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# Economic and policy implications of relocation of agricultural production systems under changing climate: Example of Australian rice industry

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ABSTRACT

The development or expansion of existing land use, agricultural industries are seen a way to manage global food security in the face climate change and reduced water availability in the traditional cropping regions. This paper examines economic and policy implications of incremental and transformational changes in production location by considering the net effects of shifting rice production from a southern area to the sugar dominated Burdekin area in northern Queensland, using a dynamic regional computable general equilibrium (CGE) model. Three rice transformational adaptation scenarios at two time points, 2030 and 2070, were considered. The results suggest a net reduction in real economic output and real income, although adopting a rice-sugarcane rotation in Burdekin could partly offset some of the negative impact. The displacement of sugar would result in a much larger net national loss and consequent net reduction in gross regional product (GRP). The study findings suggest that there is unlikely to be a rapid and spontaneous increase in rice production in the north, because of a lack of infrastructure, wariness in relation to the agronomic issues, the lower profits and the opportunity cost of turning away from sugar. Currently private investment in infrastructure can keep pace with the level of production, but a more rapid expansion would need access to government assistance.

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## 1. Introduction

Climate change has the potential to significantly change the rainfall distribution and conditions for crop production, with important implications for food security (Kellett et al., 2015; Risbey, 2011; Potgieter et al., 2013; Sinivasan, 2010; Smith et al., 2013; Steffen et al., 2011). Under climate change it is expected that the southern part of Australia will generally become drier, while there is a likelihood of increased rainfall and the frequency and intensity of extreme events in parts of the north (IPCC, 2007; Robertson and Murray-Prior, 2014). The possibility of climate change leading to less rainfall in the south-east of mainland Australia triggered renewed interest in northern irrigation projects, with proposals to effectively reconfigure the geography of intensive agriculture (IPCC, 2007; Henstra, 2015; Camkin et al., 2007; Northern Australia Land and Water Taskforce, 2009b; Davidson, 1966; Mushtaq et al., 2013). In Australia there has long been an interest in, perhaps even obsession with, 'northern development', which has been argued for on the grounds of nation-building decentralization and even as a defense strategy (justifications reviewed in Davidson, 1966). The latest justification for, or driver of, this renewed interest in northern agriculture is to develop a potential new food basket 'in the face of climate change' (Shanahan, 2007; Millar and Roots, 2012; The Sydney Morning Herald, 2007). Most importantly, northern development could fill some variable production and supply gaps associated with climate change and variability.

This land use expansion, it is argued, would not only address increasing food demand in Asia but could offset possible decreases in the irrigated area and output of the Murray–Darling Basin (MDB) resulting from decreased inflows, buybacks of environmental water under the Murray–Darling Basin Plan (Murray–Darling Basin Authority, 2010; Loch et al., 2015; Adamson and Loch, 2014; Wallis et al., 2013), and possible trading of water to other uses (National Water Commission, 2009). The offset would, however, be at the national level, with production moving from one location to another. The regional impacts could be significant, especially given that agricultural production has long been seen as the mainstay of regional development (Davison, 2005) and there are many communities highly dependent on irrigation schemes (Marshall et al., 2012).

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For such investments to succeed, it is imperative that sustainable and profitable rotational systems are identified and adopted (Gustafson et al., 2014; Connor and Minguez, 2012). Enterprise profitability is especially critical because Australian governments are generally reluctant to commit to long-term and direct support of industry development. This is in contrast to the foundation of European-derived agriculture in Australia, whereby governments distributed land and provided subsidized finance in return for requiring particular development outcomes, such as clearing and grain production (Johnston, 1988; Connors, 1970; Lake, 1987; Roberts, 1924). Later, there were state irrigation schemes, of which the Burdekin dam was one of the last (1985) and a range of support measures including: machinery and fertilizer bounties; tariffs on competing imports; and the creation of centralized marketing systems, such as the Rice Marketing Board. State 'intervention' was however, criticized, notably by some agricultural economists, from the 1960s on (for overviews see Gruen, 1986) especially in the wake of some notable development failures in the north (Davidson, 1966; Graham-Taylor, 1982; Wooding, 2008). From the early 1970s, there was an incremental reduction in agricultural (and secondary industry) support, the winding back of tariffs, a reduction in subsidies and the privatization of marketing boards (Cockfield, 2009). For irrigated agriculture, the additional consequences were increasing water prices to cover infrastructure (1990s on) and the deregulation of water pricing and trading (1990s–2000s). Most recently, the environmental costs of water have increasingly been considered, leading to the MDB Plan.

There are then, four questions in relation to northern irrigation developments:

- Are there the natural resources (soil and water) to support irrigated agriculture?
- Are there suitable crops and crop varieties?
- Will it be profitable?
- What are the social impacts?

Some work has been undertaken to identify suitable soils and available water in the northern areas (Camkin et al., 2007; Northern Australia Land and Water Taskforce, 2009a) and this work is recommended to continue (Northern Australia Land and Water Taskforce, 2009b). The paper mainly focuses on the last two questions; with assumptions that there are suitable soils and crops varieties are available. The paper recognizes these as heroic assumptions and all recommendations should be seen as confined only to consideration of the private and public benefit if those resources are available.

The Burdekin area was chosen for the current study to avoid considering the cost of additional irrigation infrastructure, given the existing dam, in line with an overall approach of examining just the economics at farm and regional level, assuming future studies of the agronomic factors. In addition, the Burdekin region is reasonably close to a major center and port (Townsville), which could minimize some of the costs and logistical problems that have constrained other northern developments.

The regional impacts are important both economically and politically because agricultural production has for many years been a mainstay of regional development (Davison, 2005; Thiene and Tsur, 2013) and there are many communities highly dependent on irrigation systems. There is a great deal of uncertainty in the community with regard to the potential implications of major structural reforms in the irrigation sector and there is a risk of over-investment in infrastructure renewal if the likely extent of future structural adjustment is not adequately recognized (National Water Commission, 2009). This paper provides information to support decisions by examining the economic and policy implications of incremental and transformational changes in production location by considering the net effects of shifting some rice production from a southern area to the sugar dominated Burdekin area in northern Queensland using a dynamic regional computable general equilibrium (CGE) model. The net effects also consider impacts of shifting agricultural production by examining possible structural adjustment in the southern rice areas, given a reduction in available water. This work also contributes to discussions about the future of the Murray–Darling Basin in that the on-farm and regional impacts of reducing water allocations are examined.

## 2. The rice industry: significance and climate change impacts

The Australian rice industry has a relatively small number of producers generating considerable export income, and value added production. Several factors combine to make rice production in Australia successful: the high grain quality owing to the climate, with plenty of sunlight and suitable temperatures, excellent water quality, good soils, expert producers who obtain an average of around 10 ton per hectare while increasing water use efficiency and the tight integration of the production, commercial, and research arms of the industry (Rice Growers Association, 2011; Dunn and Gaydon, 2011; Mushtaq et al., 2009). Taking into account processing and packaging operations, the rice industry directly employs more than 8000 people and supports more than 60 towns. Indirectly, the industry further supports 33,000 people, mostly in the Riverina region in NSW (SunRice, 2010).

Australia has one of the highest yields of rice per hectare (10 t/ha) in the world. Over the past thirty years there have been substantial increases in irrigation and total water productivity. The long term Water Productivity (WP) for rice has increased by more than 60% from the 1980s to 2008 (Lacy et al., 2009; Dunn and Gaydon, 2011). Rice is a globally traded commodity and a financially attractive crop due to relatively high net returns (gross returns—total costs) which depend on the type of rice grown. For example, net returns from medium grain rice can be close to $2000 per ha while long grain rice can make around $1750 per ha. In the Burdekin, rice can be grown during winter and summer season but the yield of both summer (5 t/ha) and winter (7 t/ha) rice is low compared to crops in the Riverina, although production is still profitable. The medium grain rice grown in winter could generate up to $1180 per ha because of the lower volumes of water use and associated water costs.

Since, the establishment of the first commercial crop of rice in Australia in 1924, there has been a gradual increase in rice area and yield (Fig. 1a and b). There are, however, significant concerns about the longer term impact of climate change and climate variability on water availability. Noticeable reductions in water availability during the 'millennium drought period (2000–2009) has resulted in a significant decline in rice area (Fig. 1a). According to current modeling, it is expected that with climate change, future average water availability will decline and the frequency of droughts will increase (Sanders et al., 2010)

The millennium drought provides a possible analog of a drier future. There was significantly reduced rainfall and above average temperatures from 2001–02 to 2009–10 and Basin inflows were much lower than average and allocations to irrigators declined, resulting in an irrigation drought (CSIRO, 2008). Total rice area in Australia has a strong linear relationship with total irrigation water allocations (Fig. 2a) and there was also a reduction in the number of farms growing rice (Fig. 2b). Although the Australian rice industry has improved its water efficiency considerably, using 50% less water than the world average (Rice Growers Association, 2011), there is further pressure for structural adjustment because of the continuous decline in water availability. This will affect farm profitability and the regional economies where rice production is concentrated.

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