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A review of the economics of regenerative agriculture in Western Australia

Anne Bennett
anne.bennett@dpird.wa.gov.au

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Department of Primary Industries and Regional Development
3 Baron-Hay Court, South Perth WA 6151
Telephone: +61 (0)8 9368 3333
Email: enquiries@dpird.wa.gov.au
Website: dpird.wa.gov.au

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Summary

- There is no published work detailing the economics of regenerative agriculture in Western Australia.
- Of the work completed in other jurisdictions and nations captured in this review, the profitability of regenerative agriculture compared with conventional agriculture was variable, although generally lower.
- The loss of income associated with the transition from conventional agriculture to regenerative agriculture is a significant barrier to adoption, although it is enterprise-sensitive.
- Farmers who are operating regenerative agriculture systems self-report higher levels of wellbeing.
- Conventional agriculture and regenerative agriculture are overlapping approaches.
- The literature presented in this review is mostly based on small samples, case studies or models. There are hazards in extrapolating this information to represent regenerative agriculture performance more generally.

1 Introduction

Regenerative agriculture (RA) is a term that has arisen internationally in the past few decades. It has received significant attention in Australia in the last 5 to 10 years and there is increasing interest in the economic performance of RA systems in Western Australia (WA).

RA is one of many agricultural approaches practised within WA. Others include conventional agriculture (CvnA), natural sequence farming, organic agriculture, biodynamic agriculture, conservation agriculture and low-input agriculture.

It is argued that the difference between RA and CvnA is mainly in philosophy (Tweeten 1990) because both systems have common factors. RA farmers place an emphasis on conserving the natural resources, minimising the use of synthetic chemicals, reducing the 'leakiness' – loss of nutrients, soil and water from the farm boundary – of a farm (Tweeten 1990), and incorporating biodiversity into production systems and areas of native vegetation (Pearson 2007). An RA farmer attempts to internalise the off-site costs of agricultural production (Pearson 2007).

CvnA in Australia also emphasises conservation of natural resources. However, its approach tends to use a high level of inputs including fertilisers, pesticides and herbicides (Gosnell et al. 2019), although it incorporates many practices considered to be regenerative. Many of the practices promoted and used by RA farmers – such as crop rotations, integration of livestock and crops, conservative use of synthetic inputs, and conservation of soil and water – were developed as a part of CvnA (Tweeten 1990). The synergies in practices demonstrate the overlapping nature of CvnA and RA approaches.

This paper reviews published papers that specifically reference the on-farm economic performance of RA. However, RA's short prominence in Australia and its broad definition have resulted in few contemporary peer-reviewed papers. Consequently, papers published in Australia were used where possible, and were supplemented with international studies where needed.

This paper is part of a group of work being undertaken by the Department of Primary Industries and Regional Development (DPIRD) investigating RA in WA. Other work includes the marketing of RA, investigating the science of RA, case studies of practicing RA properties in WA, and whole farm nutrient mapping.

2 How is regenerative agriculture defined?

RA is an approach to farming that uses natural systems to increase biological activity, sequester carbon, rejuvenate soil health, improve nutrient cycling, restore landscape function and produce food and fibre, while aiming to maintain or improve farm profitability. RA can occur across all agricultural endeavours, but has had most traction in agricultural and pastoral production.

How RA looks on-farm is different between farms. The approach is guided by a series of principles:

- growing plants for as much of the year as possible
- minimising soil disturbance
- keeping the soil covered
- diversifying the plants, animals and soil microbiota
- integrating animals into farming systems
- reducing or eliminating synthetic chemicals.

Proponents of the approach use a wide range of practices that integrate biological and ecological systems to drive production and restore landscape function. The broad aim is to take advantage of natural processes such as:

- capturing soil carbon through photosynthesis
- establishing healthier and more-diverse symbiotic relationships between soil microbiota, plants and animals
- using biological systems to increase water-holding capacity through improved soil structure
- integrating herbivores and their planned impact on plant and soil diversity.

3 On-farm economic studies

Proponents of RA suggest that RA systems can be profitable and that consumers are increasingly seeking RA food, with premium markets emerging for produce from low-input farming systems (Pearson 2007). However, if farmers are receiving premiums (not covered in this review), the price received and consequently farm performance will be influenced by the volume of produce in the market, which is determined by on-farm production and the adoption of RA farming across the farming community.

As with any diversion from current predominant practice, there can be challenges as well as opportunities. For instance, RA systems are generally more labour intensive, creating the opportunity to reinvigorate rural communities, but at the same time increasing the costs of production (Pearson 2007). RA systems also aim to internalise and minimise many of the external costs of production by focusing on minimising leakage from the system (Pearson 2007), which can increase the costs of production or reduce yields.

Additionally, through its focus on improving soil health, RA systems seek to minimise or reverse on-farm soil constraints. This is also a priority for CvnA farmers. Examples of on-farm soil constraints include soil erosion, salinity and acidification, all of which can reduce yield (Wade et al. 2008). DPIRD (n.d.) has estimated the annual on-farm opportunity costs (forgone income) of soil constraints in the agricultural areas of the south-west of WA for 2009–10 to 2013–14 and 2014–15 to 2018–19. Subsoil acidity has the single greatest opportunity cost (Table 1). For comparison, the average Gross Value of Agricultural Production in WA between 2010 and 2014 was $6,726 million, and between 2015 and 2019 was $8,884 million (ABS 2020).

Table 1 Estimated annual opportunity costs of soil constraints in the agricultural areas of south-west WA

Soil constraint	Estimated annual opportunity costs 2009–10 to 2013–14	Estimated annual opportunity costs 2014–15 to 2018–19
Subsoil acidity	$1,507m	$1,718m
Sodicity	$577m	$744m
Soil salinity	$519m	$686m
Subsoil compaction	$517m	$656m
Water repellence	$362m	$461m
Transient salinity	$91m	$97m
Wind erosion	$50m	$62m
Waterlogging & inundation	$35m	$46m
Water erosion	$3m	$3m

m = million

Note: These costs cannot be added together because many of the hazards can interact and occur together. The opportunity costs are maximums and the methodology assumes each constraint is the only one present. For instance, if acidity is already pruning the roots then compaction will have a minimal further effect on yield.

Source: DPIRD (n.d.)

Agriculture can play a significant role in preserving and improving biodiversity in Australia. Currently, land managers and farmers are making a significant contribution of time and money to deliver these outcomes. However, climate change is affecting biodiversity and natural capital assets at the same time as affecting farm incomes, potentially compromising the capacity for farmers to invest in environmental projects (McRobert et al. 2020). RA may be one approach to maintain or improve natural capital into the future.

Following is a list of papers reviewing the financial performance of RA. The papers that are of most value are those focusing on farmers who are long-term adopters of RA to ensure the costs of transition do not obfuscate the steady-state financial performance.

The potential financial performance of a property is influenced by the quality of its natural resources, including the soil type mix, location and climate. The usefulness of financial benchmark comparisons is determined by the area the benchmark encompasses and how closely this reflects the study farm.

3.1 Published studies in Western Australia

In WA, a small number of farmers have been using RA for decades (J Bowyer [DPIRD], personal communication, 7 July 2020). Recently, Planfarm, an agricultural consultancy firm in WA, undertook a cursory review of the farmers in their client list who fit the definition of RA outlined earlier. They had less than 10 RA farmers, but noted that more farmers had tried to adopt RA, but they had moved away or exited farming within the transition period. Primary observations by G McConnell (Planfarm, personal communication, 14 July 2020) of their RA clients were they:

- had lower crop yields
- mostly had lower productivity
- had better operating efficiency than CvnA because costs were lower (better operating efficiency = lower costs as a percentage of income)
- had varied return on capital, with some performing well and others performing poorly.

The low number of RA farmers in WA observed by J Bowyer and G McConnell suggests that most farmers in WA are yet to be convinced they can adopt RA and remain financially sustainable.

3.2 Published studies in Australia

The following studies are listed in alphabetical order of authors. No critical assessment of the studies was made. Note that there is limited validity in extrapolating economics results from one region to another.

Francis J (2019) *Regenerative agriculture – quantifying the cost*, Holmes Sackett, accessed 28 May 2020.

This work was completed in response to Ogilvy et al. (2018). Holmes Sackett used their figures to compare the profitability of RA systems to CvnA systems. Both systems were found to be profitable, with a return on assets managed (ROAM) of 1.66% (RA) and 4.22% (CvnA). The difference in ROAM between the 2 systems over a 10-year period equalled $2.46 million per farm in favour of CvnA. This work was criticised because the properties selected did not allow for like-to-like comparisons of RA and CvnA farms because of differences in location, soil type and climate.

Ogilvy S, Gardner M, Mallawaarachichi T, Schirmer J, Brown K and Heagney E (2018) *NESP-EP: Farm profitability and biodiversity project final report* [PDF 3.9 MB], Canberra Australia.

The National Environmental Science Program – Emerging Priorities program compared 16 RA farm finances to industry benchmark data. Using earnings before interest and tax per dry sheep equivalent (EBIT/DSE) for comparison, RA farms were profitable. Losses experienced in poor years were less dramatic, but the profits in good years were not as high. Over a 10-year period, the average EBIT/DSE for the RA farms was below the industry benchmark for wool flocks, but above the average for beef herds.

The RA farmers reported higher levels of personal wellbeing, satisfaction with life and higher levels of feeling life is worthwhile. As part of the study, RA farmers were asked a set of questions identical to the Regional Wellbeing Study (RWS) that surveys 13,000 Australians annually. The RA farmer responses were compared with samples of the 4,000 farmers from the RWS. The questions asked how they would describe their average farm business performance. Sixty-four per cent of RA farmers, and only 32% of CvnA farmers, reported making a moderate to large profit. However, 21% of RA farmers, compared with 14% of CvnA farmers, reported their farm was under a lot of financial stress. Note that self-reporting on financial measures, such as profitability, is based on the participant's expectations, and does not give a comparative measure of profits between RA and CvnA. However, it does suggest that RA farmers generally have a higher level of satisfaction with profits.

Francis (2019) and others criticised this work, saying that EBIT/DSE was not an adequate measure for providing insight into the profitability of the farm. For instance, an increase in $/DSE could be driven by a decrease in the number of animals. Other, more-robust financial metrics would provide a more-sound insight into the profitability of RA. Criticism was also made about the report being released prior to formal peer-review.

3.3 Published studies in the United States

The following studies outline the experience of a group of farms. No critical assessment of the studies was made. Note that there is very limited validity in extrapolating economics results from international studies to the WA experience.

LaCanne CE and Lundgren JG (2018) 'Regenerative agriculture: merging farming and natural resource conservation profitably', *PeerJ*, 6:e4428, doi:10.7717/peerj.4428.

A study from the US in 2017 investigated the profitability of RA corn and CvnA corn. They found RA growers had a 29% lower yield, but 78% higher profits than CvnA. The higher profits were due to reduced input costs and higher prices. There was positive correlation between profit and particulate organic matter of the soil rather than yield.

Taylor DC and Dobbs TL (1988) 'South Dakota's sustainable agriculture farmers', *Economics Commentator*, Paper 260, South Dakota State University.

Of the 32 RA farmers surveyed in a South Dakota (US) study, two-thirds considered RA to be more profitable than CvnA farming. Reasons given were lower input costs and improved market prices for RA produce, as well as lower production and price risk.

4 On-farm economic case studies of RA in Australia

These case studies outline the experience of single farms. Comparison of with versus without can be useful when exploring case studies. However, for many of these case studies, it was difficult to find the economic evidence comparing before RA with after RA, often because of the significant period of time since the farmers adopted RA.

Note that while comparing RA to CvnA benchmarks is useful, the potential financial performance of a property is influenced by farm management practices and the quality of its natural resources, including soil type mix, location and climate. The area the benchmark encompasses and how closely this reflects the case study farm will determine the usefulness of the benchmark as a comparison.

The following Soils for Life case studies and Perth NRM webinar are listed in alphabetical order of author. Soils for Life is a not-for-profit organisation aiming to maximise the adoption of RA and has undertaken many case studies since 2011. Consequently, these studies cannot be considered independent.

Only those case studies most relevant to WA are discussed in detail. No critical assessment of the case studies was made, and these case studies were not peer-reviewed.

The case studies give all data as indexed figures – indexed to the first year of analysis for the benchmarked farm to ensure confidentiality – and are not on-farm figures.

Perth NRM (23 June 2020) 'Nick Kelly – operating a regen farm [webinar]', *Perth NRM*, YouTube, accessed 1 July 2020.

Nick Kelly outlines the costs of production on his property at around $5 per hectare ($/ha) for fertiliser and around $5/ha for fuel, and he sells all his grain for over $500 per tonne. He states the business is based on relationships with customers who are seeking RA products. With a number of buyers interested in his products, he says they are becoming price setters rather than price takers. However, further context around these numbers is needed before any meaningful conclusion can be drawn.

RSM (2020a) *Fairhalt case study: economics report*, report to Soils for Life, accessed 26 May 2020.

The 300 ha case study farm is near Crookwell, New South Wales (NSW). It is part of a larger parcel of properties managed together and covering 690 ha, however, the case study focused on Fairhalt. On average, the property produces 2000 tonnes of seed and gourmet potatoes each year, contributing 66% of revenue; stocks on average 1,800 prime fat lambs, contributing 21% of revenue; produces hay and fodder, contributing 11% of revenue; and grows wool, contributing the remaining 2% of revenue.

Productivity of the potato production is compared with benchmark data from ABARES' Vegetable Growers Farm Surveys Report for a vegetable grower in NSW and shows on-farm yields are higher than the average. However, the Vegetable Growers Farm Surveys data includes all vegetable growers, with potato growers making up only 42% of the total. Consequently, the validity of the benchmark data as a comparator for the potato growing part of the business is questionable.

This data is also used as the 'average farm' for other areas of comparison. Given the difference in enterprise mix of the case study farm and the 'average farm', the comparison of data is not discussed because of its limited validity.

ABARES' AgSurf data is used as a benchmark for comparing the prime lamb component of the business. It is not clear which subarea from the AgSurf data is used as a benchmark. However, from 2010 to 2014, the property's gross margin in lamb sales outperformed the average benchmarked farm in 4 out of 5 years. From 2015 to 2018, the property had a similar or lower gross margin than the average farm. The property consistently sells the same number of lambs each year. The drivers of the changes in gross margin were due to changes in lamb and input prices.

Pasture expenses for the property were significantly less than the AgSurf NSW or Australian farm average. Synthetic fertilisers have not been used on the property since 1998. Instead, organic compost has been used and this has dramatically reduced input costs.

RSM (2020b) *Salisbury case study: economic report*, report to Soils for Life, accessed 26 May 2020.

The case study farm is 20,000 ha and located in the Marra region of NSW. It is a self-replacing merino flock enterprise that, on average, stocks 5,000 ewes and 2,500 ewe lambs each year. Since 1977, the owners have implemented RA systems. Livestock sales contribute 58% of income and wool contributes 42%. The sheep gross margin per hectare per 100 mm rainfall exceeded the average farm every year on the presented data from 2009 to 2017. In 2011 to 2015, the farm had a period of low rainfall, and in response, more animals were sold. In 2009 to 2017, the farm outperformed the average NSW farm (Meat and Livestock Australia [MLA] industry benchmarks) with respect to wool income per hectare.

The farm business profit was maintained above average during the periods of low rainfall between 2011 and 2015. Profit was reduced in 2016 because of reduced wool sales, and in 2017, it was reduced because of increased property improvements.

The benchmark data used was for a specialist sheep enterprise in the pastoral zone, from the MLA farm survey reports. The validity of this benchmark data as a comparator for this property is not known.

RSM (2019) 'Glenelg case study: economic report' in Soils for Life *The Glenelg story*, Soils for Life, accessed 28 May 2020.

MLA farm surveys provided the benchmark data used in this case study. The property financial data was indexed to the benchmark data to retain confidentiality for the case study farm. The benchmark data used was for a specialist sheep producer with a flock size of 2,500 to 5,000. The area encompassed by the benchmark data is not provided. The validity of this benchmark data as a comparator for this property is not known.

The case study farm is 4,000 ha and located near Mungallala, Queensland. It is a grazing enterprise with around 4,100 sheep, 180 breeding cattle and 60–100 feral goats. The most significant RA practice on this farm is conservative stocking, which resulted in a consistent income even during poorer rainfall years. The introduction of an exclusion fence to keep out pests dramatically reduced the mortality rate, although it also reduced profitability in 2017 and 2018 because of increased depreciation costs. The farm generally has higher profits than the MLA industry benchmark because the lower costs and improved productivity result in greater income.

Other Soils for Life case studies undertaken in 2018–20

Other case studies which reference the economics are summarised in Table 2; however, these are considered less relevant to WA.

Table 2 Summary of other Soils for Life case studies which reference economic performance

Farm name	Farm size and location	Enterprise	Major findings
Collingwood	242 ha in Grampians, Vic	Black Angus cattle	Between 1996 (start of transition) and 2019, there has been a 36% average annual increase in profits, and a significant reduction in input costs.
Illawong	160 ha, with 136 ha of grazing land, located 32 km from Albury, NSW	140 cattle	Compared with the 'average farm' MLA farm survey data: • expenses were lower • profits were higher, although more variable.
Jillamatong	450 ha in Braidwood, NSW	about 300 cows, prime lambs, garlic, truffles and yabbies	Compared with the Holmes Sackett benchmark average 2005–2014: • expenses per DSE were lower • income per DSE was lower • net profit per DSE was higher.
Quirk	116 ha in Tumblegum, northern NSW	100 ha of sugar cane, 16 ha of cattle	Compared with benchmarked farms in the Tumblegum region, dollars per hectare farmed are consistent with peers. Compared with peers in the area, the farm has lower expenses.

Source: Soils for Life (n.d.)

Soils for Life (2012) *Innovations for regenerative landscape management: case studies of regenerative land management in practice*, Soils for Life, accessed 26 May 2020.

Case studies were undertaken on 19 properties in 2011–12. Many of the properties cited increased profits, reduced input costs, increased productivity measures and a smoothing of profit peaks and troughs. Incremental change starting on the areas of greatest production allowed for the increased profits to then be used to improve the lower performing areas of the property. This approach was cited as a way of reducing the risk of cash-flow stress of adoption.

Some of the case studies included specific references to financial performance indicators:

- Case study 1 in Theodore, Queensland, began RA farming in 1993
  - productivity increased by 30% with the introduction of cell grazing, and the increased productivity paid off infrastructure investment in 3 years
  - gross margins per hectare were between $64 and $113; no reference was given to base gross margins or averages for the area; paddocks with 40% canopy cover had greater gross margins than cleared paddocks
  - no comment was made about profit
- Case study 3 in Glen Innes, NSW, began RA farming in 2005
  - costs of production reduced by 30–50%
  - no comment was made about profit
- Case study 7 in Braidwood, NSW (Jillamatong), began RA farming in 1994
  - total profit per 100mm of rain was 10 times greater than the local average
- Case study 8 in Bombala, NSW, began RA farming in 1995
  - on moving to rotational grazing, there has been a relatively consistent profit increase compared with set stocked grazing.
- Case study 12 in Gulgong, NSW, began RA farming in 1993
  - annual costs decreased by $120,000
  - no comment was made about profit.

5 External costs of production

In CvnA, environmental benefits and costs tend to be treated separate to the cost of food production (Pearson 2007). When the full cost of food is calculated, including natural capital costs, the cost of food production incurred by a farmer can be significantly less than the full cost. For example, Pretty et al. (2000) showed the total measurable external costs of agriculture to society in the United Kingdom equivalent to £208/ha of arable and permanent pasture. Costs included contamination of drinking water with pesticides, nitrates, cryptosporidium and phosphate, as well as soil erosion and organic carbon costs, damage to habitats, food poisoning and bovine spongiform encephalopathy. Pretty et al. (2000) suggest this cost is an underestimate because it only includes those externalities that have quantifiable financial costs.

For some RA farmers, the motivation in using particular farming practices is the intent to create a system that internalises the off-site costs of agricultural production and, where possible, increase or create benefits (Pearson 2007). Many of the practices identified as RA are a part of CvnA. For instance, no-till agriculture can reduce soil erosion, although it does rely on synthetic herbicides; crop rotations can reduce disease burden; cover crops can reduce soil erosion and increase water infiltration; and good grazing management can reduce the risk of erosion (Ranganathan et al. 2020).

Off-farm costs are generally less for RA than CvnA, but are rarely zero (Pearson 2007). High-input CvnA can be associated with nutrient run-off, resulting in issues such as eutrophication of waterways; potential spray drift; and increased exposure to weeds, and wind and water erosion, which can lead to significant loss of soil, nutrients and carbon. Internalising off-site costs can increase on-farm costs, although reducing application of synthetics can reduce costs. However, no broadacre agricultural system is closed, with nutrients exported in products and some off-site effects (Pearson 2007).

In WA, there is scant literature estimating the off-site costs of farming, let alone by how much costs would be reduced under RA compared with CvnA. DPIRD (2014) estimated the off-site costs of agriculture in the south-west agricultural region of WA. The off-site costs of wind and water erosion are estimated to be between 1.5 to 4.5 times the costs of on-farm damage, making the public cost between $75 and $225 million annually. The off-site costs of salinity are estimated to be $5 million for rural towns, $505 million for roads repair and maintenance, $11 million for railways repairs and maintenance, and $63 million as an imputed cost of protecting 10% of affected areas of vegetation. This totals $584 million, although the true cost is likely to be higher. For the Peel–Harvey estuary and waterways, the off-site costs of phosphorus export are estimated to be $361 million annually. The extent these costs could be reduced through RA best practice rather than CvnA best practice in WA needs to be investigated in more depth before any conclusions could be made comparing RA and CvnA off-site cost performance.

6 Transitional economic studies on specific forms of RA

Transforming from CvnA to an alternative approach to farming is informed by beliefs, values, worldviews and paradigms (Gosnell 2019). The costs associated with and approaches to transition are enterprise and management specific. How transition is undertaken can be a significant determinant of success.

Moving from CvnA to RA requires a shift in strategy and practice of farmers. Surveyed farmers have cited a number of reasons as barriers to adoption, but one of the biggest is the cost of transition (Renton et al. 2020). For example, David Pollock found the transition period of moving Wooleen Station from CvnA to RA through immediate and complete destocking to rejuvenate the station's pastures significantly reduced income. This put the family business on the brink of financial collapse (Pollock 2019).

In adopting RA farming, there can be short-term costs of transition, such as reduced production, yields and return (Soils for Life 2012). Some farmers have reported wanting to make the transition to RA, but because of their high levels of debt they cannot afford the risk of lower revenues often associated with transition (Siegfried 2020). Issues associated with the transition period that can translate to costs include drop in crop yields due to the time required for the soil biome to establish an equilibrium; time needed for the farm manager to learn about the practicalities of the new system; and price premiums not being available in the first few years after conversion (Wynen 1992).

The costs of transition also highlight the importance of steady-state comparison to validly compare RA and CvnA financial performance.

The following papers are listed in alphabetical order of author. No critical assessment of the papers was made. Where possible, papers from Australia were sourced, however, these were supplemented with articles from Europe. Note that there is limited validity in extrapolating economics results from one region to another, let alone across countries. Studies based on models should be treated as indicative only and cannot be directly translated to lived experience.

Grashof-Bokdam CJ, Cormont A, Polman NBP, Westerhof EJGM, Franke JGJ and Opdam PFM (2017) 'Modelling shifts between mono- and multifunctional farming systems: the importance of social and economic drivers', *Landscape Ecology,* 32:595–607, doi:10.1007/s10980-016-0458-7.

This European study compared CvnA farming systems that generally have a single focus on maximising profit to multifunction farming systems (like RA) aiming to achieve profit, and environmental and social outcomes using a cellular automata model to shift between systems. The model simulated farmer behaviour based on income, drive to produce sustainably and social pressure.

The study found the most important driver of the size of the shift to multifunction farming systems was influenced by the relative costs of 'green' infrastructure on a multifunction farm compared with the costs of applying pesticides on a CvnA farm. The second most important driver was the ratio of farmers with a 'green' drive to the number of farmers driven by social pressure: the higher the number of farmers with a 'green' drive, the greater the shift. The third most important factor was a high remaining yield after a pest outbreak for multifunction farming system farmers.

The most important driver for farmers to convert from one system to another was sensitivity to social pressure from neighbours. The second most important driver was the cost of implementing multifunction farming systems practices: as costs of a multifunction farming system increase, the number of farmers converting to a multifunction farming system reduces, and in some instances multifunction farming system farmers convert back to CvnA. The third largest influence is the size of the neighbourhood exerting social pressure on a farmer: the bigger the neighbourhood, the lower the number of multifunction farming system farmers

Another finding was that to maintain multifunction farming systems, it is important to invest in social cohesion between multifunction farming system farmers.

Kerselaers E, Govaerts W, Lauwers L, De Cock L and Van Huylenbroeck G (24–27 August 2005) '[Modelling farm level economic potential for conversion to organic farming]' [conference paper], *XIth European Association of Agricultural Economists*, Copenhagen, Denmark, accessed 15 June 2020.

Costs of transitioning to an organic system from CvnA were investigated using a linear programming model run on a sample of 690 farms in Belgium. The results showed the potential for conversion to organic agriculture was high, although strongly dependent on farm type. Three farm types were studied: suckler cow farm, dairy farm and arable farm. The model results suggest suckler cow farms can convert to an organic system without losing income, including in the years of transition, because the costs of transition are low. Transition of dairy farms was much lower at around 32% of farms, although this rose to 69% when the transition period was excluded. Reasons given for the lower conversion rate are the reduced density of cattle required for organic certification and lower milk yields per cow. For arable farms, 47% of properties could convert to organic agriculture without losing income, and when the transition period was removed, this increased to 84%. Lower income was attributed to lower yield, high labour costs and postponed premium prices for organic produce during the transition.

This data suggests the costs of transition can significantly impede conversion to an organic farming system.

Wynen E (10–12 February 1992) '[Conversion from conventional to organic agriculture]' [conference paper], *36th Annual Conference of the Australian Agricultural Economics Society*, accessed 15 June 2020.

This study compared the costs of transitioning from a conventional cereal–livestock system to an organic cereal–livestock system in South Australia. The study found the possible returns were reduced when converting to an organic system. How much the returns were reduced depended on the availability of premium prices for organic products, changes in conventional prices, the level of yield reduction, changes in rotations and new investments needed (Wynen 1992).

7 Adoption

Adoption of RA farming in Australia is growing. A major factor that influences adoption of a new practice is the relative advantage of the practice. Other factors affecting adoption are:

- characteristics of the innovation that influence its relative advantage
- characteristics of the practice influencing the ease and speed of learning about it
- characteristics of the potential adopters that influence their ability to learn about the practice (Kuehne et al. 2017).

In WA, there has been a handful of RA innovators transforming their approach to farming for several decades (J Bowyer [DPIRD], personal communication, 7 July 2020). Adoption of RA is likely to be slow where conversion to RA is perceived to be, or is, a profit-decreasing event (Kerselaers et al. 2005).

However, there are studies showing that adoption of RA is not solely driven by economic factors, and farmers are making the shift for many reasons. The following papers are listed in alphabetical order of author. No critical assessment of the papers has been made. Where possible, papers from Australia were sourced, however, these have been supplemented with papers from the US. Note that there is limited validity in extrapolating economic results from one region to another, let alone across countries.

Gosnell H, Gill N and Voyer M (2019) 'Transformational adaptation on the farm: Processes of change and persistence in transitions to 'climate-smart' regenerative agriculture', *Global Environmental Change,* (59):1–13.

Gosnell et al. (2019) interviewed 28 Australian RA farmers to find out the factors that influenced the adoption of RA farming. The study divided the factors into 2 groups: friction and traction. Friction are those factors preventing adoption, traction are those factors encouraging adoption. Examples of friction factors are fear of change, habit, pride, identity, challenge in learning a new system, tolerating weeds and pests, shift in thinking from yield to profit, costs of transition, stocking and destocking, and social pressures. Examples of traction factors are experience of an event that 'opened the door', questioning approach to farming, alignment between values goals and behaviour, focus on happiness and relationships, identifying as an earth steward, better health, observation of soil improvement, increased drought resilience, improved soil moisture retention, and reduced inputs and expenses.

Overall, findings of the study suggest:

- transformational adaptation can be triggered by crisis, epiphany and exposure to alternative pathways
- decisions to transition to RA involve important nonmaterial subjective factors such as feelings, emotions, virtues and motivations
- sustained adoption is influenced by a range of environmental, economic, social, and personal factors.

Ogilvy S, Gardner M, Mallawaarachichi T, Schirmer J, Brown K and Heagney E (2018) *NESP-EP: Farm profitability and biodiversity project final report* [PDF 3.9 MB], Canberra Australia.

RA farmers in this study reported the 3 most common goals for being an RA farmer were:

- leaving the farm in good or better condition
- improving biodiversity
- achieving a satisfactory level of income.

The RA farmers also reported higher levels (than CnvA farmers) of personal wellbeing, greater satisfaction with life as a whole, and higher levels of feeling life is worthwhile. Using a self-reporting measure, all farmers in the study were asked how they would describe their average farm business performance over the last 3 years. Sixty-four per cent of RA farmers, and 32% of CvnA farmers, reported making a moderate to large profit. However, 21% of RA farmers, compared with 14% of CvnA farmers, reported their farm was under a lot of financial stress.

Prokopy LS, Floress K, Arbuckle JG, Church SP, Eanes FR, Gao Y, Gramig BM, Ranjan P and Singh AS (2019) 'Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature', *Journal of Soil and Water Conservation*, 74(5):520–534, doi:10.2489/jswc.74.5.520.

This study reviewed the adoption of agricultural conservation practices in the US between 1982 and 2017. There were a range of factors that positively influenced a farmer's adoption of conservation practices, including self-identifying as a steward of the land, previous experience with conservation practices, an awareness of and positive attitude to the programs and practices, seeking and using information, greater farm size, higher levels of formal education, higher income, engaging in marketing that increases the price received for produce, and expecting a positive yield outcome.

Taylor DC and Dobbs TL (1988) 'South Dakota's sustainable agriculture farmers', *Economics Commentator*, Paper 260, South Dakota State University.

Taylor and Dodds (1988) surveyed 32 RA farmers in South Dakota, where the average time RA farming was 14 years. When compared with all South Dakota farmers as reported in the 1982 Census of Agriculture, the survey of RA farmers showed 45% of RA farmers, compared with 17% of CvnA farmers, were in the 35–44 age bracket, while 40% of CvnA farmers, compared with 19% of RA farmers, were in the 55+ age bracket. The top 4 reasons farmers had switched to RA were:

- to be a good steward of the soil
- to reduce pollution of ground and surface water supplies
- to raise a residue-free, high quality product
- to reduce possible harmful effects of farm chemicals on the health of the farmer and their family.

8 Conclusion

There are few published papers reviewing the economic performance of RA in Australia and worldwide. There were no identified published papers for RA in WA, and no studies estimating reduction in off-site costs from RA in Australia or WA were found.

The 2 most recent papers comparing the performance of RA and CvnA in Australia – Ogilvy et al. (2018) and Francis (2019) – were criticised regarding the validity of methods or benchmarks used. The Soils for Life case studies reviewed provide information on specific properties, but do not provide a comparison of systems. In addition, the data used for comparing performance was often not like for like, given differences in management practices, climate, soil type and location. Making valid comparisons is challenging because there are so few adopters of RA and the economic performance of any particular practice is highly sensitive to the biophysical and socioeconomic contexts of each farm.

It is difficult to compare the financial performance of RA farmers because the definition of RA contains a very broad spectrum of approaches to farming. RA farmers may only operate one section of their property as RA, with the remainder considered to still be run as CvnA. RA can encompass practices such as natural sequence farming and organic farming. And many CvnA businesses may be running sections of their properties consistent with RA.

To be able to compare RA and CvnA financial performance, the RA farmers need to have fully transitioned because the costs of transition can obfuscate the true financial performance of RA. Transitioning from one system to another can be costly. The studies presented in this review suggest the magnitude of cost in transitioning from CvnA to RA depends on the industry and approach to transition, and is a significant barrier to adoption.

The main messages from the papers reviewed are:

- RA can be a profitable system.
- RA in Australia could be a lower risk system than CvnA: losses in the bad years are not as high. Conversely, the profits are not as high in the good years.
- The financial performance of RA farms is mixed, with some studies citing higher profitability, while others suggest lower profitability. Overall, the studies suggest RA is profitable, but generally not as profitable as CvnA.
- RA has lower input costs.
- Transition to RA and the approach to transition can be challenging and a significant determinant of success.
- RA farmers have higher self-reported levels of wellbeing.
- A range of factors, not just economic, influence the adoption of RA.

Shortened forms

Short form	Long form
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
CvnA	conventional agriculture
DPIRD	Department of Primary Industries and Regional Development
DSE	dry sheep equivalent
ha	hectare
km	kilometre
MLA	Meat and Livestock Australia
mm	millimetre
NSW	New South Wales
RA	regenerative agriculture
US	United States
Vic	Victoria
WA	Western Australia

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