

# Path dependence: an approach for framing constraints on adaptation in Australian dairy farms

Lisa Kay Cowan

B.A. English (University of Washington, Seattle WA, USA)

M. Soc. Pol. & Plan. (Charles Sturt University, Wagga Wagga, NSW)

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# Abstract

Climate change is a salient issue for southern Australia, which has been identified as one of the regions most vulnerable to climate change in the world. The potential impacts of climate change on farms could be profound and may require that producers adapt their farms to a much greater degree than currently undertaken. Generally speaking, it is expected that climate change will require considerable change to agriculture, with the responsibility for this change lying squarely with producers, many of which are small family businesses. In this thesis I explored the capacity of producers to adapt their farms in the face of climate change. Underpinning this exploration was a question regarding the role, if any, for public policy to support producers with managing climate change impacts.

I made a case that producers are constrained in the set of options available to them regarding feasible adaptations to their farms. These constraints are multifaceted and reflected in the sequential and cumulative changes made to the farm through time. Understanding the capacity to adapt the farm, then, logically needed to consider these dynamic constraints. I developed an integrated model of constraints on farms, drawing on farm control theory, value chain functions and image theory to identify a comprehensive set of constraints on farm decisions. Path dependence was then used to frame consideration of the dynamic interaction among constraints in farms.

The model was applied to 16 family dairy farms in northern Victoria. Producers were interviewed about the history of decisions regarding the family farm. Data were converted to narratives which were then analysed. Patterns of constraints were identified, using the integrated model. Using path dependence theory, these identified constraints were mapped as critical junctures and reinforcing decisions to reveal the dynamic interaction among constraints. Insights for understanding constraints on farms were then discussed, using examples associated with responses to drought, exiting dairy production and fertility management.

The model was assessed as a comprehensive and useful framing of constraints in farms and several principle insights were identified that were associated with:

- the salient constraints that exist in farms,

- the diversity of paths in farms due to constraints associated with the producer and family,
- the dire consequences that can result from compounding constraints, and
- the role of capability in determining farm decision options.

A number of implications for producer adaptation to climate change and the role of policy to support adaptation were then identified.

Overall, the research presented a picture of a future in dairy farming that will be characterised by a diminishing ability to cope with increasing variability. There appears to be an expectation that producers need to act now by adapting their farms to increase their capacity to manage increased variability. Yet producers are already constrained in their change options, due to path dependence as an accumulation of dynamic constraints.

If policymakers wish, or are pressured, to assist producers in this context, it may best be provided through support that enables preparation. Such policy support should focus on the provision of specific and relevant information and useful adaptation options. Central here are having information ready when producers are receptive to the need for change, and the maintenance of relationships with producers that enable greater understanding of their context-specific constraints. The development of technologies that enable flexibility is critical to supporting preparation on farms.

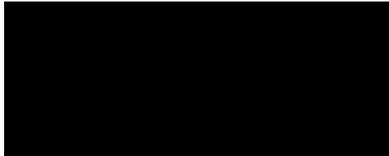
These findings suggest that timely preparation will not always be possible. Policy to then support producers to cope with the consequences of impacts will likely be inefficient, because of the diversity in constraints that exist in farms. Given an increased likelihood of failed businesses, policy to support agricultural adjustment may be useful.

This presents considerable challenges for developing appropriate responses to support farm adaptation to climate change. These findings suggest that support should emphasise generating and maintaining information to support the needs of diverse farms. Government also needs to be prepared to respond when producers are receptive to this information. This implies a need for increased breadth and flexibility on the part of government research, development and extension services.

# Certification

I certify that the substance of this thesis has not already been submitted for any other degree and is not currently being submitted for any other degree or qualification.

I certify that any help I received in preparing this thesis and all sources used have been acknowledged in this thesis.





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# Glossary of terms

Agistment	A farm practice of sending cows off of the farm for a period of time. A fee is paid to the manager of the property where cows are agisted. Agistment is generally used for managing young and dry stock.
Allocation, irrigation	The percentage of water allocated, within irrigation entitlements, to irrigators in the irrigation district.
Backbone	A term describing the main regulated irrigation supply channel into and within the G-MW irrigation area as determined by recent irrigation system reform, described as 'modernisation'.
Bobby calves	Calves that are less than two weeks old and have been removed from their mothers
Carryover water	Leftover water from an irrigator's allocation that is allowed to be carried over into the following irrigation season.
Check banks or border checks	Raised banks of soil that are used in flood irrigation to guide the flow of irrigation water within irrigation bays
Conserve feeding	A practice of feeding hay, grain and silage to stock that was grown, harvested and stored for the purpose.
Cow parking	A farm practice of sending cows off of the farm for a period of time. The cows are milked by the manager of the property where the cows are parked. This differs from agistment, in which the cow owner pays a fee for looking after the cows. Instead, payment is derived through the production of milk.
Deep lead bore	A bore that is accessing deep aquifer water that is recharged over a very long timeframe.
Delivery shares	An entitlement that is linked to the land and enables a certain amount of water to be delivered the farm. A delivery share determines the maximum amount of water that can be used on a property in a season. (i.e. the combination of carryover, high and low security water cannot be greater than the delivery share)
Deregulation of milk	The removal of both state and federal legislation to regulate the sourcing and pricing of whole milk. The deregulation process occurred in 1999-2000.
Dethridge wheel	A wheel used to calculate the water that is being taken onto a farm property at an irrigation outlet. In process of being upgraded to magflow meters or flume gates.
Drought constructs	<i>Agricultural drought</i> - when there is reduced irrigation water available to primary producers (can be the result of factors separate from meteorological drought, such as over allocation and policy change)  <i>Meteorological drought</i> - when observed rainfall total fall within the lowest 10 per cent of long-term precipitation records, which in the context of irrigation is manifested very clearly into changes in allocations
Dry cows	Cows that have been managed to stop lactation in the weeks up until calving
Empty cows	Cows that are not in calf, or pregnant

Entitlement, irrigation	An ongoing agreement between the local water authority and an irrigator that ensures irrigator access to a designated amount of water, measured in mega litres (ML) from a specified consumptive pool. This includes both low and high security water as determined by reliability of water. This is also known as a water share.
Environmental flows	Broadly, this can mean water released into the river system for environmental reasons. This phrase is often used to describe water in the pool of water available with the irrigation district that has been separated out for river health.
Farm apprenticeship	A training program that included on-the-job training and coursework at a technical college or university.
Farm management deposit account	A savings account that includes a tax benefit for farmers as they can deposit money pre-tax as long as it is left in the account for more than 12 months.
Feed pad	A designated area for feeding supplementary feed, sometimes constructed out of cement.
Feeding in the bail	Offering supplementary feed as pellets or grain to cows as they are milked.
Flume gates	A metered irrigation outlet gate that has replaced many of the Dethridge wheels used in managing the flow of irrigation water onto properties.
Goulburn-Murray Water (G-MW)	A regional water authority responsible for managing irrigation water and infrastructure in the district in which interviews were conducted.
High security water	The high reliability portion of an irrigator's water entitlement. The expectation is that 100 per cent of high security water would be achieved 95 years out of 100. This is similar to the notion of permanent water. When irrigators describe the number of ML associated with their farms, this is what they are describing.
Imported feed	Feed that is brought onto the farm for use as stock feed. This can include grain, hay and silage. Also called purchased feed.
Lead feeding	A practice of transitional feeding, in which the farmer alters the feed given to cows up until and after calving to reduce the incidence of problems transitioning the cow back into milk production.
Low security water	The low reliability portion of an irrigator's water entitlement. Low security water is available once there is enough water to meet the high security water needs in the consumptive pool for the current season and the minimum inflows for the following season. This is similar to sales water.
Magflow	A type of water meter used to measure the volume of water entering a farm property at an irrigation outlet. Superseding the Dethridge wheel on some properties.
Modernisation	A term used to describe recent irrigation system reform. The program has included the removal of water authority management of some parts of the public irrigation infrastructure, described as 'rationalising'.
Murray Goulburn Co-operative	A milk supplier established in 1950 that is owned by Australian dairy farmers. It processes about 1/3 of Australia's milk supply for the domestic and export market
Permanent water	An older way of describing the high reliability portion of an irrigator's water entitlement. This is similar to the high security water.

Northern Victoria Irrigation Renewal Project (NVIRP)	The organisation that was created to deliver irrigation system reform, described as modernisation. Recently, NVIRP has been integrated into G-MW as a group called G-MW Connections.
Pugging	A term used to describe stock damage cause by hooves sinking into the soil creating deep divots and damaging pasture.
Sales water	An older way of describing the low reliability portion of an irrigator's water entitlement. This is similar to low security water.
Shallow bore or spear point bore	A bore that accesses water in shallow aquifers (down to 30 metres). Water levels fluctuate more readily than deep lead bores, more closely aligned with climate
Shandy	Refers to the mixing of saline groundwater with fresh water to reduce salinity of irrigation water
Spur	A term describing the publicly owned parts of the irrigation system that are connected to the backbone.
Stock and domestic	Describes the use of water for household needs and watering of stock. This is separate from an irrigator's irrigation entitlement.
Supplementary feed	Any feed given to stock other than via direct grazing. Supplementary feed includes conserved feed and imported feed.
Tatura Milk	A milk supplier established in 1907 that is now a wholly owned subsidiary of Bega Cheese. Tatura Milk produces a number of dairy products (e.g. infant formula and butter) for domestic and export.
Temporary water	Water that can be purchased on the temporary water market within a season.
Whole milk	Milk sold in liquid form, also referred to as fresh milk
Whole farm plan (WFP)	A plan that is developed in a two stage process entailing a farm survey and design. WFPs are used to plan for farm development including the farm's irrigation system layout. This includes consideration of land slope and paddock sizes.

