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RESEARCH

Achieving win-win outcomes for pastoral farming and biodiversity conservation in New Zealand

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Abstract: Pastoral farming is the dominant land use in New Zealand today and is under considerable domestic social and political pressure to reduce its environmental footprint. In this article, we explore options to enhance native biodiversity conservation within New Zealand pastoral systems. We argue that there is strong synergistic interdependence between biodiversity conservation and pastoral farming and suggest that it is possible to have win-win outcomes for both. Landowners need to be incentivised and rewarded for good biodiversity management, rather than relying on a strict rules-based approach. To bring integrity and objective support to this incentive-based approach, farmers need to adopt environmental management planning that is supported by good biodiversity extension resources. Alongside this, a verification system is required that shows farmers are doing what they say they are doing and reflects agreed management targets for biodiversity. This approach requires trust and partnership among all players in agroecosystems – farmers, government, food and fibre processors, scientists, conservationists, NGOs, and the wider New Zealand population. We suggest that if we change the way we think about how farming and biodiversity interact, then we will achieve substantial biodiversity gains across the 50% of New Zealand under pastoral farming. This then brings integrity to the existing and expanding market story for pastoral farming and creates a stronger connection between all New Zealanders and the farming sector. Advancing our thinking in this way will enable New Zealand to maintain a premium for our farming products internationally while supporting conservation of our native biodiversity.

Keywords: agroecosystems, biodiversity, conservation, ecosystem services, environmental verification, incentives, pastoral farming, policy

Introduction

Pastoral farming is the dominant land use in New Zealand, occupying at least half of the land area (40% sheep and beef, and 10% dairy; Norton & Pannell 2018), and is a critical part of the New Zealand economy contributing 36% and 38% of export earnings (including international tourism) in 2017 and 2018 respectively (Stats NZ pers. comm. 2019). Pastoral farming occurs primarily at lower elevations where loss of original habitat has been greatest (Ewers et al. 2006; Perry et al. 2014) and where there is little public conservation land, although significant remnants of native vegetation still remain (Norton & Pannell 2018). Before humans reached New Zealand (1230–1280 AD; Wilmshurst et al. 2011), the areas where pastoral farming currently occurs were dominated by diverse, mostly forested ecosystems (Leathwick 2001), although grasslands and shrublands were present in some parts of the eastern South Island high country (McGlone 2000), and wetlands, although small, occured throughout. The temperate climates, reasonable rainfall and fertile soils that favoured diverse native forests have made these areas well suited to pastoral farming (Leathwick et al. 2001).

Pastoral farming is under considerable domestic social and political pressure to reduce its environmental footprint. Substantial concerns have been raised about the impact of farming systems (especially high intensity dairy farming) on water quality (Foote et al. 2015) and the contribution of grazing animals to greenhouse gas emissions, especially biogenic methane (PCE 2019; MfE 2019a). Internationally, the agricultural sector, especially the animal-based farming sector, is also under increasing pressure. Concerns around the contribution of animal farming to greenhouse gas emissions, biodiversity loss and animal welfare and health are all increasing (Newbold et al. 2015; Poore & Nemecek 2018, Almiron & Tafalla 2019), with calls for a significant shift away from current consumption of red meat and dairy products towards synthetic and plant-based alternatives.

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Agriculture's impact on biodiversity has been well documented at global (e.g. Tilman 1999, Potts et al. 2010) and local scales (e.g. Dale et al. 1994, Butler et al. 2010). In the 2019 IPCC Special Report on Climate Change and Land (IPCC 2019a), expansion of agriculture and forestry as a result of Earth's growing human population has contributed to 23% of the total anthropogenic greenhouse gas emissions, as well as increasing the loss of natural ecosystems, contributing to declining biodiversity. It seems clear that as the global human population continues to grow, food production and distribution will need to become more efficient. Notwithstanding this, pressures from farming on biodiversity are likely to continue (Crist et al. 2017; Balmford et al. 2019). Land sparing and land sharing have been proposed as two ways of conceptualising how we might manage biodiversity within agroecosystems, although the consensus seems to be that both are likely to be important, especially because land set aside for biodiversity conservation under the land sparing model is vulnerable to future impacts (Fischer et al. 2014). While land sparing and land sharing can be seen as opposite ends of a continuum of approaches to biodiversity management within agroecosystems, the relative importance of either is strongly influenced by both the social-ecological history of the area under consideration and the spatial scale at which landscape elements are being considered (Grass et al. 2019).

In this article, we explore options to enhance native biodiversity conservation within New Zealand pastoral agroecosystems while also optimising primary production. We believe that there is strong synergistic interdependence between biodiversity conservation and pastoral farming that is not well recognised, and that it is possible to have win-win outcomes for both in New Zealand. However, to do this we suggest the need for a fundamental shift both in our farming systems and in the way we implement and support biodiversity management and enhancement. This shift needs to be away from traditional thinking where biodiversity conservation or pastoral farming are viewed as a dominant land management objective on their own to one where they are spatially integrated and complement each other. We focus here primarily on forested ecosystems because, with the exception of parts of the eastern South Island high country, forest was the predominant pre-European vegetation cover in the areas where pastoral farming now occurs.

Biodiversity and pastoral farming – a brief overview

Biodiversity in New Zealand pastoral systems

The composition, structure and spatial arrangement of native biodiversity in those parts of New Zealand where pastoral agroecosystems dominate is different to those in areas with extensive public conservation lands. With some exceptions, native habitats tend to be small, isolated, and modified to varying degrees by grazing (domestic and feral), historic logging, plant invasions and edge effects resulting in changes to their composition and structure (Timmins & Williams 1991; Burns et al. 2000; Smale et al. 2008; Burns et al. 2011; Ruffell & Didham 2017). While some of these native habitats are protected through covenants or as part of the public conservation estate, most do not have any formal protection (Norton & Pannell 2018). The fragments of native habitat that occur comprise both remnants of the original forests and regenerating vegetation that has established on sites that were previously farmed. Woody native vegetation can range from a continuous native canopy to scattered trees through a paddock.

Notwithstanding its fragmented and isolated nature, a surprisingly large amount of native biodiversity remains across pastoral landscapes in rural New Zealand, including many nationally and regionally rare plant and animal species (e.g. MacLeod et al. 2008; de Lange et al. 2010; Pawson et al. 2010). While species requiring large areas of intact habitat such as kōkako *Callaeas cinerea* and kākā *Nestor meridionalis* are usually absent, other nationally rare species still sporadically persist (e.g. pōpokatea *Mohoua albicilla* and brown kiwi *Apteryx mantelli* in the North Island). As is the case on public conservation land, many native plants, birds, lizards and invertebrates are in decline in pastoral agroecosystems because of the ongoing effects of predation pressure, as well as the legacy effects of fragmentation (loss of resources and landscape connectivity). Nonetheless, the remaining native biodiversity that is present in pastoral landscapes is critically important across extensive areas of lowland New Zealand because these remnants are often all that remains of the original pre-human ecosystems (Norton & Pannell 2018).

Pastoral farming systems

New Zealand farming systems are still largely grass-based and display a continuum from relatively extensive, low-input systems to high-input intensive farming systems. Intensification has been characterised by increases in stocking rate, fertiliser use, irrigation area, cultivation techniques and extent, and smaller paddock sizes (MacLeod & Moller 2006; Didham et al. 2015). Much of this has been driven by the expansion of dairy farming, often replacing sheep and beef farming. Irrigation is often seen as a key indicator of intensification, although the increasing area of irrigated land is not just a result of dairy expansion, with significant irrigation increases occurring in other sectors including sheep and beef farming (17% irrigated area), arable farming (13%), and horticulture including viticulture (11%) (see: www.stats.govt.nz/indicators/irrigated-land). Intensification across a range of landscapes, but especially associated with dairy farming, has resulted in reductions in stream flows, increases in nutrient discharges into streams and groundwater, and eutrophication of wetlands (Foote et al. 2015; Ramezani et al. 2016). However, in some farming systems intensification has actually improved environmental outcomes. For example, the shift from flood irrigation (wild flood and border dyke) to pivot irrigation on some pastoral farms has led to improved environmental outcomes for these systems due to less overland flow resulting in a decrease in leaching losses and nutrient concentrations in receiving water bodies (McDowell 2017).

Plantation forestry, primarily with radiata pine (*Pinus radiata*), has also expanded over the last few decades in traditional sheep and beef farming areas (Wallace 2019). Government policy initiatives (e.g. Erosion Control Funding Programme in Gisborne District and the Hill Country Erosion Fund more generally) have facilitated this expansion (www.teururakau.govt.nz/funding-and-programmes/environment-and-natural-resources/erosion-control-funding-programme/). Many farmers have also been actively establishing trees, woodlots and farm forestry on their properties for erosion control, to earn carbon credits through the Emissions Trading Scheme (ETS), and as a future income source for retirement and succession planning (Kennet et al. 2010, Hutching 2019).

With an increasing focus on the effects of climate change, the One Billion Trees Programme (Te Uru Rākau 2018), the New Zealand Government's target of being carbon-zero by 2050, and a predicted rising value of carbon credits (www.carbonnews.co.nz), trees may become a more attractive investment for some sheep and beef farms than traditional farming (Timar 2016). These more recent policy initiatives have triggered another shift from sheep and beef farming to exotic plantation forestry for carbon credits with suggestions that as much as 30 000 ha in the eastern North Island has been converted in 2018–19 (Wallace 2019).

Regulatory environment

There is increasing pressure on farmers from markets, different levels of government, environmental NGOs and society generally, to be more environmentally responsible (Gabzdylova et al. 2009; Mitchell 2017; Diprose 2018; MfE 2019a). District and regional councils are increasingly regulating farmers in terms of how they interact with biodiversity, primarily through the use of planning tools (Brown 2016), including restrictions on vegetation clearance, pastoral intensification, and riparian management. Several district and regional councils now require farmers to have farm environment plans that include biodiversity in order to obtain or retain resource consents for a variety of on-farm management activities (e.g. irrigation, fertiliser application, vegetation clearance; Blaschke & Ngapo 2003). Central Government has recently released a draft National Policy Statement for Indigenous Biodiversity which proposes even stricter requirements on farmers in terms of indigenous biodiversity (MfE 2019b).

At the same time, there is increasing recognition within the farming sector of the need to prove its environmental credentials as part of its social licence to operate (e.g. Dairy Tomorrow 2017, B+LNZ 2018a). Many individual farmers are responding positively through retiring bush and wetland areas from farming and in some cases covenanting them. However, covenants (mainly through the QEII National Trust) only account for 3% of the total area of native vegetation on sheep and beef farms (Norton & Pannell 2018). Some farmers are reluctant to covenant or otherwise formally set aside areas on their farms, fearing that this might compromise future options especially if regulation becomes more restrictive. This fear of regulation also has the potential to lead to perverse outcomes such as farmers being prepared to accept fines for vegetation clearance as a better outcome than what might be perceived as a likely expensive and drawn-out resource consent process. Notwithstanding this, the uptake of farm management plans (also called farm or land environment plans) has been increasing (Maseyk et al. 2019) and Beef + Lamb New Zealand have called for all sheep and beef farmers to have next generation land environment plans for their farms that include consideration of water, soil, carbon and biodiversity as the four pillars for sustainable farming (B+LNZ 2018a).

Government has, and continues to, put in place policies encouraging tree planting, including native trees, in agroecosystems. The Emissions Trading Scheme and Permanent Forest Sink Initiative together with various afforestation grants work to discourage deforestation and encourage reforestation by providing an avenue for the creation of permanent forests (Leining & Kerr 2018). The ETS was set up to reduce deforestation in old forest (pre-1990 exotic forest) and incentivise new forest (post-1989 native and exotic forest). While the ETS and voluntary carbon-trading systems incentivise landowners to establish native and exotic trees, or promote natural regeneration, the direct benefits to biodiversity through reforestation have been limited because significantly more carbon credits can be earned through exotic plantations as low carbon prices generally make native afforestation uneconomic. Furthermore, under the ETS, a carbon-credit earning forest can still be harvested, as long as it is replanted, providing another income source from timber yield (Leining & Kerr 2018) which again does not promote biodiversity conservation. The One Billion Trees programme (Te Uru Rākau 2018) offers further incentives for farmers to integrate trees into their landscape by helping fund land retirement, fencing and the planting of native species. With the recently legislated Zero Carbon Act 2019 and the One Billion Trees programme, coupled with rising carbon prices (www.carbonnews.co.nz), there is now the very real potential for land owners to optimise income through carbon sequestration by planting or enhancing existing stands with native woody species providing significant co-benefits and opportunities for enhancing biodiversity in working pastoral landscapes.

Can we better integrate biodiversity conservation and pastoral farming?

The answer is yes, but to do this we suggest a rethink of the approach towards both biodiversity conservation and pastoral farming in rural landscapes is required; each depends on the other, addressing one in isolation will not result in a sustainable future for either (Norton & Reid 2013). What is required is for New Zealanders to engage in social and ecological discussions about the future of these systems; we need to be asking what will make these systems sustainable in 2050 and beyond? We believe that these discussions need to consider several propositions in order to obtain sustainable win-win outcomes for biodiversity conservation and pastoral farming (Table 1).

In developing a new future for pastoral farming and biodiversity conservation, we need to address some fundamental issues:

(1) The first is that conservation groups and the wider New Zealand public need to trust that, if properly incentivised, valued and resourced, farmers are the best stewards of native biodiversity on their land (Norton & Reid 2013). The Department of Conservation does not have the resources to manage the public conservation estate let alone work with the myriad of small habitat patches dotted across rural New Zealand. District and regional councils also lack the resources, expertise, trust and mandate to do this. A recent phone survey of 500 sheep and beef farmers showed that nearly 80% felt that protecting and managing native biodiversity on their farms was important (Buckley 2020).

(2) At the same time, it is important that farmers recognise that there are many groups and individuals outside their farms who have an interest in and expertise about biodiversity across pastoral agroecosystems and want to help (directly or indirectly) achieve positive biodiversity outcomes on farms. Trust needs to work both ways.

(3) To make biodiversity conservation economically viable in agroecosystems we need to focus on producing value-added products that can be differentiated, marketed, verified and sold based on their method of production and on their environmental/biodiversity story. The current Beef+Lamb NZ campaign "Taste Pure Nature" is a good example of this.

(4) In developing a new future for pastoral farming and biodiversity conservation, contributions from all the different

Table 1. Key propositions underpinning biodiversity conservation in pastoral systems.

Proposition	Explanation
Change the approach to biodiversity conservation	Biodiversity conservation in pastoral agroecosystems will be different to that on public conservation land in terms of how it is done, and the outcomes achieved. However, it will also be complementary, and contribute significantly to regional and national biodiversity conservation by helping to reverse the declines in native species across all of New Zealand.
Prove biodiversity conservation is occurring in agroecosystems	Evidence of active biodiversity management and resultant outcomes is essential for pastoral farming as part of its social licence to operate domestically and to market value-added products globally.
Show that biodiversity benefits farming	Biodiversity enhances 'multifunctionality' in agroecosystems and landscapes (e.g. cultural benefits, carbon sequestration, alternative income sources, and reversing environmental damage such as water quality and quantity) and leads to better on-farm human wellbeing (Maseyk et al. 2017) and animal health.
Farming is economically sustainable	Economically-sustainable pastoral farming businesses are essential to fund biodiversity conservation work across pastoral agroecosystems, both through individual farms having the financial freedom to do their own biodiversity work and for government to collect sufficient rates and tax income to fund government's biodiversity work (Norton & Reid 2013).
Support farmers to achieve biodiversity goals	Good management planning, extension and demonstration services, verification and incentive/reward systems to support farmers are essential for good biodiversity outcomes in agroecosystems.

groups involved (private sector, consumers, land managers, local communities, Māori, policy makers) to create enabling conditions for this and to scale up to regional and international markets (IPCC 2019b.).

(5) Finally, we need to enhance the current and proposed (through the National Policy Statement for Indigenous Biodiversity) regulatory approach to managing biodiversity in agroecosystems taken in District and Regional Plans, by incentivising and rewarding farmers for their biodiversity conservation actions. Such changes to the current approach need to be based on trust, partnership and collaboration.

In managing native biodiversity in agroecosystems, it is important to recognise that the amount of native biodiversity on individual farms will vary, but it is difficult to conceive any pastoral farms that do not have some native biodiversity, even if only visits by mobile species such as pūtangitangi *Tadorna variegata* and korimako *Anthornis melanura*, or riparian restoration plantings. All pastoral farmers need to understand and appreciate the value of whatever native biodiversity they have, including its significance in terms of criteria defined in district and regional plans, and incorporate biodiversity into their farm planning systems. To do this, biodiversity management should be seen as a collaboration that involves everyone from enviroschools and kids, to scientists and conservation groups, to local and central Government, supporting farmers in appropriate ways to manage biodiversity, while also recognising that farmers need to be operating profitable businesses that benefit not only farming families and their immediate communities, but all of New Zealand.

How do we achieve win-win outcomes for native biodiversity and pastoral production in agroecosystems?

To achieve win-win outcomes we need to better target biodiversity management on farms, do our farming smarter and provide genuine support for farmers in implementing biodiversity management on their farms.

Targeted biodiversity management

Before we commence on the how, let's be clear about what we are collectively trying to achieve. Protection of all that remains of our original old-growth forests and wetlands, and the extensive areas of regenerating native forest is essential (Norton et al. 2018). The sustainability of remnants of the original old growth forests is critical even when they might have been impacted in some manner through historic logging, grazing animals or the effects of adjacent agricultural activities (Smale et al. 2008; Burns et al. 2011; Didham et al. 2015). These remnants are the direct connections with the past and the source of propagules (plant, animal, fungal) for the future. Regenerating forest represents systems that are already developing towards a more mature phase and, through appropriate management, are a low-cost way to enhance native biodiversity at landscape scales. Simply protecting these areas legally or even just fencing them off is not, however, sufficient to guarantee their viability (Norton 1988). What is required is the implementation of management practices in remnants and regenerating vegetation to enhance them so that native biodiversity flourishes (e.g. Dodd et al. 2011; Ruffell & Didham 2017). This need not exclude economic uses (shelter, timber, grazing, honey etc) depending on the local situation and the values present.

Restoration of native habitat on farms is also important, both for ensuring that key resources for native fauna are present, such as year-round food supplies and nesting opportunities, and for enhancing connectivity across landscapes (Richard & Armstrong 2010). Restoration can involve a mix of strategic planting and seeding, facilitated natural regeneration, and enhancement of existing areas of degraded and regenerating forest through enrichment (Norton et al. 2018; Forbes et al. 2020). Exotic habitats, such as farm woodlots and homestead gardens, can also contribute to enhancing connectivity and increasing resource availability for native fauna (Norton 1998; Campbell et al. 2008; McArthur et al. 2019). Management of remnants, regenerating vegetation and restoration requires plant and animal pest control, especially of herbivores and omnivores (deer, goat *Capra hircus*, pig *Sus scrofa*, possum *Trichosurus vulpecula*), as well as consideration of interactions between different land uses (e.g. fertiliser drift). However, addressing predation (carnivore) pressure alone without

enhancing resources and increasing connectivity is insufficient for biodiversity conservation and will not result in enhancement of all native biodiversity in agroecosystems, especially of mobile species such as birds (Pannell et al. unpubl. data).

Biodiversity conservation activities on farms might occur through land sparing (taking land out of production for restoration), but it will also occur within the farmed landscape itself. Enhancing and conserving biodiversity might involve using a different mix of species for woodlots, erosion plantings and shelterbelts, retaining and planting scattered native trees in paddocks (Manning et al. 2006; Fukuda et al. 2011), shrub retention (e.g. matagouri *Discaria toumatou*), ensuring that year-round food supplies are available for native birds and invertebrates (including exotic tree sources), and taking advantage of recent advances in precision agriculture to minimise farming impacts on areas of native habitat. Economic use of remnants and regenerating vegetation may also be appropriate so long as the core values present are not compromised.

The key is taking a landscape-scale perspective on farming and biodiversity conservation, making sure that farming is undertaken in a manner that is friendly to biodiversity (land sharing), and recognising that much of this native biodiversity can directly benefit farming through shelter, shade, soil retention and nutrient management (Balmford et al. 2019; Case et al. unpubl. data) and that farming can benefit biodiversity (Norton & Reid 2013). While there are still gaps in our knowledge of native biodiversity in agroecosystems such as dispersal patterns for mobile native species (Norton 2001; MacLeod et al; 2008; Pannell et al. unpubl. data) we are suggesting the critical factor is to be able to design our agroecosystems using an approach that optimises both biodiversity management and pastoral farming at the landscape scale.

Smarter farming

Underpinning our biodiversity management, continuing to get smarter with how we farm is equally as important. This needs to include matching the right animals, grazing practices and forage plants to the right parts of the farm. We can continue to improve how we do this through better using and mapping land use capability and developing specific actions for identified land management units (Dominati et al. 2016). This might include adapting animal husbandry to different areas of the farm (e.g. different forms of rotational grazing), picking forage plants that best suit the environment (especially with climate change), reducing nutrient losses by targeting animal type and fertiliser use, thinking more about soil management, retiring difficult-to-farm areas or making the most of technology to optimise production in each of those land management units (e.g. precision agriculture). New Zealand pastoral farming has already done much in this space, with sheep and beef farmers for example producing the same amount of product with fewer animals today than in the past (B+LNZ 2018b). Adopting or enhancing some of the ideas of regenerative agriculture within our farming systems (minimising cultivation, maintaining good ground cover, more diverse pastures and use of deeper-rooted species) are also likely to be important for the future of pastoral farming in New Zealand (www.regenerationinternational.org). While a reduction in farmed animals is important to reduce biogenic methane production, smarter farming can actually increase farm income, even with fewer animals. We can also use native biodiversity to help address adverse effects of climate change on farms, for example through green firebreaks (Curran et al. 2018), in the provision of shade, and for erosion prone soil management.

Most importantly, pastoral farming needs to focus on adding value to products before they are exported from New Zealand. While considerable value has already been captured, more progress is and will be made by those processing farm products (e.g. milk processing companies, meat processors and timber mills). As a long-term investment in New Zealand's future, this is essential, both to enhance our economic prosperity and our environment. The increasing focus on value-added exports requires ongoing strategic thinking around supply-chains and the development of processing infrastructure able to supply value-added products. The success of the NZ Merino Company in taking an historically low value commodity (wool) and adding significant value to it, initially with fine wools but increasingly now with coarser wools, is testament to what can be achieved (www.nzmerino.co.nz). A critical part of that added value in the eyes of discerning customers and consumers is New Zealand's distinct brand story of which biodiversity and extensive pastoral farming's role in that plays a starring role. While adding value within New Zealand might not necessarily provide immediate additional return to farmers when you take into account the additional cost of getting products retail-ready, packaged, branded and shipped to multiple markets, our distinct brand story is important in the medium and longer term for being able to market our products globally to those who are prepared to pay for quality products with a good environmental story.

Tourism has been suggested as a more sustainable alternative to pastoral farming in New Zealand, but the environmental and social impacts of tourism are poorly understood and documented, and its carbon costs are not included within national-level accounting but are known to be high (Creutzig et al. 2015). Tourism carbon costs are especially high for a country like New Zealand where access requires either long-haul flights or substantial ocean journeys for international tourists. Tourism is also sensitive to events like natural disasters such as the Christchurch and Kaikoura earthquakes, terrorist attacks, disease outbreaks (e.g. COVID-19 virus) and downturns in the global economy (as Iceland is currently experiencing). While tourism is and will continue to be an important part of the New Zealand economy, and can provide complementary income to farmers (through accommodation, farm experience and recreational opportunities), it would seem an unwise strategy to rely on tourism alone for sustaining the New Zealand economy and environment into the future. The increasing success and pressures of tourism, both on our native habitats and greenhouse gases do present significant opportunities for long-term partnerships between tourism operators and farmers seeking support for long term investment in restoring native forest that also generates income from carbon.

The ETS provides some incentive for establishing native vegetation on farms. However, the exclusion of native forests, including degraded (cutover) and regenerating native forests that were already present in 1990 from the ETS is ignoring the immense value these areas have for both carbon sequestration and biodiversity conservation. Furthermore, small (< 1 ha) post-1989 regenerating or planted native forest patches are also excluded under the ETS, yet can be vitally important for biodiversity conservation and carbon-sequestration at the farm scale. Providing a financial credit associated with carbon-sequestration from both pre-1990 forests and < 1 ha areas of post-1989 regenerating and planted native forests

could be a critical incentive for farmers to retain and enhance biodiversity on their farms.

Rising carbon credit value can, however, also result in perverse outcomes for biodiversity (Lindenmayer et al. 2012). This is particularly relevant to rural New Zealand where regenerating native forests are under risk of being converted to exotic plantations because of their potential to earn greater carbon-credits. While landowners are unable to earn carbon credits from a post-1989 exotic plantation that was established on land that was formerly native forest, regenerating kānuka (*Kunzea* species) forest appears exempt from this. This occurs because of anomalies in the definition of 'forest' under the ETS where there are no carbon liabilities associated with converting pre-1990 kānuka stands to plantation species. Such perverse outcomes need to be avoided. It is critical for finding win-win outcomes for pastoral farming and biodiversity that these policy and incentive issues are addressed if we are to support a transformative landscape approach to biodiversity conservation in New Zealand. In particular, allowing farmers to earn credits for carbon-sequestration associated with pre-1990 forests and making clearance of pre-1990 kānuka subject to carbon liabilities would further incentivise retention of native woody vegetation on farms.

The cultural context for biodiversity conservation in agroecosystems is also critical (Brown et al. 2019). When farmers feel ownership for native biodiversity on their farms and it becomes an integral part of their farm and family story, they are far more likely to want to sustain and enhance it than if they are required to do this as a result of regulation. The land stewardship ethic and inter-generational thinking that characterises much of pastoral farming in New Zealand, especially sheep and beef farming (Elliott & Wakelin 2016), represents a huge opportunity for biodiversity conservation. The challenge is to incentivise, support and reward farmers for what they are currently doing and what they can do in the future, rather than taking a punitive regulatory approach towards biodiversity in agroecosystems, essentially focusing on restrictions rather than facilitation.

Supporting on-farm biodiversity management

A key factor that can support our ability to achieve the win-win outcomes advocated for in this article is the establishment of an integrated New Zealand-wide independent verification system that focuses on biodiversity outcomes and shows that farmers are actually doing the things they say they are doing (Williams et al. 2019). This is vital for being able to sell value-added farm products based on our environmental story to the world market as well as retaining the 'social license to operate' in New Zealand. Most international agricultural sustainability standards address biodiversity conservation, for example, including requirements for habitat protection, prohibiting clearance of certain land-cover types (including native forests), identifying priority habitat areas, and managing impacts to threatened species including measures to address invasive species (Milder et al. 2015, Englund & Berndes 2015). These standards have brought benefits for farmers through improved branding position, increased market access, an enhancement in their social licence to operate and in some cases improved prices. However, the degree to which each standard delivers environmental benefits vary (Blackman & Rivera 2011; Tayleur et al. 2017). The development of agricultural sustainability standards requires a robust evidence-based monitoring framework focused on environmental and biodiversity outcomes that are measured using objective time-series methods (Williams et al. 2019). However, such a framework needs to be developed and applied in a way that is financially viable for farmers. Stakeholders and consumers need to be confident that farmers really are doing the things they say they are doing on-farm. Ideally, the verification system will enable transparency and traceability where a consumer will be able to access information about the farm the product is sourced from and be able to obtain information on what is actually happening on that specific farm (Lernoud et al. 2017).

The verification system should be supported by farm environment planning where biodiversity (and other environmental issues) is just as central to farm management as soils, pasture and animals. To do this, a comprehensive demonstration and extension system focusing on both farmers and their advisors is required that provides information to farmers about what biodiversity is, why it is important and how it can be managed. This extension system should be independent of the regulatory system otherwise uptake will be limited (Norton & Reid 2013). Having specific biodiversity knowledge additional to what people know generally is important to support farmers. Time and money are key limitations to farmers acquiring advice on what biodiversity they have and how best to manage it, issues which such a resource can address. Development of a biodiversity support resource is critical for achieving the win-win outcome model proposed here and needs to be based on well-developed (online) extension resources, supported by independent biodiversity experts (biodiversity ambassadors *sensu* Norton & Reid 2013) who take this information out to the farming community (farmers and farm advisors).

Conclusions

To obtain win-win outcomes for biodiversity conservation, pastoral farming and New Zealanders generally, we need to avoid letting our policy systems (national, regional and district) fall back on a strict rules-based approach. This tends to stifle innovation and result in perverse outcomes. We need to reorganise our policy system to incentivise and reward farmers for good biodiversity management which includes looking after remnants of forest and wetlands, and regenerating native forest and shrubland, and improving connectivity through landscape-level integration. The approach advocated for here requires trust and partnership among all players in agroecosystems – farmers, government, food and fibre processors, scientists, conservationists, NGOs, and the wider New Zealand population. If we redesign our policy frameworks to support and empower a true landscape scale partnership-based approach to managing and restoring biodiversity, share resources between business, public, landowners and Government, and back this with an independent verification system, then and only then will our biodiversity thrive. If we can achieve that collectively it will strongly support market access, our strong brand story to support premium primary produce, and most importantly a biodiverse thriving New Zealand of which all New Zealanders can be proud.

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