Enabling Sustainable Production-Consumption Systems

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Abstract

The pursuit of sustainability in particular places and sectors often unravels at the edges. Efforts to tackle environmental problems in one place shift them somewhere else or are overwhelmed by external changes in drivers. Gains in energy efficiency of appliances used in houses are offset by greater total numbers or compensating changes in patterns of use. Analytical perspectives and practical initiatives, which treat production and consumption jointly, are needed to complement experiences and efforts with sector-, place-, product- and consumer-oriented approaches.

There is now a growing body of scholarship exploring a diverse range of initiatives and experiments aimed at enabling sustainable production-consumption systems (PCSs). Different approaches make divergent assumptions about market institutions, government regulation, sociotechnical innovation, and actor partnerships. From this body of work flow useful insights for others who would engage, for example, in redesigning relationships around services rather than products or between third world producers and first world consumers in fair trade initiatives.

Contents

1. INTRODUCTION

The pursuit of sustainability in a place, sector, or life often unravels at the edges.

Efforts to tackle environmental problems in one place shift them somewhere else. Campaigns to protect tropical forests undermine the livelihood of farmers. Initiatives to promote consumption of locally grown food can turn out to be less ecologically sustainable than food grown in developing countries. Clean technologies available in wealthy countries are not accessible in developing countries, or if they are, these technologies remain too closely bound to their original developers and thus undermine domestic capacities to innovate.

Efforts to reduce environmental impacts of making products in a sector can be overwhelmed by net growth in demand for those items or in how they are used and disposed of. The adoption of cleaner technologies across a sector fails to reduce pollution loads overall when demand for products increases by multiples. Gains in energy efficiency of appliances used in homes, or fuel efficiency of cars, are off-set by greater total numbers or compensating changes in patterns of use.

Efforts to alter lifestyles face many practical challenges in the web of interactions that make up everyday life. Individual consumers are urged to cycle and walk to work to help save their local and global environment—and then encouraged to fly halfway around the world for their holidays. Marketing and advertising extol us to purchase things we do not really need; consumer campaigns tell us we can shop, save the world, and express our solidarity with downtrodden farmers at the same time.

Clearly, consumption needs to be much more closely integrated into how we think about sustainable development (1–4). Many problems related to consumption do not result directly from dangerous and inefficient production processes (5). Likewise, a narrow focus on household consumer behavior may fail to identify much more powerful leverage points to reduce environmental impacts by meeting a need or aspiration in a different way (6, 7). Perspectives that treat production and consumption as a common system, or a production-consumption system (PCS), are needed to compliment experiences and efforts with sector-, place-, product- and consumer-oriented approaches (8).

World leaders already recognize the sustainability of production and consumption as central to achieving sustainable development (9–11). In the decade since the formulation of Agenda 21 at the Earth Summit in Rio de Janeiro in 1992, this has been regularly acknowledged in international meetings. The World Summit on Sustainable Development (WSSD) in 2002 (9, 12) called for the development of a 10-year framework of programs (13), indicating the lack of progress since Rio (12).

Scholarship addressing difficult challenges of measurement and system transformation has advanced in parallel with political and business agendas but often without as much fruitful exchange as needed. In part, this reflects institutional deficiencies. The arenas where citizens, firms, researchers, and policy makers can jointly engage pressing sustainability issues in a PCS

PCS: production-consumption system

are uncommon and scattered across places, sectors, and initiatives.

This review is about progress in the interdisciplinary science that is helping us to better understand efforts to transform production and consumption systems toward sustainability. In it, we review scholarship on initiatives that explicitly attempt to influence both production and consumption. We do not dwell on the vast and important literature on clean and efficient production technologies or on the rapidly growing literature on consumer behavior where these are the single perspective.

Before launching into our review proper, we provide definitions of key terms and a simple framework to organize our initial interrogation of PCSs.

2. A SYSTEMS PERSPECTIVE

A PCS is defined as a system that links environmental goods and services, individuals, households, organizations, and states through linkages in which energy and materials are transformed, utility is derived, and relationships (for example, transactions of money or information and exercise of influence and social control) take place (8).

Production (P) transforms inputs from the harvest of environmental resource (E) into a good or service, which, in turn, is provided to consumers (C) (**Figure 1**). Postconsumption materials and energy may be reused, recycled or returned to renew the environment. Otherwise they become waste. Postproduction materials may be returned to ecosystems for renewal or become waste. Waste accumulates in sinks (S), which can degrade the environment and affect people, including consumers and producers (e.g., employees). Utility is derived from a PCS in several distinct ways. Three common kinds are: benefits of use, returns on investment, and benefits of conservation (**Figure 1**). A fourth, negative, utility, is the risks and burdens associated with sinks.

Setting the boundaries of the target system of interest is an important analytical decision (7, 14). In some cases, specific, or closely related, commodity or service chains may be most appropriate. In other instances, a broader, more functional, bounding-like "mobility system" might be needed to ensure relevant alternatives are considered. Much depends on where within the PCS an analysis begins or focuses. A particular system may have many E-P and P-C relationships arranged in supply, or
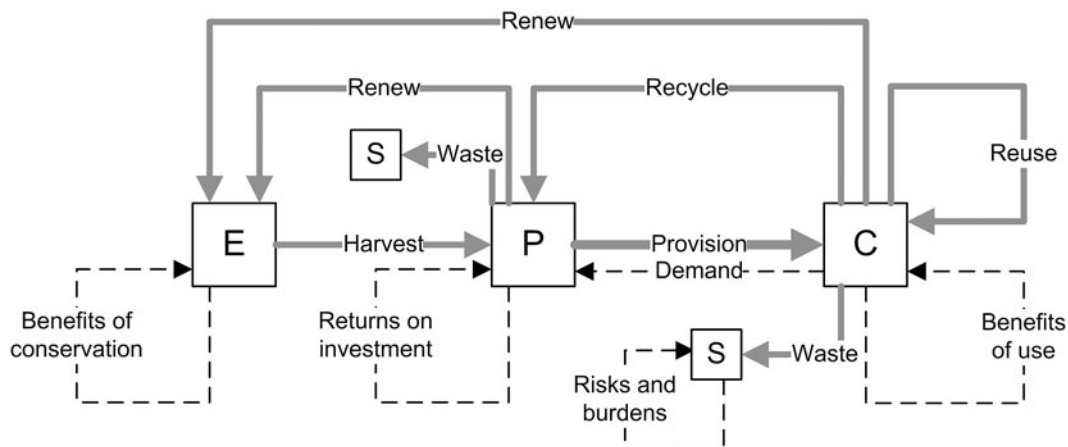

Figure 1

Material flows and derived utilities in a generalized production (P) and consumption (C) system that draws on environmental resources (E) and adds waste to sinks (S). Solid lines are flows. Dotted lines are derived utilities.

value-added, chains or more complex networks of transformation and assembly. Thus, a particular node may be a producer in some relations and a consumer in others.

A sustainable PCS is one in which the transformation of energy and materials maintains or improves human well-being (or utility) without irreversibly reducing the environmental resources. We refer to such a system as "just" if the social relationships within it allocate burdens, benefits, responsibilities, and risks fairly (15).

Measures of sustainability for a PCS relate utilities (**Figure 1**) to material flows and environmental conditions or allocations among social groups. Studies draw on a wide range of tools to assess impacts including life cycle analysis, material flows analysis, and footprint analysis (16, 17). Units of analysis are often product oriented, but aggregation can be made at various levels, for instance, the household, firm, or nation (17, 18).

Understanding who could, and who does, take action toward transforming a PCS can be framed as a stakeholder, or alternatively a social network, analysis. For example, production may be regulated by an international agreement, policies of a government, codes or norms of an industrial sector, or the shareholders in the firm. A certification and labeling scheme might involve a complex mixture of stakeholders in its formulation, negotiation, and implementation. Campaigns to reduce consumption of certain products undertaken by civil society groups are resisted and subverted by firms wanting to continue to sell those products. Differences in interests, power, influence, and position of different stakeholders are highly relevant to competition, contest, and conflict in a PCS.

Many different individual actors may be involved in the logistics of trade, from distributors to export-import holding agents through to retailers. Conversely, a single firm with a vertically integrated structure could be responsible for a lengthy series of actions taking on producer, distributor, and consumer roles within one PCS. Likewise, a single subsistence farming household might usefully be considered to constitute a PCS in some analyses. An actor may have a role in several otherwise largely independent PCSs; thus, an employee in a manufacturing plant has a producer role at work but also becomes a consumer when buying rice at the end of the day.

Material flows and social relationships depend on, but also shape, the behavior of actors. Personal consumption, for instance, is a socially embedded activity affected by other actors and institutions. Consider the factors affecting what a household buys. A number of relationships shape values of consumers including notions of utility and need. "Having things, interacting with things, and shopping for things are all aspects of consumption that are important to many people in modern, industrial societies. Consumption contributes to self-satisfaction and serves as an indicator of a good, successful life" (4). Initiatives that aim to enable a sustainable PCS must grapple with both production processes and how consumption is perceived and circumscribed.

3. ENABLING MECHANISMS

Researchers and practitioners have proposed and explored many mechanisms for enabling the sustainability of PCSs. We classified these for purposes of this review into 11 approaches, using short labels that reflect common ways they are identified in the literature (**Table 1**). This section is organized around these 11 ways by which a sustainable PCS might be enabled. The order of presentation of these roughly flows from initiatives that emphasize production activities through to those that are more consumption related. Some important links and overlaps between these categories are discussed in the text.

3.1. Produce with Less

For manufacturers, being able to reduce energy and materials used to produce a good because it lowers costs of inputs is a standard objective; therefore, this objective is commonly a primary focus for research and development.

Table 1   Examples of enabling mechanisms for sustainable production-consumption systems

Enabling mechanism	Short description	Concerns, constraints, or challenges
Produce with less	Innovations in production process reduce the environmental impact per unit made.	Rebound effects occur through which gains are wiped out by increases in the number of units or how they are used.
Green supply chains	Firms with leverage in a chain impose standards on their suppliers to improve environmental performance.	There may be unfair control of small producers.
Codesign	Consumers are involved in design of products and services to fulfill needs with less environmental impact.	Incentives are not adequate to involve consumers.
Produce responsibly	Producers are made responsible for waste from product disposal at end of life.	Incentives for compliance without regulation may be too low for many types of products.
Service rather than sell	Producers provide service rather than sell or transfer ownership of assets, which reduces number of units made while still providing functions needed.	This is a difficult transition for firms and consumers to make as it requires new behaviors and values.
Certify and label	Consumers preferentially buy labeled products. Labels are based on independent certification, and producers with good practices increase their market share.	Consumers are easily confused with too much information or with a lack of transparency and credibility of competing schemes.
Trade fairly	Agreements may include a minimum price, and other investments or benefits are made with producers. Consumers preferentially buy products labeled as or sold through fair trade channels, and producers get a better deal.	Mainstream trade still dominates. It is hard to maintain fair trade benefits to producers when a product becomes mainstream.
Market ethically	Reducing unethical practices in marketing and advertising would reduce wasteful and overconsumption practices.	There is a reluctance by policy makers to tackle very powerful private sector interests with regulation.
Buy responsibly	Campaigns educate consumers about impacts of individual products, classes of products, and consumption patterns, resulting in overall behavior changes.	Converting intentions and values into actions in everyday life is often difficult for consumers. Issues of convenience, flexibility, and function still matter a lot.
Use less	Consumption may be reduced for a variety of reasons, for example, as a consequence of working less. There are many potential environmental gains from less overall consumption.	There is a dominant perception that using less means sacrifice. Less income and consumption may not automatically translate into better consumption impacts.
Increase wisely	Increasing the consumption of underconsumers can be effected in ways that minimize environmental impacts as economic activity expands.	Wealthy developed countries need incentives and goodwill to assist the poor and those in developing countries, for example, by leaving adequate space and natural resources for them to develop.

Reducing environmental impacts is a broader environmental management challenge as it includes consideration of waste streams. Production strategies are well studied and important to sustainability, but not the focus of this review. The notion of producing with less that interests us here is when producer-oriented innovations explicitly reach out to the relationships with other actors, especially consumers (**Table 1**). These include a diverse mix of strategies and initiatives. We illustrate with four divergent examples: public disclosure of environmental performance, organic farming, cement and construction, and virtual water trade.

3.1.1. Public disclosure. Regulation, monitoring, and penalties are the conventional policy instruments for getting firms to produce with less impact. An alternative is to require organizations to disclose to the public their

environmental performance and let public sentiment and media pressure stimulate improvement. We give two examples, one aimed at firms and the other at cities.

The Program for Pollution Control Evaluation and Rating (PROPER) was introduced by the government of Indonesia in mid-1995 as a follow-up to the earlier Clean River Program or Program Kali Bersih, which successfully induced several polluters of local waterways to make major improvements in water quality (19). The main idea was to use a color-coded rating scheme, and through public disclosure, reward and shame firms according to environmental performance (19). The biological oxygen demand (BOD) emission standards were developed in consultation with industry, environmental nongovernmental organizations (NGOs), and other government agencies. Performance relative to regulations at the firm level was coded by BAPEDAL, the environmental impact management agency, using a five-color scheme: gold, green, blue, red, and black. The criteria for assigning colors were kept simple, and multiple sources of data were used to reduce risks of errors or manipulation. In the first round of ratings, high-rating plants were rewarded by being identified, and those with low scores were not named but counted. Low-scoring firms then had six months to improve performance before they were rerated and findings made public. The program had the high-level political support it needed to give black ratings to the worst polluters and was also simple enough for media, community leaders, and environmental NGOs to understand how the rating system worked (20). Improvements in compliance were observable within six months.

China introduced the Urban Environmental Quantitative Examination System at the city level in the early 1990s to improve environmental quality (20). Each year, the major cities are rated and ranked by their environmental performance using the system developed by the State Environmental Protection Agency. The system is implemented at the city level by environmental protection bureaus and commissions. The findings are publicized in yearbooks, newspapers, and on television. Evidence from management actions, improved trends in ambient environmental quality, and indications that other possibly responsible policies for improvement have not been effective suggest that the scheme has been working (20). City mayors have a strong incentive to get involved and lead because they are responsible for meeting targets to improve their city's scorecard and rank (21). Today local leaders strive to achieve the status of National Environmental Model City as this helps with attracting foreign investment and events (22).

From these two examples it is clear that the public disclosure approach is not strictly an extension from producer to consumers, but a broader appeal to citizens and officials concerned or affected by production activities, and possibly also to others, such as employees or shareholders, who want to see their company be perceived as behaving responsibly toward the community.

3.1.2. Organic food movement.

The organic food movement can be understood as an effort to produce more with less impact (23), for instance, by eliminating use of pesticides, antibiotics (24), and artificial fertilizers. Organic practices were more widespread in much of the developing world, but the label "organic" was rarely applied to peasant systems, although this has changed recently. Seyfang (23) argues that a local organic food network, given the right enabling conditions, could reduce everyday environmental impacts. Local organic food schemes are a niche activity involving both technical and marketing innovations that might have wider implications for a food PCS (25).

As a result of broader consumer concerns with the health and safety of industrial agriculture, organic food has become mainstream: A large part of the organic food market has shifted into the domain of global agro-food networks (26). Much of the market is now concerned with either product quality characteristics, such as food safety and the value to health, rather than concerns with environmental impacts. Much greater policy support for local

experiments and initiatives is needed to create enough space for bottom-up enterprises to emerge (27).

3.1.3. Cement, construction, and housing.
Construction and housing invariably turn up as key domains for environmentally sustainable household consumption (28–30). Cement is a critical input into construction in many parts of the world, but concerns exist about energy efficiency and CO_2 emissions in its manufacture. In the past decade, however, significant advances in technical innovations have improved the efficiency of cement manufacturing (31).

China, in particular, has produced very rapid improvements in energy efficiency and environmental performance within the past decade with positive implications for global rates of CO_2 emissions growth (32). But major challenges still lie ahead (33). The stock of older buildings includes many with relatively short life spans that will need to be replaced (34). Industrial urban-based economic growth is driving huge increases in demand for concrete and steel, both highly energy-intensive industries. At the national level, the structural shift is leading to increases in energy intensity in spite of efficiency gains within this sector (33).

Additional efforts to make the cement-construction-housing PCS in China more sustainable are highly desirable at many levels. The evidence above implies that this will require an approach to producing more with less, which more explicitly addresses demand and consumption issues. From a PCS perspective, one of the keys for reducing emissions may be in greater attention to how urbanization affects urban form and function (35, 36). Sustainable cities programs might be one of the policy outlets for such analysis insofar as they can bring about necessary policy coordination and incentive systems (37).

Rebounds like those observed with respect to cement and steel production in China, described above, are a frequently identified dilemma in sustainable consumption analyses. The rebound effect refers to situations where responses to measures to improve environmental performance have other side effects, which significantly offset the gains. For example, increased efficiency may be offset by greater use of a product (38). Apart from rebound effects, there may also be co-benefits and spillover effects. New products may change the way consumers live, giving them more time and saving them money. What this enables them to do may be better (or worse) for the environment. These forms of side effects are understudied (38).

3.1.4. Virtual water.
Virtual water is water used in producing a particular commodity or service; it is virtual because most of it does not end up in the final product. One way of making more for less is to make it with someone else's water. A cup of coffee in the Netherlands is not made with Dutch water: 140 litres are needed to make that cup, and most of the water is from Brazil or Colombia (18). In general, trade in virtual water is expanding between poor, but water-rich, states and richer, but water-deficient, states.

A good example of the policy relevance of considering virtual water comes from recent work done within China. North China faces severe shortages of water. Water used to produce food for South China makes up at least 10% of water used in agriculture in North China. The volumes of virtual water involved each year are more than the maximum planned to be transferred back from South to North via the three huge canals in the South-North Water Transfer project (39). It is not clear that this huge virtual transfer is worthwhile given the huge environmental implications of compensating for that use. Of course other development and land constraints need to be taken into account in policy.

Analysis of virtual water trade may help water-scarce countries or regions reconsider agricultural crops and import-export policies when production is water intensive (40). Thus, southern and eastern Mediterranean countries could benefit from expanding fruit and vegetable exports to the EU (41). Options to reconfigure relationships between places through trade, however, are also affected by other concerns and barriers (41).

3.2. Green Supply Chains

Supply chains form and are managed by firms with the logistical capacity and leverage to meet a variety of business objectives (42). The need to meet environmental standards in national regulations or to participate in some international markets, for example, can lead key firms to initiate standards and other methods to improve the environmental practices of their suppliers (**Table 1**).

Motorola, a multinational corporation, introduced global firm-based environmental standards for its plants and also applied these to subsidiaries and suppliers in the mid-1990s (31). The corporation introduced various internal reporting procedures, covering toxicity indices for products, to encourage continuous improvement in environmental performance. Innovative management tools were introduced to handle products and components that were later assembled. An in-depth study of Motorola Penang in Malaysia showed how the company was able to reduce use of lead and other toxic metals in product processes and products (31). These firm-based standards and procedures, in turn, reflect the evolving regulatory environment in major markets, in particular, EU directives such as the European Waste in Electrical and Equipment Initiative (WEEE) and the Restrictions on Hazardous Substances Directive.

Most empirical research on greening supply chains has focused on manufacturing and has looked at the relationship between key firms and smaller suppliers (42). These underline the important power of key firms and the strategies used to build partnerships among actors. But there are also a growing number of studies of food systems, which start at the retail end and examine how their practices work back through suppliers to ultimately impact on farming (43), harvesting (44), or labor (45) practices.

The EU, for example, substantially lowered residue thresholds for nitrofuran antibiotics in imported shrimp after concerns with health impacts and the availability of new technology for detection in imports (46, 47). Subsequent bans of shipments of farmed shrimp from Thailand forced drastic reductions in the prophylactic use of antibiotics (48) and arguably also consolidated the shift from rearing black tiger prawns to Pacific white shrimp (49, 50).

Fagan (45) used global commodity chain analysis methods to study efforts to improve conditions of workers and environmental impacts in the banana industry. An important insight of more general interest from this study is the observation of how different stakeholders use arguments about scale to support their positions. Another is that global supply chains need to be understood within the different institutional contexts through which they pass (45, 51).

Contemporary, industrial-based food systems may not be difficult to transform if they have strong support from core firms. Green & Foster (52), for example, argue that any alternatives to the frozen pea food system in the United Kingdom, whether toward higher technology, but environmentally improved, or low-technology organically produced, would ultimately depend on the decisions of a single corporation. Unilever is the main research and development investor and knowledge base in the current frozen pea food system with a large capacity to determine which innovations are "taken on board" in almost any part of the commodity chain.

Many efforts to green supply chains involve the introduction of standards. The introduction of more abstract, less personalized standards and other quality assurance instruments often alters the very basis of social relations in systems of exchange formerly based on trust and history of interaction (53, 54). Standards sometimes may also become a basis for control, or exercise of power, in a PCS: "Standards have enabled supermarkets to transform the world's food supply by dictating not just which foods can be sold on their shelves, but also how and by whom they can be produced" (43).

Initiatives to green supply chains bring to the fore issues of power and fairness in a PCS. If power moves to retailers or large manufacturing firms, the value-added bargaining power

of farmers and small- and medium-scale enterprises is reduced. In vertically integrated systems, jointness in design may arise from highly autocratic, rather than democratic or more self-organizing, processes of the market. Government oversight and supporting policies may be needed to ensure that small producers are not at an unfair advantage.

3.3. Produce Responsibly

Extended producer responsibility policies require producers to continue to be financially or physically responsible even after the useful life of their products (55). The rationale is that this will create incentives for redesigning products in ways that use fewer materials and for making products that are easier to recycle (**Table 1**).

Producer responsibility has two elements. The first is to turn responsibility into action in their production processes and products. Here, they doubtlessly have a power to act. The second is to report about it and so create knowledge and transparency for the actors further along the product chain. The power to act here is often more limited and may require third-party support.

Research on extended producer responsibility (EPR) has usually focused on the performance of individual policies, regulations, or schemes. Methods to assess effectiveness and explore weaknesses vary widely.

Concerns with hazardous materials in wastes have been an important driver of policy innovation in Japan. A 1999 law to reduce dioxins from waste incineration set a reduction target of 90% by 2003. Take-back legislation that requires producers to collect products at the end of their lives has been central to the new waste-management paradigm and framework of general laws and more specific regulations (56). Responsibilities are explicit and shared with consumers. Under the Home Appliance Recycling Law (HARL) of 2001 in Japan, home appliance consumers pay, retailers collect, and producers recycle. Costs for recycling are paid at different times depending on product: at purchase time for computers and cars, but at dis-

posal for home appliances (56). The laws were explicitly designed to be reviewed and adapted.

In the United States, initiatives are usually framed as shared responsibilities and implemented through voluntary programs. Producers should minimize impact, for example, by designing them in ways that make recycling easier. Consumers should preferentially buy products so designed and practice recycling (57).

Approaches have historically varied across Europe but are arguably converging more under shared EU policies. Consensus-based politics in the Netherlands often created close working relationships between industry and government (58). A covenant on packaging in 1991 was developed with industry and included specific targets for take-back levels, amounts to be recycled, and so on; it has been highly effective in reducing waste (59). In contrast, notions of producer responsibility introduced around the same time in Germany involved a much more legislated approach. In terms of rates of collecting packaging material, the program has been a success, but there were other side effects, such as the export of subsidized waste to other EU member states for disposal.

The effectiveness of the approach is controversial, in part, because of costs and resistance in some sectors and countries to mandatory take-back or end-of-life programs (60). Voluntary schemes may be easier to implement than mandatory ones in the sense of being less likely to be resisted by industry. They may also provide needed flexibility that stimulates innovation. Without independent monitoring, however, such programs lack legitimacy (57) and thus risk failing to significantly change material use or recapture hazardous materials.

It is also not clear to what extent EPR programs stimulate improvements in product design. A study of the lighting sector in Europe carried out a few years after the introduction of the EU Directive on WEEE found little evidence for changes in product development (61). Rather producers just passed on the costs to consumers with little impact on their sales (61). Other research on end-of-life processing of vehicles and another EU directive (59) also

suggest that incentives for product innovation are hard to maintain (62). The HARL in Japan is less comprehensive than the EU WEEE directive but seems to have benefited from having mandatory take-back and consumer payment for disposal.

Most analyses of EPR have focused on recycling, but other strategies such as reconditioning or remanufacturing are relevant for end-of-life disposal of some kinds of products. Remanufacturing has an advantage in that the energy that went into making the product, and is embodied in it, need not be lost (63).

EPR initiatives are in some ways the flip side of green procurement or supply chain management. But getting core firms to behave responsibly after they have passed something on is much harder than before they produce something. EPR efforts are very important for dealing with hazardous substances, but even so, the evidence of producer innovation in products in response to regulations has often been surprisingly modest. A consumption-oriented perspective needs to be applied to the behavior of firms to tease out why some do take up the sustainability challenge while others focus on finding ways to pass on or avoid any short-term costs.

In this review, our focus has been on EPR mechanisms that focus on end-of-product-life issues. Other important aspects of responsibility, discussed in earlier sections, include producing more with less impact and greening supply chains. In the following two sections, we present issues of codesign and service systems—two strategies that depend on incorporating a better understanding of how products or services are used into their design so as to, for example, reduce energy needed when they are used, not just when they are made.

3.4. Codesign

Producers and consumers who work together to assess and design how to meet specific needs more sustainably may create new options that are both competitive (profitable) and useful (**Table 1**). Most insights about codesign come from studies of mass product research, development, and marketing in business.

Research on involvement of users is expanding. Normal users, even more than design experts and advanced users, are increasingly recognized as valuable to the design of mass products and related services, for instance, for mobile phones (64, 65). Studies of why some new products are more successful than others confirm that meeting customer needs and product advantage are important (66), two factors for which codesign can clearly contribute.

Much of the promise of codesign and insights on how firms might actually be effective at doing it come from research on conventional products. Studies of consumer engagement in design of products for sustainability are significantly more scattered across product areas and diverse in approaches.

Alam's (67) study of 12 service firms is notable for the practical framework through which users' intensity and modes of engagement are assessed across the various stages of design. His study showed that along a 10-stage development process users were most involved early on in idea generation, in service design, and later in the process in service testing and in a pilot run. In the context of idea generation, consumers state their needs, problems, and solutions; criticize existing services; identify gaps in the market; and provide a wish list of service requirements. In the stage of service or process design, the users help develop blueprints, suggest improvements, and compare their wish list with the proposed blueprint of services. Finally, their contribution in the service testing is to participate in a simulated delivery process and to suggest final improvements.

An insight from scholarship on codesign is that acts of consumption take place in particular contexts and can shape them as well (4). The relationship of people to products matters to their attractiveness. To become environmentally sustainable, products need to be designed so they are "not only less environmentally destructive, but also meaningful and pleasurable to use, maintain and repair" (68), and this allows consumers to be engaged in the activity

of "doing" (68) as, for example, using a manual peppermill, a manual coffee percolator, and a shaving brush and shaving soap (69).

Just how much say and influence consumers really have in design is often unclear (70). This is especially so when we consider issues beyond the producer's interest in looking for marketable product advantage or differentiation. Product-life extension for example is often desirable for consumers and would be a contribution to sustainability in terms of less use of resources for manufacturing. But many factors influence whether markets for more durable products can emerge (71). Producers need to capture some of this increased value to consumers if there is to be an incentive to make longer-lasting products (72), for instance, through higher prices for higher quality goods. Regulators can also contribute, for example, through directives specifying requirements that should be met for products (61).

The concept of codesign in principle can also adapt to a more general societal context. Technology assessment can be thought of as a form of codesign if the public as beneficiaries—affected or at risk—have inputs that come early enough in the process to influence what kinds of products are allowed to be introduced. Participation here is motivated by concerns of consumers to protect themselves from health, or other, risks (73). Technology assessments jointly conducted by various actors involved in production and consumption, including those at risk from harvesting or wastes, are likely to be more effective than expert, concerned-community, or industry-driven appraisals (69).

Some of the benefits of codesign might not be embedded in the products itself but more broadly in the knowledge system, of which firms are a part, as a result of an improved mutual understanding of constraints, capacities, and needs of producers and consumers.

Finally, the evolution of design for sustainability reaches beyond all the stages elaborated so far and shifts from environmental management to systems design (74). This concept necessarily involves the perspective from the consumption end. It can focus, for example, on

how to gain specific results or how to meet needs (75), which can—but does not necessarily have to—be fulfilled by products. An example of sustainable codesign is given in Section 3.5, below. On the basis of their level of needs, consumers start to design service solutions, integrating innovative offers from producers as much as necessary.

3.5. Service Rather than Sell

The business strategy of selling services rather than just products has proven successful in several areas, especially to corporate consumers (76, 77). Such product-service systems (PSSs) have the potential to make some PCS more sustainable (77–79). The central idea is that dematerialization can be achieved through service or asset use rather than product or asset ownership (78, 80) (**Table 1**).

A business that pursues this strategy can differentiate itself from competitors as offering something of higher value than just a stand-alone product. From the consumer's perspective, they get better functionality. One good example is the total-care package that Rolls Royce provides airlines by which the company maintains the ownership of the engines (81).

Research on PSSs is largely based on qualitative case studies documenting success stories. Baines et al. (81) argue that stakeholders need to be involved in research to help test and guide theory on the basis of emerging practices. Although practices are likely to expand on such merits as a competitive strategy, it is less obvious that the sustainability gains are automatic. For this reason, research to assess how shifts to PSSs affect overall material and energy use remain important.

Consumer benefits include reduced responsibility for monitoring, taking care of, and replacing/disposing of the product (81, 82). A PSS may also provide greater flexibility in upgrading as a customer's needs evolve and as solutions are less tied to asset management constraints. Successful PSSs are usually designed with the involvement and perspective of users (81) or codesign (see previous section). Such

engagement is especially important to capture indirect and nonfunctional issues in design (77).

Mont (83), for example, described an effort to reduce environmental impacts through facilitation of consumers and other stakeholders in the design of a workable system for sharing power tools and garden equipment. From the consumers' perspective, a tool could be shared when it is infrequently used, and neighborhood access could be more convenient then rental. Producing firms or retailers would have little interest in dealing with households individually, but a business model could be derived through a middleman. Because there were uncertainties, she adopted a scenario planning approach through which stakeholders could explore the strengths and weaknesses in different business models and refine a business solution (83). Each of the business model scenarios were assessed for both cost and environmental performance, and the obstacles and benefits to different actors were evaluated. This example also illustrates the benefits of codesign; typically a critical feature in developing integrated product-service solutions.

Halme and colleagues (84) considered sustainable home services including a social dimension in addition to eco-efficiency. Their evaluation of sustainable services was based on equity, health, safety, security, comfort, social contacts, empowerment, information, and awareness in addition to traditional criteria, such as energy use and waste. Also economic criteria were taken into account, including employment, profitability for the provider, and profitability for the community. They found that easy and flexible access to the service was a key factor in success. Ecological improvements were not an outcome of consumer demand, but consumers were important in designing such improvements. Their study, analyzing 200 cases in six European countries in fields, such as repair, supply and disposal, and care and supervision, was developed into a model for providing orientation and guidance to those who intend to establish a sustainable home service or would like to develop an existing one in a more sustainable direction.

Partidario et al. (85) describe a multistakeholder process used to design, test, and refine a product-service solution to provide food for elderly people living at home and for workers in isolated industrial estates without food provision. The solution included private and public partners. The idea of incorporating sustainability was introduced early on in the process. Simple criteria and methods were used to assess the solution against social, environmental, and economic criteria, identifying improvements in alternatives and areas where improvements were needed (i.e., increased packaging and thus waste). This study illustrates the value of a systems-oriented and context/place-sensitive approach to transforming production-consumption problems.

There are important barriers to PSSs from both producer and consumer perspectives. Consumers may be reluctant to accept ownerless consumption (81). Products that are not owned have less symbolic value, and these values may even be more important than functional ones (77). Outsourcing could lead to more careless behavior (86). Conventional marketing techniques may be needed to overcome resistance to, and make more attractive, PSS solutions (77). Finally, in order to meet customer acceptance, PSSs should be designed to minimize transaction costs, for example, by decentralizing product pools, introducing delivery services, or optimizing the user interface (87).

Producers are concerned with price, taking on additional risks, and making the changes to the structure and skill base of an organization that are required to be service oriented (81). Not enough is known about how to manage such transitions within firms. Some of the challenges of transforming firm capacity to a PSS suggest that an alternative might be use of specialized third-party firms that take on the service-system design functions.

Evidence of sustainability from reduced environmental loads is modest and case specific (88). Car sharing, for example, does not necessarily reduce number of new cars made. In spite of an impressive and diverse range of successful

case studies, there is still only a modest level of systematic knowledge to help design a PSS, especially if the focus is on improving sustainability of PCSs. Trends showing increased use of PSS models in industry will not automatically improve environmental outcomes (88), but they could be harnessed to do so.

In creative communities, citizens themselves develop collaborative services toward sustainable ways of living. In a comparison of European initiatives of creative communities with examples from Brazil, India, and China, Manzini and colleagues (89) studied how enterprising people are inventing and putting into practice original ways of dealing with everyday problems: from childcare and care of the elderly to getting hold of food, from looking after green spaces to alternative means of transport, and from building new solidarity networks to the creation of new forms of housing and shared facilities and services.

They found that the new collaborative engagements are roughly the same in emerging countries as in most industrialized regions. Creative communities and collaborative services are very diverse in their nature and in the way they operate. But they are always innovations of local systems in the sense that they challenge traditional ways of doing things and introduce a set of new, more sustainable ones through bringing production and consumption of services back to direct exchange systems.

3.6. Certify and Label

The core idea behind certification and labeling is that with better, trustworthy information about individual products or overall household energy and material use, people will elect to change their behavior so as to reduce environmental impacts (**Table 1**). Standards, codes, and labels are supposed to fill the information gap by providing the characteristics of product and processes in a summarized, easily accessible form.

Practitioners and scholars frequently consider standards and codes of conduct a powerful instrument to influence the sustainability of production and consumption decisions. Most studies focus on particular schemes or take a resource at risk, e.g., an ocean fishery, and look at the contribution of existing and potential alternative certification and labeling schemes. This analysis is often institutional and stakeholder based. Attitudinal studies of consumers are common, but more in-depth studies of actual practices when making purchase decisions are rarer.

Labels are claims made by sellers about their products to potential buyers (90). Those that make claims about sustainability are in part marketing tools, but also claims about what is the right thing to do, both for consumer and producer (26, 54). Literature distinguishes between Type I labels, which are part of a voluntary third-party program that awards a license and authorizes the use of environmental labels on products; Type II labels, which are informative environmental self-declaration claims; and Type III labels, which are part of voluntary programs set by a qualified third party and verified by that or another qualified third party.

It is the Type I and Type III labels that make the difference and provide a linkage within the PCS. Such labels introduce cooperative elements into the relationships, for example, to achieve quality assurance in the supply chain. An example is the first worldwide environmental label, the Blue Angel (Blauer Engel), a German certification for products and services that have environmentally friendly aspects. The certificate has been awarded since 1978 by an independent jury consisting of environment and consumer protection groups, industry, unions, trade, media, and churches. By now, it certifies 10,000 products from 1000 licensees.

Experiences with ecolabels as communication instruments suggest that many can be better designed, especially by paying more attention to context in which they are used (91). Negative and positive labels appeal to different consumers; ecolabels largely appeal to consumers who already have environmental interest (91). Establishing trust is an important but difficult challenge. De Boer, for example,

analyzed what labeling means for producers, consumers, policymakers, and other groups in society and summed up his findings as "producers and consumers are still learning how to communicate about sustainability issues in the context of the marketplace" (90).

Although there are examples of labels that increase awareness and shift practices, often the share of market affected is small, and gaps remain between values and actions (92, 93). Just providing more information on labels is not sufficient to change behavior (94). One reason is that much daily behavior is habitual, involving relatively automated behavior scripts rather than cognitive reasoning. Routines are of great practical importance. When such behavior is reinforced by immediate rewards, however, they may be hard to change even if long-run outcomes are bad, for example, the nicotine kick from cigarettes, which cause lung cancer (95).

Conventional marketing techniques may help improve the impact of labeling schemes, for example, by shifting emphasis on labels as product information to a promotion tool (91). This is especially important for expanding appeal beyond already green consumers, a key factor if such schemes are going to really impact sustainability. The promotion of green products has relied too strongly on ecolabels in isolation and could make better use of the full range of marketing tools available (91).

Certification schemes themselves often lack independence, quality, and fairness. Often this is because they are not developed with open deliberation among all parties in the PCS and thus end up reflecting too narrowly the perspectives of a particular stakeholder group, i.e., retailers, consumers, or producers. The financial incentives associated with environmental labels can be high; in the case of the seafood industry, this has led to proliferation of self-attributed, misleading ecolabels for products that further undermine already collapsing fisheries (96, 97).

Two detailed examples illustrate the challenges for pursuing a sustainable PCS through certification and labeling: ecotourism and farmed shrimp.

Tourism is the second largest sector in the Costa Rican economy. Along with the hotel sector, tourism has grown quickly with correspondingly detrimental impacts on the environment. In 1997, the Ministry of Tourism developed a sustainable tourism certification scheme, targeting hotels, to verify and reward actions toward environmental sustainability taken beyond regulatory compliance practices (98). The voluntary scheme was codesigned with hotel managers and associations, academics, and environmental organizations. The Ministry of Tourism has promoted the program in national advertisements since 2000. Other countries and the World Tourism Organization have also adopted the voluntary program. Riviera's study (98) found that government monitoring, trade association membership, and a focus on green consumers were important factors for participation in the scheme. The presence of a large green tourism consumer segment in Costa Rica was a factor in both the success of the program and the kind of hotels joined. But hotels interested in environmental sustainable and certification are still very much in the minority; only about 10% of hotels, overall, choose to enroll.

Several initiatives are under way to certify ecotourism, using criteria that should provide benefits to local communities. Developing certification criteria and schemes can be difficult. Medina's (99) study of stakeholders in the Belize tourism industry found that different local and international stakeholders had divergent views on what counts as local benefit and participation. In her view, efforts must be made to harmonize and define key terms for certification to succeed.

Certification for farmed shrimp in Thailand has had strong industry involvement from the beginning (100), arguably laying the foundation for formal regulations and mandatory certification schemes now emerging in practice. Adoption of the Code of Conduct (COC) for shrimp aquaculture was slow. A second incarnation, the Good Aquaculture Practices (GAP) program has been much more quickly and widely adopted. One reason is that processors were

making GAP certification mandatory, following bans by EU of imports because of nitrofuran residues (47). Another reason appears to have been the ease with which certification could be acquired (24). Affected people in local communities were not involved in setting the COC or GAP standards; they are only referred to under the standards on social responsibility (24).

More recently tensions have risen because of apparent lack of independence and consultation with developing country stakeholders. Thus, Wal-Mart, the world's biggest retailer, now requires those who sell shrimp to them to be certified by the Aquaculture Certification Council (ACC). The ACC scheme was developed by the Global Aquaculture Alliance, a shrimp industry consortium in the United States, which also helped forge the initial deal with Wal-Mart. Smaller firms are likely to be at a disadvantage in certification schemes driven by external actors as negotiation with shrimp farmers is absent from their business arrangements (24). Greater engagement with producers and the communities in which they work, whether shrimp farmers or ecotourism guides, is needed in developing certification schemes.

Information about impacts, both adverse impacts on the environment and, less frequently, positive impacts on livelihoods, has clearly been the focus of many initiatives aimed at making PCSs more sustainable. But the results have often been disappointing when carefully scrutinized. Scholarship has cataloged a diverse range of reasons why information is often not enough and underlined that information provisions in certification and labeling are part and parcel of consumption politics.

3.7. Trade Fairly

The notion of fair trade has been around for a while, but only recently has it begun to take on economic and political significance (101). The pursuit of greater equity in international trade has been driven by concerns for a greater share in the benefits of resource use and economic development for workers and farmers in developing countries. The agendas pursued by organizations in developed, and increasingly within developing, countries are diverse. Issues of fair trade have become linked with issues of environmental sustainability. The proposition is that markets and trade that aim to reduce poverty by improving the livelihoods of poor producers can be designed to simultaneously address issues of ecological and economic sustainability (**Table 1**).

Fair trade research falls largely into three groups: studies of producer communities endeavoring to engage in and benefit from those markets (102), studies of initiatives to support fair trade (101), and studies grounded in institutional analysis and political economy (103).

Smith (102), for example, studied the experience of the coffee cooperative COOPABUENA in southern Costa Rica. Despite substantial efforts, fair trade markets were never more than a small fraction of total trade, and ultimately, the cooperative could not help its producers survive as markets changed. This was in spite of a mature institutional setting. More than 50 years earlier, the democratic cooperative, a marketing system, and supportive state laws, which limit charges processors and sellers could deduct from the price of coffee beans, were established. When prices were high, fair trade did not yield better prices than conventional ones. When coffee prices were low (in the early 1990s) production of fair trade was too small a share of the total to help because growing conditions limited expansion of favored organic products within areas of this cooperative (102). Eventually, an alternative initiative using direct marketing of sustainable coffee helped 50 of some 800 members of the cooperative. The detailed history of the cooperative is an illustration of a more general claim that "for many farmers around the world, fair trade remains a promise rather than a reality, revealing itself not as a supportive community, but as a demanding market" (102, p. 97).

Initiatives to support fair trade include efforts to create alternative trading networks (54), market products labeled as coming from fair trade, and promote fair trade as an alternative in order to influence purchasing practices and

trade rules (101). Fair trade agreements with producers usually include minimum price and may also provide advance working capital or premiums for development (101).

Alternative trading networks may include specialist shops with direct links to producers. One strategy has been to shrink PCSs through localization strategies (see Section 5.2). This approach draws on the subset of consumers linked to activist networks (101). The major European fair trade company GEPA is working together with producers in over 160 cooperatives and marketing organizations in Africa, Asia, and Latin America and sells their products in 800 world shops, via 6000 action groups, as well as in supermarkets.

Using a commodity network framework, Raynolds (104) analyzed the multifaceted connections linking consumers and producers in expanding North/South fair trade networks. Within them, progressive ideas and practices related to trust, equality, and global responsibility are intertwined with traditional commercial and industrial conventions. The negotiation of these divergent conventions via the alternative trading organizations shortens the social distance between fair trade consumers and producers.

More typical are certification schemes that depend on using information on labels to influence purchasing behavior of retailers and consumers in more conventional shopping situations (see Section 4.2). Fair trade can provide retailers with opportunities to demonstrate corporate social responsibility. By selling fair trade products, retail organizations can tap into a new and growing market and, in the process, enhance their own brand value. Fair trade, on the other hand, can provide small producers better access to markets.

Campaigns to promote fair trade target retailers, government purchasers, international agencies, and individual consumers. Activists have provided substantial support to fair trade as an alternative to conventional international trade. The extent of penetration of fair trade products into markets varies hugely among products and countries. Fair trade in Europe has

a long history and is now increasingly a mainstream marketing channel (105). In the United States, growth is more recent, especially after creation of the labeling organization Transfair in 1998. Market share of fair trade coffee in the United States increased from 0.6% to 4.3% between 2000 and 2006 (101).

Institutional, cultural, and political analyses underline more nuanced relationships created by fair trade. Fisher (103), for example, explores the notion of fair trade as "commodified activism." In her analysis, she teases apart commodification's association (giving exchange value) with alienation (Marx's commodity fetishism) and concludes, contrarily, that the growth of fair trade is evidence for expanding social awareness and activism. Campaigns for fair trade create representations that let consumers feel good about themselves, or demonstrate "caring at a distance," but these may not reflect the perspectives of producers in developing countries (106).

Even so, overall, there has been little consideration of who can participate in fair trade. Are the ways and places in which fair trade products are marketed and sold excluding certain classes of people from involvement? Who gets to feel good about buying fair trade coffee?

Although many fair trades are still driven by retailers and consumers in northern countries, this is changing. Producers in southern countries are not only target beneficiaries but also the originators of fair trade initiatives, often with some state involvement. Within the developed and developing countries, the large domestic markets are increasingly considered as approachable from the fair trade angle within a country (107). These shifts may affect how fair trade is seen in northern consumer markets, with repercussions for producers in developing countries.

While fair trade grows with greater participation of big business, there are risks that the original objectives of redistribution of value-added products will not be met (54). One reason is that the distance between consumers and producers increases as more intermediate players and institutions take shape. Standards

and quality assurance criteria, for example, can make it difficult for the very producers that fair trade was supposed to help, and instead create clubs of privileged producers much like those for any other boutique product.

Looking ahead, it is clear that issues of governance will stay at the fore, shaping how benefits, burdens, and risks will be distributed within the PCS (44). Meaningful representation of interests of small producers in developing countries will be critical to negotiations and monitoring of fair trade. More research is needed on initiatives promoted as fair trade, teasing apart the claims made from practices and impacts.

The consumer's participation in global food production networks should be explored for ways that small-scale farmers can benefit (108). One example might be to exploit the documented interest of wealthy consumers in unusual, or unfamiliar, foods and for which high premiums are willingly paid.

A PCS perspective is particularly salient to the study of fair trade because fruitful inquiry can begin at many different points in the system. Starting with consumers, important work has been done on consumer movements and how they build relations with producers in alternative schemes or seek to expand support for fair trade through labels in mainstream market channels. Starting with producers, research has explored how producers cope with the demands of fair trade markets.

3.8. Market Ethically

Advertising and marketing play a critical role in what is consumed and how much. It is the dominant operating system by which a capitalist world economy is driven. Clever marketing exhorts us with countless promises of convenience, comfort, and pleasure. Retailers, through advertising, do not just stimulate demand but create wants (109).

Consumers are increasingly bombarded by messages from retailers, marketing firms, government agencies, and consumer organizations. Consumer confusion arises from information overload, brand similarity, and mislead-

ing or ambiguous information (110). Confusion is an important barrier to information-based campaigns that try to influence consumption choices along more sustainable pathways (111).

A lot of advertising is embedded in sponsorship of events, in soap operas, and in "news info-tisements." Firms pay to have their products placed in film frames outside the conventional commercial broadcast slots.

Consumers have to learn to deconstruct advertising messages however they appear. An example is the anticonsumerism organization Adbuster (112). Adbuster challenges the dominant messages of multinational corporations and consumer capitalism not simply by using factual information, rational argumentation, legal language, and traditional political tactics, but also by turning the commercial techniques of image and emotion back on itself with the idea of "subvertisement." Successful Adbuster subvertisements include those parodying alcohol, cigarettes, fast food, and the fashion industry (113).

Children are particularly vulnerable targets of marketing. Schor (114) for example estimated that 40,000 ad messages a year were directed at the average U.S. child, with budgets of as much as US$15 billion targeted at children under age 12. This is a threat for sustainability insofar as it intends to raise generations conditioned to the idea that people shop for acceptance by the family and to show they care and they love (114). But children can also learn to deconstruct media messages if parents and friends help deconstruct marketing and advertising ploys as a pastime.

Some actors, accepting the basic tenets of the global economic system either as desirable or inevitable, nevertheless argue that there should be ethical, culturally negotiated limits on what marketing tactics are acceptable in society (**Table 1**). Ethical marketing provides a framework of cultural and social values for the consumer through an honest and factual representation of a product. The philosophy of marketing is not lost with the ethical approach, but rather it hopes to win customer loyalty by reinforcing the positive values of the brand. As part

of the philosophy, ethical marketing should target only consumers who can perceive and understand the persuasive tactics in commercials. Ethical marketing should only promote products that are not harmful to children, and even products that are widely seen as valuable and good for children should not be marketed in deceptive and manipulative ways (115).

Beyond these considerations on advertising in general, environmental claims in marketing also deserve special attention. Ginsberg & Bloom (116) recognized that green marketing—as developed in the mid-1990s—has not lived up to the hopes and dreams of many managers and activists. Although public opinion polls consistently show that consumers would prefer to choose a green product over one that is less friendly to the environment when all other things are equal, those other things are rarely equal in the minds of consumers. For example, when consumers are forced to make trade-offs between product attributes or helping the environment, the environment almost never wins. Still, the number of people who are willing to pay a premium for green products from organic foods to energy-efficient appliances is growing. Companies intending to go for green marketing must keep in mind that consumers are unlikely to compromise on traditional product attributes, such as convenience, availability, price, quality, and performance.

Environmental marketing is also a difficult issue from another perspective. A remarkable amount of products, from yogurt to cars, are advertised either with explicit reference to better environmental performance or more subtle use of images with a natural landscape or other environmental features. This green washing is on the edge of misleading advertising and can produce a backlash from environmental or consumer protection organizations.

This leads to a third pillar of the market ethically strategy: regulative instruments are required. A multicountry review of policies to regulate food advertising on television aimed at children found that the tension between legislation and voluntary codes is strong (117). The food advertising industry is still in self-interested denial over the impacts of their efforts on food choice. Few countries take the outright ban route, but one of the exceptions is Sweden.

In Sweden, all advertising aimed at children under the age of 12 years is banned, as are advertisements before or after children's programs. The guiding principle is fair play and protection of children from undue influence. It is remarkable that this initiative was introduced not to serve a specific goal, e.g., to reduce obesity or to improve health per se. Instead, it is seen as a matter of human rights built on findings from research that children under 12 years of age cannot clearly distinguish advertising messages from program content. The Swedish Culture Minister has called for children to be declared a "commercial-free zone" (117).

To conclude, in a sustainable PCS, adhering to ethical marketing principles should be part of corporate social and environmental responsibility policies. Combined with other enabling mechanisms, e.g., consumer campaigns, this may help build partnerships among actors that truly span a PCS. If not, regulatory forces should consider how to value consumers' human rights as stronger than the forces of the free market.

3.9. Buy Responsibly

Buying responsibly is recognized as a relatively recent phenomena of consumer engagement for the environment or for sustainability. Robins & Roberts (118) describe the 1990s mainly as a shift from "voluntary simplicity" and "boycotting the bad" to marketing promoting the "good goods." Several authors (58, 119) describe the change in societal perception in the Netherlands. They note that the focus has shifted from appealing to consumers' responsibility for their own consumption levels in the 1980s toward green niche markets and products at the end of twentieth century. By now, a remarkable number of people belong to the consumer market segment known as LOHAS or "lifestyle of health and sustainability," providing a clear target for marketing and advertising (120).

Consumption has become a rallying cry around which social protest and pressure groups have amalgamated, with highly diverse interests, ideologies, and priorities (121). Informed consumption choices, it is argued, will, in a democratic and voluntary way, bring about environmental and justice gains (97). Labeling, discussed above, is based on such an assumption. Here, we focus on the campaign side in which people are encouraged to buy responsibly (**Table 1**).

Key studies have been done on campaigns by government agencies and consumer groups. These can be, and are often, contrasted with conventional tactics in marketing. Other scholars have focused more broadly on the different ways buying responsibly is articulated and practiced, asking questions about its relevance to politics and consumption.

As the language and practices of the market increasingly infiltrate government-citizen relations around the world, the ideal consumer participation is that with environmental concerns incorporated into consumer preferences, or as Shove (122) puts it, "policy makers encourage consumers to make 'the environment' their preferred brand as part of a broader strategy of ecologically modernizing their lives."

Ethical consumption and related movements should be seen as a form of political activism (123). The point is to act (124) through boycotts of products from firms with bad practices or by switching to those with positive associations, such as a fair trade label, as an act of solidarity. As a form of individualistic activism, campaigns are needed to document trends and recruit new followers. Magazines and brochures play mobilizing roles by recounting ethical acts (125). Much of the activism is not directed at the state but at firms, sectors, and international institutions and so looks beyond the state.

Social movements, which seek to alter consumer behavior directly, draw on the idea that the movement is beneficial to the individual and, at the same time, should also through demonstration effect lead others to adopt such practices (126). But people often feel that the

impacts of their own changes in behavior on environment are trivial. Collecting information about indicators of benefit are an important tool used by the Global Action Plan (127), an independent organization founded in the United States in 1989 with the aim of providing information on how to live more sustainably. Consumer movements also "must walk a tightrope between conviction and conversion and avoid the pitfalls that come from turning mainstream consumers into adversaries" (121).

Communicating information concerning product characteristics is easier than telling a potential buyer how it was made or how it should be thrown away. Trade-offs between functional qualities of a product and ethical values constrain such campaigns (128). A tactic, therefore, is to emphasize that ethical values can support the functional qualities of a product and thus create market value (people will pay more). One example, might be "organic" foods, which, because chemicals are not used in production, are also viewed as healthy. Durability and energy efficiency are other qualities that can be linked to ethical value. Such tactics are important; otherwise, green consumers may respond positively to surveys but fail to buy green products (91).

By contrast, many consumer campaigns are simplistic narratives of a commodity culture. Fair trade promotions of solidarity or shopping for the environment draw on standard imagery and stereotypes of the peoples and places we are asked to care about (106). Alternative consumer identities are manufactured. Consumption can be about creating personal identity, satisfying feelings, performing civic duty, and compensating for social exclusion (129). A study of Irish consumers suggest they look at waste, but not consumption, as an environmental problem (130). As green consumers they look for a communication value in commodities that support a particular green image (130). Conventional marketing and alternatives already have much more in common than perhaps either would be willing to admit (91).

Most consumer education campaigns start from a rather narrow base of assumptions about

lifestyles and values. For example, assumptions still linger that ethical and environmental consumers are the relatively wealthy (and usually white and western) individuals who possess "postmaterialist" values (131). This is true regardless of whether the origins are with state agencies or for-profit or nongovernmental organizations (132, 133). The little research that explores such consumers' motivations and values in-depth challenges the generalized assumptions of who, what, and why individuals take part in alternate forms of consumption (134).

The shopping metaphor has some limitations because of its association with households and physical products. Procurement policies of governments and firms, not just households, are crucial to the sustainability of PCSs. These behaviors are not properly captured by scholarship on greening supply chains by key firms, as they do not reflect the significant marketing and other information campaigns to which government departments and firms are also exposed. A consumption perspective is helpful throughout the PCS (1).

Power to influence the PCS can be gained from public procurement. WSSD committed public authorities to "promote public procurement policies that encourage development and diffusion of environmentally sound goods and services" (9). The possibility of using the purchasing power of public authorities covers a wide range of products and services, such as electronic devices, cleaning and maintenance, food and catering, construction, transport, and green electricity (135).

Firms are in some ways similar to governments or households as consumers. Like conventional consumers their procurement practices are constrained by the limitations of what competing suppliers can provide; but unlike the shopper in a supermarket, the capacity of core firms to dictate "must-have features" is much more powerful and less dependent on market features, whereas smaller suppliers are often in dependent relationships with their "mother firm."

3.10. Use Less

The logic of buying responsibly, pursued further, can introduce the option of not buying at all. Some people choose to consume less (**Table 1**). Their motivations are diverse. Some are primarily concerned with environment, whereas others believe that living more simply will improve the quality of their life (68, 136). Of course, some people live simply because they cannot afford to do otherwise; this section is not concerned with involuntary simplifiers.

The growing literature on sustainable consumption underlines that consumer behavior is key to the impact that a society has on the environment (137). Sustainable consumption is becoming a new focus for national and international policy (13). A lot of attention is given to increasing the efficiency of consumption; a consumer's responsibility is to buy eco-efficient products. Improving efficiency is a necessary prerequisite for achieving sustainable consumption, but it is not sufficient because efficiency gains are easily overcompensated by growth in consumption volumes (138). Efficient consumption alone can only lead to a weak version of sustainable consumption. Strong sustainable consumption also requires changes in consumption patterns and reductions in consumption by the global consumer class. Options simply to buy less need to be supported through changes in public infrastructures as well as personal and societal questioning of the levels and drivers of consumption (139).

3.10.1. Simplify. Much of the early research on downshifting and voluntary simplicity has a promotional flavor, but more recent scholarship has helped differentiate the motivations and impacts of different degrees and styles of change in practice. Other work has been focused more on the potential to expand the number of those who engage in these social movements; analyses for Australia suggest that "downshifting," or choosing to work less, is a widespread phenomenon (140).

Voluntary simplicity and downshifting movements often start with the basic findings

from research or personal experience that conspicuous and high levels of consumption along with the work needed to maintain them do not make you happy (141–144). Consumers in this movement are already recognized as a market segment by experts under the acronym LOVOS, meaning a lifestyle of voluntary simplicity.

For many, downshifting that reduces stress from overwork is the primary objective (136). For some, reducing adverse environmental impacts of consumption are an acknowledged side benefit (145, 146). Trading income for time may be popular with employees but may be harder for firms to support without other changes in policy, for example, correspondingly reduced responsibilities for welfare contributions (147).

More rarely, altruistic feelings, caring for others or the environment, are given as primary reasons. Most people, however, who adopt more sustainable lifestyles have perceptions about personal benefits from doing so (68). Focusing on personal benefits and motivations, such as having more time with children or becoming less attached to material objects, may be an effective way to promote responsible consumption and lifestyles (68).

The observation that simplifying gives people a sense of increased control over their lives is noted in several studies (136). Simplifying, like other forms of resistance, promotes alternative values and behaviors, e.g., sufficiency, frugality, charity, and humility (137, 148). Although voluntary simplicity movements do not have a coherent political agenda, there continues to be a significant engagement of their participants in community and neighborhood affairs; they are not a retreat from civic life (143).

At the same time, simplicity can be, and often is, successfully marketed to consumers. Thus, simple is associated with plain and natural colors on the supermarket shelf (68). Voluntary simplicity as such can be critiqued as having parallels with other personal improvement fads like crash diets. The broad participation across class in various studies of simplifiers would tend to argue against this view (143), but not many

of these studies really have much in the way of longer-term follow-up.

Although there may be a so-called double dividend from using less, i.e., better quality of life and less impact on the environment, it may not be easy to guide PCSs in ways that create such opportunities given all other factors at play (126). Experiments show consumers are loss adverse; they are more willing to risk income or benefits not yet received than give up, or risk, what they already have (147). Social status and conventions constrain efforts to reduce household energy use (4). Consumer behaviors, through who they exclude or include, help maintain class structures (150, 151).

Alcott (152) takes a global perspective on simplicity, or the sufficiency strategy as he calls it. Based on the classic equation (I = PAT) relating environmental impact (I) to the interaction of population (P), affluence (A), and technology (T), he expects sufficiency to cause a rebound effect if the affluence factor is autonomously lowered. With lower demand from the affluent, prices will lower too, stimulating demand by others. Simplicity, if it is to contribute to sustainability, needs to be assessed and pursued within a PCS framework.

3.10.2. Localize. Another common strategy promoted to use less is to localize. As with simplifying and downshifting, localizing discourses and practices are diverse. The localization of economies, often linked with notions of building or strengthening communities, has been articulated by many as a desirable alternative or antidote to changes brought by globalization. The links and disconnects between localizing and simplifying are underexplored.

Research either in favor or critiquing local food provision initiatives rarely provides quantitative assessments or other evidence about impacts except from general arguments. One approach has been to estimate costs associated with transport of food in the notion of "food miles" (153). But some places are highly unsuitable for making particular products that consumers want, and thus attempts to reduce food

miles might make things worse (154). It is far from clear, for example, that it is ecologically or socially better for dryland American farmers to grow rice than Vietnamese or Thai farmers in the wet tropics. Moreover, local food may not be organic compared to that which could be imported. Narrow claims about level, as in local or regional, need to be understood as a form of politics of scale without necessarily implying anything about sustainability or justice (53, 155). A successful example of localization is the Slow Food movement in Italy. Established in the mid-1980s, it has continuously spread and grown since then. Although many of its members seek to celebrate the simple pleasures of eating and drinking local produce and share a series of homespun philosophies, the movement itself has ambitious and potentially far-reaching goals in its criticism of the fast-food industry (156).

Important contributions to localization are made by the local exchange trading scheme (LETS). Most analyses of LETS focuses on local economic development. Seyfang (157) concentrates on localization and self-reliance: (*a*) shifting consumption patterns toward sharing, recycling, reuse, and reducing resource use; and (*b*) building green social networks. Her findings indicate that these community currencies are successful in allowing participants to make small changes in their lifestyles, consumption, and employment patterns, but these findings also identify limitations of size, scope, funding, and management to be overcome before this can be achieved more effectively with LETS.

Not only food or products are brought to more distant places. The consumption of leisure travel and tourism is hugely significant to the footprints of places, households, and nations (158), and these effects are less well understood from the perspective of sustainability than other domains. In part, this is because there are indicators that the leisure travel basket is hard to green or reduce (58).

A footprint analysis of inbound tourism to Amsterdam suggested that bringing tourists from closer locations could reduce environmental impacts (158). A shift in marketing strategy away from long hauls to more local markets is plausible in that tourist accommodation demand exceeds supply in high season periods. An exploration at the national level for France suggests that tourism/leisure-related greenhouse gas emissions could rise substantially because of long-haul travel by a relatively small group of frequent travelers (159).

3.10.3. Actioning. Participation in sustainable consumption initiatives is often framed in international and national policy documents and practices as the meeting of positive environmental values with rational consumption choices (160). However, individual dispositions do not do a very good job of explaining behavior (161). Corral-Verdugo (162) found that Mexican housewives' self-reports on reuse and recycling did not match their observed behavior. Beliefs predicted self-reported conservation behavior, but competencies (assessed by performance in a direct demonstration exercise) were associated with observed behavior.

Most actors have difficulties accepting and linking broad messages about environmental sustainability with narrow experiences and knowledge in everyday life, for instance, around their home (163). Unless the messages fit with common sense thinking, they may not lead to changes of practices (163). By contrast, routines are affected by changes to technologies in everyday use (164).

Global Action Plan UK has a program, Action at Home, that aims to help "households to reduce their impacts on environment and save money" (163). One of the innovative features of the program is the use of support groups. According to the chair, a key lesson learned has been that "individual behavioural changes are easier to make as a member of a social group than alone" (127). This is in sharp contrast to the mainstream framing of consumption research, and policies on media-based blitzes, aimed at inspiring changes in behavior by individual consumers.

Hobson's (163) study of the Global Action Program in two contrasting locations, however,

showed that the behaviors changed were no or low cost, e.g., turning off lights. In these cases, thinking about habits led to new habits. Other practices were much more resilient; shopping and car-use practices rarely changed. At the same time, participants in the program demonstrated an understanding of how they were being manipulated, for example, through advertising or retailing practices (163).

There is clearly a need for more studies on how to link broader goals of sustainability with everyday contexts and heuristics (165). Studies of simplifying, localizing, and action movements are valuable (166). The need is particularly great in nonwestern societies as the prevailing assumption of international agencies and consumer organizations may simply not apply in different cultural contexts. A better understanding could also help resolve the dilemma in which the vast majority of people still view sustainable consumption as a sacrifice and boring, or only relevant to developed countries. Downshifting is of special interest because it affects both production and consumption activities simultaneously but is not motivated by concerns with environmental impact, so some of the sustainability side benefits may not be secure.

3.11. Increase Wisely

Chronic and pervasive underconsumption is not sustainable or just. It may also, in some circumstances, create problems for environmental sustainability that keep people poor and miserable as the immediate necessity to focus on short-term survival can limit investments in long-term solutions. Increasing consumption opportunities for the poor, to meet both basic needs and pursue growing aspirations, can be wise (**Table 1**). The pollution, waste, and inefficiency problems experienced by countries that industrialized first, for example, do not need to be repeated with expanding wealth and increasing economic activity (167). Experiences with better technologies and social policies can be drawn upon to help build sustainability concerns into a PCS from near its beginnings.

There is, of course, a huge field of scholarship on poverty and development. In this section, we focus on a few examples of initiatives informed by production and consumption perspectives to address underconsumption.

3.11.1. Trade and investment. The globalization of trade, and how it is being ruled, creates challenges and opportunities for sustainability arising from the different ways flows of money, commodities, resources, and people are treated. We have already considered the example of fair trade and ethical consumption, which can be pro-poor. Trade policies that link together low-consumption countries could help improve their competitiveness (168), but there are also other challenges and opportunities in globalization.

Trade liberalization can drive overexploitation of natural resources in developing countries to produce agricultural products for consumers in developed countries. But on the other side, as a result of shortages of farm labor, agriculture in developed countries depends much more on chemical, mechanical, and energy inputs, and this also has significant environmental impacts (169). One way of enabling more sustainable food systems, therefore, would be to allow greater freedom of labor to move from developing to developed countries. Such policies, however, can face political, cultural, and nationalist constraints.

Shah (169), in response, suggests as an alternative, or complement, compensatory flows of investments from developed into developing economies. Hamilton (170) has made similar suggestions in addressing the problems associated with too narrow a focus on economic growth. High-consumption countries need to provide low-consumption ones with opportunities for a fair share of the global resource wealth (168). Debt relief could help with expansion of domestic economies and growth in consumption (168). These and other macroeconomic policy approaches to more closely linking challenges posed by under- and overconsumption in a PCS deserve more exploration and critical attention.

3.11.2. Sustainable livelihoods. Many initiatives under the rural sustainable livelihoods label can be usefully viewed through the lens of pursuing a more sustainable PCS via the mechanism of wisely increasing production and consumption activities together. Typically these programs look to improve food security, employment opportunities, and income-generating activities that are compatible with local resource inputs (171). Doing so may involve building capacities and skills, or removing barriers to access of natural resources, such as land and water for cultivation. Increased wealth from income-generating activities creates opportunities to raise consumption and invest more in education, health, and technologies and, at the same time, reduce poverty, vulnerabilities, and other insecurities. Poverty and well-being has many, often locally specific, dimensions (172). Many programs discover that understanding the political as well as economic features of input and commodity markets is crucial to success. Credit and seasonal availability of labor may be limiting factors. Opportunities for quality control, value adding, and alternative markets are easily missed.

Partnerships with business may help link sustainable livelihood objectives with other elements of a sustainable PCS. Kambalame & de Cleene (173) describe three corporate social responsibility initiatives in the agriculture sector of Malawi that strive to improve livelihoods through more joint management of supply and value chains.

Thus, too narrow a focus on households, communities, and individual commodities can mean that policies modifying the impact of factors operating at larger scales are ignored. Initiatives at local levels need to be cognizant of, and often work under the influence of, global financial capital flows and trade relations and how these impact on more local agribusiness development. Likewise, national conservation policies that limit access to natural resources can be a major constraint to people whose livelihoods depend on those resources (174).

3.11.3. Markets for the poor. An example of a more local initiative is the work of International Development Enterprises in Nepal and India in introducing, as a package, small-plot irrigation technology and smallholder market chains (175). Demand is used to stimulate production improvements. Demand comes from providing assistance in identifying specific market opportunities. Production improvements are made possible to poor farmers through a supply chain of affordable, income-enhancing technologies, in this case study, foot pumps and drip irrigation equipment. The development of a business services model also has similarities to integrated product-service projects discussed above.

A lot has been tried and learned about how to make markets work better for the poor. The so-called M4P, or markets for the poor, approach has been promoted by the U.K. Department for International Development, Swedish International Development Cooperation Agency, and the Asian Development Bank. M4P focuses on institutions and aims to create effective markets. Research is carried out to better understand how markets work, "many markets don't work effectively because the ruling elite does not want them to work" (176). To understand causes of market failure, the focus on institutions in the M4P approach often needs to be complemented by analysis of networks, organizations, and communities (176).

Big business can be important to such initiatives in providing the backbone around which a commodity chain can form. Thus, in the Novella project, the Unilever company along with several NGOs, including SNV Netherlands Development Organisation and Friends of the Nation, and various local businesses assembled a supply chain for oil from Allanblackia trees in forests or on farms in Ghana (177). Supply from naturally growing trees encouraged improved forest management; early success saw the company offer to expand sources with plantings nearer communities. The NGOs played an important mediation role among the many partners and their different interests.

Partnerships appear to be crucial to many of these initiatives, even though the final outcome includes a competitive market place. If disadvantaged consumers (e.g., low income, underconsuming, poor access) and producers (e.g., small, low technology, few assets) are given meaningful opportunities to participate in how PCSs are assembled, then effective markets can benefit the poor.

4. SYNTHESIS

There is already a substantial body of scholarship exploring the sustainablility of PCSs. Approaches that jointly consider production and consumption activities, and look at individual relationships from both perspectives, are better able to identify salient leverage points to help transform system performance. But the diversity of experiments and initiatives underway is huge, and it is important that a critical and systematic understanding of these experiences shape future practices, policy, and research.

4.1. Summary

A range of initiatives have been undertaken by governments, firms, and NGOs sometimes working together, and at other times independently, to transform PCSs along more sustainable pathways. The key elements of these efforts were classified into 11 enabling mechanisms (**Table 1**).

The various ways actors have tried to enable sustainability in a PCS have important differences as well as similarities. Researchers have begun identifying the conditions under which certain classes of mechanisms are more likely to emerge, succeed, and fail (**Table 1**). At a first level of synthesis, these can be distilled into assumptions, or necessary conditions, with respect to market institutions, government regulation, sociotechnical innovation, and actor partnerships.

Market institutions, which allow consumers to choose among differentiated products, are obviously central to several mechanisms, such as certify and label or trade fairly (**Table 1**).

In several other mechanisms, market access and prices are important for green products to reach a wider number of consumers, as in produce or buy responsibly. If government policies distort markets through subsidies or allowing monopolies to form, then these may need to be reduced or removed to allow green production and products to compete fairly (37).

Government regulations are also important to several mechanisms wherein the right incentives would be otherwise unlikely to emerge. Reducing the environmental impact of production processes, whether by using less energy and materials, or recycling waste (**Figure 1**), or improving environmental performance along an entire chain of activities often involves standards and incentives. Standards are important to the produce with less, green supply chains, and produce responsibly mechanisms.

Sociotechnical innovations are a key component of all mechanisms for initiatives that are meant to bring about change toward a more sustainable PCS (**Table 1**). Innovation in production processes is central to the produce with less and codesign mechanisms. The green supply chain mechanisms often also imply changes in organization among firms. Some enabling mechanisms involve combinations of assumptions. For example, fair trade requires changes to both business and consumer practices, whereas the buy responsibly mechanism is more focused on consumer practices. Use less is also more directly about consumer practices, but in some variants, e.g., downshifting, it may also benefit from coordinated changes in business practices and regulation.

Stakeholder partnerships are important to several mechanisms but have differences in timing. Thus, in codesign, partnerships from perspective of individual consumers are restricted to the early life of a product, whereas in produce responsibly, the focus is on the product's end of life (**Table 1**). The service rather than sell mechanism requires well-maintained relationships. Fair trade mechanisms may include agreements with small producers that also require sustained relationships. The use less mechanism has several variants. In the

localization strategy, maintained relationships are very important, whereas in the simplify strategy, they need not be. A key feature of stakeholder partnerships is that they usually require a process of negotiating meanings, criteria, and objectives. This is consistent with how programs on sustainable development cast more broadly are emerging (178).

4.2. Promise

From our review we conclude that analytical approaches that treat production and consumption as a system hold more substantial promise than narrow framings for several reasons.

First, leverage to improve performance in the direction of sustainability can exist at diverse nodes in a network, which are sometimes remote from where pollution is emitted, a resource overharvested, or a consumer in need. A PCS perspective allows consideration of alternative leverage points in the pursuit of ways to uncouple improvements in well-being from their environmental impacts.

Second, the sharing of value-added benefits, burdens, and risks from a PCS depend on relationships within the system. A PCS perspective allows consideration of alternative ways of governing allocation not just at particular nodes, as in markets or through trade agreements, but also along supply and waste chains. Issues of fairness and social justice can be more thoroughly explored in a PCS perspective.

Third, commodity chains and firm-supplier networks can be thought of as a series or set of many production and consumption relationships (3). For each linkage, we can ask questions from both a production perspective (How could this industrial process be made more resource efficient?) and a consumption perspective (What are the underlying drivers of downstream demands in the network or value chain?) (1). This opens the possibility of assessing demand management and supply augmentation options jointly.

Fourth, gross overconsumption and acute underconsumption coexist in the real world,

and both are challenges to sustainable development (2). A PCS perspective highlights the opportunities and constraints in such initiatives as fair trade or localizing systems of exchange, but it also exposes the limitations of state-centric and North-South framings. Environmentally, significant consumption (179) increasingly takes place through the activities of a global consumer class in the capitals of the developing world (180). Justifying policies using conventional measures of the level of development of national economies is likely to be too crude an approach (cf., 37).

Fifth, a PCS perspective creates opportunities for incorporating understanding of the behavior of diverse actors into initiatives to change a PCS. An emphasis on agency underlines the hidden potential of actors taking on unexplored roles. The contributions that business can make to a sustainable PCS are not just in technological innovation but also in changing the incentives they provide to staff and suppliers as well as in social and cultural change (181). Consumers are also shareholders and employees and live in the communities where production takes place. Businesses, like household consumers, are neither in control of the system of consumption and production nor necessarily caught in its web.

4.3. Constraints

Our review also revealed some important limitations, with both theoretical and practical implications, in how PCSs are being studied.

First, few studies have grounded social observations on material flows or ecological constraints of the system they set out to describe, or if they do so, the studies largely leave social mechanisms for explaining behavior unspecified. A diversity of methods and frameworks have now been explored, but there are still many gaps, with certain disciplinary preferences for particular problem areas and styles of research (179). A much deeper integration across disciplines is needed, and this will likely require new methods.

Second, few studies are able to both deal with the complexities of power and knowledge in the multiple relationships that underlie many PCSs, and at the same time adequately handle issues of scale of impact or intervention. The systems of innovation approach, with its notions of niches, landscapes, and regimes, is promising (37, 182) both to explain transformation and stasis. But political-economy approaches are also needed to interrogate the wider social processes that allow unsustainable practices to flourish in the first place (122) as well as to explain the emergence of a sustainable PCS. Key questions include: Who benefits from initiatives on sustainable consumption and production? Who is excluded from participating in them? Why are some people much more responsive to engaging in sustainable activities than others?

Third, gaps between knowledge and action are a recurrent challenge faced by initiatives aimed at more sustainable PCSs through their integrated management. Gaps occur both within specific groups of actors as well as among different actors along a chain. The conventional approach to gaps is that they can be closed with better communication, so that scientists and experts can tell practitioners and decision makers what they need to know. A key conclusion from social science studies is that such a pipeline model of science, however, often does not fit the evidence of how knowledge systems and practices evolve (183, 184).

Fourth, the degree to which transitions in a PCS are inducible and guidable is open to query and probably varies substantially among systems. Multiple linkages and dependences mean that substantial change may result out of internally generated innovation and largely self-organizing processes. By contrast, the proliferation of initiatives and some modest indications of impact imply that PCSs are open to influence through actions of a modest number of key actors or the modest actions of many actors. PCSs are part of larger sociopolitical systems and, conversely, arenas for everyday resistance and submission. Enabling might be driven by a leader with foresight, or it may unfold in the daily practices of hundreds of millions who finally decide that what they really want is a better quality life.

SUMMARY POINTS

1. There is now a growing body of scholarship exploring a diverse range of initiatives and experiments aimed at enabling sustainable PCSs. An approach that jointly considers production and consumption activities and looks at individual relationships from both perspectives can identify more highly salient leverage points.

2. The diversity of initiatives is huge. This complexity can be usefully reduced by considering the mechanisms from which they are strategically composed. In this review, we identify 11 enabling mechanisms. These differ in which activities they target for intervention and in who is expected to act or change practices. Other classes of enabling mechanisms undoubtedly exist.

3. The 11 enabling mechanisms identified differ in the mixture of assumptions they make about conditions or instruments with respect to market institutions, government regulation, sociotechnical innovation, and actor partnerships.

4. Exactly how a PCS is bounded and defined depends on purpose. Nevertheless, individual PCSs still vary widely in their complexity. This has important implications for the way they are studied and the social processes and enabling mechanisms that may be needed.

5. Research- and experience-based knowledge both play critical roles in initiatives to enable PCSs, but rarely is enough known about how information and knowledge shape practices (or vice versa) to institutionalize relationships. Much more work is needed on the physical and virtual arenas where knowledge-action linkages are made.

FUTURE ISSUES

1. How can social relationships, material flows, and environmental impacts best be captured within a single analytical framework for assessing sustainability of a PCS?

2. Who benefits from an unsustainable PCS? Who is excluded from initiatives to enable a sustainable PCS?

3. How have knowledge and action brought together successful efforts to enable more sustainable PCSs? What are the common features of the physical and virtual arenas that have been demonstrably effective at linking knowledge and action?

4. To what extent, and under which circumstances, can the enabling mechanisms help transform an unsustainable PCS into a more sustainable one?

5. When do people care enough about others that they take responsibility for the consequences of their production, marketing, and consumption activities? How do they decide how much is enough?

6. Can policies to address underconsumption be more closely linked to unsustainable overconsumption practices both within and among countries?

7. How do different systems of governance allocate benefits, burdens, and risks among actors engaged in and affected by PCSs?

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