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# Improving conservation outcomes in agricultural landscapes: farmer perceptions of native vegetation on the Yorke Peninsula, South Australia

**Bianca Amato**[1,2] · **Sophie Petit**[1,2]

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## Abstract

With agriculture the primary driver of biodiversity loss, farmers are increasingly expected to produce environmental outcomes and protect biodiversity. However, lack of attention to the way farmers perceive native vegetation has resulted in conservation targets not being met. The Yorke Peninsula (YP), South Australia, is an agricultural landscape where < 5% of vegetation remains on private properties and roadsides. To identify YP farmers' barriers to vegetation conservation on the roadside and private properties, we interviewed 35 farmers representing 56,980 ha of farms (11% of the YP area) and three agronomists. We identified five barriers to conservation: (1) negative perceptions of roadside vegetation and (2) management bodies; (3) absence of effective conservation programs making use of farmers' motivations; (4) > 50% farmers perceived that long-term planning was for ≤ 30 years, not enough time to promote ecosystem conservation; (5) a lack of natural resource management information for farmers—as a result, farmers relied on their own experience to manage vegetation. Furthermore, most farmers depended on agronomists, who generally had no stake in biodiversity conservation. We recommend that (1) the Local Council restore social capital by liaising with farmers to promote roadside vegetation (2) long-term farmer-led conservation action be established and supported by Government and industry acting as facilitators rather than project managers; (3) a change in policy and training promote the involvement of agronomists in conservation and its management on private properties; (4) all levels of Government develop schemes to demonstrate the tangible benefits of native vegetation as habitat for wildlife; (5) on-farm conservation be celebrated as successful farming.

**Keywords** Agricultural advisor · Agronomists · Biodiversity conservation on farm · Long-term planning · Roadside vegetation · Social capital

## Abbreviations

| | |
|---|---|
| CRMP | Collaborative Resource-Management Program |
| PIRSA | Department of Primary Industries and Regions |
| DEW | Department for Environment and Water |
| NRM | Natural Resource Management Boards |
| RD&E | Research, Development and Extension |
| RVMP | Roadside Vegetation Management Plan |
| SA | South Australia |
| YP | Yorke Peninsula |
| YPASG | Yorke Peninsula Alkaline Soils Group |

✉ Sophie Petit
sophie.petit@unisa.edu.au

[1] UniSA STEM, University of South Australia, Mawson Lakes, South Australia 5095, Australia

[2] Kangaroo Island Research Station, Penneshaw, South Australia 5222, Australia

## Introduction

Agricultural production occupies ~ 40% of the earth's terrestrial surface (Foley et al. 2005) and is a large contributor to habitat loss and extinction (Dudley and Alexander 2017). Australia is not impervious to the issue; for example, it has one of the worst mammal extinction rates in the world. In the last 200 years, 30 endemic Australian mammals have become extinct, representing 35% of the world's modern mammal extinctions (Woinarski et al. 2015). Geyle et al. (2018) predicted that another 7 Australian mammals and 10 Australian birds will be extinct by 2038 if management is not improved. Habitat conservation in agricultural landscapes has become a global emergency (Haddad et al. 2015), and keeping the *status quo* will aggravate biodiversity loss.

Traditionally, large fragments of remnant vegetation have been the main focus for conservation and legislative protection, based on ecological theory (theory of island

biogeography, MacArthur and Wilson 1967; species-area relationship, Rosenzweig 1995; patch size–population density relationships, Connor et al. 2000). In Australia, the average size of protected reserves is 9900 ha (Watson et al. 2011). These large reserves fail to protect many species, with 166 threatened species existing entirely outside protected areas (Watson et al. 2011). These reserves are often spatially isolated from each other (Watson et al. 2001), and the lack of protected areas between them does not allow for the movement of many species.

Conservation outside large, protected reserves is essential for the recovery of many threatened species, especially in highly modified landscapes. In Australia, at least 22% of major vegetation communities have more than 50% of their vegetation remaining in patches smaller than 1,000 ha (Tulloch et al. 2016). Small fragments are the most vulnerable to land clearance. The conservation of small fragments is often overlooked, even when protecting and managing small fragments connects fragmented landscapes and large protected areas (Bennett 1999), and benefits biodiversity (Tulloch et al. 2016; Busse et al. 2021) and agricultural production (e.g., water purification, carbon sequestration, nutrient recycling, soil stability and fertility, biological pest control, waste decomposition, seed dispersal, and pollination; Scherr and McNeely 2008). In Australia, roadside vegetation is often the only extant vegetation in heavily cleared landscapes. Roadside vegetation provides habitat to sustain biodiversity (Muñoz et al. 2014; New et al. 2021), provides corridors that facilitate wildlife movement (Bennett 1991), and increases the ecological connectivity across the landscape (Forman 2012). Roadside vegetation is under threat from clearing and degradation as a result of inadequate policy and inconsistent management (Bushfires Legislation Amendment Act 2020; New et al. 2021). The conservation value of roadside vegetation and small privately owned fragments must not go unnoticed.

Conservationists and all levels of Government expect farmers to deliver conservation outcomes and maintain natural vegetation; however, farmers' main business aim is the profitable production of their crops and livestock rather than the maintenance of biodiversity (Farmar-Bowers and Lane 2009). Many scientists and policymakers have expressed frustration at the low levels of rural conservation practices (Pannell et al. 2006).

Economic incentives, education programs, and policy are the three main forces that engage farmers in biodiversity and ecosystem conservation. Government programs such as Australia's National Landcare Program offer economic incentives (grants or compensation) to encourage landholders to adopt conservation practices. Critics have voiced their doubts about the effectiveness of economic incentives to halt biodiversity loss (McCauley 2006; Redford and Adams 2009) and argue that economic incentives dilute and lessen the effectiveness of pro-nature and social motivations for engaging in biodiversity and ecosystem conservation (Rode et al. 2015). Economic programs have not been sufficient in delivering high levels of conservation (Pannell 1999) and have had varied success across States and communities.

The effectiveness of environmental education in behaviour change has been contentious. One view is that environmental education and relevant information have little effect on decision making and adopting pro-environmental changes, and that subjective beliefs and social norms are the key to behavioural change (Owens 2000; Jensen 2002; Kollmuss and Agyeman 2002; Gifford et al. 2011; Fang et al. 2017). Studies such as that by Kempton et al. (1996) found that knowledge was not a prerequisite for pro-environmental behaviour. Even detailed technical knowledge does not foster pro-environmental behaviour (Diekmann and Franzen 1999). Llewellyn et al. (2007) found that programs raising the awareness of herbicide resistance did not significantly influence integrated weed management practices in Western Australia.

Governmental policies aim to encourage farmers to adopt conservation practices through incentives, legislation, research, consultation, and the removal of policy barriers that harm biodiversity conservation. The effectiveness of policy-driven conservation is dramatically different around the developed world (Díaz et al. 2019). Policy in South Australia (SA) relies on legislation and its regulatory powers to protect and prevent large-scale clearance (e.g., *Native Vegetation Act 1991*). The State Government of SA has attempted to promote conservation to private landowners by encouraging habitat restoration of large remnant areas via Heritage Agreements, voluntary Landcare groups, or economic incentives for invasive species control (*Landscape South Australia Act 2019*). The current SA policy model does little to acknowledge the importance of small vegetation patches to biodiversity on agricultural landscapes (Bardsley et al. 2019).

Economic incentives, education programs, and policies struggle to motivate or engage farmers in on-farm conservation (Home et al. 2014). Traditionally, research into pro-environmental behaviours on farms has focused on either demographic or psychological factors (Kollmuss and Agyeman 2002). Farm characteristics, education, gender, and economic circumstances can influence private conservation (Vanclay and Lawrence 1994; Barr and Cary 2000; Kollmuss and Agyeman 2002; Curtis et al. 2003; Knowler and Bradshaw 2007; Larson et al. 2015; Lechner et al. 2015;). Raymond et al. (2011) and Seabrook et al. (2008) found that education, farming experience, and the prevalence of existing native vegetation influenced farmers' engagement and conservation values. These studies identified specific areas, factors, and people likely to engage in conservation programs successfully. In many agricultural communities, it

can be argued that farmers are generally not environmentally engaged, and studies such as these will only identify the very few who are likely to adopt conservation outcomes freely (Cary et al. 2001).

Psychological studies and theory-drive frameworks predict an individual's intention to engage in a pro-environmental behaviour based on their values, identity, social-norms, and emotions (see Cognitive Evaluation Theory, Amabile et al. 1976; Theory of Planned Behaviour, Ajzen 1991; and Self-Determination Theory, Dworkin 1988). Despite the abundance of research aimed at understanding adoption behaviours and to promote conservation, few universal theories explain conservation adoption, and uptake is still poor (e.g.,Knowler and Bradshaw 2007; Prokopy et al. 2008, 2019). Knowler and Bradshaw (2007) indicated that the results of adoption research should be meaningful for local management rather than be based on universal frameworks. Considering the *locational specificity* of agricultural communities (Wandel and Smithers 2000), we used an inductive approach to help us understand farmers' perceptions of native vegetation and the other mechanisms, such as place attachment and social capital that prevent or support conservation of privately-owned remnant vegetation or roadside vegetation.

Connectedness to nature or place attachment is not a new approach to pro-environmental behavioural research (Hinds and Sparks 2008), but it has not been used much to understand farmers' motivations in conserving native vegetation (Gosling and Williams 2010). Place attachment refers to the emotional bond between an individual and an environment (Seamon 2013). It is hypothesized that spending time in nature helps individuals care about the environment and ultimately protect it (Beery and Wolf-Watz 2014). Intrinsic motivations based on emotional attachment are more effective at changing behaviours, and many studies argue that biodiversity must be meaningful to farmers for them to adopt conservation practices (Yliskylä-Peuralahti 2003; Herzon and Mikk 2007; Henle et al. 2008). For example, Gosling and Williams (2010) showed that vegetation protection on private farming properties increased connectedness to nature. However, place attachment should be explored in more depth in adoption research as a non-tangible motivator for conservation (Kals et al. 1999).

Social capital is the notion of individuals engaging in social networks in order to secure benefits (Lin 2017). Putnam (1993) described social capital as the trust and norms of reciprocity that are inspired in social networks, and that can improve society. Brought to prominence by Bourdieu (1985) and Coleman (1988), the concept has gained popularity in natural resource management because social capital can overcome barriers to achieve mutually beneficial conservation outcomes (Pretty and Ward 2001; Auer et al. 2020). Positive social relationships at the individual and community levels facilitate collective action, shared knowledge, and governance around conservation (Pretty and Smith 2004; Petrosillo et al. 2013; Alló et al. 2015; Arnott et al. 2021). As a result, people have the confidence to invest in the environment, promoting a greater chance of sustained environmental stewardship (Auer et al. 2020). However, in Australia, negative past experiences and distrust in the government decreased farmers' willingness to protect biodiversity (Ens et al. 2013). Social capital among farmers and local government could play a role in conserving remnant and roadside vegetation.

Agronomists are key stakeholders in a farm's success and can influence landscape management strongly. The agronomist's role is to support and advise farmers on new technologies, production, research, policy issues, best practices, legislation, commercial enterprises, and environmental processes (Ingram 2008). As a result, agronomists have become an integral part of farm management, and the increase in their numbers is a testament to their popularity (Kuehne et al. 2019). In the past, agronomists have advised policymakers (Ploeg and Douwe 1989), been agents of change (Ingram 2008), and distributors of technical information and expert knowledge (Burgess et al. 2000; Tsouvalis et al. 2000). This top-down approach gives agronomists a considerable amount of power on the farm. Agronomists often have long-established relationships with farmers, creating a bond built on reliability, trust, and empathy (Ingram and Morris 2007). Many are farmers themselves, with similar shared experiences and normative beliefs. The nature of their relationship allows agronomists to facilitate the adoption of new farming practices. Rather than persuading the farmer to undertake new initiatives or comply with regulations, a successful agronomist will support practical farming decisions based on mutual trust (Ingram 2008). We propose that agronomists could be a means of delivering credible environmental knowledge that informs conservation, especially since 86% of farmers use agronomists on the YP, a practice that mostly influences the management of agricultural land (Llewellyn and Ouzman 2014).

We focused our study on farmers and agronomists from the agricultural region of the Yorke Peninsula (YP) in SA. Twenty-four out of 30 terrestrial native mammals have become locally extinct there since agricultural development in 1846 (McDowell et al. 2012). Currently, 267 plant and 140 animal species are critically endangered, endangered, vulnerable to extinction, or considered rare (Gillam and Urban 2008). The YP is predominantly an agricultural landscape. The remaining native vegetation is situated at the southern tip of the peninsula at Dhilba Guuranda-Innes National Park, totalling 24,921 ha of protective native vegetation (4.3% land cover). A further 27,721 ha of unprotected native vegetation remains on roadside, private properties, and coastlines (4.8% cover). Only 2% of vegetation patches

are > 100 ha (Neagle 2008); most are too small to maintain viable plant and animal populations of many species. Engaging with the farming community is crucial to effect conservation at landscape scale and ensure the survival of the last few native vertebrate species. Lack of conservation engagement by many landholders threatens what little biodiversity remains on the YP.

We interviewed traditional farmers and agronomists. Traditional farmers were also grouped as high, moderate and low adopters of conservation based on the frequency of revegetation on their properties. The first objective of this study was to examine farmers' perceptions of roadside and privately-owned native vegetation (hereafter, native vegetation), and their future long-term goals for their farm. We specifically split the two vegetation types, roadside and native vegetation, to identify whether they needed to be managed differently according to the results of this study. Roadside vegetation was controlled and managed by the District Council of YP's Roadside Vegetation Management Plan (RVMP) and legally enacted under the *Landscape South Australia Act 1991*. Under the policy, the Council and the Northern and Yorke Landscape Board are solely responsible for managing roadside vegetation and the invasive species present in the roadside vegetation. Privately-owned native vegetation is partially protected from clearance by the *Native Vegetation Act 1991*) and the *Native Vegetation Regulations 2017*). However, farmers are responsible for managing their native vegetation and can apply to the Native Vegetation Council to remove vegetation under the guidelines of the Act and Regulations. We hypothesized that strategies to promote conservation would differ according to perceptions of the different vegetation types. Secondly, we wanted to determine whether perceptions differed among farmer groupings. This knowledge would help to target farmers with differing perspectives and behaviours, ensuring multiple strategies could be implemented to promote conservation. Our third objective was to determine whether information access was a barrier to roadside and native vegetation management. We also interviewed agronomists to determine whether agronomist vocational training could be a tool to effect conservation outcomes. Finally, we wanted to come up with recommendations to improve conservation outcomes based on the findings of this study. Understanding the perceptions of famers is critically important to help overcome the barriers to conservation adoption, and for intervention and engagement strategies to be implemented successfully.

## Methods

### Study area

The Yorke Peninsula is located in SA, Australia. The 5,834-km$^2$ peninsula was cleared for agricultural development from 1846, leaving most of its natural environment highly fragmented (Fig. 1; Corbett 1973). Of the ~11,000 people who reside there, over 16% are employed in the grain growing, or grain-sheep and grain-beef cattle farming industries, compared to 0.8% of South Australians (Australian Bureau of Statistics 2016). The small patches of intact vegetation remain on soils unsuitable for agriculture (deep sand or shallow soils over calcrete). Threatened animals that persist on the YP includes the nationally threatened plains wanderer (*Pedionomus torquatus*), the malleefowl (*Leipoa ocellata*) and the mallee whipbird (*Psophodes leucogaster leucogaster*). Introduced predators are common throughout the YP, exacerbating the impacts of habitat loss and fragmentation on existing species and future mammal reintroductions (Graham et al. 2013).

### Data collection

We used qualitative face-to-face surveys. Farmers from the study region advised us that respondents were more likely to answer short open-ended interviews face-to-face rather than a mail-out or online survey. Raymond and Weber (2014) found that the response rates to a mail-out survey for the YP was < 10%, suggesting that farmers preferred short interview to lengthy questionnaires. The interview consisted of 27 open-ended and short-answer questions, requesting demographic, farming history, vegetation management, and perception-related information.

We collected data at the Paskerville Field Days (29–30 September and 1 October 2015), the Minlaton Show (7 October 2015), and the Maitland Show (11 March 2016). We had a booth connected to SA's Department for Environment and Water (DEW) (formerly Department for Environment and Natural Resources) and Alkaline Soils Group community displays. We asked those passing by or stopping at the booths if they were farmers and would like to participate in a survey about native vegetation on the YP. Respondents who completed the survey went into a draw to win a $500 voucher. In addition, we gave three agronomists from the YP a similar open-ended survey, with additional questions relating to their qualifications, role, and what farming success meant to them.

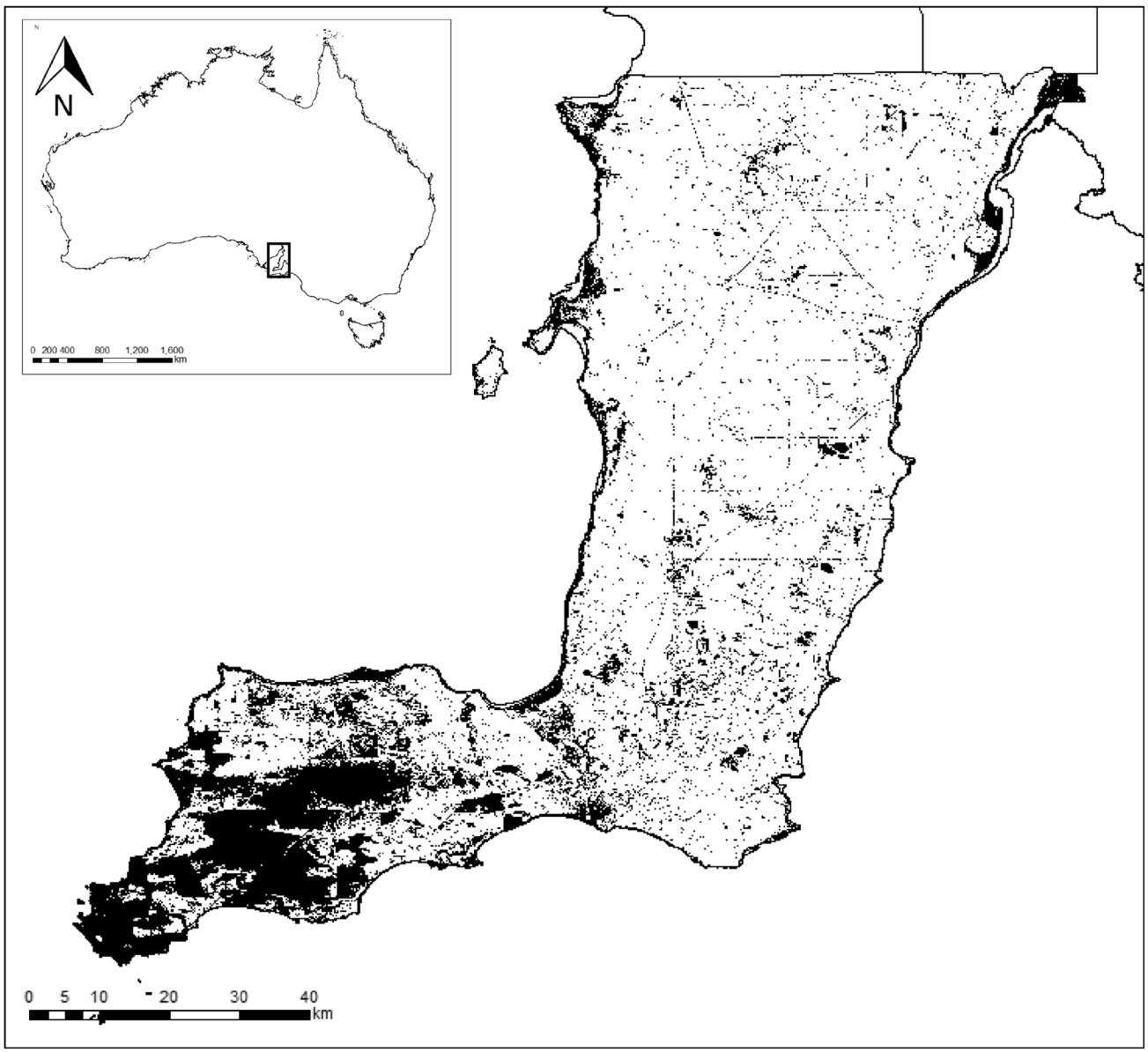


**Fig. 1** Native vegetation (in black) on the Yorke Peninsula (Data source: Government of South Australia 2018a, 2018b)

## Survey design

Initial survey questions were related to the respondents' perceptions of roadside and native vegetation. We gave farmers a participation form to read, which defined roadside and native vegetation: roadside vegetation consists of narrow strips of vegetation parallel to roads and tracks. Native vegetation is an area consisting mostly of native trees, shrubs, and herbs, not in a strip along a roadside, and including at least three trees clumped together. We reiterated the differences before the interview began and ensured that they understood the questions about native vegetation on their privately owned properties. This terminology is standard in the agricultural area of the YP and farmers indicated that they understood the differences. Respondents listed the problems and benefits of the two vegetation types, their fears regarding vegetation management, and who they felt was responsible for vegetation management on the YP.

The second section of the survey was related to respondents' behaviours and motivations. We asked respondents how often they planted native plants on their property in the last ten years, the motivations that led to that decision, and they selected from a list of answers what would motivate them to plant native plants on their property (see results). Respondents also gave their long-term vision for their property, and explained what long term meant to them.

The third section focused on information accessibility. We asked respondents where they got their roadside and native vegetation management information, as well as information on the benefits of revegetation.

### Data analysis

We asked famers if they had revegetated in the last ten years to measure their conservation engagement and adoption level. We hypothesized that farmers who revegetated regularly were more likely to be environmentally conscious and have positive environmental, social, and agricultural perceptions of native vegetation (e.g., Reimer et al. 2012; Kalcic et al. 2014). We used multiple regressions in SPSS Version 27.0 to determine whether a relationship between demographic (age, farming experience, and farming generation) and landscape factors (farm size and area of native and roadside vegetation) and revegetation characteristics existed (IBM Corp. 2020). Our exploratory study aimed to develop an understanding of farmers' perceptions of native roadside and remnant vegetation, which is inductively based on patterns across participants' responses (Bengtsson 2016), and draw tangible solutions based on the site-specific context of the YP.

We used qualitative content analysis, which incorporated some of the procedures of Grounded Theory, such as open coding and memoing (Sandelowski and Barroso 2003; Cho and Lee 2014). Data were analysed using QSR International's NVivo 11 software (2015). Data were open-coded with descriptive codes based on Babbie's (2000) and Bengtsson's (2016) methods. During the second coding round, we examined the descriptive codes and organised them into themes deductively and inductively. Table 2 shows our conceptual themes derived from our own findings as wells as the existing theoretical frameworks and prior categories (Kleinheksel et al. 2020). Themes were compared across interviews and validated between authors. The sample size was adequate to exemplify views across the YP, representing 11% of the total agricultural landscape.

Respondents were grouped by their frequency of revegetation in the last ten years, as high, medium, or low adopters of conservation. High adopters revegetated parts of their properties annually or biennially, medium adopters had revegetated once or twice, and low adopters had not completed any revegetation activities in the last ten years. We compared conceptual themes among the three groups, and used SPSS's Version 27.0 (IBM Corp. 2020) multiple response analysis, which involves a frequency analysis for data when respondents have more than one response. We also performed semi-structured interviews with four of the highest adopters of conservation. They were a part of the Conservation Action Planning Group run by the Department of Environment, Water and Natural Resources ($n=3$), or intensely involved in revegetation ($n=1$). Interviews were conversations, and provided additional insight into the agricultural community of the YP.

## Results

Quantitative results are presented in Supplementary Information A, B, C, and D. A summary of the conversations with the four most engaged high adopters of conservation is presented in Supplementary Information E.

### Response rates and socio-demographics

Thirty-five farmers who managed 11% (56,980 ha) of the farming land on the peninsula (as determined by geospatial analysis) and three agronomists were surveyed. Most respondents were males aged 46–55 years. Most respondents were either fourth- or fifth-generation farmers, and the mean (± S.D.) farming experience was 40.5 ± 13.8 yr. The properties ranged from 180 to 6,070 ha, and 75.6% of properties were < 2,000 ha. Cereal crops (wheat and barley), followed by legumes and sheep, were the most common agricultural products (Table 1).

**Table 1** Socio-demographic characteristics of respondents ($n=35$)

| Socio-demographic Characteristic | Responses category | Response % |
|---|---|---|
| Sex | Male | 91.5 |
| | Female | 8.5 |
| Age | Under 25 | 0 |
| | 26–35 years | 2.9 |
| | 36–45 years | 17.1 |
| | 46–55 years | 34.3 |
| | 56–65 years | 11.4 |
| | Over 66 years | 34.3 |
| Total area of properties (ha) | 0–1000 | 40.5 |
| | 1000–2000 | 35.1 |
| | 2000–3000 | 13.5 |
| | 3000–4000 | 2.7 |
| | 4000–5000 | 5.4 |
| | Larger than 5000 | 2.7 |
| Generation farmer | First | 0 |
| | Second | 2.9 |
| | Third | 28.6 |
| | Fourth | 31.4 |
| | Fifth | 37.1 |
| Main livestock/crops by area | Cereal (wheat/barley) | 97.1 |
| | Legume (lentil/bean) | 51.4 |
| | Sheep | 48.6 |
| | Cattle | 14.3 |
| | Canola | 8.6 |

**Table 2** Conceptual themes used within the study and their definitions

| Theme | Definition | References | Example quotes |
|---|---|---|---|
| Economic and/or agricultural productivity | Vegetation is expressed as either an expense or a monetary asset to the farmer. This theme's context is that the farm is a business and farmers are strongly focussed on agricultural productivity | Reimer et al. (2012) | "Farming is a business, [the long-term vision] is to continue to make money."<br>"It [native vegetation] restricts income. It is prime farming land."<br>"It [vegetation] harbours weeds that are hard to control… trees take out fences."<br>"It [vegetation provides] shelter for stock… brings up moisture… controls erosion." |
| Place attachment | Farmers have positive bond with natural vegetation, including enjoying vegetation for its aesthetic value, emotional connection, and a sense of stewardship and inherent responsibility for the land | Altman and Low (1992); Gosling and Williams (2010); Raymond et al. (2011) | "Economically no [benefits to native vegetation], but I prefer to keep it. It just makes you feel good."<br>"As I'm getting older, I appreciate vegetation more." |
| Social capital | Farmers working together to influence positively the adoption of conservation<br>This theme also includes negative perceptions of vegetation managers (e.g., Local Council) | Warriner and Moul (1992); Knowler and Bradshaw (2007); Jones et al. (2009) | "[Information about vegetation management comes from] word of mouth… neighbours."<br>"Council don't take care of it [roadside vegetation] anymore. Weeds are out of control from lack of Council management."<br>"Council clears it [roadside vegetation] back too far, they just bulldoze it down instead of trimming." |
| Environmental engagement | Farmers' concern for vegetation is expressed through this theme. Farmers recognise the off-farm benefit of vegetation, such as habitat for wildlife, increasing biodiversity, and local conservation issues | | "It [revegetation] provides corridors for native animals."<br>"It [vegetation] hosts native birds and insects."<br>"[My greatest fear is the] disappearance of a full spectrum of species." |
| Hazards and safety | Concerns of car accidents, fire and public liability relating to vegetation | | "If fire is out of control, it is too hard to get in to [native vegetation] and fight."<br>"It [roadside vegetation] is mostly dangerous, there is no visibility and kangaroos are lurking. It is dangerous for vehicles." |

## Themes and motivations

Respondents' perceptions were coded into five themes: economic and/or agricultural productivity, place attachment, social capital, environmental engagement, and hazard and safety. Conceptual themes were based on our own finding and existing literature (Table 2).

## Demographics related to environmental adoption

Only 37.1% of respondents had not revegetated or planted native plants on their properties in the last ten years. Linear regression showed no relationship between the respondents' demographic factors (generation farmer, years of experience, farm size, and age) and the percentage of area revegetation of their property within the last 10 years ($R^2 = 0.167$; $F_{4,30} = 1.165$, $p = 0.350$) (gender was removed from the analysis because of the small sample size of females). Farmers with a large percentage of existing native vegetation were more likely to revegetate in the last ten years ($R^2 = 0.217$; $F_{1,33} = 10.395$, $p = 0.003$), but we found no significant relationship between the demographic factors and extant of existing native vegetation ($R^2 = 0.231$; $F_{4,34} = 2.247$, $p = 0.087$).

High adopters ($n = 12$) of conservation were farmers who revegetated annually (22.9%) or every second year (11.4%), moderate adopters ($n = 10$) revegetated once (5.7%) or twice (22.9%), and low adopters ($n = 13$) had never revegetated (37.1%) within the last ten years. Differences in perceptions and future motivations among the three groups are discussed under each thematic heading (Figs. 2 and 3).

## Economic and agricultural productivity

Economic productivity was the most prominent theme found throughout the entire survey. Over 80% of respondents perceived that roadside vegetation reduced their economic and/or agricultural productivity, compared to 60% for native vegetation. None of the respondents expressed monetary concerns over managing roadside vegetation; instead, they listed physical issues that cost them time and resources, or problems that reduced farm productivity. Managing weeds was the main economic issue associated with roadside (62.9%), followed by vegetation overgrowth on fences and crops (28.6%). Feral animal control (17.1%), vegetation overgrowth (17.1%), and taking up productive land (17.1%) were the second greatest economic problems associated with native vegetation behind weeds (37.1%). Several farmers commented on the economic cost of managing native vegetation: "It can be a large cost when planting native vegetation," and "it restricts income. It is prime farming land." These perceptions were absent when farmers were responding to questions about roadside vegetation.

Most farmers perceived that roadside (74.3%) and native vegetation (77.1%) had on-farm economic benefits. Agricultural economic benefits such as providing a windbreak (54.3%, 20.0%) and shelter for stock (40.0%, 60.0%)

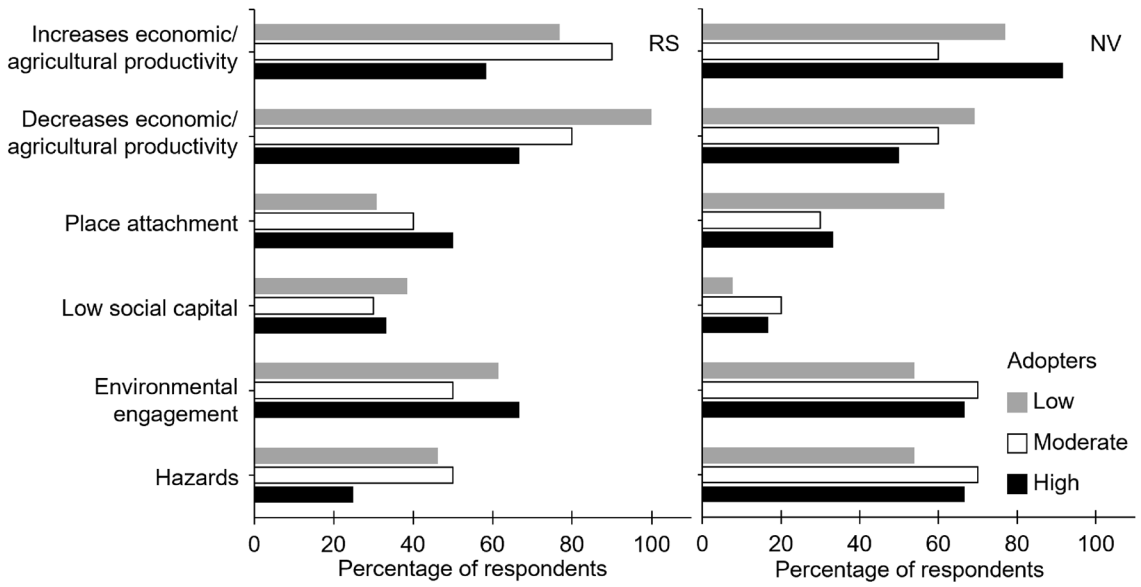


**Fig. 2** Perceptions of roadside (RS) and native vegetation (NV) for low, moderate, and high adopters of conservation. Perceptions were coded, sorted via themes, and a multiple response analysis was used to determine the proportion or respondents within each theme (low adopters, $n = 13$; moderate adopters, $n = 10$; and high adopters, $n = 12$)

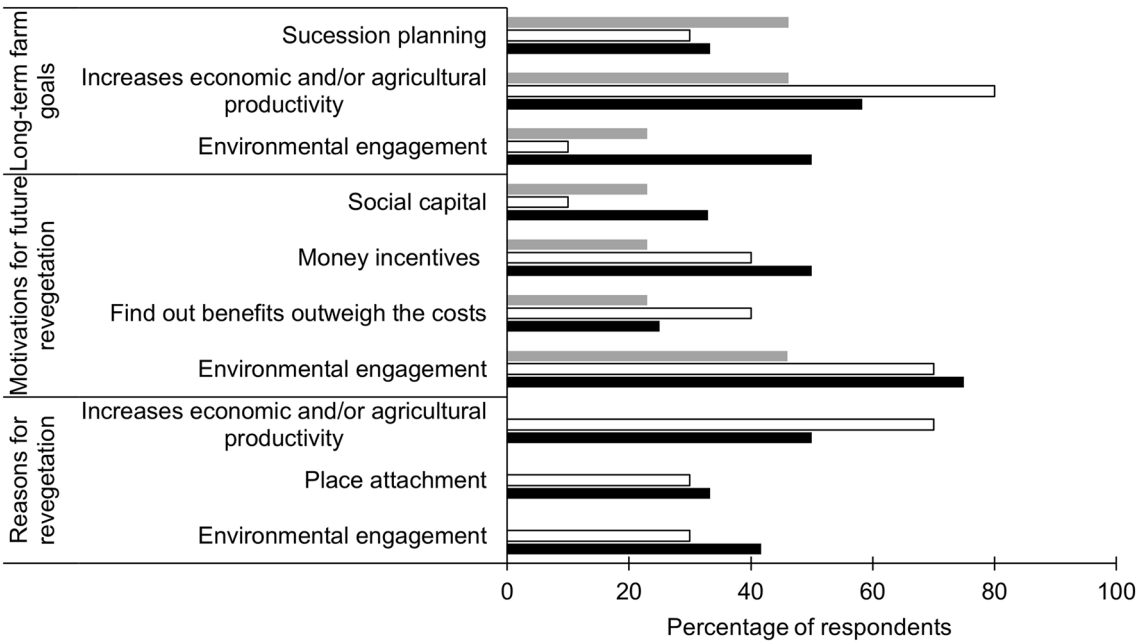


**Fig. 3** Farmer responses of their long-term goals ($n=35$), motivations for future revegetation and their current reasons for revegetation in the last 10 years. Perceptions were coded, sorted via themes, and a multiple response analysis was used to determine the proportion or respondents within each theme (low adopters, $n=13$; moderate adopters, $n=10$; and high adopters, $n=12$)

were the most highly ranked perceived benefits for both roadside and native vegetation, respectively.

All three adoption groups believed that roadside vegetation had a greater negative influence on their economic and agricultural productivity than did native vegetation (Fig. 2). All of the moderate, and 80% of low adopters believed that roadside vegetation decreased their economic potential, but they also emphasised the on-farm benefits of roadside vegetation (76.9% of moderate and 90.0% of low adopters) more than did the high adopters (58.3%). High adopters perceived native vegetation to have the greatest economic benefits among the adoption groups (Fig. 2).

When we asked farmers what their long-term goal was for their properties, 71.4% of respondents gave answers that were related to the economic growth and productivity of their farms. Responses included keeping the farm viable and profitable, expanding the farm, and improving the soil. One respondent remarked, "I don't know how to keep the farm profitable if we don't expand." Farmers who emphasised the economic losses due to roadside and native vegetation were more likely to have long-term agricultural productivity goals.

Only 13 out of 35 farmers said that they would be motivated to revegetate parts of their land by money incentives. Several respondents ($n=4$) from the high-adoption group believed that government incentives were not successful within the wider farming community because there was a lack of trust among stakeholders. Ten out of the 35 respondents said finding out that the benefits outweighed the costs would increase their motivation to revegetate in the future. Among the farmers who had revegetated in the last ten years ($n=22$), 59.1% were motivated by increasing farm productivity via the reduction of salinity (40.9%), creating shelter and food for stock (36.4%), creating windbreaks (27.3%), and erosion control (18.2%).

Most moderate (80.0%) and high (58.0%) adopters' long-term goals for their property were to increases economic and/or agricultural productivity (Fig. 3). Moderate adopters placed a large emphasis on increasing agricultural productivity and remaining viable. In agreement with this finding, 70.0% of moderate adopters said they had revegetated for economic reasons—for example, increasing agricultural productivity by reducing salinity or creating windbreaks.

High adopters were more motivated by money incentives than any other group (Fig. 3). The most conservation-minded farmers from the high-adoption group had the strongest understanding of the agricultural benefits of roadside and native vegetation, but it was not their main reasons for engaging in revegetation; rather it was the conservation outcomes. They also perceived roadside and native vegetation as economically more valuable than environmentally valuable.

## Place attachment

Several of the respondents described an emotionally derived set of perceptions for roadside and native vegetation. Forty per cent of respondents listed aesthetics or that roadside vegetation made them feel good. Native vegetation was ranked lower in this theme (20%). Native vegetation provided 14.3% of respondents with leisure activities (e.g., camping). We observed that some respondents looked uncomfortable when their perceptions were emotionally based. One farmer stated: "It makes the area look good, but is that really a benefit?" One farmer even perceived native vegetation as having "no economic benefit, but it makes you feel good to keep it." Those farmers who already have revegetated on their properties were motivated for aesthetic reasons (36.4%), with one farmer stating: "it makes the place look better."

Low adopters of conservation placed a large emphasis on place attachment for native (62.0%) but not roadside vegetation (31.0%). The opposite was true for high adopters, where half were emotionally connected to roadside vegetation, but only a third to native vegetation. Four of the respondents from the high-adoption group emphasised that they were responsible for protecting the natural environment for future generations. When we asked farmers their reasons for revegetating, a quarter of high and moderate adopters were motivated by the beautification of their property and because it made them feel good (Fig. 3).

## Social capital

When we asked farmers what would motivate them to revegetate in the future, responses directly related to social capital (e.g., working with a community group) were the lowest response (22.8%) compared to economic and/or agricultural productivity and environmental engagement. One-fifth of all respondents said that working with community groups would motivate them to revegetate, and 8.6% said working with respected friends would.

Respondents from the high-adoption group (41.6%) were the most likely group to be motivated to revegetate by working with friends and community groups. Several farmers from this group have already sought out like-minded peers and more information through Landcare SA, the Native Vegetation Council, Greening Australia, Trees for Life, or local conservation groups. Respondents felt the information gained through these groups allowed them to implement conservation practices on their properties. As a result, respondents felt empowered, and their connection to the land and nature increased, with one respondent saying: "I realised that there was more to planting trees." Despite the fact these conversation-minded farmers were well respected within the farming community, they did not directly encourage other farmers to make conservation-focused decisions; instead, they kept their thoughts on conservation to themselves or shared them with like-minded people. One respondent believed that other farmers in the community thought that they were "nuts," and being "green" was a negative attribute, while another hoped that other farmers would see the benefits of native vegetation from their actions on their property but did not like to "cause trouble."

Respondents' poor relationship with the Council and natural resources managers also influenced their perceptions of roadside vegetation. Over half of all respondents had a negative perception of Council and their roadside vegetation management. High adopters were the most concerned by Local Council's perceived mismanagement (75.0%), followed by low (46.2%) and moderate (30.0%) adopters. Half of the high-adoption group farmers feared that the Council would destroy roadside vegetation and cut too much down: "Council clears it back too far, they just bulldoze it down instead of trimming" and "Council will come by and destroy it." Low adopters were mostly concerned that the Council was not doing enough to manage roadside vegetation (23.1%) or managed it incompletely (30.8%). For example, one respondent said, "There is a lack of effort from Council and NRM to manage [roadside vegetation]. It costs money from the landowners to manage". Farmers for all three adoption groups felt that it was the Council's responsibility to manage roadside vegetation even though many farmers managed it themselves (e.g., spraying for weeds and trimming branches) because they were dissatisfied with the Council's work quality.

The most environmentally engaged farmers from the high-adoption group agreed that the Government (including the YP Council) was perceived negatively and wished the State Government invested more time and energy in making connections with farmers. Respondents believed that there was a lack of trust between farmers and natural resource managers. One high adopter stated, "the people who work for the Government do not know who we are, they are not from here."

Most respondents (66%) felt they were solely responsible for managing native vegetation on their property, even when they had leased the land to another farmer. Fewer social capital themes were reported with native vegetation (14.3%) than with roadside (34.3%). Farmers often elaborated that they had no fear or concerns (25.7%) with native vegetation management because they were in control of it and managed it accordingly.

However, several reported that they were fearful of losing control of their native vegetation and of different conservation groups forcing them to conserve vegetation. One farmer stated, "farmers do not want to lose control of their land," while another farmer said, "I am fearful of losing control if someone finds a rare orchid. One man found a rare grass, and the authorities took his paddock."

## Environmental engagement

The majority (60.0%, 62.9%) of respondents had positive environmental perceptions of roadside and native vegetation, respectively. For roadside vegetation, providing habitat for birds (20.0%), habitat for native animals (17.1%), and corridors for animals (17.1%) were the greatest environmental benefits of roadside vegetation. The greatest off-farm environmental benefit for native vegetation was habitat for native animals (28.6%), followed by representing what was historically there (8.6%). Additionally, 22.9% of respondents expressed concern about the potential loss of native species and the clearing of roadside and native vegetation.

Moderate (70.0%) and high adopters (66.7%) of conservation were more likely than low adopters (58.8%) to perceive the environmental benefits of native vegetation (Fig. 2). However, moderate adopters had the lowest percentage of responses for the environmental benefits of roadside vegetation (50.0%) compared low and high adopters (61.5% and 66.7%, respectively). High adopters were the only group that found roadside and native vegetation as equally beneficial to the environment (Fig. 2).

Farmers who had strong views of the economic losses from roadside vegetation on their livelihood (three or more examples of economic loss) were still able to mention at least one off-farm environmental benefit of roadside vegetation. In contrast, over half of the respondents who had three or more examples of economic loss as a result of native vegetation could not describe one environmental benefit of native vegetation. Respondents who perceived vegetation as an economic burden were able to see a small environmental benefit of roadside vegetation, but did not for native vegetation.

Wildlife was the strongest motivator for farmers to revegetate in the future. Sixty percent said that improving native wildlife and/or improving the status of rare plants and animals would motivate them to revegetate. This was especially true for high and moderate adopters of conservation (75.0% and 70.0%, respectively; Fig. 3). However, it was not the main long-term vision for farmers' properties, with only high adopters committed to increasing and/or maintain native biodiversity.

## Hazards and safety

Several respondents were fearful that incorrect management by Council could lead to increased fire risk. Farmers perceived fire risk as a problem for roadside (34.3%) and native (25.7%) vegetation. Farmers were also concerned with the safety and welfare of drivers for both roadside (17.1%) and native vegetation (14.3%): "someone can hit a tree if the roadside is overgrown." None of the respondents mentioned hazards and safety when considering the future goals of their farming property or what motivated them to revegetate or what would motivate them in the future to revegetate.

## Long-term thinking

We asked respondents about their long-term visions for their properties. We hypothesized that short-term goals were a barrier to long-term conservation on the YP. Respondents' long-term vision and planning were relatively short. Over half of respondents' long-term vision was 1–30 years.

Respondents close to retirement age across all three adoption categories emphasised keeping the farm in the family was a priority, or passing it on to a responsible person. One respondent felt "responsible for handing it over to the next generation." Another was adamant his property "is not for sale." Over 35% of respondents included the next generation or succession planning in their long-term vision.

When asked how much into the future was long term, high adopters were more likely to say forever (41.7%) or 50 years (25.0%). No high adopter perceived 10 years or less as long term. In contrast, 53% of low adopters said that long term was less than 10 years.

We anticipated that farmers with long-term thinking (greater than 50 years) might have different perceptions and motivations than short-term thinkers. However, we found no large difference in perceptions among the long-term categories. Long-term thinkers often commented that they were stewards or caretakers of the land. Farmers often interpreted this perception as being economically and agriculturally sustainable. Only some high adopters interpreted being a caretaker of the land as increasing native vegetation, or as one farmer stated: "leaving it better than when I started."

## Information accessibility

When asked where respondents got their information regarding roadside, native vegetation, and revegetation management, most responded from their "own experiences" (48.6%, 45.7%, and 36.4%, respectively). Government resources provided most information for roadside (28.6%) and native (28.6%) vegetation management. The information gained via the participants' peers was greater for native vegetation (25.7%) than for roadside vegetation (17.1%) and revegetation (18.2%).

High adopters of conservation were more likely to get their information regarding vegetation management from their peers and family than the moderate and low adopters. High adopters were the only group who did not say that no information was available regarding vegetation management. All three groups used their own experience to help them manage native vegetation; however, low adopters relied on their own experiences the most. Low adopters also used government sources, such as Natural Resource Management

Boards (now Landscape SA) and the Department of Primary Industries and Regions (PIRSA).

### Agronomists

Over 75% of the survey respondents either hired or sought advice from an agronomist. From the 55,723 ha of farming land owned by the surveyed farmers, 47,150 ha of farming land was managed by an agronomist (84.6%). Farmers used independent agronomists (31.4%), followed by small local agronomic businesses (e.g., YP Ag) (22.9%), Landmark (14.3%), or unknown (8.6%). Multiple regression determined no relationship between hiring an agronomist, the respondents' age, size of the property, vegetation size or the percentage of revegetation in the last ten years ($R^2 = 0.192$; $F_{2,13} = 1.780$, $p = 0.159$).

The three agronomists surveyed consulted with many of the YP farmers. Two agronomists were employed by large agribusinesses, and one was independent. Two agronomists had Bachelor's degrees, and all three agronomists had been working within the agricultural industry as farmer, researcher, or agronomist for over 20 years. All three were born and raised on the YP and came from second- or third-generation farming families.

Advice to their clients included fertiliser and cropping plans, pesticide use, soil testing, and farm management. Recommendations not adopted by their clients depended on their clients' financial constraints and willingness to adopt new technologies. They indicated that older farmers were less likely to collect long-term data from their crops and adopt new technologies. One agronomist stated that "it is hard to get older farmers to use new technologies."

We asked the agronomists what they believed were indicators of a successful farm. All three agronomists agreed it was equity, yield, productivity, adaptability, and cost management. Or as one agronomist said, "increasing agricultural productivity sustainably for long-term investment."

The independent agronomist believed another indicator of farming success was the relationship that they built with their clients. They knew they had been successful when they were rehired and made a commitment to foster a bond with them. The agronomists shared their views of farming success with most of their clients; however, they believed that some farmers still had a narrow vision of farming success, such as pure profit.

We asked the agronomists questions similar to those we asked the farmers regarding the problems and benefits associated with roadside and native vegetation on farming land, and the problems associated with their management. The agronomists listed machinery access, an abundance of weeds, and herbicide and pesticide drift on vegetation as the three main problems associated with roadside and native vegetation; and reducing erosion and salinity, providing resources for livestock, and facilitating pollination as the main benefits associated with roadside vegetation and native vegetation. The most significant problem with roadside vegetation management was the Council's perceived inability to communicate with landowners about its actions and its inability to manage it effectively. The agronomists believed that the greatest problems associated with the management of native vegetation were controlling spray drift and reducing overgrazing.

The agronomists participated in professional development throughout the year, including attending conferences and workshops, as well as collaborating with universities, industry, and government-funding bodies. However, natural resource management was not a part of their professional development. For example, one agronomist sought roadside and native vegetation management information purely for their interest, but they did not disseminate that knowledge to their clients.

Upon being asked about their view of the benefits of native vegetation and revegetation, the agronomists responded that native vegetation was an essential provider of ecosystem services (e.g., pollination) and a part of what makes the YP unique. The agronomists stated that they supported the revegetation and conservation of native vegetation on the peninsula. However, not only did the agronomists feel that it was not a part of their job description, but they believed that farmers would not respond favourably to those recommendations. The only advice the agronomists gave to their clients regarding native vegetation was herbicide consultations to remove weeds and recommendations to reduce salinity by planting stock fodder (e.g., saltbush). The independent agronomist believed there was a lack of clear management guidelines for farmers to manage their native vegetation. One agronomist was particularly interested in the potential of native vegetation to harbour pollinators to promote crop pollination, but did not consider it a part of their job to promote revegetation.

## Discussion

No socio-demographic factor was related to farmers' likelihood of being environmentally minded or engaged in revegetation of their property, but farmers owning a large area of remnant vegetation were more likely to have revegetated in the last ten years. The fact that we did not identify more significant demographic factors indicating environmental engagement shows the complexity of conservation adoption on the YP. Conceptual themes helped us to categorise the perceptions of farmers, leading us to a more nuanced discussion about the barriers to conservation

on the YP. We found five barriers to conserve on private properties on the YP associated with our groupings: (1) negative perceptions of roadside and native vegetation and their management, (2) an absence of effective conservation programs making use of farmers' motivations and place attachment, (3) low social capital derived from the interactions between farmers and natural resource managers, (4) lack of long-term goals for sustainable management, and (5) information accessibility. In addition, we recognise that agronomists play a large role in decision-making, and that their actions may have an impact on conservation efforts on the YP.

## Perceptions of native and roadside vegetation

Economic and agricultural productivity, low social capital, and hazard themes are all barriers to conservation on YP. Roadside vegetation was viewed negatively, especially by the low and moderate adopters of conservation. This negative economic view of roadside vegetation was also exacerbated by the mistrust between farmers and the Council and the perceived risk of car accidents on YP roads.

Many respondents understood some economic and agricultural benefits of the ecosystem services provided by native vegetation, especially low and high adopters. It is interesting that the latter were motivated by an increase in agricultural production, which may present finances as a barrier to future revegetation. Over half of all respondents within the three adoption groups had views of roadside and native vegetation within the environmental engagement theme. However, only a few partook in conservation behaviours.

It is often thought that demonstrating the value of ecosystem services for agricultural productivity would motivate conservation. Most farmers have some understanding of the benefits, yet the uptake of conservation behaviours is still poor (Smith and Sullivan 2014). Positive attitudes and perceptions towards conservation do not always lead to environmental behaviours (Waylen et al. 2009; St John et al. 2011; Selinske et al. 2015). For example, Infield and Namara (2001) found that communities in Uganda had a more positive attitude towards conservation and wildlife after being included in a seven-year-long conservation program, but poaching and illegal grazing remained unchanged.

In our study, the perceived economic cost of vegetation management outweighed money incentives and ecosystem services of vegetation on the YP, which is consistent with other studies (Lamarque et al. 2011; Blanco et al. 2020) except for the high adopters, over half of whom said that they would be motivated by money incentives for future revegetation projects. Many high adopters already had environmental values and were intrinsically motivated to conserve nature for its inherent satisfaction, rather than by a monetary reward (see Deci 1971; Ryan and Deci 2000). Economic incentives for achieving biodiversity remain contested, with some arguing that they degrade intrinsic motivations over time and compromise the individuals' sense of self-determination (Bowles 2008; Kosoy and Corbera 2010; Rode et al. 2015). We argue that financial programs that support high adopters' internal motivations will provide much-needed financial relief in supporting their conservation goals. Ramsdell et al. (2016) found that farmers responded positively to a flexible incentive program that gave them a high level of autonomy. Social change is required for conservation action, but its success can be enhanced by accounting for the financial needs of farmers.

High and moderate adopters of conservation said they would be motivated to revegetate on their property if they were improving native wildlife and the status of rare plants and animals. This response suggests that most farmers in the study have an emotional attachment to the area beyond its value to grow crops and are environmentally engaged. Low adopters lacked the motivation to partake in revegetation compared to the other groups. However, environmental engagement was the low adopters' greatest motivator for future revegetation. Furthermore, their perceptions of native vegetation were strongly within the place attachment theme, and they were moderately environmentally engaged with roadside and native vegetation. To target low adopters, their desire to help native wildlife could be used to motivate them (Olive and McCune 2017), as could the connection between aesthetics (place attachment) and biodiversity. Gosling and Williams (2010) found that vegetation on private land fosters connectedness to land, which could create a new positive cycle between low adopters and revegetation adoption. Kusmanoff et al. (2016) found that landholders were more biased towards messages that promoted the environmental benefits of private land conservation than economic and social benefits.

Demonstrating the role that native vegetation plays in creating habitat for vulnerable and charismatic species could be the tangible project the peninsula needs to promote conservation to farmers. However, further research needs to determine the best ways to communicate how farmers can help threatened species via the protection of native vegetation.

## Perceptions of long-term planning

Most respondents said their long-term goals were to increase productivity, particularly moderate adopters. However, *long term* ranged from one year to forever, with a dramatic difference between low (15.4%) and high adopters (41.6%) for long term perceived as forever. For 54.3% of farmers, the long term was 30 years or less. This perception of the long term could affect the likelihood of engaging in conservation measures dramatically. To protect what is left of the

YP's natural environment, we argue that long-term objectives for sustainable management should encompass future generations, not just the current farmers' life span. Short-termism is the excessive focus on short-term results at the expense of long-term interests (Marginson and McAulay 2008). People's decision making is biased towards short-term outcomes (Gray 1999). Farmers generally do not tend to consider the long-term benefits or consequences of their practices because they do not affect them directly (Govaerts et al. 2021). For example, promoting vegetation restoration can increase crop yield and resilience over time by promoting free pollination, biological pest control, and a reduction in erosion and salinity (Power 2010), but these long-term benefits may be misunderstood or perceived as detrimental to short-term profits (Dang et al. 2015; Weiner 2017). Long-term thinking and planning need to be promoted to farmers by policy, research, and education that emphasise long-term conservation outcomes and the benefits to production (Reimer et al. 2014).

Only the most environmentally engaged of the high adopters said that their goal was to create a balance between farming and native vegetation. Similarly, Beedell and Rehman (2000) found that farmers with greater environmental awareness were influenced more by conservation-related issues than agricultural problems, compared to other farmers. Current schemes to promote environmental outcomes on private properties engage only high adopters of conservation farmers and have alienated them as being *too green*. Overcoming this subjective normative barrier requires formal acknowledgement and awards established by reputable agencies and industries that could recognise farmers' efforts. If local farming organisations supported these farmers, they could become participants in mentoring schemes, or as previously mentioned, farmer-led conservation research. The challenge will be for the government and environmental agencies to act as facilitators rather than project managers.

### Low social capital and poor information accessibility

Many farmers were dissatisfied with how the Council managed the roadside vegetation, especially high and low adopters. Many respondents felt the YP Council ignored their expertise, which was based on their knowledge and experience.

Of the four main social capital factors (social trust, institutional trust, compliance with social norms, and social networks; Coleman 1988; Putnam 1993), we found that institutional trust was the most important in our study. Institutional trust refers to trusting the institution with the functioning of a community (e.g., the YP Local Council managing roadside vegetation). Institutional trust depends on the institution's performance and the extent to which people perceive the institution as reliable and responsible (Danish and Nawaz 2022). Institutional trust makes people more likely to cooperate, comply with regulations, and understand policies (Algan and Cahuc 2014). Trust in the Council was exceptionally low, with some respondents regarding Local Council as an outsider. Any future conservation initiatives from the YP Local Council are likely to be unsupported by farmers because of their negative perceptions and low levels of institutional trust towards the Council (Pannell et al. 2006; Jones et al. 2011; Ranjan et al. 2019).

Generally, low social capital has poor outcomes for the environment (Ostrom 1994; Pretty and Ward 2001). Our findings highlight the need to implement tools that generate institutional trust. However, the difference in negative perceptions between the high and low adopters creates complexity, with the former believing Council removes too much vegetation and the latter feeling they do not do enough to manage vegetation. We found that some farmers are turning away from Council's RVMP, and individually managing roadside vegetation for conservation (high adopters) or safety concerns and weed control (low adopters), and that despite negative social capital, some positive environmental outcomes may be achieved, provided that their vegetation management is sound. These actions may foster increasing resentment, however.

Restoring and rebuilding institutional trust between farmers and Local Council is not a one-size-fits-all scenario. Communities are not homogeneous; they contain individuals harbouring different values and beliefs. Understanding the root of the conflict may allow for effective management of roadside vegetation and reconcile tension. Estévez et al. (2013, 2015) recommended a structured decision-making process, which can minimize combative relationships, clarify stakeholders' beliefs, and explore a consensus solution. The challenge will be to incorporate the values and perspectives of all stakeholders, so as not to isolate further high adopters or anger low adopters of conservation. Furthermore, the Council needs to develop transparent decision-making processes and communicate them effectively.

We recommend a collaborative resource-management program (CRMP) run by the community and the YP Council, rather than the current RVMP. CRMP has proven to build trust and develop new norms within a community (Pretty and Smith 2004), leading to effectively managed watersheds, forests, pests, wildlife, farm, flower meadows, and research (Pretty and Ward 2001; O'Riordan and Stoll-Kleemann 2002; Fleury et al. 2015).

Many farmers rely on locally derived education to alleviate their uncertainty for farm-specific information, but not conservation-related information. The reliance of farmers only on their own expertise for vegetation management is hindering conservation on the YP. Farmer-led groups have successfully integrated agricultural research and locally-adapted solutions (Bellotti and Rochecouste 2014). In

Australia, many farmers participate in the Research, Development and Extension (RD&E) process. Through this RD&E process, social capital is built, and farmers become the primary information distributors, differently to a top-down approach (Llewellyn 2007). Most RD&E projects are successful at information dissemination if they are local, with farmers perceiving information from high-profile interstate research groups as less valuable than State and local information (Llewellyn 2007). Since 1999, the YP Alkaline Soils Group (YPASG) has facilitated a community-run RD&E program to address the challenges of farming on alkaline soils. The YPASG brings together farmers, agronomists, and community members to conduct farm trials and deliver workshops. Previous projects have focused on increasing agricultural productivity and sustainability, but YPASG has also been involved in improving the biodiversity of southern YP woodlands and producing and distributing vegetation fact sheets. According to a spokesperson (August 2021), the group was no longer active because the interest from the community decreased, aging members passed away, and solutions to agricultural issues were not found. One agronomist we consulted about this matter indicated that corporations had taken over research and development. The loss of local agricultural groups may lead to the lack of representation of farmers' values and increasingly difficult protection of biodiversity.

Farmers from the high-adoption group who participated in conservation work did not have the support and information that comes with traditional agricultural RD&E programs. Despite their social capital and power of persuasion in the community, one farmer believed they were perceived as "nuts" for having environmental values, which isolated them from their peers. Their knowledge was not shared, and the wider community did not readily adopt conservation on private lands. Most (4 out of 7) high adopters would be motivated to revegetate by working with community groups, possibly because they had greater social connectedness to like-minded peers. An agricultural RD&E program such as the YPASG could be a suitable vehicle to host conservation-engaged farmers and conservation projects. A local network fostering sustainable agriculture and engaging high, moderate, and low adopters of conservation would help them to exchange ideas and decrease the negative stigma of environmental values. However, the existence of community-led program does not automatically guarantee success, which also depends on sustained facilitation, careful design, and two-way information processes to ensure active and prolonged engagement within the community (Blaikie 2006; Wright et al. 2014).

Existing sources of information have not successfully promoted conservation and engaged farmers on private properties in Australia or the YP. For our recommendations to be successful, it is essential that conservation programs and environmental information be engaging and effectively communicated. Environmental education and awareness programs can give individuals the skills, attitude, motivation, and intellectual capability to implement new skills and change (Heimlich and Ardoin 2008). Farmers successfully implemented sustainable agricultural practices (e.g., conservation tillage) when information was received via field days, seminars, and workshops (Cary et al. 2001; D'Emden et al. 2008). We argue that integrating traditional means of agricultural communication and education (e.g., consultants, field days, workshops, and R&DE programs) with conservation outcomes that farmers and agronomists lead, could increase the likelihood of conservation practice adoption among farmers. Farmers are more likely to trust agricultural-sector information sources (Cawley et al. 2023). It would be helpful if research could compare current conservation education programs with an agricultural-conservation hybrid scheme. This comparison could provide valuable guidelines for future education and environmental engagement programs aiming to integrate conservation successfully in rural landscape management.

## Agronomists as drivers of change

We wondered whether agronomists could connect the gap between farmers and the need for conservation and restoration, and facilitate conservation practices. The power to make decisions on the farm often lies with the agronomist and not the farmer. Agronomists can play an integral role in fostering the transition to sustainable farming and conservation (Charatsari and Lioutas 2019). With only three interviews, we cannot determine whether this role is possible. However, these three persons co-managed a large proportion of the YP, and we did observe that farmers depended greatly on their agronomists for advice and support, and they were unlikely to contradict their agronomy expert advice (as found by Ward 1995). The apparent positive social capital based on expertise and shared farming interests may have a detrimental impact on farmers' conservation behaviour, when agronomists are solely focussed on agricultural productivity.

An alliance between conservationists and agronomists would support vegetation conservation, especially since both disciplines have backgrounds in plant biology, microbiology, soil science, chemistry, and ecology. However, it would be naïve to believe that a genuinely collaborative approach could be implemented in the near future. For such progress to be made, best-practice methods supported by policy must be integrated into farm management, and taught in agronomy degrees. A cultural shift associating farming success with conservation outcomes is needed and must be backed up by policy co-developed with farmers (Massy 2017).

Traditional agricultural programs focus on teaching future agronomic professionals in narrowly defined disciplines with

limited objectives (e.g., yield, nutrient intake, or return on investment) (Jordan et al. 2014; Valley et al. 2018). In collaboration with several universities, the Australian Government created AgLTAS (Learning and Teaching Academic Standards Statement for Agriculture), which produced the Good Practice Guide: Threshold Learning Outcomes for Agriculture in 2014 to develop a national academic standard statement for learning outcomes and inform curricular design for agriculture. The guide acknowledges that agriculture affects the environment (e.g., erosion, biodiversity loss, issues in the use and disposal of chemicals, and high greenhouse gas emissions), emphasising sustainable agriculture. However, the guide focuses on productivity first, and sustainability is only a means to reduce environmental destruction rather than promote the conservation of biodiversity. Parr et al. (2007) argued that academic institutions needed to broaden their agricultural curriculum beyond the dominant conventional agriculture paradigm. Their research found that 93% of agricultural academics deemed the most important content for undergraduate students to learn were the ecological processes within agricultural systems, followed by environmental impacts of agriculture (86%). Furthermore, Charatsari and Lioutas (2019) determined that agronomists had low to moderate levels of knowledge, facilitation skills, and networking competencies to promote sustainable agriculture. Higher education institutions have a crucial role in the development of new agricultural professionals who encourage farmers to adopt conservation practices.

Based on our survey showing that farmers are much stronger stakeholders in biodiversity health than are agronomists, and considering the extraordinarily high proportion of land directly managed by agronomists (84.6%), we suggest that farmers should be empowered by knowledge so that they may take a stronger part in the decision-making on their farms. Local extension programs are vital to perform this function, and all levels of Government have a major role to play.

## Conclusions

This exploratory study of farmers' perceptions of roadside and native vegetation aimed to make several tangible recommendations that may help increase conservation in agricultural landscapes. However, complementary research should include the role of women and young people in agriculture, testing the effectiveness of environmental education programs delivered by Local Council, agronomists, or farmer-led research groups, the influence of *long-term* decision making on conservation, and extending our work to deliver a theoretical framework based on decision-making. Women have an increasing role in farm decision-making (Pini 2005). Our sampling at field days may have targeted middle-aged or older men because they were more likely to attend field days, which removes women who may be the primary carer in traditional farmer marriages.

Historically, conservation management and education were left to National and State Governments in Australia. However, our research demonstrates that there is a role for Local Council in working with farmers to promote biodiversity. Although the Council is encouraged to engage with the community, little research explores the best way to achieve this connection (Chitty 2016). It focuses mainly on Local Government's ability to drive climate change adaptation (Measham et al. 2011), rather than measures to improve biodiversity conservation. We recommend that further research examine the development and effectiveness of future environmental policies and education programs run and managed by Local Councils, underpinned by targeted science communication.

Awareness that farmer perceptions differ based on revegetation groupings is important in targeting farmers comprehensively. Low adopters, while having a strong negative economic view of roadside and native vegetation, do have strong place attachment. Motivating them may rely on programs that use their emotional connection as stewards of the land rather than just promoting the benefits of ecosystem services. High adopters need to be supported by local and agronomic agencies to continue their conservation work, thus helping foster positive community relationships.

The negative perception that low and moderate adopters had of roadside and native vegetation reflects the low uptake of conservation on the peninsula. Conservation will be successful on the YP only if (a) the relationship between Local Council and farmers is restored, (b) long-term conservation goals are promoted via farmer-led conservation action and R&DE, which are supported by Government, industry, and the community, (c) agronomists champion and promote conservation, (d) the benefits of native vegetation for the survival of rare and endangered species are demonstrated, (e) conservation successes are celebrated by agricultural communities and associated with successful farming.

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**Bianca Amato** is a PhD candidate at the University of South Australia in the program of Environmental Science. Her research examines the management and ecology of agricultural landscapes for biodiversity and agricultural benefits.

**Sophie Petit** is Associate Professor of Wildlife Ecology. She studies ecology and biodiversity conservation and management in natural and agricultural landscapes.