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Agricultural Inventiveness: Beyond Environmental Management?

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Abstract

In 2014, I began working on a collaborative art project called Sugar vs the Reef? The project came about following an invitation from John Sweet, a retired farmer and active community worker in the Queensland town of Mackay. Sweet's hunch was that the involvement of artists in a complex environmental management problem might help to catalyse positive transformations in the sugar cane industry, which is often accused of polluting the pristine waters of the Great Barrier Reef with agricultural run-off. This chapter is based on some of the early field research for Sugar vs the Reef? and my task is to present the inventiveness of three change agents: two human and one non-human. The first is Simon Mattsson, a sugar cane farmer in Mackay, and a founder of Central Queensland Soil Health Systems (CQSHS). The second is Allan Yeomans, director of the Yeomans Plow Company on the Gold Coast and inventor of the Yeomans Carbon Still: a device for measuring carbon sequestration in soil. The third change agent has been around for millennia: the humble plant-specifically grass-and the complex soil community of which grasses are an integral member. While presenting the inventiveness of these three change agents together here, I also want to point to some of the factors that have thus far inhibited the broader uptake of their inventions. I do so in the hope that identifying such barriers might be a small positive step beyond the paternalistic discourse of environmental management, and towards the formation of more dynamic relations in social and ecological systems between humans and plants.

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15

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Lucas Ihlein

In 2014, I began working on a collaborative art project called *Sugar vs the Reef?* The project came about following an invitation from John Sweet, a retired farmer and active community worker in the Queensland town of Mackay. Sweet's hunch was that the involvement of artists in a complex environmental management problem might help to catalyse positive transformations in the sugar cane industry, which is often accused of polluting the pristine waters of the Great Barrier Reef with agricultural run-off.[1] This chapter is based on some of the early field research for *Sugar vs the Reef?* and my task is to present the inventiveness of three change agents: two human and one non-human. The first is Simon Mattsson, a sugar cane farmer in Mackay, and a founder of Central Queensland Soil Health Systems (CQSHS). The second is Allan Yeomans, director of the Yeomans Plow Company on the Gold Coast and inventor of the Yeomans Carbon Still: a device for measuring carbon sequestration in soil. The third change agent has been around for millennia: the humble plant — specifically grass — and the complex soil community of which grasses are an integral member. While presenting the inventiveness of these three change agents together here, I also want to point to

1 *Sugar vs the Reef?* is a collaboration between artists Lucas Ihlein, Kim Williams, and Ian Milliss, together with farmers and community members from Mackay, Queensland. See Lucas Ihlein et al., 'About the Project,' *Sugar vs the Reef?*, http://www.sugar-vs-the-reef.net/about/.

some of the factors that have thus far inhibited the broader uptake of their inventions. I do so in the hope that identifying such barriers might be a small positive step beyond the paternalistic discourse of environmental management, and towards the formation of more dynamic relations in social and ecological systems between humans and plants.

The Great Barrier Reef, Sugar Cane Farming, and Soil Health Systems.

The bleaching of the Great Barrier Reef (GBR), which received widespread media coverage in early 2016, [2] brought attention to the harmful effects of global warming on coral ecosystems.[3] Besides climate change, the major factors affecting the health of the reef include fishing, coastal development, and run-off from terrestrial agriculture.[4] Due to the abundance of land used for growing sugar cane in the GBR catchment along the Queensland coast, this industry has come under particular scrutiny. The most obvious impact of sugar cane farming derives from run-off, as nitrogen-based fertilisers, soil sediments, and pesticides are carried by heavy rainfall into adjacent creeks and rivers and out to sea.[5] The addition of agricultural nitrogen to the GBR ecosystem

2 Michael Slezak, 'The Great Barrier Reef: A Catastrophe Laid Bare,' *The Guardian,* June 6, 2016, http://www.theguardian.com/environment/2016/jun/07/the-great-barrier-reef-a-catastrophe-laid-bare.

3 The world's oceans have begun to increase in temperature, as well as becoming more acidic as they absorb carbon dioxide from the atmosphere. Warming waters can trigger 'coral bleaching' — the process by which coral polyps eject the zooxanthellae algae with which they exist in symbiosis. If the water remains too warm for too long, the zooxanthellae will not return, and the coral will die. Increasing acidity weakens the calcium carbonate skeletons of the coral. This process is described succinctly in Callum Roberts, *Ocean of Life: How Our Seas Are Changing* (New York: Penguin, 2012), 96–108, 191.

4 Great Barrier Reef Marine Park Authority, 'Great Barrier Reef Outlook Report 2014,' *Great Barrier Reef Marine Park Authority,* http://hdl.handle.net/11017/2855.

5 Nearly 70,000 tonnes per year of agricultural nitrogen runs into the Great Barrier Reef, as well as approximately 14,000 tonnes of phospho-

helps to increase the population of Crown of Thorns starfish, which predates on coral. This weakens the resilience of the coral and its ability to bounce back from periods of higher than normal temperatures.[6]

The sugar cane industry has been subject to carrot and stick legislation to encourage farmers to reduce the amount of run-off from farms, and significant improvements have been made through the adoption of Best Management Practices (BMP) over the last 30 years.[7] Improved practices for sugar cane now include: cutting green, the elimination of the traditional pre-harvest burning; trash blanketing, the application of sugar cane mulch onto the surface of the soil; minimum till, the reduction of soil-disturbing tillage practices; and the application to the soil of mill mud, a nutrient-rich substance that is a byproduct of milling. The use of these and other BMP methods — such as the increased efficiency of fertiliser application by GPS-guided tractors — can improve the health of the soil and minimise its tendency towards erosion, thereby reducing the nutrient, herbicide, and sediment run-off significantly. However, the uptake of BMP by sugar cane growers is still insufficient to meet the federal government's *Reef Plan 2050* requirements of an 80% reduction in run-off by 2025.[8]

rus and at least 30 tonnes of herbicide. These chemical inputs produce tangible detrimental effects on the coral reef ecosystem. See Jon Brodie et al., 'Terrestrial Pollutant Runoff to the Great Barrier Reef: An Update of Issues, Priorities and Management Responses,' *Marine Pollution Bulletin* 65, nos. 4-9 (2012): 81–100, https://doi.org/10.1016/j.marpolbul.2011.12.012.

6 'Backgrounder: Impact of Land Runoff,' *Australian Institute of Marine Science,* http://www.aims.gov.au/impact-of-runoff.

7 'About Smartcane BMP,' *Canegrowers,* http://www.smartcane.com.au/aboutBMP.aspx.

8 Lara Webster, 'Queensland's Cane Industry Milestone Tarnished by Ongoing Criticism of Great Barrier Reef Run-off,' *Queensland Country Hour,* ABC Rural, April 11, 2016, http://www.abc.net.au/news/2016-04-11/queenslands-cane-industry-milestone-tarnished-by-criticism/7315730; Queensland Government, *Great Barrier Reef Report Card 2015: Reef Water Quality Protection Plan,* State of Queensland, 2015, http://www.reefplan.qld.gov.au/measuring-success/report-cards/2015/assets/gbr-2015report-card.pdf.

Mackay farmer Simon Mattsson has been agitating for sugar cane farming practices to improve well beyond BMP standards: he began experimenting with no-burn harvesting in 1986, and stopped tilling for fertiliser application the following year. However, despite his adoption of these improvements, from the late 1990s, Mattsson noticed a pattern of declining yields in his annual sugar crops.[9] This led him to a long period of research and experimentation, including practical on-farm trials and observations, alongside a survey of published literature on regenerative agricultural systems. In 2013, Mattsson was the recipient of a Nuffield Scholarship, enabling extensive field trips to explore holistic farming systems in eleven countries. Upon his return to Mackay, Mattsson established Central Queensland Soil Health Systems (CQSHS), an affiliation of farmers dedicated to exploring the crucial role of soil ecosystems in agriculture.

In his Nuffield Scholarship report, Mattsson outlines the principles underpinning his experiments in sugar cane farming.[10] Aligning himself with an international movement known as regenerative agriculture, Mattsson focuses on soil health. The principles are summarised as follows:

1. Minimise mechanical soil disturbance.
2. Maintain permanent organic soil cover.
3. Maintain a living root in the soil.
4. Plant diverse crop species in sequences and/or associations.

The common agent connecting all of these principles is the plant. Sugar cane is classified as a perennial C4 deep-rooted grass, and in nature such grasses tend to grow in a close relationship with a diverse network of other species, each of which provides aboveground and sub-soil services to the overall community.[11] Indus-

9 Simon Mattsson, *Making the Most of Your Soil's Biological Potential: Farming in the Next Green Revolution* (Nuffield Australia, June 2016), viii, http://www.nuffieldinternational.org/rep_pdf/1467606487Simon MattssonreportFINAL.pdf.

10 Ibid., iii.

11 David A. Wardle et al., 'Ecological Linkages Between Aboveground and Belowground Biota,' *Science* 304, no. 5677 (June 11, 2004): 1629–33,

trial monoculture cropping, by contrast, grows sugar cane in isolation from other plant and animal species, which actively works against the development of this diversity. As a result, monoculture cropping requires nitrogen-based fertilisers to supplement the nutrients which would otherwise have been made available to the plant's roots by a diverse sub-soil ecosystem. Monocrops also require chemical pesticides and herbicides to suppress species other than the target crop. While they may be successful in knocking back a known weed or parasite, chemical inputs always have unintended side effects, such as killing beneficial nematodes and fungi.[12] Thus in the case of conventionally farmed sugar cane, a C4 grass is being asked to survive without the network of other plants, fungi, and micro-organisms that in nature would be working together to cycle nutrients and continually re-establish multi-species equilibrium. This weakens the sugar cane and makes it prone to further attacks from pests. The result is a spiral of dependence, requiring increased chemical inputs from the farmer, with the risk of these chemicals being picked up by heavy rainfall and transported as run-off from the farm to the reef.

In his experiments, Mattsson has attempted to 'emulate nature' by planting a range of brassicas (such as daikon radish) and legumes (such as peanuts) in amongst his sugar cane.[13] The daikon, with its very large root, is able to reach down into the earth and break up compacted soil. If left in the ground, it will decompose and contribute much needed carbon-based organic matter to the soil. Peanuts and other legumes such as soya beans provide the additional service of taking nitrogen from the atmosphere into the soil via bacteria, called rhizobia, which are located in nodules on their roots. From the point of view of the

https://doi.org/10.1126/science.1094875.

12 Graham Stirling et al., 'Yield Decline of Sugarcane: A Soil Health Problem Overcome by Modifying the Farming System,' in *Soil Health, Soil Biology, Soilborne Diseases and Sustainable Agriculture: A Guide* (Melbourne: CSIRO Publishing, 2016), 165–86.

13 Mattsson, *Making the Most of your Soil's Biological Potential,* 31. Mattsson's multi-species intercrop trial has so far involved the following species: radish, turnip, chickpea, soybean, common vetch, cereal rye, and oats.

farmer, this reduces the need for chemical fertilisers. Healthier sugar cane plants result from the diverse sub-soil community associated with multi-species cropping, with the effect that the soil becomes enriched with carbon-based biological matter and acts like a sponge, reducing run-off and erosion.[14]

Barriers to the widespread adoption of Regenerative Agriculture in the Sugar Cane Industry

While experiments like Mattsson's are relatively new in the sugar cane industry, they have been a feature of other kinds of progressive farming (particularly in pasture grazing) for a long time. One of the major factors inhibiting widespread adoption of multi-species cropping is the superstructure of the sugar cane industry itself. Unlike vegetables or fruits, which require only sorting and packing for market, the sugar cane plant needs to go through an intensive industrial milling process after harvesting. The cane is crushed to extract the juice, then evaporated and crystallised, and the crystals are separated from the mother liquor using a centrifuge. The dried sugar may then be refined into different market varieties. In Australia, more than 80% of sugar produced is exported, so bulk storage, shipping, and the price fluctuations of international markets are also major factors which constrain sugarcane farming methods.[15]

The industry tends to be very centralised, with mills setting the harvest timetable for all the surrounding farms. The milled sugar from each farm is bundled and sold as a commodity product, without any system of provenance connecting a packet of sugar on the supermarket shelves back to a particular farm. The efficiencies required for these processes mitigate the wider uptake of multi-species cropping: growing diverse species can slow down the monocrop harvesting process, and require the farmer

14 Ibid., 3.

15 Australian Government Department of Agriculture and Water Resources, 'Sugar,' *Australian Government Department of Agriculture and Water Resources,* February 25, 2015, http://www.agriculture.gov.au/ag-farm-food/crops/sugar.

to connect with new markets for non-sugar crops such as legumes and brassicas.

Since 2015, Mattsson has tried to address these challenges by growing a dual crop of sugar cane and sunflowers in alternating rows.[16] Planted at the same time, the sunflowers (an annual species) quickly take advantage of the available sunlight, germinating and growing up faster than the sugar cane (a perennial species). This also functions to shade out some of the weeds that might emerge in the early stages of the sugar cane crop. The sunflower plant contributes to the flourishing of sub-soil biological diversity, which benefits the health of the sugar plant, by establishing its own rhizosphere (the zone surrounding the roots) within which an abundance of bacteria, fungi, nematodes, and animal life forms cohabit. Finally — and this is significant for the economy of such an experiment — because of their rapid growth and maturity, the sunflowers are ready to harvest well in advance of the sugar cane. A harvester can move through the field, lopping off the heads of the sunflowers while the sugar cane is only half-grown. The sunflower seeds are processed and sent to market, while the sunflower stalks are left to decompose in the field, providing further carbon-based biological matter for the health of the sugar cane plant.

Plants and farmers working together as change agents

At the time of writing, Mattsson's experiments are still in progress, and the efficacy and economy of this dual crop has not yet been scientifically proven.[17] However, given that there are over four thousand sugar cane farms in Queensland, the impact of

16 Lucas Ihlein, 'Sunflowers as agricultural and cultural change agents,' Lucas Ihlein et al., *Sugar vs the Reef?*, September 7, 2016, http://www.sugar-vs-the-reef.net/sunflowers-as-agricultural-and-cultural-change-agents.

17 Mattsson is currently collaborating with three soil scientists — Graham Stirling, Susanne Schmidt, and Jay Anderson — who are studying the impact of his multi-species cropping method on the population of nematodes in the sub-soil environment.

his work with plants could be wide-reaching.[18] Continuing to practice as a sugar cane farmer, and demonstrating that alternative polycropping methods are not only possible but also economically advantageous, Mattsson can push the industry to evolve, find new markets, increase overall yields, and improve soil health.[19] Such human-plant partnerships may in fact become a necessity for survival of any agricultural practice which wants to remain viable in the mainstream carbon economy of our short term future. A discussion of this economy forms the basis of the second part of this chapter.

The Engineer, The Carbon Economy, and the Role of Plants

I now want to introduce the entrepreneurial research of an engineer, Allan Yeomans, who is working to facilitate Australia's transition to a carbon economy, and who believes this will drive financial (and soil health) benefits for farming communities. Over the past decade, various Australian proposals for a carbon tax, carbon emissions trading scheme, or carbon price have been proposed.[20] Despite the diversity of proposed systems, all these schemes hold in common the notion of a *carbon economy.* Because of the tangible cost of the effects of human-induced global warming, a future economy of this sort would measure, quan-

18 Australian Sugar Milling Council, 'Australian Sugarcane Industry Overview,' *Australian Sugar Milling Council,* http://www.asmc.com.au/industry-overview.

19 If one of the goals of an action is cultural transformation, then the definition of a *yield* can be expanded beyond tonnes per hectare of sugar. Elsewhere, I have touched on this issue of yield from a Social Ecology perspective. See Lucas Ihlein, 'PA Yeomans and Social Ecology,' in Lucas Ihlein and Ian Milliss, *The Yeomans Project,* October 31, 2011, http://www.yeomansproject.com/pa-yeomans-and-social-ecology.

20 The only scheme actually implemented — the Labor government's Clean Energy Act (2011) — was subsequently repealed in 2014 after a change of government. See Alexander St John and Juli Tomaras, 'Australian Renewable Energy Agency (Repeal) Bill 2014,' *Parliament of Australia: Parliamentary Business,* Commonwealth of Australia, October 17, 2014, http://www.aph.gov.au/Parliamentary_Business/Bills_Legislation/bd/bd1415a/15bd035.

tify, and assign financial value to the cycling of carbon in the atmosphere. To date, the atmosphere has been treated as a free resource, or commons, which can be exploited without being properly accounted for.[21]

However it seems inevitable that globalised trade systems will soon force into existence a system in which carbon dioxide emissions will become part of the total accountable costs of goods and services.[22] It is possible that this system will pay individuals or organisations that are able to reduce the stock of greenhouse gases in the atmosphere. But how, exactly, could such payments be organised? Allan Yeomans, the director of Yeomans Plow Co. on the Gold Coast, Queensland, has been working towards a plant-based solution for this problem for the past decade.

Yeomans' father Percival Alfred (P.A.) was the inventor of Keyline, a method for the design and management of dryland farming in Australia. Keyline, unlike conventional models of agriculture imported from Europe, is responsive to the specific requirements of the Australian climate. Keyline design involves laying out a farm according to its topography and landforms, strategically situating dams and irrigation channels to maximise the soil's capacity to store moisture.[23] Keyline farming also involves the use of a deep-ripping subsoil implement to assist with this process — the Yeomans Plow — which allows air and water to penetrate below the roots of pastureland without violently inverting the soil. Now in his eighties, Allan still runs the Yeomans Plow Company, having inherited his father's inventive and entrepreneurial spirit.

21 Ottmar Edenhofer et al., 'The Atmosphere as a Global Commons – Challenges for International Cooperation and Governance,' *Mercator Research Institute on Global Commons and Climate Change,* June 2013, http://www.mcc-berlin.net/fileadmin/data/pdf/Final_revised_Edenhofer_et_al_The_atmosphere_as_a_Global_Commons_2013.pdf.

22 John Fialka, 'China Will Start the World's Largest Carbon Trading Market,' *Scientific American,* May 16, 2016, http:// www.scientificamerican.com/article/china-will-start-the-world-s-largest-carbon-trading-market/.

23 Lucas Ihlein, and Ian Milliss, 'P.A. Yeomans and the Art of Landscape Design,' *World Water Day Symposium,* March 22, 2012, http://waterwheel.net/media_items/view/1474.

In the context of the carbon economy, Allan Yeomans' agricultural heritage is significant. One of the possible ways to remove carbon from the atmosphere is by working with plants to perform the function of sub-soil sequestration. This can be achieved by a variety of methods. Yeomans' Keyline system, Peter Andrew's Natural Sequence Farming, Allan Savory's Holistic Management, and Joel Salatin's Polyface farming are all members of a family of agricultural systems which claim to build soil carbon. The way this works in a grass and cattle system is described by P.A. Yeomans in his book *Water for Every Farm.*[24] Grasses in pastureland photosynthesise using energy from the sun. Photosynthesis allows the grass to put on weight (growing leaves and roots), while drawing carbon dioxide and nitrogen from the atmosphere. When the plants reach maturity and begin to produce seed, cattle are sent in to intensively graze them. Grazing gives the grass plants a shock, and they drop a large proportion of their roots below the soil surface. The dead roots decay and contribute to the build up of soil organic matter, 58% of which is carbon.[25]

Recent developments in regenerative grass and cattle systems also recommend the use of mob-grazing or cell-grazing, where the herd is kept in a very small enclosure with lightweight mobile electric fences. The cattle are moved regularly (daily in some cases) by shifting the fences, grazing intensively, eating the leaves of all the plants (not just the more palatable ones) and depositing manure within the fenced area.[26] This contributes to the rapid regeneration of the grasses, which through repeated cycles of growing new roots and then dropping them, build a deeper layer of topsoil rich in carbon content.

24 P.A. Yeomans, *Water for Every Farm: Yeomans Keyline Plan* (Southport: Keyline Designs, 1993).

25 Edward Griffin, 'What is Soil Organic Carbon?' *Government of Western Australia Department of Agriculture and Food,* November 18, 2016, http://www.agric.wa.gov.au/climate-change/what-soil-organic-carbon.

26 This process has been described as 'mimicking nature,' insofar as wild herds of cattle on grasslands constantly move through the landscape, and stick together tightly as a defence against predators. See Jody Butterfield et al., *Holistic Management Handbook: Healthy Land, Healthy Profits* (Washington, DC: Island Press, 2006).

Allan Yeomans experimented with this type of pasture grazing together with his father in the 1950s. Long before carbon was an element of global currency, a common qualitative testing practice was to use a shovel to extract a cube of soil in order to inspect the depth of root penetration, and check for the presence of earthworms. More recently, as a design engineer and author, Allan Yeomans has been developing a method to assist with the quantitative measurement of soil carbon on a much larger scale. His self-published book, *Let's Pay Our Farmers to End Global Warming,* has two functions — operating as a passionate call for action and as a practical guide, or protocol, for how a soil carbon sequestration payment system could work. [27]

Yeomans' protocol (simplified here) works as follows. The land of any farmer who wishes to be paid to sequester carbon needs to be first baseline tested to determine its starting carbon content. This is done by collecting a set of samples randomly distributed across the paddock in question (Yeomans has invented an augur device to collect the samples reliably and with repeatable consistency). The soil samples are cleared of live plant matter, after which they are put through a series of sieves to reduce soil particle size to 2mm. The resulting sifted soil is then placed in the Yeomans Carbon Still (a special oven with an inbuilt weighing scale) and heated to just over 100 degrees Celsius, to evaporate any water content. After evaporation, the soil is weighed, and the Carbon Still heats the dry sample to 550 degrees Celsius, at which temperature the carbon content burns away. The soil sample is weighed again, and the difference between the first and the second weights indicates the amount of carbon in the sample. A final calculation is made by multiplying the sample size to work out the soil carbon content of the whole paddock.

If this protocol is repeated each year (the farmer having in the meantime applied regenerative agricultural methods), it would be possible to determine the incremental increase in soil carbon content from the baseline measurement. This change is what

27 Allan Yeomans, 'Let's Pay our Farmers to End Global Warming: Protocols and Test Apparatus for Reward Based Agricultural Soil Carbon Sequestration and How and Why it Works,' *Yeomans Plow Co.,* http://yeomansplow.com.au/10-carbon-still-soil-test-system/.

would be used in determining the payment to the farmer for soil sequestration services.[28]

Barriers to the Widespread Adoption of Soil Carbon Sequestration Measurement

In *Let's Pay Our Farmers to End Global Warming,* Yeomans describes a number of factors which slow down the implementation of his soil carbon sequestration measurement system. These can be grouped into the following categories: technical complexity, cost effectiveness, and legislative problems. The first category, technical complexity, relates to the difficulty in designing a workable protocol (set of procedures) by which soil samples could be collected and analysed.[29] The second category, cost effectiveness, includes the expense of performing and monitoring the soil testing procedures, as well as administering payments to farmers.[30] There is little motivation for implementing a system of payments to farmers if the cost of doing so outweighs the benefits of the service. The third category, legislation, is a blockage at a higher level: until a global carbon economy becomes a legal reality, and passes into national law in Australia, the collective will to solve the other limitations will not gain momentum.[31]

28 A comprehensive description of this 'loss on ignition' method of testing soil carbon content is published at Allan Yeomans, 'Soil Carbon Tests. Big Cheap & Easy,' *Yeomans Concepts,* 2016, http://yeomansconcepts.com/1-soil-carbon-tests-big-cheap-easy.

29 Yeomans proposes that his Carbon Still protocol (which requires no specialised skills and can be performed on-farm) will address this gap.

30 At approximately 10,000 Australian dollars (AUD), Yeomans argues that the Carbon Still could pay for itself after only ten soil testings. Yeomans proposes that a group of farmers could collectively purchase a still, and thus bypass the current expensive government soil testing regime.

31 One of the organisations working to accelerate the legal acceptance of carbon accounting is Carbon Farmers of Australia. I called director Louisa Kiely to ask about the difficulties Yeomans was experiencing in having his Carbon Still accredited. Kiely advised that the standard process for accreditation would involve selecting a piece of grazing land, paying to have the soil baseline tested for carbon content via the current government protocol (which could cost approximately AUD 100 per hectare),

Yeomans is an innovator working with plant-based soil systems to create positive environmental and social transformations. Beyond the limitations outlined above, one of the fundamental barriers Yeomans describes is the existence of a disciplinary demarcation in how research is defined. For Yeomans, it is his practical experience as a farmer and engineer that has enabled him to identify problems, trial solutions, and report on insights. However, he does not belong to one of the special social groups (politicians, academic scientists, or media makers) whose voices are heard in discussions around climate change mitigation, and in his book he repeatedly expresses frustration in his attempts to bring the Yeomans Carbon Still to wider attention.

Conclusion: Beyond Environmental Management?

In this narrative about innovation and the barriers to change, I have focused on the work of two human change agents collaborating with plants to transform industrial agricultural systems: to improve crop yield through soil health (Mattsson), and to perform a global service by facilitating the sequestration of carbon dioxide from the atmosphere (Yeomans). Despite the crucial role played by plants in each of these processes, human action is given priority in the way my stories are told. In each case, plants are managed by humans and marshalled towards a human-centric goal. Perhaps this is to be expected: we humans are more practiced in telling and hearing stories in which we are the protagonists.

In my own research as an artist beginning to work at the edges of agriculture and engineering, I have noticed the prevalence of the term 'environmental management,' and I have begun to use this language myself. It's practical: environmental management has widespread acceptance in scientific research and policy development, where the priority is to report on what is

and then using the Yeomans Carbon Still to test the same piece of land. If identical results are generated, then the Carbon Still will be in a position to apply for accreditation as an approved carbon measurement system. See Carbon Farmers of Australia, 'What is Carbon Farming,' *Carbon Farmers of Australia,* http://www.carbonfarmersofaustralia.com.au/About/what-is-carbon-farming.

knowable.[32] We want soil micro-organisms to be observed under a microscope, we want yields that can be quantified with precision (tonnes per hectare of sugar), and we want rates of carbon sequestration to be precisely determined in a given area over a known period of time. These are all environmental management processes. The results of these processes — usually reported in peer reviewed academic journal articles, or filtered through government funding schemes — are the tools for generating positive changes for 'the environment.' And yet, implementation of the recommendations of this knowable research — as shown in each of my case studies above — can be painfully slow. So what is going on? If we *know* what works, and if we are still not able as a society to do what we know works, then it can only be assumed tha*t factors beyond the knowable* must be at play. It is at this point that environmental management as a strategy of control starts to break down. How might we invent alternative ways of generating change?

One approach which attempts to find a way of framing human and nonhuman relations beyond the management paradigm has emerged from the field known as the environmental humanities. The writing of scholars like Val Plumwood and Deborah Bird Rose is exemplary of this approach.[33] Their work

32 As an indicator of the widespread use of this term, two major international journals use it in their titles: the *Journal of Environmental Management and Environmental Management,* both of which started publishing in the mid-1970s. In its journal scope description, *Environmental Management* has the following: 'As the principal user of nature, humanity is responsible for ensuring that its environmental impacts are benign rather than catastrophic.' Similarly, the *Journal of Environmental Management* outlines its goals: 'As governments and the general public become more keenly aware of the critical issues arising from how humans use their environment, this journal provides a forum for the discussion of environmental problems around the world and for the presentation of management results.' Both of these journal scope descriptions outline an instrumental relationship to 'nature,' where humans are its 'users' and 'managers.'

33 Martin Mulligan and Stuart Hill, *Ecological Pioneers: A Social History of Australian Ecological Thought and Actio*n (Cambridge: Cambridge University Press, 2001), 276–89.

describes the position of humans in a world where we are not always the managers, but rather in relationship with a multiplicity of non-human species. By necessity, a decentred form of philosophy must embrace diverse modes of knowledge. This is a complex intellectual endeavour, and its influence is percolating throughout the humanities. However, I have yet to hear these ethically decentring ideas being used *practically* by scientists researching the Great Barrier Reef, nor by politicians tasked with environmental portfolios — and certainly they have no currency in the mainstream media. There is a gulf between *environmental management* (humans attempting to control nature) and the *environmental humanities* (humans trying to think their way towards a reciprocal relationship with nature, or indeed to move beyond the culture-nature divide). Is it possible to bridge this gulf? What new practices might be needed for this endeavour?

While it is still at an early stage in its development, this is one of the areas of focus for *Sugar vs the Reef?* The method of socially engaged art employed by the project shuttles between the outcomes-focused priorities of environmental management on one hand, and the deliberately non-instrumental ethics of the environmental humanities on the other. Socially engaged artists do this by embracing their own disciplinary ambiguity.[34] Their way of working allows practical experiments in the field — such as collaborations with farmers and engineers working with the materiality of plants and soil — to co-exist with unresolvable philosophical, ethical and aesthetic discussions. These experiments and stories are published side by side in the project blog, and are embodied in the various public collaborations which will constitute *Sugar vs the Reef?* over its lifespan. One of these in-

34 In his influential book on Socially Engaged Art, artist and educator Pablo Helguera discusses the importance of disciplinary ambiguity: 'Socially engaged art functions by attaching itself to subjects and problems that normally belong to other disciplines, moving them temporarily into a space of ambiguity. It is this temporary snatching away of subjects into the realm of art-making that brings new insights to a particular problem or condition and in turn makes it visible to other disciplines.' See Pablo Helguera, *Education for Socially Engaged Art Practice: A Materials and Techniques Handbook* (New York: Jorge Pinto Books, 2011), 5.

volves the planting of a dual crop of sugar cane and sunflowers in the Mackay Botanical Gardens, in collaboration with Simon Mattsson and members of the Australian South Sea Islander Community, whose descendants were forcibly removed to Australia in the 1860s to work as indentured labourers in the sugar cane fields. This cross-disciplinary group will work together to map the topography of the terrain, test the soil, plant and tend the cane, and eventually harvest and process it. The multi-year duration allows a set of collaborative processes around the life cycle of a plant, and all its accompanying species both above and below the soil, to slowly develop. The sugar cane crop-as-artwork thus transcends its normal role as a functional element in an industrial system, and becomes instead the fulcrum, and physical site, for dialogue around a host of economic, social, cultural, and environmental issues. In planning these events, and in reflecting on the collaborations between farmers and engineers with non-human lifeforms like sugar cane, I am searching for a form of social-environmental catalysis which goes beyond management, and into a more reciprocal relationship between humans, plants, and social/ecological systems.