2021. The orange line (O) is the total number of studies within the grey line, identifying studies specific to Australia; the blue line (B) studies specific to the GBR. The purpose of the integration is to compare any trend in the volume of studies between the two sets of numbers (2011-2021 and 2017-2021) and the number of studies which were respectively for Australia and the GBR within the total data sets.

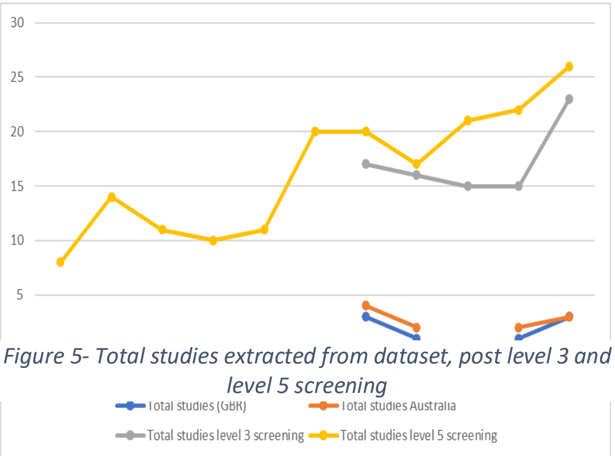

Figure 5- Total studies extracted from dataset, post level 3 and level 5 screening

The comparison for total studies indicates that the years 2011-2021 follow a clear chronological increasing trend for the volume of studies, while over the period 2017-2021, there is also an increase, but the trend is not linear. Both the Australia-related and the GBR-related studies show decreasing then increasing volume of studies, with the latter making up the majority of the Australian studies. The data indicate that overall, there is a growing interest in the topic, particularly from the years 2020 to 2021.

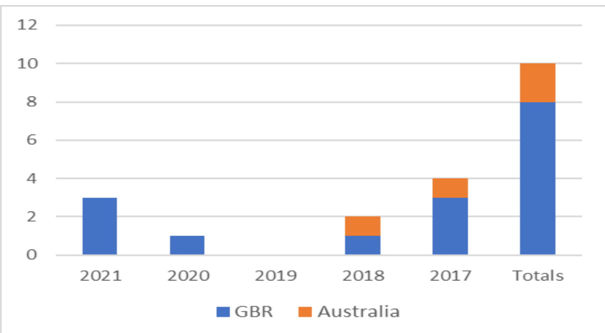

Figure 3- Studies Specific to Australia

Location of Study

It was deemed important to identify the location of the studies, e.g., farmers in the USA (Figure 4). If the study involved multiple countries in a specific region (e.g., European Union), it was recorded as that region. If the study involved more than one identified country, the study was added to each involved country, and if the location was not identified in the study, it was marked as 'Unknown'. The purpose for recording "location of study" was to ascertain to what degree Australia and/or GBR were places of interest in studies relating to the topic.

Figure 4 highlights that the topic of farmer's attitudes to environmental protections is of global interest, with studies (n= 62) set in the northern hemisphere, but some studies

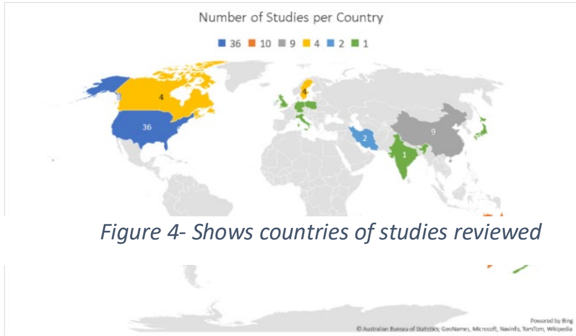

Figure 4- Shows countries of studies reviewed

relating to Australia (n= 10), New Zealand (n= 1), and South Africa (n= 1). Of the 86 studies, 71 were divided across fifteen individual countries, and four studies were shared between two locations (EU/USA, Canada/USA x 2, Australia/NZ). Five studies are allocated to one region (European Union), and 11 studies have unknown locations.

The data shows the USA dominated, with 36 studies (41.86%). Australia was second with ten studies (11.62%), close to China with nine studies (10.47%). Sweden and Canada collectively represented 9.3 % of the sample, while the remaining ten countries together represented 12.79% of the total studies.

Further analysis of the studies highlights concerns for NPS pollution in the USA, Australia, and China; calculated on population, the scoping review shows that Australia far exceeds the USA for the number of studies per head of population at 0.4 studies per one million as opposed to 0.11 studies per one million in the USA across the 5-year range. Looking specifically at the GBR, Australia still exceeds the USA number with a study count of 0.32 per one million heads of the population. This fact reinforces concerns about NPS pollution for Australia and specifically the GBR.

Figure 5 shows of the ten studies relating to Australia, 8 (9.3%) relate specifically to the GBR, with studies covering topics such as water quality themes, BMP adoption, and government policy. The remaining two studies are related to agricultural practices. This percentage of studies dedicated to the GBR reinforces concerns around its exposure to threats of NPS pollution. It highlights the ecosystem's prominence in a global context, reinforcing the value of developing policies to increase BMP adoption in the GBR region.

Industry

In this scoping review, 'industry' refers to the specific type of agricultural practice, such as row crops (wheat, corn, barley, maise) or livestock rearing (e.g., cattle, poultry), with the information sourced from titles, abstracts, and/or keywords. If no specific industry was identified in the study, the label ‘agriculture’ was allocated unless the industry/topic of the study was clearly not agricultural, in which case it is categorised as ‘other’. The purpose of this approach was to determine if one industry type is more dominant and what bearing that has on other aspects of the data.

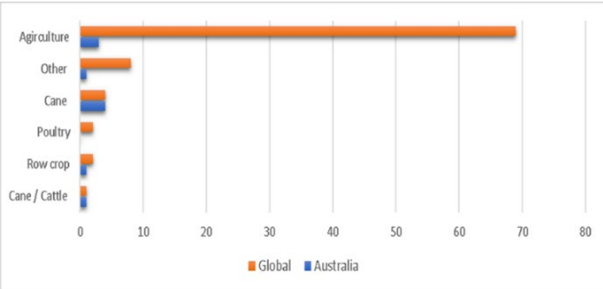

Figure 6- Industry segments

Figure 6 shows that overall, the sugar cane industry and agriculture were the two dominant industries, with ‘agriculture’ often including the sugar cane industry. The generic term ‘agriculture’ appeared in 69 studies (80.23%), with the sugar cane industry being the most prominent (4.6%), while ‘other’ represented community activities, aquaculture, and other non-specified land use. For the Australian studies, the sugar cane industry represented (40%) of the studies. As outlined in stage two, subheading 7.1.1, this confirms the Australian Government directs significant resources to address the issue of NPS pollution associated with growing sugar cane adjacent to the GBR

Study Method

Studies retrieved were assessed to determine the methodology type used, e.g., qualitative, quantitative, or mixed method. The intention of collecting this data was to identify the predominant method type and inform future research.

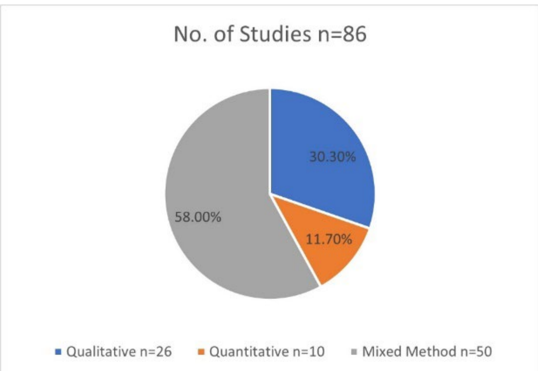

Figure 7- Study methods used for studies reviewed

Figure 7 indicates that the mixed-method is the preferred methodology (50 studies), qualitative methodology was also popular (26 studies), and quantitative methods least (ten studies). The results suggest that all three methods can be used in future research.

Theories and Models

Behavioural theories and models were identified to explain stakeholder action or inaction in relation to government environmental protection policy within the studies. This data also showed to what degree behavioural theories and models are used in studies. A first analysis sought to determine how many studies per year are using theories and models.

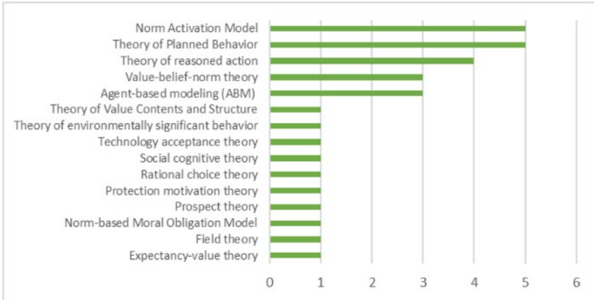

Figure 8- The range of theories and models found in the studies extracted.

Figure 8 shows that the Norm Activation Model (NAM) and Theory of Planned Behaviour (TPB) are the primary behavioural theories/models applied to farmers’ actions. The TPB is recognised as an evolution of the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980). In combination, TPB and TRA represent the primary theory (29%) used in research to explain and predict farmer behaviours. The results show that there is interest in understanding farmers’ attitudes and behaviours, and researchers are utilising different approaches to understanding farmers and their actions.

Stage Five – Collating, summarising, and reporting the result

The following sections present the ‘substantiative results’ and summarise and explore the themes that emerged more deeply.

Substantiative results

As per stages one, two and three of Braun and Clarke’s (2021) protocol for thematic analysis (Figure 1), seven primary themes emerged from the 86 studies: Stakeholder Adoption & Incentives, Farmer Typology, Best Management Practices (BMP), Stakeholder Engagement & Collaboration, Pollution & Water Quality, Stakeholder Attitudes, Government Policies & Strategies.

The explanation for the process undertaken to establish the seven primary themes was undertaken in two stages. For Stage One, each study in the data set, post level three screening (180 studies, see Figure 2), was reviewed via study title, abstract, and keywords to extract information relating to participant/context/content. The purpose of the first data charting process was to allocate a code or codes to each study. Stage one started from a zero-point, so the initial code(s) per study allocation were selected based on the apparent code(s) focus of each study and, through iteration, evolved through the processing of successive studies, resulting in a total of 27 levels of coding, e.g., farmer perceptions, farmer attitudes, farmer behaviour, climate change, policy framing, environmental protection (Figure 9). Because the intention was to scope the data, each study could be allocated one or more codes due to factors including studies being multi-code focused and/or a lack of familiarisation of data and topic by the reviewer at this initial stage.

For Stage Two, the purpose was to identify conceptualised themes that better reflected the research project's purpose. The outcome of this process resulted in the allocation of 27 levels of codes into three groups (Figure 9):

- **Group one.** Twenty-two levels of codes were regrouped into seven themes
- **Group Two.** Two areas of code are allocated separate category headings in the charting process.
- **Group Three.** Three areas of code were not included because they are not seen as significant to the project title and PCC.

Stakeholder Adoption & Incentives

The Stakeholder Adoption and Incentive's theme relates to aspects surrounding farmer uptake of NPS mitigation practices. It considers reasons why farmers will or will not change behaviours, what incentives are being offered by governments and what incentives have proven to be effective in achieving the desired adoption of policies. Prokopy et al. (2019) identified that independent variables such as age, gender and years of farming have consistent statistically significant relationships with adoption; however, some variables are more positively linked to adoption. These include farmers with pro-environmental attitudes, awareness of and positive attitudes toward BMP programs, greater farm size, higher income levels, and formal education.

Other authors state that multiple factors influence adoption, including farmer age, education, years of farming, farm size (Li et al., 2021), risk tolerance, perception regarding consequences of adoption (Ward et al., 2016), suitability of practice to current farming methods (Adusumilli & Wang, 2018), participation in past conservation programs, farmer information sources, existing attitudes and values (Houser et al., 2019) and economic incentives (Piñeiro et al., 2020; Wang et al., 2021b).

Because farmer values, attitudes, and beliefs influence pro-environmental behaviour and preference for incentive types (Okumah et al., 2018), Prokopy et al. (2019) highlight the need for further examination of the relationship between farmers' identities and conservation adoption and the need for more research to evaluate message impact and delivery options for reaching farmers. Palm-Forster et al. (2017) and Pannell and Claassen (2020) stress the value of understanding delivery options to design agri-environmental programs that engage more farmers at a lower cost.

Farmer Typologies

The theme of Farmer Typologies sought to capture the heterogeneity of attitudes and other factors in a given farming population. Several studies echo the effect that farmers' attitudes have on the adoption of BMP's. Rolfe and Harvey (2017) pointed out that heterogeneity among farmers and farming systems makes BMP adoption challenging in the GBR catchment. Furthermore, Hamman and Deane (2018) suggested a rigorous and comprehensive evaluation of strategies to confirm they are culturally appropriate for farmer typologies.

In addition to attitudes towards conservation, Boyer et al. (2018) noted other factors influenced the total number of practices adopted: individual risk perceptions (Ramsey et al., 2019), gender (Wang et al., 2018), education, farming experience, social expectations (Zeman & Rodríguez, 2019). Based on this understanding, Zeman and Rodríguez (2019) recommend more investment in understanding farmer typologies, and Foguesatto et al. (2019) propose identifying and understanding subtypes of farmers to tailor policy framing for BMP adoption. Finally, Hansson and Kokko (2018) recommended broadening farmers' identities and sense of self-worth outside the focus of traditional agricultural production values to assist in connecting them to their role in conservation efforts.

The relevance of acknowledging the existence of variation in farmer typologies is the efficacy of arbitrarily applying "one size fits all" measures to mitigate NPS pollution (Adusumilli & Wang, 2018). This review highlights understanding farmer typologies is crucial for policymakers as a key factor in determining the predictive ability and eventual success in shaping favourable environmental behaviour.

Best Management Practice (BMP)

Several studies in this scoping review cover aspects relating to BMP, which is now the preferred regulatory mechanism for pro-environmental practices. Liu et al. (2018) conclude that uptake of BMPs is positively influenced by the following factors: government subsidies, environmental consciousness, the profitability of the practice, land tenure, farm size, experience, and education. Furthermore, Piñeiro et al. (2020) reinforce the importance of technical assistance in maintaining the success of BMP's. Adding to the conversation, Martinho (2019) recommends providing financial and other forms of incentives to encourage adopters to promote BMP's and Calliera et al. (2021) suggest the benefits of collaborative approaches of all stakeholders (Farmer and Government) in framing BMP policy to create commitment from the outset. Finally, Martínez-Dalmau et al. (2021) and Hamid et al. (2021) identify a lack of information as one of the main hurdles to achieving changes in farmer practices. All these recommendations provide useful considerations for future research.

A study of the sugar industry in Queensland identifies farmer heterogeneity complicates the adoption of BMP's which creates challenges to finding effective mechanisms to encourage adoption (Rolfe & Harvey, 2017). Liu et al. (2018) state it is unclear or debatable if factors, including farm size, land tenure, farmer experience, education, age, gender, political views, and social-political beliefs, have any real bearing on BMP adoption. Campling et al. (2021) point out lack of coordination between different institutional bodies promoting BMP measures can result in overly costly programs with sub-optimal outcomes. Additionally, Schall et al. (2018) highlight that no studies consider the range of viewpoints stakeholders have as a starting point when framing, promoting, and delivering BMP instruments.

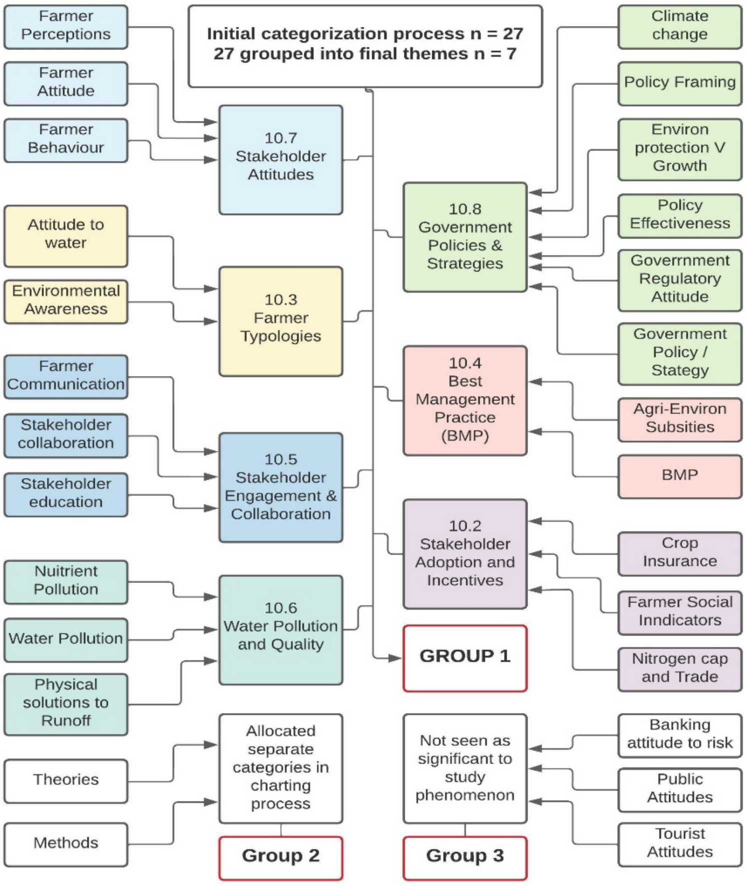

Figure 9- Flowchart shows the process of categorising studies into seven themes (group 1)

Stakeholder Engagement & Collaboration

The theme of Stakeholder Engagement and Collaboration refers to any interaction beyond the enactment of policy by farmers of government regulation, e.g., farmer organisations and Government collaborate on formulating policy, especially within farmer networks. Farmers who are actively part of networks (Pape & Prokopy, 2017) have more positive attitudes toward water quality and a greater understanding of the severity of water pollution; Žilinskaitė et al. (2021) identify the length of time a farmer is in a network influences adherence to NPS mitigation policy. Evidence from the scoping review suggests that strengthening farmer networks (Pape & Prokopy, 2017) and creating channels for more democratic discussions (Santiago & Hong, 2020) to disseminate information within farming communities lowers the cost for governments to promote adoption. Armstrong et al. (2019) advise policymakers to focus on understanding networks' values to guide communications emphasising collective values instead of individual views for more effective policy implementation.

Effective environmental outcomes are achieved through collaboration and dialogue between stakeholders (Santiago & Hong, 2020) at the most inclusive level possible (Olvera-Garcia & Neil, 2020), from Government and farmers to the community level (Campling et al., 2021; Gassett et al., 2021). In Australia's case, the Federal and State levels are the most effective in facilitating reductions in land-based runoff (Deane et al., 2020). Also, discussions need inclusion of payment for an ecosystem services model to improve the efficacy of any policies to safeguard the GBR's future (Oza et al., 2021)

An example of collaboration and information exchange identified in this review was "The Spill Over" effect (Liu & Ruebeck, 2020) as a strategy for governments to lower costs and improve adoption rates. They contend that actions and behaviours migrate within neighbouring farmers, and so it is suggested to design a policy to support and encourage existing BMP farmers in the expectation that BMP benefits will pollinate non-BMP farmers' beliefs and behaviour.

These studies suggest that investing in mechanisms that foster collaboration for information exchange (specifically between early adopter farmers of BMP practice and hesitant adopter farmers) bolsters hesitant farmers' capabilities to enact those same BMP practices.

Water Pollution & Quality

Few studies have water pollution/quality as the primary focus, but in most of the studies, pollution and water quality are the reasons for the study, as exemplified by; "poor water quality caused by intensive sugarcane farming has been among the main causes of degradation on the GBR" (Oza et al., 2021, p. 537) and "nutrient runoff from sugarcane farming practices are a significant threat to the Great Barrier Reef" (Deane et al., 2020, p. 4).

Some studies state 'that agricultural non-point source pollution as a major cause of water quality degradation

(Drangert et al., 2017; Li et al., 2019; Wang et al., 2021a; Zhang et al., 2019) or in more general terms, referring to water quality being threatened as a result of agricultural runoff (Boyer et al., 2018; Floress et al., 2017). Other studies refer to nitrogen as the primary pollutant (Bijay & Craswell, 2021; Gao & Arbuckle, 2021; Yoshida et al., 2018). While others recommended disseminating information on the causes and effects of water pollution (Gharibdousti et al., 2019; Liu et al., 2021; Martínez-Dalmau et al., 2021). Furthermore, Foulon et al. (2019) identify policies focused more on the management of the problem and less on the reduction of the cause of the problem.

Stakeholder Attitudes

This scoping review highlights two theories that are central to understanding farmer attitudes: the Norm Activation Model (NAM) and the Theory of Planned Behaviour (TPB), with the latter being an evolution of the Theory of Reasoned Action (TRA).

NAM states that personal norms define our internal values, moral obligations, and self-expectations, while social/subjective norms are the perceived social pressures to engage (or not) in a behaviour (Schwartz, 1977). TPB explains behavioural outcome (how we act) and is affected by three factors (behavioural belief, subjective norms, and behavioural control) (Ajzen, 1991). Collectively these two concepts represent most behavioural theories underpinning the studies of this scoping review.

Peer pressure and social norms, concepts in NAM and TPB, directly affect farmers' perceptions and attitudes (Prokopy et al., 2008). Study results by Pradhananga and Davenport (2019) identify personal norms and behavioural control influence that pro-environment practices. A study conducted by Hamid et al. (2021) showed that personal norms were stronger predictors of intention, whereas subjective norms had no impact on intention. Liu & Li (2021) showed that subjective norms weaken the effect of environmental concern on both behavioural intention and actual behaviour.

Utilising TPB, Floress et al. (2017) point out that incentives for practice change may need to be re-evaluated considering that farm-as-business attitudes, stewardship attitudes, and awareness of water quality problems are related and that there is growing evidence that pro-social variables influence conservation attitudes. Building on this work, Pannell and Claassen (2020) advise more research is needed to understand why adoption varies, while Eberhard et al. (2021) recommend the use of enhanced monitoring programs to improve on existing evidence for a better understanding of factors that are relevant and effective in influencing adoption decisions.

Government Policies and Strategies

The theme of Government Policies and Strategies relates to interactions of Government and stakeholders (e.g., farmers); policy lever options are discussed above (Government Regulations). Government policy implementation has a direct effect on shaping farmers' attitudes toward the policy, according to Ibrahim and Johansson (2021). Top-down approaches result in a passive farmer population, less connected to pro-environmental commitment, while bottom-up strategies result in more active and environmentally invested farmers. Martinho (2019) suggests accommodation for farmers' needs and perceptions should be incorporated at the policy farming stage of the regulators' policy goals, especially given the growing evidence that pro-social attitudes influence conversation decisions, Whitmee et al. (2015) advise governments should reconsider if economic variables are the sole motivator for positive stewardship by farmers.

Selective targeting of policies is considered more effective in using government funds than blanket approaches currently adopted (Liu & Ruebeck, 2020). Pradhananga and Davenport (2019) advise tailoring a combination of behavioural intervention strategies underpinned by the NAM is more effective at appealing to farmers' values. According to Ibrahim and Johansson (2021), accounting for farmer education levels and expectations when designing training programs needs to also be considered.

Policy instruments have proven to be most effective if culturally appropriate and tailored to consider specific characteristics of a farmer population (Hamman & Deane, 2018; Piñeiro et al., 2020). This includes considering the associated trade-offs between economic, environmental, and social outcomes. In the case of the GBR, a cap and trade scheme for nitrogen is considered unrealistic (Deane & Hamman, 2017); instead, Deane et al. (2017) advocate for a combined instrument approach that involves incentives first, followed ultimately by penalties if required.

6. Conclusion

This scoping review set out to identify the conceptualisation of farmer attitudes to environmental protection, specifically attitudes to protecting the GBR and considering government regulations. Overall, it showed that in the studies examined, both at a global level and specific to Australia, research highlighted discussions relating to the Government's policy options in addressing concerns for water quality. The studies reviewed revealed that farmers are primary contributors to NPS pollution, and researchers have outlined factors in relation to reasons for, or resistance to, behaviour change to mitigate the pollution. The factors for global studies are the same factors that hold true for Australian studies. The scoping review revealed that no government policy or policy combinations are universally effective in influencing farmers' attitudes towards environmental protection.

It also showed that all countries studied are experiencing and dealing with the problem of NPS pollution in some form or another. The US was the most prominent country in the scoping review (41.86%) and represented a spread of available strategies for governments to apply to mitigate NPS pollution. The results showed that the adoption of incentives could be universal within farming populations to equal or varying degrees of efficacy (e.g., financial incentives) or non-universal (e.g., appealing to conservational attitudes) and can be present or absent in different combinations. Across all the studies, there was variation from country to country in the degree of incentivising and adoption taking place (Zhang et al., 2019). The scoping review identified an agricultural ecosystem comprised of a broad range of farmer typologies responding to a broad range of policies and adoption incentives with varying degrees of efficacy across diverse geographical locations.

The scoping review also illustrates that farmers are not homogeneous in attitudes and can be divided into various typologies as identified by various studies, highlighting that no one policy or policy combination has universally desirable outcomes across stakeholder populations within given geographical locations. It appears that farmers are not acting in a binary fashion for decision-making but rather are motivated by a diverse range of incentives to adopt pro-environmental practices. This finding led to thinking of the importance of decision-making, and the resultant behaviour, being important aspects of any future research. Consequently, there is a need to explore key behavioural and/or decision-making theories, including TPB and the NAM.

In summary, the literature lacked evidence explaining the connection of factors for the non-adoption of government policies from the farmers' perspective. It does not seem to account for possible complexities arising from various government mitigation mechanisms being misaligned with farmers' day-to-day decision-making processes. Hence, it is recommended more research be undertaken to explore factors that impact farmers' decision-making and their attitudes relating to the adoption of government regulations.

Building on the findings of the scoping review, especially the recommendations made in respective papers from the data set, future research should address the following.

- Identify attitudes of farmers towards government regulations.
- Identify the significance that attitudes play in a farmer's day-to-day decision-making process.
- Explain how attitudes are influencing farmers in a range of situations and why.
- Develop a framework to inform government regulation for BMP application.

The value of understanding the role of attitudes in farmers' day-to-day lives presents an opportunity to assess if there are cognitive or emotional biases that are involved in influencing decisions necessary for the enactment of preferred pro-environmental behaviour (Floress et al., 2017). Such data could lead to identifying factors driving farmers' attitudes and provide policymakers with opportunities to shape mechanisms that specifically target factors underpinning heuristic decision-making. Heuristics are efficient cognitive processes, conscious or unconscious (Gigerenzer & Gaissmaier, 2010), that ignore part of the information but are undertaken to get a problem solved (a job done) as opposed to decisions for actions that are recognised to be optimal decisions (Dale, 2015). Examples would be applying "a rule of thumb," "gut feeling," "best guess," and intuitive judgments. The intent of such research could be to develop a framework that will facilitate the process of design, creation and implementation of realistic and achievable regulations. Therefore, the proposed research could adopt a theoretical framework that incorporates TPB and TRA thinking with heuristic decision-making.

The interests of the sugar cane industry and the Government in protecting the GBR can appear to be diametrically opposed at times. The challenge for stakeholders is to shift the relationship from one of the trade-offs (actions positively benefitting one ecosystem while adversely affecting the other) to one more aligned with coexistence, without undue negative influence by either party on the other. The purpose of this scoping review has been to identify the conceptualisation of farmer attitudes to environmental protection, specifically attitudes to protecting the GBR and in light of government regulations.

Australian studies are well represented within the scoping review giving the opportunity to draw clear comparisons and differences. The review demonstrates similarities in mechanisms adopted by numerous countries and commonalities in the challenges of effecting policy goals based on the policy mix employed.

The review confirms that the use of voluntary incentives and extension strategies is the preferred strategy to mitigate anthropogenic impacts on our ecosystems from NPS pollution globally. It highlights the value of collaborative governance with inter-stakeholder exchanges, exposing behavioural theories that underpin factors influencing the adoption of conservation practices. It is also clear from the literature that mitigation strategy effectiveness is directly influenced by an understanding of farmer typologies, allowing for tailoring incentive options to improve adoption within a known heterogeneous population.

This presents challenges for policymakers both in Australia and elsewhere to structure mechanisms that are perceived to be tailored at an individual farmer level yet broad enough to encompass the entire farming population. In light of this consideration and the recommendations highlighted in the scoping review, including further research, the emphasis is consistent for all stakeholders to work collaboratively to develop outcomes that meet the needs of farmers charged with feeding humanity and the Government charged with protecting the environment.

7. Limitations

This scoping review does have limitations. The primary limitation was use of only one data source, "Google Scholar". For the purpose of increased validity, integration of additional databases such as "Web of Science" and "Scopus" would have improved the research. Another limitation was the number of years covered in the review: 2017-2021. Hence, a recommendation would be to extend the year range to other years.

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