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Food prosumption technologies: A symbiotic lens for a degrowth transition

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Abstract

Prosumption is gaining momentum among the critical accounts of sustainable consumption that have thus far enriched the marketing discourse. Attention to prosumption is increasing whilst the degrowth movement is emerging to tackle the contradictions inherent in growth-driven, technology-fueled, and capitalist modes of sustainable production and consumption. In response to dominant critical voices that portray technology as counter to degrowth living, we propose an alternative symbiotic lens with which to reconsider the relations between technology, prosumption, and degrowth living, and assess how a degrowth transition in the context of food can be carried out at the intersection of human-nature-technology. We contribute to the critical debates on prosumption in marketing by analyzing the potentials and limits of technology-enabled food prosumption for a degrowth transition through the degrowth principles of conviviality and appropriateness. Finally, we consider the sociopolitical challenges involved in mobilizing such technologies to achieve symbiosis and propose a future research agenda.

Keywords

degrowth, prosumption, sustainability, technology, symbiosis

Introduction

“Self-providing is great, but it needs advanced technology to be liberating, which is a crucial departure from one strand of the self-reliance and sustainability movements, which had promoted the return of historical, low-tech methods” (Schor, 2010: 106).

Technology-enabled food production processes in which individuals and collectives increasingly participate offer societal benefits far beyond self-providing and self-reliance, as Schor’s statement suggests. Such co-creative processes—termed prosumption in marketing and consumer research (Alhashem et al., 2020; Ritzer, 2014; Xie et al., 2008)—can meet consumption needs while offering an alternative to the current global food production system. Indeed, prosumption has the potential to play an essential role in transforming the industrial food production system, thereby overcoming troubling distances between what consumers eat and how their food is produced (Veen et al., 2020). Prosumption has been described as a post-consumption phenomenon associated with finding alternative ways of producing and consuming, consuming less (Carrington et al., 2016), and reimagining different kinds of relations between human and more-than-human beings (Arnould, 2022; Chatzidakis et al., 2014; Scaraboto, 2022). Consumers are increasingly engaging in food prosumption through community gardening, alternative food networks, and politically motivated consumerism (Press and Arnould, 2011; Shaw et al., 2016). Food prosumption allows consumers to establish new collective identities, to act on their values and ideological orientations toward sustainability (Shaw et al., 2016), and to take up new roles and responsibilities when it comes to managing their food consumption (Dusi, 2018; Moraes et al., 2010; Shaw et al., 2016).

As consumers’ interest in food prosumption grows, food prosumption technologies (FPTs hereafter) are increasingly offering tools and practices that reconfigure and reduce

dependence on conventional food production systems (Beacham, 2018). Examples of such FPTs include urban rooftop farms that use vertical technologies (e.g., Agripolis), individual prosumption technologies such as soilless indoor gardens (e.g., Natufia), and groundless, modular, small-footprint systems for growing food (e.g., Hexagro). FPTs also include digital solutions that facilitate food production by consumers in urban apartments, offices, schools and public spaces (e.g., Agrove), and AI-operated regenerative prosumption communities (e.g., ReGen Villages). Through indoor, vertical, soilless food production technologies, consumers and local businesses produce organic food that is free of cross-contamination and pesticides, which Monbiot (2020) suggests could play a significant role in restoring the environment. Such technologies apply biomimicry principles that mirror the structure and function of the natural ecosystem and its organisms to deliver more sustainable and local food system solutions.

Prosumption gains momentum (Anderson, 2012; Scaraboto, 2022) among the critical accounts of sustainable and ethical consumption that have enriched the current marketing discourse (Bradshaw and Zwick, 2016; Coffin and Egan-Wyer, 2022). Besides, attention to prosumption is increasing as the degrowth movement is emerging as an alternative perspective through which to tackle the contradictions inherent in growth-driven, technology-fueled, capitalist modes of sustainable production and consumption. Degrowth stresses meaningful and collectively consented sustainable futures (Chatzidakis et al., 2014; Lloveras et al., 2018, 2022; Varey, 2010) and provides a critical outlook on the role and impact of alternative provisioning systems (Lloveras and Quinn, 2017). Sustainability, in a degrowth scenario, is a political stance that gives valuation to people, nature, and communities in the context of a finite scheme of resources (Varey, 2010). Despite the potentials this scenario represents, researchers have yet to give sufficient attention to the connections between degrowth and sustainability (Lloveras et al., 2022) and to the role of technologies in the transition toward degrowth living (Kerschner et al., 2018). Indeed, technology and degrowth have been viewed as irreconcilable,

with critical voices overwhelmingly portraying technology and techno-social imaginaries as counter to degrowth living (Castoriadis, 2005; Ellul, 1964; Illich, 1973). This disproportionality in scholarly accounts highlights the need for an alternative lens to reconsider the relations between technology, prosumption, and degrowth living (Lloveras and Quinn, 2017; Lloveras et al., 2022; Scaraboto, 2022).

In this conceptual article, we contribute to the critical debates in marketing about prosumption (Ritzer, 2014; Xie et al., 2008) by analyzing the potentials and limits of technology-enabled prosumption in a transition toward degrowth living. Recognizing the technology-degrowth controversy, we propose an alternative symbiotic lens to assess how a degrowth transition in the context of food can be carried out at the intersection of human-nature-technology. Symbiosis refers to a type of relational interaction wherein different actors live together in “companionship,” “diversity,” and “inclusiveness,” which maintain the vitality and viability of all life forms (Albrecht, 2019; Rod and Kera, 2010). Symbiosis, which underlines the interconnectedness of human and more-than-human beings and problematizes dyadic human-nature relationships (Arnould, 2022), has been seriously disrupted by an industrial food system predicated on growth and profit maximization. This disruption alienates consumers from food production and food sources (Albrecht, 2019). We critically examine how FPTs, when used in support of a degrowth transition, can achieve or challenge symbiosis through the degrowth principles of conviviality and appropriateness. We conclude by considering the broader sociopolitical and environmental implications of FPTs before proposing a future research agenda for critical marketing scholars on the applicability of a symbiotic lens and the degrowth principles of conviviality and appropriateness.

Prosumption revisited

Prosumption is not a new phenomenon, yet it has evolved by means of epochal shifts. While self-sufficiency in food production was the norm in the pre-industrial era, in the industrial era, which was characterized by a clear separation between production and consumption, people began to produce food predominantly for exchange. In the post-industrial era, which Toffler (1980) calls the third wave, technological advancements and shifts in cultural and economic models (e.g., an increase in sharing and circularity) led to a blurring of the distinctions between production, provisioning, and consumption (Veen et al., 2020). As the digital era dawned, these changes enabled people to willingly engage in prosumption activities in digital spaces (Ritzer, 2014) and to produce value for themselves and others (Alhashem et al., 2020).

Prosumption has been recognized as a new consumer competency (e.g., Cova and Cova, 2012) that departs from a romanticized past in which consumers were all producers (e.g., Firat and Dholakia, 2006) and whose emergence has evoked a celebratory sentiment in the marketing field. The making of the current consumer subject, who is autonomous, agentic, productive, and ultimately reflexive, is a process brought about by different drivers, including paradigm shifts, technological and ideological changes, and the rise of environmentalism. In Cova and Cova (2012)'s account, paradigm shifts, like the postmodern turn and relationship-oriented approaches, as well as innovative technologies have catalyzed the emergence of this new consumer who is both willing and capable of co-creating value.

Recent politico-ideological analyses have documented the trajectories of “consumership” (e.g., Bajde and Rojas-Gaviria, 2021; Giesler and Veresiu, 2014) and the marketing-dominant project of constructing the consumer subject under neoliberalism (e.g., Lambert, 2019). This more or less “ideologized” consumer subject is conscious, moralistic, and responsible for practicing or “producing” contributions to the sociopolitical agenda of the day. Such an agenda typically includes values of environmentalism, well-being, and economic

stability. Studies of the neoliberal consumer subject paint a portrait of an agent who contests the dominant market system (e.g., Thompson and Kumar, 2021), and collectively mobilize the public to resist the system (e.g., Fontenelle and Pozzebon, 2021). This critical literature intensifies the political stakes of an increasingly political term—the consumer.

Prosumption, originally theorized as an added “face” or role of the consumer (Cova and Cova, 2012), has now become a political act. It has also become a conspicuous characteristic of individuals and local businesses who contribute at different levels to desirable socio-politico-cultural causes as they are responsabilized, using different capacities and methods (Bajde and Rojas-Gaviria, 2021; Giesler and Veresiu, 2014; Thompson and Kumar, 2021). This shift makes prosumption more “meaning-full” as a principle and a practice. That is, the *pro* in prosumption now not only stands for production but also signals a stance on the part of consumers who favor and actively support certain modes of consumption. One such mode is sustainable consumption, a relentlessly elusive agenda.

Yet, contrary to capitalist modes of sustainable consumption and production, life modes that are simpler (Alexander and Ussher, 2012), decelerated (Husemann and Eckhardt, 2019) and more critical (Prothero and McDonagh, 2021) all converge upon an alternative political economy of conducting businesses as (un)usual: the degrowth mode of being. Despite the compelling discourses and scholarly narratives around degrowth living and consumer lifestyles, the marketing literature lacks descriptions of what constitute our new habits of living and day-to-day prosumption practices in the post-growth era we are entering (Chatzidakis et al., 2014; Lloveras et al., 2018, 2022). We argue that degrowth provides a meaningful perspective through which to theorize and critically assess the role of alternative economies and provisioning systems (Lloveras and Quinn, 2017). Drawing on this perspective, we ask whether and how technology can provide the key to a degrowth life mode by making meaningful incisions to a current food system in the post-growth economy.

Degrowth living

Degrowth refers to the “planned reduction of energy and resource use designed to bring the economy back into balance with the living world in a way that reduces inequality and improves human well-being” (Hickel 2021: 1). Moving beyond the dominant market logic centered on growth and endless consumption, the organization of degrowth prioritizes simple living and conviviality by restructuring and relocalizing production and consumption and more generally rethinking our relationships with nature and technology (Latouche, 2009).

A transition toward degrowth living is being heralded as the only viable way to address and implement sustainable living for all (D’Alisa et al., 2014; Kallis et al., 2012; Lloveras et al., 2022). Marketing and consumer research has explored degrowth-compatible consumer lifestyles such as voluntary simplicity, anti-consumption, and slow and mindful experiences (Lloveras et al., 2022). More broadly, scholars have acknowledged the irreconcilability of growth-driven capitalism with desired models of sustainable consumption and production predicated on a fairer use of resources (Carrington et al., 2016; Chatzidakis et al., 2014; Lloveras et al., 2018, 2022). The current convergence of crises (e.g., climate change, Covid-19, an increasing scarcity of resources) calls for an increased commitment to boosting a transition to degrowth (Buch-Hansen, 2018). This transition requires wider societal changes and shifts in value systems (D’Alisa et al., 2014) that include choosing conviviality, sufficiency, and cooperative communal action for well-being over the endless pursuit of growth, efficiency, and material pleasures (Lloveras et al., 2022). Sufficiency-oriented lifestyles ally with the principles of degrowth living by aiming to reduce overall consumption levels and/or shift to a consumption mode that is less resource intensive (Sandberg, 2021). Such lifestyles are more responsible (Carrington et al., 2016) and focus on reducing negative environmental impacts (Spangenberg and Lorek, 2019).

McGreevy et al. (2022) argue that sustainable food production systems for a post-growth world function under the principle of sufficiency. Under this principle, food production is organized to ensure adequate and equitable fulfillment of the needs of all who are involved in food production and consumption (Liegey and Nelson, 2020). Sufficiency thus recognizes the rights and needs of more-than-human beings (McGreevy et al., 2022). Food production practices that pursue sufficiency instead of growth-induced conceptions of efficiency are integral to post-growth agrifood systems (McGreevy et al., 2022). Though advanced technologies may have rendered products and services more efficient, a capitalist, growth-driven model has largely emphasized satisfying consumers' growing wants and desires "efficiently," instead of satisfying their needs "sufficiently" using less energy and fewer resources. The practice of sufficiency requires conviviality, which is framed as a collective consciousness for prosuming a quantity of goods that is 'just' sufficient for the optimal well-being of all, human and non-human alike (Princen, 2005). Sufficiency-oriented practices offer opportunities to support more environmentally friendly "Lifestyles of Enough," by providing appropriate materials, spaces, and skills (Kropfeld, 2022: 1).

A degrowth transition requires shifts in value systems in addition to relational changes between human and more-than-human actors (Chatzidakis et al., 2014). As Kallis et al. (2014: 4) note, "in a degrowth society everything will be different: different activities, different forms and uses of energy, different relations, different gender roles, different allocations of time between paid and non-paid work, and different relations with the non-human world." Food prosumption practices are potentially constructive levers of such changes for a degrowth transition (Cristiano et al., 2020). In this context, reshaping provisioning systems to ensure social and environmental well-being for all is crucial. Yet the ways in which "such provisioning systems can link resource use with social outcomes, for both physical systems (infrastructure and technology) and social ones (governments and markets)" (Hickel et al., 2022: 402) demand

further research. Moreover, technologies that enable different relations between human and more-than-human worlds and that permit “the possibility of a postindustrial society in which several distinct modes of production would complement each other” (Illich, 1973: 104) must be included in this degrowth scenario (Vetter, 2018).

Degrowth and technology, an inextricable paradox

Debates about the role of technology in advancing sustainable growth are ongoing. Eco-modernist perspectives emphasize the power of technology to generate eco-efficient solutions to environmental problems (Grunwald, 2018). In contrast, others warn of a dangerous indifference toward technology’s risks and unwanted effects in a sustainable growth scenario (Kerschner et al., 2018). In line with these detractors, critical marketing scholarship argues that a technology-led solution to the environmentally devastating effects of capitalism is a “fetishistic disavowal of reality” that, while profitable, represents a limited form of progress (Bradshaw and Zwick, 2016: 267; Cronin and Fitchett, 2020).

Degrowth proponents question the necessity of economic growth for human and more-than-human well-being. They argue that dominant eco-modernist discourses must rethink our relationship with technology, democracy, sufficiency, and well-being (Grunwald, 2018). Degrowth scholars focus on imagining alternative futures that transform how we frame the role and impact of technology on our lives, including how technology can equitably reshape production and consumption (Pansera et al., 2019). Regarding the transition toward degrowth living, Heikkurinen asks (2018: 1655), “what kind of technology is necessary to fulfill needs in a degrowth society?” Deepening this inquiry, we ask what kind of relationships between human and more-than-human worlds, including technology and nature, must develop for a degrowth transition to occur.

Critical accounts of modern technologies (Castoriadis, 2005; Ellul, 1964; Illich, 1973; Schumacher, 1973) emphasize modernity's obsession with constant progress through humanity's unequivocal belief in science and technology. From this perspective, any technological fix to environmental issues is merely a techno-fetishist solution nurtured by capitalistic ideology. Researchers warn that technological innovations risk being co-opted by growth-minded corporations in ways that could ultimately increase energy consumption, with the result that scaling up in sustainable ways to confront dominant provisioning systems poses challenges (Kallis et al., 2012; Zacaes et al., 2021). Technology has thus remained a focal concern for degrowth scholars (Martínez-Alier et al., 2010).

Illich's reflections on technology center on creating a subsistence society imbued with conviviality, solidarity, and voluntary simplicity, leading to decreasing dependence on markets and the state (Samerski, 2018). The technology-degrowth paradox that these accounts emphasize derives from the neoliberal appropriation of technology, which not only fuels growth but encourages a techno-utopian fantasy concealing the realities of ecological destruction and concomitant threats to human health (Cronin and Fitchett, 2020). This appropriation of technology is especially the case in food production and consumption, where technology implies extensive mechanization and genetic modifications and is a source of pollution and foodborne illness (Stuart and Worosz, 2013). Nonetheless, in a degrowth scenario, technology is considered an essential catalyst for understanding, predicting and repairing nature (Canniford and Shankar, 2013).

Degrowth proponents suggest that technologies need to be reappropriated to enable participatory decision-making in consumption and production compatible with degrowth living (Samerski, 2018). In degrowth living, a radical dissociation of "consumption from the desire (namely, the constant lack and impossible pursuit of pleasure) that fuels it" (Scaraboto, 2022: 14) promotes a mindset where we produce to use. A degrowth mindset consequently requires

a transformation of institutional actors in such a way that consumers increasingly become producers, makers, and fixers. It also requires a decrease in throughput to avoid the depletion of more-than-human beings.

In this context, technology should be appropriated to construct the social and material conditions necessary to instilling degrowth values of autonomy, sociality, and care for the environment (Garcia et al., 2018; Likavcan and Scholz-Wackerle, 2018). The goal of technological innovations should be to (1) initiate a shift in value systems that enable equitable living for all and participatory production (Latouche, 2009), and (2) generate tools and systems that enable prosumption practices that are convivial and pleasurable and allow for mutualist frameworks of growth (Meadows et al., 1972). Such shifts in value systems align with recent calls to raise the mean market morality (Coffin and Egan-Wyer, 2022). With this end in mind, the potentials and limits of FPTs for a degrowth transition can be assessed along the axes of conviviality and appropriateness (Kerschner et al., 2018), which enable symbiosis between human and more-than-human worlds.

Convivial FPTs for a degrowth transition

Many degrowth proponents criticize growth by focusing exclusively on material technologies and their ecological implications (D'Alisa et al., 2014). Yet such criticisms rarely consider the relationship between humans and their technological tools (Ellul, 1964; Schumacher, 1973). Convivial tools (Illich, 1973) refer to instruments and institutions by which humans realize their intentions (Cayley, 2005), satisfy their needs, and enhance social solidarity, mutual giving, and companionship. These tools can be modified and adapted by their users, who can decide when and whether to use them (Samerski, 2018) and who learn by doing. Convivial technologies offer autonomy and creativity to users to express their intentions and values (Illich, 1973).

To showcase how FPTs could become convivial tools, we mobilize three dimensions from the degrowth literature: connectedness, responsabilization, and accessibility. These dimensions reveal “caps” or performative limits to FPTs that shape the transformative potential of degrowth living (Coffin and Egan-Wyer, 2022) and that are themselves shaped by various sociological, technological, economic, and material forces. These limits can redirect attention and interest toward degrowth living to slow environmental degradation and ‘buy time’ while critical scholars and activists assess degrowth’s potential for averting apocalyptic scenarios (Bradshaw and Zwick, 2016; Coffin and Egan-Wyer, 2022). Indeed, degrowth perspective may provide a space for critical marketing scholars to examine contexts where “consumption is arguably not the primary unit of analysis” (Fitchett et al., 2014: 503) and technology’s potential for a degrowth transition can be assessed in the current food system.

Connectedness. Conviviality signifies the connectedness among human and more-than-human beings. When attributed to technologies for degrowth living, connectedness implies alternative production modes that are more inclusive and participatory (Vetter, 2018). Connectedness among technology, humans, and nature addresses concerns about how technology interacts with living organisms and how technologies may enable caring (e.g., caring for nature, supporting health, enhancing the quality of soil, water, and air) (Vetter, 2018). These concerns highlight how enhancing connectedness between human and more-than-human beings through technological intermediation can enable symbiosis (Vetter, 2018). For example, vertical farming technologies that do not need soil or sunlight influence our way of seeing and valuing nature’s inherent qualities and the meanings we attach to food regarding taste and nutrition. How is symbiosis achieved and simultaneously challenged in this scenario?

Historically, nature has been perceived as a passive, static entity—a domain of objects that are regulated by scientific laws and that form a background against human activity (Heidegger, 1966). From this understanding, the fusion of human institutions and modes of

thought with the industrialized food system emerges as a cultural response to the challenge of controlling nature, provisioning food, and harnessing material objects for growth and profit, while continually reinforcing the alienation between humans and nature (Descola, 2013). Indeed, counter-modernist accounts of the nature-human relationship argue that technological advances disrupt the holistic balance of nature and encourage alienation by fueling humans' insatiable urge to perceive nature as inferior and to exercise control over it. These accounts argue that a non-controlling reconnection to nature is only possible by escaping such alienating technologies (Thompson and Troester, 2002: 558). From these perspectives, then, the question of whether FPTs offer the potential to bring people back into an alliance with nature by reducing human control and domination over nature (Beacham, 2018) remains vital.

Indeed, concerns about affordability, efficiency, and environmental effects (Kalantari et al., 2018) arise in response to indoor FPTs that often integrate LED-light technology and create a fully controlled environment for food production. Alternatively, urban and local collectives that adopt FPTs can enable individual and collective prosumers to grow food without soil while still benefiting from the natural energy source of the sun and thus avoiding LED-supported food production. In so doing, they establish a more balanced symbiosis between humans, nature, and technology. Such efforts also convert public spaces, corporate gardens, and apartment gardens into shared food prosumption platforms and micro-oxygen generators while mixing different zones of production, consumption, and living in urban locales.

McGreevy et al. (2022) argue that urban gardens as small-scale food prosumption platforms are essential to sustainable post-growth agrifood systems. These platforms contribute to food security as they often require few fossil fuels and energy inputs, while they promote biodiversity conservation by encouraging the growth of medicinal plants and ingredients for consumption by domestic animals (McGreevy et al., 2022; Ricciardi et al., 2021). Such

collective initiatives contribute to a sense of well-being in urban areas as people become more physically active and “directly engaged in creative stewardship of their home places, creating communities in the process and enabling multispecies well-being” (McGreevy et al., 2022: 3). Hence, FPTs in home and urban gardens can potentially cultivate deeper nature-human connectedness. Moreover, these FPT-supported initiatives provide a different avenue for nature-human connectedness than by fleeing to a romantically infused wilderness untouched by humanity (Canniford and Shankar, 2013) or seeking out remote rural spaces (Kosnik, 2018). In addition to maintaining stronger bonds among societal collectives, FPTs encourage symbiosis between technologies and plants when they recognize plants’ well-being (e.g., by providing water, nutrients, music). Such a connectedness aligns with neo-animist ontologies that suggest addressing environmental challenges through “multi-species partnerships” based on symbiotic coordination (Arnould, 2022: 82).

By mimicking nature’s inherent qualities (e.g., temperature, water, nutrients), individual and collective FPTs generate a controlled natural environment for food prosumption that differs from the romantic idea of nature as a remote wilderness. FPTs can thus be interpreted as both instantiating a techno-scientific ideal of control over nature and as reducing human intervention and control of nature, helping nature regenerate itself while minimizing the risks posed to food production by an entirely unregulated nature. In agrarian degrowth research, this reduced intervention has been described as a way to decrease the metabolism of energy and materials found in industrial regions and spaces (Gerber, 2020). Prosumption spaces enabled by FPTs (e.g., indoor, urban vertical farms and apartment gardens) can curb further expansion into nature and the overuse of soil. The latter is an important consideration given the degradation of soil by the industrial food system. Moreover, the redesign of urban and rural spaces for food prosumption, in harmony with nature, should help us better understand and act on what nature requires from us to achieve symbiosis. For example, Regen Villages use a

controlled environment permitted by a “software connection to the natural world” to maintain biodiversity in AI-enabled bio-regenerative prosumption communities.

Convivial technologies for food prosumption should also promote an ideology that integrates collective well-being through education, with the aim of generating systemic knowledge about food production, environmental policy programs, and job creation. These technologies should raise the *mean morality* of the dominant food system (Coffin and Egan-Wyer, 2022). Indeed, when adopted by local collectives in urban corporate, public, and apartment spaces, FPTs can enable collective prosumption practices around food by promoting social relations and local skill sharing and development. Convivial FPTs should enable green(er) cities by partnering with local businesses and educational institutions for collective prosumption. Converting urban spaces into spaces of prosumption can re-establish harmonious relations between producers, nature, and community, an aspect often absent in neoliberal and consumerist market relations (Shaw et al., 2016).

Responsibilization. To achieve symbiosis, convivial FPTs for degrowth living should also enable shared responsabilization between human and more-than-human beings in food production (Beacham, 2018). Responsibilization is often tackled as a human-subject-oriented concept in marketing (Bajde and Rojas-Gaviria, 2021; Giesler and Vereisu, 2014; Mesiranta et al., 2021), especially when it relates to sustainability (Arnould 2022; Coffin and Egan-Wyer, 2022). From this perspective, green or ethical consumers can drive market developments with their demand alone (Carrington et al., 2016). Consumers thus increasingly bear the responsibility of directing sustainable change (Chatzidakis, 2015). In line with critical marketing scholarship (Bradshaw and Zwick, 2016; Cronin and Fitchett, 2020; McDonagh and Prothero, 2014), we argue that a heedless belief in the consumer as a sovereign actor who has the power and responsibility to change the world fails to consider the agency and ontology of more-than-human beings (Arnould, 2022; Canniford and Bajde, 2016). Rather than taking

consumer subjects as individually responsible for issues linked to sustainability, we propose that responsabilization hinges on FPTs.

Responsibilization must be tackled as a multi-stakeholder phenomenon (Mesiranta et al., 2021) inclusive of human and more-than-human actors. FPTs that incorporate nature's qualities and automate human practices for food production at personalized levels can synergize symbiotic agency (Neff and Nagy, 2018). Responsibilization then becomes a relational assemblage that acknowledges the technological intentionality to mimic nature and to construct a natural reality for producing food away from nature (Verbeek, 2008). One challenge derived from this assemblage relates to humans' food technology literacy. Research has shown that a lack of such literacy is associated with skepticism about decisions made using computer- and machine-led learning (Bartha, 2019). Likewise, a lack of eco-literacy creates challenges in fostering a profound appreciation of nature and of activities that maximize the well-being of human and more-than-human beings (Capra and Jakobsen, 2017). Given this lack of literacy, the plethora of solutions offered by technological algorithms and simulations in the effort to establish a food growth symbiosis may lead to a human-technology clash. For example, a project to implement a machine-led, 100% food self-sufficient community in the Vlierhof ecovillage in Germany backfired when community members became skeptical of the reliance on computer models to make decisions about the production, consumption, and sale of their food, as well as the treatment of their crops, soil and animals. The differing interpretations of computer-generated results on the part of community members made it impossible to reach a consensus in decision-making (Bartha, 2019).

Another palpable challenge is that while technologies seemingly liberate prosumers from conventional food systems, they may also render prosumers tech-dependent and reduce their autonomy (Castoriadis, 2005). Fully automated FPTs satisfy our desire for convenience and stimulate food prosumption practices. Yet the design of such technologies should demand

a shared responsabilization between humans and technology in contributing to a degrowth transition. Dholakia and Firat (2019) refer to this transition period, in which humans and technology must co-exist and cooperate adaptively, as heteromation. This approach, with its emphasis on cooperation and shared responsabilization, offers alternative roadmaps for reducing the potentially dystopian and exploitative effects of technologies and dominant economic systems. It also aims at deconstructing consumer and producer categories altogether, to enable transmodern futures that include multiple stakeholders (Dholakia and Firat, 2019).

Accessibility. Conviviality also encompasses a concern for accessibility (Vetter, 2018), which refers to human access to material and immaterial necessities in order to build, use, modify, and adapt technology. Accessibility implies that the technological literacy available to many local/global and not-for-profit institutions should be adaptable to different environments (Vetter, 2018). Gorz (2010) draws attention to the democratizing feature of technology and the importance of knowledge that is produced as a common good to empower people in various prosumption practices. Technology's democratizing power, however, also stems from an attention to inclusivity and to making accessible the knowledge and skills for prosumption (Pansera et al., 2019).

Degrowth living presents potentialities for symbiotic relationships to co-exist and spread among a multiplicity of niche innovations (Vandeventer et al., 2019), including technology-suffused local degrowth transitions (Latouche, 2009). FPTs should consequently be made more accessible to urban farms and alternative food networks that encourage increased public involvement in prosumption activities. These technologies should be accompanied by workshops, knowledge-sharing platforms, and applications enabling consumers and local businesses to acquire new skills and develop literacy in practicing food prosumption. Given the range of FPTs, however, such accessibility can be a double-edged sword. Some indoor individual prosumption technologies (e.g., Natufia) are technological simulacra for the

affluent, which further inequalities. Similarly, AI-operated prosumption communities (e.g., ReGen Villages) can perpetuate segregation and amplify social distinctions. In this context, technological elitism is also a major concern. While capitalism can seem a scapegoat for everything today, the co-optation of FPTs by the interests of a capitalist, socioeconomic system undoubtedly feeds class-structured interests and growing inequalities (Chatzidakis et al., 2012; Cronin and Fitchett, 2020). Such co-optation limits the development of degrowth living and restricts the impact of FPTs on supporting degrowth ends. One way to address this challenge is to ensure that technologies for degrowth are appropriate.

Appropriate FPTs for a degrowth transition

Appropriate technology, also called intermediate technology (Schumacher, 1973), enables alternative food production using local and community-level human and more-than-human resources rather than those of global techno-giants. Similar to Illich's (1973) notion of convivial tools, appropriate technologies empower individuals and communities to contribute to environmental well-being and reduce the distance between people and producers (Kerschner et al., 2018). Such technologies have changed the post-industrial paradigm and given way to civic cooperation while reducing the barriers to participation in food prosumption and in prosumer-focused business models (Murray, 2013). Appropriate technology also arises as an outcome of people's values and aspirations that advocate local and small-scale production in alliance with nature (Alexander and Yacoumis, 2018) while reinforcing sufficiency, creativity, and local skill sharing (Hollick, 1982). Appropriateness denotes an assemblage of tools, ideas, institutions, practices, and policies that facilitate prosumption and local participation (Park and Ohm, 2015). Appropriate FPTs should therefore enact a hyperlocal food prosumption ideology by reconnecting production spaces with places of consumption (Michel, 2020).

Relocalization of food prosumption. The degrowth proposal favors small and local businesses that (1) pursue sufficiency, well-being, and collaborative value creation (Latouche, 2009) that is inclusive of human and more-than-human beings; (2) adopt decentralized and cooperative governance systems and structures; and 3) replace profit motive with viability (Hinton, 2021). Therefore, appropriate technologies for degrowth must support cooperation and skill sharing at the local level (Edwards and Espelt, 2020) and encourage prosumption practices by individual consumers, communities, and local businesses. Adapting FPTs for local food coops, employee-owned businesses, and community-supported-agriculture is essential to reducing resource throughput and overdependence on the global food trade (McGreevy et al., 2022) while increasing individual and local sufficiency.

Though the scalability of FPTs used by individuals and collectives (e.g., urban vertical farms) remains questionable (Laamanen et al., 2021), global crises have emphasized the importance of prioritizing small-scale food production and sufficiency and of reducing overreliance on the industrial food market for food provision. Scaling *through* the adoption of FPTs by local governments (e.g., municipal, urban projects) (Laamanen et al., 2021) can potentially help reduce food miles (i.e., reduce energy throughput) and increase food security by creating local, resilient, prosumer economies. Food security measures should embrace “relocalizing food production, rooftop gardens and urban agriculture, direct sales from farms to institutions, and food-related social enterprises” (Lans, 2013: 174). Such measures should also include using urban spaces as community-based civic alternatives to global food provision (Eizenberg, 2012). Relocalizing food prosumption through the use of FPTs should support respatialized and resocialized agrifood systems, aiming to achieve symbiosis by bringing nature to urban spaces and by reclaiming social relations among urban neighbors and businesses.

To avoid the risk that relocalized food prosumption may obscure alternative food systems' social justice and environmental concerns, aggravate current inequalities, and empower local elites (Dupuis and Goodman, 2005), FPTs must encourage inclusive and cooperative relations in local food systems. Crises like Covid-19 have taught us the importance of collective urban food sufficiency and local resiliency. Through FPTs, individuals and collectives can reduce their overdependence on the global food supply (Boonstra and Jooste, 2013) by converting unoccupied urban spaces or wastelands into spaces of prosumption. This relocalization in geographical terms also denotes a relocation or reterritorialization of industrial food systems into personal and community networks as well as inter-local and inter-connected networks (e.g., Slow Cities, municipality networks, transition towns) (Cattaneo, 2015). If adopted by shared apartment spaces and urban and local collectives, FPTs can strategically contribute to the diversification of small farming. Diversified small farms “produce higher yields while using land and water more efficiently than industrial agriculture” (McGreevy et al., 2022: 3). Such diversification aligns with a suggested degrowth strategy for food based on four Rs: “Re-territorialization of production, re-localization of markets, re-vegetarianisation of diet, re-seasonalisation of food consumption” (Amate and Molina, 2013: 32). Such a reterritorialization can help minimize the flows of material and energy used across the global economy, as long as economic growth is not set as the main institutional policy objective at the expense of planetary well-being (Lloveras et al., 2022).

Discussion

With increasing global crises such as pandemics and climate change, we have come to a crossroads at which limits to growth appear. Prosumption and sufficiency are emerging as the new currencies of the post-growth economy (Banerjee et al., 2021; Kropfeld, 2022) and the “Symbiocene,” in which a balance between the interests of human and more-than-human

beings can counter the current, industrialized food production system that almost always disregards symbiosis (Albrecht, 2019). Degrowth emerges as an alternative to growth-driven capitalism and sustainability and encompasses a rethinking of human relationships with technology and nature that is based on the ethics and practice of care (Pansera and Fressoli, 2021). Degrowth allows economic activities that pursue relocalized production, knowledge and skill sharing (Liegey and Nelson, 2020). Concomitantly, provisioning systems must be reshaped to ensure diverse stakeholders' participation and well-being (Hickel et al., 2022).

The role of technology in degrowth has often been questioned by scholars envisioning a degrowth economic system that would completely break from capitalism (Lloveras et al., 2022). Under the current capitalist socioeconomic model, technological innovations can lead to a rebound effect against degrowth by boosting consumption and increasing tech-dependence, despite enabling a more efficient use of energy and environmental resources (Banerjee et al., 2021; Zink and Geyer, 2017). We argue that technology-enabled prosumption for a degrowth transition must be anchored by the principles of conviviality and appropriateness and must enable symbiotic relations between human and more-than-human beings. Symbiosis is essential to degrowth living and requires re-socializing and re-localizing interdependent human-nature-technology relations in a market system (Watson and Ekici, 2017). Symbiotic relations between human and more-than-human beings thus take on vital importance (Arnould, 2022). These relations are often missing in the current market ontology of sustainable consumption and production, which treats nature as an object or a resource but not as a system composed of actors (Descola, 2013).

Our critical examination of how symbiosis can be achieved and challenged by FPTs in a degrowth transition reveals concerns that center on the material/energy impact of FPTs, technological literacy and dependency, accessibility to knowledge and skills for prosumption, the threat of technological segregation and co-optation, and the scalability of FPTs. We hope

to initiate a constructively critical scholarly dialogue around these issues by offering possible remedies for the challenges involved in mobilizing FPTs and achieving symbiosis.

The mirage and mileage of tech-no-capitalist degrowth

While we argue that FPTs can bring significant advantages that would improve the condition of sustainability as a current, collective goal in the capitalist market system, it is critical to recognize the peril accompanying the potential of FPTs. These risks include co-optation of FPTs by techno-capital corporations and dominant food regimes, exploitation of prosumption culture (Cova and Cova, 2012; Ritzer, 2014), and the possibility of hyperconsumption (Ritzer and Miles, 2019).

The current food system may prosper and enrich its complexity through a myriad of alternative, co-opted, capitalist, and non-capitalist configurations of food provisioning (Gibson-Graham, 2006). Vandeventer et al. (2019) argue that degrowth as a niche regime within capitalism is currently not well-developed enough to replace capitalism. Nevertheless, degrowth is dynamic and exhibits potentials for symbiotic relationships at localized scales (Vandeventer et al., 2019). Degrowth aims to bring social change “not by relying on a rigid dichotomy between reform and revolution but rather seeing the possibility and necessity of transformation occurring in multiple avenues that may include normative changes that impact dominant institutions and wider society” (Ford and Kuetting, 2020: 285). Lloveras and Quinn (2017: 137) posit that degrowth “translates into a vision of socially sustainable and equitable change from below by rendering visible a myriad of provisioning activities including locally oriented-initiatives and alternative economies that reduce dependence on growth-driven institutions.”

Moore (2016) coined the term Capitalocene to provide a more specific historical critique of the processes leading to the geological age commonly known as the Anthropocene.

The Capitalocene directly connects capitalism to the externalized responsibilities of global corporations that have continually accessed nature for a bargain price (Patel and Moore, 2018). While Moore's argument that "the Capitalocene signifies capitalism as a way of organizing nature" may seem a limited and sweeping view, capital has devised almost all of the prototypical politico-economic arrangements and configurations in recent world history (Moore, 2016: 6). The conception of nature as cheap resource that is expected to continuously "max out" its capacity in the service of capital(ism) is what has precisely enabled and empowered the capitalist system (Moore, 2016: 112). Given this view of nature as a resource to be maximally exploited, tech giants and others with a significant amount of accessible capital will not cease to infringe upon the degrowth potential of FPTs by co-opting them to maintain an affordable price for nature. While FPTs are expected to ultimately make food production more accessible to diverse stakeholders in a more ecologically desirable way, these capacities may only expose FPTs to further appropriation by capital.

Suarez-Villa (2012) argues that the relentless, exploitative process of extracting economic value from technological progress, which sustains techno-capitalism, is both the essence and specific consequence of capitalism's appropriation of FPTs. This century-old profit-driven ideology operates on a twofold premise. First, it treats all consumer subjects as subjects in a large-scale societal experiment within which consumers' practices serve as both catalysts for growth and products of it. There is no exception to this experimentalism for FPTs, as is evidenced by the many cases of technological experiments conducted by corporations including biopharmaceutical companies and social media platforms. Second, creativity, whether grassroots, R&D-based, or both, must be commodified because "the social context provides the capacity for those who exercise creativity to think differently, breaking with preexisting dogmas, conventions, and precepts" (Suarez-Villa, 2012: 35). In other words, creativity is not only too valuable and risky to entrust to the public outside the capitalist system

but also too social for the “network effect” to be underestimated. These aspects make creativity’s value almost inexhaustible within capitalism.

Ironically, when it comes to a degrowth mode of living, the vulnerability of FPTs and users to the capital-intense, systematic absorption of creative alternatives must be addressed via networks. Therefore, we have advocated for the relocalization of food prosumption, which can be accelerated and expanded by FPTs. Small-scale yet rhizomatic (Deleuze and Guattari, 1980) food production and distribution networks in urban, (sub)urban, and rural communities can sustain themselves without being incorporated into a larger system dominated by global corporations. In this model, localization and the realization of FPTs’ potential for degrowth are corequisite. Small-scale, non-traditional networks also provide practical benefits that can further protect them from hegemonic corporate experimentalism. First, the synergies from localized or contextualized food networks result in much lower food miles (Zumkehr and Campbell, 2015), which is not necessarily financially attractive to corporate capitalism. Second, a localized food system can help enhance community spirit to foster a culture of caring for other more-than-human members (e.g., Hong and Vicdan, 2016). The consequent collective involvement and engagement in food prosumption can insulate these local networks and make them less susceptible to the current system of co-optation. Overall, ecologically and economically localized networks tend to be sustainable and sufficiently safeguarded from the dominant capitalist social paradigm (e.g., Oliver et al., 2018).

Future research agenda

We argue that technology-enabled prosumption could play an important role in the transition to degrowth living, which offers an alternative path toward sustainability (Chatzidakis et al., 2014) and an approach unshrouded by the contradictions inherent in capitalistic, market-based progress (Bradshaw and Zwick, 2016; Cronin and Fitchett, 2020). In assessing the potential

applications and limits of FPTs for a degrowth transition, new questions surface that deserve further attention.

First, our proposed symbiotic lens serves as an organizing principle of relations between human, technology and nature for a degrowth transition. The entanglement between human and more-than-human beings can establish a form of mutualistic yet unintentional symbiotic coordination (Neff and Nagy, 2018). Mutualistic symbiosis, ensuring the well-being of all involved in food production, may seem utopian when compared to dominant food provisioning systems. To make symbiosis a reality, then, what new capacities are required of human and more-than-human beings to ensure that their mutualistic entanglements benefit all (Gontier, 2016; Neff and Nagy, 2018)? To respond to this question, neo-animist perspectives that decenter anthropocentric bias in value creation and exchanges (Arnould, 2022) could be useful to understanding the role of FPTs in mutualistic symbiosis. Yet existing research substantiates little about neo-animist consumption systems and about how and why particular forms of consumption or prosumption help facilitate neo-animist perspectives. What role do such neo-animist perspectives play in constituting small yet rhizomatic food production entities? More generally, how might neo-animist perspectives enrich the material relationships of FPTs with human and more-than-human beings? More articulated discussions of how symbiosis thinking is implemented in individual and collective prosumption practices is warranted.

Symbiotic thinking should also be applied to different conceptualizations relevant to sustainability, such as the concept of well-being. Indeed, enhancing consumer well-being is a high priority for scholars and industry alike (Ostrom et al., 2010). Food well-being (FWB) is a holistic consequence that incorporates connections between diverse actions and actors (Block et al., 2011). Researchers can investigate the impact of symbiotic thinking on FWB by taking a non-anthropocentric view of well-being and extending it to more-than-human actors, such as air, animal, plant, and soil well-being. Harnessing symbiosis can uncover blind spots in the

current FWB model that prioritizes humans. Future research can also apply the symbiotic lens to analyze the potentials of new technologies in must-degrow contexts, such as fashion. The symbiotic lens can be used to articulate how advances in biodesign fashion technologies (e.g., the integration of living processes such as working with algae, mushrooms, bacteria, and proteins) can reconfigure relations among human, nature, and technology.

Second, in so far as degrowth living underscores the importance of connectedness and communal responses to global crises, it is imperative to understand the extent to which ideological forces shape the mean market morality through FPTs. Market morality is a perspective that “asks how heterogenous relationships interact to produce and preclude consumption possibilities within a market” (Coffin and Egan-Wyer, 2022: 114). The project of degrowth living proposes consuming less but also differently and more responsibly (Carrington et al., 2016). Concurrently, the project of critical marketing scholarship promotes “political and ethical deliberation” over values embedded in institutional frameworks that are environmentally destructive and legitimized through an ideology of ever-expanding consumption (Kilbourne et al., 1997: 19). Given these factors, how might degrowth ideology influence prosumption activities that raise the mean morality of markets? We suggest that the unique reconfiguration of market actors under degrowth living will likely introduce a new set of values and insights to shift the morality embedded in existing institutional frameworks. Among opportunities where such shifts may occur, we observe that degrowth perspectives share more, produce uniquely, and distribute resources more fairly. Today, engagement in technologically mediated food prosumption necessitates an ideological compromise that accepts the technological alteration of nature in the pursuit of ideologically superior outcomes (e.g., well-being, sustainability). Studies should address the role of ideology in the symbiotic organizing of relationships between human and more-than-human beings. Empirical studies

could demonstrate whether the ideology activated by FPTs delivers on the promises of access to the material and immaterial necessities of degrowth living.

Regarding conviviality in a degrowth transition, we underscore the importance of community well-being and its key pillars: equity, connectedness, and livability (Keyes and Benavides, 2020). As previously discussed, food prosumption activities can contribute to community equity or provoke further inequalities. Future research could explore how collective sufficiency emerges through the principles of inclusivity and participatory social engagement when collectives adopt FPTs. Connectedness can be fostered through social networks and cooperative relations that motivate civic engagement and enhance social trust (Watson and Ekici, 2017). If the “livability” of community residents is improved through food prosumption, future work should explore how FPTs support this aim by reducing spatial waste in urban places and making more productive use of space, as observed in the examples of FPTs used in urban rooftops and shared public and corporate spaces.

Third, further investigation into the limits of FPTs integration within the degrowth movement is warranted, given that “the flows of material and energy used in the global economy are unequally distributed and often massively oversized, especially in industrialized countries” (Gerber, 2020). To what extent are FPTs incubators for degrowth and deeper transformation or simply the object of new forms of energy-intensive commercialization? Neither degrowth theory nor praxis is anti-technology (Zacares et. al. 2021). However, after centuries of technological progress, “degrowthers simply advocate for the right to choose what to take and what to leave behind” (Gerber, 2020: 239). How likely are FPTs to become allies of the degrowth movement? We need substantive research on how FPTs can link resource use with environmental and social outcomes while reshaping the food provisioning system (Hickel et al., 2022).

Lastly, how do we create systematized local and collective knowledge about food prosumption when FPTs relocalize prosumption practices? Knowledge systems exist through “agents, practices, and institutions that organize the production, transfer and use of knowledge” (Cornell et al., 2013: 61). In the case of collectives, such as urban farms as alternative food networks and ecovillages, a localized patchwork system emerges to create transformative possibilities for degrowth living. These collectives and communities become spatially distinct nodes of knowledge- and skill-based capacities. Would it be possible to systematize local knowledge of FPTs? Are there ways to create systems of reciprocal exchange mediated by gift economies (e.g., Arnould, 2022) inherent in the symbiotic organizing principle of degrowth living? Future work can examine how we generate interactions and reconfigure these capacities to foster a cumulative body of knowledge, practices, and beliefs.

Concluding remarks

We propose that prosumption signals the cooperation and co-evolution of humans and more-than-humans in symbiosis. This view amalgamates new philosophies (i.e., the degrowth mode of being) with an emphasis on praxis to suggest an alternative approach to FPTs in post-growth markets. Noteworthy in this particular type of praxis is nature’s necessary inclusion in the prevailing discourse around the human-technology relationship. We acutely recognize, however, that these modern-technological fixes for the environmental crisis at hand remain subject to criticism arising from the technology-focused framing of those problems. Rather than perpetuating approaches inherited from modernity based on a dualistic worldview (i.e., nature-human, human-technology, and technology-nature), we have identified the potentials and limits of FPTs to address the century-old impasse between humans and more-than-humans. Together, conviviality that encompasses connectedness, responsabilization, and accessibility, and appropriateness that signifies relocalization as the potentials of FPTs, can detoxify the

growth-ridden ideology of the global food system and the mindset of the typified consumer, blasé about the production and consumption of what has been disproportionately degraded in the matter of morality and culture.

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