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Economic evaluation of irrigated forage production in a beef cattle operation in the semi-arid tropics of northern Australia

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ABSTRACT

Australia's northern beef industry is a significant contributor to regional economies in northern Australia, but is economically challenged by a range of factors including declining real beef prices, limited market opportunities, stalled productivity growth, increasing levels of enterprise debt, and low returns on investment. The long-term viability of the industry depends on achieving herd productivity gains and lifting enterprise profitability. Typical of the northern Australian beef industry, beef enterprises located in the Gulf of Carpentaria river drainage basins or catchments of north-west Queensland rely on extensive grazing of unimproved native pastures. Feed of reasonable quality is relatively plentiful during the annual wet season, but this is typically followed by feed shortages and sharply declining feed quality in the following dry season. Irrigation of some pasturage could potentially increase the availability and quality of dry-season feed and improve the productivity of these cattle enterprises. To explore this issue, an enterprise-scale bio-economic model was employed to consider several development scenarios involving investments in irrigation infrastructure for a case-study beef enterprise located in the Flinders River catchment in north-west Queensland. Our findings showed improvements in key productivity indicators, such as beef turnoff and enterprise profitability for some forage-based irrigation scenarios. However, the capital cost of installing and operating the infrastructure associated with the assumed scale of irrigation development had a significantly negative effect on returns. The findings suggest that investors will need to be judicious with capital expenditure and investment decisions informed by an understanding of the interplay between irrigation water storage size, expected reliability of filling, and the ability to meet seasonal crop water demand.

1. Introduction

The extensive grazing of native pastures by beef cattle is the dominant economic land use of the northern regions of the Australian continent (Gleeson et al., 2012). The northern beef industry comprises approximately 30% of the Australian cattle herd and annually contributes around AUD[1] 2 billion to the national value of agricultural production of AUD 49 billion (CSIRO, 2009; Grice et al., 2013). Despite its macroeconomic significance, the industry is confronted by a series of microeconomic challenges, including falling real farm incomes attributed to a declining trend in the 'terms of trade' in production and marketing, and increasing levels of enterprise debt (McCosker et al., 2009; Gleeson et al., 2012; Hunt et al., 2014).

The traditional strategy for addressing such economic challenges of adopting more efficient technologies or management practices (Glau, 1971) has failed to secure productivity growth in terms of beef yields per animal carried and total turnoff of sale stock for the past decade (McCosker et al., 2009).

Finding a solution to this productivity dilemma and ensuring the longer-term sustainable growth of the northern beef industry are a significant public policy challenge (ONA, 2014). One avenue lies in exploring production and marketing opportunities that are emerging from the strong growth of developing economies, particularly in Asia, (Gleeson et al., 2012), and the potential to profitably exploit under-utilised water resources through small to medium scale irrigation developments (NAWLT, 2009; Grice et al., 2013).

The scope that irrigation, where feasible, might have to improve the productivity of northern beef enterprises can be considered against the contemporary production and marketing context of those enterprises. The majority of beef cattle enterprises carry breeding cow herds whose progeny may maintain herd numbers, be grown out in situ to weights that are suited for live export or direct slaughter, or transferred or sold to other enterprises outside the region for growing out on better pasturage or in feedlots (Gleeson et al., 2012).

Grazing is generally on unimproved native pastures with high levels of intra- and inter-seasonal variability in forage availability and quality, as determined by the interplay of land and vegetation type

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[1] AUD — Australian dollar. At the time of writing 1.00 AUD = 0.88 USD and 1.00 AUD = 0.69 Euros.

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and condition and the duration of the annual wet and dry seasons (Bortolussi et al., 2005b). Animal growth, and hence market options, are constrained by the limited quantity and quality of available forages in the late dry season where many animals may lose weight and overall body condition (Gramshaw and Lloyd, 1993; McIvor and Monypenny, 1995; Mott and Moore, 1985; Sollenberger and Vanzant, 2011). These seasonal feed and forage gaps are typically filled by purchased concentrate supplements and hay. Pasture development options based on irrigation infrastructure, where feasible, may offer an opportunity to secure more abundant and better quality feed to address such critical feed gaps. It may also open up opportunities to secure higher prices per animal turned off, or to access different markets, via a combination of accelerated animal growth and altered finishing periods (i.e. achieving age and weight specifications more quickly for an existing market or turning off older but heavier animals) (Bortolussi et al., 2005c; Ash et al., 2006). Access to irrigation may also offer the scope for procuring supplementary dry season fodder at less cost than the traditional option of having it trucked in from outside the region.

Bridging the feed gap addresses a key risk factor identified by Gleeson et al. (2012) – that is, export market risk – and may allow producers to move from operating 'breeding' enterprises to 'finishing' enterprises necessary to supply meat processors with slaughter-ready cattle. While the foregoing points to potential advantages for a northern beef enterprise from accessing more and better quality forages, the actual development of improved pastures, including irrigated pastures, has been very limited across northern Australia (MacLeod et al., 2013). Moreover, where some form of irrigation development has been established on individual enterprises, it has generally been at a relatively small scale (e.g. 500–2000 ha) and occupying only small proportions of the total land area, which typically ranges from several thousands to several million hectares (Bortolussi et al., 2005a).

Despite the limited uptake of irrigation by individual beef enterprises, there has been a long history of both public and private interest in the possible use of water resources to support further agricultural development in northern Australia (e.g. AIPS, 1954; Kelly, 1966; Powell, 1991; Tracey, 2012). Most recently, the North Queensland Irrigated Agriculture Strategy (NQIAS) was developed to promote irrigation in two significant river drainage basins or catchments of the Gulf of Carpentaria, the Flinders and Gilbert River catchments. The Flinders and Gilbert Agricultural Resource Assessment (FGARA) (Petheram et al., 2013a, 2013b), was undertaken as part of NQIAS to provide a comprehensive evaluation of the technical feasibility, economic viability and sustainability of irrigation-based agricultural development in the two river catchments.

The technical feasibility of irrigation-based development in the two catchments was explored by a multi-disciplinary team comprising climatologists, hydrologists, soil scientists, agronomists, and irrigation engineers (Petheram et al., 2013a, 2013b). Assessing the economic feasibility of irrigation-based agricultural developments is complex because it necessarily involves the simultaneous consideration of many technical and financial issues. These, for example, include the scale of the irrigation development, reliability of seasonal water supplies, skills and experience of managers, land uses under the proposed development, as well as markets and transport costs for the produce from the irrigation development (e.g. fodder, livestock or alternative crops and produce).

In the specific case of the Flinders and Gilbert River catchment assessments, some preliminary budgeting studies had suggested that on-property application of irrigation for forage or hay crops might offer positive net economic benefits to individual enterprises (e.g. Mason and Larard, 2011). However, these studies were essentially partial cash flow budgeting analyses specifically based on the irrigated forages being exploited by single classes of fed animals; and also employed qualitatively established yield responses for both the forages and livestock. As such, they did not account for the systemic nature of northern beef production systems, and high level of inter- and intra-seasonal climatic variation in the catchments which affects total pasture biomass availability and quality (both irrigated and dryland), the productivity of the whole herd (including reproduction, growth and mortality), as well as water availability, extraction and application costs and scheme efficiency.

To more comprehensively reflect the enterprise-wide scope for impact, and especially the stochastic nature of irrigation productivity and efficiency in a rangeland environment, the FGARA economic assessment was based on bio-economic simulation modelling of the productivity of representative beef enterprises under a range of potential irrigation development scenarios using historical climate data for the regions (Brennan McKellar et al., 2013). Although a number of beef cattle models have been developed to simulate different production systems around the world (e.g., Foran et al., 1990; Tess and Kolstad, 2000; Teague and Foy, 2002), none of the available models was well suited for simulating either extensive production systems in tropical regions or the inclusion of irrigation technology. The bio-economic simulation model that was employed for the study is the Northern Australia Beef Systems Analyser (NABSA) (McDonald, 2012; Hunt et al., 2014; Ash et al., 2015), which was specifically developed within CSIRO for assessing the production and financial impacts of the application of novel technologies or management practices on beef production systems in northern Australia. A key feature of the NABSA model is that projected levels and patterns of animal growth and reproduction performance of various classes on animals within a herd are directly determined by the biomass and quality of forages on offer through either direct grazing or supplementary feeding.

As part of the irrigation development scenario modelling procedure, several central questions were addressed, including:

- How might access to irrigation opportunity be employed within an existing enterprise to change the basic nature of the current production and marketing system?
- What type and scale of development is required to support such irrigation opportunities?
- What is the level of efficiency associated with such irrigation opportunities?
- What is the cost of commissioning and operating such developments?
- Do the various developments offer any positive economic advantage over the present (baseline) production systems?

In this paper we address these questions using material drawn from the Flinders River catchment component of the FGARA economic evaluation. The choice of this catchment was based on the greater apparent scope for employing irrigation based on drawing river water from off-stream storages (e.g. large farm dams or earthen ring tanks) to support cattle production systems (Petheram et al., 2013a). The outcomes of the analysis are of direct relevance to the Flinders River catchment and, additionally, the case-study outcomes also highlight some important issues for assessing the economic prospects for on-property irrigation development applications across the wider north Australian context, and possibly beyond.

2. Methods

2.1. Case-study

The case-study is constructed around a hypothetical 'representative' beef cattle enterprise that is assumed to be located near the regional centre of Richmond which is a principal town lying within the Flinders River catchment in north-west Queensland, Australia (Fig. 1).

2.1.1. Catchment characteristics

At ~1000 km, the Flinders River is the longest river in Queensland and the sixth longest river in Australia (Fig. 1) and has a catchment