

# UC Santa Cruz

## UC Santa Cruz Previously Published Works

### Title

The incumbent advantage: corporate power in agri-food tech

### Permalink

<https://escholarship.org/uc/item/37z9s1xr>

### Authors

Fairbairn, Madeleine

Reisman, Emily

### Publication Date

2024-02-06

### DOI

10.1080/03066150.2024.2310146

### Copyright Information

This work is made available under the terms of a Creative Commons Attribution-NonCommercial-NoDerivatives License, available at <https://creativecommons.org/licenses/by-nc-nd/4.0/>

Peer reviewed

## The incumbent advantage: corporate power in agri-food tech

Madeleine Fairbairn & Emily Reisman

To cite this article: Madeleine Fairbairn & Emily Reisman (06 Feb 2024): The incumbent advantage: corporate power in agri-food tech, The Journal of Peasant Studies, DOI: [10.1080/03066150.2024.2310146](https://doi.org/10.1080/03066150.2024.2310146)

To link to this article: <https://doi.org/10.1080/03066150.2024.2310146>



© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group



Published online: 06 Feb 2024.



Submit your article to this journal [↗](#)



View related articles [↗](#)



View Crossmark data [↗](#)

# The incumbent advantage: corporate power in agri-food tech

Madeleine Fairbairn <sup>a</sup> and Emily Reisman <sup>b</sup>

<sup>a</sup>Department of Environmental Studies, University of California, Santa Cruz, CA, USA; <sup>b</sup>Department of Environment and Sustainability, University at Buffalo, Buffalo, NY, USA

## ABSTRACT

The agri-food tech sector is touted for its potential to disrupt established industry. Yet research reveals that incumbent agribusinesses are buying their way into the sector through startup investments and acquisitions. Drawing from extensive qualitative research, we show that incumbent influence also shapes agri-food tech in more subtle and pervasive ways. Startups rely on incumbents' social and material infrastructure to achieve the rapid growth demanded by their venture capital funders. Incumbent influence, we argue, is ambient, continuous, and frequently indirect. It saturates the spaces where malleable startups take shape, influencing even those with whom incumbents have no direct contact.

## KEYWORDS

Corporate power; incumbent firms; agri-food tech; venture capital; entrepreneurship; political economy of agriculture

## Introduction

Over the past decade Silicon Valley has turned its attention to food and agriculture, introducing a torrent of novel technologies that promise to deliver a 'fourth agricultural revolution' (Rose and Chilvers 2018). Spanning the value chain, from artificial intelligence and robotics on the farm to platforms mediating food trade and retail to novel foods such as insect protein and cultured meat, the agri-food tech sector is unified less by a specific technology than by a style of innovation adopted from Silicon Valley's software industry. The speed and scale which characterize venture-capital backed technology, promoters argue, can accelerate change in a sector they represent as inefficient, unsustainable, and stubbornly slow-moving (Sippel and Dolinga 2023). The ambitions of agri-food startup founders and their allies are often framed in contrast to an unsustainable and unhealthy status quo that they aim to 'disrupt' or even 'revolutionize' (Leclerc 2016). But this raises a question: what role is there within agri-food tech for the established firms that currently structure and profit from that status quo?

A robust body of critical agri-food research reveals that, in fact, such established firms – which we will refer to as industry 'incumbents'<sup>1</sup> – often absorb the very upstart startups

**CONTACT** Madeleine Fairbairn  mfairbai@ucsc.edu  Department of Environmental Studies, University of California, 1156 High St., Santa Cruz, CA 95064, USA

<sup>1</sup>An incumbent firm, in this context, is a well-established company that numbers among the largest and most influential in its sector. These types of firms are referred to in the scholarly literature and by our research participants by several

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

that threaten to disrupt them. Critical agri-food scholars have chronicled a decades-long process of corporate concentration among transnational agribusinesses, in which, through successive rounds of horizontal and vertical integration, a handful of oligopolistic firms have achieved market dominance across multiple agri-food subsectors (Clapp 2018; 2023; Heffernan 2000; Hendrickson 2015; Howard 2016). Extending this tradition, researchers have recently mapped consolidation in the alternative protein sector, which includes companies that derive protein from plants, fungi, and insects, as well as cellular agriculture companies that produce lab-grown meat and milk from cultured animal cells. This research reveals that incumbent meat companies are rapidly acquiring, investing in, or partnering with the startups pursuing a meat-free future for protein (Howard et al. 2021). Studies of digital agriculture – which refers broadly to approaches that make extensive use of digital data in farm management – likewise show that the biggest seed-chemical and machinery firms are aggressively acquiring digital ag startups (Bronson and Sengers 2022). These studies suggest that incumbents, in their pursuit of fresh revenue streams and sustained market dominance, may stymie the disruptive ambitions of agri-food tech, further entrenching an agri-food system as unsustainable as it is unjust.

Yet this existing scholarship tends to place an overriding emphasis on acquisitions and investments – those discreet and generally publicly reported moments in which incumbents gain an ownership share in a startup – while overlooking more subtle mechanisms of incumbent influence. Our four-year study engaging closely with the agri-food tech entrepreneurial community of Silicon Valley during its meteoric rise<sup>2</sup> shows that incumbent influence actually begins much sooner and is far more prevalent than generally described. Incumbents, we argue, do not simply acquire, appropriate, or coopt fully formed agri-food technologies. Instead, they are an integral part of the agri-food tech firmament within which startups are formed. Our analysis draws from economic sociology and geography scholarship which describes startups as highly malleable works-in-progress, shaped and re-shaped by their many encounters (Doganova and Eyquem-Renault 2009; Doganova and Muniesa 2015; Heimstädt 2023). While this scholarship has tended to emphasize the formative influence of venture capital (VC) (Cooiman 2022; Goldstein 2018), we show that, within agri-food tech at least, incumbent corporations are an equally influential force, operating in tandem with VC.

After reviewing relevant scholarship and detailing our research methods, we begin by examining *why* these relationships are frequently sought out by both incumbents and startups. For incumbents, startups can deliver access to the kind of innovative ideas and technologies that they have difficulty generating in-house. For startups, incumbents serve as crucial gatekeepers to the physical and human infrastructure of food and

---

terms, including 'established firms,' 'incumbent firms,' 'corporates,' and 'strategics.' We primarily use the term 'incumbent' because it captures the tensions surrounding anticipated change and challenges to power as new businesses vie for market share. As with elections, the incumbent is understood to hold significant advantages over its less established competitors. Yet over the past decade, the entrepreneurial agility of 'disruptive' technology companies has also recast incumbent size and longevity as a potential source of vulnerability. Though agri-food tech has also attracted computer technology incumbents such as Microsoft, IBM, and Google, particularly in the realm of data infrastructure services, here we focus on incumbents within the agri-food industries, such as farm input suppliers, grain traders, and food processors. This focus reflects the preoccupations of our interlocutors, whose pitches, interviews, and informal conversation frequently recurred to issues surrounding these dominant agri-food supply chain actors.

<sup>2</sup>The agri-food tech sector attracted over \$51 billion in venture capital in 2021, up from just \$2–3 billion in 2012–2013 according to prominent industry research and investment group AgFunder (2022).

agriculture, including manufacturing facilities, product-specific knowledge, distribution channels, and customer relationships. The unique material and social characteristics of food and agriculture, which agrarian political economists have long argued act as barriers to capitalist accumulation (Mann and Dickinson 1978), here have the effect of driving startups toward partnership with established firms. This effect is magnified by VCs, whose pursuit of rapid growth and a definite exit frequently lead them to encourage the startups they fund to seek out incumbent partnerships. We then explore *how* incumbents pervade the agri-food tech sector, shaping startups throughout their existence. Incumbent influence, we argue, is ambient (permeating the spaces where startups take shape), it is continuous (affecting the startup throughout its life, not just at discrete moments), and it is frequently indirect (exercised via discourses and expectations that affect even those with no direct relationships to incumbents). We illustrate these themes with three examples: how incumbent perspectives suffuse industry conferences, how business development programs groom startups to serve the needs of incumbent clients, and how startups anticipate and configure themselves for a prospective incumbent acquisition that may never come. Incumbent influence, however, is also not absolute. We conclude the paper by discussing arenas in which incumbents appear to exercise far less influence, suggesting opportunities for advancing more truly disruptive possibilities.

## Literature review

### *Incumbent power in food and agriculture*

Scholars working in critical agri-food studies have been writing about the forms and consequences of corporate power for decades. One prominent theoretical vein within the political economy of agriculture explores how technological change has facilitated the ever-incomplete capitalist transformation of agriculture. Agriculture presents unique social and material difficulties not present in other industries: seasonal production creates labor challenges, fragmented land ownership hinders scalability, a perishable final product makes storage and distribution a nightmare, etc. (Kautsky 1988; Mann and Dickinson 1978). Due to these challenges, scholars have argued, corporations have tended to avoid engaging in farming itself, yet they have nonetheless managed to appropriate a greater and greater share of profits both upstream and downstream of the farm by relocating production to the lab or factory where it can be more easily controlled (Goodman, Sorj, and Wilkinson 1987). This process has been enabled, in the US, by the extension of intellectual property protection to plants (Kloppenborg 2004) and by a shifting of university research from the public interest towards partnerships with industry in pursuit of commercializable discoveries for private profit (Buttel 2005; Glenna et al. 2007; Welsh et al. 2008).

Food and agriculture have also seen rampant corporate consolidation. In the US, during the final decades of the twentieth century, horizontal integration allowed a shrinking number of companies to gain oligopolistic control over key industries at ever-expanding geographic scales. Meanwhile, many of the same corporations also engaged in vertical integration, using strategic acquisitions to achieve control over multiple different nodes of a value chain (Heffernan 2000). This concentrated corporate control has fostered a global food system which is environmentally harmful, susceptible to crises, and riven

by stark power inequalities (Clapp 2018; 2023). Scholars have quantified the increasing market share of top agribusiness companies through metrics such as the C4 index (Hendrickson 2015) and have produced graphics that visually represent how these companies have absorbed the competition through successive rounds of mergers and acquisitions (Howard 2016).

These classic themes have been carried forward by a new wave of critical agri-food scholarship that takes the novel technologies of ‘agriculture 4.0’ as its object of study (Klerkx, Jakku, and Labarthe 2019). This scholarship largely reaffirms the tendency for incumbents to dominate emerging fields of innovation. The technologies associated with digitized ‘smart farming,’ for example, are in many ways following the same trajectory of oligopolistic intensification established by past technological shifts (Bronson and Sengers 2022; Miles 2019; Rotz et al. 2019; Wolf and Wood 1997), often using similar legal strategies (Carbonell 2016; Carolan 2017) and sustaining the dominance of the very same firms (Bronson and Sengers 2022). The livestock sector has drawn particular scrutiny, as incumbents such as Tyson, Cargill and Purdue have made prominent acquisitions and investments in cellular agriculture technologies, buying their way onto the cutting edge of technological change (Guthman et al. 2022; Howard et al. 2021; Stephens, Sexton, and Driessen 2019).

While rich and insightful, the existing scholarship on incumbent power in agri-food tech has tended to emphasize bounded and quantifiable moments of corporate influence, overlooking the extent and subtlety of its forms. One important exception is Heimstädt (2023), who shows how, through a process of ‘exploratory assetization,’ an agtech startup transitioned by degrees to serving the needs of the established agricultural industry. For the most part, however, incumbents feature in critical agri-food scholarship as appropriating or acquiring entities which unilaterally coopt novel agri-food innovations. We argue, in contrast, that they should be viewed as already deeply enmeshed in the agri-food tech sector, part of mutualistic relationships with startups which rely on them for a host of tangible and intangible resources and are transformed in fundamental ways through their interactions. This perspective is informed by scholarship within economic sociology and geography, as well as business studies, on the role of startups in technological innovation.

### ***The malleable startup***

Scholars of US industry have, for decades, documented the changing relationships between incumbent firms and technology startups when it comes to innovation. For much of the twentieth century – and particularly the decades following WWII – industrial R&D took place primarily in-house at large corporations. Corporations tended to be highly vertically integrated and they aspired to high levels of self-sufficiency across all stages of product development, including commercializing products that came from their own laboratories and financing that research internally through their own retained profits (Block and Keller 2009). Starting around the 1980s, however, there was a shift in the locus of technological innovation. Innovation in many industries became more collaborative and diffuse, emerging from resource and idea exchange across complex collaborative networks (Block and Keller 2009; Mowery 2009; Pisano 2010), often geographically clustered in innovation hotspots such as Silicon Valley (Saxenian 1991).

Many entities participate in these innovation networks, held together by non-market social ties as well as formal contracts, and each bringing different resources to the innovation process (Ferrary and Granovetter 2009). Here we mention only the most prominent of these entities. *Startups* have some kind of innovative discovery or technology but lack the financing, entrepreneurial know-how, and business connections to commercialize it (Spender et al. 2017). *Venture capital (VC) firms* provide startups with capital, as well as intangible resources including entrepreneurial guidance and access to social networks (Ferrary and Granovetter 2009) in the hopes of gaining a five to ten times return on their initial investment but knowing that many startups will fail to produce any return at all (Hogarth 2017). *Incubators and accelerators* foster startups by providing them with space, contacts, training, and other resources, sometimes in exchange for an equity stake in the startup (Cohen 2013). *University researchers* may participate in research collaborations or spin off their research into new startups, often with assistance from their institutions, many of which are embracing the role of ‘entrepreneurial university’ and taking on incubator- or VC-like activities (Glenna et al. 2007; Welsh et al. 2008). Large *incumbent firms* may fund, acquire, collaborate with, contract with, or license technology from startups and university researchers in an effort to maintain their competitive edge in a rapidly changing industry (Steiber and Alänge 2021; Weiblen and Chesbrough 2015). Sometimes they actively cultivate startup partnerships by founding *corporate venture capital (CVC) firms*, which make equity investments in startups that not only have the potential to be profitable but also to further the incumbent parent company’s strategic goals (Dushnitsky and Lenox 2005). In fact, a whole industry has grown up around the need to broker encounters between these various network actors, including through the maintenance of industry databases and the hosting of industry conferences (Doganova and Muniesa 2015).

Importantly, startups are not just embedded within innovation networks, they are shaped and reshaped by those networks over time. One well known definition of a startup is as ‘a temporary organization designed to search for a repeatable and scalable business model’ (Blank 2013, 5). With a deep uncertainty about the often-nascent markets they wish to capture, no past experiences to extrapolate from, and few resources to waste, startups must experiment, learn, and adapt rapidly and repeatedly. Rather than knowing in advance what kind of company they wish to create, startup founders engage in an iterative, trial-and-error process of ‘effectuation’ (Sarasvathy 2001) or ‘entrepreneurial bricolage’ (Baker and Nelson 2005), in which they experiment with different business models while gradually assembling the customer base and network of strategic partners needed for success. This conceptualization within the business management literature was paralleled by the popularization of the ‘lean startup’ methodology among entrepreneurs (Bortolini et al. 2018). Economic sociologists, meanwhile, have explored the evolution of startups as a performative process of assemblage, in which the ever-changing business model serves as a key ‘market device’ for enrolling prospective allies. With each successive encounter, the startup and its technology is tested and transformed until it has settled on the form and assembled the network of allies needed for success (Doganova and Eyquem-Renault 2009; Doganova and Muniesa 2015).

Work within economic sociology and geography has tended to emphasize the formative role of venture capital in shaping startups and their products. In his exploration of the cleantech sector, Goldstein compares the shaping of entrepreneurs by investor capital to

the training of dressage horses. Venture capitalists, he argues, ‘*break the entrepreneurs in, bend them, teach them to be bent, to follow rules, to run at the pace and along the path of an investor-sanctioned commercialization model*’ (Goldstein 2018, p. 73, original emphasis). For Goldstein, venture capital influence over startups is important because it trains their immense innovative capacity toward the production of ‘non-disruptive disruption’ via products which produce reliable investor returns but not systemic transformation. Importantly, the pressure to conform to investor expectations is frequently internalized and anticipatory (Doganova and Muniesa 2015). In particular, scholars have argued, venture capital revolves around a logic of ‘assetization’ in which the startup and its products are valued primarily for their ability to produce a reliable stream of revenue into the future (Birch 2017; Cooman 2022; Doganova and Muniesa 2015; Heimstädt 2023). To make up for the massive risk of startup investing, VCs also demand short time horizons toward commercialization, the potential for rapid scalability, and limited technological risk (Cooman 2022; cf Goldstein 2018). The unique structural power of venture capital as key financial gatekeepers, Cooman (2022) argues, allows them to ‘imprint’ their logics of assetization and rapid growth upon the startups they fund. Startups hone stories about themselves – their future valuations and likely exits – that are calculated to appeal to the VC mode of valuation (Birch 2022), in the process performatively shaping themselves and their products.

Established corporations have received considerably less attention than venture capital in sociological studies of startup culture, perhaps in part due to the common belief that the most profitable startups are those which undermine or ‘disrupt’ these legacy institutions. However, work in strategic management and organization studies shows that, much like VCs, incumbents act as gatekeepers: to customers, to distribution networks, to manufacturing capacity, and many other ‘complementary assets’ (Teece 1986) without which startups stand little chance of exploiting their innovations. Yet the logics which incumbents imprint on startups will necessarily be somewhat different from those of venture capital. Guided by a desire to protect their existing market share or complement their current technological capacities, incumbent influence may be more likely to nudge startups toward conformity in the present, rather than disruptive reconfigurations for the future (see, for example, Polidoro Jr and Yang 2021).

Overall, scholarship from economic sociology and business studies suggests that incumbents and startups are not really fully separable. Multiply linked through dense innovation networks, the impact of incumbents on startups is likely to be diffuse, anticipatory, and internalized.

## Methods

This article draws from interviews and participant observation conducted as part of a four-year study of the Silicon Valley agri-food tech sector that launched in 2018. Unlike most social science studies of agri-food tech, this project does not focus on a particular technological subsector, such as cellular protein, digital agriculture, or confined environment agriculture. Instead, we examine the entire agri-food tech sector, a generalist approach mirroring that of quite a few investors, incubators, and other industry entities, which often work with startups across the food/agriculture continuum. Our research methods are qualitative, including interviews with industry actors and participant observation at



industry events. As such, we do not attempt to quantify or comprehensively describe incumbent acquisitions, investments, or joint ventures with agri-food tech. Instead, we examine how incumbent influence is experienced by other actors in the sector, unpacking a much wider array of processes by which established firms shape the practices and expectations of investors and entrepreneurs.

Our analysis draws on 77 interviews conducted by the research group (see Appendix 1) between August 2018 and February 2023 with interlocutors based in the San Francisco Bay Area of California, USA. Our interviews fell into four categories: first, entrepreneurs, including founders and other key executives of startups working in ag tech (e.g. field sensors, harvesting robots) and food tech (e.g. cellular meat, precision fermentation, supply chain, delivery) (39 interviews); second, investors, primarily venture capital and corporate venture capital (18 interviews), third, what we are calling intermediaries, which include leaders of agri-food tech incubator and accelerator programs, as well as think tanks, consulting firms, and non-profits focused on the sector (14 interviews), and fourth, industry experts who served as key informants on the sector as a whole (6 interviews). In reality, many research participants play multiple roles in the sector – an industry consultant may also have a sideline as an angel investor, or an agri-food focused VC may have founded a startup earlier in their career – in the text and appendix, however, we generally mention only their one or two most prominent roles in order to avoid inadvertently identifying them through over-specification. Because this study focused on dynamics within the Bay Area tech sector, we did not interview agribusiness incumbents themselves, but their prominent presentations at agri-food tech conferences in Silicon Valley provide a window into how they approach this emerging sector, as do the five interviews we conducted with incumbent-backed corporate venture capital (CVC) firms. Our analysis centers how entrepreneurs, investors and other sector participants describe, interpret, imagine, and respond to incumbents in their industry. By virtue of their political economic might, incumbents most often came up in conversations with interlocutors unprompted. All interviews were recorded and transcribed. The transcripts were thematically coded through an inductive and iterative process (Charmaz 2014) using the qualitative data analysis software Dedoose.

We also draw on participant observation at agri-food industry events. Between August 2018 and November 2021, our team attended over 80 events, including conferences, pitch nights webinars, and farm field trips, though for this article we draw primarily from the 14 events attended by the authors themselves. Like other scholars, we have found that such ‘event ethnography’ allows us to observe engagements between various actors within a scientific, industry or governance field (Brosius and Campbell 2010). Especially when a field is still just emerging, events provide a valuable opportunity to witness sector-defining activities as they take place, including the moments of contradiction or contestation that arise and how they are negotiated by event participants (Garud 2008).

### **Complementary assets: why incumbents and startups work together in agri-food tech**

Like other Silicon Valley sub-sectors (Geiger 2020; Hogarth 2017), agri-food tech has a fetish for narratives of disruption. In think tank reports (Sippel and Dolinga 2023) and

startup pitches (Fairbairn, Kish, and Guthman 2022) it presents itself as purveyor of the technological solutions necessary to transform an inefficient and unsustainable industry. While claiming disruptive potential may prove effective at attracting investors, the actual relationship between incumbent firms and startups looks more like mutual dependence: incumbents depend on startups as a source of external innovation, while startups rely on incumbents for access to crucial material and social infrastructure.

### ***'We need to be a part of it rather than being subjected to it': Why incumbents are driven towards startups***

Many industries are now characterized by a 'division of innovative labor' (Arora, Fosfuri, and Gambardella 2002, 7) in which large firms purchase or lease innovative discoveries from startups and universities, rather than seeking to develop them under their own rooves. The agri-food industry is no exception. Our interlocutors paint a picture of incumbent firms which, facing pressure from financial markets and technology-fueled competition from rivals, have come to rely on startups as a source of external innovation.

For publicly listed companies, short-term financial pressures can be a major impediment to internal innovation. The need to deliver shareholder value is often at odds with the time-scale of meaningful innovation (Lazonick 2007). Agri-food incumbents experience this shareholder pressure acutely, as one industry expert and angel investor explained:

Yeah, so the big strategics, most of which are publicly held, are very slow to innovate because they are responsive to the markets and they have to worry about short-term dividends, not long-term improvement, right? Like tomorrow, they have to figure out how they're going to pay out stockholders and make their stock increase a quarter point, not two years from now. (#77)

This financial pressure makes it very difficult for incumbent executives to pursue future-oriented approaches which won't pay off for several years to come. To illustrate this point, he gave the example of Campbell's, which, in his telling, 'canned' its former CEO – Denise Morrison – who was very forward-thinking and 'invested a ton in innovation,' because in the short-term it was more profitable for shareholders if the company doubled down on its existing portfolio of shelf-stable convenience-food brands, despite the fact that they no longer aligned well with consumer preferences (for a more mainstream account of these events see Buss 2018). For him and several others we interviewed, the expectation to produce shareholder value in the short term is also a prime impediment to progress on social and environmental issues within food and agriculture. As another industry expert and investor put it while describing the challenges faced by one plant-based foods company: 'capital markets have short-term, quarterly expectations. And until somebody breaks that cycle, I don't think we're going to have real food systems transformation' (#75).

Yet despite financial pressures that discourage long-term investment in innovation, large corporations must still innovate enough to stay ahead of the competition. Venture capitalists often described this in hyperbolic terms as a struggle to avoid obsolescence: 'it's existential for them' (#50), according to one, 'they're scared, they don't want to be disrupted' (#47), according to another. An agri-food tech consultant put it this way:

Big Ag companies, they're in a race to develop and commercialize new technologies and you just can't win that race by looking totally internally. Big companies, big public companies,

they have shareholders to report to. They have profits per share to think about. They're somewhat limited and restrained in just how far on a limb they can go with trying new ideas and new things. Startup companies don't have that problem. (#59)

As in other industries (Lazonick 2007), shareholder expectations shrink the possibilities for internal corporate innovation and make relationships with startups increasingly imperative. Yet, also like other industries, incumbents must acquire innovative technology to get a leg up on their competition, or as a hedge to prevent it from falling into the hands of their competitors where it might threaten their own market share (Birch 2017).

Stuck between the rock of public market pressure and the hard place of competition with other large firms, agri-food incumbents have become increasingly dependent on startups for the innovative technologies necessary to maintain their market dominance. The CVC executives we interviewed often framed their work as a critical intelligence gathering activity that helps the parent company maintain a competitive edge. A CVC executive with a food industry parent company described it as providing 'a window into what's going on, and how the space is evolving' with 'real value for the company,' (#43). An executive at a CVC firm with an agriculture industry parent company employed a different visual metaphor, describing it as a way to 'look around the corner at what's next' in order to bring that perspective back to the corporate business units. He concluded: 'We need to know what's going on. [...] We need to be part of it rather than being subjected to it' (#41). For one food company, the drive to participate in the emerging alternative protein space, was the very impetus for their corporate venture group, after determining they 'needed a way to start to access that food technology,' but had to be 'humble enough to realize that we can't do this all by ourselves internally' (#42). Incumbents must look to startups not only because they have the innovative ideas, but also the talent. As another agribusiness CVC executive explained, 'we have innovation centers within our company, but the reality is, it's hard to really compete with a lot of these startups (#44)' when they offer the possibility of enormous payouts to early employees. 'The best and brightest people in the industry have moved to startups,' he admitted.

### ***'A complicated industry to succeed in': Why startups are driven towards incumbents***

Agri-food startups not only generally welcome the legitimacy offered by incumbent collaborations (Fairbairn, Kish, and Guthman 2022), they are also often compelled to seek them out. Given the complexity of the agri-food sector, startups gravitate toward potential incumbent partnerships to enable rapid growth within an industry requiring elaborate material and social infrastructures.

Incumbents are experienced in dealing with the complex material challenges of food and agriculture. Some of these challenges stem directly from the obstacles to the capitalist development of agriculture (Mann and Dickinson 1978) long theorized by agrarian political economists. In a published interview, for instance, ag-tech investor Kieran Mahanty explained:

The defining challenge of agtech is the extraordinarily long development cycle: while software platforms measure release cycles in hours and minutes, agri-tech products often get

one shot per year. That makes developing a killer product and demonstrating market-fit extremely challenging. In my view, the solution has to come via early and sophisticated engagement with incumbent strategics. (ReThink n.d)

The ‘extraordinarily long development cycle’ with only ‘one shot per year’ is among the key challenges to capitalist development within agriculture. The need to work with plant and animal biology, and often on a seasonal schedule, creates obstacles to rapid R&D, which can only be partially overcome through genetic modification and other technological fixes (Goodman, Sorj, and Wilkinson 1987; Kloppenburg 2004). Facing the biophysical challenges of a land-based production system, partnership with an experienced incumbent corporation may be the best course of action for startups. The material challenges which slow capitalist penetration of agriculture in general may therefore, ultimately, reinforce the power of those capitalist entities that have already succeeded in making headway within the agri-food space.

In general, what incumbents lack in innovativeness, they make up for in practical assets and abilities (Arora, Fosfuri, and Gambardella 2002). Incumbent strengths include, among other things: product formulation expertise, manufacturing capacity, legal resources, design/branding/marketing expertise, established distribution channels, and a pre-existing customer base. These are precisely the skills that startups lack. A plant-based foods consultant and entrepreneur explained that the challenges of actually manufacturing and selling food products are insurmountable for most startups:

The food industry is not an easy place to succeed, and the margins are razor-thin. By the time the product reaches the consumer, you’ve got to get over 50 massive hurdles. [...] the reality is of the food manufacturing, of food distribution, of the complicated mess of middlemen that exist, to even get your product to the grocery store. And then the limited shelf space in grocery stores, and the fees that the grocery stores charge. [...] then there’s the shipping and a lot of these products need to be shipped frozen, that’s not easy. And finally, you’ve got to convince people to buy it. And then you’ve also got to keep it affordable and competitive. [...] It is a complicated industry to succeed in, and in the end of the day it wears most people down. And exit becomes the most viable way for them to scale. Because why go try to build all these partnerships and distribution relationships and pay everyone a little fee, if you can just get acquired by Nestlé, make your investors happy and plug into their existing system, and hopefully do the right thing and change the world. (#60)

Entrepreneurs may seek independence at first, but they are eventually worn down by the organizational minutiae, narrow margins, and reliance on intermediaries inherent to the agri-food industry. Getting a perishable food product onto store shelves in a timely manner presents a world of difficulties not present in software development and sales. An executive at a think tank and accelerator which aims to supplant animal agriculture explained that the need to work with incumbents was something they ‘had to come to terms with pretty early on’ because the logistical barriers to entry are much higher when it comes to agri-food tech:

We had to work with the companies that have the access to consumers, the distribution channels, and the manufacturing expertise [...] We did not see a path between A and B, or where we’re at and where we hope to be, without working with the companies who have this type of infrastructure. I mean, again, if this was a tech industry and it wasn’t so infrastructure heavy, then I think we would think about the industry quite differently. (#63)

Compared to purely digital technologies, in other words, agri-food technology requires manufacturing and distribution infrastructure that startups lack but incumbents have in spades.

Incumbents also provide access to important social infrastructure. For products sold directly to farmers, corporate partnerships not only solve a physical distribution problem for startups, they also offer a short-cut to the time-consuming process of building trust among customers. In a published interview, the founder of Conservis, a farm management software startup, described the slow process of building a farmer customer base: 'Farming is a trust-driven business [...] It's not like other tech sectors where you can launch an app on social media and three months later have three million users and then three months after that maybe have none.' An irrigation technology entrepreneur we interviewed expressed a similar sentiment:

Farmers are concerned about reliability, how they're going to work with people, customer service, and they really want to work with people who have a track record in the industry. Farming is very reputation based. If you have no track record of making people's lives easier over a multi-year period, they can view you as, 'I don't want to take a gamble on this.' (#11)

Distribution channel partnerships with incumbents circumvent the time-consuming process of establishing relationships and building trust with farmer-consumers (cf Fairbairn, Kish, and Guthman 2022).

Incumbent partnerships are also encouraged by the understandable farmer preference for using a single, familiar platform when accessing digital tools. An executive at an agricultural sensor startup described being relieved when her company started working with a major agricultural equipment manufacturer for this reason:

They're one of the ones that has this very comprehensive program that would bring in data from all these different areas, so you can use just one single platform. So telling farmers that we have that capability has been kind of a relief. (#7)

A CVC executive argued that this dynamic made a certain amount of industry consolidation under the leading incumbent firms inevitable. Many digital ag startups, he pointed out, offer only 'a single layer of data,' but

if you're a grower [...] you can't work with 12 different types of companies. It's too much to handle and so, I do think you are going to see [incumbent] companies acquire or roll up a number of these different startups or develop their own. (#40)

Even for digital startups, then, whose distribution would seem to be relatively frictionless, incumbent alliances may be crucial to growing their user base.

In short, while VCs are gatekeepers to funding (Cooiman 2022), incumbents are gatekeepers to the material and human infrastructure of the agri-food industry, which is just as critical to startup success. Political economists studying agriculture have long argued that the material difficulties of working with biological commodities and the social difficulties of coordinating production across many farms combine to hinder the capitalist transformation of food production (Goodman, Sorj, and Wilkinson 1987; Mann and Dickinson 1978), but here we see that these challenges may also drive corporate concentration by forcing newer capitalist entrants into the arms of those established firms that have already to some degree mastered these complexities.

Venture capital, in its quest for speedy returns, magnifies the pressures on startups to partner with incumbents. Cooman (2022) argues that venture capital brings a particular logic to working with startups, one which prioritizes ‘hypergrowth’ – the possibility that their value will grow exponentially, reaching a valuation in the billions within the time-frame of the fund (generally only three to seven years). While such speedy growth is achievable for software-based startups with platform business models (Cooman 2022; Rahman and Thelen 2019), the material and social complexities of agri-food production act as speedbumps that incumbents are best able to overcome. One VC explained that incumbents ‘have a ton of assets that we can leverage to go faster and do more in a shorter period of time’ (#52). A CVC executive described it very similarly, saying that his incumbent parent company has the ‘assets and capabilities and ingredients to help these companies scale up much, much quicker than they could without us ...’ (#44). Several of the VCs and intermediaries we interviewed, in fact, described the facilitation of startup-incumbent partnerships as a key part of their jobs.

For startup founders with an explicit moral mission, such as those advancing alternatives proteins, incumbent partnerships can also offer a rapid route for effecting meaningful change. An executive of a cellular dairy startup, for instance, explained their decision to work with dairy industry incumbents by arguing that ‘if we don’t get them on board, this movement is not going to scale as fast as we’d like it to’ (#28). While an executive at a fermentation-based alternative meat company explained that their recent partnership with an incumbent meat company is ‘a big advantage for us “because” our company is about reducing meat consumption now and not nine years in the future’ (#26).

For other entrepreneurs, working with incumbents is simply the *only* way to make an impact in food and agriculture. In this vision, the potential disruption caused by startups is not a seismic shift which puts incumbents out of business so much as a gentle nudging that invites them to be involved in ‘facilitating their own disruption’ (#63). A food tech entrepreneur explained that his startup was ‘like a tugboat to their container ship (#36),’ gradually steering the big firms into more sustainable pathways. A venture capitalist, on a separate occasion, employed almost the same nautical metaphor in explaining why his firm encouraged the startups in its portfolio to work with incumbent firms:

You’ve got large boats that are sort of shipping container boats [...] and then you’ve got a bunch of speed boats that are disrupting them. They’re probably annoying and don’t make that big of a difference, but occasionally there’s one that really will move the freighter and they’re going to have to buy or deal with [it]. (#54)

Like the ubiquitous technology ‘ecosystem’ metaphor, the boat metaphor emphasizes that innovation emerges from the interactions of diverse actors, but whereas ecosystems imply competition, the image of large and small boats emphasizes the asymmetrical power of the actors involved. Startups may be fast and nimble innovators, but their revolutionary ambitions are dwarfed by the sheer size and inertia of incumbents.

While generally desirable, incumbent relationships also entail considerable risks for startups, leading one influential organization studies article to describe it with a darker maritime metaphor: ‘swimming with sharks’ (Katila, Rosenberger, and Eisenhardt 2008). In our research, these risks came up primarily around the subject of incumbents as

early-stage investors. One VC, for instance, argued that early-stage investment from an incumbent firm could be ‘a grenade’ and ‘toxic to the success of really good companies’ because ‘legacy companies survive and thrive because they have figured out how to freeze change’ (#48). Of particular concern is the ‘signaling risk’ that can arise if an incumbent invests at an early stage but then its priorities change and it chooses not to exercise any investment or acquisition options that may have been built into that contract, harming the startup in the eyes of other prospective purchasers. There are also risks associated with incumbent acquisitions: ‘some of these companies ultimately are going to get sold to Tyson Foods just to be buried’ (#50); ‘some of these smaller innovations sell to these bigger players and then they either screw it up or they intentionally kill it’ (#72). Such ‘killer acquisitions’ (Cunningham, Ederer, and Ma 2021) – when an incumbent acquires a promising startup whose innovations partially overlap with their own in order to squash it and thus protect their market share – were not, however, a major concern among our interviewees, with some dismissing this fear as overblown. Finally, some of our interviewees expressed more generalized concerns that incumbents’ superior financial and technological resources would allow them to steal startup ideas or reverse engineer their technologies.

Although their vastly disproportionate power can make them dangerous allies, agri-food startups are nonetheless driven towards incumbent partnerships by the messy material and social reality of food and agriculture, mediated by the Silicon Valley imperative for rapid growth and equally rapid impact. Indeed, as the following section will argue, the presence of incumbents is so pervasive within agri-food tech, that it is likely to influence even those startups that never work directly with incumbents.

### **Ambient, continuous, and indirect: how incumbent influence operates within agri-food tech**

Critical agri-food scholarship has already convincingly shown that incumbents pervade agri-food tech, calling the sector’s revolutionary ambitions into question (Bronson and Knezevic 2016; Bronson and Sengers 2022; Guthman et al. 2022; Howard et al. 2021). However, their analysis tends to focus on acquisitions and investments, overlooking the complex processes through which technoscientific startups come into being (Doganova and Eyquem-Renault 2009). As datapoints on incumbent power, acquisitions and investments have the benefit of being widely reported and potentially quantifiable, but they are also, we contend, just the beginning of the complex ways in which incumbent influence permeates the sector. Returning to the (perhaps now hopelessly overburdened) maritime metaphor, we might argue that incumbents appear in the life of the startup not only as freighters or sharks but as a constitutive part of the ocean itself. In reality, incumbent influence is *ambient*, saturating the spaces within which startups are nurtured; it is *continuous*, operating on them from the earliest stages of their development; and it is frequently *indirect*, influencing them through sector-wide discourses and expectations that shape even those who may never work directly with an incumbent. We see these three dimensions intertwine in the form and content of industry conferences, the priorities of incubator and accelerator programs, and the orientation of the entire sector towards incumbent acquisition as a possible exit.

## ***Industry events amplify incumbent visions***

The 2019 World Agri-Tech Summit in a posh San Francisco hotel began by imploring the audience to dream big and invest in ‘moonshot’ ideas. The next panel carried forward this ambitious tone, describing genetic and microbiological technologies as ‘making ‘science fiction’ a reality.’ Shortly afterwards the CTO of Corteva, an agrichemical company owned by industry behemoth Dow-Dupont, took the stage with a 15-minute scripted speech showcasing their seed and chemical products as ‘the tools to get us there.’ Carefully bracketed by bucolic images of children with chickens and family-run farms, the presentation brought the conversation down to Earth. The technologies may be radically new, but their purveyors, it seems, will be very much the same.

These proceedings were indicative of the way incumbent firms center themselves in industry narratives about the future of agri-food technology and how their presence permeates the events where startup founders and investors form their beliefs about the industry. Not only do established firms occupy prime speaking slots (likely via paid sponsorship), but they also moderate panels of startups, act as judges in pitch competitions, and prominently display their logo on brochures and banners. Incumbent involvement varies by degree depending on the venue – at some events they feature in every single session, in others they appear in only some – but high incumbent participation was consistent across the events we tracked. Incumbent voices not only pervade these gatherings, they punctuate them at key moments, providing an overarching narrative of what the future will hold. The program for the most recent 2023 Future Food Tech conference in San Francisco, for example, details how senior executives from Kraft Heinz hosted a branded ‘Innovation Challenge’ where they publicly critiqued and rewarded startup contestants. The conference later closed with executives of retail giant Kroger and multinational food manufacturer Mars laying out their ‘2030 Visions: Digging into the Future of Food.’ Unsurprisingly, when incumbents describe the future of food and agriculture, their own interests appear as inevitable markers of progress and their role in innovation as indisputable. The visions conveyed by incumbent firms are likely particularly impactful for the large share of tech entrepreneurs now turning to the agri-food industry for the first time.

Investor panels, typically among the most eagerly attended by early-stage companies, underscore the importance of corporate venture capital within the sector. Back at the World Agri-tech Summit, a CVC explained to the audience the benefits of incumbents as investors. Incumbents, he explained, provide relatively ‘patient capital,’ because

traditional VCs, that are not in ag, they see something cool and they want to see an exit in 5–7 years. If they don’t see it they walk away ... as a corporate we don’t have that pressure for an exit.

Even on investor panels with no CVC representatives, incumbents loom large as possible investors. At the same conference, a veteran technology investor explained in an investor panel,

This ecosystem cannot be very successful if it doesn’t know how to work with the corporate venture ecosystem, because [...] the preponderance of corporate venture capitalists is way higher in this space than a lot of traditional other technology spaces.

Partnership with incumbent firms, he argued, is ‘required for a lot of these startups over here to be successful.’ While others on the panel disagreed, recommending caution when



working with incumbent investors, the prolonged conversation that followed was a striking reminder of the centrality of established firms in this industry that purportedly aims to disrupt them. The resounding message for entrepreneurs is that ambitions for revolutionizing the food system are technological not structural, that incumbent priorities should be their priorities, and that their ability to raise funds depends upon their attractiveness to corporate players.

### ***Intermediaries project incumbent interests***

Incumbents are present not only throughout the spaces of agri-food tech, but throughout the life of a startup, their pervasiveness temporal as well as spatial. A close examination of the agri-food tech incubator and accelerator programs in Silicon Valley, for instance, reveals that many, though not all, of them explicitly select and support startups in preparation to do business with agribusiness firms. One accelerator, for example, has a food tech program that promises to ‘supercharge’ corporate partners by identifying, vetting and coaching startups that serve their needs. ‘It’s a very corporate driven accelerator,’ an executive explained in an interview, ‘so all these big companies sit on our board, and tell us how to run the program, and we do it for their benefit essentially.’ The incumbent firms are not eager to acquire startups, he made clear. ‘Typically these guys, they want to solve a challenge. They don’t want to own it. They just want to have this company come in and create a solution for them’ (#65). Prominent partners of this accelerator include mega-retailer Walmart, poultry corporations Smithfield and Tyson, grain trader ADM, and consumer packaged goods companies PepsiCo and Mondelez. Its workspace features a designated corner, appointed with luxury seating and decorative touches, specifically reserved for the chemical company DuPont.

Though not all accelerators share this laser focus on training startups to serve the needs of incumbent clients, many are nonetheless closely guided by the interests of corporate partners. An executive at a venture-capital backed accelerator, for instance, explained that ‘corporates’ are treated in their program as subject matter experts, helping to select the most promising companies from hundreds of program applicants (#67). The corporate partners then welcome the selected startups with meetings and tours of their facilities. Accelerators with venture funds also invest in startups for their own financial gain, independent of corporate partnerships. Yet their meetings with corporate clients are likely to influence their investment strategy. When mergers and acquisitions provide the primary pay-out for investors, the insights of incumbents are considered invaluable intelligence. Whether corporate partners directly select startups or indirectly support and inform programs, accelerators are a clear conduit of incumbent influence on the business development process.

With or without support from such intermediaries, many startups do eventually end up selling technology or services to incumbents, and this client relationship can be a major vector for incumbent influence that is not necessarily publicly disclosed. As big-ticket customers for eager startups, incumbents provide a consistent injection of revenue but also have targeted needs that can potentially reshape the company’s products or business model. One example of the behind-the-scenes influence exerted by incumbent clients comes from Heimstädt’s (2022, 63) in-depth study of a crop damage detection startup that, early in its development, licensed its algorithm to a major agrichemical company.

This relationship, Heimstädt finds, shaped the direction of the app's development, as the corporate client's needs influenced which crops and which types of plant damages were included in its 'diagnostic repertoire.' The licensing agreement allowed for the use of the algorithm only in a 'white-labeled' manner, in part due to reputational concerns of the startup, meaning that while this client relationship profoundly affected the startup's evolution towards its eventual form it was not easily observable. This type of subtle corporate influence operates on startups throughout their life spans, frequently encouraged by incubators and other sources of early-stage mentorship.

### ***The anticipation of acquisition drives investment***

Though incumbent influence saturates the spaces of Silicon Valley, it frequently operates quite indirectly. Just as entrepreneurs anticipate and configure themselves to please the 'investor's gaze' (Doganova and Muniesa 2015, 122), so too do they anticipate and orient towards the desires of incumbents, in part because it is what investors want to see. Few startups will be acquired by an incumbent agri-food corporation as they are much more likely to form a business relationship which incurs lower risk for the incumbent, if they form any relationship at all. Nonetheless, the possibility of an acquisition operates powerfully on all startups and the sector as a whole. Investors, we were told, see acquisition as their most likely exit, and startups must orient themselves towards this expectation. As one incubator executive and consultant described:

Far and away the majority of companies in this ag space, their financial exit for their investments will be an acquisition by a larger player, and the history of this industry has shown consolidation. [...] It's just the Pacman kind of gobbling up those smaller ones to make yourself bigger. [...] I'm not sure every startup entrepreneur starts with that as an assumption, but that's what they come to realize. (#70)

This aligns with Birch's (2017) research on the bioscience industry, in which he finds that the 'trade sale' to another company with a strategic interest in buying the firm is increasingly replacing the much-vaunted stock market initial public offering (IPO) as the most common exit strategy. Within agri-food tech, the notion that acquisition is the most realistic expectation for startups has been reinforced by the dramatic failure of the headline grabbing 2019 Beyond Meat IPO. After initial success, the stock for this alternative protein company plummeted to a fraction of its original share price a couple of years later, and has yet to revive (Garcia 2023; Wiener-Bronner 2022). It now serves as a cautionary tale for entrepreneurs with ambitions to go it alone and for their prospective investors. Courting acquisition, it seems, is the surer bet.

Though not all entrepreneurs start out with dreams of corporate acquisition, they often come to accept – and prepare for – the possibility. One ag tech entrepreneur, for instance, explained 'most of us on the management team [...] would like to stay independent as long as possible. We're all enjoying what we're doing very much. And we have more freedom' (#13). However, with investors intent upon a timely exit, and agri-chemical input companies expressing interest in their product, he was increasingly reconciled to the likelihood of an eventual corporate acquisition. Another ag tech entrepreneur described how prior entrepreneurial experiences had caused him to focus on obtaining patents along the way as a means to prepare for a strategic acquisition:

In our previous business that we built, we had a patent that ended up carrying a lot of weight during an acquisition. And I think that we've tried to remember that experience, and I think it helps from a business strategy point of view [...] Defensible IP I think is a really attractive thing. (#17)

The corporate acquisition, in other words, is not just a one-time event. Instead, anticipation of a possible acquisition influences the process of 'exploratory assetization' (Heimstädt 2023) by which startups discover a workable business model in the first place. The knowledge that a strategic acquisition is a likely outcome shapes startups long before (in fact, regardless of whether) any acquisition actually takes place.

Acquisitions also loom large in the origin story of the agri-food tech sector as a whole. Many of our interlocutors named the acquisition of The Climate Corporation by Monsanto (now Bayer) in 2012 as the sector's key catalyst. As one CVC investor explained:

When [Monsanto] bought Climate Corps for \$1 billion. All of a sudden now every Silicon Valley startup was like, oh, we're doing digital ag, even though we don't know anything about agriculture, but we want to be a billionaire, so we're going to apply our knowledge of all this AI stuff and put it to farming. (#44)

Acquisition by a major agribusiness incumbent is thus not only an attractive outcome, but a motivating force from the very inception of countless companies, particularly those coming from technology industries. An agricultural technology entrepreneur described the way that the Climate Corporation acquisition pulled data scientists into agriculture 'Because everyone's like, "Okay, how do I copy the play?" without really understanding how these things work... "Oh yeah, I could be the Climate Corp for blah-blah-blah!"' (#3). The opportunity of duplicating a spectacular incumbent acquisition becomes the formula for cultivating investor interest. Incumbent interests thus indirectly shape business decisions throughout a startup's trajectory, regardless of whether a partnership or acquisition ever becomes a realistic possibility.

### **Pervasive but not ubiquitous**

While the influence of incumbents in agri-food tech innovation may be pervasive, it is not ubiquitous. Our research suggests that the social context of entrepreneurs and the ethical orientation of business development leaders may both serve to temper incumbent influence. What the exceptions share is an approach to innovation which considers venture capital as a possibility rather than a priority. In this way the exceptions prove the rule, underscoring how closely incumbent influence is tied to the anticipatory logics of investment.

While many of the most high-profile companies in the agri-food tech sector have come from the tech industry towards agriculture, others have taken the opposite path from a start in agricultural communities. Our research suggests that entrepreneurs with farming backgrounds are somewhat less likely to seek the rapid growth and scalability that motivates venture capitalists and tech entrepreneurs to engage with incumbents. As a representative from a Central Valley-based accelerator described 'If the founders come from [the agricultural] industry [...] I'd say typically they'd rather bootstrap. They'd rather own 100%' and focus on revenue rather than just on 'hitting quarterly numbers and growth figures in order to basically prime the pumps for acquisition' (#69). Sometimes pejoratively called 'lifestyle' businesses by those rooted in Silicon

Valley venture capital culture, entrepreneurs seeking steady revenue rather than the quickest exit may not be quite as eager to court incumbent partners or to modify their offerings to suit incumbent needs. Incumbents and venture capital likewise are often less attracted to companies taking this slow and steady approach.

Incubator and accelerator programs which are explicitly mission-driven also foster business development strategies less intertwined with incumbent players. The non-profit accelerator Food System 6 based in the San Francisco Bay Area, for example, selects companies by rating them on their contributions to advancing health, vibrant farms, justice, and fairness as well as standard business operations, taking a 1.5% equity stake in exchange for their services. The startup founders they work with seek to be cash-flow positive rather than court venture capital with rapid growth trajectories, and they have little direct contact with incumbent players. In fact, the accelerator's website is explicitly critical of 'agri-food monopolies' which 'extract resources from the planet, increase food insecurity, expose us to harmful pesticides, and push us to the brink of ecological extinction' (FS6 n.d.) In addition to technology companies developing livestock data analytics tools or solar powered equipment, they also support both for-profit and non-profit organizations advancing social innovations such as farmworker welfare certification standards or regional food distribution networks. A broader lens as to what innovation can be – in terms of business priorities, pace, and profit orientation – renders incumbent players largely irrelevant.

## Conclusion

This study contributes to the growing body of work on corporate power within agri-food tech (Bronson and Sengers 2022; Howard et al. 2021). We find that agri-food tech startups and incumbent firms are deeply entangled with one another in ways that go far beyond isolated moments of investment or acquisition. Their co-dependence is, for both parties, largely a product of financial pressures: incumbents use startups as a means to outsource costly and time-consuming R&D activities as demanded by their shareholders, while startups rely on incumbents' practical knowledge, networks, and infrastructure to swiftly scale their operations as demanded by their VC funders. For startups, the reliance on incumbents is also partially a product of the unique material and social characteristics of agriculture. The seasonality of production, the need to work with plant and animal biology, the perishability of the finished product, and the time-intensive process of earning farmer trust – all potential obstacles to the capitalist development of agriculture – appear in this case to favor established (capitalist) firms over (equally capitalist) startups with less idea of how to navigate these obstacles. What results is an agri-food tech sector permeated by incumbent influence. The voices of established firms resound through the spaces where the industry builds its sense of current purpose and future direction. Their opinions are elevated and acted upon by the incubator and accelerator programs that teach startup founders how to develop their business. The mere anticipation that they may someday act as an investor or acquirer is powerfully present, even when incumbents themselves are not.

That incumbent influence is so ambient, so continuous, and so indirect in the lives of agri-food tech startups is important because it suggests the obstacles to tech-led food system transformation. Some scholarship on digital and cellular agriculture harbors considerable optimism about the possibility of circumventing incumbent influence by

embedding novel technologies in alternative social organizations or economic models. Though mainstream precision agriculture technologies have so far tended to further intensification and corporate value extraction, this work points out, there is nothing inherent to the technologies themselves that would prevent them from being used instead to advance agroecological production (Rotz et al. 2019) or food sovereignty (Carolan 2017; 2018). Scholars argue, for instance, that the responsible research and innovation approach (Stilgoe, Owen, and Macnaghten 2013) holds promise for achieving more equitable digital transitions in agriculture (Bronson 2019; Rose and Chilvers 2018) or that cellular agriculture could be democratized if embedded within more egalitarian socio-economic arrangements (Chiles et al. 2021). Our research highlights just how entrenched incumbent influence is and therefore how difficult to avoid. However, the spaces where incumbents are less present provide a glimmer of hope. Funding that eschews the demands of venture capital, broadens the scope of innovation, and retains stronger community ties to its industry may provide more fertile ground than Silicon Valley for breaking from the historic concentration of corporate power. The incumbent advantage may be more expansive than previously thought, but it is not absolute.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

This work was supported by National Science Foundation [grant number 1749184].

## ORCID

Madeleine Fairbairn  <http://orcid.org/0000-0003-0168-4179>

Emily Reisman  <http://orcid.org/0000-0002-0199-5746>

## References

- AgFunder. 2022. *AgFunder AgriFoodTech Investment Report*. <https://agfunder.com/research/2022-agfunder-agrifoodtech-investment-report/>.
- Arora, A., A. Fosfuri, and A. Gambardella. 2002. *Markets for Technology: The Economics of Innovation and Corporate Strategy*. Cambridge, MA: MIT Press.
- Baker, T., and R. E. Nelson. 2005. "Creating Something from Nothing: Resource Construction Through Entrepreneurial Bricolage." *Administrative Science Quarterly* 50 (3): 329–366. <https://doi.org/10.2189/asqu.2005.50.3.329>.
- Birch, K. 2017. "Rethinking Value in the Bio-Economy." *Science, Technology, Science, Technology, & Human Values* 42 (3): 460–490. <https://doi.org/10.1177/0162243916661633>.
- Birch, K. 2022. "Reflexive Expectations in Innovation Financing: An Analysis of Venture Capital as a Mode of Valuation." *Social Studies of Science* 53 (1): 29–48. <https://doi.org/10.1177/03063127221118372>.
- Blank, S. 2013. "Why the Lean Start-Up Changes Everything." *Harvard Business Review*. May, 2013. <https://hbr.org/2013/05/why-the-lean-start-up-changes-everything>.
- Block, F., and M. R. Keller. 2009. "Where do Innovations Come from? Transformations in the US Economy, 1970–2006." *Socio-Economic Review* 7 (3): 459–483. <https://doi.org/10.1093/ser/mwp013>.

- Bortolini, R. F., M. N. Cortimiglia, A. de M. F. Danilevicz, and A. Ghezzi. 2018. "Lean Startup: A Comprehensive Historical Review." *Management Decision* 59 (8): 1765–1783. <https://doi.org/10.1108/MD-07-2017-0663>.
- Bronson, K. 2019. "Looking Through a Responsible Innovation Lens at Uneven Engagements with Digital Farming." *NJAS: Wageningen Journal of Life Sciences* 1–6: 100294. <https://doi.org/10.1016/j.njas.2019.03.001>.
- Bronson, K., and I. Knezevic. 2016. "Big Data in Food and Agriculture." *Big Data & Society* 3 (1): 205395171664817. <https://doi.org/10.1177/2053951716648174>.
- Bronson, K., and P. Sengers. 2022. "Big Tech Meets Big Ag: Diversifying Epistemologies of Data and Power." *Science as Culture* 31 (1): 15–28. <https://doi.org/10.1080/09505431.2021.1986692>.
- Brosius, J. P., and L. M. Campbell. 2010. "Collaborative Event Ethnography: Conservation and Development Trade-Offs at the Fourth World Conservation Congress." *Conservation and Society* 8 (4): 245–255. <https://doi.org/10.4103/0972-4923.78141>.
- Buss, D. 2018, May 24. *Campbell Soup CEO Leaves: A Warning for Acquisitive Leaders*. ChiefExecutive.Net. <https://chiefexecutive.net/campbell-soup-ceo-resigns-warning-acquisitive-leaders/>.
- Buttel, F. H. 2005. "Ever Since Hightower: The Politics of Agricultural Research Activism in the Molecular Age." *Agriculture and Human Values* 22 (3): 275–283. <https://doi.org/10.1007/s10460-005-6043-3>.
- Carbonell, I. 2016. "The Ethics of big Data in big Agriculture." *Internet Policy Review* 5 (1): 1–13. <https://doi.org/10.14763/2016.1.405>.
- Carolan, M. 2017. "Agro-Digital Governance and Life Itself: Food Politics at the Intersection of Code and Affect." *Sociologia Ruralis* 57 (S1): 816–835. <https://doi.org/10.1111/soru.12153>.
- Carolan, M. 2018. "'Smart' Farming Techniques as Political Ontology: Access, Sovereignty and the Performance of Neoliberal and Not-So-Neoliberal Worlds." *Sociologia Ruralis* 58 (4): 745–764. <https://doi.org/10.1111/soru.12202>.
- Charmaz, K. 2014. *Constructing Grounded Theory*. 2nd ed. London: Sage.
- Chiles, R. M., G. Broad, M. Gagnon, N. Negowetti, L. Glenna, M. A. Griffin, L. Tami-Barrera, S. Baker, and K. Beck. 2021. "Democratizing Ownership and Participation in the 4th Industrial Revolution: Challenges and Opportunities in Cellular Agriculture." *Agriculture and Human Values* 38 (4): 943–961. <https://doi.org/10.1007/s10460-021-10237-7>.
- Clapp, J. 2018. "Mega-Mergers on the Menu: Corporate Concentration and the Politics of Sustainability in the Global Food System." *Global Environmental Politics* 18 (2): 12–33. [https://doi.org/10.1162/glep\\_a\\_00454](https://doi.org/10.1162/glep_a_00454).
- Clapp, J. 2023. "Concentration and Crises: Exploring the Deep Roots of Vulnerability in the Global Industrial Food System." *The Journal of Peasant Studies* 50 (1): 1–25. <https://doi.org/10.1080/03066150.2022.2129013>.
- Cohen, S. 2013. "What Do Accelerators Do? Insights from Incubators and Angels." *Innovations: Technology, Governance, Globalization* 8 (3-4): 19–25. [https://doi.org/10.1162/INOV\\_a\\_00184](https://doi.org/10.1162/INOV_a_00184).
- Cooiman, F. 2022. "Imprinting the Economy: The Structural Power of Venture Capital." *Environment and Planning A: Economy and Space*, 0308518X221136559 (online first). <https://doi.org/10.1177/0308518X221136559>.
- Cunningham, C., F. Ederer, and S. Ma. 2021. "Killer Acquisitions." *Journal of Political Economy* 129 (3): 649–702. <https://doi.org/10.1086/712506>.
- Doganova, L., and M. Eyquem-Renault. 2009. "What do Business Models do?" *Research Policy* 38 (10): 1559–1570. <https://doi.org/10.1016/j.respol.2009.08.002>.
- Doganova, L., and F. Muniesa. 2015. "Capitalization Devices: Business Models and the Renewal of Markets." In *Making Things Valuable*, edited by M. Kornberger, L. Justesen, A. K. Madsen, and J. Mouritsen, 109–125. Oxford: Oxford University Press.
- Dushnitsky, G., and M. J. Lenox. 2005. "When do Firms Undertake R&D by Investing in new Ventures?" *Strategic Management Journal* 26 (10): 947–965. <https://doi.org/10.1002/smj.488>.
- Fairbairn, M., Z. Kish, and J. Guthman. 2022. "Pitching Agri-Food Tech: Performativity and non-Disruptive Disruption in Silicon Valley." *Journal of Cultural Economy* 15 (5): 652–670. <https://doi.org/10.1080/17530350.2022.2085142>.

- Ferrary, M., and M. Granovetter. 2009. "The Role of Venture Capital Firms in Silicon Valley's Complex Innovation Network." *Economy and Society* 38 (2): 326–359. <https://doi.org/10.1080/03085140902786827>.
- FS6. n.d. *Mission, Vision & Impact*. Food System 6. Accessed November 2, 2023, from <https://www.foodsystem6.org/about.html>.
- Garcia, T. 2023, November 2. "Beyond Meat Slashes Revenue View Again, Will Cut 8% of Jobs." *Bloomberg.Com*. <https://www.bloomberg.com/news/articles/2023-11-02/beyond-meat-slashes-revenue-view-again-will-cut-8-of-jobs>.
- Garud, R. 2008. "Conferences as Venues for the Configuration of Emerging Organizational Fields: The Case of Cochlear Implants." *Journal of Management Studies* 45 (6): 1061–1088. <https://doi.org/10.1111/j.1467-6486.2008.00783.x>.
- Geiger, S. 2020. "Silicon Valley, Disruption, and the end of Uncertainty." *Journal of Cultural Economy* 13 (2): 169–184. <https://doi.org/10.1080/17530350.2019.1684337>.
- Glenna, L. L., W. B. Lacy, R. Welsh, and D. Biscotti. 2007. "University Administrators, Agricultural Biotechnology, and Academic Capitalism: Defining the Public Good to Promote University–Industry Relationships." *The Sociological Quarterly* 48 (1): 141–163. <https://doi.org/10.1111/j.1533-8525.2007.00074.x>.
- Goldstein, J. 2018. *Planetary Improvement: Cleantech Entrepreneurship and the Contradictions of Green Capitalism*. Cambridge, MA: MIT Press.
- Goodman, D., B. Sorj, and J. Wilkinson. 1987. *From Farming to Biotechnology: A Theory of Agro-Industrial Development*. New York: Basil Blackwell.
- Guthman, J., M. Butler, S. J. Martin, C. Mather, and C. Biltekoff. 2022. "In the Name of Protein." *Nature Food* 3 (6): 391–393. <https://doi.org/10.1038/s43016-022-00532-9>.
- Heffernan, W. D. 2000. "Concentration of Ownership and Control in Agriculture." In *Hungry for Profit: The Agribusiness Threat to Farmers, Food, and the Environment*, edited by F. Magdoff, J. B. Foster, and F. H. Buttel, 61–75. New York: Monthly Review Press.
- Heimstädt, C. 2022. *Feeding the World with an app: Digital Agriculture, Startups, and the Appeal of Little Devices*. Paris: Mines ParisTech.
- Heimstädt, C. 2023. "The Exploratory Assetization of a Crop Protection app." *Environmental Science & Policy* 140: 242–249. <https://doi.org/10.1016/j.envsci.2022.12.014>.
- Hendrickson, M. 2015. "Resilience in a Concentrated and Consolidated Food System." *Journal of Environmental Studies and Sciences* 5 (3): 418–431. <https://doi.org/10.1007/s13412-015-0292-2>.
- Hogarth, S. 2017. "Valley of the Unicorns: Consumer Genomics, Venture Capital and Digital Disruption." *New Genetics and Society* 36 (3): 250–272. <https://doi.org/10.1080/14636778.2017.1352469>.
- Howard, P. H. 2016. *Concentration and Power in the Food System: Who Controls What we eat?*. London: Bloomsbury Academic.
- Howard, P. H., F. Ajena, M. Yamaoka, and A. Clarke. 2021. "'Protein' Industry Convergence and Its Implications for Resilient and Equitable Food Systems." *Frontiers in Sustainable Food Systems* 5: 684181. <https://doi.org/10.3389/fsufs.2021.684181>.
- Katila, R., J. D. Rosenberger, and K. M. Eisenhardt. 2008. "Swimming with Sharks: Technology Ventures, Defense Mechanisms and Corporate Relationships." *Administrative Science Quarterly* 53 (2): 295–332. <https://doi.org/10.2189/asqu.53.2.295>.
- Kautsky, K. 1988. *The Agrarian Question*. London and Winchester, MA: Zwan Publications.
- Klerkx, L., E. Jakku, and P. Labarthe. 2019. "A Review of Social Science on Digital Agriculture, Smart Farming and Agriculture 4.0: New Contributions and a Future Research Agenda." *NJAS: Wageningen Journal of Life Sciences* 1–16: 100315. <https://doi.org/10.1016/j.njas.2019.100315>.
- Kloppenburg, J. R. 2004. *First the Seed: The Political Economy of Plant Biotechnology, 1492-2000*. 2nd ed. Madison, WI: University of Wisconsin Press.
- Lazonick, W. 2007. "The US Stock Market and the Governance of Innovative Enterprise." *Industrial and Corporate Change* 16 (6): 983–1035. <https://doi.org/10.1093/icc/dtm030>.
- Leclerc, R. 2016, July 5. "The Next Phase For Agriculture Technology." *Forbes*. <https://www.forbes.com/sites/robleclerc/2016/07/05/the-next-phase-for-agriculture-technology/>.

- Mann, S. A., and J. M. Dickinson. 1978. "Obstacles to the Development of a Capitalist Agriculture." *The Journal of Peasant Studies* 5 (4): 466–481. <https://doi.org/10.1080/03066157808438058>.
- Miles, C. 2019. "The Combine Will Tell the Truth: On Precision Agriculture and Algorithmic Rationality." *Big Data & Society* 6 (1): 1–12. <https://doi.org/10.1177/2053951719849444>.
- Mowery, D. C. 2009. "Plus ça Change: Industrial R&D in the "Third Industrial Revolution"." *Industrial and Corporate Change* 18 (1): 1–50. <https://doi.org/10.1093/icc/dtn049>.
- Pisano, G. P. 2010. "The Evolution of Science-Based Business: Innovating how we Innovate." *Industrial and Corporate Change* 19 (2): 465–482. <https://doi.org/10.1093/icc/dtq013>.
- Polidoro Jr, F., and W. Yang. 2021. "Corporate Investment Relationships and the Search for Innovations: An Examination of Startups' Search Shift Toward Incumbents." *Organization Science* 32 (4): 909–939. <https://doi.org/10.1287/orsc.2020.1421>.
- Rahman, K. S., and K. Thelen. 2019. "The Rise of the Platform Business Model and the Transformation of Twenty-First-Century Capitalism." *Politics & Society* 47 (2): 177–204. <https://doi.org/10.1177/0032329219838932>.
- ReThink. n.d. "Nurturing AgTech Innovation: Navigating the Investment Landscape Beyond 2023". World AgriTech Innovation Summit. <https://worldagritechinnovation.com/nurturing-agtech-innovation/>.
- Rose, D. C., and J. Chilvers. 2018. "Agriculture 4.0: Broadening Responsible Innovation in an era of Smart Farming." *Frontiers in Sustainable Food Systems* 2: 87. <https://doi.org/10.3389/fsufs.2018.00087>.
- Rotz, S., E. Duncan, M. Small, J. Botschner, R. Dara, I. Mosby, M. Reed, and E. D. Fraser. 2019. "The Politics of Digital Agricultural Technologies: A Preliminary Review." *Sociologia Ruralis* 59 (2): 203–229. <https://doi.org/10.1111/soru.12233>.
- Sarasvathy, S. D. 2001. "Causation and Effectuation: Toward a Theoretical Shift from Economic Inevitability to Entrepreneurial Contingency." *The Academy of Management Review* 26 (2): 243–263. <https://doi.org/10.2307/259121>.
- Saxenian, A. 1991. "The Origins and Dynamics of Production Networks in Silicon Valley." *Research Policy* 20 (5): 423–437. [https://doi.org/10.1016/0048-7333\(91\)90067-Z](https://doi.org/10.1016/0048-7333(91)90067-Z).
- Sippel, S. R., and M. Dolinga. 2023. "Constructing Agri-Food for Finance: Startups, Venture Capital and Food Future Imaginaries." *Agriculture and Human Values* 40: 475–488. <https://doi.org/10.1007/s10460-022-10383-6>.
- Spender, J.-C., V. Corvello, M. Grimaldi, and P. Ripa. 2017. "Startups and Open Innovation: A Review of the Literature." *European Journal of Innovation Management* 20 (1): 4–30.
- Steiber, A., and S. Alänge. 2021. "Corporate-startup Collaboration: Effects on Large Firms' Business Transformation." *European Journal of Innovation Management* 24 (2): 235–257. <https://doi.org/10.1108/EJIM-10-2019-0312>.
- Stephens, N., A. E. Sexton, and C. Driessen. 2019. "Making Sense of Making Meat: Key Moments in the First 20 Years of Tissue Engineering Muscle to Make Food." *Frontiers in Sustainable Food Systems* 3: 45. <https://doi.org/10.3389/fsufs.2019.00045>.
- Stilgoe, J., R. Owen, and P. Macnaghten. 2013. "Developing a Framework for Responsible Innovation." *Research Policy* 42 (9): 1568–1580. <https://doi.org/10.1016/j.respol.2013.05.008>.
- Teece, D. J. 1986. "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy." *Research Policy* 15 (6): 285–305. [https://doi.org/10.1016/0048-7333\(86\)90027-2](https://doi.org/10.1016/0048-7333(86)90027-2).
- Weiblen, T., and H. W. Chesbrough. 2015. "Engaging with Startups to Enhance Corporate Innovation." *California Management Review* 57 (2): 66–90. <https://doi.org/10.1525/cmr.2015.57.2.66>.
- Welsh, R., L. Glenna, W. Lacy, and D. Biscotti. 2008. "Close Enough but not Too far: Assessing the Effects of University–Industry Research Relationships and the Rise of Academic Capitalism." *Research Policy* 37 (10): 1854–1864. <https://doi.org/10.1016/j.respol.2008.07.010>.
- Wiener-Bronner, D. 2022, December 7. "What's gone wrong at Beyond Meat | CNN Business." CNN. <https://www.cnn.com/2022/12/07/business/beyond-meat-sales/index.html>.
- Wolf, S. A., and S. D. Wood. 1997. "Precision Farming: Environmental Legitimation, Commodification of Information, and Industrial Coordination 1." *Rural Sociology* 62 (2): 180–206. <https://doi.org/10.1111/j.1549-0831.1997.tb00650.x>.



**Appendix: Interviews.**

#	Date	Format	Actor type
1	Jun 2019	Video conference	Entrepreneur: Ag tech
2	Jun 2019	Phone call	Entrepreneur: Ag tech
3	Jun 2019	Phone call	Entrepreneur: Ag tech
4	Jul 2019	In person	Entrepreneur: Ag tech
5	Jul 2019	In person	Entrepreneur: Ag tech
6	Jul 2019	In person	Entrepreneur: Ag tech
7	Jul 2019	In person	Entrepreneur: Ag tech
8	Jul 2019	Phone call	Entrepreneur: Ag tech
9	Jul 2019	Phone call	Entrepreneur: Ag tech
10	Jul 2019	Phone call	Entrepreneur: Ag tech
11	Oct 2019	Phone call	Entrepreneur: Ag tech
12	Jun 2021	Video conference	Entrepreneur: Ag tech
13	Jul 2021	Video conference	Entrepreneur: Ag tech
14	Aug 2021	In person	Entrepreneur: Ag tech
15	Aug 2021	Video conference	Entrepreneur: Ag tech
16	Aug 2021	Video conference	Entrepreneur: Ag tech
17	Oct 2021	Video conference	Entrepreneur: Ag tech
18	Aug 2019	Phone call	Entrepreneur: Ag tech
19	Jan 2023	In person	Entrepreneur: Ag tech
20	Jun 2019	In person	Entrepreneur: Food tech
21	Aug 2020	Video conference	Entrepreneur: Food tech
22	Jul 2019	In person	Entrepreneur: Food tech
23	Mar 2020	Phone call	Entrepreneur: Food tech
24	Oct 2021	Video conference	Entrepreneur: Food tech
25	July 2019	Phone call	Entrepreneur: Food tech
26	Jul 2019	Phone call	Entrepreneur: Food tech
27	Jul 2019	In person	Entrepreneur: Food tech
28	Sep 2019	Phone call	Entrepreneur: Food tech
29	Sep 2019	Phone call	Entrepreneur: Food tech
30	Mar 2020	Phone call	Entrepreneur: Food tech
31	July 2020	Video conference	Entrepreneur: Food tech
32	Sep 2020	Video conference	Entrepreneur: Food tech
33	Jan 2021	Video conference	Entrepreneur: Food tech
34	Jan 2021	Video conference	Entrepreneur: Food tech
35	Jan 2021	Video conference	Entrepreneur: Food tech
36	Jan 2021	Phone call	Entrepreneur: Food tech
37	Feb 2021	Video conference	Entrepreneur: Food tech
38	Jul 2021	Video conference	Entrepreneur: Food tech
39	Oct 2021	Video conference	Entrepreneur: Food tech
40	Jul 2019	Phone call	Investor: CVC
41	Aug 2021	Video conference	Investor: CVC
42	Aug 2021	Video conference	Investor: CVC
43	Sep 2021	Video conference	Investor: CVC
44	Oct 2021	Video conference	Investor: CVC
45	May 2021	Video conference	Investor: VC
46	Jan 2021	Video conference	Investor: VC
47	Feb 2021	Phone call	Investor: VC
48	Mar 2021	Video conference	Investor: VC
49	Apr 2021	Video conference	Investor: VC
50	Apr 2021	Video conference	Investor: VC
51	Apr 2021	Video conference	Investor: VC
52	Apr 2021	Video conference	Investor: VC
53	May 2021	Video conference	Investor: VC
54	June 2021	Video conference	Investor: VC
55	Dec 2022	Video conference	Investor: VC
56	Jan 2023	Video conference	Investor: VC
57	Aug 2021	Video conference	Investor: VC
58	Nov 2018	In person	Intermediary: Consulting

*(Continued)*

Continued.

#	Date	Format	Actor type
59	Jul 2019	Phone call	Intermediary: Consulting
60	Mar 2021	Video conference	Intermediary: Consulting
61	Jan 2019	In person	Intermediary: Consulting
62	Feb 2021	Phone call	Intermediary: Convening, non-profit
63	Mar 2021	Phone call	Intermediary: Convening, non-profit
64	Oct 2022	Phone Call	Intermediary: Convening, non-profit
65	Apr 2019	In person	Intermediary: Incubator/accelerator
66	Apr 2019	In person	Intermediary: Incubator/accelerator
67	July 2019	In person	Intermediary: Incubator/accelerator
68	Aug 2019	Phone call	Intermediary: Incubator/accelerator
69	Aug 2019	Phone call	Intermediary: Incubator/accelerator
70	Nov 2019	In person	Intermediary: Incubator/accelerator
71	Jun 2021	Video conference	Intermediary: Industry association
72	Apr 2021	Phone call	Industry expert
73	Apr 2021	Video conference	Industry expert
74	Mar 2021	Video conference	Industry expert
75	Feb 2021	Video conference	Industry expert
76	Jan 2019	In person	Industry expert
77	Sep 2021	Video conference	Industry expert

**Madeleine Fairbairn** (mfairbai@ucsc.edu) is an Associate Professor and Pepper-Giberson Endowed Chair of Environmental Studies at the University of California, Santa Cruz. She studies the political economy of agriculture, including the financial sector's growing interest in farmland and the Silicon Valley agri-food tech sector. Her first book, *Fields of Gold: Financing the Global Land Rush* was published in 2020 by Cornell University Press.

**Emily Reisman** is an Assistant Professor in the Department of Environment and Sustainability at the University at Buffalo located in Buffalo, New York. Her research concerns the political ecology of agricultural knowledge, most recently in almond production and emerging agri-food technologies.