

# Transforming the bush: robots, drones and cows that milk themselves | Paul Daley

Rural Australia is being progressively hollowed out of its people. Will it be reduced to a vast mechanised place of scant human habitation?



Video

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These cows are in no hurry. Each just meanders to the dairy, all rolling hindquarters, swishing tails and loping heads, the blue-black and tan Rorschach ink-blot patching of their hides vivid against the washed-out Australian summer light. They stop as they please along the way. Chew cud. Moo. Drop pats. Moo again. They nudge the soft earth or a companion before snorting and continuing on up through the paddocks to the shed.

It's milking time – just as it's always milking time in this dairy for about 360 Friesians at Camden, where the outer orbit of Sydney gives way to the gentle rise that becomes the southern highlands. These cows are not held to the human clock and milked according to the dairy farmer's traditionally antisocial (for both people and cows) timetable, at the crack of dawn and again at dusk. And they don't have to line up for hours, either, cramped in a race, their udders bursting, in order for a dairy worker to quickly wash their teats, apply the suction cups, extract their milk, disinfect and send them on their way.

Induced to wander to the dairy only by the irresistible promise of fresh pasture beyond, these animals are milked according to a pattern that largely meets their rhythm of grazing, watering, resting and lactating.

They are not herded or cajoled in any way to head for the shed. There are no dogs snapping at stragglers' fetlocks. It's rare for people to bother them at all. Indeed, there's scarcely a person in sight on this dairy

farm, situated in the New South Wales Department of Primary Industries Elizabeth Macarthur Agricultural Institute.

There are no people about because, once the cows reach the shed, they effectively milk themselves in what is the world's first robotic rotary milking dairy. The result of a collaboration between the Swedish dairy equipment producer DeLaval, Dairy Australia and the University of Sydney's faculty of veterinary science, the Camden property is host to the research-and-development prototype FutureDairy, which can automatically milk up to 90 cows an hour.

## Gala - The world's first commercial AMR

Life on a FutureDairy farm in Tasmania.

Two commercial models of FutureDairy have been operating since 2012 on large-scale Australian dairy farms, one in Tasmania and the other in Victoria. About 36 other commercial farms in Australia employ the smaller-scale robotic technologies of other innovators to do what has hitherto been the backbreaking manual and, later, semi-automated, work of dairy farmers for well over two centuries.

While the name FutureDairy is freighted with prescience for an era yet to be reached, it is, in fact, already arriving and transforming the economies and lifestyles of the early adopters. Its positive implications for dairy production are no less profound for animal welfare and, of course, for the wellbeing of the dairy farmer – a person who, almost invariably, endures the unforgiving rigidities and relentless physical work of milking cows by virtue of birth rather than choice.



No less acute or obvious are the potential ramifications for the dairy farm labourer. On a conventional Australian dairy farm the rule of thumb is one human for about 100 cattle. So, a farm with 400 cows would

probably employ four people, nearly three-quarters of whose time is spent milking (the rest would be dedicated to feeding, feed production and animal welfare).

But at FutureDairy each of the cows, once in the dairy yard, moves on to one of 16 milking points on the rotary platform. As the platform gently turns, robotic arms wash the teats and attach the cups. The milk is extracted, the teats disinfected and the cups flushed. About eight minutes later the cow steps off the revolving platform and into a yard, where it receives a feed reward before being allowed into fresh pasture. Each cow is identified by a dongle around its neck that electronically records and transmits the time and volume of its last milking.

Sensors on the drafting gates that separate the dairy yards from the pasture automatically read each cow's data. Those who've been milked too recently are sent back to pasture instead of on to the robotic milker.

The farmer can control all this remotely: checking yields and production mechanics on an iPad and needing to attend the dairy only in case of a malfunction, after an automated phone call or text.

Not a single person needs to touch a cow during any 24-hour milking cycle.

In Australian agriculture you don't need to imagine the future to be able to see a part of it.

In a decade or two more of the cows than not on big dairy farms will probably milk themselves thanks to systems such as FutureDairy. Roving surface-based machines and drones, with their capacity to efficiently survey and even herd animals from above, will threaten the livelihood of that already dwindling breed, the stockman. Not to mention the kelpie.

Global Positioning Systems technology is already the norm on many farms. Applied to traditional farming equipment such as tractors, harvesters, ploughs and sprayers, it has enhanced labour efficiency and helped curb costly waste by enabling large-scale crop farmers to harvest and spray fields with pesticide and herbicide with centimetre accuracy.

Such traditional, driven machines – even those adapted with [GPS](#) – are, however, already threatened with obsolescence. Big, driverless machines, including tractors, will be a reality on some Australian farms this decade. While they will represent an obvious next phase in the evolution of that titan of rural production, the tractor, first commercially introduced to Australia by AH McDonald in 1908, people-less vehicles will not represent *the* cutting edge of agricultural technology and production.

That will most likely be left to the robots. [Robots](#) that can plant, fertilise, spray, weed, monitor and, ultimately, harvest, pack and transport crops will inhabit the countryside. While the drones hum overhead other remotely controlled intelligent surface robots will be able to inspect and herd farm animals (the prototype of one, "the Shrimp", has already been tested with the FutureDairy herd at Camden).

Australia's 2013 national food plan outlined a commonwealth ambition to increase by 45% the value of this country's agricultural and food-related exports by 2025 – a figure that can be achieved only with the continual advent of technologies such as robots. In 2010–11 the Australian Bureau of Statistics estimated that in just one year the area covered by farming in Australia had increased by 3% to 409.7m hectares, while the land mass dedicated to cropping went up 24% to 32m hectares. About 53% of the continent's total land mass is used for agriculture.



Roving machines and drones will threaten the livelihood of that already dwindling breed, the stockman. Photograph: Quinn Rooney/Getty Images

Inverse to the significant rise in agricultural production, more and more Australians are leaving rural and remote areas for the big cities and urban centres. Almost 89% of us live in major cities and inner regional areas.

Despite Australians' sentimental and cultural attachment to those vast expanses of uninhabited outback, stock runs, russet fields and verdant crop lines that we romantically generalise as "the bush", Australians have always predominantly been most comfortable dwelling and working on the coastal, urban plains where most big cities and centres are. While most Australians lived outside the cities at federation in 1901, by 1908 only four in 10 people lived rurally. By 2001, just 14% of Australians lived outside "urban" areas, which the ABS defines as a "population cluster" of 1,000 people.

Despite Australia's agricultural output as a proportion of the economy being among the highest in the OECD, the number of farmers has been in steady decline since the 1960s as more and more small family operators sold out to large-scale businesses.

According to ABS yearbooks, the proportion of workers employed in Australian agriculture fell from 30.2% in 1911 to 4.3% in 1996. The World Bank recorded a further significant 25% drop to 3.3% in the decade and a half to 2009. During the three decades to 2011 the number of Australian farmers declined by 106,200 or 40%. This translated, in more starkly human terms, to an average of 294 farmers leaving their properties each month.

The human implication of all of this is clear: despite Australia's reliance on locally produced food and its economic dependence on agricultural exports, the number of small- and medium-sized farmers living off the land is dwindling rapidly. Rural communities all across Australia are shrinking, along with the ancillary

businesses and services – main-street shops, doctors' surgeries, schools, car dealerships, places of worship, community centres and sporting clubs – that have traditionally served them.



Yes, while it produces most of Australia's food needs, contributes handsomely to gross domestic product and export earnings, the bush is being progressively hollowed out of its people. By the time, in a future this side of the horizon, that the cows are milking themselves – when commercial applications of the Shrimp are herding the sheep and cattle, when few tractors carry drivers, and when robots are tending fields and harvesting apple and pear orchards devoid of people – what will remain of this country's supposed connection to the land?

The next question, of course, is will Australians in the cities still be willing to spend their taxes on supporting services, including roads and hospitals, the maintenance of the national broadband network, telephone systems and publicly funded transport?

Will the bush be reduced to a vast mechanised place of scant human habitation beyond those specialists who service the robots – a place that exists primarily to service the cities and the export markets?

Non-Indigenous Australia's emotional nexus with the land – with its roots in masculine pioneering stories and blinkered notions of benign settlement, and for all its subsequent embodiment in the over-mythologised, stylised story of Anzac – is already stretched with the emergence of each new urban generation.

Robots could well see it broken and "the bush" largely reduced to a state of imagination.



A wheat farmer checks his crop at Warracknabeal, in Victoria's Wimmera region. 'For each generation, two farms would combine into one and this trend continues today,' says farmer Phil Koschitzke. Photograph: Peter Walton Photography/Getty Images

In the late 1980s Phil Koschitzke left the family wheat farm at Warracknabeal in Victoria's Wimmera district to study at university in Melbourne. He returned in 1997 with a doctorate in aeronautical engineering to become the fifth generation of his family to grow wheat on land that his original settler forebears began working in the 1870s. "I suppose I was a farmer who went and got an education – not a doctor who went farming," he says.

He explains succinctly the constant exodus of farmers from, and the continual amalgamation of, properties in the Wimmera, in the context of the evolution of automation, beginning with the tractor and combine harvester in newly federated Australia. "When this area was settled each farmer was allowed to select 320 acres only," he says.

"Ever since the original settlement, as farming practices became more automated, the size of farm holdings has continuously expanded about every score [20 years]. For each generation, two farms would combine into one and this trend continues today. My local area had 60 children enrolled at the primary school in my grandfather's time. Now it's about a handful of kids in total."

Institutions adapt accordingly, he says. Or shrink and eventually die.

Sport, including various football codes, women's basketball and netball competitions – with their legend-forging long historical inter-town rivalries – has traditionally been a community and social glue in the bush. But it's getting increasingly difficult to field teams, as evidenced by the abandonment at the end of the 2015 season of the Mallee football netball league. This led to the merger of old rivals Walpeup-Underbool and Ouyen United, and the entry of the new club, the Ouyen United "Kangas", into the Wimmera league. As if to reinforce Koschitzke's point that a doubling of the size of properties each generation has a corresponding

negative impact on social infrastructure, the Mallee league formed in 1997 with the merger of the Northern Mallee and Southern Mallee football leagues.

He says his local Warracknabeal football league is finding it increasingly difficult to field teams, as skilled labourers – especially tradesman, such as electricians and carpenters – are lured to the cities and regional centres by the prospect of steady work and higher pay. “Skilled workers are in demand, but there is a shortage of them because they are all leaving,” he says. “There’s a corresponding dwindling demand for unskilled manual labour, partly as a result of automation.”



Koschitzke uses GPS equipment on his heavy machinery. It has dramatically minimised his fatigue (and, therefore, the risk of an accident), increased his efficiency and lowered costs – especially those associated with spraying. This is due to the capacity of global positioning to minimise duplication or double spraying.

Not surprisingly, Koschitzke does not use robotics, which are largely at the research-and-development stage for broad-acre farming in Australia. But, he says, farmers of all types are becoming increasingly engaged with the emergence of a new generation of smart automated machinery and its potential to further enhance production and efficiencies.

In a report published in June 2015 by the committee for economic development of Australia on the future of the Australian workforce, a research team led by the University of Sydney’s Hugh Durrant-Whyte wrote: “In the next decade, most mines will operate with less than a third of current workforces, with a significant number of these engaging remotely. The same levels of automation are likely to occur in related industries where routine operation is the norm, such as in agriculture.”

A standout example of automating mineral production is Rio Tinto’s giant Pilbara iron ore operations, a world leader in the use of remote-control mining technology. The operations of Rio’s 15 mines, four ports, 1,700km of rail, 180 locomotives, 11,000 ore cars and 361 other giant vehicles in the Pilbara have consistently evolved with increasing automation.





Autonomous haul trucks drive through a pit at a Rio Tinto iron ore mine in Western Australia's Pilbara region. Rio is a world leader in the use of remote-control mining technology. Photograph: Bloomberg via Getty Images

Automation began with train ore dumpers, stackers and, in 1994, robotic product analysis, and now includes autonomous haulage and drilling systems. Since June 2010 the management of individual production



components was centralised to Perth, some 1,500km away. “The operations centre produces better, smarter, faster decisions at every level monitoring and controlling the mining, rail and port activities remotely from a single location,” Rio’s managing director of Pilbara Mines, Michael Gollschewski, wrote in his contribution to the committee for economic development’s workforce report.

Of course, mining is not farming. But the research, development and implementation of automated and robotic mine equipment in Australia is distinctly linked to the world-leading contemporary Australian R&D for similar machines intended for this country’s agricultural sector.

Which leads us back to the cows at Camden and the Shrimp – a collaboration between the University of Sydney’s Australian Centre for Field Robotics and the faculty of veterinary science’s dairy science group.



The director of the field robotics centre, Prof Salah Sukkarieh, consulted on Rio’s Pilbara automation. He is now at the vanguard of making robots to work on farms. “In terms of field robotics – robots that can actually work outdoors – we are becoming international leaders, and the reason why is that so many other industries have been using it,” he says. “In mining, in infrastructure monitoring, in aerospace – we have been able to translate a lot of that knowledge across from Australian industry that already has these systems in place ... into the agricultural industry. So we are leading the world, and we are doing some pretty cool stuff in that space.”

In a field close to the Shrimp, you might soon find “the Ladybird”, a ground robot designed for broad-acre vegetable farming. The solar-powered machine is equipped with sensors for measuring vegetable growth, and for the detection of animal and plant pests. It has a robotic arm that can remove weeds and potentially harvest vegetables.

Asked if the Rio experiment was a potential template for the automation of larger-scale farm production, Sukkarieh says: “Yes, well that’s what we were thinking. I mean, it’s a while away because the difference is that [Rio Tinto](#) is a large corporation and so can invest heavily in the capital infrastructure ... while in agriculture you still predominantly are dealing with individual players.

“But what you can imagine is ... a farmer who has ... a robot out there doing its task and relaying its information back to the desktop. It might be weeding or it might be fertilising or it might be seeding.”

Will the farms of the near future be characterised by driverless tractors and harvesters, and an array of robots carrying out various tasks instead of humans? “I think so, yes,” he says. “You might be just looking at it from an Australian perspective but we are seeing that all around the world. Every single country has some sort of automation program going on in agriculture. So it won’t be long before we start to see an autonomous farm or a partly autonomous farm operating in some way.”

While the automation of agricultural production and the phasing in of robotics would cost some jobs, it was also a response to shortages of reliable rural labour, he says.

“When you had the mining industry taking all the people it became a lot more expensive to get labour on to the farm and, hence, you are relying a lot more on contractors. Contractors will end up going where the dollars are and so you could have workers on your farm today but not tomorrow. So there is a labour variability that farmers are concerned about and there are labour costs that farmers worry about in those situations.

“When you don’t have a productive mining industry and you end up with greater access to affordable labour, then farmers aren’t really interested in automation any more. And so you kind of go through those cyclic patterns. That’s usually expected in any automation world – it kind of goes up and down but generally the trend over the longer term is that things end up being more automated.



Crops on the Darling Downs of southern Queensland. Despite Australia’s reliance on locally produced food, the number of small- and medium-sized farmers living off the land is shrinking rapidly. Photograph: Dave Hunt/AAP

“Now, what that means is that the type of people who work on farms are different because they have to be more technology-ready and versed, and that has an implication for the rural region as a whole – you know, the town centre and what happens there. I think we are still trying to understand all that and I think that fits under the broader topic of social licence and what bringing in automation to an area does to that region as a whole, which we don’t quite know yet.”



When the economist Stephen Koukoulas contemplates automation and robotics in a liberal market economy, he describes an ideal model where those left behind because of attachment to an old workforce re-skill and advance, too. “From an economist’s perspective automation, technology – robots if you like – help with cost reduction and efficiency,” the Guardian Australia columnist says. “And all of that is good and desirable. Every

business, government and even household uses things akin to robots: a vacuum versus a broom; the dishwashing machine versus a tub of hot water and a brush; a press-button heater versus gathering wood for a fire; the drill versus the screwdriver.

“Automation in the production process yields efficiency and productivity benefits for each economic unit. Inevitably it means higher output with less labour. Or time saving. It is a critical driver of economic growth and with that comes higher living standards for the population, including even for the workers displaced by technological advancement who, in a strong economy, will find alternative employment. Redundant broom makers might become baristas, for example.

“In the cities, where bank tellers are made redundant by computers, Eftpos and internet banking, there are alternative avenues for work in the hundreds of other potential occupations within a short radius of where they live. Perhaps it is in information technology, by driving an Uber car, as a gym instructor or working in the cafe industry. But in rural communities, where technological advancement has been just as rapid as in other industries, the displaced labour from mass production and huge, remotely operated, machinery and other technologies ... have few options but to leave. There are few alternative occupations.”

The ideal public policy response to such rural labour market change is to bolster education, skills and training to maximise new opportunities for displaced workers in the bush. To soften the impact of the exodus of farming families from the land, federal and state governments have, since the 1980s, been decentralising the labour-intensive functions of some public service departments to regional cities. But in an age when algorithms can trade on global stock markets or write a newspaper story, aspects of commonwealth and state service delivery that were once labour-intensive – for example, the collation of taxation and social security data – are now computerised and automated.

Jobs lost in the bush to robots may not, ultimately, reappear in another guise in the towns, regional centres and cities. The bush will be left without the jobs or the people who once did them.

The combination of agricultural robots and the remodelling of crop and tree architecture will have clear consequences for a dwindling pool of itinerant labourers. Not to mention foreign backpackers. But as Salah Sukkarieh says: “ [Farmers] ultimately don’t care what the German backpacker is thinking. Eventually the technology will be a lot cheaper than a backpacker. A farmer who’s trying to run a business will look at it from that perspective.”



It was, in reality, the opposite. The aroma – ammonia and shit – tells you right away that you're in a dairy. And while there's plenty of metal, including the robotic arms that wash the teats, attach and remove the cups, the animals are remarkably calm.

I am standing by the milking robot with Kendra Kerrisk, FutureDairy's New Zealand-born project leader and senior researcher. She smiles and says, "Happy cows. Very happy." [Cattle](#), she says, are creatures of habit that "really like predictability and routine".

"And when you take people out of the system it becomes very predictable for cows because they don't have to try to predict who is milking today, what mood they're going to be in – you know, are they going to be in a rush because it's Friday night and they want to get to the pub, or are they going to have low tolerance because it's Sunday morning and they're going to have a hangover?"

For at least a decade robotic milking has been a strong feature of the European dairy industry, where small herds of up to 200 cows are housed in barns and milked by small robot systems that service single or several cows at a time. The take-up in Australia has been slower because, for the most part, Australian herds are much bigger and the cattle live in pasture.

A bigger machine and an associated, food incentive-based cow-management system had to be designed. The 38 Australian dairy farmers who use some sort of robotic system have done so with different aims, Kerrisk says. Some want to increase their herds and production. Others want to maintain – or even downsize – the number of cows and consequently reduce labour or reallocate it to other farming priorities such as pasture management and animal welfare.

Since the introduction of semi-automated milking in Australia, herd sizes have increased. The close, personal attention to the welfare of individual animals has gradually eroded. Once, the farmer of the small herd would have been familiar with the quirks of individual animals. He might even have named them.

It seems ironic that, as Kerrisk explains it, robotic systems such as FutureDairy will liberate the farmer to pay more attention to individual animals. "I'm very mindful that consumers or the general public would hear something about robotic farming and would think, 'That's awful – it's metal on flesh, it's industrialised, now all of a sudden the farmer can't even be bothered to milk the cows.' But the reality is it's just a gorgeous way to

farm. And I would love to get that message out to the general public because I think if they could see it and understand it, it is just so far removed from factory farming.”

Kerrisk believes that while some dairy farmers will definitely use robotics to shed jobs and cut labour costs, ultimately the impact on employment in the Australian dairy industry could be negligible. “Some have done it [adopted robotics] in order to attract the next generation back on to the farm, some have done it as a retirement plan – they think, ‘Well, we don’t want to quit farming just yet but we are getting too old to be doing it as intensively as we are so let’s put robots on and take a step back to reduce the number of labour units.’

“I don’t think it’s going to cost jobs. I think if anything it’s going to help us attract people into the industry. The reality is that we just don’t have enough people out there to milk the cows at the moment and farmers are finding it tougher and tougher to find good staff ... It does require a different skill set which means that our farms’ staff will need different levels of training.”

She says that unless you’re born into dairy farming “it’s quite hard to develop a passion for it”. “But if you grow up with it then you know you could get shat on by a cow and you know you have to milk in the wee hours of the morning and you have to do it again in the afternoon and you can’t go off to sports after school because it’s milking time. If you’ve not grown up with it it’s really quite hard to sell it to someone. But when you take away that drudgery of having to milk cows or having to be there at set milking times twice a day then all of a sudden it becomes a lot more appealing.”

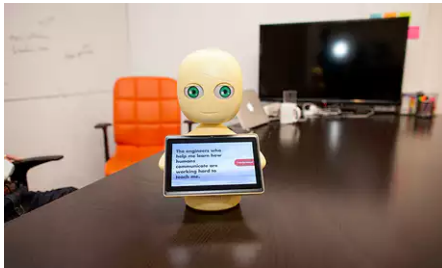
Even though it is probably not far away, you *will* need to imagine this: a swarm of small, lightweight intelligent machines with various sensors, that will plant crops and then wander through them, monitoring and accurately predicting the yield, removing weeds, killing parasites and harvesting the fruit, vegetables or grain.



A SwarmFarm robot. The company believes its ‘Swarmbots’ – cheaper and more agile than traditional heavy farming equipment – will make it easier to work land that is now unviable. Photograph: SwamFarm

This is the aim of SwarmFarm, a company that grew from the desire of Andrew and Jocie Bate, grain growers from central Queensland, and the agronomist and horticulturalist Neville Crook to use latest technology to enhance farming productivity. SwarmFarm has also collaborated with Sukkarieh's centre for field robotics and with researchers from the Queensland University of Technology.

Three prototype robots – “SwarmBots” – have been tested on the Bate family property near Emerald and, by mid-2017, will be available to farmers in other parts of Australia on a fee-for-service basis. This year the company will begin offering a weed control service in broad acreage grain and cotton farms, orchards and vineyards in the Emerald district. Ultimately the company aims to significantly expand into new national and potentially international markets.



The SwarmFarm system comprises “the Swarm” (multiple robots working together); the SwarmHive (the replenishment station for herbicide, fuel, fertiliser, insecticide or seed); and the SwarmView (the app used to monitor the robots in the field). None of this works without a farmer. He or she is the “SwarmKeeper”.

It's an idea that challenges not only the orthodoxies of traditional farming, but also the Australian and multinational producers of agricultural equipment, such as John Deere and Case IH, whose heavy machinery has long dominated Australia's rural landscapes.

SwarmFarm's company chairman, the former Queensland premier [Campbell Newman](#), says: “Our philosophy is this – farming now is about very big machines, expensive machines, heavy machines, and we've hit the productivity plateau. But we are talking about using swarms of lightweight, low-cost machines to do a multitude of tasks. One of these robots will actually be able to do, we believe very easily, not just weed control but also insect control, fertiliser application and planting.

“The only other part of the cycle in, say, grain cropping is harvesting. So one machine with appropriately designed applications or detachable equipment will eventually be able to do all of those things.”

The principals of SwarmFarm believe the robots, cheaper and more agile than traditional heavy equipment, will make it easier to work land that is now unviable. Efficiencies in spraying and fertiliser applications will also have environmental benefits. But will the robots and the SwarmKeeper cost rural jobs?

“There's a lot of talk about job losses and changes to the workforce due to robotics,” says Newman. “I think there are far greater ramifications for other industries than there are in agriculture. [Agriculture](#) has already seen ... the deployment of a lot of capital, you know very big machines, expensive machines and huge productivity gains and there isn't a lot of labour out there now.

“So we don't see that there will be significant disruptions in that regard because of the labour-saving side of it. What we see is that there will be probably technological jobs created in rural Australia ... jobs that didn't exist before – people who can write code, people who can repair robotics systems and develop things for farmers' new applications.”

That, of course, is the next great challenge to rural economic adjustment. Will the people who once worked in the dairies stay in the bush and learn how to write code? And will the labourers, who come in at picking time, teach themselves how to repair robotic systems? Or will they just walk away and abandon the bush to the robots – and to the cows that milk themselves?

- *This essay appears in [Griffith Review 52: Imagining the Future](#), edited by Julianne Schultz and Brendan Gleeson (Text).*