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How do farmers react to varying water allocations? An assessment of how the attitude to risk affects farm incomes

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ABSTRACT

A risk farmers have to cope with is annual changes in the availability of irrigation water. In this paper the relationship between irrigation water allocated to farmers and the incomes they derive in the Coleambally Irrigation Areas (CIA) in Australia is quantified. It is shown empirically that farmers reduce the area cropped when faced with reduced water availability. Increasing the availability of water does not necessarily lead to more stable (less volatile) income streams, as it offers the opportunity to include more water intensive, yet also more risky, crops in the cropping pattern (e.g. rice). However, it does lead to an overall increase in incomes. It was found that rice is the dominant crop for all levels of risk aversion, as shown by a stochastic dominance approach and by the stochastic efficiency with respect to a function. The optimal farm plan portfolio besides rice also includes a substantial amount of wheat if irrigators are somewhat risk averse, while more risk-averse farmers prefer more maize in their farm crop plans. The relative reduction in expected income from the optimal farm plan chosen, given a rather risk averse farmer, compared to the expected income of the optimal farm plan chosen by a risk neutral farmer, is approximately 9%.

1. Introduction

As rain fed arable farming is an inherently risky enterprise, especially in drought prone regions, establishing irrigation is therefore often seen as a risk management strategy to overcome water deficiencies. However, the level of water allocated becomes an important input constraint if water resources available for irrigation are limited. In addition, water allocations (which in Australia are defined as the access entitlement holders have to a volumetric amount of water that can be used or traded in each water year), can vary depending on seasonal conditions and particular regulations. Thus, the very element that is provided to farmers to reduce uncertainty, an allocation of water, also has a degree of uncertainty attached to its supply.

Increased and more reliable water allocation levels seems desirable from a farmer's perspective, as they might induce ex-ante investment in more inputs in order to enhance their incomes. However, crucial to understanding just how farmers cope in this situation depends not only on the level and reliability of the water allocated, but also on their attitude towards risk. For example, more risk averse farmers might cope differently than less risk averse farmers given the downside risk of crop failure. Differences in decisions farmers make when faced with these uncertainties will manifest itself mainly in total area planted and the mix of crops in the portfolio, as these are the factors they can influence.

The purpose in this paper is to quantify the relationship between the irrigation water allocated to farmers and the incomes they derive, in order to explore the consequences of changes in the water allocation levels and its reliability on farmer's decision making. This research is needed because prior to the Millennium drought (2002–2009) irrigators could rely on the quantity of water they had been allocated. During those periods available supplies of regulated water exceed demand. So even during some dry years the stock of water held in a reservoir was enough to cover the requirements of irrigators. However, because the Millennium drought was so severe, the demand for water exceeded its supply. As water is fully allocated to users any changes in the supply of irrigation water, due to a prolonged drought, cannot be met every year of that drought from reserve supplies, as it had in the past when droughts were not as prolonged. More to the point, this is a situation which may become a perennial concern in Australia as the water allocated to farmers is reduced in order to satisfy the environmental demands of river health.

This research focuses on the Coleambally Irrigation Area (CIA) in Australia. Farm incomes for various water allocations in CIA will be assessed over the period from 1997/98 to 2009/10. This period includes the Millennium drought in this region from 2002–03 to

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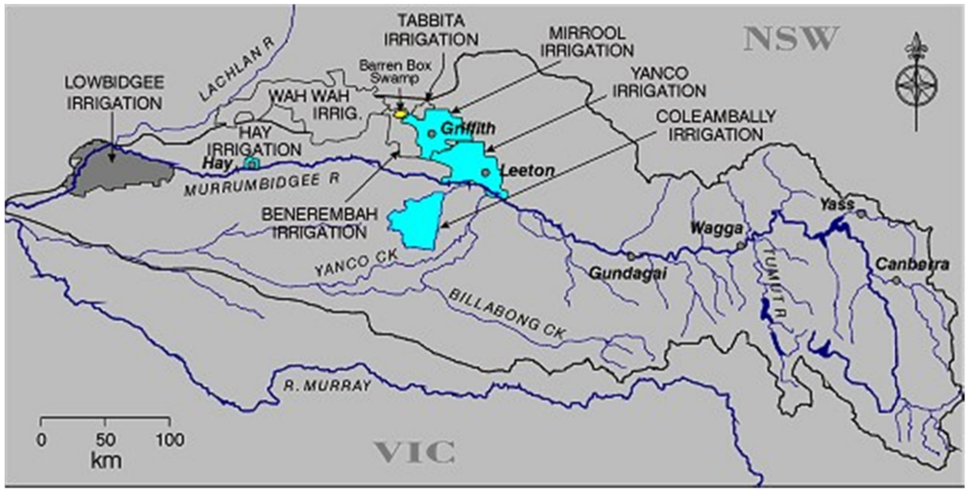

Fig. 1. Murrumbidgee catchment and Coleambally Irrigation Area.
Source: Bowmer (2003) Agriculture for the Australian environment–learning from existing practice. Reflections on developing a water sharing plan. *Kathleen Bowmer and Associates*.

2009–10. As a consequence during the period under investigation water availability ranges from 100% down to only 6%. Under such circumstances farmers have faced massive risks and challenges, and have reacted rationally and realistically. It should be noted that using groundwater to alleviate drought conditions in the CIA is only a short term fix, and one not considered in this study.

To understand and predict how farmers react to water shortfalls, farmers response to changes in water availability are observed and assessed. In undertaking this task initially the CIA region and method applied are described. Subsequently, the relationship between water availability and farm income is analysed, as well as the cost of risk aversion measured in terms of relative reduction in expected income.

2. Case study and methodology

2.1. The Coleambally Irrigation Area

The CIA is located in the Riverina district of New South Wales, in the southern part of the Murray Basin of Australia. The area is situated between the Murrumbidgee River to the north and Yanco Creek to the south (see Fig. 1). The CIA was established in the late 1960s in order to use the water collected and diverted westward from the Snowy Mountains Scheme, and was principally to be used for agriculture. The CIA holds the bulk water licence of approximately 620,000 megalitres (ML) per year and serves an arable area of approximately 100,000 hectares (ha) of intensively irrigated farms. Water is also provided for livestock, which is grazed on an area of approximately 300,000 ha. There are 477 irrigated farms in the CIA, each farming an average of 220 ha. Each farm has, on average, a general security water entitlement of approximately 1300 ML (Austin Evans, Water Manager, CIA, personal communication, 27 July 2012).

The CIA is not just an irrigation area – large parts of it are used for dryland extensive farming. Many farmers also have a sizable livestock enterprise. In addition, sowing winter cereals into areas where rice was grown in the previous season is undertaken in order to access sub-soil moisture. Thus, farmers use a range of strategies to manage production across dryland and irrigation activities, involving many inputs and process than just those associated with water. That being said, it should be noted that decisions surround water are critical to the outcomes of any activities undertaken by the farmers in the region.

The entitlements structure (sometimes called a general security entitlement) allocates water as it accumulates in storage. Each irrigator has the right to a proportion of the accumulated supplies in any one year. So, if the reservoir is full the irrigator may well get 100% of their allocated water rights, and in some cases more. However, if it is only half full, then irrigators will receive only a percentage of their full entitlement; with every irrigator receiving the same percentage reduction. This type of entitlement system, with all its inherent uncertainties, has resulted in irrigators preferring to plant annual crops over the production of perennials (fruit and grapes). The inter-year water requirements of perennial activities are ill-suited to this type of system, despite the fact that at times irrigators have accessed significant amounts of groundwater.

In the CIA the minimum amount of water a farmer will receive is announced before the main planting season starts. This allows the farmers to react to a reduction in the water availability before planting a crop. Knowing this, it could be argued that farmers would all be extremely risk averse. However that might not be the case, because irrigators could take a risk and plant a greater area than they can irrigate at the time of planting, and hope that the allocation will rise as the season progresses or anticipate sufficient rainfall amounts to compensate for a lack of irrigation supplies. Despite this, it could be argued that farmers face a reduction in the downside risk that might arise from a lack of water availability.

2.2. Methods and data

In such a complex system it makes little sense to only contemplate the decisions to sow rice and/or winter cereals as completely independent. In a similar vein it can be quite misleading to assess situations using individual crop annual data when it comes to intra-seasonal production choices. For example, faced with a low allocation, farmers can opt to use the limited water to 'finish off' a winter cereal crop in order to raise yield. This is a common strategy when water allocations are particularly low or the season dries unexpectedly. While the complementarities that occur with any production system need to be considered, and they are in this study by assessing different crop mixes, it is essential to initially assess each crop individually.

To assess how farmers in the CIA might react to a reduction in water availability a regression analysis is undertaken, where the areas of the various crops (both in aggregate season total and