Title

Sensing the Fields: A Report on the Emerging Ag-Tech Initiative at UCSC

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SENSING THE FIELD
A Report on the Emerging Ag-Tech Initiative at UCSC

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In 2018, conversations began at the University of California, Santa Cruz (UCSC) to make ag-tech a major priority in programming. Many of the discussions referred to how this programming could build on three distinct campus strengths: agroecology, engineering, and an overarching commitment to social justice, all while being positioned between the tech-heavy Silicon Valley and the agriculturally prolific Salinas Valley.

In light of these emphases and UCSC's unique campus setting, the research detailed in this report sought to identify the synergies and frictions between agroecology and ag-tech, the potential for meaningful collaboration across campus units, and the prospects for incorporating social justice values into campus ag-tech efforts. Based on interviews with 23 UCSC engineers, agroecologists, and social scientists, we found far fewer synergies than anticipated, and indeed hoped for, and some significant barriers to collaboration.

Given what we identified as substantial differences in disciplinary approaches, potential uses and beneficiaries of ag-tech, and access to institutional resources among engineers, agroecologists, and social scientists, it is clear that for an ag-tech initiative to move forward and achieve widespread buy-in, sustained, respectful, and more symmetrical dialogue must take place. **Otherwise, UCSC risks chipping further away at its reputation as an alternative and socially engaged institution, and thus ironically dispensing with its singular competitive edge in this domain relative to the many other universities in the US with long histories in ag-tech.**

INTRODUCTION

In 2018, conversations began at the University of California, Santa Cruz (UCSC) to make ag-tech a major priority in programming. Some of these conversations emerged from the Future of Food & Agriculture Themed Academic Working Groups (TAWGs) born of a strategic planning process and others from development staff, deans, and specific faculty members. The interest in ag-tech was also spurred, at least in part, by the current university administration's renewed interest in the Monterey Bay Education, Science, and Technology (MBEST) site, a roughly 1,000-acre land parcel south of campus in Monterey Bay. Acquired in 1994, the MBEST site was transferred to the University of California from the Army Reserve, with 500 acres allotted to development and the remaining 600 to a natural reserve. Currently funded through UCSC's Chancellor, a Dean-selected committee was appointed to shape MBEST's direction.

Although these discussions were initially fairly disconnected, since then many around campus have come to refer to a campus "ag-tech initiative." As featured in several campus websites and announced at several events, such an initiative will build on UCSC's unique campus strengths in agroecology, engineering, and an overarching commitment to social justice, all while being positioned just over the hill from the Silicon and Salinas Valleys – the latter a major "big ag" region raking in some of the highest crop values in the nation (Monterey Farm Bureau 2019). In practice, recent efforts surrounding this emerging ag-tech initiative have consisted of discussions mostly between engineers and agroecologists, some campus seed funding to generate relevant research projects, and a spring 2021 ag-tech symposium to share work already being done on campus and identify further areas of collaboration. In addition, at least one new full time faculty position has been put forward with the intention of hiring someone whose work combines agroecology and ag-tech. Given this coalescence of events, discussions, and resource commitments, in what follows we will refer to these efforts as the ag-tech initiative.

The research detailed in this report sought to identify the synergies and frictions between agroecology and ag-tech, the potential for meaningful collaboration across campus units, and the prospects for incorporating social justice values into campus ag-tech efforts. Our interest in researching an ag-tech initiative on our own campus was twofold. First, Guthman is the Primary Investigator of the UC AFTeR Project (the University of California Agri-Food and Technology Project), to which Sullivan contributes as a Graduate Student Researcher. Funded by the National Science Foundation officially titled, "Investigating the 'grand challenge' solutions of Silicon Valley ag food tech," this multi-campus collaboration of social scientists and humanists examines how the ag- and food-tech sector engages in food system problem-solving in the context of Silicon Valley's funding and innovation cultures, often under the rubric of addressing climate change, food security, and resource use. Attending to the unique material, cultural and political economic aspects of food and agriculture, the goal of the UC AFTeR Project is to encourage investment in solutions most likely to be efficacious, equitable, and widely embraced, all while avoiding the mistakes of past interventions. We felt these concerns would be relevant and potentially useful to UCSC's ag-tech initiative.

Second, we are both social scientists who study food and agriculture through a social justice lens and noted that despite references to social justice goals in the ag-tech initiative, to our knowledge no campus social scientists who study social justice concerns were asked to join its conversations at the outset. Indeed, social scientists were gradually included only after Guthman inquired about the initiative having heard of it incidentally. We thus became interested in the character of the collaboration itself, hoping to support the initiative with social science perspectives on social justice as well as meaningful stakeholder engagement. As such, our position is one of an engaged and invested research team.

Our approach is animated by a large body of literature in science and technology studies (STS) about responsible innovation (RI) and asymmetries in funding and legitimacy for STEM and non-STEM fields in technological development and assessment. Stilgoe et al (2013) propose four axes of responsible innovation: anticipation, reflexivity, inclusion, and responsiveness. For our purposes, this means examining the considerations being made about ag-tech and its impacts (anticipation), how those driving the initiative situate themselves and reflect on their work (reflexivity), who is involved in discussions and decision making (inclusion), and how the group meets any challenges (responsiveness). Such iterative dialogue, some argue, can mitigate the problem of public reticence of new technologies, or what Wynne (1992) has famously called "misunderstood misunderstandings." At the same time, STS scholars have also noted that such interdisciplinary dialogue and collaboration does not generally occur on even terrain despite recognition that science and social dynamics are inextricably bound. As Albert and Paradis (2014) have reported, interdisciplinarity is often promoted under the assumption that all actors will contribute and be valued equally, but rarely is this the case in practice where "several structural barriers limit social scientists' ability to be full contributors" (362).

AGROECOLOGY, AG-TECH, AND SOCIAL SCIENCE AS FIELDS

To contextualize this initiative and the impetus for our project, it is important to state key differences between agroecology, ag-tech, and social science as fields of study and practice. Agroecology is an intellectual and normative approach to farming that putatively underpins organic and other diversified farming practices that nurture soil and omit toxic pesticides. Traced to the early 1900s (Wetzel and Soldat 2009), agroecological science fosters complex species interactions to enhance biodiversity and support beneficial ecosystem services such as nutrient cycling and weed, disease, and pest management.

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To some, agroecology also includes social, political, and economic components and an overarching goal of achieving food system transformation alongside indigenous and peasant communities that have been practicing ecologically-based agriculture for centuries. Scholars have thus referred to agroecology as a science, practice, and movement (Méndez et al 2012; Isaac et al 2018). Although its meanings are contested, with different interpretations supporting divergent agricultural and social outcomes (Bellwood-Howard and Ripoll 2020), it is a recognized academic discipline and field of practice.

Ag-tech, in contrast, is not a distinct field in the same manner as agroecology, per se. Although agricultural technology has a long history, and includes tools like plows and shovels, in conventional farming practice, ag-tech connotes technologies of industrial agriculture that increase productivity and efficiency, such as mechanization, plant and animal breeding, chemical and pharmaceutical disease and pest management (Goodman et al 1987). With Silicon Valley's newfound interest in agriculture, more recently ag-tech has come to be associated with Silicon Valley approaches to innovation. As such, today ag-tech is associated with "high tech," often digital devices such as drones, robots, microbials, and all manner of data-driven and precision agriculture (Miles 2019). However, the fact that ag-tech is not strictly identified with a set of principles suggests it may be amenable to organic and low-resource farming, including agroecology, and thus, some postulate that their union is possible and presents a path to a more sustainable food and farming future.

As for social science, it is composed of many disciplines each with their own histories, canons, methodologies, and styles. That said, most of the social science work attending to the sociality of agriculture is based in anthropology, geography, and sociology, and sometimes goes by the name of critical agrarian studies. Critical agrarian studies is generally theory-driven and has long been interested in technology introduction as it affects farmer differentiation, farm labor, and wealth and income inequality – all questions of social justice. Somewhat separately, social scientists of agriculture are increasingly drawing on STS for its attentiveness to knowledge-making and dissemination practices, in recognition that they, too, affect social outcomes. As such, questions of ontology (what we assume about an object of study in order to study it) and epistemology (how we know the reality we see) are central to the enterprise.

SITUATING UCSC'S STRENGTHS

UCSC is a unique context within which to pursue an ag-tech initiative due to its historic and continued prominence in the fields of agroecology, engineering, and critical agrarian studies. It is the proposed convergence of these strengths that ostensibly animates the ag-tech initiative as a natural direction for UCSC. But in considering the development of ag-tech on campus, it is important to note that UCSC was not part of the University of California's land grant system. Land grant universities were established in every state in 1862 by the US Morrill Act, in which the federal government granted 30,000 acres to every state in the union, acres which could be sold to establish and finance colleges of "agriculture and mechanic arts."

While Berkeley was the original land grant college within UC, many of the land grant activities were eventually devolved to UC Davis and UC Riverside. It was at the land grant universities that massive research was undertaken to support almost wholly conventional agriculture that has traditionally been associated with ag-tech interventions. As such, UCSC – unlike UC Davis and UC Riverside – does not have agronomics or agricultural engineering departments, meaning all engineers involved in UCSC's ag-tech initiative had no previous experience with agriculture. Being apart from the land grant university poses some structural constraints, as well. For instance, non-land grants lack well-developed extension operations and receive no funding from the 1887 Hatch Act, which otherwise guarantees a yearly funding stream to those within the land grant system. By the same token, not being a land grant perhaps offers degrees of freedom and flexibility not available to land grant universities.

Agroecology at UCSC

UCSC's leadership in agroecological research and practice cannot be understated. The tradition dates to at least 1967 when Alan Chadwick founded the first organic garden on campus, attracting a great deal of student interest from those invested in 'alternative' modes of farming. Stephen Gliessman, who led the field of agroecology to world-renowned prominence (Reti 2007), joined UCSC in 1980, overseeing the creation of an Agroecology Program – the first UC initiative centered on sustainable and organic growing approaches (Brown 2000). Key to UCSC's reputation in the field, the program included an apprenticeship component whose graduates have started farms around the world, while many also remained in the central coast region. Historically propelled by agroecological scientists interested solely in sustainable farming, at UCSC, with its engaged students and practitioners, agroecology became a program that emphasized food systems transformation and included social justice. In 1993, the Agroecology Program was renamed The Center for Agroecology and Sustainable Food Systems (CASFS) to reflect its equal commitment to environmental and social issues that continues today.

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The Jack Baskin School of Engineering & Silicon Valley

Starting in 1983, UCSC began offering engineering degrees in Computer Engineering, but it was not until 1997 that the Jack Baskin School of Engineering was officially established, accelerating UCSC's recognition in the field. Contributing at least in part to engineering's new position as a distinguished campus strength was its proximity to the now-flourishing Silicon Valley, where UCSC began operations of a satellite campus in 2016. Baskin Engineering has produced numerous successful "spin-offs and start-ups," or companies originating from departmental research (engineering.ucsc.edu), most dealing with genome

sequencing, perhaps what the school is best known for. UCSC engineers, along with other campus scientists, became internationally known for pioneering the Human Genome Project in the 1980s, with the department now home to the world class Genomics Institute. In addition, UCSC was the first university in the nation to offer a graduate degree in Serious Games, building on its reputation as a leader in the growing field. Now boasting six departments, eleven distinct research centers, and 116 faculty, the Jack Baskin School of Engineering is one of UCSC's premier assets.

The Santa Cruz School of Critical Agrarian Studies

UCSC has a rich history of attracting and cultivating students and scholars alike who want to examine, and often challenge, the agri-food system. The tradition began with Bill Friedland whose work on the political economy of California agriculture was seminal for the sociology of agriculture. With additional recruitments, by the late 90's, UCSC became internationally recognized for what some dubbed the "Santa Cruz School" of critical food and agrarian studies, referring to work that critically investigated the political economic and cultural dynamics of industrial agriculture, as well as its organic counterparts. Several UCSC social scientists produced canonical research in the field, laying the foundation of a strong and storied tradition that continues today. UCSC's seminal and foundational attention to the race, class, citizenship, and body politics of agri-food system transformation has contributing to UCSC's ongoing association with social justice values. The increased urgency in addressing the social and ecological consequences of food systems and the turn to technological solutions underpins much current research of UCSC's critical food and agrarian scholars, with the UC AFTeR project as a key example.

METHODS

Between January and March 2021, co-author Sullivan conducted 23 interviews via Zoom. We recruited interviewees primarily through their involvement in the ag-tech conversations and projects, but also went beyond to include those with pertinent practice-based and/or research backgrounds. Given that the intent of the initiative is to build on campus strengths (agroecology, engineering, and social justice), we opted to interview people from all three areas. The division of interviews is as follows: agroecologists (n=11), engineers (n=7), and social scientists (n=5). All but one participant is employed by UCSC. It is worth noting that interview request emails were sent to 42 relevant people at UCSC and that the by-field response percentages leading to an interview were: engineers 38%, agroecologists 65%, and social scientists 83%. Inter-field disparities in the amount of data presented reflect this uneven participation. All three groups include both faculty and staff.

photo credit: Summer Sullivan

We acknowledge that these categories are imperfect, with many people doing cross-cutting work or holding multiple campus roles. With consent, we recorded interviews, transcribed them with a web-based transcription software, and coded them.

FINDINGS

In what follows we detail significant differences and occasional agreement across three categories: ag-tech and agroecology's disciplinary compatibility, ag-tech's application and dissemination, and the nature of the collaboration. At the outset, however, it is important to note the lack of agreement of the very content of the initiative. While all parties agreed that they heard mentions of the university's interest in ag-tech and UCSC's potential ability to produce a "unique" approach due to its confluence of strengths, beyond that its objective and status was elusive. When asked what they thought about the ag-tech initiative, one engineer asked rhetorically, "What is ag-tech?" and noted their current understanding of ag-tech is "very low." A social scientist said, "There is no definition of ag-tech at UCSC... the process we're going through is to figure out how we want to define it." And several agroecologists, entirely passed on the question of how they might define ag-tech saying they also had not thought much about it.

Ag-tech, agroecology, and social science's disciplinary compatibility

In this section we report on conversations with agroecologists, engineers, and social scientists about disciplinary approaches and the dynamics between their fields at UCSC.

Approaches to research

Not surprisingly, when it comes to research, agroecology, engineering, and social science approach their work in highly distinct ways. Agroecologists communicated a wide or "systems" lens through which they see and undertake research and practice. As one agroecologist said,

> *[in agroecology] you need to understand the community that you're embedded in, and the impact that your agriculture has either on or within that community... from production to our use of resources, potential pollution, things like that... it is a very whole systems perspective.*

Agroecologists also maintain an attention to "whole systems" in their description of farming practices, as they root their approach in the complexity of biological organisms and the use of practices that further foster species diversity and "interactions between plants, soil, microbes" and so on.

Alternatively, engineers were interested in zooming in on specific phenomena and processes. One engineer said that the largely unpredictable nature of complex biological systems – core to agroecology – is their biggest challenge, as it impedes their overarching goal of increasing systems efficiency.

As such, one engineer described their goal to "characterize every tidbit [of a biological system] individually," in order to enhance predictability of specific diseases, for instance. In other words, while the lens of agroecologists is wide, the engineers describe a slimmer scope, concerned mostly with controlling specific, on-farm biological processes.

Though no agroecologist thought of the engineers' approach as inherently wrong, some noted that the different lenses through which each group viewed their work affected their ability to find common ground within the initiative, as the object(s) of discussion were simply not the same. One agroecologist summed up the differences between the scope of the research lenses by comparing agroecologists to public health experts who are concerned with whole populations and communities, and engineers to medical doctors, concerned with individual people. Another noted that the engineers' expertise lies at the "cellular and individual organism level" whereas agroecologists are thinking about "the crop field level."

Most social scientists also noted field incompatibilities between their approach and the engineers'. One social scientist said that "Where social scientists are useful may not intersect with engineers very easily and obviously," leading to what another called a "mismatch" between their field and engineering. While one thought their skillset might be able to "help engineers be more ethical and thoughtful about their work and the unintended consequences and implications," some other social scientists were more skeptical of such convergence, recalling conversations that involved both engineers and social scientists where the word "epistemology" was introduced. In response to the social scientists' desire to engage in a discussion surrounding the varied epistemological foundations of their shared research within the ag-tech initiative, this social scientist recalled the engineer's reaction: "...the engineers are like, 'oh, my God.'" This social scientist concluded that such a dynamic between the fields "gets challenging."

Problems & solutions

As suggested above, different disciplinary norms around research manifest in quite divergent approaches to defining problems and identifying how to solve them, going to the very core of what an ag-tech initiative could do. One engineer laid out their discipline's approach by saying, "As an engineer, if there's a problem somebody has, and I have a technology that can provide a solution, that's what I do." Another engineer, taking this a step further, said that within the field of engineering, "if you aren't solving problems, you're just in the frickin' mud."

While this streamlined approach serves engineers in numerous ways in certain contexts, agroecologists saw food system problems as inherently complex and questioned the extent to which ag-tech could provide the needed solutions. One agroecologist said,

> *A lot of the persistent problems that we have within the agricultural and food system are things that can't be easily solved. Thinking about issues of food access, hunger and distribution, and equal access of wealth... Those are the real persistent and wicked problems, and none of those are going to be solved by a technological fix.*

Instead, most advocated for historically embedded approaches that centered local and marginalized communities. As one agroecologist put it, "So much of our society is just designed to make a technology or a solution to fix the problem, rather than changing the system so that it isn't a problem."

A lot of the persistent problems that we have within the agricultural and food system are things that can't be easily solved.

This led another agroecologist to add that thinking of the consequences or outcomes of a particular technology is not in the forefront of engineers' minds, as they are so focused on solving particular problems. Another said the different approaches to problems and solutions was the fundamental conflict between the fields. Much in line with this, one engineer noted what they called "distance" and "lack of a shared language" between their approach to problems and solutions and that of the agroecologists,' ultimately agreeing that finding common ground in this area would be difficult.

Social scientists generally agreed. While one social scientist offered a suggestion for common ground, saying that engineers and social scientists might be able to come together to work on a "specific problem," other social scientists took issue with such an approach. As one said,

Social scientists have a very different set of methodological tools to think about individuals, communities, politics, ethics and systems. Instead of just coming up with a tool... social scientists are able to deal with the contradictions and paradoxes, the gray areas that too often get erased or ignored... it's one thing to come up with a better tool, but we can ask, are people actually going to use it? Why? How might they reinvent it for themselves?

Another social scientist objected altogether to such a "solutions-oriented framework," as they put it.

Notions of interdisciplinarity

All three groups had very different understandings of and experiences with interdisciplinarity, in no small part because they incorporate and value different types of knowledge, ways of knowing (epistemologies), and knowledge-sharing practices. Described by one as the field's "epistemic plurality," agroecologists discussed the incorporation of a range of knowledges like ecology, sociology, economics, and agronomy. This led many agroecologists to say the field as inherently inter- or trans-disciplinary, further supported by the frequent mention of indigenous, peasant, and local community knowledges as foundational to their work. Agroecologists further noted the necessity of wide, community-rooted engagement and sociality to their work, stating that agroecological knowledge is shared via farmer to farmer and peer to peer networks, a practice that made one describe agroecology as "knowledge intensive." Another agroecologist said, "You can't extract that social piece and community piece from agroecological systems, because they rely on those communities and connections in order to function."

One engineer noted their field is increasingly becoming interdisciplinary, saying, "I just think that collaborative work is the future. I think single PI [primary investigator] research projects are a thing of the past." However, when engineers spoke of interdisciplinarity, they largely referenced collaborations between themselves and other types of biological or natural scientists, or other kinds of engineers. One listed the areas of mathematics, machine learning, statistics, and dynamic modeling as essential to their work, while another simply said that "curiosity" is necessary in their field. Further, one engineer noted,

There's a balance between too many perspectives, [because] then it's difficult to get actionable items. In the beginning, it's always easier to start small and then see how things work out.

Social scientists as a group were perhaps the most reticent about interdisciplinary projects, with some citing first-hand experiences that had not gone well. One imitated how non-social scientists think about interdisciplinary collaboration, saying, "'Oh, we need to study people, so we'll have a social scientist do that,'" further noting that this inclusion is "in the service of somebody else's research project." Another voiced awareness that social science criticism in interdisciplinary collaborations if often unwelcome and dismissed as overly negative rather than offering a possible corrective. "We're always seen as complaining and pointing out the flaws and risks and potential problems, like that irritating fly in the room." They added that their attitude is actually not one of "being cynical and skeptical about everything... I am critical, but it's not a predisposition towards being a pessimist. It's actually the radical optimism that there are other ways of doing things." This, for most social scientists, was what opening up the question of meaningful collaboration might entail: doing things differently, or perhaps according to the approach captured in the UCSC tagline of 'the original authority on questioning authority.'

Incorporation of social justice

The question of how social justice would be incorporated into the ag-tech efforts generated particularly animated responses, with engineers and agroecologists noting – to various degrees – increased conversations about such issues and social scientists expressing doubt over the commitment to social justice entirely. Many agroecologists said that the campus's approach to agroecology emphasizes social justice and distinguishes it from other modes of sustainable farming, noting that UCSC agroecology "encompasses political change and social movements." One said that many of UCSC's agroecological practitioners are "really focused on sovereignty, building connections with the [local indigenous] tribal band, and thinking about Black Lives Matter and how that intersects with agroecology." Importantly, though, not all agroecologists see social justice as central to the work. As described by one, "The way I was raised through agroecology is applying ecological principles into agricultural management. I certainly appreciate the extent that the Santa Cruz School of agroecology really embraces the human community aspects of agroecology, as well."

Even though most agroecologists agreed that UCSC agroecology uniquely centered social justice, they were simultaneously skeptical of the university's goal to create ag-tech with such values. Indeed, they viewed the social justice rhetoric as an administrative attempt to brand the initiative and make it attractive to potential funding partners, citing lack of engagement with those who might be able to help successfully shape such an outcome. One said,

[it's] a little awkward because right now [we are] so focused on building up equity in the food system... We have all this sustainable agriculture

photo credit: Summer Sullivan

and it's gonna blend with ag-tech, but there isn't any real involvement, even of the farmers that we have here on campus, which doesn't necessarily bode well for how the initiative is gonna impact farmers out in the world.

Social justice was not central in most conversations with engineers, although one reported increased "reflection" about social issues spurned by the murder of George Floyd in May 2020. This engineer said that since the campus is "thinking about social justice," UCSC would inherently produce ag-tech for social good. When asked about who might benefit from UCSC's ag-tech initiative, though, one engineer said they had not thought about the potential social benefit, noting their interest lay mostly in increasing agricultural systems' efficiency and the overall "acceleration of science."

Social scientists were particularly troubled by the presumption that an ag-tech initiative would necessarily incorporate social justice simply because UCSC has historically pursued such values. As one social scientist put it, UCSC's goal to produce a socially just ag-tech could "be really distinct and provide some major contributions," but they and others asserted that if the campus wants to achieve such an outcome, it should make the effort to meaningful engage those who might make it a reality. Moreover, some expressed reservations about this goal altogether, citing the longstanding social concerns surrounding ag-tech regardless of its intentions. One summed up their position by saying they were aware of the initiative's "intention to be mindful of both ecological sustainability and social justice," but continued,

I have a lot more questions when it comes to grappling with the structural constraints into which technology enters. We can say that a technology is going to be socially just, but how you do that in the absence of economic policy change or land reform? . . . I have a hard time taking the rhetoric seriously.

Ag-tech's application and dissemination

This section considers the kinds of technologies engineers, social scientists, and agroecologists think might be useful for growers and how and to whom they should be developed and distributed. In this section we also address diverging views of the appropriate scale of ag-tech.

Useful ag-tech

Although engineers, agroecologists, and social scientists generally shared definitions of ag-tech, they had different ideas of how it might be useful to growers, and therefore incongruous ideas about the type of ag-tech UCSC might produce. However, many agreed that applications that address issues that have long stymied low-input farmers would be a positive contribution to the ag-tech scene.

Engineers equated ag-tech to applications like drones, artificial intelligence, machine learning, fertilizers, remote sensing, precision agriculture and anything that might enhance the efficiency of agriculture. Agroecologists generally agreed these to comprise the broader landscape of ag-tech, but argued that those types of devices are geared toward large-scale, conventional farmers and currently do not work for agroecologists. They did, however, identify kinds of ag-tech that could be of interest to them, such as

I have a lot more questions when it comes to grappling with the structural constraints into which technology enters.

those that would center the health of farmworkers, be easy to repair, and help them with everyday farming tasks, like a social platform that would connect farmers to each other and to potential consumers. More pointedly, agroecologists emphasized the lack of tools that expressly support the goals of agroecology per se, such as those that enhance biodiversity. These were described by one agroecologist in the following way:

...tools that would specifically seek out and enhance the complex dynamic, that would foster ... an attention to the deeply complex and dynamic, subtle, maybe sometimes not so subtle, but difficult to otherwise understand, measure, track, analyze, and interpret biophysical reality that's taking place in ecosystems and agroecosystems. [These tools would] allow for us to move towards a more complex and dynamic management.

Along these lines, there was notable agreement around one particular tool, commonly mentioned by both agroecologists and engineers: an affordable nitrogen sensor. Described as "poison to the planet" by one agroecologist, nitrogen from conventional fertilizers used in industrial agriculture has led to severe groundwater and soil contamination, posing health risks to both humans and the environment. As such, both engineers and agroecologists agreed that a low-cost sensor to test soil nitrogen levels would be an important and unique contribution to diversified agriculture.

Although social scientists did not generally weigh in on the question of what technologies might be useful, they did have views on ag-tech more generally. Some social scientists mentioned that in order for a technology to be useful to agricultural communities, it should be "hackable" and "enable farmers or rural communities to co-design, fix, and repair their tech, which would be much more aligned with the principles of sovereignty." Another said that hacking as a principle "has the potential to "blur the lines between science, art, and social justice." Though open to the potential of a hackable technology, the prior social scientist still strongly cautioned against technology as any sort of solution.

If you have a dominant food system that today structurally produces food insecurity through surplus production, creates environmental harm. If there is race, class, and gender exploitation throughout the system, and then you throw a technology into it, very likely, you have a force multiplier effect. That encapsulates my reservations and concerns. If we are not focused primarily on the systems that produce these injustices and these exploitations technology itself doesn't pivot those around right, it may work in favor of a system that is much more intentionally constructed and designed to redistribute and reduce inequalities, but by itself thrown into that mix, it tends to be disciplined by the system and to exacerbate those inequalities.

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Partners and beneficiaries

All agreed that for the initiative to be successful, outside partners would need to be involved. Who those partners might be and how they should influence the distribution of ag-tech to broader publics, though, greatly differed and impacted who was conceived of as the initiative's potential beneficiaries. Engineers were generally interested in working on ag-tech related projects as a way to advance and expand their research. For them, that entailed developing industry partnerships, with the possibility of patenting a technology or even obtaining funding for a campus ag-tech facility. Engineers thus assumed the natural progression of an ag-tech initiative would be to partner with incumbent industries in Silicon and/or Salinas Valley. As one engineer said, "You have to engage with industry to be relevant." Some agroecologists acknowledged the issue, noting that larger partners can take on a lot of the risk that comes with developing a new technology, risks smaller operations often cannot afford.

Most agroecologists, however, expressed discomfort with industry partnerships. Often assuming that the ag-tech initiative was propelled by "the Chancellor's interest in potential funding and research partnerships with Silicon Valley," they questioned the presumption that the initiative could simultaneously engage with or serve the small or diversified farmers that have been CASFS's historic clientele. Agroecologists were particularly concerned that the "drive for innovation" was too tied "to privatization and profit." Most emphatically, they felt that any ag-tech developed at the university should be publicly owned and made widely available, not subject to intellectual property right protections that industry often seeks. One agroecologist connected their perspective to UCSC's standing as a public university saying,

> *There's a huge push in the university to patent so that the university can benefit economically. And to what extent will that get in the way of sort of creating more sort of scale neutral, low-cost approaches? I don't think that's appropriate for a public university. I think we're meant to provide information free of charge. But I know that's not a philosophy that holds anymore in the current funding situation for the university.*

Tensions around industry partnerships were perhaps best indicated in varied levels of knowledge and buy-in regarding development of the MBEST facility. Engineers largely supported the idea of turning MBEST into a research park based on a P3 model, or public-private partnering model. As one pointed out, the area's designation as an "opportunity zone," would additionally provide "tax benefits for investment development investment in that area." Engineers were particularly interested in the fundraising and research potential presented by MBEST, with some already seeking funding to help link ag-tech to its development. One shared that corporations such as Driscoll's had already been contacted and had expressed interest in a potential ag-tech partnership with UCSC, which, according to the engineer, could be "mutually beneficial." Providing a somewhat different justification, one social scientist, who argued that industry partnerships could support research that has socially just applications, highlighted the economic development possibilities presented by MBEST's partners and the potential to "center racial justice" depending on who the partners are.

You have to engage with industry to be relevant.

A contrasting opinion was shared by an agroecologist who stated that "the whole goal is to do this so that it can be done by the people, not by the giant industrial corporations." Other social scientists corroborated agroecologists' concerns about partnering with large incumbent corporations as a way to obtain funding. As put by one,

Is this meant to bring in money? Or is this meant to do to spend money to create research? Are we just going to become Monsanto's little playground? That's where the big social justice question comes in. Half the campus is going to go up in flames if we sign a partnership with Monsanto.

Social scientists more generally raised concerns about the beneficiaries of any developments in the ag-tech realm. One recalled a conversation where UC Davis was frequently mentioned, which made them question whether the intent of UCSC's initiative was to compete with such a large ag school, saying,

I'm not sure whether the interest is having more purchase or buy in or legitimacy with kind of the large-scale growers. That's going to be a very different framework starting point than if we were specifically and intentionally going out to support farmers of color and marginalized communities. Those are very important questions. Who are we talking about?

In this vein, more than one social scientist mentioned UC's development of a mechanical tomato harvester in the 1960's which catalyzed a near ten-year legal battle between farm workers and small farmers who argued such a device puts them out of work. In 1987, a judge ruled that small farmers (though not necessarily farmworkers) must benefit from UC research moving forward and implemented a review process to ensure it. Two years later, though, this ruling was overturned based on UC's appeal which argued that only scientific merit – not size of farm – should be considered to determine research projects. In reversing the initial decision, the court claimed that the 1887 Hatch Act says nothing about prioritizing small farms in funding. A social scientist summed up the court decision by saying that, "in fact, you can use public money to displace workers," adding that the suit "highlights the point that for many people, new tech or ag-tech is a threat."

Questions of Scale

The issue of scale has dogged ag-tech more generally and it was no less the case here, as participants expressed diverging (and somewhat conflated) views both of whether technologies could be scaled up to reach wide markets and whether they would be scale neutral in regard to farm size. Regarding the objective of the ag-tech initiative in terms of farm scale, one engineer said, "To me, it's a question of scale," which they elaborated upon by saying,

Who gets into sustainable ag? I think there's the real and there's the ideal. This comes with the notion of what it looks like and feels like, and then there's the issue of scale. It's one thing to have a little patch of lettuce in my backyard, and it's another thing to need to feed the world... For the UCSC ag-tech thing, there needs to be a clearer vision of the intervention.

Other engineers emphasized the imperative of scaling-up markets in order for developers and funders to make a return on investment. After acknowledging the shared goal of producing cheap and accessible ag-tech, one engineer noted the distinction between "the research side of

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It's one thing to have a little patch of lettuce in my backyard, and it's another thing to need to feed the world.

technology" and those "who need to make it and, in order to make it, they need to make money out of it." Connecting the imperative to make a return with the need to work with larger scale growers, this engineer said it would be difficult to produce a small scale or scale neutral ag-tech application because "the market is cruel." Agroecologists were clearly cognizant of these issues, but for them these market concerns were another basis for reticence. One recounted another, similar project in which they were involved that had begun with intentions to develop an accessible, scale neutral technology. They said,

In the second or third conversation, they're talking about, what's the scale? What's the price point? How are our numbers going to add up? And as soon as you're in that conversation, it's going to direct the technology in a certain direction... because as soon as you rely on these things that aren't in some ways indigenous to the area, there's going to be that power exchange.

In these discussions, questions of scale were also expressed in terms of the potential applicability of any given technology. One engineer noted that the discipline takes a "universalized" approach to application of technologies, expanded upon by commenting that "context rarely matters." In contrast, for the agroecologists, context, or what each of them called agroecology's "place-based" nature, was an essential part of their practice. For them, a place-based approach meant attuning practices to farming locations, or adhering to "both the biophysical complexities, but also the socio-economic complexities" of a particular location. As put by one agroecologist:

When we're talking about agroecology, we're talking about deep place-based knowledge systems. They're very specific place to place. I'm not sure how that reconciles with ag-tech. If you pick up this technology and put it in another place in the country or another place in the world, how will that enhance it? Or how will it be difficult to integrate?

Social scientists were intrigued by the initiative's proposal to create scale neutral ag-tech, as well, and at least one was explicit in their skepticism of the ability of any ag-tech to be scale neutral, regardless of intention. For several social scientists, the initiative was not taking seriously the well-documented histories of ag-tech that have demonstrated the perils of promised scale neutrality. One referred to the legacies of the Green Revolution, in which promises of scale neutral seed technologies actually required chemically-intensive, mechanized approaches to farming that resulted in the displacement of many peasant farmers. For social scientists of food and agriculture, the Green Revolution represents an inflection point whose history bears heeding. As put by this same person:

One of the prominent discourses surrounding [Green Revolution technologies] was that they would equally benefit large farmers and small farmers. Because [the] technology is scale neutral, all you need is for a USAID to go and disseminate these around the world... Henry Bernstein later on, wrote about this, and he was like, 'scale neutrality does not mean resource neutrality.' Compared to the small farmers, larger scale, wealthier, better capitalized farmers... risked less than adopting the seeds had more access to irrigation, and had more access to farm credit.

Nature of the Collaboration

This set of findings details the experiences of agroecologists, social scientists, and engineers within ag-tech initiative discussions, as well as some of their concerns and hopes for meaningful collaboration.

Asymmetrical and ad-hoc involvement

One area in which there was significant agreement was the opacity in which various campus constituents were invited into campus ag-tech discussions. Agroecologists and engineers both noted that they had been asked by administrators, yet as mentioned earlier, initially no social scientists were asked to participate. Moreover, virtually all who eventually were brought in stated that they neither generated nor sought out the collaboration on their own, leading each group to communicate a sense that the initiative – despite being a collection of faculty – was not faculty driven.

In describing the nature of the collaboration, agroecologists used descriptors such as “ad-hoc,” “slapped together” and a “forced marriage.” An engineer said they “just happened to be in the same room” with people involved in ag-tech discussions and was invited to join from there. For their part, most social scientists felt largely left out of the ag-tech conversation, and even confused by it. One said that when they joined one ag-tech conversation, thinking it was still in the very early stages, they were struck by people asking questions of dissemination before a technology had even been developed or a partner community identified, saying, “I feel like we're at step ten. And we forgot steps one through nine.” For another social scientist, the

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top-down or “pre-determined” nature of the initiative was concerning for its future direction. They stated,

I worry about initiatives like this one. It's just creating a solutions-based approach, as opposed to actually opening up and even questioning what are the right problems or questions that we need to be asking.

Across all groups, many also expressed concern about the lack of participation from communities outside the campus. Multiple agroecologists mentioned that few, if any, practicing farmers and agroecologists, or “stakeholders” had been invited to the ag-tech discussions, though they also expressed reservation about the ways in which they are typically asked to engage. One agroecologist shared that they get approached from people from Silicon Valley frequently, saying,

There's always a couple a year. I'm like, look, if you're gonna take eight hours of my time and then disappear, which is almost always what happens... Tell me what I get out of this. They come in, and they flitter out.

An engineer also noted the importance of off-campus community connections, yet expressed the difficulty of cultivating such relationships, saying, “Connecting with the community is not easy... There

are times when I'm like 'Oh, I'm ready to offer my help and services.' And I don't even know where to start." However, this engineer expressed the importance of such a process in order to produce relevant ag-tech, stating,

It's easy to get caught up in the theory and the equations for just for the sake of it, with no real applications and no real interest from other communities, right? So we can pretend that we're solving equations that people in agriculture care about. But the reality is unless we communicate directly with them, we won't really know what is relevant.

Social scientists joined the chorus of those calling for the need to engage communities in advance of developing technologies. At least one advocated for inviting small farmers and community members whom the initiative may impact to be included, yet as cautioned by another, this had to be more than performative. Referring to the often used metaphor of having a seat at the table, they said, "I don't want to have a seat at the table, I want to decide if we want a table at all, what materials we're going to use, what is the design and structure of this table? Or do we want to chop it up and build a fire?"

Funding Differences

Another area of agreement was that divisional funding is uneven at UCSC, although such agreement does not of course ameliorate the tensions that arise from these differences. There was a general sense among agroecologists that their work, practice, and research was "resource-limited" and noted the opportunities that often accompany interdisciplinary STEM partnerships. As such, some agroecologists felt compelled to join the ag-tech initiative despite their concern that "high-tech" ag-tech has not been a central feature of their work. Without such opportunities, even though not ideal, "we have no money," as one agroecologist said. Another described a hierarchical campus dynamic of "political and social capital" that did not favor agroecologists. Some agroecologists even expressed resentment toward the initiative, stating they would rather work on their own research projects.

Engineers expressed less concern about funding, with some describing various channels through which they had direct access to funding and support, notably from the Office of Research. That said, many shared the concerns of agroecologists that they were spread thin between the ag-tech initiative and their own research projects. Moreover, engineers recognized that funding disparities between departments could dampen collaboration. One engineer said of the funding dynamics between departments, "There's just so many reasons it becomes politically challenging for true interdisciplinary work to happen," and went on to note that while certain on and off-campus funding bodies are trying to promote this type of collaboration, UCSC's funding infrastructure itself presents multiple barriers to meaningful interdisciplinarity.

Social scientists felt particularly frustrated with campus funding mechanisms, with one expressing that the campus "de-prioritized" the funding of their work. This person described an instance where they applied for a large, prestigious grant and advanced to the next round of review, only to have campus administrators choose to move forward with another, more lucrative project. This social scientist also described the prioritization of engineering projects on campus, saying, "If anything goes through

So we can pretend that we're solving equations that people in agriculture care about. But the reality is unless we communicate directly with them, we won't really know what is relevant.

campus, unless it comes out of the school of engineering, it gets dinged." They further noted that while funding models are indeed different in different disciplines, funding norms favor STEM projects because they are so expansive, often supporting primary investigators, graduate student researchers, travel expenses, and so on. On the other hand, social science grants "look puny compared to other disciplines because it's not funding my salary, it's just funding my research."

Insufficient funding for social science research also affects faculty ability to participate in such collaborations. One described their experience with campus funding discrepancies and made specific note that insufficient financial support affects their bandwidth and the number of projects they pursue:

There's always challenges. A lot of it is me being the fundraiser, me being the facilitator... I'm the one making the website, I became the director... It also means we would only be able to do two to three projects a year, so it keeps it small. This is what I can handle until the administration wants to give me more.

Agreement on the Need for Sustained Communication

Despite the many differences, there was one final unifying theme among all involved. All agreed that sustained conversation and engagement are needed for the ag-tech initiative to be successful. An engineer noted that the pandemic should not be an excuse to avoid such conversations, especially since the groups involved had seldom worked together previously. An agroecologist discussed the necessity of coming together to discuss what people in both parties described as "communication differences" stemming from different disciplinary norms. Social scientists were particularly animated in arguing for a robust conversation before moving forward.

There was also agreement that these conversations might not be easy, especially because of their interdisciplinary nature and because they had not interacted with each other much previously. Yet, all parties willingly offered ideas to address such challenges. Agroecologists expressed interest in meeting with engineers to have a conversation about goals and needs, with multiple people referring to the potential for fruitful collaboration if such meetings took place on a regular basis. One engineer, noting that everyone involved in the initiative is busy, expressed a desire for "a physical place to develop these communities, so we're forced to take time away to focus all our attention on [this] topic." In a similar way, one agroecologist said that while conferences are helpful at starting conversations, a seminar for both graduate students and faculty led by "a number of different instructors" could be a sustained way to expose each group to the others' research. Another agroecologist suggested their desire "to start from scratch about what we want the impact of this technology to be," beyond the "nitty gritty" questions like the value of technology.

Social scientists concurred, offering a few ideas as to what might generate such discussions. One said that a third party could convene a gathering and "work with communities to have a co-created space where the people are designing the agenda, deciding who is participating, and setting the rules of who speaks." Another shared an idea of a weekly seminar series with people from "different disciplines and different kind of places within and outside of academia – and not just from UC Santa Cruz." This person went on to describe a fruitful experience with such a convening, saying,

The conversations were generous of spirit and generous intellectually. I think some of those conversations naturally generated research questions and collaborations. It was... an intellectual space for people to come and talk and meet each other and learn more about each other's work, I think the one important thing to allow those ideas to emerge generatively.

CONCLUSION AND STEPS FORWARD

This report does not paint a glossy picture of the current ag-tech initiative in the making. Despite great enthusiasm from campus administration, the development office, some engineers and a few others, most interviewees voiced significant skepticism that such an initiative can successfully build on and combine distinctive campus strengths in agroecology, engineering, and an overarching commitment to social justice. Our interviews reveal great differences in how faculty and staff in different fields approach their research and address problems, collaborate in interdisciplinary teams, and incorporate social justice into their work. They also show significant divergence in appreciation of the utility of ag-tech for agricultural problem-solving, ideas of who should be involved in the initiative and who it should benefit, and whether ag-tech can meet the needs of small-scale farmers. Finally, they reveal that many points of agreement are actually sources of tension regarding who has been summoned to participate, the uneven funding support that both incentivizes but also makes for resentful participation, and the ability to create "bandwidth" to participate.

This is not to say there were not glimmers of possible coalescence expressed in our interviews. Participants from all three groups hinted that ag-tech specifically aimed towards the needs of small-scale, low-resourced growers that practice agroecological techniques might provide a source of synergy. Engineers might be excited by the challenge of problem-solving in a domain that values multi-species complexity, agroecologists might welcome use of the farm to collaborate on designing and experimenting with new tools as long as they do not undercut their historic clientele, and social scientists might be satisfied that technologies geared toward ends other than productivity and efficiency would avoid some mistakes of the past. That these synergies are tentative and only partially address significant tensions only goes to show a larger point: that we need to talk.

For us and others, beginning that conversation was the original purpose for holding a cross-campus symposium on ag-tech, first suggested by author Guthman and enthusiastically endorsed by the social science dean. With its ties to the Public Interest Technology program and, hence, connections to the engineering school, the social science division's Institute for Social Transformation (IST) appeared to be the logical organizing body. IST thus took the lead in organizing the symposium, and convened a committee representing all three fields to plan it, with Guthman as the social science lead. After much deliberation, the committee settled on a format in which all interested faculty and graduate students would give 4-minute lightening talks. These talks would be followed by break-out groups that focused on questions regarding areas that attendees would be interested in

pursuing, areas of strength in ag-tech that are worth supporting or building upon, and valuable next steps in developing more ag-tech work at UCSC.

Despite its forward-looking and practical approach, the event, held in April 2021, corroborated many of the findings discussed in this report; that we are not (yet) all on the same page. The lightening talks further highlighted fairly disparate understandings of what ag-tech could be at UCSC, with some presenters showcasing their work on autonomous vehicles, others discussing the utility of a bee hotel, some promoting their particular facility or program, and still others hinting at the potential for unintended consequences. The break-out discussions that followed (held in Zoom, recorded in Google docs) were even more telling, possibly precipitated by the final two presentations: Sullivan's report of our preliminary findings and a coordinated presentation by four agroecologists. Beginning their presentation with a "cautionary tale" of the UC mechanical tomato harvester, they shared a quote from its lawsuit: "Not a penny was spent to study the implications of mechanization on jobs, on farm sizes, on prices, on the environment."

During these break-out sessions, some attendees expressed excitement about the initiative and followed the session prompts; however, many strayed from them and expressed that the symposium's proceedings exemplified the need for further reflection and dialogue. Perhaps the most instructive indication came from some engineering attendees noting that they had not previously thought of the social justice implications of their work. Others were struck by the lack of local, off-campus stakeholders who might have much to say about the development of such an initiative. In other words, the event not only highlighted disciplinary siloes; it affirmed the sense that we are getting ahead of ourselves. It further made clear the need for a larger effort to pull people together – from both on and off campus – for sustained, iterative, and respectful conversation about the future of ag-tech at UCSC in order to achieve meaningful buy-in and collaboration.

As engaged social scientists, with ethical and intellectual investments in both the process and the outcome of this initiative, we agree with the views of most other social scientists interviewed – for example that we must pay attention to the unintended consequences of ag-tech past and future, be conscious and reflexive of who and what we intend to serve, and that social scientists should not be tokenized or dismissed as overly critical, but valued for the insights they bring. **Indeed we hold that pursuing this initiative without fully attending to these concerns risks chipping further away at UCSC's reputation as an alternative and socially engaged institution, and thus ironically dispensing with our singular competitive edge in this domain relative to the many other universities in the US with long histories in ag-tech.**

We thus strongly suggest that moving forward we, as a campus community, heed the principles of responsible innovation discussed at the outset of this report: we **anticipate** and examine the considerations being made about ag-tech and its impacts, we **reflect** on how those driving the initiative situate themselves and their work, we aim for **inclusion** in discussions and decision making, and we are deliberate and **responsive** to the challenges that come before us.

Indeed we hold that pursuing this initiative without fully attending to these concerns risks chipping further away at UCSC's reputation as an alternative and socially engaged institution...

For if the goals are indeed to create an ag-tech program uniquely committed to developing a socially just form of ag-tech, then it is imperative to invite all relevant parties and, ideally, broader publics, into meaningful and equitable dialogue where concerns, questions, goals, and ideals are evaluated and valued in a symmetrical manner. Our goal, in other words, shared by nearly all interviewees, is to provoke a robust, ongoing, real-time campus conversation – that, to borrow on a metaphor, assesses how the train is loaded and where it is going before it leaves the station.

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