

BOTS ON THE LANDSCAPE

Large scale farming is so inefficient and destructive that it makes robots seem like a good idea.

SIMON FAIRLIE investigates.

Greed and technology are the two classic agents of dispossession, the twin forces that have removed the greater part of humanity from the land. Though they often work hand in hand, greed was the dominant partner over many centuries of engrossment, enclosure and colonial invasion. But since the industrial revolution, as tractors have replaced horses and then quadrupled and requadrupled in size and capacity, the majority of farmers have been squeezed off the land by economies of scale. One person with a 200 horse power tractor that can mow or plant over 40 acres an hour puts a dozen people with 100 acres out of business. One person milking 600 cows with a rotary parlour replaces a dozen 50-cow dairy farms.

Now, with less than one per cent of the population left on the land in many industrialised countries, we are reaching the moment in technological progress where we could conceivably get rid of everyone. Over the last five years robots which require no human being to be present during their operation have begun to appear in our farmyards, and there is every likelihood that they will soon be appearing in our fields.

The Fight Against Drudgery

The most successful and advanced so far of these is the robot cow milker. Disappointingly, this is no Shiva-like automaton with four arms, lurching from udder to udder, but an unprepossessing capsule somewhat like a carwash, which tempts the cow inside with feed, cleans its udder, attaches the teat cups, extracts the milk, disengages, cleans up and sends the cow on her way. Cows are free to enter the machine whenever they fancy — normally about three times a day, and one robot can serve 60 cows a day. It is the mobility of the cow that explains why robot milkers are pioneering the agribot revolution. The machines don't need to move, and so there are fewer safety issues than there are with robot tractors and harvesters.

Robot milkers are proving increasingly popular with dairy farmers, not least because their acquisition can benefit from up to 40 per cent grant funding. But the main incentive for installing them is to get rid of the “drudgery” of milking — drudgery occasioned by the huge numbers of cows that farmers must milk nowadays to remain profitable, and by the miniscule profit margins that discourage them from employing relief milking staff.

Since milking-time is the moment when dairy farmers get to see, touch and talk to their cows, and find out how they are faring, you might think that it was a bit more than mere drudgery and that getting a machine to carry out the milking would result in poor husbandry. On the contrary (so the makers claim and farmers confirm), the machines scrutinise 60 cows with an attention to scientific detail that no human can afford — weighing them, taking their temperature, recording the milk yield, analysing the cell count of the milk taken from every quarter, and so on.

Unfortunately, this information is of no use unless it is analysed, and most farmers find that while robots relieve physical labour and the need to milk at a given time, they do not necessarily lower the total workload — instead drudgery becomes bureaucratic rather than manual. A survey carried out by Hull University reported:

“Many of the interviewees who used automatic milking systems stressed that the system generated much more information than they could actually make sense of and use. They felt subject to ‘information overload’ and had neither the skills nor the time to fully explore the possibilities raised by analysing the data.”

Since the robot alerts the farmer on his mobile phone whenever anything is amiss, some felt like vets on permanent night duty:

“Farmers using automatic milking systems did not necessarily find that their total workload had reduced: for some their day had got longer as they did not have the break of routine milking duties to stop them in what they were doing, and indeed they could feel that they were always on call in case the milking system developed a problem.”

Most farmers report that their cows were more “happy”, “chilled out” or “relaxed”, under the less regimented robot milking regime — which is perhaps not surprising given the overcrowded and understaffed conditions under which dairy farms have to operate to stay viable. On the other hand, although there are some robot systems where cows have access to fields, in most cases cows are kept indoors all year round. Opinions differ as to how this affects their



Spot the cow. The Dutch made Lely Astronaut is the leading make of robot milking machine.

“happiness”, but it clearly will do nothing for their vigour or the taste of the milk.

The clear losers from the spread of robots, however, are relief milkers — the part time workers who come and do the milking so that farmers can take a break. Not having to pay them is one of the factors that make robots a viable option for farmers. Relief milking is a major source of part-time and full-time employment for many country people, including ex-dairy farmers. If the health of the rural economy were a concern, then a better way to reduce drudgery would be to pay dairy farmers more so that they could employ more relief milkers. If robot milking becomes the norm, then yet another rural occupation will disappear.

Limits to Growth

On the other hand, there is one sense in which robot milking might benefit the rural economy. Robots are currently designed to serve 45 to 60 cows, and are therefore potentially accessible to average-sized UK dairy farms of around 120 cows. If robots provide a way of keeping family dairy farms competitive, then this could help to prevent the spread of mega-dairy farms (such as that proposed at Nocton (see *The Land* issue 13), which rely on the economies of scale provided by huge rotary milking systems capable of milking 300 cows an hour.

Resistance to gigantism is also a key element in the development of robots for arable farms. Over the last century farmers have competed with each other by getting progressively bigger and more powerful machinery capable of working larger and larger



A fleet of lightweight robot tractors in a field of maize, as envisaged by Simon Blackmore of Harper Adams Agricultural College.

acreages. Now the limits of growth have been reached; there is nothing to be gained in making tractors any bigger, at least not in Europe, because they can barely get into the fields as it is. Instead of trying to attain more acres per tractor driver, the smarter solution for the farmer who wishes to be more competitive will be to dispense with the driver altogether.

It is now common to find tractors that are guided automatically by GPS and similar technologies, to an accuracy of less than two centimetres. So far most of those in use still require a supervisor in the cab, who in the words of one exponent can “sit back, crank up the music and enjoy the ride”. But once safety issues are resolved, it will not be long before completely driverless machines, currently under development by mainstream companies such as John Deere and Fendt, hit the market. The Autonomous Tractor Corporation of Fargo, North Dakota, for example, is developing a 300 horsepower machine designed so that one operator can control up to 16 of them at one time.

Labour saving on this scale has obvious economic advantages; but robot tractors are also promoted as environmentally friendly, in two respects, both of which address problems caused by agricultural gigantism.

Precision Farming

Robots are being promoted as part of the wider concept of “precision farming”, in which the tractors, sprayers and harvesters working the land are programmed to detect and map the yield, nutrient content, weed and pest incidence in different parts of the field — and then to tailor the amount of seed, fertiliser and herbicide applied accordingly, resulting in less nutrient leaching and use of chemicals.

It is not as though humans can’t do this — indeed this is what farmers have traditionally done — but now farms have become too large for one person take in all the detail, as Chris Andersen, head of the California firm SD Robotics which manufactures agricultural drones explains:



Cows on robot-equipped farms are usually kept in all year round, giving rise to the need for another robot, which moves up and down the aisle ensuring that silage is within reach of the stalled cows.

“Once upon a time farms were small, you could walk the farm, farmers knew what was going on. They knew it intimately, they knew every plant, every inch of the field. The consolidation of agriculture means bigger and bigger farms with fewer and fewer people on them, oblivious to many aspects of the farm. This is the level of information scarcity you have in farms today. The solution to big labour problems without the labour is automation, robots.”

Andersen, who used to be an editor of the techno magazine *Wired*, is at the California hippy end of the agribot industry, though he now sports a John Deere baseball cap. His firm produces drones, small robotic aircraft programmed to fly over farms detecting areas of low fertility, poor drainage, fungal infections — everything that a small farmer would observe on foot. These drones are lightweight and inexpensive, a few hundred dollars: “They use a cheap camera because they are flying low — you can’t do this with a plane or satellite.”

All a drone can do, however, is carry out surveillance, whereas robot tractors not only identify problems but also address them. The driverless tractors currently being developed by the likes of John Deere and Bosch provide a platform for a wide range of high resolution operations. On board sensors identify weeds and trigger a micro-dot chemical spray only to the leaf of the plant, or else zap it with a laser. Soil probes determine the correct amount of nutrients to apply to a given area. Spectral imaging and other high-tech sensors measure the growth rate and health of individual plants with a view to selecting seed for breeding. Harvesting machines can be programmed to pick only fruit that meets supermarket standards.

This level of micromanagement, necessary for the optimum use of resources, could until recently only be carried out by manual workers wielding a knapsack sprayer, a hoe or a pair of secateurs. It is not only tractor drivers who will lose their job to robots, but manual and casual workers of every description. In the UK they represent perhaps half of the agricultural workforce. In some parts of the world that represents half the entire population.

Treading Lightly on the Soil

The other environmental argument in favour of robots is that they can be a lot smaller than modern tractors. The only reason why modern tractors need to be so huge and powerful is so that they can economise to the maximum on human labour. Eliminate the driver and there is no point in having monster machines; the work can be done equally well by a larger number of smaller machines. In fact it can be done better, because smaller tractors cause less soil compaction. According to Simon Blackmore, of Harper Adams Agricultural College,

“Up to 90 per cent of the energy going into cultivation is there to repair the damage caused by machines. If we do not damage the soil in the first place we do not need to repair it.”

This is a good argument for going back to horse power, but, as head of engineering at his college, Blackmore looks ahead to a time when the fields of Britain will be managed by fleets of lightweight remote-controlled cultivators like those in the illustration on the previous page.

These arguments have been taken further by John Payne who comments on agricultural robotics for the website *Robohub*;

“The one-to-one correspondence between operator and machine has driven the increasing size and power of tractors and other machinery, and breaking that correspondence is a necessary first step toward a robotics-intensive approach. Given autonomous machines and the resulting possibility of operating many of them, the use of much smaller, lighter machines becomes an option. If these machines are also capable of dexterous or otherwise detailed manipulation, an altogether different approach to agriculture becomes possible, one based on the best practices of gardening, applied on a grand scale.”

Payne’s machines would either walk on legs that only stepped on predefined spots or else run on rails, to avoid soil compression, and would be capable of performing operations such as planting, weeding, pruning, harvesting and saving seed. Robots of this calibre, he argues, could bring about a benign transformation of agricultural methods:

“You have a platform justifying the effort to develop higher level software which supervises beneficial plant combinations in space (polyculture) and time (crop rotation), which is capable of mixing annuals with perennials (permaculture), which makes room for native plants (particularly those that are threatened or endangered), which also makes room for animals without allowing them to ruin crops, and which can make sure there are enough flowers throughout the season to keep pollinators healthy.”

As Payne himself suggests, what is anticipated here is a form of permaculture where it is machines, rather than humans that are integrated into the natural order.

“Let them be Doctors and Lawyers and Such”

As robotic technologies spread through the agricultural sector we shall doubtless hear a lot more about their environmental advantages — though they are only doing what humans could be doing, and perhaps would be more inclined to do if agricultural wages were commensurate with the costs of rural accommodation.

Advocates of agricultural robotics are also keen to allay fears that robots will cause unemployment. Simon Blackmore argues that “while agricultural robots will replace semi-skilled drivers, an equal number of highly skilled agricultural robot engineers will be needed”. If this were true, it would mean that robot tractors would not be labour-saving, nor indeed would they be viable since the labour required would be more highly paid. More to the point, perhaps, are the large number of manual workers who could lose their jobs to robots — fruit and vegetable pickers, pruners, nursery workers, relief milkers and so on. Are they too expected to do engineering degrees? More likely they will end up in call-centres.

Since robots do not appear to be very reliant upon economies of scale, their proliferation is unlikely to result in a fall in the number of farmers (as opposed to farmworkers). However the farmer’s role is likely to become increasingly managerial and bureaucratic, with more time spent at the computer screen digesting an overload of information and specifying robot activity, and less time in the field.

Over time even this managerial role may recede. As one writer puts it “the holy grail of precision agriculture research will be the ability to define a Decision Support System for whole farm



If you go down to the woods today you're in for a big surprise... Empty forests are the ideal place for testing quadrupedal robots. On the left is Boston Biodynamics "Big Dog" carrying a 400lb burden, developed for the US military. On the right a similar technology is being developed in Finland by John Deere's subsidiary, Plustech Oy.

management with the goal of optimising returns on inputs while preserving resources." In other words even the job of telling robots what to do can be delegated to a software programme.

The Military Agricultural Complex

It remains to be seen whether farmers adopt sophisticated mobile robots with the same enthusiasm that they have shown for robot milkers and GPS tractors. It will, of course, depend upon whether they can be made economically viable; but there is one other reason why we may see a flowering of robotics in our fields: farmland offers the ideal arena for robotics enthusiasts to experiment in.

To date, most of the cutting edge work in robotics — at least in respect of drones and walking robots — has been carried out for the US military, which funds such research through the Defense Advanced Research Projects Agency. You have only to key in "DARPA drones" into Google to view the impressive array of projects that DARPA is funding — collaborative drones, underwater drones, laser-armed drones, transmogrifying drones etc. Or check out the bipedal robots developed by Boston Dynamics with DARPA funding (www.bostondynamics.com/) which can run at 30 mph, carry heavy loads over rough terrain and climb vertical walls.

But for many working at the Silicon Valley open-source end of the robotics industry the association with the military is unhelpful: it has given robots, and particularly drones, a bad name. What they seek is a sector of the economy which offers a haven where computers can be developed safely and without scaring people — and the depopulated farmlands of the USA are ideal. Chris Andersen is frank about the reasons why he chooses to promote his drones to farmers:

"Drones are controversial. People are worried about privacy, about safety, about use by the police. The one place drones are not going to be deployed any time soon is in cities . . . Why are farms so attractive? Private land under 400 foot, no obstructions, no people, no privacy issues. It's the perfect place to deploy drones — as far from people as possible."

The same probably holds true for bipedal and quadrupedal robots which, even if they are less associated with the military and surveillance than drones, are decidedly spooky. The sort of technology which DARPA and Boston Dynamics has used to develop its Big Dog robot, is now being applied by agricultural machinery manufacturers John Deere in the remote forests of Finland (see photos above).

The demilitarisation of robot technology took a step forward recently when Google acquired a string of companies specialising in robotics, including Boston Dynamics, Schaft (another company with DARPA contracts) and Deep Mind, the UK based artificial intelligence company. Google has stated that Boston Dynamics will honour existing DARPA contracts, but decline to take on new ones, which will leave the US Defence Department deprived of one of its most valued contractors.

It is arguably more worrying to find the robotics industry driven by Google than by the US Department of Defence. At least we can understand why the military develops drones and robots, but nobody seems to know why Google is taking an interest in them. Or for that matter why it recently took the madcap prophet of the Singularity, Ray Kurzweil onto its board of advisors (see "The Transhuman Agenda", *The Land* 5). Whatever the reason, we should pay attention. Google's phenomenal control of information and wealth could eventually make it a more powerful player on the world stage than even the US government.

Such concerns are several steps removed from the development of contraptions for milking cows. But anyone who wants to remain physically engaged with the natural world, rather than submit to cybercratic banality, needs to be wary of agricultural robots. The land is not something to be managed from a computer screen, nor is it a playground for geeks and their toys. If the farming industry goes too far in that direction, it might be time for a little Luddite sabotage.