

If they come, we will build it: in vitro meat and the discursive struggle over future agrofood expectations

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Accepted: 26 September 2012 / Published online: 1 February 2013
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Abstract According to recent literature in the sociology of expectations, expectations about the future are “performative” in that they provide guidance for activities, attract attention, mobilize political and economic resources, coordinate between groups, link technical and social concerns, create visions, and enroll supporters. While this framework has blossomed over the past decade in science and technology studies, it has yet to be applied towards a more refined understanding of how the future of the modern agrofood system is being actively contested and understood. I seek to redress this gap by using the sociology of expectations to explain the discursive topography surrounding in vitro meat, a nascent agrofood technology whereby processed meat products are developed from stem cells as opposed to live animals. In discussing the obstacles and challenges which confront the proponents of this technology, I utilize three key concepts from the sociology of expectations: (1) hype, (2) retrospective prospects, and (3) the role of myth, metaphor, and ideology. I find that despite sluggish results and financial setbacks, the controversial legacy of previous agrofood technologies, and persistent cultural skepticism, the core ideological justifications for in vitro meat have proven to be resilient in buoying the technology through rough discursive waters.

Keywords In vitro meat · Agrofood · Sociology of expectations · Technology · Discourse · Stakeholders

Introduction

Discussion and analysis concerning how various agrifood technology controversies unfold remains a cornerstone of food and agriculture scholarship (Buttel et al. 1990; Kloppenburg 2004; Buttel 2000, 2005; Busch 2005), particularly as concerns media hype, ideological conflict, competing ethical values, and knowledge contestation (Kloppenburger et al. 1996; Barham 2002; Lockie 1998, 2006). Typically, agrifood scholars study these and other facets of technological controversies by focusing their inquiries on currently existing technologies as opposed to those which exist more in concept than actual application. As demonstrated by the sociology of expectations literature (Brown et al. 2000; Borup et al. 2006), however, much can be learned by examining the initial expectations which infuse and establish meanings about a technology in the first instance (i.e., before the relevant stakeholders have had the chance to crystallize their perspectives as to what the future outcome of the technology might be). Studying in vitro meat—a nascent agrifood technology whereby meat scientists, tissue engineers, and other researchers attempt to create processed meat products from livestock stem cells—provides such an opportunity. While in vitro meat’s skeptics doubt whether the technology can ever become commercially viable, proponents essentially issue the following response: if they come, we will build it. In other words, provided that expectations about the technology remain positive and sufficient financial/cultural/political support is offered, proponents guarantee that the promise of in vitro meat can be transformed into a reality. In this paper, I use the sociology of expectations to provide a unique perspective on how the discursive struggle over in vitro meat has been waged and how positive expectations can help an embryonic agrifood technology bounce back from repeated cultural, technical, and fiscal difficulties.

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This study thus addresses the following question: how are expectations about in vitro meat shaped by hype, retrospectives on past technologies, and ideological commitments? Put differently, to what extent do positive publicity, recollections about previous food technologies, and rhetorical appeals mutually influence each other to fix understandings about a nascent agrofood technology? In order to address this issue, I conducted in-depth telephone interviews with social actors who I identified as potential stakeholders in the in vitro meat debate.

As noted by Simon and Xenos (2000) p. 363, “The origins of public opinion—the sacred icon of democracy—lay in elite discourse.” The impact of experts and other key stakeholders is particularly pronounced when the public does not have established attitudes towards a particular issue or object and/or the issue does not affect people’s everyday lives (Yin 1999). In vitro meat, an “as-yet undefined ontological object” (Stephens 2010) p. 400, is relevant in both of these instances. Interview data was complemented by a content analysis of in vitro meat media coverage from 2005 to 2011. While the ultimate fate of in vitro meat is yet to be determined, I anticipate that successful promotion of in vitro meat in key stakeholder circles will hinge upon promoters’ ability to distance themselves from the disappointments of previous controversial technologies, align themselves with dominant ideological paradigms, and mitigate the fallout that comes from technological setbacks.

This paper extends existing agrofood scholarship in several important ways. First, while several agrofood scholars have engaged in speculation on the future outcomes of various technologies, the data for this work has often been collected at comparatively advanced stages in the technology’s development. I address this gap by engaging and interviewing potential stakeholders at a point in time before the technology has yet to take off and limited information is available about it. This provides richer detail (and potentially more accurate information) on the incipient stages of a controversy than one might otherwise find in post hoc interviews or archival data. Second, while research on agrofood technology controversies frequently includes a discussion of hype, retrospection, myth, metaphor, and ideology, these concepts have all too often been treated in relative isolation from one another. In drawing upon the sociology of expectations, I expand the breadth of these concepts by illustrating the crucial points of intersection and mutual reinforcement between them. This paper also adds an empirical contribution to both the sociology of expectations literature (where there are few case studies on food and agriculture) and the critical scholarship on in vitro meat (where most published studies are in ethical philosophy or other areas in the humanities). In contrast to the philosophical literature, which focuses

primarily on the cogency and epistemology of the various arguments being offered, I use data from in-depth interviews and media content to analyze how in vitro meat’s stakeholders are putting ethics into action.

In the following section, I examine the story behind in vitro meat thus far—societal justifications for developing the technology, the techniques which have been adopted towards its pursuit, and some of the initial reactions towards the technology. I then discuss my conceptual framework and data collection before proceeding with my analysis.

In vitro meat: a brief history

To begin, the deliberation over in vitro meat takes root within the context of a much older debate—namely, the ongoing polemic surrounding the technologies, techniques, and practices which constitute conventional meat production. Ubiquity notwithstanding, the modern upsurge in meat production and consumption has met with intensified controversies over meat’s associations with natural resource depletion, climate change, food-borne illness, epidemic zoonotic diseases, and the unethical treatment of other species. Traditionally, critics of the modern meat system have argued for personal as well as societal reforms such as the elimination of meat from the diet, reduced consumption of meat products, diminished subsidies for animal feed, more stringent safety regulations, expanded auditing of production facilities, and/or more localized methods of production. Recently, however, advances in tissue engineering and stem cell research have presented a plausible technological solution.

Creating in vitro meat involves deriving processed meat products directly from muscle tissue cultured in vats as opposed to once-live animals (Benjaminson et al. 2002; Edelman et al. 2005; Datar and Betti 2010). Thus far, multiple competing approaches to enactment of this technology have emerged. The first major in vitro meat project involved taking a pre-existing muscle specimen, growing it in a nutrient medium, and then harvesting the surplus muscle (Benjaminson et al. 2002). While NASA temporarily funded this research in the early 2000’s for the purpose of feeding astronauts on long space missions, the technique has since declined in popularity. The next generation of in vitro meat technology—largely inspired by the work of visual artists who specialized in tissue engineering—involved selectively choosing embryonic or adult cells, placing them on a scaffold, growing them in a bioreactor, and exercising them to form muscle (Catts and Zurr 2002; Edelman et al. 2005). Subsequent efforts include: propagating stem cells in small strips and stacking them on top of each other (Kelland 2011); spraying cell

material into sheets and/or other structures using inkjet printing techniques (Bhat and Bhat 2011); and other procedures that continue to evolve (Hopkins and Dacey 2008; Mironov et al. 2009; Langelaan et al. 2010; Bhat and Bhat 2011; Post 2012).

Following the termination of NASA funding, the technological development of in vitro meat is proceeding at a steady albeit non-linear pace (see Table 1). After 4 years of failed attempts at securing funding, scaffolding researchers received €2 million towards their efforts from the Dutch government from 2004 through 2009 (Pincock 2007). Additional support has come from Smithfield Foods subsidiary Stegeman and other private sector actors. More recently, an anonymous philanthropist donated \$330,000 toward the development of the first in vitro meat hamburger (Boyle 2012). The sheer novelty of the approach has captured the imagination of the popular press (Revkin 2008; Ketzler 2008; Specter 2011; Boyle 2012) and provided endless fodder for food and technology bloggers.

Ethical philosophers and other humanities scholars are also raising a host of questions about in vitro meat, specifically as regards patent controls, regulatory processes, labeling, traceability, and the lack of a broader legal-ethical framework on how “semi-living” entities ought to be socially integrated (Zurr and Catts 2003; Catts and Zurr 2006; Armaza-Armaza and Armaza-Galdos 2010; McHugh 2010). In that respect, despite the non-sentience of in vitro meat, McHugh (2010) argues that it invokes many of the same ethical issues as Enviropigs (living animals that have been genetically altered to reduce phosphorous pollution). The Union of Concerned Scientists and Friends of the Earth voice particular concern that the pursuit of in vitro meat will only further consolidate and industrialize food production (Ketzler 2008; Ford 2009). People for the Ethical Treatment of Animals and the Humane Society of the United States nonetheless defend in vitro meat as a positive

step towards reducing animal suffering and environmental degradation, and many ethicists echo this position as well (Hopkins and Dacey 2008; Pluhar 2010; Van der Weele 2010; Welin and Van der Weele 2012; Welin et al. 2012). As Driessen and Korthals (2012) observe, the material and symbolic features of in vitro meat are opening new spaces for social deliberation over the future of food and agriculture. Looming over these and other debates that might take place regarding the upsides and downsides of this technology, however, is the decisive issue of whether or not key stakeholders will be optimistic enough to support future research and development.

What's present is prologue: using the sociology of expectations to examine an agrofood controversy

Agrofood scholarship that has sought to predict the future of various agrofood technologies has yielded interesting and valuable findings. Kloppenburg and Kenney (1984), for example, quite accurately forecasted the economic, social, and political ramifications of the then-embryonic field of biotechnology by exploring the nexus between institutional interests and technological innovation. Studying in vitro meat at the turn of the millennium, however, provides unique analytical challenges and opportunities as compared to biotechnology in the early 1980s. By 1984, Kloppenburg and Kenney note that capital had already embraced what would eventually become the bio revolution (as evidenced by the chemical industry's moves to accumulate seed companies). With in vitro meat, however, the battle for positive expectations is still being waged: despite showing some tentative interest, capital has yet to get off the fence and fully commit to the technology.

Busch (2008) recently speculated on the hype surrounding future agrofood applications of nanotechnology,

Table 1 In vitro meat—key events 2005–2011

Date	Event
April 2005	Dutch government grant for in vitro meat research begins; slated for 4 years
May 2005	Edelman et al. publish commentary on in vitro meat production in <i>tissue engineering</i>
April 2008	In vitro meat symposium held in Ås, Norway
April 2008	PETA offers \$1 million prize for the first commercially viable in vitro meat product
October 2009	Dutch researchers release in vitro meat desk study; Dutch government grant ends
December 2009	Dutch researchers produce 1 cm long strips of in vitro pork
June 2011	Oxford study concludes that the environmental impact of in vitro meat is “substantially lower” as compared to conventionally produced meat
August/September 2011	In vitro meat exploratory workshop held in Gothenburg, Sweden
October 2011	Dutch researcher announces that an anonymous philanthropist has awarded him €300,000 to make an in vitro meat hamburger

noting that investors burned by the disappointments of biotech have been slow to embrace nanotech. What is missing from this work, however, is a close assessment of how the potential stakeholders for nanotech interpret and articulate their understandings about the future of the technology. In what follows, I build and expand upon Busch's approach by using in-depth interviews to observe stakeholders' initial impressions while contextualizing these interviews in the broader media environment through the use of content analysis. The sociology of expectations—a dynamic strain of literature that emerged within science and technology studies in the early 2000s—offers a distinctly helpful framework with which to examine these issues.

Drawing on the social constructivist tradition, sociologists of expectations work to develop more sophisticated and intellectually rigorous ways of analyzing futuristic discourse, namely by critiquing the contexts and practices whereby these discourses are produced and circulated (Borup et al. 2006). Expectations scholars thus aspire to nudge social scientists “from *looking into* the future to *looking at* the future” (Brown et al. 2000), p. 3, emphasis in the original), where the future is accordingly treated as a socially mediated artifact that exists in real time rather than an objective temporal space. Over the years, sociologists of expectations have further expanded this insight by incorporating literature in discourse analysis (Horst 2007), risk and uncertainty (Brown et al. 2000), and the sociology of knowledge (Borup et al. 2006) to further refine analytic understandings of future-oriented deliberations.

A central contention of the sociology of expectations scholarship is that “expectations are both the cause and the consequence of material scientific and technological activity (Borup et al. 2006), p. 286.” Expectations are thus performative—speculation upon what might happen tomorrow makes things happen in the present day, in real time. Positive expectations about future technologies provide guidance for activities, attract attention, mobilize political and economic resources, coordinate between groups, link technical and social concerns, create visions, and enroll supporters (Brown et al. 2000). Negative expectations can threaten to unravel all of these advances, as debate, dispute, and discord as to the veracity of various expectations exacerbates uncertainty (Brown et al. 2000; Brown and Michael 2003; Kitzinger 2008; Williams et al. 2008; Wilkie and Michael 2009). In what follows, I draw upon three key concepts from the sociology of expectations in analyzing the discourse surrounding in vitro meat: hype, retrospective prospects, and the use of myth/metaphor/ideology. I discuss previous treatments of these concepts in existing agrofood literature before illustrating the contribution made to these concepts by the expectations scholarship.

Hype

To be sure, the role of hype in the history of a technology has been noted and discussed by numerous agrofood scholars. For example, the extravagant and unrealized promises made by proponents of genetically modified foods, particularly when the technology was in its infancy, have been well documented (Kloppenborg 2004; Lockie 2006; Meghani 2008). Lehrer (2010), in discussing a similar phase of exuberance in the mid-2000s surrounding biofuels, notes that the actual benefits of ethanol production proved unable to sustain the promises that had been made about them. In developing the concept of *hype cycles*, however, sociologists of expectations expand upon agrofood scholars' understanding of hype by systematically outlining the trajectory and content of hype production according to particular temporal patterns. For example, a certain degree of hyperbole has been shown to be necessary and required in order for nascent technological projects in order to attract initial attention and win critical early support (Geels and Smit 2000; Brown 2003; Borup et al. 2006). Strongly optimistic projections are nearly ubiquitous for new technological projects, and by the same token, such enthusiasm can be seen as a marker of a project that is in its infancy (Brown and Michael 2003). The need to generate hype can also drive research agendas, as scientists may pursue work that leads to breakthroughs, excitement, and more funding as opposed to pursuing the more mundane (but ultimately necessary) incremental tasks. Hype cycles also vary according to the technical and cultural features of the technology in question. As observed by Ruef and Markard (2010), even if a technology fails to live up to the hype as concerns generalized expectations, disappointment can be allayed if the legitimating narrative surrounding the technology remain positive. In sum, the sociology of expectations problematizes the hype that surrounds a given technology by putting it into a political and temporal context while using the history of other technologies as a basis for comparison.

Retrospective prospects

Social actors' experiences with past hype cycles can lead them to see the hype surrounding a nascent technology in a different light. Hence, retrospective prospects—social actors' memories of how they used to think about the future—are a significant influence on today's expectations (Geels and Smit 2000; Brown and Michael 2003; Wilkie and Michael 2009; Ruef and Markard 2010). The unfulfilled promises of the past can sour an audience to promises that sound like more of the same, while an old proclamation that proved the naysayers wrong might nudge otherwise reluctant actors to temper their doubts the next time

around. For example, upon consulting researchers about the relevance of xenotransplantation (a technology which failed to live up to expectations) to contemporary hype about stem cells, Brown and Michael (2003) observed that retrospectives on xenotransplantation tended to calibrate the way in which arguments came to be articulated on both sides (Brown and Michael 2003). The significance of retrospective prospects—what Klein and Kleinman (2002) refer to as “technological legacies” has unfortunately been largely neglected thus far in agrofood scholarship. This concept may prove to be of increasingly relevance in the post-biotech era.

Myth, metaphor, and ideology

Hype cycles and retrospective prospects occur within cultural contexts. The utilization of myth, metaphor, and ideology in the articulation and establishment of future expectations thus concerns the way in which appeals to common sense narratives and taken-for-granted cultural perceptions can shape the degree to which certain expectations about the future gain traction (Konrad 2006; Selin 2007; McGrail 2010). This is not to say that political support or opposition to various technologies is “just ideological” in the pejorative sense; rather, it means that political and cultural commitments are articulated and interpreted through the use of narrative (see Oliver and Johnston 2000 for further discussion). In the aftermath of the cultural turn (Beardsworth and Keil 1997; Buttel 2000)—and, more recently, the quality turn (Goodman 2002)—analysis of ideology and discourse has played an increasingly significant role in agrofood scholarship (DuPuis 2000; Brasier 2002; Lockie 2006; DeLind and Howard 2008). The sociology of expectations can extend these insights by showing how myth, metaphor, and ideology shape the contours of hype cycles while infusing understandings about retrospective prospects with particular meanings and symbolisms. López (2008), p. 1280, for instance, uses the sociology of expectations to illustrate how nanotechnology proponents used sci-fi imagery to instill hype regarding the technology’s prospects: “[sci-fi] images provide the symbolic collateral that bridges the distance between what can now be achieved and what its promoters promise it will realize; it maintains the hype notwithstanding nano’s current operating losses.” Similarly, van Lente (2000), p. 48 demonstrates that appeals to the widely shared cultural notion of “progress” provided high-definition television proponents with the rhetorical leverage needed to curry favorable political opinion and win investments. Here, by disseminating the idea of high-definition television as the next generation of television—whereby “the notion of generation suggests that it is natural to replace it by a new one”—a futuristic “promise” evolved

into a self-fulfilling “requirement” (van Lente 2000), p. 57. At the same time, myth and metaphor can also be used to influence retrospective prospects. For example, in downplaying the relevance of xenotransplantation’s failures to the contemporary hype surrounding stem cell research, stem cell proponents glossed over apparent similarities in the two approaches by making a mythical appeal to the order of nature. Here, xenotransplantation was articulated as “going against basic biology” and “unnatural” whereas stem cell research, in contrast, did not face the same obstacles (Brown and Michael 2003), p. 11. Negative metaphors can be particularly powerful. For example, after the avian flu outbreak at Asian poultry farms, natural disaster allegories were used in the media to trigger arousal and provoke a sense of urgency (Nerlich and Halliday 2007).

Data collection

While hype, retrospective prospects, and myth/metaphor/ideology are constructed and contested by all who choose to participate in civic discourse, stakeholders, experts, and other authorities have traditionally wielded considerably more influence in the marketplace of ideas than lay people. Experts and other stakeholders, given their access to resources and key institutions, thus exist as inherent “gatekeepers” to this marketplace. Stakeholders have long been recognized as critical social actors in food and agriculture discourse, and they accordingly receive a great deal of attention in the agrofood literature (Hjortsø et al. 2005; Lehrer 2010; Neef and Neubert 2011; Fuchs et al. 2011). Stakeholder analysis is also consonant with the expectations scholarship (Williams et al. 2008). As noted by Brown et al. (2000), p. 12, “The future seems no longer to be produced collectively for some subscription to a wider collective set of norms, but consumed through disaggregated stakeholder populations.”

By stakeholders, I am referring to individuals who, by virtue of their knowledge, position, or commercial/legal/academic/political interests can be expected to have a vested interest in the outcome of in vitro meat and may be actively involved in the process by which this outcome unfolds (either through research, lobbying, advertising, financing, networking, campaigning, or some other means). My research accordingly involved in-depth telephone interviews with 22 North American stakeholders in the in vitro meat debate: researchers, environmentalists, agribusiness representatives, food retailers, government experts, animal protectionists, and citizen advocates. Given the lack of a single authoritative perspective on the viability of in vitro meat, using the sociology of expectations to analyze stakeholder reactions proved to offer an optimal fit between conceptual framework and available data.

My data collection approach is rooted in the tradition of theoretical sampling (Glaser and Strauss 1967). Accordingly, the purpose was not to represent views that are statistically significant with respect to the overall population of potential stakeholders. Rather, my objective was to develop *categories* of competing stakeholder positions and perspectives that were useful for illustrating and explaining key concepts (Glaser and Strauss 1967; Charmaz 2000). My units of observation are the individual participants who may well represent—in hindsight—the likely perspectives of these stakeholders. In order to construct my sample, I chose organizations and individuals based on a priori categories which have been useful in observing other food controversies in addition to using participant referrals. Interview accounts are supplemented by public statements made from both North American and European in vitro meat scientists.

I also complement the interview data with a content analysis of in vitro meat media coverage. Using LexisNexis, I searched for all media stories that included the term “in vitro meat” and recovered 259 media entries (including news and magazine articles, selected blogs, and other venues) between 2005 and 2011. I use the media coverage data primarily to further illustrate the in vitro meat hype cycle (see Fig. 1).

Upon collecting the data, I compared the results with the previously identified concepts from the sociology of expectations literature. Had the literature proved to be inapplicable to the data, Merton’s (1973) ideal of pure, autonomous, and asocial scientific production likely would have been on full display: the scientific practice that undergirds in vitro meat would have emerged as immune and distanced from media coverage, expert participants would have regarded the legacies of prior food technologies in isolation from in vitro meat’s own unique characteristics, and study participants would have described the upsides and downsides of in vitro meat in bland language that bore little relation to hegemonic discourses within the broader society. This was not the case. Instead, consonant with the sociology of expectations, efforts to promote in vitro meat in the media created ripple effects which shaped

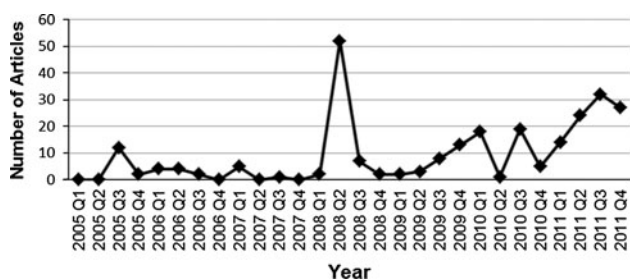


Fig. 1 Number of media articles containing phrase “in vitro meat” (2005–2011)

subsequent research endeavors, participants readily offered their position on in vitro meat in relation to the history of genetically modified foods, and experts on both sides of the debate used mythical and metaphorical appeals in aligning their positions with popularly shared beliefs and values.

Coming soon: the importance of hype in the early stages of technological development

From the very beginning, the promotion of hype and positive expectations about the technology’s technical viability has been a linchpin of the in vitro meat supporters’ strategy (Mironov et al. 2009). As noted previously, expectations about the potential of a given technology are performative, and in vitro meat supporters have managed to generate significant positive momentum by articulating positive expectations in journal articles, popular media, and conferences (see Table 1). Edelman et al. (2005), as inspired by the efforts of Benjaminson et al. (2002) to develop in vitro meat for NASA missions, gave an optimistic assessment as to the feasibility of in vitro meat production in a *Tissue Engineering* commentary. Their efforts paid off, as the article generated a groundswell of interest among peers and the popular media (Schonwald 2009), which led to further research collaborations and eventually economic support from Senter Novem, a scientific funding body for the Dutch government. In several instances, in vitro meat researchers’ positive expectations in the media have been sufficient in and of themselves to win over other researchers. For example, after an article in *The Economist* (2006) reported that “Researchers believe it will soon be possible to grow cultured meat,” a report to the European Union Commission cited this article in arguing that “The technology is not really a wild card because the development is rather feasible” (Cuhls 2008), p. 18.

Much of the in vitro meat research agenda has been driven by a desire to hype the technology and demonstrate its overall potential, work that continues in tandem with the more basic nuts and bolts of incremental scientific work. For example, in order to further advance their cause, in vitro meat proponents commissioned a “Preliminary Economics Study” with eXmoor Pharma Concepts—a biopharmaceutical consultancy—for the purpose of identifying key technical and financial issues (Omholt 2008; Osborne 2008). Many in vitro meat proponents seized upon the positive findings of the eXmoor study to articulate the feasibility of the technology among colleagues and circulate positive expectations in the popular media (DiGregorio 2008). Next, in seeking to assuage environmental doubts about the technology, an in vitro meat publicity group

funded a collaborative study between Oxford and University of Amsterdam researchers. The authors concluded that “In comparison to conventionally produced European meat, cultured meat involves approximately 7–45 % lower energy use (only poultry has lower energy use), 78–96 % lower [greenhouse gas] emissions, 99 % lower land use, and 82–96 % lower water use depending on the product compared” (Tuomisto and Teixeira de Mattos 2011), p. 6117. As they had done with the release of previous scientific papers, in vitro meat proponents took advantage of the findings to rally further support, and the environmental study received positive coverage in the press (Harvey 2011; Meyers 2011).

At times, the desire to do research which generates hype has taken precedence over work intended to achieve more incremental results. Mark Post—a Dutch in vitro meat researcher—went before the media and declared his interest in creating an in vitro meat hamburger rather than work more incrementally on the long-term practical problems. As one journalist reported in *The New Yorker* (Specter 2011), p. 32, “The research is not theoretical, but at this point the Dutch scientists are far more interested in proving that the process will work than in growing meat in commercial quantities.” This phenomenon frustrated one in vitro meat researcher, who told *The New Yorker* “Scientists hate this type of work, because they want breakthroughs, discoveries... This is development, not research. And that is the biggest problem we face” (Specter 2011), p. 32.

The desire to hype a nascent technology, in addition to driving research agendas, frequently corresponds with bold pronouncements and predictions. When I spoke with Bruce Friedrich (People for the Ethical Treatment of Animals) and Vladimir Mironov (an in vitro meat researcher), they referred to the technology as being “inevitable” and “inescapable” in light of increasing population growth and the diminishing availability of land for agriculture. While these types of claims were rejected by Margaret Mellon (Union of Concerned Scientists) as “crazy” and “too simplistic of an analysis,” bold predictions may be a rhetorical necessity for proponents of radically new technologies. If proponents fail to gain the early attention that is required for financial and/or political support, new projects will never get off the ground. Accordingly, not only can expectations and promises create needed momentum toward political and economic resources (particularly for technologies which have yet to demonstrate immediate practical benefits), but technologies that involve high levels of uncertainty require a similarly high promise of potentially revolutionary breakthrough. The idea that an innovation will substitute or replace existing ways of doing things is also another indication of innovations in very early stages (Geels and Smit 2000). As technologies mature

over time, however, expectations tend to evolve as well (Brown 2003). This has already happened to an extent with in vitro meat, and several researchers (both in my interviews and in the media) have sought to be optimistic while downplaying expectations of quick results—a discursive posture which is difficult to sustain when other proponents periodically assert that in vitro meat is only 5 years or so away from hitting grocery shelves.

In vitro meat researchers also argue that if the technology fails it will be due to a lack of hype and public excitement. When I asked one in vitro meat researcher as to whether or not he thought the technology would be commercially successful, he responded

There [are] obviously technical challenges, but they’re not ones that haven’t been overcome ... I mean, it’s already been done. So we’re not talking about whether it could be done, we’re talking about whether or not it could be scaled. ...Anything where there’s an economic or a political or moral desire for, you’ve eventually been able to scale.

Here, he re-articulated in vitro meat’s viability as a political issue rather than a technical one. This sentiment was echoed in my interviews with other in vitro meat proponents. Accordingly, in the event that something goes wrong, or the technology is otherwise underdeveloped, the problem is not the fault of either the science or the scientists (Shackley and Wynne 1996).

In sum, scientists pursuing new technologies often have little other leverage, beyond the circulation of hype, by which to advance their work (Brown 2003). The importance of hype in the earliest stages of nascent technological development is evident in the research papers, feasibility studies, academic conferences, and subsequent media coverage which in vitro meat proponents use to garner attention, network with colleagues, cultivate alliances, and secure as much funding as possible. Moreover, if in vitro meat’s proponents (or other stakeholders) fail to advance beyond the initial game of expectations, they likely will not have an opportunity to compete in later rounds of technological development (Bakker et al. 2011). Perhaps sensing this, the skeptics who I spoke with were quick to contest proponents’ findings, articulate their concerns, and sound the alarm about in vitro meat in the early rounds of the debate. Much of this concern arose from negative retrospectives of other agrofood technologies. In a testament to the power of hype, one participant—Leslie Lowe of the Interfaith Center for Corporate Responsibility—commented that “when these things get rolling, there are no breaks.” Lowe’s recollection exemplifies the way in which retrospective prospects can further contribute to understandings and expectations about the future.

“We’ve heard that before”: retrospective prospects and the long shadow of yesterday’s promises

Participants drew upon their past experiences and memories in order to make sense of the hype surrounding in vitro meat. Sociologists of expectations refer to these understandings as “retrospective prospects,” as social actors draw upon their retrospectives of yesterday’s hopes and expectations when prospecting the future (Brown and Michael 2003). Here, old corporate promises about genetically modified foods and other agrofood technologies loomed large with respect to several participants’ expectations regarding in vitro meat. When I asked Leslie Lowe of the Interfaith Center for Corporate Responsibility if in vitro meat technology could possibly help solve world hunger, she immediately retorted: “We’ve heard that before.” She proceeded to make the following appeal:

When these things get rolling, there are no breaks. And that’s my biggest concern—that as a society, because of the dominant ideology that markets are all knowing and only produce things for the good, which is clearly not the case, we have abdicated—our government has abdicated—its responsibility to protect the public interest. And until we get back to a point where we can really have confidence that government is regulating in the interest of the public—and not just the people who paid for politicians’ campaigns—I’d be very, very suspicious of new technologies.

Not only does this comment reaffirm the scars that can be left by the unfulfilled expectations of previous technologies, but it also reaffirms the performative ability of expectations with respect to generating momentum and marshaling resources. Participants’ expectations with respect to the future of in vitro meat were also shaped by the legacies of existing regulatory structures, systems that had left several participants disappointed and wary towards future agrofood technologies. Here, Patty Lovera of Food and Water Watch characterized her initial impression towards in vitro meat as “wait and see, combined with skepticism”:

Every technology in the last 15 years or so... everything just gets rubber stamp approval. And, you know, 15 years later people are still asking questions about whether they want to eat it... The burden is always on people to prove it’s unsafe, and there’s not as much burden on the producers to prove that it’s safe, and we think that’s backwards.

This comment thus articulates in vitro meat as being—at least potentially—only the latest incarnation in a series of inadequately reviewed food technologies.

Another significant historical legacy which has shaped in vitro meat discourse concerns the past work of in vitro meat researchers themselves. Several in vitro meat researchers have frequently criticized each other’s respective production technique, sometimes publicly. In the Dutch publication *NRC Handelsblad*, in vitro meat researcher Henk Haagsman sharply criticized Morris Benjaminson et al. (2002) in vitro meat research for NASA as “very funny to read (about)” and “not efficient” (Heselmans 2005). This type of practice mitigates doubts about scientists’ own work by distinguishing it from the alleged shortcomings of their peers. It also pre-empts future disappointment with in vitro meat as a whole by attributing failure to individual actors rather than the entire field. Another in vitro meat researcher similarly found fault with Benjaminson’s approach. For this critic, the NASA funded research had helped to give in vitro meat a marginal, almost comical brand within the scientific community:

I mean, when my colleagues see it in print, they, you know, I get calls, and I get teased a little bit, to where—you know, I still see a lot of the references go back to this, you know, NASA hamburger... If you have to haul more nutrients up there than it takes you—than is in the nutrient content of what you harvest—why would you do that? ... So there’s discounting of sort of the entire field because of that. As much as it was interesting to get some interest from NASA at that time, and some funding, and some folks who were able to advance the field a bit and learn some things, on the other hand, you know, some of the spin of that... has been detrimental.

This debate demonstrates that the stakes for protecting hype and pre-empting negative retrospectives are so high that in vitro meat researchers will even criticize each other—publicly—lest their colleagues (perceived) missteps make them lose face by virtue of association. When reporting on the results from the Dutch government research grant, Haagsman et al. (2009) and his colleagues were similarly apprehensive about a possible decline in hype following the circulation of unrealistic expectations in previous years. In an unpublished study that was released online, Haagsman et al. (2009), p. 38 wrote that “Coverage by the media has been beneficial for public awareness and initiating discussions about innovative ways to produce animal proteins. On the other hand, media attention raised high expectations by citizens and media alike... If research continues at the present pace and progress remains slow, the present enthusiasm for the technology may dwindle.”

As illustrated in Fig. 1, the high water mark of media entries occurred in April of 2008, when PETA announced that it would pay a \$1 million prize for the first commercially viable in vitro meat product. In 2009, however (the

same year that Haagsman et al. wrote the aforementioned report), there was a precipitous drop in media interest: the grant provided by the Dutch government had come to an end, and there was little available funding to conduct additional research and stoke further excitement. Again, finger-pointing ensued. According to *Scientific American* (Bartholet 2011), p. 64, Willem van Eelen—an in vitro meat patent holder and long-time proponent—called one of the Dutch researchers “stupid” while lamenting “I don’t know what they did in 4 years—talking, talking, talking—every year taking more of the money.” Meanwhile, as anticipated by Haagsman and his colleagues, signs of disillusionment and impatience in the public arena were beginning to show. One headline in a popular technology blog read “10 years in, lab-grown meat still stuck in its infancy” (Loftus 2011), while a similar headline appeared in a popular blog on food culture: “In-vitro meat still not on the table” (Best 2011).

In sum, no technology emerges in a historical vacuum, and as such retrospective prospects are critical to social actors’ understandings of hype. Past experiences with related food technologies, the regulatory regime, mass production, and in vitro meat’s own history all guided stakeholders’ expectations about in vitro meat’s future. Beyond retrospective prospects, however, another critical dimension in the formulation of future understandings is the cultural realm of myth, metaphor, and ideology. It is in this domain that the hype surrounding in vitro meat has oscillated between fragility and resilience, thus exhibiting a kind of discursive dualism.

Building (rhetorical) bridges to the future: the role of myth, metaphor, and ideology

Myth, metaphor, and ideology provide the fuel to the fire for hype and retrospective prospects. Not surprisingly, many participants (including in vitro meat’s supporters and opponents) articulated in vitro meat within the context of ecological modernization, a business-oriented ideology that has come to dominate environmental discourse (Hajer 1995; Dryzek 1997; Adger et al. 2001). For instance, throughout my interviews, both in vitro meat supporters and skeptics championed the cause of “efficiency,” a core value of ecological modernization. Thomas Powell of the American Meat Science Association made an appeal to the myth of scientific progress in describing in vitro meat as “the ultimate for any food processor—just dial up what you want for the consumer.” By praising the technology as “the ultimate,” Powell articulated in vitro meat as the zenith of high technological progress for his colleagues in the food sciences. Other participants who were optimistic about the technology made similar use of the scientific

progress mythology. One in vitro meat researcher commented that while usually the goal of science is to get closer to Mother Nature, here, the goal was to “optimize” naturally occurring processes. Pursuant to the progress mythology, this comment articulates in vitro meat as being even better than real thing. Appeals to this narrative were also heard in the interviews with animal rights advocates: Paul Shapiro of the Humane Society of the United States argued that in vitro meat was like any other technology that improves efficiency. Not only does this statement frame in vitro meat within the context of a technological trajectory wherein we can continually do things better and better, but it also frames in vitro meat as being not unlike other technologies which seek to refine production practices.

In vitro meat proponents also sought to articulate the technology as safe and natural. Vladimir Mironov, an in vitro meat researcher, commented that the FDA considered cell culture products to be “natural” so long as they didn’t involve genetic engineering. Another proponent, in comparing in vitro meat to hydroponic tomatoes, argued that researchers were simply creating the same product with a different process. This type of metaphoric linkage associates in vitro meat with a product that is arguably regarded as safe and familiar, despite its alternative production practices (thus distancing in vitro meat from Frankenfood metaphors).

In contrast, those who were less optimistic about in vitro meat drew upon their own myths, metaphors, and ideologies. One meat industry specialist used mythical imagery in his interview to articulate in vitro meat as being too fantastical. He argued that the technology seemed like something from Star Trek, and that maybe people would consume something like in vitro meat when they lived on Mars. By invoking a vivid sci-fi metaphor and “what if” scenarios, this argument associated the technology with being about as realistic as a TV show. Other participants drew upon populist, anti-business ideology to express their skepticism. As noted earlier, one environmentalist used the metaphor of “rubber stamping” to describe the regulatory history of previous food technologies and articulate that history in relation to in vitro meat.

Perhaps the most iconic negative metaphors concerning in vitro meat, however, have emerged online. For years, an ongoing stream of comments on online message boards and blogs have referred to in vitro meat as “shmeat (shit + meat),” “Frankenfood,” and “Soylent Green” (a reference to a dystopian 1970’s science fiction film wherein humans were secretly being fed to one another), among other derogatory labels. The staying power of these pejorative connotations illustrates both the fragility and instability of in vitro meat’s image in popular culture and the power of myth and metaphor to shape commonsensical understandings. Should in vitro meat become more prominent, the

resuscitation of Frankenfood and other familiar symbols in the coming debate would likely serve as a clarion call for many foodies (particularly among enthusiasts of slow foods, farmer's markets, do-it-yourself slaughter, and other local foods activities). Accordingly, Jaydee Hanson of the International Center for Technology Assessment was convinced that the novelty of *in vitro* meat would bring with it a zero tolerance standard and increased public sensitivity with respect to food safety issues. He commented to me that "if it has any potential health problems, whoever's doing this can forget it."

In addition to fixing understandings about nascent technologies, myth, metaphor, and ideology can also be used to shape retrospective prospects by re-articulating the legacy of modern technology. In his interview, Thomas Powell of the American Meat Science Association emphasized that modernity had witnessed countless technological developments which had gone on to prove the naysayers wrong. "It's mind-boggling what we can do today," he argued. Similarly, in a previously stated passage, one *in vitro* meat research invoked the myth of progress by arguing that if there was a will to scale-up the technology, there was a way—a time-tested appeal to the nation's ability to accomplish its most important priorities through science (e.g., Kennedy's determination to land on the moon).

Myth, metaphor, and ideology play another crucial role in the shaping of future expectations. Should advances within the *in vitro* meat community and related fields fail to meet technical expectations, disappointments might also be allayed if the overall ideological imperatives which legitimated the technology remain positive (so long as the promises of *in vitro* meat researchers are successfully transformed into attainable requirements). If the expectations continue to be positive but the legitimating narrative is lost, *in vitro* meat will likely need to be re-articulated in accordance with a new narrative in order to regain its social legitimacy (Ruef and Markard 2010). Therefore, unless there is a collapse of both the technical expectations and the values which undergird *in vitro* meat's support, the pursuit of the technology is likely to persist despite potential setbacks.

One poignant example of the material and discursive buoyancy provided by a legitimating ideology is the recent \$330,000 donation by an anonymous philanthropist towards the production of a single *in vitro* meat hamburger. As reported by MSNBC (Boyle 2012), one *in vitro* meat researcher explained that the philanthropist was "interested in 'life-transforming technologies' and (believed) lab-grown meat could revolutionize the food industry." The announcement of the award, in October 2011, also provided a surge in media hype. Once again, thanks to a legitimating ideology, *in vitro* meat was back. The

Telegraph, a popular British newspaper, posted the following headline: "First artificial burger to cost £220,000; Artificial meat created in a lab could be ready to eat within 6 months" (Collins 2011).

In sum, *in vitro* meat proponents have seized upon the hegemonic discourses of efficiency and progress in order to legitimate and sell their core ideological concerns for animals, the environment, and public health. While negative cultural metaphors like Frankenfood have been used to stigmatize *in vitro* meat and associate it with retrospectives of other controversial agrofood technologies, the ideological promise of *in vitro* meat as savior from the woes of conventional meat production has thus far safeguarded it from falling into obscurity.

Discussion

In this paper, I explored the potential fault lines of future debate over *in vitro* meat by illustrating the critical interconnections between hype, retrospective prospects, and myth/metaphor/ideology. Despite sluggish results and financial setbacks, the controversial legacy of previous food technologies, and persistent cultural skepticism, the core ideological justifications for *in vitro* meat have generated enough positive hype to buoy the technology through rough discursive waters.

The findings and conceptual tools from this study have three important implications. First, the case study of *in vitro* meat suggests that there is much to be learned from studying emerging agrofood technologies before understandings about them (and the fault lines of the debate) have fully crystallized. Given the lack of available data on the technology, many of the study participants who professed either agnosticism or skepticism toward *in vitro* meat also noted that they were not fully committed to their positions. Getting stakeholders' initial expectations about an agrofood technology on record provides useful comparative material upon which future analyses can be based. Subsequent research of *in vitro* meat can now draw upon the current study and provide further clarity as to how stakeholder expectations influence both the trajectory of the debate and the material development of the technology itself.

Second, this study demonstrates how the sociology of expectations can be used to illuminate the context with respect to how agrofood technology debates unfold. While much of the agrofood scholarship has discussed media hype, historical context, ideology, and related themes, these accounts can be further expanded by considering the ways in which these concepts are intertwined and mutually reinforcing. Consistent with literature in the sociology of expectations, findings from the *in vitro* meat case suggest that some degree of hype is necessary in order for nascent

technologies to win early attention and support. Hype, however, is a double-edged sword: if the technology is unable to live up to expectations, disinterest and disillusionment may ensue. The positive effects of hype can also be blunted by stakeholders' retrospectives on disappointing technologies that were hyped in years past. Technologies may nonetheless survive these setbacks and earn second chances if they are durable in the ideological battlefield. Assuming that the problems associated with modern meat production and consumption continue to persist, the legitimating narrative behind in vitro meat is thus unlikely to go away anytime soon.

Finally, observing stakeholders' reactions to novel technologies proved to be fruitful in its own right. In this study, musings on a future world in which meat comes from laboratories revealed deep-seated, commonsensical understandings as to whether or not food technologies should inherently be regarded with skepticism, what the "real" problems with the current food system are, whether technological development was truly a technical (as opposed to a social) issue, how nature ought to be treated and regarded, and, more generally, how we ought to live as a society (for a historical perspective, see Belasco 2006).

By studying emerging technologies, agrofood scholars have the potential to make unique and timely contributions to debates which might otherwise succumb entirely to the forces delineated in this paper: hype, retrospective prospects, and myths/metaphors/ideologies. In the embryonic debate over in vitro meat, discursive resources are being marshaled and deployed by proponents and skeptics alike. While these forces are important sources of guidance and meaning making for stakeholders and others (academics included), we need not be beholden by them in setting an informed research agenda for the future of the agrofood system. By exploring these and other discursive features of a potentially broader controversy early on, agrofood scholars can crack open a window onto what might have been as well as what could be.

Acknowledgments This article would not have been made possible without the generous feedback and comments from Jack Kloppenburg and Daniel Kleinman. The author would also like to thank Harvey James, the three anonymous reviewers, Mike Bell, Susan Squier, Emiko Ohnuki-Tierney, Susan Lederer, The University of Wisconsin-Madison Department of Community and Environmental Sociology, and all of those who participated in the study. Any errors or omissions are the author's alone.

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