

On-farm biodiversity conservation in Australia's tropical savannas: production trade-offs, impediments, motivators and policy approaches

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Abstract

Tropical savanna ecosystems cover the vast majority of northern Australia. The predominant land use of these landscapes is grazing for cattle production. Based on a literature review this paper demonstrates the negative effects of grazing and recent intensification measures on biodiversity outcomes from grazing lands, specifically for the grazing-sensitive spectrum of biodiversity. This is of concern given the low extent of protection of savanna ecosystems in conservation reserves. The literature review shows that intensification is economically motivated and principally due to the increasing relative scarcity of land. However, a number of socio-cultural, institutional and personal descriptors help to explain why some landholders more readily adopt (biodiversity) conservation practices on their farms than other landholders. These attributes can be clustered into 'farming styles'. There is an extensive suite of policy types and instruments that can be conceived to support biodiversity conservation on-farm. A mix of complementary instruments is required to two reasons, firstly to appeal to the different styles of landholders and secondly to achieve broad-scale conservation as well as conservation of biodiversity hot-spots. This paper represents a preliminary output from research-in-progress, which is funded through the National Action Plan for Salinity and Water Quality and the National Heritage Trust.

1. Introduction

Biodiversity is the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity, 1992). Biodiversity generates a suite of use and non-use values for humanity, both private and public (eg. Mountford and Keppler, 1999; Rolfe, 2002).

The tropical savannas of northern Australia are typified as landscapes of grassy woodlands (Tropical Savanna CRC, 2005). Tropical savannas cover around 1.9 million square kilometres – or around one-quarter of mainland Australia's land area – and stretch from Townsville on the Queensland east coast to Broome on the pacific coast of Western Australia. These landscapes harbour high levels of biodiversity but only a small proportion of the landscapes and biodiversity is protected in formal nature reserves and national parks. The beef cattle grazing industry is the major user and manager of land in the tropical savannas. Thus grazing practices – through the utilisation and modification of ecosystems – have a large impact on biodiversity.

This paper summarises the findings of a literature review to examine the trade-offs between cattle grazing in the tropical savannas (and other landscapes) and biodiversity conservation. It goes on to investigate the variety of factors, economic, social, institutional and other, that explain why some landholder engage more in biodiversity conservation than others. For this purpose, the paper draws on literature from the general sphere of natural resource management and adoption behaviour, though it must be stressed that biodiversity conservation and natural resource management show principal differences in the relative distribution of public and private benefits, and systems characteristics such as the irreversibility of biodiversity loss (Gunningham and Young, 1997). Where possible, the paper makes reference to research conducted in the Burdekin Dry Tropics rangelands in east Queensland, which is the case study region for the overarching in-progress research.

On the basis of this review the paper goes on to hypothesise what mixes of policy types and instruments might be suitable for providing incentives for different types of landholders in a tropical savanna grazing context – for the purpose of both broad-scale biodiversity conservation as well as the protection of biodiversity hotspots.

2. Trade-offs between production and biodiversity conservation in tropical savannas

The threats to on-farm biodiversity in the tropical savanna grazing lands are multiple and include: clearing of native vegetation, habitat fragmentation, altered fire regimes, spread of exotic fauna and flora and climate change and various aspects associated with the intensification of grazing systems.

For example, Sangha et al (2005) report on the decline in pasture species diversity and detrimental impacts on the nutrient cycle and soil properties as a result of tree clearing in central Queensland. Woinarski & Ash (2002) find that grazing has led to considerable rearrangement of vertebrate fauna, especially for reptiles, mammals and birds associated with the ground and understorey vegetation layers. It is thought that grazing intensification is linked to the decline of several mammal species in far north Queensland, including the black footed tree rat (*Mesembriomys gouldii*), northern quoll (*Dasyurus hallucatus*), common brushtail possum (*Trichosurus vulpecula*), rufous bettong (*Aepyprymnus rufescens*), some rock wallabies (*Petrogale* spp.) and the antilopine wallaroo (*Macropus antilopinus*) (Ritchie, E. 2005). Landsberg et al. (1997) establishes that grazing impact on biodiversity in the Australian rangelands is particularly related to distance to artificial watering points for cattle. They identify a number of grazing sensitive species, whose abundance declines due to grazing (decliner species). This relationship has been confirmed – and linked to a general decline in landscape function due to grazing intensity – in other case studies in Australia (eg. Ludwig et al. (1999) but the relationships are equally applicable to other ecosystems, for example Europe (eg. Atkinson & Watson 1996). Furthermore, McKeon et al (2004) find that drought events contribute to a decline in resource conditions specifically if graziers fail to de-stock early or to a sufficient extent.

The decline in biodiversity in the tropical savannas has also been linked to the suite of new technologies that have been introduced by graziers to achieve efficiency gains (MLA, 2005). This includes the establishment of Brahman (*Bos indicus*) breeds of cattle, introduction of exotic grass species, provision of additional stock watering points, and the widespread provision of nutrient supplements for cattle. Bortolussi et al. (1999) document the widespread adoption of improved grasses and legumes, rumen modifiers and hormonal growth promotants to enhance productivity. Stokes et al (2004) note that these technological advances have increased the ability of cattle to harvest grass and convert grass to meat – while no equivalent improvements have been made in the productivity of the primary renewable resource. They also observe that grazing intensification has been accompanied by the fragmentation of landscapes. These changes are major drivers of habitat modifications, leading to the decline of native species and loss of genetic diversity (DEST, 1996). While tree clearing has been principally addressed in Queensland through the 2005 Vegetation Management Legislation, other intensification options in the savannas abound, including addition of more artificial watering points, cell grazing and paddock subdivision. Increasing adoption of these ‘best management practices’ foreseeably contribute to further decline of ‘decliner’ native plant and animal species, while ‘increasers’ – many of who are introduced species – will continue to flourish (Landsberg et al, 1997).

The biodiversity of tropical savannas is particularly poorly represented in the national reserve system. In the Burdekin River catchment region, Roth et al. (2002) consider there not to be adequate areas of conservation to protect the key vegetation and habitat types, with only some of the vegetation

protected in National Parks and a small number of conservation areas. Only approximately 2.2% of the Brigalow Belt bioregion that takes in a large proportion of the Burdekin catchment is reserved in protected areas (Sattler and Williams, 1999). However, the situation there is not unique. According to Sinden (2004), federal and state government in Australia rely heavily on on-farm conservation of biodiversity to meet international and domestic commitments for biodiversity protection. Scanlan and McIvor (2002: p20) identify the need for a comprehensive reserve system in order to *'overcome some of the major problems associated with excessive or inappropriate grazing'*. In the absence of such a system, and in light of the above-mentioned threats to on-farm biodiversity, the declining state of biodiversity and the evident lack of protected areas in the Burdekin Dry Tropics Region, on-farm conservation of biodiversity is the key strategy.

3. Factors that work in support of and against on-farm biodiversity conservation

3.1. Motivations for biodiversity conservation

There is a diversity of factors that motivate landholders' decision making in regard to on-farm conservation. Landholders pursue different strategies, which reflect many influences including farm household values and objectives. Decision making systems are complex, hierarchical, adaptive and they incorporate strategic, tactical and operational elements.

Economic based motivations appear to be a dominant driver of landholders' motivation to implement on-farm conservation measures. For example, previous studies have discovered perceived profitability to be the most important factor influencing landholders use of sustainable agricultural practices (see Camboni and Napier, 1993; Cary and Wilkinson, 1997; Saltiel et al, 1994). Principally, farm properties are businesses and thus are seeking to maximise profit – or disposable income – through the use of their resources. Economic theory suggests that as rational economic agents, farmers conserve biodiversity to the extent where the private benefits they receive from biodiversity conservation are equal to the private costs they incur of doing so. On-farm biodiversity conservation does not usually yield an income and would thus not appear to be part of a rational production or land-use mix on a property – beyond the extent to which it supports resource sustainability and production (Sinden 2004). Furthermore, on properties where land has not been a binding resource, on-farm biodiversity conservation has been an inadvertent by-product, which has cost the landholder nothing to produce (Motte et al, 2002). In this situation conservation and production are (partially) non-competitive and farming provides positive spill-overs for society without negative impact on the farm financial position.

Where trade offs exist between production and conservation, financial assistance to implement biodiversity conservation practices is an important motivating factor for landholders. Financial

incentives have been found to reduce the risk of adopting new agricultural conservation practices in the United States (Nowak, 1987), influence New Zealand landholders intentions to fence and revegetate riparian areas (Rhodes et al, 2002), and motivate landholders in the United Kingdom to join on-farm conservation programs (Lobley and Potter, 1998; Wilson, 1996). In Australia, Binning and Young (1997) demonstrate that those states that have provided financial assistance to landholders and/or used legislation to generate participation in remnant vegetation management agreements have been more successful in encouraging landholders to enter such agreements. In addition to financial motivations, studies of landholders' participation in on-farm conservation programs in the United Kingdom indicate that many landholders are largely motivated to participate due to the program being compatible with the existing farming system: the ability to fit the necessary activities into routine management operations (Webster and Felton, 1993) and participation not interfering with the production system (Morris and Potter, 1995). At a farm operational level, Gibon (2005) describes the highest level in the decision making hierarchy as a provisional year-round strategic spatio-temporal plan that landholders have, on the basis of which they allocate functions and sequences to various fields or paddocks. She stresses that traditional-based grassland management optimises overall efficiency of the system at the farm level.

There is increasing recognition that landholders, while being business people and needing to generate income and return on investment, have an encompassing set of values that also includes lifestyle and conservation outcomes as part of their objectives, concept of utility and pursuit of happiness. As Bryant (1992:p.162) puts it: *“The economic dimension is an important factor which guides and restricts farmers' choices for Landcare; however, to define the relationship of the farmer to nature in economic terms alone would be to ignore farms as actors with values and ideologies that also shape their relationship to the land.”* However, when landholders' livelihoods depend on farm income, it seems that economic based motivations prevail above others in most cases in regard to biodiversity conservation. Ryan et al. (2003), for example, find intrinsic motivation (i.e. due to attachment to land) to be important in the adoption of riparian zone conservation practices in the United States, though most landholders in their study farm part-time and own their farm. Similarly, aesthetic appreciation is the strongest motivator for retaining woodlots, (especially for non-farmers) in a rural area of Michigan, United States (Erikson et al, 2002). In the New South Wales area of the Murray catchment, Australia, the two most common motivations for conserving remnant vegetation are conservation reasons (46%) and management reasons (40%): landholders perceive conservation benefits to have production benefits and some believe conservation is important in it's own right (Driver and Davidson, 2002).

“It is attractive to me to have a good-quality remnant vegetation for wildlife protection and just for its own sake. But, one of our reasons was that we finally realised we did have

a salinity problem. So a lot of our fencing project has been to do with fencing out recharge areas.” (Landholder in survey by Driver and Davidson (2002, p.86).

Peculiarly, Beedell and Rehman (1999) suggest that farmers have a ‘creative’ rather than a ‘preservative’ view of conservation, implying that farmers rather plant trees and create ponds than manage existing features on their farms such as hedges and woods.

3.2. Impediments to biodiversity conservation

Taking a national perspective, Nelson et al. (2004) show that socio-economic factors and considerations are the most important variables influencing the adoption of sustainable farming practices in Australia, including farm size, off-farm income and farm equity. Previous participation in natural resource management programs is a key positive factor. Other institutional and personal characteristics such as farm ownership, attitudes to change, planning horizons and age are not important (Table 1.). This is not to suggest that these and other indicators may not explain adoption in specific local contexts: influences on landholder behaviour vary between regions and situations and generalisations may not be helpful when trying to understand specific contexts.

Table 1: Individual and business-related indicators of conservation practice adoption

(Adapted from BRS (2001))

Type of indicator	Linkage to adoption	Expected impact on adoption
Age of property owner/manager	Desire to remain on property, environmental attitudes	Negative
Formal education of owner/manager	Skills; environmental attitudes; desire to remain on property; information	Positive
Years of management experience	Skills; habits	Ambiguous
Farm family with dependent children	Financial capacity; desire to remain	Positive
Farm equity ratio	Financial capacity; security	Positive
Farm profit at full equity	Desire to remain	Positive
Total farm family income	Financial capacity; skills	Positive
Farm family off-farm income	Financial capacity	Positive
Farm cash income	Financial capacity; desire to remain; security	Positive

Economic theory can explain, in part, the relative lack of on-farm biodiversity conservation. The difference between public and private costs of on-farm conservation means that landholders who pursue a profit maximising approach will not adopt biodiversity conservation because the benefits accrue to society while the costs are borne by the farm (Greiner et al, 2003). Economic considerations gain further importance when capital investment is required to undertake conservation activities., especially if landholders are in a state of ‘agricultural involution’ (Geertz, as cited in Vanclay and Lawrence, 1995, p.89), which is the inability to undertake capital improvements and change

management strategies that involve (perceived) risk due to a lack of farm capital and/or inability to obtain finance for such purposes. For example, financial constraints have been found to be the most important factor limiting adoption of recommended riparian management practices in the Goulburn catchment of Victoria (Curtis and Robertson, 2003), and to fencing and conserving remnant white box woodlands in New South Wales (Elix and Lambert, 1997).

Small or unviable property size is also a key explanatory variable for the lack of landholder capacity to adopt recommended practices. The 2004 ABARE survey of Australian landholders identifies landholders managing larger sized properties as more likely to change management practice to address degradation problems (Nelson et al, 2004). Surveys of crop landholders in Queensland (Earle et al, 1979) and in the United States (Korsching et al, 1983) have also linked larger property size with higher adoption rates of soil conservation practices. Similarly, a key reason for landholders not entering into agreements to conserve woodlands in the United Kingdom is because such programs reduce the effective farming area and impact on farming systems and practice (Potter and Gasson, 1988).

Adequate, sufficient and/or diffusion of information about an environmental problem and strategies to address the problem have also been found to influence the adoption of best conservation practices. For example, Rhodes et al. (2002) and Traore et al. (1998) demonstrate that the adoption of best management practices by landholders is influenced by exposure to adequate information about firstly the damage to the riparian vegetation caused by agriculture and secondly the practices to address the problem. In a summary of Australian case studies, Viv Read and Associates (2003) find that the key limiting factors for biodiversity conservation include a lack of understanding of values and threats to biodiversity and uncertainty about biodiversity outcomes. Young et al. (1996) equally identify insufficient information as a barrier to the understanding of threats and the appreciation of biodiversity values in case studies undertaken by in Australia. However, in believing there is sufficient information on the threatening processes to biodiversity, the barrier to individual and community action to conserve biodiversity perceived by Young et al. (1996) relates to the provision and accessibility of information by management agencies, rather than the lack of information per se.

Even in the absence of the above-mentioned barriers, landholder may still not adopt conservation practices if they lack commitment. As Vanclay (1997, p.18) highlights: *“It is not so split a barrier such as money or lack of information that leads to non-adoption. Where non-adoption occurs, obviously a real commitment to the innovation does not exist”*. Commitment to conserving biodiversity is related to the values, beliefs and attitudes of the landholder: how ecocentric or anthropocentric landholders are in their value orientation is likely to influence their decisions and management practice in relation to biodiversity conservation. For example, Maybery et al. (2005), in their survey of Australian landholders along the Murray River in N.S.W., identify landholders with

'economic', 'lifestyle' or 'conservation' values. Landholders' beliefs and attitudes surrounding biodiversity conservation have previously been identified as key obstacles to landholders' adoption of conservation practices. The difference between beliefs and attitudes is that "*beliefs are the knowledge base upon which attitudes are formed*" (Cary et al, 2002: p.34). Resistant attitudes to on-farm conservation programs in the United Kingdom have been linked to non-adoption of such schemes and such attitudes include: denying a need for such conservation schemes, not seeing the scheme to be relevant for their farm, believing that the scheme will lead to inappropriate management (Lobley and Potter, 1998), and regarding the scheme as short-term political measures for controlling production and an imposition of external controls and regulations (Morris and Potter, 1995). Similarly, Raedeke et al (2001) identify a major impediment to landholder participation in voluntary ecosystem management programs in Missouri, United States, to be concern that such involvement may make participants more vulnerable to future government regulation of their land use. In Australia, Fielding et al (2005) identify beliefs about the benefits of riparian zone management (i.e. reducing erosion and weeds, protecting water quality, easier management of livestock and property) and perceptions of the extent to which barriers (i.e. lack of money, fence and water point maintenance, lack of time, physical characteristics of the property and having to change management practices) impede riparian zone management as most significant for determining landholders' intentions to manage riparian zones in the Fitzroy catchment, Queensland.

3.3. Farming styles and on-farm biodiversity conservation

In an attempt to deal with the diversity of beliefs, attitudes and other factors impacting adoption, Morris and Potter (1995) view landholders' participation in on-farm conservation programs in the United Kingdom along a 'participation spectrum' from non-adoption to active-adoption. Non-adopters show little recognition of the schemes' conservation value and tend to see the schemes as contrary to the agricultural management system and having little significance for their farm situation. Conditional non-adopters give many of the same reasons for non-adoption as the non-adopters; however, this group includes landholders who consider enrolling land into a scheme in the future if either the scheme and/or their socio-economic situation changes. Passive adopters are attracted to the scheme primarily for financial reasons and the financial incentives rather than the conservation objectives. This group is more likely to compartmentalise their land into scheme and non-scheme land and minimise the impact of scheme participation on to the rest of the production system. Active adopters appreciate the environmental objectives of the scheme. They may have undertaken conservation investment in the past and are willing to justify conservation management as a legitimate use of their time and resources. Wilson (1996) perceives landholders to have distinct attitudes along the 'participation spectrum', from utilitarian based attitudes associated with resistant non-adopters to well established conservation-orientated attitudes amongst the active adopters.

Focusing on remnant vegetation management in Australia, Binning and Young (1997) similarly identify that landholders attitudes, values and motivations will vary considerably. They conclude that the likelihood of success in vegetation protection will be highest where there is a match between landholder willingness to conserve and remnant vegetation of highest value.

Vanclay (1997) provides a different landholder categorisation based on ‘farming styles’, which represent landholder decision making as a socio-cultural process: each ‘style’ of farming has an integrated knowledge base and management practices are consistent with the values, attitudes, knowledge and beliefs held by this group. Schmitzberger et al. (2005) shows that farming styles influence biodiversity conservation in Austria’s rural areas where landholders that re highly production orientated have the lowest level of biodiversity on their land. They suggest that lack of landholder awareness about biodiversity values is a more significant driver of loss of biodiversity than financial constraints since the landholders that conserve least biodiversity are very good economic performers.

3.4. Burdekin Dry Tropics region case study

There has been limited research into what motivates landholders in the Burdekin Dry Tropics region to implement on-farm (biodiversity) conservation practices. Studies by Greiner et al. (2003) and Lankester (2005) have looked at impediments to the adoption of on-farm conservation practices in the Burdekin Dry Tropics region and the social dimension to riparian management in the Burdekin rangelands sub-region, respectively. Both studies reveal that economic factors dominate landholders’ decision making in regard to biodiversity conservation and natural resource management. On the basis of qualitative interviews with 25 landholders Lankester (2005) concludes that riparian management decisions are mainly motivated by perceived positive production and/or expected economic benefits. Although, many landholders say that they implement practices for conservation outcomes, it is rare for this to be the sole reason for adoption. As one landholder puts it (Lankester 2005: p.35):

“We’re not going to say that we are going to fence it to save the river bank and that’s all we’re going to do it for, it’s because we’re going to benefit from it...from our management point of view.”

Haberkorn et al (2001) review the adoption of sustainable resource management practices by pastoral producers across the rangelands of Australia and show that practices that are profitable and for which benefits are readily apparent are more likely to be adopted. This is corroborated by empirical research conducted by Greiner et al. (2003) in Burdekin Dry Tropics region, which shows that the self-reported level of adoption of biodiversity conservation measures – such as planting/fencing off riparian/remnant vegetation for conservation – is much lower than the adoption of practices that can be

considered best cropping/grazing management. Within the Burdekin Dry Tropics region, implementation of biodiversity conservation measures is highest in the Bowen-Broken region.

In exploring impediments to implementing natural resource management and conservation practices in the Burdekin Dry Tropics rangelands, Greiner et al. (2003) and Lankester (2005) both find financial factors to be the key constraints to adoption. Financial constraints are manifest in landholders citing lack of labour, lack of time and the costs associated with implementation of practices as well as ongoing/maintenance costs associated with practices as impediments to implementation. This is consistent with the findings by Haberkorn et al. (2001) who identify the costs of more sustainable farming/grazing practices and constraints on time and labour as financial impediments to adopting sustainable resource management practices. Other financial constraints include the need for consistent annual income and low returns on investments.

Greiner et al. (2003) and Lankester (2005) further note that risk considerations constitute another major impediment. Farmers typically avoid or reduce exposure to risk by, for example, choosing less risky ways of producing commodities, postponing decisions or applying cautious safety standards, specifically in the absence of comprehensive information (Anderson, 2003). Perceived riskiness and uncertainty, as well as risk attitude, profoundly influence the adoption of new technology (Marra et al, 2003). If a conservation action exacerbates (perceived) exposure to risk, directly or indirectly, then landholders are unlikely to adopt even if the action is income neutral. Risk considerations are especially relevant in highly variable production environments, such as the Burdekin Dry Tropics rangelands, where rainfall – and therefore production – is highly variable, as are cattle prices received by graziers.

Greiner et al. (2003) note that landholders consider there to be a significant ‘lack of government incentives’ to the implementation of natural resource management practices. The findings are further consistent with international research, for example in the United Kingdom, which shows that ‘insufficient’ level of payment is a deciding factor for landholders declining to participate in on-farm conservation programs (Brotherton, 1991; Loblely and Potter, 1998; Morris and Potter, 1995). In contrast, funding incentives are considered sufficient in the context of riparian management by most landholders in the study by Lankester (2005). The majority of respondents in that study have accessed funding for riparian management but were planning to undertake the recommended practices anyway. This difference may indicate that there are more private benefits from implementing riparian management practices compared to other natural resource management/biodiversity conservation practices. Other factors influencing graziers’ riparian management decisions in the study by Lankester (2005) are property size, type of river system, beliefs and perceptions, research and information availability, social interaction, planning and management skills and new leasehold agreements.

4. Policies and incentives to enhance biodiversity conservation

A substantial literature seeks to set up and analyse different classes of policy instruments (eg. Young et al 1997; Industry Commission 1997). Generally, a distinction is drawn between government regulations and market-based instruments. This paper adopts the definition of ‘incentives’ as encompassing both spectra of policies – even though the term ‘incentives’ is often explicitly or implicitly meant to refer to market-based instruments only (Department of Natural Resources and Mines, 2005). Regulations are primarily based on legislative and regulatory provisions and are implemented through directives from regulatory authorities. There has been discussion of introducing a ‘duty of care’ to the environment legislation on managers and owners of natural resources and biodiversity (Bates, 2001). On the other hand, market-based instruments, while supported by legislation, tend to devolve decision making and opportunities for innovation to the market place. They usually allow for adaptive choice and constrained risk-taking by those whose behaviour is to be modified. Table 2 provides an overview of policy instruments that have been used to enhance environmental performance by firms and individuals. Policy types range from property rights to financial incentives and regulation, to suasive instruments and community based mechanisms and research.

Table 2: Taxonomy of policy instruments to support conservation activities

(Source: Adapted and expanded from Panayotou, 1994)

Property Rights	Charges and Fees	Leases and Licences	Regulations	Financial Programs
Leasehold	Pollution charges	Extraction licences	Permits	Grants
Private ownership	Input charges	Harvest licences	Area restrictions	Compensation payments
(Tradeable) shares	Royalties	Discharge licences	Output controls	Free advice
(Tradeable) quotas	User fees	Load-based licences	Input controls	Debt-for-conservation swaps
Conservation covenants	Entry fees			Free advice
Enforcement	Bonds and Deposits	Accreditation	Empowerment	Information and Suasion
Fines	Security deposits	Status agreements	Third party rights	Education
Forfeiture of rights	Conditional resource security	Labelling	Rights of access to information	Extension
Director liability	Assurance bonds	Industry accreditation	Co-management	Research
Audit	Performance bonds	Prizes	Self-regulation	Monitoring
Institutional Mechanisms	Tax policy	Leverage Mechanisms	Awards	Auctions
International conventions	Accelerated depreciation	Cross compliance	Awards	Auctions for env. service provision
Constitutional settlements	Income equalisation	Conditional grants	Prizes	
	Tax deductions			

Different instruments are relevant in different situations and for different purposes. Binning (1997) argues that off-reserve conservation requires new approaches, policy tools and institutional structures that are generated through small innovative programs. Also, innovative ways of combining multiple instruments to enhance environmental outcomes are continually being discussed and explored (eg. Young et al, 1996; Greiner et al, 2000; Productivity Commission, 2001). Many authors have stressed that a policy mix – of market and non-market instruments – is necessary to achieve an efficient long-term level of conservation and sustainable use of biodiversity (eg. OECD, 2004; Young et al, 1996). It appears that a mixed approach using a variety of policy types and instruments best addresses issues associated with policy and market failure. This thinking builds on Tinbergen (1950) who suggested that a policy mix is superior to a single instrument approach in situations where there are multiple objectives and issues. An effective mix contains at least one policy instrument to alleviate each threat and pursue each objective, allowing for adjustment of each element of the mix without compromising other objectives. Young et al (1996) argue that compliance with the Tinbergen principle ensures that as knowledge, prices, technology and social values change over time, the policy mix can be adjusted efficiently and equitably. As Greiner et al (2000) demonstrate in the context of policies for the marine environment, a diversified approach is better able than one instrument alone to address the suite of criteria which determine policy outcomes – including effectiveness and dependability, precaution, productive efficiency of industry, collective economic efficiency of resource use, intrinsic motivation, administrative feasibility, transaction costs, equity, and political and community acceptability.

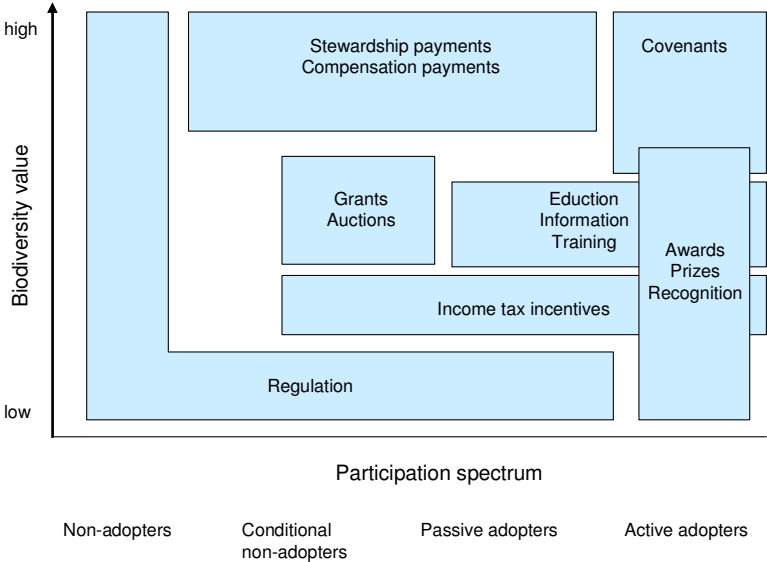
A diversified suite of policies is also able to appeal to a more landholders given the ‘participation spectrum’ and different ‘farming styles’ by providing a range of mechanisms to encourage on-farm conservation practice in order to match the range of landholders’ values, attitudes and socio-economic situations. Schmitzberger et al. (2005) consider that in order to maintain and enhance on-farm biodiversity, each group or ‘style’ of landholder requires tailored programs that appeal to their characteristics and attitudes.

Binning and Young (1997) suggest stewardship payments will help increase landholder willingness to conserve vegetation and that encouraging voluntary action by landholders to conserve vegetation may be the most suitable option for those landholders that are already highly motivated. Morris and Potter (1995) recommend that to move more passive participators along the spectrum, extension advice and training programs could be used. Improved information about the conservation goals of the on-farm conservation programs have been suggested by Wilson (1996) to push ‘passive adopters’ – who are landholders for whom financial reasons are the main motives for participation – to become ‘active adopters’ – for whom conservation is an integrated farm management goal. Furthermore, Maybery et al. (2005) suggest that landholders that have higher ‘economic’ values are more likely to participate in environmental auctions and those with higher ‘conservation values’ are more likely to be Landcare

members. Figure 1 attempts a diagrammatic presentation of a variety of incentives working together to conserve areas of different biodiversity value across the participation spectrum of landholders. While active adopters respond well to suasive instruments and property rights options such as covenants, different financial incentives can be targeted at the passive or conditional adopters. This helps to raise the net private benefit of conservation practices (Herr et al, 2005) and generates cost sharing arrangements, which are favoured by landholders (Greiner et al, 2003). Regulation is primarily targeted at enforcing a baseline of duty of care and, being a blunt instrument, assisting with conservation generally. Similarly, income tax incentives can achieve some generic conservation outcomes.

Figure 1: Policy mix targeted at different types of landholders and conservation of areas with different biodiversity value

Note: the instruments are broadly positioned in the diagram where they are best targeted; their applicability extends beyond that space



5. Conclusion

On-farm biodiversity conservation is recognised as a critically important strategy to conserve biodiversity in the tropical savannas of Northern Australia. Grazing across these landscapes has been intensified to increase industry efficiency – and with detrimental biodiversity outcomes. To effect on-farm biodiversity conservation it is necessary that policy makers understand what motivates landholders to conserve biodiversity, what prevents them from doing so, and what incentives are suitable and effective measures of intervention. This paper presents a literature review which suggests that economic considerations are likely to dominate landholders’ decisions in regard to biodiversity conservation and that financial constraints – disguised as lack of labour and time, low returns on

investment, and ongoing management costs – pose the key impediment to the implementation of best natural resource management practices in general and biodiversity conservation measures specifically. Given the high degree of environmental and economic uncertainty of the production environment in the Burdekin Dry Tropics rangelands, the perceived impact of conservation practices on farm risk exposure is another key consideration. In addition, there are a suite of social, institutional and psychological factors which also influence adoption behaviour generally. The literature shows typologies of landholders in terms of ‘farming styles’ and ‘participation spectrum’, which draw out key aspects of landholder characteristics that influence participation in biodiversity conservation programs. The paper concludes by arguing that among the suite of incentive instruments available to policy makers to pursue environmental outcomes, a mix of instruments is required to ensure firstly, engagement of the entire participation spectrum of landholders in biodiversity conservation and secondly, enable customisation of policy to biodiversity conservation requirements. Further, taking a regional perspective on biodiversity conservation, it is paramount that policy makers consider a wider spectrum of incentive instruments that go beyond the on-farm adoption of conservation practices. There are a suite of incentives, available to government and other stakeholders, that work towards a transition of land use in some areas out of grazing (and other production systems) and into conservation (eg. DEH, 2005).

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