IS THERE ROOM FOR ORGANICS?

IT MAY NOT BE ABLE TO FEED THE WORLD ALL BY ITSELF, BUT IT HOLDS MANY LESSONS FOR MODERN AGRICULTURE

BY JAMES MITCHELL CROW
Western Australia at harvest time is a place of smoke and fire. By day, the signs are subtle: you need to come back in the relative cool of the night to witness the flames. Some fires burn in long orange-red stripes across the vast dark fields. Others are towering pyres. Death is in the air, but nobody is mourning. The fires are killing the seeds of multi-herbicide-resistant weeds, carefully collected during harvesting. Next year’s weeds, nipped in the bud.

The WA weed fires are a recently established ritual. Twenty years ago, the farmers simply sprayed weedkiller to keep their fields weed-free, often diluting the chemical to save a few dollars. The weeds soon became immune to these chemical treatments, forcing the farmers to find new ways to control them.

Seed burning is one form of non-chemical “harvest weed seed control”, a grassroots movement pioneered by farmers. If anyone could be said to lead this movement, though, it’s Stephen Powles. Softly spoken, yet forthright and direct, there’s a pragmatic air to Powles that speaks to his deep farming roots. Powles grew up on a New South Wales dairy farm. Today, he is an academic expert in weeds, researching them for 30 years. Powles directs the Australian Herbicide Resistance Initiative (AHRI) at the University of Western Australia.

“Until recently, Australia had the world’s biggest problems with herbicide-resistant weeds,” he says. That Australia no longer tops this list is a credit to Powles and his team’s work alongside farmers. The 1990s were the most alarming time. During that decade, weeds resistant to farmers’ two main classes of chemical herbicides spread quickly across the grain belt, threatening yields. To protect their crops, Australian farmers started hunting for non-chemical means to keep the weeds down, helped by AHRI researchers.

Intercepting and destroying the seeds while they are still seeds, burning or mechanically crushing them, is proving particularly effective. The success of these chemical-free weed treatments could be considered a nod toward organic farming, although Powles is at pains to point out that these “organic” approaches were developed on conventional farms, and they are still combined with careful applications of herbicides that do still work, such as glyphosate and parquat. Australian wheat farmers are simply using every trick and tool they can come up with to keep food production high. But are all of these tools – in particular, the synthetic herbicides, fertilisers and pesticides the farmers use – really necessary? Avoiding any use of synthetic herbicides, pesticides and fertilisers is the fundamental tenet of organic food production. Could this approach ever offer a sustainable, secure way to feed the world’s rapidly growing population?

It’s hard to pinpoint the exact moment when the organic farming movement began. The first shoots seemed to spring up in the 1940s and early 1950s in multiple places from the US to Europe. In the UK, the Soil Association was established in 1946 over concerns that intensive, industrialised agriculture was damaging soil, the environment, and the nutritional value of food. In 1967, its first organic standards were drawn up. More recently, these groups have campaigned vociferously against genetically modified crops.

The Soil Association is one of many organic advocacy groups to claim that GM crops aren’t needed to feed our growing global population. In fact, never mind GM, it says we don’t even need synthetic fertilisers, pesticides or herbicides. All it takes is organic farming, according to their recent position statement Feeding the future: How organic farming can help feed the world. It’s an optimistic view given that certified organic agriculture is currently a niche activity accounting for less than 1% of the world’s farmland. In some areas, most farming is by necessity organic. These include Africa, where people are simply too poor to afford chemicals, and Cuba (see page 71).

It is early evening when I call organic farmer Raoul Adamchack at his California home, to ask his views on this question. One of his children answers the phone [“Dad, there’s some English journalist on the phone for you”] and we talk over the comforting background clatter and hum of a family preparing dinner.

Adamchack is a committed organic farmer. “I started in the mid-70s, which was a very environmentally conscious time,” he recalls. Agent Orange was still fresh in the memory, and the battle to ban the environmentally damaging pesticide...
ANALYSES SAY THAT IF WE WERE TO HAVE WIDESPREAD ORGANIC FARMING, WE WOULD HAVE A 30% REDUCTION IN FOOD PRODUCTION

DDT was still raging. "The idea, for me, of applying pesticides that would affect my health, or the health of beneficial insects, or the health of my customers, seemed so alien that organic farming seemed like the way to go. And I've been doing it more or less ever since."

Today, Adamchak runs the organic market garden at the University of California Davis, teaching students organic vegetable production. He speaks passionately and candidly about the challenges of organic farming. "It's not easy," he says. "You lose some of your crop to pests that you just aren't able to deal with."

He comes across as a very pleasant man, and having been invited via phone line into his home, I find myself reluctant to challenge him on the standard organic doctrine that we should forget GM and let organic feed the world.

Talking to Powles in an earlier phone call, I'd had no such worries. I hadn’t got the feeling he was a man who would argue strongly for organic farming, despite his battles with weed killer resistance. Powles had dispatched the question with typical efficiency: "The serious analyses say that if we were to have widespread organic farming, we would have a 30% reduction in food production."

In 2012, for example, an analysis in the journal Nature compared 66 recent studies and reported that organic crop yields were, on average, 25% lower than at conventional farms. To maintain current levels of food production on an organic-only planet we'd have to expand farmland at the cost of natural habitat, hardly an ecologically sound solution.

Bracing myself, I ask Adamchak's view. His answer is a surprise, although given his frank and honest answers to earlier questions, perhaps it should not have been. "The challenge for organic agriculture is to help solve the global issues of feeding people in the face of climate change and with increasing population," he says. "On some level, it becomes clear that organic agriculture isn't going to be able to do that by itself."

"No matter how you figure it, there aren't enough animals making enough waste to fertilise more than a small fraction of the cropland that we need," he explains.

This fertiliser problem – that the world's natural sources of nitrogen are no longer enough to keep the world's growing population fed – first became apparent in the closing years of the 19th century. Thanks to German chemist Fritz Haber and industrial engineer Carl Bosch, we can now "fix" nitrogen from the air to make synthetic fertiliser, albeit in an energy-intensive process. At the time their process swung into production in 1913, the global population stood at 1.6 billion. Agronomists like Vaclav Smil from the University of Manitoba, estimate that if we were to rely on organic sources, agriculture could feed only four of the seven billion people now sharing the planet.

Organic agriculture hasn't found a way around the problem. Farm animal waste only spreads so far. "But what that creates, in my mind, is a niche where those animal wastes are recycled, because if they aren't brought back into agriculture then they are a huge environmental waste problem," Adamchak says. "So organic is a relatively small part of the whole, but it is an important part."

In the developed world, only around 65% of manure is currently reused to fertilise croplands, says CSIRO chief research scientist Mario Herrero, a livestock expert who has studied agricultural nitrogen flows. In the developing world, where a subsistence farmer might have a couple of cows, all the manure will be used on his or her crops, although it will only supply about half of the nitrogen the crops ideally need, notes Herrero. The challenge to using more of it on the large, industrialised farms of the developed world is getting it to where it is needed. Manure is heavy, bulky stuff, expensive to store and transport. "In the developing world it is a precious resource but in the developed world it is seen as a waste product."

It would be easy to dismiss organic food production as insignificant, especially at a time when the population is rocketing and climate change is adding to the challenge. Yields drop when switching to organic, and there isn’t enough organic fertiliser to go around anyway. But dig a little deeper and it seems that organic farming’s roots have been spreading. Navin Ramankutty at McGill University in Canada co-authored the 2012 Nature paper comparing organic yields with conventional. Although the headline finding was that organic crop yields were 25% lower than conventional, for some crops there was almost no yield gap. "Organic seems to work very well for legumes, and for perennials – tree crops, things like apples," he says. Or cocoa (see page 64).

Why do legumes and tree crops do so well under organic cultivation?
Legumes fix their own nitrogen from the soil, and tree crops can spread their deep roots wide in search of water and nutrients. If organic can play a limited role in global food production, these are the crops that we should focus organic production on, Ramankutty says. “It makes sense to use organic where it works best.”

Ramankutty comes at the question of sustainably feeding the growing population by stepping back and looking at the global picture. In terms of its environmental impact, agriculture is the match of any heavy industry, he says. It has a large carbon footprint, is the biggest driver of biodiversity loss, the biggest user of water, and the biggest polluter of water, just to name a few of its impacts. “I work on two main thrusts,” he explains. “One, simply to characterise agricultural practices globally, and then using these data to help answer the question of how we can do agriculture better.”

Organic agriculture isn’t necessarily agriculture done better, he adds. “I’m not convinced yet that organic is a more sustainable way to farm.” Water pollution is a particular concern, due to the run-off from manure, which is more easily leached from the soil than pellets of synthetic fertiliser. But then, much conventional agriculture still leaves a lot to be desired, particularly because of fertiliser overuse.

“We are not doing conventional agriculture in a smart way right now, doing monoculture with intensive chemical inputs,” he says. “I think the philosophy behind organic offers lessons that conventional agriculture could benefit from.”

Ramankutty is not alone in this vision for a form of agriculture that looks strikingly like organic food production, but with the addition of careful chemical inputs and the inclusion of GM crops. Another proponent is Richard Roush, dean of the School of Land and Environment at the University of Melbourne. Roush was recruited to the cause of agriculture after reading Rachel Carson’s 1962 book, Silent Spring, which rang alarm bells over the impact of insecticides such as DDT on birds and the environment at large. He trained as an entomologist to find more environmentally friendly ways of combating insect pests.

For several years in the mid-2000s, he led the team responsible for promoting organic agriculture and other sustainable agriculture programs at the University of California. These days, based in Melbourne, Roush is a regular media commentator. He’s earned a reputation as “pro-GM”, although that’s not an accurate portrayal, he tells me. “There’s just so much crap spoken about GM that I can’t restrain myself from correcting the facts on it from time to time.”

His time in California is certainly evidence of an open mind. “I didn’t find that to be a challenge to my psyche in any way,” he says. “The conclusion I came to was that organic should be congratulated for a kind of bioprospecting – looking for new ways to address issues in agriculture, and coming up with a lot.” Legume cover crops are a great example, he says. Grown either in fallow seasons or as an understory to food crops, they protect soil from being blown or washed away, while suppressing weeds and pests and adding nitrogen. But, like Ramankutty, Roush is keen to give me examples of organic practice where he believes synthetic chemicals would be better. While he was working in the US, there was growing evidence that farm workers in organic vineyards were developing respiratory problems because of the amount of sulphur – a “natural” chemical allowed under organic production standards – being used to protect the grapes against powdered mildew fungus, he says. “I came to the view that this was more dangerous to farm workers than a bit of use of the modern fungicides called ergosterol biosynthesis inhibitors, which have extremely low mammalian toxicity.
"I think the future of agriculture will be to pick the eyes out of the best techniques used by organic growers, but allow ourselves the opportunity to use synthetic inputs where they are reasonably safe," Roush adds.

"The enormous challenges we have in growing crops are such that you wouldn’t want to arbitrarily tie one or both arms behind your back."

By the time I talk to renowned food sustainability and ecology expert Rudy Rabbinge at the University of Wageningen in the Netherlands, the message is becoming familiar.

"Organic farming is based on bans on fertilisers, pesticides and GMOs," he tells me.

"I’m not saying that you should promote use of these things, but to eliminate them completely is in my opinion stupid." By using them with care and a sound understanding of their effects, "you see high productivity, very low environmental impact, and systems contributing to human health", he says.

Rabbinge’s comments resonate with an old idea known as integrated pest management (IPM), the concept that liberally dousing croplands with chemicals is not the only—or the best—way to control weeds, crop diseases or troublesome insects.

Some form of IPM is now practised in the majority of conventional farms, even if only in a form as basic as rotating crops, or spraying with pesticide only when insect pest populations exceed a certain density.

For some pests, IPM has proven particularly effective. Take the diamondback moth, says Roush. This pest has spread around the world gorging on broccoli, cabbage and other "crucifer" vegetable crops. It is particularly quick to evolve resistance to chemical pesticides.

"What they are susceptible to, though, are natural enemies," says Roush. Farmers have had good success by deploying these allies in their fields. Ladybirds love to eat their eggs and larvae, and the diamondback is especially vulnerable to certain parasitic wasps that lay their eggs inside the developing caterpillar, killing them. "These can keep the densities of the moth down to reasonable numbers," says Roush.

The latest step, which Ramankutty and Rabbinge are promoting, is to expand this minimum-input approach to include fertilisers, too. Rabbinge is among the researchers who have been working to establish the benefits of careful nitrogen application. In 2013, for example, he co-authored a paper in the Wageningen Journal of Life Sciences reporting on results from a Netherlands mixed crop-livestock farm at Oostelijk Flevoland on land reclaimed from the sea in the 1950s. Best-practice techniques introduced at the farm included planting nitrogen-fixing cover crops in rotation with other crops, and innovations such as giving the farm dairy herd a fibre-rich diet that improved herd health and milk production.

Right: Integrated pest management has been successful at controlling the Diamondback Moth.

Below: Pro-GM entomologist Richard Roush believes we should also use the best of organic techniques.

IS ORGANIC FOOD BEST?

Organic food is better for your health, and tastes better too, or so consumers of organic food believe. In survey after survey, these are the two main reasons consumers cite for buying organic.

Is there any evidence to support these beliefs?

First, health. In 2012, researchers from Stanford University reviewed the scientific literature on this subject for the journal Annals of Internal Medicine. They found there was no evidence that organic food is any more nutritious than conventionally grown produce.

Raoul Adamchak, who runs the organic market garden farm at University of California Davis, says the result tallies with all the studies on the topic that he has seen, including those done at Davis. There’s a greater nutritional difference between different varieties of a crop—tomato, say—than between the same tomato variety grown by organic versus conventional farming, he points out.

A more significant factor is food freshness, he says. "In the US, there is so much organic food that is local, and is fresher, and you have nutrient benefits just because of that," he says. "But then if conventionally grown food were local and fresh it would probably have the same benefit."

Fresh food generally tastes better too, no matter how it was grown.

The other side of the Stanford review was to examine whether conventionally grown food contained more pesticide residues than organic produce does. They found that organic food had a 30% lower chance of containing detectable traces of pesticide residues than conventional produce. However, the chance of those contaminants exceeding legal safe limits was very small and conventional produce was no more likely to exceed these limits than organic food was to exceed limits of "natural" pesticides.
output while also improving the quality of their manure for fertilising the fields. Nitrogen use efficiency on the farm rocketed to 73% – far above the 15% efficiency typical of Dutch dairy farms in the mid-1980s when synthetic fertiliser use was at its most lavish – while crop production equalled or exceeded the local average, and the output of the farm’s milking cows increased.

And new technologies are now coming into play that will enable farmers to cut chemical inputs still further. Why spray a whole field with pesticide when only one corner is infested with a pest? On the most forward-looking farms, unmanned aerial drones are already autonomously patrolling the fields, using UV cameras to scan for any small clusters of stressed crops in need of some chemical assistance. Other sensor technologies allow tractors to constantly tailor the amount of chemical sprayed based on plant need (see Precision Agriculture, page 20).

Stephen Powles is not just a researcher. Eight years ago he took the plunge and bought his own 650-hectare property at Quairading, a two-hour drive inland of Perth. He grows wheat, barley and canola.

As you might expect, Powles’ farm does well. “We apply state of the art technology,” he says. It starts with the soil, which is never ploughed – a process that wrecks soil structure and releases precious moisture. Instead, satellite technology guides farm machinery to drive the same “tramlines” to and fro across the field, preventing heavy tractors and harvesters from compacting the strips of soil where crops grow. Not ploughing means using herbicides to help control weeds, so Powles includes GM herbicide-resistant canola in his crop rotation cycle, which he can spray with herbicide if necessary.

And of course there are the harvest weed control techniques that Powles has helped to pioneer. The fires burning on WA farms after recent harvests hint at a new kind of farming, in which judicious use of chemicals could be combined with organic practices to the benefit of all – better yields, more profitable farms, high quality produce, and the smallest possible environmental impact.

Progress is tangible. For the last few harvests, no springtime fires have been lit on Powles’s farm, where they were damaging his precious soils as well as the wider environment. Instead, his harvesters now funnel the weed seeds directly onto the compacted tramlines his satellite-guided vehicles always follow. Most weed seedlings simply don’t survive along this hostile strip of ground.

Powles isn’t done with work to improve yields still further. “I’m certain that in some cases there would be things that conventional farmers could learn from organic food production,” he says.

James Mitchell Crow is deputy editor of COSMOS magazine.

called pyrethrins, allowed under organic cultivation.

Yes, organic food growers are allowed to use “natural” pesticides, whose toxicity is no less – and no more – of a concern than chemical pesticides. Plants are full of natural chemicals that they produce to battle pests, and we consume far more of these than the residues of pesticides added by farmers, argues renowned biochemist and cancer expert Bruce Ames from the University of California Berkeley. A single cup of coffee contains more of these natural pesticides, which animal tests show are just as carcinogenic as synthetic compounds, than the amount of synthetic pesticide residue a person would ingest in a year from eating fresh food, he says. And yet drinking coffee has not been found to cause cancer in humans it seems to be protective, in fact.

Again, Adamchak agrees. “Tests I’ve seen show that there are more frequently pesticide residues on conventional produce but that they are nearly always within the Environmental Protection Agency tolerance levels and there doesn’t seem to be evidence that these low levels impact peoples’ health,” he says. “And, of course, the benefits that people would get from eating fresh vegetables and fruits far outweigh the impact of very low levels of residues,” he adds, echoing Ames’ research.

Still, it’s a good reminder to wash your fruit and vegies before eating, whatever their origin.