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Life Cycle Costing and Food Systems: Concepts, Trends, and Challenges of Impact Valuation

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LIFE CYCLE COSTING AND FOOD SYSTEMS: CONCEPTS, TRENDS, AND CHALLENGES OF IMPACT VALUATION

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ABSTRACT

Our global food systems create pervasive environmental, social, and health impacts. Impact valuation is an emerging concept that aims to quantify all environmental, social, and health costs of food systems in an attempt to make the true cost of food more transparent. It also is designed to facilitate the transformation of global food systems. The concept of impact valuation is emerging at the same time as, and partly as a response to, calls for the development of legal mechanisms to address environmental, social, and health concerns. Information has long been understood both as a necessary precursor for regulation, and as a regulatory tool in and of itself. With global supply chains and widespread impacts, data necessary to produce robust and complete impact valuation requires participation and cooperation from a variety of food system actors. New costing methods, beyond basic accounting, are necessary to incorporate the scope of impacts and stakeholders. Furthermore, there are a range of unanswered questions surrounding realizations of impact valuation methods, e.g. data sharing, international privacy, corporate transparency, limitations on valuation itself, and data collection standardization. Because of the proliferation of calls for costing tools, this article steps back and assesses the current development of impact valuation methods. In this article, we review current methods and initiatives for the implementation of food system impact valuation. We conclude that in some instances, calls for the implementation of costing have outpaced available and reliable data collection and current costing techniques. Many existing initiatives are being developed without adequate consideration of the legal challenges that hinder implementation. Finally, we conclude with a reminder that

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although impact valuation tools are most often sought and implemented in service of market-based tools for reform, they can also serve as a basis for robust public policies.

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INTRODUCTION

Our global food systems create pervasive environmental, social, and health impacts. The scale of land used for food value chains alone is immense, with 11 percent of the globe's land surface being used for crop production and 26 percent used for livestock grazing.[1] Further environmental and social impacts stem from transportation networks, input production, food processing, and retail and distribution infrastructure. Health impacts measured by annual healthcare costs of malnutrition (obesity, diabetes, stunting, etc.) range in estimates from 1 trillion dollars in the United States to 3.5 trillion dollars globally (11 percent of global GDP).[2] Human communities and the environment are impacted by every stage of the food life cycle, including water and air pollution, exposure to pesticides, and food waste. At the same time, it is estimated that 500 food companies control 70 percent of the global food and beverage industry.[3] Through global value chains, social and envi-

1. FOOD & AGRIC. ORG., WORLD AGRICULTURE: TOWARDS 2015/2030: AN FAO PERSPECTIVE 127 (Jelle Bruinsma ed. 2003), http://www.fao.org/3/a-y4252e.pdf; LIVESTOCK, ENV'T & DEV. INITIATIVE, FOOD & AGRIC. ORG., LIVESTOCK'S LONG SHADOW: ENVIRONMENTAL ISSUES & OPTIONS 271 (2006), ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf.

2. Peter Lehner, *The Hidden Costs of Food*, HUFFINGTON POST (Aug. 15, 2016), https://www.huffingtonpost.com/peter-lehner/the-hidden-costs-of-food_b_11492520.html; *see also* CREDIT SUISSE, SUGAR CONSUMPTION AT A CROSSROADS 44 (2013), https://publications.credit-suisse.com/tasks/render/file/index.cfm?fileid=780BF4A8-B3D1-13A0-D2514E21EFFB0479 (30-40% of the $3 trillion spent annually on healthcare goes toward issues closely related to excess sugar consumption); CECILIA ROCHA, INT'L PANEL OF EXPERTS ON SUSTAINABLE FOOD SYS. & GLOB. ALL. FOR THE FUTURE OF FOOD, UNRAVELLING THE FOOD-HEALTH NEXUS: ADDRESSING PRACTICES, POLITICAL ECONOMY, AND POWER RELATIONS TO BUILD HEALTHIER FOOD SYSTEMS 5 (Nick Jacobs ed. 2017), http://www.ipes-food.org/images/Reports/Health_FullReport.pdf.

3. OXFAM, BEHIND THE BRANDS: FOOD JUSTICE AND THE 'BIG 10' FOOD AND BEVERAGE COMPANIES 5 (2013), https://www.behindthebrands.org/images/media/Download-files/bp166-behind-

ronmental performance, product design, ingredient choice, and advertising, these companies have a tremendous direct and indirect impact on billions of lives and the planet. By influencing what we buy, these companies, for example, influence our personal health and carbon footprint.

Multiple sectors now recognize the externalized impacts of the food sector and the relatively concentrated set of actors involved in the production of most of these impacts.[4] As a lever to provide market advantage to lower impact products and producers the European Union, for example, now allows life-cycle costing (*i.e.* the assessment and monetization of environmental impacts associated with all the stages of a product's life from "cradle-to-grave") to be considered in public procurement decisions.[5] Sweden, in particular, has created a national agency for public procurement specifically targeting public spending on more sustainable goods, including food.[6] The world's largest food companies acknowledge the need for industry change through forums such as the EAT Foundation and the World Business Council for Sustainable Development Food Reform for Sustainability and Health (FReSH) initiative.[7] Investors in the food sector are demanding environmental and social governance (ESG) data. In fact, S&P Dow Jones Indices recently acquired TruCost, a private company that provides environmental and social impact estimates.[8] Non-governmental organizations are seeking to pressure transformation in the food system by popularizing and promoting the concept of the "true cost of food."[9] For example, the Externalities Working Group, one of the three working groups of the Global Alliance for the Future of Food, a collaboration of philanthropic foundations, aims to identify, measure, and value the positive and negative

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brands-260213-en.pdf [hereinafter OXFAM]; *Retail Trends*, U.S. DEP'T OF AGRIC. ECON. RES. SERV., https://www.ers.usda.gov/topics/food-markets-prices/retailing-wholesaling/retail-trends.aspx (last updated Apr. 5, 2018); *see generally* 25 *Leading Global Companies Join Together to Accelerate Transformational Change in Global Food Systems*, WORLD BUS. COUNCIL FOR SUSTAINABLE DEV. (Jan. 19, 2017), http://www.wbcsd.org/Projects/FReSH/News/25-leading-global-companies-join-together-to-accelerate-transformational-change-in-global-food-systems ("Close to 100% of the food consumed across the world is produced and supplied by the private sector.") [hereinafter WORLD BUS. COUNCIL FOR SUSTAINABLE DEV.].

4. Externalized costs are those costs not borne by an actor. The environmental, social, and health impacts that result from food production, consumption, or disposal are often not included in the cost of food or the costs paid by the actor causing these impacts. *See generally* OXFAM, *supra* note 3, at 5; *see also* WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., *supra* note 3.

5. Council Directive 2014/24, 2014 O.J. (L. 94) 65.

6. *See Sustainable Public Procurement*, NAT'L AGENCY FOR PUB. PROCUREMENT, https://www.upphandlingsmyndigheten.se/en/sustainable-public-procurement/ (last visited Jan. 22, 2018).

7. WORLD BUS. COUNCIL FOR SUSTAINABLE DEV., *supra* note 3.

8. *S&P Dow Jones Indices Acquires Trucost*, TRUCOST, (Oct. 3, 2016), https://www.trucost.com/trucost-news/sp-dow-jones-indices-acquires-trucost/.

9. *See* IAN FITZPATRICK ET AL., SUSTAINABLE FOOD TR., THE HIDDEN COST OF UK FOOD (2017), http://sustainablefoodtrust.org/wp-content/uploads/2013/04/HCOF-Report-online-version-1.pdf; SUSTAINABLE FOOD TR., THE TRUE COST OF AMERICAN FOOD (2016), http://sustainablefoodtrust.org/wp-content/uploads/2013/04/TCAF-report.pdf; ROCHA, *supra* note 2.

environmental, social, and health externalities of food and agricultural systems and to deploy innovative strategies to affect associated policy and market change in order to make the true cost of food more transparent.[10]

Impact valuation (also known as life cycle costing) is an emerging concept that aims to quantify all environmental, social, and health costs of food systems in an attempt to make the true cost of food more transparent. The measurement and valuation of impacts is an emerging process, but the scale of its present use is limited. Current applications of impact valuation include basic fiscal accounting, risk assessment of individual firms across supply chains, and efforts to meet specific sustainability goals. Few, if any, of these efforts fully assess all environmental, social, and health impacts or extend beyond limited perspectives. Policy and legal developments calling for the implementation of impact valuation, such as European Union public procurement, are in danger of outstripping the ability of scientific methods and tools to deliver monetized and non-monetized comparison of companies and products.

Food producers and distributors, consumers, government, and civil society can all benefit from the development of a method that can accurately measure and value these impacts. Food producers, distributers, and sellers can use impact valuation tools and outputs to respond to consumer demand for products; assess dependencies, risks, and opportunities of natural and social capital; comply with current and expected regulations; and manage litigation and reputational risks. Consumers can use impact valuation to make informed purchasing decisions based on personal values and preferences. Investors can use impact valuation to assess the risks and opportunities rooted in dependencies on natural and social capital, as well as respond to changes in market demand. Government can use impact valuation as a consumer itself in public procurement decisions or in order to further environmental, social, and health-related goals through policy and regulation. Civil society can use impact valuation to promote environmental, social, and health goals. Overall, impact valuation can facilitate a transformation of global food systems.

Impact valuation emerges today out of a recognition of these potential benefits. However, reliance on basic accounting methods hinder the development of impact valuation because these methods are unable to incorporate the scope of impacts. New costing methods are necessary. With global supply chains and widespread impacts, gathering the data necessary to produce robust and complete impact valuation requires participation and cooperation from a variety of food system actors. It is only with these complete data sets that alternatives can be compared. There are a range of unanswered questions surrounding realizations of impact valuation methods, e.g. data sharing (hundreds of companies and multiple sectors can be involved in the production of one food product), international privacy (ingredients from food products originate and may be shipped through multiple jurisdic-

10. *Externalities*, GLOB. ALLIANCE FOR THE FUTURE OF FOOD, https://futureoffood.org/working-groups/externalities/ (last visited Jan. 23, 2018).

tions), and corporate transparency (the requirements for disclosure of environmental and social data of a corporate entity legally or wholly operating in a different jurisdiction than where the product was consumed). Impact valuation must also confront actual and conceptual problems with valuing impacts, such as where impacts fall outside of the market or where values are highly subjective. Other issues include problems with data collection norms, data compatibility, and issues of equity with how this data is used.

The concept of impact valuation is emerging at the same time as, and partly as a response to, calls for the development of legal mechanisms to address environmental, social, and health concerns. Information has long been understood both as a necessary precursor for regulation and as a regulatory tool in and of itself.[11] As a regulatory tool, data can facilitate market-based solutions to complex problems such as environmental and human rights harms. In the food system, the fields of corporate social responsibility and private governance, public procurement, and eco-labeling are examples of such policy developments that may rely on valuation.[12] These avenues necessarily include considerations of cost of environmental, social, and health impacts. Recent legal literature on these subjects has called for the development and implementation of robust cradle-to-grave accounting.[13]

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11. *See generally* Peter S. Menell, *Structuring a Market-Oriented Federal Eco-Information Policy*, 54 MD. L. REV. 1435 (1995) (discussing the implementation of consumer information programs in the early 1990s); *see also* James Salzman, *Teaching Policy Instrument Choice in Environmental Law*: *The Five P's*, 23 DUKE ENVTL. L. & POL'Y F. 363 (2013) ("[T]he theory . . . is that the government can change people's behavior by forcing them to think about the harm . . . and by publicizing that harm."); Richard Stewart, *A New Generation of Environmental Regulation*?, 29 CAP. U. L. REV. 21, 35-36 (2001) (highlighting both the difficulty of information collection in crafting regulation and the use of information as a regulatory tool).

12. *See*, *e.g.*, Adam Sulkowski & Sandra Waddock, *Beyond Sustainability Reporting*: *Integrated Reporting Is Practiced*, *Required*, *and More Would Be Better*, 10 U. ST. THOMAS L.J. 1060, 1061 (2013) ("Based on our review of recent history, the current needs of investors, and the definition of materiality, it is clear that existing laws and related rules already require greater disclosure . . . than commonly understood."); Robert H. Cutting et. al., *Spill the Beans*: *Goodguide*, *Walmart and EPA Use Information as Efficient*, *Market-Based Environmental Regulation*, 24 TUL. ENVTL. L.J. 291, 292 (2011) ("Information on corporate environmental compliance, as well as the environmental effects of a product or service over time (life cycle assessment or LCA), can be an efficient tool to influence consumer and investor behavior. . . ."); Jason J. Czarnezki, *The Future of Food Eco-Labeling*: *Organic*, *Carbon Footprint*, *and Environmental Life-Cycle Analysis*, 30 STAN. ENVTL. L.J. 3, 4 (2011) ("[C]onsumer informational labeling can be an effective regulatory tool in encouraging eco-friendly choices."); Eur. Comm'n, *Strategic Public Procurement*: *Facilitating Green*, *Inclusive and Innovative Growth*, 12 EUR. PROCUREMENT & PUB. PRIV. PARTNERSHIP L. REV. 219, 219 (2017) (encouraging public entities in the EU to recognize the value of procurements as a tool for implementing environmental policy); Francesco Testa et al., *Drawbacks and Opportunities of Green Public Procurement*: *An Effective Tool for Sustainable Production*, 112 J. CLEANER PRODUCTION 1893, 1893 (2016) ("Because 'public procurement' accounts for approximately 17% of the OECD countries Gross Domestic Product (GDP), the use of 'green' criteria in public procurement can be a very effective way of stimulating the production of greener products.").

13. *E.g.*, Nicole E. Negowetti, *Exposing the Invisible Costs of Commercial Agriculture*: *Shaping Policies with True Costs Accounting to Create a Sustainable Food Future*, 51 VAL. U. L. REV. 447, 482 (2017) ("Obtaining more accurate and comprehensive data about the true costs of industrial commodity crop

Because of the proliferation of calls for costing tools, it is important to step back and assess the current development of impact valuation methods. In this article, we review current methods and initiatives for the implementation of food system impact valuation. We conclude that in some instances, calls for the implementation of costing have outpaced available and reliable data collection and current costing techniques. We also argue that many existing initiatives are being developed without adequate consideration of the legal challenges that hinder implementation. Finally, we conclude with a reminder that although impact valuation tools are most often sought and implemented in service of market-based tools for reform, these tools can also serve as a basis for robust public policies such as Pigovian taxes.

Part I introduces the impact valuation concepts, identifies key constituencies, and defines critical terminology. Part II sums up challenges facing robust implementation of impact valuation. Although significant barriers remain, Part II argues that none are fatal to the continued development of these tools, which continue to have great potential to facilitate transitions toward a more just and sustainable food system. Part III surveys existing applications, noting how different constituencies have contributed to development of impact valuation both on the supply side through the development of new methods and application, and on the demand side, through requiring or requesting the provision of data. Part III also notes existing shortfalls in relation to these specific impact valuation methods. Part IV surveys a variety of ongoing efforts to standardize methods. Part V briefly concludes.

I. IMPACT VALUATION CONCEPTS

Impact valuation is the measurement and quantification of environmental, social, and health impacts.[14] Other terms analogous to impact valuation include: true cost of food and life cycle costing.[15] Impact valuation employs traditional life cycle assessments and quantifies values such that externalities, as well as alternatives that might minimize or eliminate externalities throughout a food product's life cycle, can be compared. In short, impact valuation provides units of comparison for activities throughout the life cycle and from the perspective of all interested and affected parties.

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production should be a key priority of agencies, such as the EPA and USDA."); Mary Jane Angelo & Joanna Reilly-Brown, *Whole-System Agricultural Certification: Using Lessons Learned from LEED to Build A Resilient Agricultural System to Adapt to Climate Change*, 85 U. COLO. L. REV. 689, 691-92 (2014) (proposing the use of the LEED certification model in agriculture).

14. *See* TRUE PRICE ET AL., THE BUSINESS CASE FOR TRUE PRICING 7 (2015), http://trueprice.org/wp-content/uploads/2015/02/True-Price-Report-The-Business-Case-for-True-Pricing.pdf [hereinafter TRUE PRICE ET AL.].

15. Impact valuation will be primarily used in this review due to the necessity and value of quantitative measures that do not rely on dollar amounts.

In order to assess the state of the field of impact valuation and its application to food systems, it is important to understand the basic life cycle concepts and establish common terminology. Costing techniques are developing in a piecemeal fashion, for the purposes of individual actors and sectors; therefore, a discussion of the "basics" within the context of food systems can aid the inquiry into how further development should be structured. This section describes the foundational life cycle costing frameworks; the constituencies that can use, benefit from, and contribute to impact valuation; and basic impact valuation terminology.

A. *Types of Life Cycle Costing*

The consideration of costs across time is not a new concept. *Conventional life cycle costing* (C-LCC) has long been used by firms as a way to consider not just the acquisition costs when making purchasing decisions, but also the costs of operation, maintenance, and disposal (when borne by the firm or user).[16] Internal costs are typically assessed from the perspective of a single market actor.[17] As a result, C-LCC, sometimes known as "the true cost of ownership," does not consider external costs, and will exclude the use and end-of-life phases if the focal actor does not internalize these costs.[18] This, in turn, likely excludes entire categories of environmental, social, and health impacts and affected parties. Most C-LCC techniques were developed and "applied in the framework of decisions over products or investments requiring high initial capital, such as buildings, energy systems, transport systems, military equipment, and durable goods in general."[19] C-LCC does not have an environmental focus, unless those costs are somehow internalized; rather, it focuses on economic viability or performance.[20]

Traditional economic valuation fails to extend beyond financial and asset capital, ignoring both natural and social capital, because of its narrowly defined perspective.[21] *Natural capital* refers to "[t]he stock of renewable and non-renewable

16. ANDREAS CIROTH ET AL., ENVIRONMENTAL LIFE CYCLE COSTING 1, 4-7 (David Hunkeler et al., eds., 2008).

17. *See id*. at 4.

18. *See id*.

19. FABIO DE MENNA ET AL., EUROPEAN UNION'S HORIZON 2020 RESEARCH & INNOVATION PROGRAMME, REFRESH: METHODOLOGY FOR EVALUATING LCC 5 (Apr. 2016), https://eu-refresh.org/sites/default/files/REFRESH_D5_2_Meth_for_ev_LCC_Final_formatted_0.pdf [hereinafter REFRESH, LCC REPORT].

20. *Id*. at 12.

21. EY, TOTAL VALUE: IMPACT VALUATION TO SUPPORT DECISION-MAKING 5 (2016), http://www.ey.com/Publication/vwLUAssets/EY-total-value/$FILE/EY-total-value.pdf ("Value creation, however, is only partially captured by a company's financial statements, since the latter mainly reflect its financial and manufactured capital. Other forms of capital, such as social, human, intellectual and natural capital, are only partially or not visible at all in a company's financial accounts.") [hereinafter EY, TOTAL VALUE]; *see also* Rashila Kerai, *Impact*: *What's it Worth*?, ROBECOSAM 4 (2017).

natural resources (for example: plants, animals, air, water, soils, and minerals) that combine to yield a flow of benefits to people."[22]

> Natural capital can be seen as fundamental in supporting all other forms of capital; it provides the resources with which we build our societies, economies, and institutions, and ultimately regulates the environmental conditions that enable human life. Furthermore, the benefits of natural capital (e.g., fresh water) are often only realized by applying other forms of capital (e.g., manufactured capital like a water pump, which is purchased using financial capital, and owned and operated thanks to social and human capital). This integration makes it impossible to completely separate any one form of capital from the others, and considering trade-offs between them will be part of any decision.[23]

The exclusion of natural capital from basic economic decisions prevents firms from adequately addressing dependencies and associated risks, where externalities are actually indirectly internal.[24]

The definition of *social capital* varies, but generally refers to "resources and relationships provided by people and society . . . . This encompasses human capital (people's skills, knowledge and wellbeing), social capital (societies' shared values, norms and institutions), and relationship capital (connections and network)."[25] Similarly, social capital must be included in life cycle costing analyses, not just because doing so would include broader perspectives and additional interested actors, but also in order to ensure that dependencies and risks are considered.

When considering the interests of actors beyond the producer or user, such as those actors interested in or affected by the product and/or its life cycle, the inclusion of social and natural capital is necessary. Even from the perspective of a singular firm or user, there is a growing realization that both natural and social capital must be incorporated into decision-making for proper opportunity and risk analysis, and in order to consider impacts on humans and the environment that are of concern to that firm or user.[26] An extension of this traditional economic valuation,

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22. NAT. CAPITAL COAL., NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE 2 (2016), http://naturalcapitalcoalition.org/wp-content/uploads/2016/07/NCC_FoodAndBeverage_WEB_2016-07-12.pdf [hereinafter NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE].

23. NAT. CAPITAL COAL., NATURAL CAPITAL PROTOCOL 3 (2016), http://naturalcapitalcoalition.org/protocol/ [hereinafter NCC, NATURAL CAPITAL PROTOCOL].

24. *See infra* Section (I)(b)(iv).

25. FOOD & AGRIC. ORG., GLOSSARY: FULL-COST ACCOUNTING 59 (2016), http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Full_cost_Glossary_final_PDF.pdf; *see also* Tristan Claridge, *Definitions of Social Capital*, SOC. CAP. RES. (Jan. 7, 2004), http://www.socialcapitalresearch.com/literature/definition.html (defining social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance or recognition . . . .").

26. *See infra* Section II(a)(i)-(ii).

therefore, requires a broader perspective, time span, and assessment of costs not directly borne by the focal actor. This broader analysis can be understood in the context of the complementary life cycle assessment framework.

Life cycle assessments (LCA) describe a "compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle."[27] The *life cycle* includes "consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal."[28] The first stage of an LCA is to define the scope of the analysis, which is dictated by the capacity and the goals of the analysis.[29] The second stage is an *inventory analysis* whereby "all the inputs and outputs in a product's life cycle, beginning with what [the] product is composed of, where those materials come from, where they go, and the inputs and outputs related to those component materials during their lifetime" are examined.[30] The third stage is an *impact analysis*, or an examination of the environmental or other impacts, from all of the inputs and outputs – without translating these impacts into costs.[31] Rather, LCA is descriptive and serves the important purpose of mapping out systems in great detail across time, space, and actors.

The application of costing or other quantitative techniques to LCA is still developing. *Environmental life cycle costing* (E-LCC), which relies on the LCA framework, considers costs borne by one or more actors connected to the product's life cycle, either directly or indirectly, and extending both upstream and downstream in the product's lifespan within the "decision relevant future."[32] Each actor will have its own decision relevant future, related to the activity that actor undertakes with the food product. This decision relevant future does not extend to activities, benefits, or costs that do not directly impact that actor. These actors might be suppliers, manufacturers, users, consumers, or end-of-life actors.[33] E-LCC is still limited in its scope and perspective. Figure 1 displays the conceptual framework of E-LCC.

27. REFRESH, LCC REPORT, *supra* note 19, at ii.

28. *Id*.

29. *Life Cycle Analysis*, ENVTL. LITERACY COUNCIL, https://enviroliteracy.org/environment-society/life-cycle-analysis/ (last visited Feb. 3, 2017).

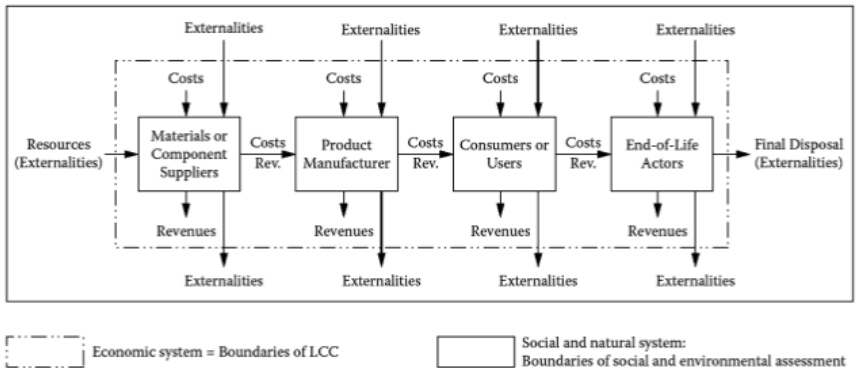
30. *Id*.

31. *Id*.

32. CIROTH ET AL., *supra* note 16, at 4.

33. *Id*.

FIGURE 1. CONCEPTUAL FRAMEWORK OF ENVIRONMENTAL LIFE CYCLE COSTING.[34]



True cost accounting or *societal life cycle costing* (S-LCC) considers costs from a broader perspective, although exact definitions vary across sources. Generally, S-LCC assesses "all costs associated with the life cycle of a product that are covered by anyone in the society, whether today or in the long-term future . . . . The perspective is from society overall, nationally and internationally, including governments."[35] The Lexicon of Sustainability defines true cost accounting as "a practice that accounts for all external costs – including environmental, social and economic – generated by the creation of a product."[36] It should be noted that environmental, social, and economic dimensions comprise the three pillars of sustainable development as defined by the European Union and other entities.[37] Other entities consider an even further expanded definition of true cost accounting where the external environmental, social, and economic costs of the entire life cycle of the product are considered. The Sustainable Food Trust defines the analysis, in the context of food systems, as:

> identifying, categorizing, quantifying, and putting a price on the range of costs and benefits arising from different production systems and developing various mechanisms through which we can ensure that in the future,

34. *Id*. at xxix.

35. *Id*. at 4; *see also* SAVANNA HENDERSON ET AL., FOOD TANK, THE REAL COST OF FOOD 18 (2015) [hereinafter FOOD TANK] (Other terms that may be used to describe this analysis include: triple bottom line, full cost accounting, natural capital accounting, or cradle to cradle.).

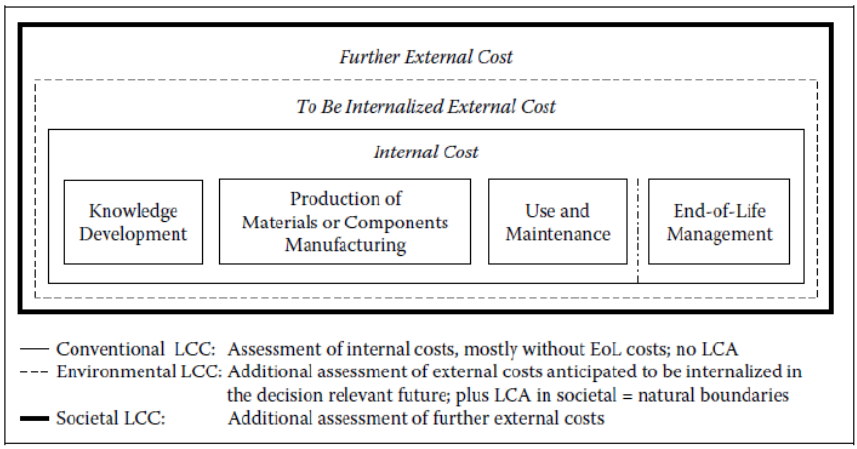
36. *True Cost Accounting*, LEXICON OF SUSTAINABILITY, http://www.thelexicon.org/tca/ (last visited Mar. 7, 2018).

37. *Sustainable Development*, EUR. COMM'N, http://ec.europa.eu/environment/sustainable-development/index_en.htm (last updated Feb. 6, 2017); *see also The Three Pillars of Sustainability*, THWINK.ORG http://www.thwink.org/sustain/glossary/ThreePillarsOfSustainability.htm (last visited July 29, 2018).

> polluters will pay and those that are producing healthy and sustainable food will be better rewarded financially than those whose food production systems are damaging the planet and undermining public health.[38]

The consideration of all human and non-human impacts is consistent among these definitions of S-LCC. Figure 2 compares the scope of C-LCC, E-LCC, and S-LCC.

FIGURE 2. COMPARISON OF C-LCC, E-LCC, AND S-LCC.[39]



All life cycle costing methods require the same basic steps shaped by the goals and applications of the analysis. First, the goal(s) and perspective of the LCC analysis will determine scope, system boundaries, cost bearers, and cost categories to be considered.[40]

> [W]hile several stakeholders can be part of the same life cycle of a product, not every actor is bearing the same categories of costs. Thus, depending on the system boundaries (cradle to gate vs. cradle to grave) an E-LCC may include costs for producers (e.g. design, production, and marketing), costs for distributors (e.g. transport, storage, and sale), costs for consumers (e.g. purchase, use, and maintenance), and costs for waste companies. In the case of Societal LCCs, also governments, country and global societies may be included as cost bearers. The identification of cost bearers leads to the inclusion of different upstream and downstream cost and should be disclosed in the description of the cost model. Since several

38. Rosie Stabile & Sarah Small, *Q&A with Sustainable Food Trust's Patrick Holden*, THOMSON REUTERS FOUND. (Jan. 28, 2015, 21:32 GMT), http://news.trust.org//item/20150128213232-9c02g.

39. CIROTH ET AL., *supra* note 16, at 5.

40. *See id*. at 17-34.

> perspectives and actors may be included in the same cost model, it is suggested to aggregate costs with caution, depending on the goal of the study.[41]

The goal(s) will also determine the alternatives to be compared to points within the current life cycle of the product or system.[42]

Second, necessary cost information must be gathered.[43] Data might not be readily available for analyses of food products and systems, or for certain categories of externalities. Challenges to accessing the necessary information to calculate costs include: transboundary life cycles, the number of actors in a given supply chain, the breadth of impacted parties, privacy concerns, proprietary information, the expense of data measurement and gathering, legal exposure, and the uncertainty of attribution of impacts. Alternative methods, such as scenarios or forecasting, may be employed if data cannot be obtained.[44] The Economics of Ecosystems and Biodiversity (TEEB) developed a *valuation framework* for the food industry that includes an extensive list of cost and value categories that might be considered in a life cycle costing analysis.[45]

Environmental costs that might be considered in a life cycle costing analysis for a food product or system include but are not limited to: air pollution, biodiversity loss, climate change, deforestation, greenhouse gas emissions, land use, soil erosion, waste, and water pollution.[46] Some of these costs overlap with social and health costs, and vice versa.[47] Social and health costs that might be considered include but are not limited to: animal welfare, antibiotic resistance, child labor, foodborne pathogens, healthcare costs, obesity, subsidies, taxes for welfare and social services, and worker's rights.[48] These social and health costs span impacts from both production and consumption.

B. *Overview of Constituencies*

Different constituencies within food systems have stakes in the development and implementation of impact valuation.[49] Consideration of each constituency can

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41. REFRESH, LCC REPORT, *supra* note 19, at 21 (citations omitted).

42. CIROTH ET AL., *supra* note 16, at 12-13.

43. *Id*. at 12.

44. *Id*. at 13.

45. *Introductory Note on Valuation Framework*, THE ECON. OF ECOSYSTEMS & BIODIVERSITY (TEEB), http://www.teebweb.org/agriculture-and-food/framework-note/ (last visited June 19, 2018). This framework, and others are discussed *infra* section IV.

46. FOOD TANK, *supra* note 35, at 13.

47. *See id*.

48. *Id*.

49. For a concise overview of the food system and food system actors, see generally Polly Ericksen, *Conceptualizing Food Systems for Global Environmental Change Research*, 18 GLOB. ENVTL. CHANGE

inform: 1) new perspectives and impacts to be included that were otherwise ignored by traditional accounting methods; 2) necessary participation in data availability and gathering; and 3) the potential uses of impact valuation tools.

1. Food Producers, Processors, and Distributors

Food producers, processors, and distributors are key players in the provision of the data necessary to undertake impact evaluation. Each of these players serves as a central decision-making point within the food system; therefore, they have access to information related to the network of activities at their respective stages. Ensuring adequate buy-in is essential for successful data collection.

Food producers, processors, and distributers might use impact valuation tools to adequately assess and address their dependencies on natural capital and the associated risks and opportunities.[50] For example:

> Availability and quality of natural capital can impact the demand for and cost of raw materials, energy, and water; [r]egulation and legal action can restrict access to resources, increase costs of access, and influence build or expansion costs; [c]hanging consumer preferences can influence sales and market share influence from stakeholders can both positively and negatively impact business practices and license to operate; [i]nvestors are increasingly committing to using environmental data alongside other metrics to inform decision making and drive value; [and r]elationships with the wider community may be positively or negatively influenced due to activities impacting local natural resources.[51]

Impact valuation allows a player to consider the life cycle of their products (and specific stages therein) and address these risks or take advantage of potential benefits of natural capital dependencies through monetized terms.[52] These methods can be described as "help[ing] decision-makers within . . . organization[s] build more

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234, 234 (2008); John Ingram, *A Food Systems Approach to Researching Food Security and its Interactions with Global Environmental Change*, 3 FOOD SECURITY 1876, 1876 (2011).

50. *See generally* TRUE PRICE ET AL., *supra* note 14.

51. NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note 22, at 10. True Price cites four benefits for producers from conducting true cost accounting:

> 1. Risk management: control and reduce risks in the supply chain due to future cost increase and regulation. 2. Cost reduction: identify projects that are both sustainable and increase resource efficiency to reduce costs. 3. Innovation: identify alternative modes of production, that are more sustainable and cost-effective. 4. Branding: communicate superior social and environmental performance of a product.

TRUE PRICE & SUSTAINABLE TRADE INITIATIVE, THE TRUE PRICE OF TEA FROM KENYA 13 (2016), http://trueprice.org/wp-content/uploads/2016/04/TP-Tea.pdf.

52. NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note 22, at 18.

future-proof businesses."[53] Firms might also be interested in these analyses when considering "whether [environmental and social] externalities are truly external or if [they] are next in line for internalization" by regulation.[54]

Food producers might use impact valuation to better evaluate inputs and production methods and to ensure that their products are marketable to those aiming to meet specific environmental, health, or social standards. Food producers can also use impact valuation to better assess health risks to farm workers and opportunities for change.

Food processors and distributors might use impact valuation to "respond[] to consumer demand for more sustainable food systems, but . . . also change[] practices to minimize negative externalities and promote positive ones."[55] Firms are able to use the results of life cycle costing to inform supply chain management. Sustainable sourcing describes supply chain partners who employ environmentally and socially responsible practices.[56] "Sustainable supply chain management built around ethical and environmental sourcing principles leverages [a firm's] purchasing power to mitigate supply chain risks, reinforces long-term supplier relationships, and builds stakeholder and customer trust."[57] Impact sourcing describes "outsourcing that benefits disadvantaged individuals in low employment areas."[58]

2. Workers

The perspectives of workers are often not included in traditional accounting methods, or even cursory life cycle costing methods, especially with regard to social and health related impacts. Participation by these players will be critical as their employers might enlist them to gather necessary data or because data related to social or health concerns must come from these players. Workers are also potential users of impact valuation tools. Open access to impact valuation data might help correct information asymmetries that often exist between workers and em-

53. EY, TOTAL VALUE, *supra* note 21, at 10.

54. *Id*. at 7 ("Carbon pricing, for instance, by the EU-ETS mechanism is a likely candidate for further internalization after the realization of the global climate change agreement signed at the COP21 in Paris. Other examples of internalized costs include extended producer responsibility (EPR) or the WEEE2 directive for e-waste.").

55. FOOD TANK, *supra* note 35, at 14; *see also* ALPHABETA, BUS. & SUSTAINABLE DEV. COMM'N, VALUING THE SDG PRIZE IN FOOD AND AGRICULTURE: UNLOCKING BUSINESS OPPORTUNITIES TO ACCELERATE SUSTAINABLE AND INCLUSIVE GROWTH (Oct. 2016), http://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf.

56. *Responsible Sourcing*, SCS GLOB. SERVS., https://www.scsglobalservices.com/responsible-sourcing-advisory (last visited May 19, 2018).

57. BILL ADAMS, THE PATH TO A SUSTAINABLE ENTERPRISE, NTSPC, http://www.pstc.org/files/public/Adams_Bill.pdf.

58. Jeremy Jockenstein, *Sourcing Matters*: *Becoming More Intentional About Your Business Spend*, HUFFINGTON POST, http://www.huffingtonpost.com/jeremy-hockenstein/sourcing-matters-becoming_b_7184432.html (last updated Dec. 6, 2017).

ployers about levels of workplace risk. If workers are fully informed with the scope of potential risks stemming from different work environments, they might be able to seek employment that minimizes these risks, if market conditions allow.

3. Consumers

For a consumer, the output is likely in the form of the true cost of food or the cost of a food product that fully incorporates all economic, environmental, social, and health costs to society.[59] The consumer might also receive information comparing a specific stage of the product's life cycle and associated costs to that same stage of another product's life cycle, or the true cost contribution to a specific environmental or social harm (i.e. the true cost of the carbon footprint of the product). This information could be presented in the form of eco-labeling.[60] The consumer, whether an individual or institution, will use this information in making purchasing decisions between products according to their values and preferences.

> Informed consumers can . . . change their food buying, consumption, and waste habits. Consumers increasingly want to understand how and where their food was produced so that they can make more informed purchasing decisions. When purchasing products in the U.S., 77 percent of families take into account the product's sustainability, including if it is locally produced, whether it comes in sustainable packaging, if it is humanely raised, whether it is non-GMO, and if it protects or renews natural resources.[61]

4. Investors

Investors in food systems will also benefit from impact valuation. This group constitutes "advanced users" of capital accounting, who can benefit in their decision-making by better understanding the risks and opportunities of associated environmental and social capital of a company or product, just like the company itself.[62] Like firms themselves, investors benefit from understanding dependencies, as well as changing market demand.[63] Impact investors are also natural users of impact valuation data.[64]

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59. FOOD TANK, *supra* note 35, at 6-11.

60. *See*, *e.g.*, Jason J. Czarnezki, *The Future of Food Eco-Labeling*: *Organic*, *Carbon Footprint*, *and Environmental Life-Cycle Analysis*, 30 STAN. ENVTL. L.J. 3 (2011).

61. FOOD TANK, *supra* note 35, at 15.

62. EY, TOTAL VALUE, *supra* note 21, at 10.

63. *See* TRUE PRICE ET AL., *supra* note 14; NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note 22.

64. ELENA PONS & MAUD-ALISON LONG, PROMOTING SUSTAINABLE FOOD SYSTEMS THROUGH IMPACT INVESTING (2013), http://web.cof.org/2013Annual/docs/AC13_SessionMaterials_BreakfastPlenary_FoodSystems_Sustainable%20Food%20Systems%20PRI%20examples.pdf.

5. Government

Governments can utilize life cycle costing in order to further environmental or social goals. "With a more accurate picture of the external costs of our food system, governments and policymakers can redirect and/or impose appropriate subsidies, incentives, and taxes to farmers and producers; require increased transparency in how our food is produced and integrate [true cost accounting] into policies and procurement mechanisms."[65] Governments, through public procurement, also act as a large-scale consumer and can seek to promote environmental or societal goals through the purchasing of food products produced in a way that aims to achieve such goals. Accurate true cost of food data can play a critical role for public policy makers considering how those costs should be equitably distributed across different food system actors. For instance, such data might facilitate a debate about the extent to which farmers, who are often not able to pass along increased production costs due to efforts to internalize externalities, should be able to do so.[66]

6. Civil Society

Civil society and nongovernmental organizations (NGOs) can facilitate the implementation of life cycle costing by firms, government, and consumers through the provision of information and tools.[67] These groups can fill the current gaps in necessary information and methodology to enable increased use of these analyses by other groups and civil society itself. Civil society can use impact valuation tools to further support their own environmental, social, or health-related goals by illuminating certain practices and promoting alternatives.[68]

C. *Other Terminology*

Cost categories: The broad categories of costs to be included in a life cycle costing analysis such as economic cost categories, life cycle stages, activity types, and other costs.[69] Economic cost categories include budget, market cost, alternative cost, and social cost.[70] Life cycle stage cost categories include "[k]nowledge development (including R&D), primary production (materials, energy, etc.), components production, manufacturing, use, and end-of-life management."[71] Activity types cost categories include: "[d]evelopment, extraction, purchase, sales, reuse, and management; [d]esign, agricultural production, schooling, public relations, re-

65. FOOD TANK, *supra* note 35, at 15.

66. *See* Margot J. Pollans, *Farming and Eating*, 13 J. FOOD L. & POL'Y 99, 107-09 (2017).

67. FOOD TANK, *supra* note 35, at 23.

68. *See id*.

69. CIROTH ET AL., *supra* note 16, at 21.

70. *Id*.

71. *Id*.

cycling, and administration; [and r]esearch, testing, packaging, transport, maintenance, waste processing, and infrastructure."[72]

Cost allocation: "The partitioning of input or output flows of a process or a product system between the product system under study and one or more other product systems."[73]

Cost bearer: The party that bears the costs. This includes different parties as the life cycle progresses, including the producer, actors in the supply chain, owners and users, suppliers of a service such as waste collectors, society, etc.[74]

Cradle to cradle: A framework in which "all material inputs and outputs are seen as either technical or biological nutrients," meaning they can, in turn, become inputs for future processes.[75] Technical nutrients can be recycled or reused with no loss of quality, while biological nutrients can be composted or consumed.[76]

Cradle to gate: A (partial) product supply chain that runs from the extraction of raw materials (cradle) to the gate of the manufacturer, wherein they relinquish control. Cradle to gate does not include distribution, storage, use, or disposal stages.[77]

Cradle to grave: A product life cycle that runs from the extraction of raw materials to end of life disposal or recycling, and includes the intermediate states of processing, distribution, storage, and use. All relevant inputs and outputs are considered for all of the stages.[78]

Discounting: "Convert[ing] costs (and revenues or value) occurring at different times to equivalent (net) costs at a common point in time."[79]

Externalities: Environmental, social, and health impacts that are not borne by an actor.[80]

Functional unit: "Quantified performance of a product system for use as a reference unit."[81]

Internal cost: "Cost directly borne by an individual or organization in supplying or consuming a product, as value added by the firm (capital and labor costs)."[82]

System boundary: "Definition of aspects included or excluded from the study. For example, for a "cradle to grave" analysis, the system boundary should include

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72. *Id*.

73. REFRESH, LCC REPORT, *supra* note 19, at i.

74. CIROTH ET AL., *supra* note 16, at 25-26.

75. *Cradle-to-Cradle*, SUSTAINABILITY DICTIONARY, http://www.sustainabilitydictionary.com/cradle-to-cradle/ (last visited Feb. 1, 2017).

76. *Id*.

77. REFRESH, LCC REPORT, *supra* note 19, at i.

78. *Id*.

79. CIROTH ET AL., *supra* note 16, at 173.

80. REFRESH, LCC REPORT, *supra* note 19, at ii.

81. *Id*.

82. CIROTH ET AL., *supra* note 16, at 174.

all activities from the extraction of raw materials through the processing, distribution, storage, use, and disposal or recycling stages."[83]

Transfer payments: "Payments between governments and private persons or organizations, involving taxes and subsidies. Payments for public services, like for waste management, may fall under this heading if paid (for example) by a local municipality from taxes or levies."[84]

True cost of ownership: The environmental and economic costs from the point of purchase through disposal that accrue to the owner.

Value added: "The difference between the cost of products purchased and the proceeds of products sold, as gross value added, being the costs of labor and capital, including profits. Net value added is obtained by subtracting depreciation from gross value added."[85]

II. CHALLENGES

Food producers and governments are increasingly integrating impact valuation techniques into everyday decision making and sustainability reviews. Ecolabels, public procurement programs, and corporate social responsibility policies already rely, to varying degrees, on impact valuation. For the most part, existing efforts are limited in comprehensiveness both as a matter of practice and as a matter of aspiration, as very few actors rely or seek to rely on complete impact valuations for products, ingredients, or manufacturing processes. And for good reason: numerous challenges hinder successful development of comprehensive tools. We identify a range of hurdles. Some are technical and relate to the complexity of the food system, while others are legal in nature. As a result of the global scale of many supply chains, impact valuation tools must necessarily grapple with a variety of legal regimes, including both the domestic laws of any country through which a supply chain passes and international trade law. Finally, impact valuation continues to face a variety of normative hurdles that may limit buy-in of necessary data-gathering participants to data end users.

A. *Information Availability and Acquisition*

The data required to conduct robust LCC analyses is extensive. The data must include information on each ingredient through every stage of processing with the life cycle crossing geographic boundaries that could affect availability of information.[86] Although there is increasing availability in LCA databases, relying on

83. REFRESH, LCC REPORT, *supra* note 19, at iii.

84. CIROTH ET AL., *supra* note 16, at 174.

85. *Id*.

86. Thomas Nemecek et al., *Environmental Impacts of Food Consumption and Nutrition*: *Where Are We and What Is Next*?, 21 INT'L J. LIFE CYCLE ASSESSMENT 607, 614 (2016).

data from multiple sources could pose problems where methodologies and assumptions do not match.[87]

System boundaries are defined according to the goals of the party conducting the LCC analysis and may include life cycle stages after sale – through consumption and disposal by the consumer.[88] It is difficult, however, to quantify the stages after the point of sale because of highly variable consumer behavior that is difficult to document.[89]

Assessing the impacts of environmental and social externalities requires data spanning diverse affected parties, geographies, and time scales – and often encompasses impact pathways that are difficult to assess. Access to this data is further limited by privacy concerns of parties throughout the supply chain and product life cycle, or information may be proprietary.

B. *Consensus on Methods*

The frameworks presented herein include comprehensive methods outlining impact valuation analyses that can guide users to assess the most relevant impacts and dependencies for their specific objectives and systems. At the same time, these frameworks, when consistently applied, can begin to produce analyses that can be compared across firms, products, and production methods.

Many of these frameworks, however, do not apply specifically to food systems. While methods are still being developed for environmental, social, and health costing generally, food system applications have lagged. It is essential that these frameworks be developed for specific application to food systems. Every sector or system produces unique environmental, social, and health impacts that stem from differing causal pathways. Therefore, a food system-specific methodology can most effectively and comprehensively include these elements. Although it might not be prudent to compose broad valuation methodologies to apply to impact valuation of food systems generally, these concerns should not leave valuation methods to be determined entirely on a purely case-by-case basis, otherwise impact valuation will remain too inconsistent to be meaningful. Rather, there are opportunities for standardization of valuation methodologies for specific food products, production methods, impacts, and so on. Therefore, when conducting impact valuation, the party can employ a set of these valuation methods that are applicable to the

87. *Id*. at 614-15 ("Publicly available [life cycle inventory] databases such as ecoinvent (ecoinvent Centre 2014) contain limited data regarding the agricultural and food sectors and allow differentiation of production systems and countries of origin only in some cases. Recent database initiatives such as the French AGRI-BALYSE (Koch and Salou 2013), the Dutch Agri-Footprint (Blonk 2014), or the US LCI (NREL 2012) partly remedy this situation. Private consultants also offer databases covering a large range of food products in several countries (JRC 2015). Thus, today a lot of different LCA databases for food products are available.") (citations omitted).

88. *Id*. at 615.

89. *Id*.

case at hand. Furthermore, by standardizing valuation on particular impacts, or other focuses, it will become clear what data and information is necessary to collect and aggregate for the completion of these analyses.

C. *Legal Barriers*

Legal barriers currently hinder data acquisition and sharing between parties. For complete impact valuation analyses, or even analyses across certain stages of a life cycle, data must be acquired from a range of actors including producers of inputs, distributors, and consumers. These parties are often protected by laws that allow them to avoid sharing information about their practices. For example, privacy laws can protect consumers from sharing information, or having information tracked, about their personal habits. Other information might be protected as proprietary information or intellectual property. Global supply chains also complicate the acquisition of data, as information for an entire supply chain might be subject to numerous legal schemes that protect information in different ways.

Participants in the production and distribution of food products might seek to take advantage of these protections in order to insulate themselves from legal or reputational risk. Due to the aggregation and provision of this information, firms could be exposed to legal claims of food fraud, misrepresentation, misbranding, mislabeling, false advertising, product liability, consumer protection, and violations of environmental regulations or workplace safety and associated costs. Firms might also open themselves up to further regulation when exposure of certain environmental and social impacts prompts a regulatory response.

Legal and regulatory structures might also hinder implementation of impact valuation. For example, federalism could restrict widespread implementation of supporting regulations because of differing interests and political climates between states. Reporting requirements might be blocked due to unfair burdens on small businesses. Legal discrimination concerns might impede implementation.

These barriers can be removed. For example, issues related to global supply chains might be dealt with by modeling after other transboundary regulatory schemes, such as consumer protection laws, food safety laws, and other public health and environmental disclosures. Policies and incentives can be implemented in order to encourage the necessary trust and data transactions across and within borders. Further consideration of legal barriers impeding the development of impact valuation methodologies and their implementation is a critical research task.

D. *Normative Barriers*

The comparison of social and environmental capital to economic capital poses challenges. While monetization aims to allow comparisons of dissimilar objects, the results might not be reflected by our values. For example, "[t]rade-offs between the different sustainability dimensions are quite common, so that adequate com-

promises are needed."[90] Lack of understanding regarding how to make these tradeoffs can be another barrier to implementation. A reluctance or inability to consider tradeoffs is rooted in unclear objectives, whereby the pursuit of one goal might result in undesired environmental consequences (i.e. strict pursuit of organic product sourcing, resulting in the procurement of non-local products), or in prioritizing one goal over another (i.e. prioritizing environmental or social outcomes).[91]

Monetization might oversimplify the comparison of impacts. "Caution is needed when adding up the different impact categories as this could oversimplify issues and even blur the overall view. For instance, human rights issues in an organization's supply chain could never be 'compensated' by the purchase of CO2 rights."[92]

This challenge is rooted in inherent limitations of economic valuation – where some values escape monetization or where equity is not supported by any valuation techniques.

> All valuation methods have advantages and disadvantages and, generally speaking, a sequential, pragmatic approach from identifying and estimating costs and/or benefits qualitatively, followed by quantification and monetization, when possible, is recommended. An important valuation limitation can be uncertainty around potential future costs or benefits, particularly in proximity to critical thresholds and potentially irreversible ecosystem changes.[93]

Furthermore, impact valuation carries an implicit assumption that it is indeed possible to monetize environmental and social impacts if the frameworks, methodologies, and impetus are established; however, there is value that simply cannot be captured through the "universal" language of money and markets.

E. *Conflict Among Uses*

While impact valuation and a true-cost of food as an idea has found support across industry, civil society, and academia, standardized implementations and data sharing might be impaired by eventual conflicts in the needs of users.[94] Public procurement and eco-labeling applications require impact valuation at the end-product level. Civil society aims at policy leverage points such as livestock consumption,

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90. *Id*. at 614.

91. *See* Julie Smith et al., *Balancing Competing Policy Demands*: *The Case of Sustainable Public Sector Food Procurement*, 112 J. CLEANER PRODUCTION 249, 250 (2016) (describing trade-offs between sustainability a social equity that could create "major challenges for governance mechanisms").

92. EY, TOTAL VALUE, *supra* note 21, at 9.

93. NCC, NATURAL CAPITAL PROTOCOL, *supra* note 23, at 82 (citations omitted).

94. *See infra* Section III.

sugar taxes, food waste, etc.[95] Industry appears predominately interested in reporting requirements to financial and investor bodies at the company level. The data resolution of company reporting is much coarser than that of processes, ingredients, or end products. Is industry open to the degree of transparency in its supply chains required for product level valuation given the potential legal risks? Who would operate and govern a trusted information system where on-demand query about environmental and social externalities of a particular product or ingredient can be supplied but the larger operation of a company is not exposed?

III. CURRENT APPLICATIONS AND DEVELOPMENT

The diverse applications of impact valuation have prompted academics, industry, government, and civil society to begin both to apply theoretical methods to case studies (with various types of valuation employed) and to develop best practices for the young field. This part reviews some of these efforts to explore the theoretical possibilities of impact valuation and assess the current state of the field. The analysis reveals that there is much work still to be done in developing methods that can overcome the challenges described in the previous part.

A. *Academic Efforts*

Academic institutions play a critical role in filling the knowledge gaps that currently limit the widespread application of life cycle costing. These knowledge gaps include a complete mapping of the social and environmental impacts of agricultural and food production systems, cost modelling, cost data for food systems, legal limitations to implementation, and linkages between this information and policy shifts. At the current stage of development of LCC of food systems, researchers also play a critical role in surveying the field and assessing the effectiveness of current methodologies. There are several academic centers contributing to the development of true cost accounting methods and practices: the Center for a Livable Future at the Johns Hopkins University Bloomberg School of Public Health (CLF);[96] the Center for Resilience at Ohio State University;[97] the Agribusiness and Economics Research Unit (AERU) at Lincoln University in New Zealand;[98] and the Natural Capital Project (NatCap), a partnership between Stan-

95. *See infra* Section III(d).

96. *Center for a Livable Future*, JOHNS HOPKINS BLOOMBERG SCH. OF PUB. HEALTH, http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-a-livable-future/ (last visited Mar. 3, 2018).

97. *Sustainable and Resilient Economy*, OHIO STATE UNIV., https://discovery.osu.edu/sustainable-and-resilient-economy (last visited May 21, 2018).

98. *Agribusiness and Economics Research Unit*, LINCOLN UNIV., http://www.lincoln.ac.nz/Research/Research-Centres/Agribusiness-and-Economics-Research-Unit/ (last visited May 17, 2018).

ford University, University of Minnesota, the Chinese Academy of Sciences, [the] World Wildlife Fund (WWF), and The Nature Conservancy.[99]

1. E-LCC

While complete applications of life cycle costing techniques to food systems by industry are few in number, researchers have applied these frameworks to specific food product or system issues. One literature review found that "most [industry reporting] refer[s] to C-LCC and focus[es] on decisions over products or investments requiring a high initial capital, such as buildings or energy sectors . . . . *No LCC application of food systems or food waste has been identified in business sustainability reporting of food industries.*"[100] However, researchers have sought to test the E-LCC framework on food products and systems. For example, researchers have applied this framework to environmental mitigation measures for dairy production,[101] ready-made versus home-made meals,[102] food waste management scenarios,[103] types of citrus growing systems,[104] and organic versus conventional olive oil.[105] Through the applications in these studies, researchers identified knowledge gaps and difficulties in applying existing E-LCC methodologies to food systems and products.

2. S-LCC

Similarly, academic researchers seek to augment the current methodologies for S-LCC analyses for the food sector. One literature review found that "no single line of investigation or agreed approach has emerged to date."[106] Some of the issues discussed in this literature review include:

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99. NAT. CAPITAL PROJECT, http://www.naturalcapitalproject.org/ (last visited May 17, 2018).

100. REFRESH, LCC REPORT, *supra* note 19, at 11 (emphasis added).

101. Anne C. Asselin-Balençon & Olivier Jolliet, *Life Cycle Costing of Farm Milk Production – Cost Assessment of Carbon Footprint Mitigation Strategies*, *in* PROC. 8TH INT'L CONF. ON LIFE CYCLE ASSESSMENT AGRI-FOOD SECTOR 70, 70-71 (2012).

102. Ximena C. Schmidt Rivera & Adisa Azapagic, *Life Cycle Costs and Environmental Impacts of Production and Consumption of Ready and Home-Made Meals*, 112 J. CLEANER PRODUCTION 214, 215 (2016).

103. Veronica Martinez-Sanchez et al., *Life-Cycle Costing of Food Waste Management in Denmark: Importance of Indirect Effects*, 50 ENVTL. SCI. TECH. 4513, 4514 (2016).

104. Anna Irene De Luca et al., *Sustainability Assessment of Quality-Oriented Citrus Growing Systems in Mediterranean Area*, 15 QUALITY - ACCESS TO SUCCESS 103, 103 (2014).

105. Bruno Notarnicola et al., *Environmental and Economic Analysis of the Organic and Conventional Extra-Virgin Olive Oil*, 2 NEW MEDIT 28, 31-32 (2004).

106. Julie Smith & David Barling, *Social Impacts and Life Cycle Assessment: Proposals for Methodological Development for SMEs in the European Food and Drink Sector*, 19 INT'L J. LIFE CYCLE ASSESSMENT 944, 945 (2014).

> that social impacts do not have quantifiable 'zero' targets, in contrast to those associated with environmental emissions or impacts on resources . . . ; issues about system boundaries and whether these are/can be identical [to LCA or LCC] or should be constructed as separate analyses . . . ; [the need to] unite disparate and often conflicting interests for the various actors and stakeholders implicated in the chain . . . ; [and] the large number of agents involved and the complexity posed by national and/or regional differences.[107]

Academic researchers have developed and tested methodologies to help overcome the challenges of including social externalities. For example, the Social Impact Methodology developed for the EU-FP7 SENSE Project seeks to measure social impacts alongside environmental impacts within the food and drink sector.[108] This methodology uses a separate system boundary for social criteria, focusing on labor rights and working conditions, within which "the company performing the assessment could influence directly where demonstrable social improvements could be made with regard to labour-related issues."[109] The stakeholder groups were defined as workers, employees, and local communities impacted by the life cycle.[110] Researchers applying this tool found that firms were not equipped to manage the data requirements that the tool required, nor could they properly translate normative values into quantifiable data.[111]

The FOODSCALE method, developed by academic researchers Gary Goggins and Henrike Rau, analyzes eleven sustainability categories covering thirty-six food sustainability indicators.[112] The method spans "the three dimensions of sustainability – society, economy, environment – treating these as interdependent and coexisting [and] considers the entire food system, thus incorporating aspects of production, distribution, procurement, consumption, and waste disposal."[113] The eleven sustainability categories are: organic; seasonality; fairly traded produce; meat; sustainably sourced seafood; eggs; water; food waste; origin of food; consumer engagement; and engaging with smaller producers and local communities.[114] The method "deploys a points system ranging from 0 to 100 . . . . Higher scores indicate greater sustainability . . . . Greater weight is given to categories that are deemed to have a higher impact on overall food sustainability and that reflect a positive attitude towards providing health, sustainable food for consumers, com-

107. *Id*. (citations omitted).

108. *Id*. at 944-45.

109. *Id*. at 946 (citation omitted).

110. *Id*.

111. *Id*. at 949.

112. Gary Goggins & Henrike Rau, *Beyond Calorie Counting*: *Assessing the Sustainability of Food Provided for Public Consumption*, 112 J. CLEANER PRODUCTION 257, 257 (2016).

113. *Id*.

114. *Id*. at 260-61.

bined with a significant commitment to change."[115] The creators of this method explain that it can easily adapt to changing definitions or perspectives of sustainability or different visions of future food systems.[116] Early applications of the method have also exposed leverage points that can be targeted for policy, such as centralized food procurement decisions.[117]

The implementation of S-LCC is limited in large part because social criteria are generally not well-established or quantified for use in life cycle costing, unlike environmental criteria.[118] Social criteria tend to be more challenging to quantify and integrate into LCC, as "there are clear differences between environmental impacts that are related to *process* and social impacts that tend to be related to the *conduct* of the company carrying out the process [and] social impacts do not have quantifiable 'zero' targets, in contrast to those associated with environmental emissions or impacts on resources."[119] Smith and Barling suggest that social criteria should be used narrowly in order to ease their application.[120] Furthermore, the integration of both social and environmental criteria in S-LCC might require different system boundaries, raising considerations of whether these analyses should be combined.[121]

3. Incorporating Health Impacts

Academic researchers also seek to expand the implementation of health considerations within S-LCC and impact valuation analyses. Acknowledging that healthier diets can correlate with reductions in environmental impacts, as well as reduce the social cost of health concerns, researchers considered environmental externalities within the context of different diets using the Combine Nutritional and Environmental Life Cycle Assessment (CONE-LCA) framework.[122] Through this framework, researchers considered the implications of consumer behavior and die-

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115. *Id*. at 259.

116. *Id*. at 264.

> The FOODSCALE method thus moves beyond many existing assessment tools that define food sustainability more narrowly. Importantly, it is easy to use and adaptable to changing external environments and different local contexts, thereby opening up possibilities for future international comparative research as well as application of revised versions of the tool.

117. *Id*. at 265.

118. *See* Smith et al., *supra* note 91; Smith & Barling, *supra* note 106, at 945; Nemecek et al., *supra* note 86, at 614.

119. Smith & Barling, *supra* note 106, at 945.

120. *Id*. at 949.

121. *See id*.

122. Nemecek et al., *supra* note 86, at 607; *see also* Katerina S. Stylianou et al., *A Life Cycle Assessment Framework Combining Nutritional and Environmental Health Impacts of Diet*: *A Case Study on Milk*, 21 INT'L J. LIFE CYCLE ASSESSMENT 734 (2016).

tary choices, as a leverage point reducing environmental externalities.[123] Other groups, such as the Stockholm Resilience Centre at Stockholm University, are also working on linking human health impacts to food systems.[124] Efforts by industry groups often focus on health impacts from consumption patterns, but health impacts also stem from production.

4. Standardized Ontologies

In order to develop a functional valuation methodology, it is important that the way we describe systems, inputs, outputs, impacts, etc., is standardized so that the necessary comparisons can be made. IC3-Foods, a group at The University of California, Davis, is an example of an effort to standardize the food system ontologies.[125] The group aims to "aggregate, design, and develop standardized human and machine-readable vocabularies and ontologies that advance the nascent fields of Food Systems, Food, and Health Informatics—enabling vast technology ecosystems capable of uniting disciplines and enabling powerful insights and discovery across knowledge domains."[126]

B. *Industry*

Full application of impact valuation or life cycle costing by industry is limited – though industry has recognized the importance of valuing environmental and social externalities and comparing alternatives. Industry is acting in response to opportunities and risks presented by dependencies on natural capital (and, therefore, pressure from shareholders and investors), changing demand of consumers, and regulatory influence.[127] Industry has shown to be responsive to implementing life cycle costing techniques.

A study conducted by RobecoSAM, a sustainability investment firm, found that of 184 companies across different industries, 80 percent reported that they measured and valued their environmental and social impacts, but upon further analysis only 25 percent actually did so.[128] Industries are largely not yet employing valuation tools, even though many appear to acknowledge their importance as evi-

123. *See* Nemecek et al., *supra* note 86, at 607.

124. *See Global Food Systems and Multifunctional Land and Seascapes*, STOCKHOLM RESILIENCE CTR., http://www.stockholmresilience.org/research/research-themes/landscapes.html (last visited June 20, 2018).

125. *About Us*, IC-FOODS, https://www.ic-foods.org/aboutus/ourmission/ (last visited Jan. 10, 2018).

126. *Id*.

127. TRUE PRICE ET AL., *supra* note 14; TRUCOST, NATURAL CAPITAL AT RISK: THE TOP 100 EXTERNALITIES OF BUSINESS (2013), http://naturalcapitalcoalition.org/wp-content/uploads/2016/07/Trucost-Nat-Cap-at-Risk-Final-Report-web.pdf.

128. Kerai, *supra* note 21, at 6.

denced by this over-reporting.[129] Of the companies considered, only 50 percent of beverage companies, and less than 20 percent of food companies, conduct any type of impact valuation.[130] 65 percent of the companies that undertook impact valuations were monetizing value, perhaps indicating a certain need for this functionality.[131] The examples of industry employing life cycle costing techniques is growing, however, and includes the development and application of frameworks and efforts to improve the sustainability of supply chains.

1. Impact Valuation Frameworks

Some firms have implemented basic frameworks that aim to accomplish the goals of more robust impact valuation techniques – yet perhaps do not employ the full methodologies of monetizing all costs and benefits of the life cycle. For example, Nestlé's Creating Shared Value performance index represents an introductory life cycle costing of their product lines as a whole, from which a true life cycle costing analysis might be developed.[132] The performance index was developed in order to quantify and communicate the company's progress towards the United Nations Global Compact Principles.[133] The index spans the following topic areas: economic; nutrition, health, and wellness; rural development; water; environmental sustainability, including production volume, materials, energy, biodiversity, emissions, effluents and waste, and environmental sustainability governance; human rights and compliance; and our people.[134] The index does not include the impacts themselves, rather broader "indicators" that signal impacts. However, the index is designed to track changes within the company's practices. It does not allow for quantifying environmental, social, and health impacts such that external actors can make comparisons between Nestlé and other actors, nor does it allow for considerations of tradeoffs between indicators.

2. Sustainable Value Chains and Impact Sourcing

Food producers, suppliers, and distributors are recognizing the need to consider environmental and social costs in supply chain management and logistics. These efforts are described with the terms: *sustainable value chains* or *impact sourc-*

129. *Id*. at 7.

130. *Id*.

131. *Id*.

132. *Progress Against our Commitments*, NESTLÉ, http://www.nestle.com/csv/performance/kpi-summary (last visited June 20, 2018); NESTLÉ, NESTLÉ IN SOCIETY: CREATING SHARED VALUE AND MEETING OUR COMMITMENTS 5-6 (2015), http://storage.nestle.com/nestle-society-full-2015/index.html# [hereinafter NESTLÉ IN SOCIETY].

133. NESTLÉ IN SOCIETY, *supra* note 132, at 5.

134. *Progress Against our Commitments*, NESTLÉ, *supra* note 132.

ing.[135] While many of these efforts do not necessarily require valuation methods, they can be further enabled by the use of valuation techniques through an evaluation of an entire supply chain to identify target points for change or for the evaluation of alternatives. These efforts are often paired with voluntary labeling schemes. Past examples include Coca-Cola Company's phase-out of HFC refrigerants in dispensers, vending machines, and coolers; Ocean Spray's redesign of its bottling distribution network to reduce carbon emissions; Campbell Soup Company's reduced usage of packaging materials used for distribution; MOM Brands' elimination of cardboard boxes by marketing cereal in bags only; Hershey Company's redesign of its syrup bottle to reduce packaging; Green Mountain Coffee Roasters' use of repurposed burlap bags to ship bulk green coffee beans; and PepsiCo's efforts to run its Frito-Lays plant at "near net zero" (currently, the plant runs on almost entirely recycled water and renewable energy).[136]

Similarly, General Mills has pledged to sustainably source 100 percent of its top ten priority product ingredients (wheat, oats, corn, palm oil, vanilla, cocoa, eggs, fiber packaging, sugar, and milk) by 2020,[137] as well as reduce greenhouse gas emissions in its operations and agricultural supply chain.[138] Hormel Foods challenged a team to reduce 4 million pounds of packaging per year—including reduction in product packaging, shipping cases, and production line operations, with packaging waste reduced at each stage.[139] MillerCoors implemented water conservation strategies in its breweries and addressed inefficiencies in irrigation at its barley farms.[140] AB InBev also set goals to reduce water used in production and to improve water management at its barley farms, and to transition to drought-

135. *See* DAVID NEVEN, FOOD & AGRIC. ORG., DEVELOPING SUSTAINABLE FOOD VALUE CHAINS: GUIDING PRINCIPLES (2014), http://www.fao.org/3/a-i3953e.pdf.

136. GROCERY MFRS. ASS'N, ENVIRONMENTAL SUCCESS STORIES IN THE CONSUMER PACKAGED GOODS INDUSTRY (2014), https://www.gmaonline.org/file-manager/Sustainability/GMAEnvironmentalSuccessStories2014_FINAL.pdf.

137. Sam Lewis, *General Mills – Saving the Planet One Box of Cereal at a Time*, FOOD ONLINE (Oct. 11, 2013), https://www.foodonline.com/doc/general-mills-saving-the-planet-one-box-of-cereal-at-a-time-0001 (General Mills defines sustainable sourcing on a case-by-case basis: "All these ingredients are specific to certain geographies, so General Mills will need to source them using many different approaches to maintain its statement of protection and sustainability." General Mills has outlined sustainability goals for each ingredient, spanning both environmental and social concerns and often including external sustainability metrics.).

138. Sam Lewis, *General Mills Pledges to Cut Emissions in Operations and Supply Chain*, FOOD ONLINE (July 29, 2014), https://www.foodonline.com/doc/general-mills-pledges-to-cut-emissions-in-operations-and-supply-chain-0001.

139. Karla Paris, *Hormel Foods' Sustainability Goals – Less Space Mean Less Waste*, FOOD ONLINE (May 29, 2014), https://www.foodonline.com/doc/hormel-foods-sustainability-goals-less-space-mean-less-waste-0001.

140. Isaac Fletcher, *Brewers are Boosting Efficiency and Sustainability During Water Scarcity*, FOOD ONLINE (Apr. 23, 2014), https://www.foodonline.com/doc/brewers-are-boosting-efficiency-and-sustainability-during-water-scarcity-0001.

tolerant varieties.[141] Heineken's "Brewing a Better World" initiative includes goals for sustainable sourcing of raw materials, acknowledging the social impacts that local sourcing can have on farmer households, and broader impacts on food security and poverty reduction.[142]

Other firms have aimed to increase transparency and information tracking throughout their supply chains to inform consumers and to enable further supply chain assessment. For example, the Gulf Wild TransparenSea seafood traceability program allows buyers to confirm that seafood is authentic and responsibly harvested through tracking mechanisms.[143] Data provided to consumers through these mechanisms includes: specific fish type, where and how the fish was caught in the Gulf of Mexico waters, name and background of the captain and the fishing vessel, fish house and city where the seafood was landed, chain of custody information as the fish is traced through the supply chain, and conservation techniques employed to protect fisheries.[144] VG Meats' supply chain farm-to-fork traceability program uses Canada's national livestock identification program to provide animal identification, location identification, health information, animal movement, and meat quality.[145] This system enables workers to look up an animal's health history on a smartphone and enables consumers to look up information using a code.[146]

The above examples indicate a growing industry awareness of the need to address environmental and social externalities – and that supply chain improvements are necessary to do so. Many of these efforts exemplify "low hanging fruit" whereby the firm directly saves money by reducing consumption of resources. Life cycle costing can further facilitate these efforts by providing companies with monetized comparisons of alternatives where simple analyses of internalized costs no longer drive change.

C. *Government*

Governments can utilize true cost accounting and life cycle costing from varying perspectives. However, a government always acts in response to social and environmental harms that it must address in its capacity as a governing body and representative of the public. First, a government is a market actor serving as a

141. *Id*.

142. *Sourcing Sustainably*, HEINEKEN, http://www.theheinekencompany.com/sustainability/focus-areas/sourcing-sustainably (last visited Mar. 15, 2017).

143. *TransparenSea*, GULF WILD, http://www.gulfwild.com/transparensea.php (last visited Feb. 1, 2017).

144. *Id*.

145. *The VG Meats Difference*: *Learn Where Your Meat Comes From*, VG MEATS, http://vgmeats.ca/the-vg-meats-difference/ (last visited Feb. 1, 2017); Elliot Maras, *F&B Tackles Supple Chain Traceability Head On*, FOOD LOGISTICS (Mar. 28, 2016), http://www.foodlogistics.com/article/12177254/fb-tackles-supply-chain-traceability-head-on.

146. *Id*.

consumer or distributor, and thus may use life cycle costing to inform its own purchasing decisions. Second, a government may use life cycle costing to encourage behavior change of industry or consumers, through regulations, levying of taxes, and other policies, or through the regulation of life cycle costing practices themselves.

1. Public Procurement

Public institutions participate directly in markets as consumers or intermediate clients.[147] One application of life cycle costing by local and federal governments is through green or sustainable public procurement. Green public procurement (GPP) focuses on environmental impacts, while sustainable public procurement (SPP) integrates economic, social, and environmental factors.[148]

> GPP by governments and public institutions is more akin to green consumerism – namely, the production, promotion and preferential consumption of goods and services on the basis of their pro-environment claims (such as eco-labelling schemes, eco-efficient production standards etc.) rather than the promotion of sustainable consumption where change in consumption behavior needs to be accompanied by change in infrastructures (social and physical).[149]

The implementation of green or sustainable public procurement programs is often limited by existing policies and rules that seek to optimize economic growth and short-term best value.[150]

The driving forces behind the implementation of SPP are often established when SPP is part of broader political strategies and goals.[151] Factors for success include: "supportive politicians (national and local), procurement officers and catering staff; a cultural context that supported changing provisioning routines and practices; and innovative criteria for awarding contracts that acknowledged the socio-environmental quality of the products and services offered."[152] Implementation depends on political will and leadership and infrastructure that can balance the

147. Francesco Testa et al., *Drawbacks and Opportunities of Green Public Procurement: An Effective Tool for Sustainable Production*, 112 J. CLEANER PRODUCTION 1893, 1893 (2016).

148. Smith et al., *supra* note 91, at 250.

149. *Id*. (citing Lewis Akenji, *Consumer Scapegoatism and Limits to Green Consumerism*, 63 J. CLEANER PRODUCTION 13 (2013)).

150. *See id*. at 249, 250-51, 254. (Smith et al. concludes that there is "a need for clarity about what is meant by 'green' public sector food procurement and 'sustainable' public sector food procurement.).

151. *Id*. at 252.

152. *Id*.

complex interplay between economic, environmental, and social drivers and demands.[153]

The main barriers to the uptake of GPP "are the lack of organizational resources for political support and of information on the real environmental impact of the products, the difficulties in finding suppliers or in preparing calls for tenders and purchasing, the lack of guidelines from higher-order authorities and of cooperation between authorities."[154] There is:

> a scarcity of data and indicators for SPP and there is a need for further research studies to gather empirical data in order to compile an evidence base on the scope and scale of food procurement schemes. This includes the mechanisms employed (what works), the tangible benefits for sustainability and how these are extended and mobilized in the wider society.[155]

Implementing GPP or SPP is often limited by the "economic growth dogma" that only aims to limit the most significant environmental problems, while primarily focusing on promoting a growing economy.[156] Relatedly, public procurement policies also limit implementation, as they often require contracts to "be awarded on the basis of 'best value' and 'the economically most advantageous tender' (i.e. low cost), with little or no consideration for the effects on human health and the environment of the entire agrifood cycle."[157] These strict rules require an incremental approach to shift food procurement, if any at all.[158] Furthermore, risks and opportunity costs are often not considered in public procurement decision making, which further excludes promotion of socio-economic and environmental objectives. Budgetary constraints, related to the allocation of funding to traditional "economic growth" buckets, also limit a shift to SPP.[159]

Decision-makers responsible for public procurement often are not equipped with the proper information or technical knowledge to appropriately apply life cycle costing.[160] Systems and indicators must be tailored for local contexts and simplified such that non-expert users can apply tools, in order to "extend procurement beyond green purchasing and create more sustainable food systems and better public health nutrition."[161] Testa et al. considered the effectiveness of two methods to aid decision makers in the implementation of GPP: toolkits or supporting infor-

153. *Id*. at 255.

154. Testa et al., *supra* note 147, at 1894.

155. Smith et al., *supra* note 91, at 255.

156. *Id*. at 250.

157. *Id*. at 251.

158. *See id*. at 254.

159. *Id*.

160. Testa et al., *supra* note 147, at 1894.

161. Smith et al., *supra* note 91, at 255.

mation; and direct training sessions.[162] The study found that "[a]wareness and knowledge of GPP techniques and procedures appear to be the greatest driver for developing this approach and, symmetrically, the most relevant barrier for non-adopters," but both guidelines and trainings can help decision makers overcome this barrier.[163]

2. Legislation

Governments can influence the implementation of life cycle costing through legislation and regulations that encourage certain actions by food producers and consumers or that mandate actions by the government itself (as described above in the public procurement subsection). Legislation can act as leverage for firms to consider environmental and social externalities and alternatives to reduce these externalities. Through the implementation of penalties or taxes, governments can effectively internalize these environmental or social costs, so that they must be included in a life cycle costing analysis from the perspective of the firm. The firm can then compare alternatives to reduce their costs and, if the penalties or taxes are set at the appropriate level, reduce the environmental and social costs to the socially optimal level. Without regulation, the firm might not be induced to consider these costs unless there is clear market demand.

Governments may also implement policies or regulations that promote the standardization of impact valuation methods or remove barriers for data acquisition. Governments may integrate impact valuation into policies, as the European Union did through public procurement directives adopted in 2014, requiring all European Union countries to adopt new rules into law by April 2016.[164] These requirements included allowing the consideration of life cycle costing in the awarding of public contracts.[165]

Government itself can also use impact valuation in promoting environmental, social, and health goals. For example, the product of the European Union Resource Efficient Food and dRink for the Entire Supply cHain (REFRESH) Project will be legislative. The Project "aims at contributing towards the EU Sustainable Development Goal 12.3 of halving per capita food waste at the retail and consumer level and reducing food losses along production and supply chains, reducing waste management costs, and maximizing the value from un-avoidable food waste and packaging materials."[166] In order to achieve this goal, the European Union will conduct a life cycle costing analysis of food waste management methods in order to

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162. Testa et al., *supra* note 147, at 1894.

163. *Id*. at 1897-98.

164. Directive 2014/24, *supra* note 5.

165. *Id*. at 83.

166. REFRESH, LCC REPORT, *supra* note 19, at 2; *see also REFRESH*: *Resource Efficient Food and dRink for the Entire Supply cHain*, *Refresh*, http://eu-refresh.org (last visited May 19, 2018).

assess policy alternatives, and will produce "guidance [for] legislators and policy makers to help support effective governance to tackle food waste."[167]

D. *Civil Society*

Civil society groups play a critical role in the development of life cycle costing techniques and the provision of information necessary for their implementation. Civil society groups working on impact valuation include: Earth Economics;[168] the Economics of Ecosystems and Biodiversity (TEEB) Agriculture and Food Project;[169] Natural Capital Coalition;[170] New Economics Foundation (NEF);[171] Sustainable Food Trust;[172] True Price;[173] Union of Concerned Scientists;[174] Wealth Accounting and the Valuation of Ecosystem Services (WAVES);[175] and the Global Alliance for the Future of Food.[176]

1. Justice

Civil society groups contribute to the growing impact valuation field, acknowledging that economic accounting systems determine business decision-making and the rules and regulations that govern businesses do not and cannot properly incorporate environmental and social impacts. These impacts are, therefore, largely ignored until some mechanism can bring them into the fold. Those affected the most by environmental and social impacts of food systems are often without a voice in other venues as well. Civil society groups are motivated by the need for promoting equity and justice in decision making for the entire scope of food value chains, such that they work to encourage and enable meaningful application of impact valuation methods and adequate sharing of information on the social and environmental impacts of food systems.

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167. *About the Project*, REFRESH, https://eu-refresh.org/about-refresh.(last visited May 19, 2018).

168. EARTH ECON., http://www.eartheconomics.org/ (last visited on May 31, 2018).

169. *TEEB for Agriculture & Food*, THE ECON. OF ECOSYSTEMS & BIODIVERSITY (TEEB), http://www.teebweb.org/agriculture-and-food/. (last visited on May 31, 2018).

170. NAT. CAP. COALITION, http://naturalcapitalcoalition.org/ (last visited May 18, 2018).

171. NEW ECON. FOUND., http://neweconomics.org/ (last visited May 18, 2018).

172. SUSTAINABLE FOOD TR., http://sustainablefoodtrust.org/ (last visited May 18, 2018).

173. TRUE PRICE, http://trueprice.org/ (last visited May 18, 2018).

174. UNION OF CONCERNED SCIENTISTS, http://www.ucsusa.org/ (last visited May 18, 2018).

175. *See About Us*, WEALTH ACCT. & THE VALUATION OF ECOSYSTEM SERVS. (WAVES), https://www.wavespartnership.org/en/about-us (last visited May 19, 2018).

176. *See* GLOB. ALLIANCE FOR THE FUTURE OF FOOD, https://futureoffood.org/ (last visited May 18, 2018).

2. Development

Civil society groups contribute to the development of life cycle methodologies and to the facilitation of implementation to further their goals of addressing environmental or social impacts. For example, the Natural Capital Coalition, a "global multi-stakeholder collaboration that brings together leading global initiatives and organizations to harmonize approaches to natural capital,"[177] published the Natural Capital Protocol, a guide specifically for the food and beverage sector for the implementation of the true cost accounting methodology – see Section IV(c) below.[178] The guide focuses on assessing the risks and opportunities that arise from natural capital dependencies.[179]

Similarly, WAVES, a World Bank-led global partnership, helps countries "[i]ncorporat[e] natural capital into national accounts [to] support inclusive development and better economic management."[180] WAVES also tests ecosystem accounting and provides guidance and capacity building for implementation.[181] Several private firms provide life cycle costing data for use by various parties, such as French AGRI-BALYSE[182] and Dutch Agri-Footprint.[183] The World Business Council for Sustainable Development also published a guide to aid industry in implementing environmental valuation, the *Guide to Corporate Valuation: A Framework for Improving Corporate Decision-Making*.[184]

3. Certification

Civil society can also play a role in providing third-party certification for the use of life cycle costing methods and conclusions that are then presented to the

177. *History*, *Vision* & *Mission*, NAT. CAP. COALITION, http://naturalcapitalcoalition.org/who/history-vision-mission/ (last visited May 19, 2018).

178. NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note 22, at 2.

179. *Id*. at 2.

180. *Frequently Asked Questions on Natural Capital Accounting* (*NCA*), WAVES, http://www.wavespartnership.org/en/frequently-asked-questions-natural-capital-accounting-nca#4 (last visited May 19, 2018).

181. *Id*.

182. *AGRIBALYSE Agricultural Database*, SIMAPRO, https://simapro.com/products/agribalyse-agricultural-database/ (last visited May 31, 2018); *see also* Vincent Colomb et al., *AGRIBALYSE, the French LCI Database for Agricultural Products: High Quality Data for Producers and Environmental Labelling*, OILSEEDS & FATS, CROPS & LIPIDS, Oct. 2014, at 1, http://prodinra.inra.fr/ft?id=D5C5A7AC-8DD0-494B-8147-0BC6CBA69185.

183. *Agri-Footprint LCA Food Database*, AGRI-FOOTPRINT, http://www.agri-footprint.com/ (last visited May 31, 2018).

184. WORLD BUS. COUNCIL FOR SUSTAINABLE DEV. (WBCSD), GUIDE TO CORPORATE ECOSYSTEM VALUATION: A FRAMEWORK FOR IMPROVING CORPORATE DECISION-MAKING (2011).

public. This role can mirror third-party certifiers of claims made on eco-labels.[185] It should also be noted that third-party certification can also be conducted by government entities.

E. *Partnerships Between Academia, Industry, Government, and Civil Society*

Partnerships between academia, industry, government, and civil society can provide necessary leverage and resources to encourage the implementation of measures that address environmental and social externalities. These partnerships can provide a public platform that can increase consumer awareness of industry efforts, develop information necessary for decision making, and expand market pressure through the participation of multiple food companies.

WWF works with retailers, buyers, and producers to create reliable certification standards for food products.[186] The Food System Impact Valuation Initiative (FSIVI) is a partnership between academia, industry, and civil society that aims to work in the pre-competitive space to promote standardized impact valuation techniques for environmental, social, and health impacts of food systems.[187] FReSH is a joint initiative between the EAT Foundation and the World Business Council for Sustainable Development (WBCSD), with nearly forty industry members, that seeks "to accelerate transformational change in global food systems, to reach healthy, enjoyable diets for all, that are produced responsibly within planetary boundaries."[188] The AgWater Challenge, a collaborative initiative organized by WWF and Ceres, requires participating industry (Diageo, General Mills, Hain Celestial, Hormel Foods, Kellogg, PepsiCo, and WhiteWave Foods) to submit detailed sustainable sourcing and water stewardship plans meeting specific criteria.[189] Nestlé, in partnership with the World Cocoa Foundation and the International Cocoa Initiative, is working to establish a certification program with the govern-

185. *See* Jason Czarnezki et al., *Creating Order Amidst Food Eco-Label Chaos*, 25 DUKE ENVTL. L. & POL'Y F. 281, 284-94 (2015).

186. *Transforming Markets*, WORLD WILDLIFE FUND, https://www.wwf.org.uk/what-we-do/projects/transforming-markets (last visited Jan. 11, 2018).

187. *See True Cost of Food: Industry, Academia and Civil Society Meet to Discuss the Valuation of Environmental, Social and Health Impacts from Food Systems*, FUTURE OF FOOD: THE OXFORD MARTIN PROGRAMME ON THE FUTURE OF FOOD (Dec. 6, 2017), http://www.futureoffood.ox.ac.uk/news/true-cost-food-industry-academia-and-civil-society-meet-discuss-valuation-environmental-social (The partnership was convened by the Environmental Change Institute at the University of Oxford, the Environmental Law Programs at the Elisabeth Haub School of Law at Pace University, and the Agricultural Sustainability Institute at U.C. Davis.).

188. *FReSH*, WBCSD, http://www.wbcsd.org/Projects/FReSH (last visited Jan. 23, 2018).

189. *The AgWater Challenge*, WORLD WILDLIFE FUND, http://www.worldwildlife.org/projects/the-agwater-challenge (last visited Feb. 10, 2017).

ments of Côte d'Ivoire and Ghana.[190] The program sets and monitors standards for child labor, provides training to improve farming practices, and shortens the supply chain to ensure that more value of the cocoa reaches farmers and supports community development.[191] The Oregon Brewshed Alliance, an alliance between Oregon Wild and six brewing companies, works together to protect water resources relied upon by both the brewing companies and conservationists and communities represented by the NGO, Oregon Wild.[192]

F. *Summary*

Actors across disciplines and perspectives have begun to explore or implement impact valuation, or similar methods, indicating a widespread and sustained interest in this tool. Thus far, these efforts have been scattered. Tools, techniques, and applications are incomplete and lack standardization. Persistent gaps in data and in methods for conducting valuation remain.

IV. DIRECTIONS TOWARD STANDARDIZATION AND OPERATIONALIZATION

This part explores future pathways towards standardization and operationalization by looking at current efforts to produce frameworks for broad application within the context of food systems. In order for life cycle costing to be broadly and reliably implemented in the food sector, there must be standardization of data and analysis. To consider and compare environmental, social, and health impacts with economic and value decisions of a user, data must be aggregated from sources throughout the food system and across the globe. It must then be translated into comparable units, which can then provide the basis for decision making by users.

Blockchain technology is a developing technology that can support the operationalization of impact valuation methodologies and tools. Blockchain is, most simply:

> a digital ledger . . . . The details of every transaction [are] stored cryptographically on the blockchain, a stream of linked data available online. The entire blockchain is decentralized, with all those using it creating copies of the blockchain record. . . . The blockchain is open and public,

190. UNITED NATIONS GLOB. COMPACT & BUS. FOR SOC. RESPONSIBILITY, SUPPLY CHAIN SUSTAINABILITY: A PRACTICAL GUIDE FOR CONTINUOUS IMPROVEMENT 40 (2010), https://www.bsr.org/reports/BSR_UNGC_SupplyChainReport.pdf.

191. *Id*.

192. *About Us*, OR. BREWSHED ALLIANCE, http://oregonbrewshedalliance.org/about-us/ (last visited Feb. 1, 2017).

> and practically impossible to alter a record once the block representing the transaction has been added.[193]

Currently, the most common use of blockchain technology is for the management of cryptocurrency, but its potential use is much more widespread. Blockchain technology can enable the tracking and sharing of data necessary for impact valuation. Blockchain is already being used for specific purposes by food and agricultural firms, such as tracking product origin, monitoring crop health, and the use of a "currency" for community-supported agriculture.[194] While blockchain is a technology that can facilitate data sharing, it is still subject to many legal and privacy concerns.[195]

Private firms, civil society, and governments have made initiatives towards developing the necessary frameworks to ensure that life cycle costing analyses can produce meaningful results for the end user, and so that these analyses can be compared across products, companies, production methods, time, and other relevant factors. A part of this push towards increasing the functionality and implementation of life cycle costing is to further develop the operationalization, so variables can be quantified. While many parties have developed frameworks, there are still gaps in the field that need to be addressed in order to fully include affected stakeholders and to allow for comparisons of alternatives.

The main guidance needed for inclusion in these frameworks is: 1) clarification on the necessary scope of the analysis, including impacts, life cycle stages, and perspectives; and 2) valuation methodology that is reliable for environmental and social capital. Below are summaries of some of the current frameworks, followed by an assessment of how these frameworks can be situated together and the remaining gaps.

A. *Ernst & Young's Total Value Analysis*

Ernst & Young's (EY's) Total Value Analysis presents an accounting framework that incorporates social and environmental costs and benefits, such that the total value of a good from the perspective of society as a whole is quantified.[196]

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193. Phil Godsiff, *Blockchain Could Challenge the Accepted Ways We Shape and Manage Society*, THE CONVERSATION (Jan. 26, 2016, 7:31 AM), https://theconversation.com/blockchain-could-challenge-the-accepted-ways-we-shape-and-manage-society-53647; *see also The Promise of the Blockchain*: *The Trust Machine*, THE ECONOMIST (Oct. 31, 2015), https://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine.

194. Richard Kastelein, *Blockchains Could Help Restore Trust in the Food We Choose to Eat*, BLOCKCHAIN NEWS (July 19, 2016), http://www.the-blockchain.com/2016/07/19/blockchains-could-help-restore-trust-in-the-food-we-choose-to-eat/; *see also* Phil Godsiff, *Blockchain*: *Measuring Impacts in the Worldwide Food System*, SURREY CODE (Apr. 27, 2017), https://surreycode.org/2017/04/26/blockchain-measuring-impacts-in-the-worldwide-food-system/.

195. *See infra* section II(c).

196. EY, TOTAL VALUE, *supra* note 21, at 9.

The Total Value approach provides a step-by-step process that aims to guide the user through outlining and conducting an analysis that best meets their goals. These steps are: 1) objective; 2) materiality analysis; 3) impact pathways; 4) measurement and valuation approach; 5) data gathering and analysis; 6) assurance and communication; and 7) so what – action plan.[197] This process is designed to ensure that the analysis is comprehensive and targeted to the stated objective. This framework, however, does not provide guidance for the actual measurement or valuation (beyond suggested input-output modeling, LCA, or direct measurement).[198] These valuation techniques must be imported from other sources; however proponents of this framework note that there are no established "rules" for costing, only best practices: "Analogous to the measurement approach, no standards are readily available that provide a rule-based approach. Good practices exist, however, that can be leveraged . . . ."[199] The framework notes that abatement costs, revealed preference, and stated preferences valuation techniques can be employed.[200] However, it should be noted that each of these suggested techniques come with significant limitations that could impact the viability of the analysis, or might not apply to certain impacts considered. In sum, this framework defines basic accounting of total value and provides guidelines for crafting that accounting so that it best, and most accurately, serves the stated objective. The framework does not provide guidelines for measuring necessary data or for valuing impacts or outcomes.

B. *Sustainable Food Trust, Quantifying Social and Environmental Benefits and Costs of Different Agricultural Production Systems*

The Sustainable Food Trust developed a framework and assessment method that "describe[s] all externalities in terms of ecosystem services, using the concept of social and natural capital."[201] This framework overlays social, economic, and natural capital with the four categories of ecosystem services: provisioning, regulating, supporting, and cultural.[202] "It classifies provisioning services as production benefits or outputs, such as production of milk, grains and meat.[203] Regulating and supporting services are grouped into environmental benefits, whereas cultural ser-

197. *Id*. at 14.

198. *See id*. at 16-17, 20 (EY notes that measurement is a prerequisite for valuation (as gathering of raw data), and that monetization is a specific type of valuation).

199. *Id*. at 17.

200. *Id*.

201. HARPINDER SANDHU, SUSTAINABLE FOOD TR., THE FUTURE OF FOOD AND AGRICULTURE: QUANTIFYING THE SOCIAL AND ENVIRONMENTAL BENEFITS AND COSTS OF DIFFERENT PRODUCTION SYSTEMS 9 (2016), http://sustainablefoodtrust.org/wp-content/uploads/2013/04/Harpinder-Final.pdf (similarly, the TEEB AgFood framework, discussed below, also focuses on ecosystem services).

202. *Id*. at 10.

203. *Id*. at 11.

vices provide social benefits."[204] The framework provides equations for the true cost of agricultural production per acre (production value per acre plus environmental benefits per acre plus social benefits per acre minus environmental cost per acre), as well as values for the following ecosystem services that comprise the aforementioned equation inputs: 1) production value; 2) environmental benefits: water regulation, carbon sequestration, nitrogen fixation, nutrient cycling, soil erosion control, and biological control; 3) environmental costs: greenhouse gas emissions and external costs of pesticides and fertilizers; and 4) social benefits: farm employment, recreation, and education.[205] The framework uses market value, direct cost, avoided cost, and replacement cost as valuation techniques for the value inputs.[206] This framework takes advantage of the advancements made in valuing ecosystem services. However, the scope of the analysis is inherently limited by those values that can be accurately captured through ecosystem services, such as those environmental benefits that are sufficiently removed or indirect or that relate to intrinsic values.

C. *Natural Capital Coalition, Natural Capital Protocol*

The Natural Capital Coalition (NCC) developed the Natural Capital Protocol ("the Protocol") in order to "help generate trusted, credible, and actionable information that business managers need to inform decisions."[207] The Protocol is applicable across sectors, but the NCC also developed targeted guides, including the food and beverage sector.[208] The Protocol is intended for use by the firm or company as a decision-maker.[209]

The Protocol outlines a framework that promotes relevance, rigor, replicability, and consistency for firms seeking to conduct a natural capital assessment, or an impact valuation.[210] The Protocol guides the user in crafting their assessment such

204. *Id*.

205. *See id*. at 12-16.

206. *See id*. app. at 28-29.

207. NCC, NATURAL CAPITAL PROTOCOL, *supra* note 23, at 2.

208. *See id*. at 3, 7.

209. *See id*. at 2.

210. *See id*. at 4-5, 7.

The basic framework is as follows: 1) Frame: Get started – why should you conduct a natural capital assessment?; 2) Scope: Define the objective – what is the objective of your assessment? Scope the assessment – what is an appropriate scope to meet your objective? Determine the impacts and/or dependencies – which impacts and/or dependencies are material?; 3) Measure and value: Measure impact drivers and/or dependencies – how can your impact drivers and/or dependencies be measured? Measure changes in the state of natural capital – what are the changes in the state and trends of natural capital related to your business impacts and/or dependencies? Value impacts and/or dependencies – what is the value of your natural capital impacts and/or dependencies?; and 4) Apply: Interpret and test the results – how can you interpret, validate and verify your assessment process and results?

that the proper impacts and dependencies are measured appropriately, in order to best meet the objective of the assessment, including: properly defining the organizations focus; the assessment's spatial boundary; the value-chain boundary (upstream, direct operations, or downstream); the chosen value perspective (business or societal); which types of values to be considered (qualitative, quantitative, or monetary); baselines; scenarios; and time horizons.[211]

Like the frameworks described above, "[t]he Protocol does not, however, explicitly list or recommend specific [valuation] tools or methodologies. This is because the choice of tools will be dependent on business context, resources, and needs. Further, natural capital measurement and valuation is evolving and new approaches and methodologies become available all the time."[212] The Protocol summarizes different monetization techniques, including market and financial prices, production function, replacement costs, damage costs avoided, hedonic pricing, travel costs, contingent valuation, and choice experiments.[213] The Protocol also references databases that can be used to source valuation data.[214]

The Protocol provides a robust foundation for firms conducting natural capital assessments by breaking down the scoping process so that the assessment is meaningful and functional. However, the Protocol does not directly provide the necessary tools to perform the measurement and valuation of capital – citing the need for individualized considerations of these tools according to the objectives of the assessment and the time and resources available. The Protocol is not specifically crafted for life cycle costing, but rather more broadly for any sort of analysis of natural capital, whether it be qualitative, quantitative, or monetized.

D. *Accounting for Sustainability: Natural and Social Capital Accounting*

Accounting for Sustainability (A4S) presents an accounting framework to be used for both natural and social capital.[215] Acknowledging that no standard methodology for assigning monetary value to natural and social capital exists, the framework seeks to provide guidance for an accounting of these values.[216] The framework focuses on six principles, with guiding questions, to aid in utilizing this

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Take action – how will you apply your results and integrate natural capital into existing processes?.

211. *Id*. at 30.

212. *Id*. at 2.

213. *Id*. at 84-87.

214. *Id*. at 89.

215. ACCT. FOR SUSTAINABILITY, NATURAL AND SOCIAL CAPITAL ACCOUNTING: AN INTRODUCTION FOR FINANCE TEAMS 4 (2014), https://www.accountingforsustainability.org/en/knowledge-hub/guides/Natural-social-capital.html ("Natural and social capital accounting involves considering the environment and society in business decision making and/or reporting.").

216. *Id*. at 4, 24.

accounting in decision making: boundaries, materiality, completeness, time, valuation, and confidence.[217] The framework suggests possible monetization methodologies that can be used for shareholder value (traditional cost-benefit analysis), societal value (social return on investment or the London Benchmarking Group Model), and combined shareholder and societal value (ecosystem service valuation, the Environmental Profit and Loss Account, total impact measurement, triple bottom line, or total contribution).[218]

A4S notes the challenges in conducting natural and social capital accounting. These assessments are often read skeptically, therefore transparency and clear articulation of scoping, assumptions, and methods applied is critical – which is what this framework, and others, aim to do.[219] Furthermore, they acknowledge that there is no common methodology for valuation.[220] Finally, they note that some impacts or dependences cannot be monetized due to human values.[221]

The A4S framework, like many of the previously described frameworks, provides guidance such that users can clearly determine the scope and assumptions of their accounting, as appropriate for the decision being made by the firm. The framework provides suggestions for valuation methods that can be used for the types of values being considered.

E. *TEEB AgriFood Valuation Framework*

The TEEB AgriFood Valuation Framework focuses on exhaustively defining externalities and impacts.[222] "[F]or the sake of completeness and comparability, it is important that the elements of value considered and evaluated in each approach are the same, defined and described in a consistent manner."[223] This facilitates comparison of alternatives and trade-offs. The framework is divided according to stages within a typical agricultural value chain and by both invisible and visible

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217. *Id*. at 11-12.

218. *Id*. at 18.

219. *Id*. at 14.

220. *Id*.

221. *Id*.

222. *See* TEEB AGRIFOOD, INTRODUCTORY NOTE ON VALUATION FRAMEWORK 1 (2015), http://www.teebweb.org/agriculture-and-food/framework-note/ [hereinafter TEEB AGRIFOOD, INTRODUCTORY NOTE].

> The framework ensures that nothing important is missed, and that the full range of impacts and dependencies (including externalities) from eco-agri-food systems can be individually examined and collectively evaluated for the application in question, be it a typology comparison, a policy evaluation, a business question or an accounting question.

See also TEEB, TEEB FOR AGRICULTURE & FOOD INTERIM REPORT 27 (2015), http://www.teebweb.org/agriculture-and-food/interim-report/.

223. TEEB, TEEB FOR AGRICULTURE & FOOD INTERIM REPORT, *supra* note 222, at 31.

flows.[224] Visible flows are those captured in traditional System of National Accounts (SNA) accounting.[225] Invisible flows are those not captured by SNA accounting, such as ecosystem services inputs and negative or positive externalities.[226]

The framework also extends the traditional value accounting methodology, noting that issues such as equity and resiliency are not captured this way.[227] The framework includes indicators that better reflect social equity and resiliency, such as "[n]umber of jobs provided by a particular type of agricultural production, [p]ercentage and wage parity of jobs provided to women, [a]gricultural income as a fraction of household income in poverty-affected areas, [f]ood output distributed to food-insecure areas as a fraction of total farm output, [r]isks and uncertainties related to human health posed by different agricultural systems, [and c]ruelty to animals in certain types of animal husbandry systems."[228]

Notably, the framework does not provide any methods for valuation, as these methods "will depend on the values to be assessed, availability of data, and the purpose of the analysis."[229] "[T]he next stage of the TEEB AgriFood project would develop [the framework] further, asking fundamental questions on how these externalities and impacts can be measured across systems, and how results can be mainstreamed into public and private decision-making."[230]

The TEEB AgriFood Framework provides the most comprehensive outline of impacts and dependencies to be considered. Although this framework is not intended for users to simply plug in data for their analysis, it provides an approach to ensuring that the relevant impacts are included. Like other frameworks, it does not assign valuation methodologies.

In order to support the TEEB AgriFood Framework, the Food and Agriculture Organization of the United Nations developed the Methodology for Valuing the Agriculture and Wider Food System Related Costs of Health (MARCH).[231] This methodology uses the Subjective Wellbeing Valuation approach, which "considers how much money would be needed to compensate people to return their wellbeing to the level without the health condition."[232] The output of this framework is in monetary terms, allowing it to be easily comparable to other factors.

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224. TEEB AGRIFOOD, INTRODUCTORY NOTE, *supra* note 222, at 1.

225. *Id*. at 2.

226. *Id*.

227. *Id*. at 3.

228. *Id*.

229. *Id*. at 4.

230. *Id*. at 1.

231. FOOD & AGRIC. ORG., METHODOLOGY FOR VALUING THE AGRICULTURE AND THE WIDER FOOD SYSTEM RELATED COSTS OF HEALTH (MARCH) 7 (Oct. 2017), http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/MARCH_for_publishing.pdf.

232. *Id*. at 7.

F. *SEEA Central Framework*

The System of Environmental-Economic Accounting (SEEA) Central Framework is the first international statistical standard for environmental-economic accounting. It was adopted by the United Nations Statistical Commission in March 2012.[233] The framework "describes the interactions between the economy and the environment, and the stocks and changes in stocks of environmental assets."[234] At its core, the framework is an accounting system providing guidance on how to organize the relevant stocks and flows.[235] It includes guidance on valuing those natural resources that can fall into traditional SNA methods.[236] "It does not include guidance on valuation methods on these assets and related flows that go beyond values already included in the SNA. Full valuation of assets and flows related to natural resources and land beyond the valuation included in the SNA remains an outstanding issue."[237] Therefore, this framework fails to include indirect, or once-removed environmental costs and benefits, or those that are not valued on the market.[238]

G. *TruCost's Valuation Methodology*

TruCost's valuation methodology[239] describes methods for the monetary valuation of natural capital for the following: global warming potential,[240] environmental pollution (acidification, smog formation, toxicity potential),[241] eutrophication potential,[242] water consumption,[243] land use change,[244] and abiotic depletion.[245] In developing methodologies for each of these impacts, TruCost relies on the same basic framework for the assessment, which can be summarized as: 1) understanding drivers of change; 2) understanding the biophysical impacts/dependences; and 3)

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233. UNITED NATIONS ET AL., SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING 2012: CENTRAL FRAMEWORK (2014), http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf.

234. *Id*. at 1.

235. *Id*.

236. *Id*. at viii, 6.

237. *Id.* at viii.

238. *Id.* at 307.

239. TRUCOST, TRUCOST'S VALUATION METHODOLOGY (2015), http://www.gabi-software.com/fileadmin/GaBi_Databases/Thinkstep_Trucost_NCA_factors_methodology_report.pdf.

240. *Id.* at 15.

241. *Id.* at 25.

242. *Id.* at 34.

243. *Id.* at 45.

244. *Id.* at 55.

245. *Id.* at 63.

valuing impacts and dependencies through economic modelling.[246] For each, TruCost relies on a different set of valuation methodologies, as are applicable.[247]

H. *Assessment of Available Frameworks*

The frameworks described above are not a comprehensive list of those currently available today. They do, however, represent the scope of current efforts to aid in standardizing approaches to impact valuation such that implementation is consistent and meaningful. Their efforts fall into four categories: 1) general guidelines for defining the objective, scope, and impacts of the analysis, including broad questions to inform the measurement, valuation, and implementation stages; 2) standardization of the appropriate and necessary externalities and impacts that should be considered; 3) more traditional accounting frameworks that seek to incorporate social and environmental valuation; and 4) valuation methodologies.

The first category, frameworks that present general guidelines to conducting impact valuations, including clearly defined stages and internal assessments that can direct each, includes EY's Total Value framework, Natural Capital Coalition's Natural Capital Protocol, and A4S's Natural and Social Capital Accounting framework. The guidelines presented in each generally follow the same structure and considerations that can apply to any entity that is conducting such an analysis for a broad scope of objectives; therefore, they have wide functionality. In theory, these guidelines would allow for consistency or comparability between analyses. These guidelines can also inform further standardization of individual processes within impact valuation, but would likely need to be specific to certain food products, life cycle stages, objectives, or end users.

The second category, frameworks that standardize the externalities and impacts that should be considered, includes the TEEB AgriFood Valuation Framework. This category is a subcategory of the previous broader framework category in that it focuses on the stage of the analysis where the scope is defined.

The third category, frameworks that rely on traditional accounting methodologies, includes EY's Total Value framework, A4S's Natural and Social Capital Accounting framework, and the SEEA Central Framework. These frameworks use basic accounting methods for impact valuation, with limitations where natural and social capital does not naturally fit. However, by using this traditional model, the frameworks aim to ease adoption and functionality. This perspective allows us to situate this new field within the bounds of a traditional, widely practiced field of accounting. These frameworks are not entirely constrained by SNA accounting or other financial capital methodologies but rather serve as initial guideposts.

The fourth category, frameworks presenting valuation methodologies, includes Sustainable Food Trust's framework and the TruCost Valuation Methodology.

246. *Id.* at 11.

247. *Id.* at 12-13.

The Sustainable Food Trust relies solely on ecosystem services to encompass environmental and social impacts, taking advantage of existing valuation methodologies. However, this framework is limited in the impacts, dependencies, and perspectives that can be included. The TruCost Valuation Methodology developed methods for valuing specific environmental impacts by combining different economic valuation techniques. Most of the other frameworks note that they do not include valuation methodologies intentionally or that these would need to be developed as next steps. Those that intentionally did not describe valuation methodologies explain that there cannot be a uniform and comprehensive practice that can apply to all impact valuations. Rather, these methods must be context-specific to the objective, the impacts and dependencies considered, and the resources of the firm. Instead, for each analysis, all economic valuation methodologies must be considered from which the most relevant ones can be applied.

CONCLUSION

Impact valuation represents an intermediate stage in a transition from purely fiscal and business internalized accounting to an accounting and economic system taking into account stocks and flows between (at least) environmental, social, and economic capital. The complexity of the food system makes it particularly challenging to account for and monetize the external impacts created by the food sector. Food products can undergo multiple processes and be composed of thousands of ingredients sourced from all over the globe. It is much more difficult to attribute extended producer recognition or responsibility for the positive or negative consequences of food consumption. Balancing this increased difficulty for the food system is the increased drive to transform a food sector, which is widely recognized as the economic sector with the worst ratio of externalized costs to purely economic value.

At present, impact valuation methodologies are diverse and nascent. Current methodologies can be used to identify policy leverage points in the system that promise to reduce impacts on health, natural and social capital, and monetization creates a dialogue in which impacts on these capitals can be compared to fiscal gains. Impact valuation methodologies are beginning to be used for ESG reporting in the financial sector.

We argue that impact valuation methodologies are not at this moment fit for more specific use in regard to applications such as public procurement or Pigovian taxation. Given the wide range of methods and their imprecision, it remains difficult to use them for regulatory limits, measuring compliance, comparison of vendors' products, or litigation. Nevertheless, we see these uses as the goalpost toward which efforts at impact valuation standardization should be striving. Although market-based uses hold much promise for achieving transitions toward equity and sustainability in the food system, tensions between these goals and profit motives may hinder complete transformation. Public policy tools can fill that gap.

The challenges to achieving this level of fitness are substantial, and it is perhaps worthwhile to compare the evolution and timeline of impact valuation with the gradual standardization and development of reporting and data collection in our current economic and fiscal system during the course of the twentieth century. One counter to this comparison is the difference in technology available to this century versus the last. Sensors, digitized logistic chains, and big data have the potential to account, track, and share information throughout the highly heterogeneous food system, from farm inputs to consumer. However, there are a diverse range of groups, private and public, competing for their own methodology to be used. Moreover, the willingness of industry, or the success of civil society, to drive and implement more sophisticated accounting of externalities in the food system is presently unclear.