

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

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The environmental, social, and health impacts of our global food systems remain pervasive. The scale of land use 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 grazing¹—without accounting for the environmental and social impacts of transportation networks, input production, food processing, 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 life cycle of food. At the same time, it is estimated that 500 food companies control 70 percent of the global food and beverage industry.³ Through their global value chains, social and environmental

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¹ FOOD & AGRIC. ORG., WORLD AGRICULTURE: TOWARDS 2015/2030: AN FAO PERSPECTIVE 127 (2003), available at <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), available at <ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e.pdf>.

² CREDIT SUISSE, SUGAR CONSUMPTION AT A CROSSROADS (Sept. 2013), available at <https://publications.credit-suisse.com/tasks/render/file/index.cfm?fileid=780BF4A8-B3D1-13A0-D2514E21EFB0479>; INT'L PANEL OF EXPERTS ON SUSTAINABLE FOOD SYS. & GLOBAL ALLIANCE FOR THE FUTURE OF FOOD, UNRAVELLING THE FOOD-HEALTH NEXUS: ADDRESSING PRACTICES, POLITICAL ECONOMY, AND POWER RELATIONS TO BUILD HEALTHIER FOOD SYSTEMS (Oct. 2017), available at http://www.ipes-food.org/images/Reports/Health_FullReport.pdf. See also 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.

³ World Business Council for Sustainable Dev., *25 Leading Global Companies Join Together to Accelerate Transformational Change in Global Food Systems* (Jan. 19, 2017), <http://www.wbcsd.org/Projects/FReSH/News/25-leading-global-companies-join-together-to-accelerate-transformational-change-in-global-food-systems>; OXFAM, BEHIND THE BRANDS: FOOD JUSTICE AND THE 'BIG 10' FOOD AND BEVERAGE COMPANIES, 166 OXFAM BRIEFING PAPER (Feb. 26, 2013), available at <https://www.behindthebrands.org/images/media/Download-files/bp166-behind-brands-260213-en.pdf>; U.S. Dep't of

performance, product design, ingredient choice, and advertising, these companies have a tremendous direct and indirect impact on billions of lives and the planet.

Multiple sectors are recognizing the externalized impacts of the food sector and the relatively concentrated set of actors involved in the production of most of these impacts. As a lever to provide market advantage to lower impact products and producers the EU, for example, now allows life-cycle costing to be considered in public procurement decisions.⁴ Sweden, in particular, has created a national agency for public procurement specifically targeting public spending on more sustainable goods including food.⁵ The world's largest food companies acknowledge the need for industry change through forums such as the EAT Foundation and World Business Council for Sustainable Development FReSH initiative.⁶ Investors in the food sector are demanding environmental and social governance (ESG) data (TruCost, one of the private companies providing environmental and social impact estimates has been acquired by S&P Dow Jones Indices).⁷ Non-governmental organizations are seeking to pressure transformation in the food system by popularizing and promoting the concept of the "true cost of food."⁸ One of the three working groups of the Global Alliance for the Future of Food concerns externalities.⁹

Impact valuation is an emerging concept that aims to quantify all external environmental, social, and health costs of food systems. The measurement and valuation of impacts is an emerging method, but the scale of its present use is limited. Current applications include basic fiscal accounting, risk assessment of individual firms across supply chains, and efforts to meet specific sustainability goals – yet very few, if any, of these efforts fully assess all environmental, social, and health impacts or extend beyond limited perspectives. With regard to an application such as EU public procurement, policy and legal requirements for impact valuation are in danger of outstripping the ability of the scientific methodology 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 methodology that can accurately measure and value these impacts. Food producer, distributors, and sellers can use impact valuation tools and outputs to respond to

Agric. Econ. Research Serv., *Retail Trends*, <https://www.ers.usda.gov/topics/food-markets-prices/retailing-wholesaling/retail-trends.aspx> (last updated Dec. 7, 2017).

⁴ Public Sector Directive 2014/24/EU.

⁵ See Nat'l Agency for Pub. Procurement, *Sustainable Public Procurement*, <https://www.upphandlingsmyndigheten.se/en/sustainable-public-procurement/> (last visited Jan. 22, 2018).

⁶ World Business Council for Sustainable Dev., *25 Leading Global Companies Join Together to Accelerate Transformational Change in Global Food Systems* (Jan. 19, 2017), <http://www.wbcsd.org/Projects/FReSH/News/25-leading-global-companies-join-together-to-accelerate-transformational-change-in-global-food-systems>.

⁷ Trucost, *S&P Dow Jones Indices Acquires Trucost* (Oct. 3, 2016), <https://www.trucost.com/trucost-news/sp-dow-jones-indices-acquires-trucost/>.

⁸ SUSTAINABLE FOOD TRUST, *THE HIDDEN COST OF UK FOOD* (Nov. 2017), available at <http://sustainablefoodtrust.org/wp-content/uploads/2013/04/HCOF-Report-online-version-1.pdf>; SUSTAINABLE FOOD TRUST, *THE TRUE COST OF AMERICAN FOOD* (Apr. 2016), available at <http://sustainablefoodtrust.org/wp-content/uploads/2013/04/TCAF-report.pdf>; INT'L PANEL OF EXPERTS ON SUSTAINABLE FOOD SYS. & GLOBAL ALLIANCE FOR THE FUTURE OF FOOD, *UNRAVELLING THE FOOD-HEALTH NEXUS: ADDRESSING PRACTICES, POLITICAL ECONOMY, AND POWER RELATIONS TO BUILD HEALTHIER FOOD SYSTEMS*, *supra* note *.

⁹ Global Alliance for the Future of Food, *Externalities*, <https://futureoffood.org/working-groups/externalities/> (last visited Jan. 23, 2018).

consumer demand for products, assess dependencies on natural and social capital, and the associated risks and opportunities, 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, 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 in public procurement decisions, or to further environmental, social, and health related goals through policy and regulation. Civil society can use impact valuation to promote environment, social, and health goals. Overall, impact valuation can facilitate a transformation of global food systems.

Impact valuation is emerging today out of a recognition of these potential benefits, but also the current limitations of basic accounting methods in providing such benefits. With global supply chains and widespread impacts, data necessary to produce robust and complete impact valuation requires participation and cooperation. Thus, in addition to the legal uses themselves of impact valuation, such as in public procurement, 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 jurisdictions), 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). Given the potential, and complex, role of impact valuation in policy and legislation for sustainability in food systems, this Article's contribution is to review the current methods, initiatives, terminology and additional uses of food system impact valuation.

I. Impact Valuation Concepts

Impact valuation is the measurement and quantification of environmental, social, and health impacts. Other terms analogous to impact valuation include: true cost of food and life cycle costing.¹⁰ Impact valuation employs traditional life cycle assessments, while also quantifying values such that externalities, and alternatives that might minimize or eliminate these externalities, throughout a food product's life cycle can be quantified and compared. In short, impact valuation provides units of comparison for activities throughout the life cycle and from the perspective of all interested and/or affected parties.

The consideration of costs across time is not itself 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 itself).¹¹ Internal costs are assessed from the perspective of the producer or user in the life cycle of the product (usually only one market actor).¹² As a result, C-LCC does not consider external costs and will exclude the use and end-of-life phases if the focal actor will not internalize these costs.¹³ Most C-LCC techniques were developed and "applied in

¹⁰ 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.

¹¹ ANDREAS CIROTH ET AL., ENVIRONMENTAL LIFE CYCLE COSTING 1, 4 (David Hunkeler et al., eds., 2008).

¹² *Id.* at 4.

¹³ *Id.*

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.”¹⁴ C-LCC does not have an environmental focus, unless those costs are somehow internalized; rather it focuses on economic viability or performance.¹⁵

Traditional economic valuation fails to extend beyond financial and asset capital, ignoring both natural and social capital, because of the narrowly defined perspective.¹⁶ *Natural capital* refers to “[t]he stock of renewable and non-renewable natural resources (for example, plants, animals, air, water, soils, and minerals) that combine to yield a flow of benefits to people.”¹⁷

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.¹⁸

The exclusion of natural capital from basic economic decisions prevents firms from adequately addressing dependencies and associated risks, where externalities are actually indirectly internal.¹⁹ 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).”²⁰ Similarly, social capital must be included

¹⁴ FABIO DE MENNA ET AL., EUROPEAN UNION’S HORIZON 2020 RESEARCH & INNOVATION PROGRAMME, REFRESH: METHODOLOGY FOR EVALUATING LCC 5 (April 2016), available at <http://eu-refresh.org/methodology-evaluating-life-cycle-costs-lcc-food-waste> [hereinafter REFRESH, LCC REPORT].

¹⁵ *Id.* at 12.

¹⁶ EY, TOTAL VALUE: IMPACT VALUATION TO SUPPORT DECISION-MAKING 5 (2016), available at [http://www.ey.com/Publication/vwLUAssets/EY-total-value/\\$FILE/EY-total-value.pdf](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.”). See also Rashila Kerai, *Impact: What’s it Worth?*, ROBECOSAM 4 (2017), <https://yearbook.robecosam.com/articles/impact-whats-it-worth/>.

¹⁷ NATURAL CAPITAL COAL., NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE 2 (2016), available at 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].

¹⁸ NATURAL CAPITAL COAL., NATURAL CAPITAL PROTOCOL 3 (2016), available at <http://naturalcapitalcoalition.org/protocol/> [hereinafter NCC, NATURAL CAPITAL PROTOCOL].

¹⁹ See section *, *infra*.

²⁰ FAO, GLOSSARY: FULL-COST ACCOUNTING 59 (2016), available at 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. CAPITAL RESEARCH (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 . . .”).

life cycle costing analyses, not just due to wider perspectives and interested actors, but 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 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, or in order to consider impacts on humans and the environment for various reasons.²¹ An extension of this traditional economic valuation, 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.”²² The *life cycle* includes “consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal.”²³ The first stage of an LCA and, in turn, impact valuation is to define the scope of the analysis, which will be dictated by the capacity and goals of the analysis.²⁴ 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.²⁵ The third stage is an *impact analysis*, or an examination of the environmental or other impacts, from all of the inputs and outputs – but these impacts are not yet translated into costs.²⁶ 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)*, again relying on the LCA framework, considers costs borne by one or more actors who are connected to the product’s life cycle, directly and indirectly, extending both upstream and downstream in the product’s lifespan occurring within the “decision relevant future.”²⁷ These actors might be suppliers, manufacturers, users, consumers, or end-of-life actors.²⁸ E-LCC is still limited in its scope and perspective. Figure 1 displays the conceptual framework of E-LCC.

²¹ See section II(a)(i)-(ii), *infra*.

²² REFRESH, LCC REPORT, *supra* note *, at ii.

²³ *Id.*

²⁴ *Life Cycle Analysis*, ENVTL. LITERACY COUNCIL, <https://enviroliteracy.org/environment-society/life-cycle-analysis/> (last visited Feb. 3, 2017).

²⁵ *Id.*

²⁶ *Id.*

²⁷ CIROTH ET AL., *supra* note *, at 4.

²⁸ *Id.*

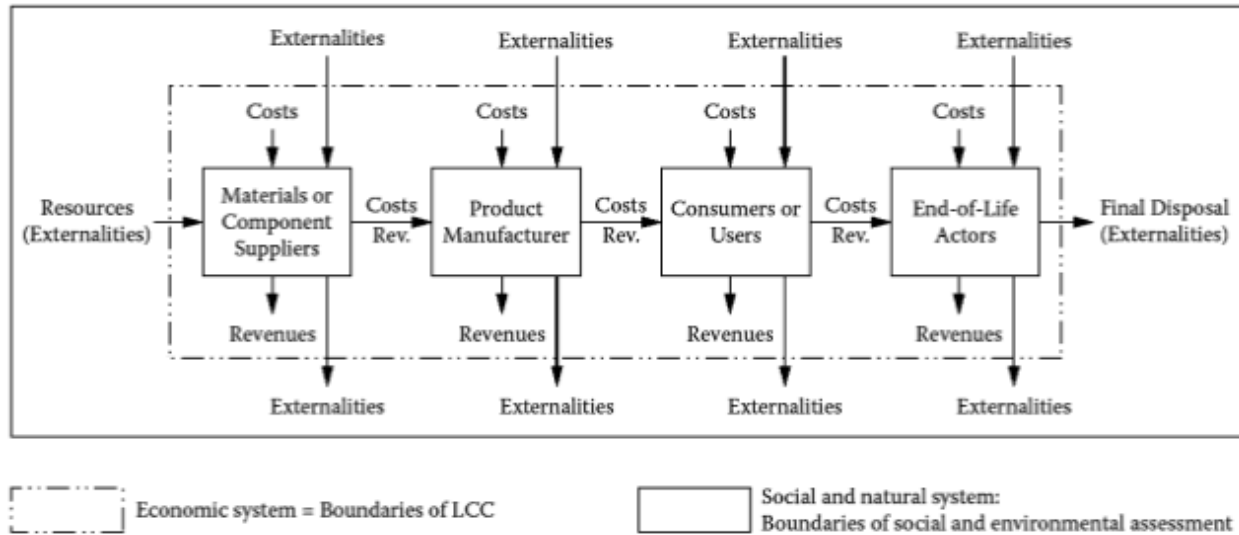


Figure 1. Conceptual framework of environmental life cycle costing.²⁹

True cost accounting or *societal life cycle costing (S-LCC)*, in contrast, 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, national and internationally, including governments.”³⁰ 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.”³¹ 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.³² Others 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, 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.³³

²⁹ *Id.* at xxix.

³⁰ *Id.* Other terms that may be used to describe this analysis include: triple bottom line, full cost accounting, natural capital accounting, or cradle to cradle. FOOD TANK, THE REAL COST OF FOOD: EXAMINING THE SOCIAL, ENVIRONMENTAL, AND HEALTH IMPACTS OF PRODUCING FOOD 18 (2015).

³¹ *True Cost Accounting*, LEXICON OF SUSTAINABILITY, <http://lexiconofsustainability.com/true-cost-accounting/>.

³² *Sustainable Development*, European Comm’n, http://ec.europa.eu/environment/sustainable-development/index_en.htm.

³³ Rosie Stabile & Sarah Small, *Q&A with Sustainable Food Trust’s Patrick Holden*, THOMSON REUTERS FOUND. (Jan. 28, 2015), <http://news.trust.org/item/20150128213232-9c02g>.

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.

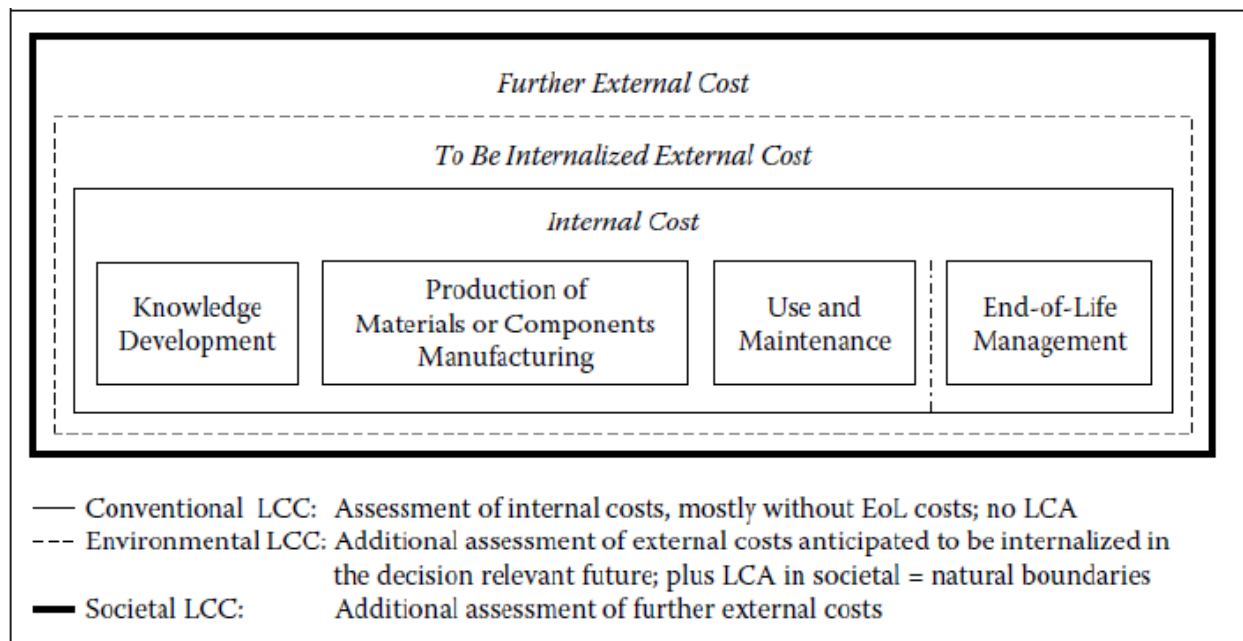


Figure 2. Comparison of C-LCC, E-LCC, and S-LCC.³⁴

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.³⁵

[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 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.³⁶

³⁴ CIROTH ET AL., *supra* note *, at 5.

³⁵ *Id.* at 17-34.

³⁶ REFRESH, LCC REPORT, *supra* note *, at 21 (citations omitted).

The goal(s) will also determine the alternatives to be compared to points within the current life cycle of the product or system.³⁷ Second, necessary cost information must be gathered.³⁸

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, number of actors in a given supply chain, breadth of impacted parties, privacy concerns, proprietary information, expense of data measurement and gathering, legal exposure, and uncertainty of attribution of impacts. Alternative methods, such as scenarios, forecasting, or other forms of estimation, may be employed if data cannot be obtained.³⁹ 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.⁴⁰

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. Some of these costs overlap with social and health costs, and vice versa.⁴¹ 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.⁴² These social and health costs span impacts from both production and consumption.

a. Overview of Applications

The output of these analyses will depend on the targeted user – and the purpose of the information. 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.⁴³

i. Consumers

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.⁴⁴ 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

³⁷ CIROTH ET AL., *supra* note *, at 12-13.

³⁸ *Id.* at 12.

³⁹ *Id.*

⁴⁰ *Introductory Note on Valuation Framework*, THE ECON. OF ECOSYSTEMS & BIODIVERSITY (TEEB), <http://www.teebweb.org/agriculture-and-food/framework-note/>. This framework, and others are discussed *infra* section *.

⁴¹ FOOD TANK, *supra* note *, at 13.

⁴² *Id.*

⁴³ *Id.* at 6-11.

⁴⁴ 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).

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.⁴⁵

ii. Industry

Food producers, buyers, and sellers might also use life cycle costing or true cost accounting to “respond[] to consumer demand for more sustainable food systems, but . . . also change[] practices to minimize negative externalities and promote positive ones.”⁴⁶ Firms might also rely on life cycle costing to adequately assess and address their dependencies on natural capital and the associated risks and opportunities. 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 influences due to activities impacting local natural resources.⁴⁷

Life cycle costing allows a firm 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 and, therefore, comparable terms.⁴⁸ These methods can be described as “help[ing] decision-makers within . . . organization[s] build more future-proof businesses.”⁴⁹ 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 regulations.⁵⁰ A report published by True Price, Deloitte, EY, and PwC titled “The Business Case for True Pricing” provides a robust background on these benefits.⁵¹

⁴⁵ FOOD TANK, *supra* note *, at 15.

⁴⁶ *Id.* at 14. *See also* BUSINESS & SUSTAINABLE DEVELOPMENT COMM’N, VALUING THE SDG PRIZE IN FOOD AND AGRICULTURE: UNLOCKING BUSINESS OPPORTUNITIES TO ACCELERATE SUSTAINABLE AND INCLUSIVE GROWTH (Oct. 2016), available at <http://s3.amazonaws.com/aws-bsdc/Valuing-SDG-Food-Ag-Prize-Paper.pdf>.

⁴⁷ NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note *, 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), available at <http://trueprice.org/wp-content/uploads/2016/04/TP-Tea.pdf>.

⁴⁸ NCC, NATURAL CAPITAL PROTOCOL, *supra* note *, at 18.

⁴⁹ EY, TOTAL VALUE, *supra* note *, at 10.

⁵⁰ *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

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.⁵² “Sustainable supply chain management built around ethical and environmental sourcing principles leverages [a firm’s] purchasing power to mitigate supply chain risks, reinforce long-term supplier relationships, and build stakeholder and customer trust.”⁵³ Impact sourcing describes “outsourcing that benefits disadvantaged individuals in low employment areas.”⁵⁴

iii. 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 from better understanding the risks and opportunities of associated environmental and social capital of a company or product, just like the company itself.⁵⁵ Like firms themselves, investors benefit from understanding dependencies, as well as changing market demand.⁵⁶ Impact investors are also natural users of impact valuation data.⁵⁷

iv. Government

Government 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.”⁵⁸ Government, through public procurement, also acts 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.

v. Civil Society

Civil society, and nongovernmental organizations (NGOs), can support the implementation of life cycle costing by firms, government, and consumers through the provision of information and tools.⁵⁹ These groups can fill the current gaps in necessary information and

examples of internalized costs include extended producer responsibility (EPR) or the WEEE2 directive for e-waste.”).

⁵¹ TRUE PRICE ET AL., THE BUSINESS CASE FOR TRUE PRICING (2015), available at <http://trueprice.org/wp-content/uploads/2015/02/True-Price-Report-The-Business-Case-for-True-Pricing.pdf>.

⁵² *Sustainable Sourcing and Supply Chain Management*, SCS GLOBAL SERVS., <https://www.scsglobalservices.com/sustainable-sourcing-and-supply-chain-management> (last visited Feb. 1, 2017).

⁵³ *Id.*

⁵⁴ Jeremy Jockenstien, *Sourcing Matters: Becoming More Intentional About Your Business Spend*, HUFFINGTON POST (May 5, 2015), http://www.huffingtonpost.com/jeremy-hockenstien/sourcing-matters-becoming_b_7184432.html.

⁵⁵ EY, TOTAL VALUE, *supra* note *, at 10.

⁵⁶ See TRUE PRICE ET AL., THE BUSINESS CASE FOR TRUE PRICING, *supra* note *; NCC, NATURAL CAPITAL PROTOCOL, *supra* note *.

⁵⁷ ELENA PONS & MAUD-ALISON LONG, PROMOTING SUSTAINABLE FOOD SYSTEMS THROUGH IMPACT INVESTING (2013), available at http://web.cof.org/2013Annual/docs/AC13_SessionMaterials_BreakfastPlenary_FoodSystems_Sustainable%20Food%20Systems%20PRI%20examples.pdf.

⁵⁸ FOOD TANK, *supra* note *, at 15.

⁵⁹ *Id.* at 23.

methodology to enable increased use of these analyses, and to further support their own environmental-, social-, or health-related goals.⁶⁰

b. Other Terminology

Cost categories: The broad categories of costs to be included in a life cycle costing analysis – economic cost categories, life cycle stages, activity types, and other costs.⁶¹ Economic cost categories include budget, market cost, alternative cost, and social cost.⁶² 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.”⁶³ Activity types cost categories include: “[d]evelopment, extraction, purchase, sales, resuse, and management; [d]esign, agricultural production, schooling, public relations, recycling, and administration; [and r]esearch, testing, packaging, transport, maintenance, waste processing, and infrastructure.”⁶⁴

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.”⁶⁵

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.⁶⁶

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.⁶⁷ Technical nutrients can be recycled or reused with no loss of quality, while biological nutrients can be composted or consumed.⁶⁸

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.⁶⁹

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.⁷⁰

Discounting: “Convert[ing] costs (and revenues or value) occurring at different times to equivalent (net) costs at a common point in time.”⁷¹

Externalities: Environmental, social, and health impacts that are not borne by an actor.⁷²

⁶⁰ *Id.*

⁶¹ CIROTH ET AL., *supra* note *, at 21.

⁶² *Id.*

⁶³ *Id.*

⁶⁴ *Id.*

⁶⁵ REFRESH, LCC REPORT, *supra* note *, at i.

⁶⁶ CIROTH ET AL., *supra* note *, at 25-26.

⁶⁷ *Cradle-to-Cradle*, DICTIONARY OF SUSTAINABLE MGMT., <http://www.sustainabilitydictionary.com/cradle-to-cradle/> (last visited Feb. 1, 2017).

⁶⁸ *Id.*

⁶⁹ REFRESH, LCC REPORT, *supra* note *, at i.

⁷⁰ *Id.*

⁷¹ CIROTH ET AL., *supra* note *, at 173.

Functional unit: “Quantified performance of a product system for use as a reference unit.”⁷³

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).”⁷⁴

System boundary: “Definition of aspects included or excluded from the study. For example, for a “cradle to grave” analysis, the system boundary should include all activities from the extraction of raw materials through the processing, distribution, storage, use, and disposal or recycling stages.”⁷⁵

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.”⁷⁶

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.”⁷⁷

II. Current Applications and Development

The diverse applications of life cycle costing have prompted academics, industry, government, and civil society to begin both to apply theoretical methodologies to case studies (with various types of valuation employed) and to develop best practices for the young field. Food producers and distributors are increasingly interested in applying LCC methodologies to their products, in part, to achieve marketable social and environmental goals. Firms can also use life cycle costing in order to compare alternatives when complying with environmental or other regulations. Firms might also rely on life cycle costing to meet shareholder interests or to assess risks within the supply chain that might be influenced by consumer awareness or regulations. Government might seek to use life cycle costing techniques in order to develop regulations and policies that achieve specific environmental or social outcomes. Government, as a consumer itself, might rely on these analyses for targeted public procurement. Finally, consumer demand for environmentally- and socially-responsible food products requires that firms both provide information on these externalities and are able to change practices in order to meet these demands. It is these interests, and the necessary functionality and reliability, that have informed current efforts.⁷⁸

a. Academic Efforts

⁷² REFRESH, LCC REPORT, *supra* note *, at ii.

⁷³ *Id.*

⁷⁴ CIROTH ET AL., *supra* note *, at 174.

⁷⁵ REFRESH, LCC REPORT, *supra* note *, at iii.

⁷⁶ CIROTH ET AL., *supra* note *, at 174.

⁷⁷ *Id.*

⁷⁸ The examples of current applications and developments included herein are intended simply to serve as examples. The following survey is, by no means, all inclusive.

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);⁷⁹ the Center for Resilience at Ohio State University;⁸⁰ the Agribusiness and Economics Research Unit (AERU) at Lincoln University in New Zealand;⁸¹ and the Natural Capital Project (NatCap), a partnership between Stanford University, University of Minnesota, as well as WWF and The Nature Conservancy.⁸²

i. 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 [firm 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.*”⁸³ 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,⁸⁴ frozen versus fresh supply chains,⁸⁵ food waste management scenarios,⁸⁶ types of citrus growing systems,⁸⁷ and organic versus conventional olive oil,⁸⁸ among others. Through the applications in these studies, researchers identified knowledge gaps and difficulties in applying existing E-LCC methodologies to food systems and products.

ii. S-LCC

⁷⁹ Center for a Livable Future, JOHN HOPKINS BLOOMBERG SCH. OF PUB. HEALTH, <http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-a-livable-future/>.

⁸⁰ Center for Resilience, OHIO STATE UNIV., <http://www.resilience.osu.edu/CFR-site/index.htm>.

⁸¹ Agribusiness and Economics Research Unit, LINCOLN UNIV., <http://www.lincoln.ac.nz/Research/Research-Centres/Agribusiness-and-Economics-Research-Unit/>.

⁸² NATURAL CAPITAL PROJECT, <http://www.naturalcapitalproject.org/>.

⁸³ REFRESH, LCC REPORT, *supra* note *, at 11 (emphasis added).

⁸⁴ Anne C. Asselin-Balençon & Olivier Jolliet, *Life Cycle Costing of Farm Milk Production – Cost Assessment of Carbon Footprint Mitigation Strategies*, PROC. 8TH INT’L CONF. ON LIFE CYCLE ASSESSMENT AGRI-FOOD SECTOR 70-71 (2012).

⁸⁵ 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).

⁸⁶ Veronica Martinez-Sanchez, et al., *Life-Cycle Costing of Food Waste Management in Denmark: Importance of Indirect Effects*, 50 ENV’T SCI. TECH. 4513, 4513-14 (2016), <http://pubs.acs.org/doi/abs/10.1021/acs.est.5b03536?journalCode=esthag>.

⁸⁷ Anna Irene De Luca et al., *Sustainability Assessment of Quality-Oriented Citrus Growing Systems in Mediterranean Area*, 15 CALITATEA 103 (2014).

⁸⁸ Bruno Notarnicola et al., *Environmental and Economic Analysis of the Organic and Conventional Extra-Virgin Olive Oil* 2 NEW MEDIT 28, 31-32 (2004).

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.”⁸⁹ Some of the issues that this literature review revealed include: “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 E-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.”⁹⁰

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.⁹¹ The 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.”⁹² The stakeholder groups were defined as workers, employees, and local communities impacted by the life cycle.⁹³

The FOODSCALE method, developed by a pair of academics, quantifies eleven sustainability categories, which cover thirty-six food sustainability indicators.⁹⁴ 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.”⁹⁵ 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.⁹⁶ 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, combined with a significant commitment to change.”⁹⁷

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.⁹⁸ Social criteria tend to be more challenging to quantify and integrate into LCC, as

⁸⁹ 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).

⁹⁰ *Id.*

⁹¹ *Id.* at 944-45.

⁹² *Id.* at 946.

⁹³ *Id.*

⁹⁴ Gary Goggins & Henrike Rau, *Beyond Calorie Counting: Assessing the Sustainability of Food Provided for Public Consumption*, 112 J. CLEANER PRODUCTION 257, 257 (2016).

⁹⁵ *Id.*

⁹⁶ *Id.* at 260-61.

⁹⁷ *Id.* at 259.

⁹⁸ Julie Smith et al., *Balancing Competing Policy Demands: The Case of Sustainable Public Sector Food Procurement*, 112 J. CLEANER PRODUCTION 249, 250 (2016); Smith & Barling, *supra* note *, at 945; Thomas

“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.”⁹⁹ Smith and Barling (2014) suggest that social criteria should be used narrowly in order to ease its application.¹⁰⁰ 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.¹⁰¹

iii. 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 be correlated with reductions in environmental impacts, alongside the reduced 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.¹⁰² Through this framework, researchers considered the implications of consumer behavior, as well as the use of consumer decision making, and dietary choices, as a leverage point reducing environmental externalities.¹⁰³ Other groups, such as the Stockholm Resilience Centre at Stockholm University, are also working on linking human health impacts to food systems.¹⁰⁴ Efforts by industry groups often focus on health impacts from consumption patterns, but health impacts also stem from production.

iv. 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 U.C. Davis, is an example of an effort to standardize the food system ontologies.¹⁰⁵ 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.”¹⁰⁶

b. Industry

Full application of impact valuation or life cycle costing by industry is limited – however, 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),

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).

⁹⁹ Smith & Barling, *supra* note *, at 945.

¹⁰⁰ *Id.* at 949.

¹⁰¹ *Id.*

¹⁰² Nemecek et al., *supra* note *, 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).

¹⁰³ Nemecek et al., *supra* note *, at 607.

¹⁰⁴ *Global Food Systems and Multifunctional Land and Seascapes*, STOCKHOLM RESILIENCE CENTRE, <http://www.stockholmresilience.org/research/research-themes/landscapes.html>.

¹⁰⁵ *About Us*, IC-FOODS, <https://www.ic-foods.org/aboutus/ourmission/> (last visited Jan. 10, 2018).

¹⁰⁶ *Id.*

changing demand of consumers, and regulatory influence.¹⁰⁷ 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 industries, 80 percent reported that they measured and valued their environmental and social impacts, but upon further analysis only 25 percent actually did so.¹⁰⁸ Of the companies considered, only 50 percent of beverage companies, and less than 20 percent of food companies, conduct any type of impact valuation.¹⁰⁹ Sixty-five percent of the companies that undertook impact valuations were monetizing value, perhaps indicating a certain need for this functionality.¹¹⁰

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.

i. 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.¹¹¹ The performance index was developed in order to quantify and communicate the company’s progress towards the United Nations Global Compact Principles.¹¹² 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.¹¹³ The index allows for the tracking and comparison of the externalities related to these topic areas using similar units.

ii. 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 sourcing*.¹¹⁴ 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

¹⁰⁷ TRUE PRICE, THE BUSINESS CASE FOR TRUE PRICING (2015), available at <http://trueprice.org/wp-content/uploads/2015/02/True-Price-Report-The-Business-Case-for-True-Pricing.pdf>; TRUCOST, NATURAL CAPITAL AT RISK: THE TOP 100 EXTERNALITIES OF BUSINESS (2013), available at <http://naturalcapitalcoalition.org/wp-content/uploads/2016/07/Trucost-Nat-Cap-at-Risk-Final-Report-web.pdf>.

¹⁰⁸ Kerai, *supra* note *, at 6.

¹⁰⁹ *Id.* at 7.

¹¹⁰ *Id.*

¹¹¹ Key Performance Indicators, NESTLÉ, <http://www.nestle.com/csv/performance/kpi-summary> (last visited Feb. 1, 2017); NESTLÉ, NESTLÉ IN SOCIETY: CREATING SHARED VALUE AND MEETING OUR COMMITMENTS 5-6 (2015), available at <http://storage.nestle.com/nestle-society-full-2015/index.html#> [hereinafter NESTLÉ IN SOCIETY].

¹¹² NESTLÉ IN SOCIETY, *supra* note *, at 5.

¹¹³ Key Performance Indicators, NESTLÉ, *supra* note *.

¹¹⁴ See DAVID NEVIN, FAO, DEVELOPING SUSTAINABLE FOOD VALUE CHAINS: GUIDING PRINCIPLES (2014), available at <http://www.fao.org/3/a-i3953e.pdf>.

change or for the evaluation of alternatives. These efforts are often paired with voluntary labeling schemes. For example: Coca-Cola Company phased out use of HFC refrigerants in dispensers, vending machines, and coolers; Ocean Spray redesigned its bottling distribution network to reduce carbon emissions (through new manufacturing/distribution capabilities; partnership for unused cargo space in returning boxcars); Campbell Soup Company reduced packaging materials used for distribution; MOM Brands eliminated cardboard boxes, marketing cereal in bags only; Hershey Company redesigned its syrup bottle to reduce packaging; Green Mountain Coffee Roasters repurposed burlap bags used to ship bulk green coffee beans; PepsiCo is working towards running its Frito-Lays plant at “near net zero” (currently run on almost entirely recycled water and renewable energy).¹¹⁵

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 2020,¹¹⁶ as well as reduce greenhouse gas emissions in its operations and agricultural supply chain.¹¹⁷ 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.¹¹⁸ MillerCoors implemented water conservation strategies in its breweries, and addressed inefficiencies in irrigation at its barley farms.¹¹⁹ 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 tolerant varieties.¹²⁰ 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.¹²¹

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, employing tracking mechanisms, allows buyers to confirm that seafood is authentic and responsibly harvested. Data provided includes: specific fish type, where and how the fish was caught in the Gulf of Mexico

¹¹⁵ GROCERY MFRS. ASS’N, ENVIRONMENTAL SUCCESS STORIES IN THE CONSUMER PACKAGED GOODS INDUSTRY (2014), available at http://www.gmaonline.org/file-manager/Sustainability/GMAEnvironmentalSuccessStories2014_FINAL.pdf.

¹¹⁶ 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.” *Id.* General Mills has outlined sustainability goals for each ingredient, spanning both environmental and social concerns and often including external sustainability metrics. *Id.*

¹¹⁷ 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>.

¹¹⁸ 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>.

¹¹⁹ 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>.

¹²⁰ *Id.*

¹²¹ *Sourcing Sustainably*, HEINEKEN, <http://www.theheinekencompany.com/sustainability/focus-areas/sourcing-sustainably> (last visited Mar. 15, 2017).

waters, name and background of Captain and his fishing vessel, fish house and city where your seafood was landed, chain of custody information as the fish is traced through the supply chain, and conservation techniques employed to protect fisheries.¹²² 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.¹²³ This system enables workers to look up an animal's health history on a smartphone, or consumers can look up information using a code.¹²⁴

The above examples indicate a growing awareness by industry 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

Government can utilize true cost accounting and life cycle costing from varying perspectives, yet always acting in response to social and environmental harms that it must address in its capacity as a governing body and representative of the public. First, government is a market actor, serving as a consumer or distributor, and thus may use life cycle costing to inform its own purchasing decisions. Second, 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.

i. Public Procurement

Public institutions participate directly in markets as consumers or intermediate clients.¹²⁵ Therefore, 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.¹²⁶ “GPP by governments and public institutions is more akin to green consumerism (GC) – 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 (SC) where change in consumption behavior needs to be accompanied by change in infrastructures (social and physical).”¹²⁷ The implementation of green or sustainable public procurement

¹²² *TransparenSea*, GULF WILD, <http://www.gulfwild.com/transparenssea.php> (last visited Feb. 1, 2017).

¹²³ *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 Supply Chain Traceability Head On*, FOOD LOGISTICS (Mar. 28, 2016), <http://www.foodlogistics.com/article/12177254/fb-tackles-supply-chain-traceability-head-on>.

¹²⁴ *Id.*

¹²⁵ Francesco Testa et al., *Drawbacks and Opportunities of Green Public Procurement: An Effective Tool for Sustainable Production*, 112 J. CLEANER PRODUCTION 1893, 1893 (2016).

¹²⁶ Smith et al., *supra* note *, at 250.

¹²⁷ *Id.* (citing Lewis Akenji, *Consumer Scapegoatism and Limits to Green Consumerism*, 63 J. CLEANER PRODUCTION 13 (2013)).

programs is often limited by existing policies and rules that seek to optimize economic growth and short-term best value.¹²⁸

The driving forces behind the implementation of SPP are often established when SPP is part of broader political strategies and goals.¹²⁹ 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.”¹³⁰ Implementation depends on political will and leadership and infrastructure that can balance the complex interplay between economic, environmental, and social drivers and demands.¹³¹

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 co-operation between authorities.”¹³² 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.”¹³³

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.¹³⁴ 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.”¹³⁵ These strict rules require an incremental approach to shift food procurement, if any at all.¹³⁶ Furthermore, risks and opportunity costs are often not considered in public procurement decision making, therefore further excluding 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.¹³⁷

Decision makers responsible for public procurement often are not equipped with the proper information or technical knowledge to appropriately apply life cycle costing.¹³⁸ 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

¹²⁸ *Id.* at 250-51, 254. Smith et al. (2016) concludes that there is “a need for clarity about what is meant by ‘green’ public sector food procurement and ‘sustainable’ public sector food procurement. *Id.* at 249.

¹²⁹ *Id.* at 252.

¹³⁰ *Id.*

¹³¹ *Id.* at 255.

¹³² Testa et al., *supra* note *, at 1894.

¹³³ Smith et al., *supra* note *, at 255.

¹³⁴ *Id.* at 250.

¹³⁵ *Id.* at 251.

¹³⁶ *Id.* at 254.

¹³⁷ *Id.*

¹³⁸ Testa et al., *supra* note *, at 1894.

sustainable food systems and better public health nutrition.”¹³⁹ Testa et al. (2016) considered the effectiveness of two methods to aid decision makers in the implementation of GPP: toolkits or supporting information; and direct training sessions.¹⁴⁰ The study found that “[a]wareness and knowledge on GPP techniques and procedures appear to be the greatest driver for developing this approach and, symmetrically, the most relevant barrier for non-adopters,” but that both guidelines and trainings can help decision makers overcome this barrier.¹⁴¹

ii. Legislation

Government 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, government 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.

Government may also implement policies or regulations that promote the standardization of impact valuation methods or remove barriers for data acquisition. Government may integrate impact valuation into its own policies, such as the EU’s public procurement directives adopted in 2014, which require all EU countries to adopt new rules into law by April 2016, which including the consideration of life cycle costing in the awarding of public contracts.¹⁴²

Government can also use impact valuation, itself, in promoting environmental, social, and health goals. For example, the product of the EU 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.”¹⁴³ In order to achieve this goal, the EU will conduct a life cycle costing analysis of food waste management methods in order to assess policy alternatives, and will produce “guidance [for] legislators and policy makers to help support effective governance to tackle food waste.”¹⁴⁴

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

¹³⁹ Smith et al., *supra* note *, at 255.

¹⁴⁰ Testa et al., *supra* note *, at 1894.

¹⁴¹ *Id.* at 1897-98.

¹⁴² Directive 2014/24, of the European Parliament and of the Council of 26 February 2014 on Public Procurement and Repealing Directive 2004/18/EC, 2014 O.J. (L 94); *EU Public Procurement Directives*, EUROPEAN COMM’N, http://ec.europa.eu/environment/gpp/eu_public_directives_en.htm.

¹⁴³ REFRESH, LCC REPORT, *supra* note *, at 2. See also REFRESH: RESOURCE EFFICIENT FOOD AND DRINK FOR THE ENTIRE SUPPLY CHAIN, <http://eu-refresh.org/>.

¹⁴⁴ REFRESH: RESOURCE EFFICIENT FOOD AND DRINK FOR THE ENTIRE SUPPLY CHAIN, <http://eu-refresh.org/>.

groups working on impact valuation include: Earth Economics;¹⁴⁵ the Economics of Ecosystems and Biodiversity (TEEB) Agriculture and Food Project;¹⁴⁶ Natural Capital Coalition;¹⁴⁷ New Economics Foundation (NEF);¹⁴⁸ Sustainable Food Trust;¹⁴⁹ True Price;¹⁵⁰ Union of Concerned Scientists;¹⁵¹ Wealth Accounting and the Valuation of Ecosystem Services (WAVES);¹⁵² and the Global Alliance for the Future of Food.¹⁵³

i. 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.

ii. 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,”¹⁵⁴ 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 * below.¹⁵⁵ The guide focuses on assessing the risks and opportunities that arise from natural capital dependencies.¹⁵⁶

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.”¹⁵⁷ WAVES also tests ecosystem accounting and provides guidance and capacity building for implementation. Several private firms provide life cycle

¹⁴⁵ EARTH ECONOMICS, <http://www.eartheconomics.org/>.

¹⁴⁶ Agriculture & Food, THE ECON. OF ECOSYSTEMS & BIODIVERSITY (TEEB), <http://www.teebweb.org/agriculture-and-food/>.

¹⁴⁷ NATURAL CAPITAL COAL., <http://naturalcapitalcoalition.org/>.

¹⁴⁸ NEW ECON. FOUND., <http://neweconomics.org/>.

¹⁴⁹ SUSTAINABLE FOOD TRUST, <http://sustainablefoodtrust.org/>.

¹⁵⁰ TRUE PRICE, <http://trueprice.org/>.

¹⁵¹ UNION OF CONCERNED SCIENTISTS, <http://www.ucsusa.org/>.

¹⁵² WEALTH ACCOUNTING & THE VALUATION OF ECOSYSTEM SERVICES (WAVES), <https://www.wavespartnership.org/>.

¹⁵³ GLOBAL ALLIANCE FOR THE FUTURE OF FOOD, <https://futureoffood.org/>.

¹⁵⁴ History, Vision & Mission, NATURAL CAPITAL COAL., <http://naturalcapitalcoalition.org/who/history-vision-mission/>.

¹⁵⁵ NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note *.

¹⁵⁶ *Id.*

¹⁵⁷ Frequently Asked Questions on Natural Capital Accounting (NCA), WAVES, <http://www.wavespartnership.org/en/frequently-asked-questions-natural-capital-accounting-nca#4>.

costing data for use by various parties, such as French AGRI-BALYSE¹⁵⁸ and Dutch Agri-Footprint.¹⁵⁹ 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*.¹⁶⁰

iii. 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 public. This role can mirror third-party certifiers of claims made on eco-labels.¹⁶¹ It should also be noted that third-party certification can also be conducted by government entities. WWF works with retailers, buyers, and producers to create reliable certification standards for food products.¹⁶²

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.

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.¹⁶³ Food Reform for Sustainability and Health (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.”¹⁶⁴ The AgWater Challenge, a collaborative initiative organized by the World Wildlife Fund and Ceres, requires participating industry (Diageo, General Mills, Hain Celestial, Hormel Foods, Kellogg, PepsiCo, and WhiteWave Foods) to submit detailed sustainable

¹⁵⁸ AGRIBALYSE Agricultural Database, SIMAPRO, <https://simapro.com/products/agribalyse-agricultural-database/>. See also Vincent Colomb et al., AGRIBALYSE, the French LCI Database for Agricultural Products: High Quality Data for Producers and Environmental Labelling, 22 OCL 1 (2015), available at <http://prodinra.inra.fr/ft?id=D5C5A7AC-8DD0-494B-8147-0BC6CBA69185>.

¹⁵⁹ AGRI-FOOTPRINT LCA FOOD DATABASE, <http://www.agri-footprint.com/>.

¹⁶⁰ WORLD BUS. COUNCIL FOR SUSTAINABLE DEV. (WBCSD), GUIDE TO CORPORATE ECOSYSTEM VALUATION: A FRAMEWORK FOR IMPROVING CORPORATE DECISION-MAKING (2011).

¹⁶¹ See Jason Czarnezki et al., *Creating Order Amidst Food Eco-Label Chaos*, 25 DUKE ENVTL. L. & POL’Y F. 281 (2015).

¹⁶² WWF, *Transforming Markets*, <https://www.wwf.org.uk/what-we-do/projects/transforming-markets>, last visited Jan. 11, 2018.

¹⁶³ See Oxford Martin Programme on the Future of Food, *The True Cost of Food: Industry, Academia and Civil Society Meet to Discuss the Valuation of Environmental, Social and Health Impacts from Food Systems* (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, the Agricultural Sustainability Institute at U.C. Davis

¹⁶⁴ FReSH, WBCSD, <http://www.wbcd.org/Projects/FReSH> (last visited Jan. 23, 2018).

sourcing and water stewardship plans meeting specific criteria.¹⁶⁵ The Food+Future coLAB is a collaboration between Target, IDEO, and the MIT Media Lab that seeks to improve food supply chains through technology advancements to empower consumers to know the history and composition of the food they consume and to increase “trust” in the industry.¹⁶⁶ The collaboration also targets waste and other inefficiencies of the food supply chain.¹⁶⁷ Nestlé, in partnership with the World Cocoa Foundation and the International Cocoa Initiative, is working to establish a certification program with the governments of Côte D’Ivoire and Ghana.¹⁶⁸ 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.¹⁶⁹ The Oregon Brewshed Alliance, an alliance between Oregon Wild and six brewing companies, working together to protect water resources relied upon by both the brewing companies and conservationists and communities represented by the NGO, Oregon Wild.¹⁷⁰

III. Directions toward Standardization and Operationalization

In order for life cycle costing to be broadly and reliably implemented in the food sector, there must be standardization of data and analysis. Private firms, civil society, and government 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, such that variables can actually be quantified. While many parties have developed frameworks, there are still gaps in the field that need to be addressed.

The main guidance that is necessary 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

¹⁶⁵ *The AgWater Challenge*, WORD WILDLIFE FUND, <http://www.worldwildlife.org/projects/the-agwater-challenge> (last visited Feb. 10, 2017).

¹⁶⁶ FOOD + FUTURE, <https://foodfuture.com/>; Elliot Maras, *Target Corp. Scrutinizes Its Food Supply Chain*, FOOD LOGISTICS (Dec. 17, 2015), <http://www.foodlogistics.com/article/12141809/target-corp-scrutinizes-its-food-supply-chain>.

¹⁶⁷ *Id.*

¹⁶⁸ UNITED NATIONS GLOBAL COMPACT & BSR, SUPPLY CHAIN SUSTAINABILITY: A PRACTICAL GUIDE FOR CONTINUOUS IMPROVEMENT 40 (2010), available at https://www.bsr.org/reports/BSR_UNGC_SupplyChainReport.pdf.

¹⁶⁹ *Id.*

¹⁷⁰ *About Us*, OR. BREWSHED ALLIANCE, <http://oregonbrewshedalliance.org/about-us/> (last visited Feb. 1, 2017).

the perspective of society as a whole is quantified.¹⁷¹ 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.¹⁷² This process is designed to ensure that the analysis is comprehensive and targeted to the stated objective. However, this framework does not provide guidance for the actual measurement or valuation (beyond suggested input-output modeling, LCA, or direct measurement): “Analogous to the measurement approach, no standards are readily available that provide a rule-based approach. Good practices exist, however, that can be leveraged”¹⁷³ The framework notes that abatement costs, revealed preference, and stated preferences valuation techniques can be employed¹⁷⁴ – 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.”¹⁷⁵ This framework overlays social, economic, and natural capital with the four categories of ecosystem services (provisioning, regulating, supporting, and cultural).¹⁷⁶ “It classifies provisioning services as production benefits or outputs, for example production of milk, grains and meat. Regulating and supporting services are grouped into environmental benefits, whereas cultural services provide social benefits.”¹⁷⁷ 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.¹⁷⁸ The framework uses market value, direct cost, avoided cost, and replacement cost as valuation techniques for the value inputs.¹⁷⁹ This

¹⁷¹ EY, TOTAL VALUE, *supra* note *, at 9.

¹⁷² *Id.* at 14.

¹⁷³ *Id.* at 16-17. EY notes that measurement is a prerequisite for valuation (as gathering of raw data), and that monetization is a specific type of valuation. *Id.* at 20.

¹⁷⁴ *Id.* at 17.

¹⁷⁵ HARPINDER SANDHU, SUSTAINABLE FOOD TRUST, THE FUTURE OF FOOD AND AGRICULTURE: QUANTIFYING THE SOCIAL AND ENVIRONMENTAL BENEFITS AND COSTS OF DIFFERENT PRODUCTION SYSTEMS 9 (2016), *available at* <http://sustainablefoodtrust.org/wp-content/uploads/2013/04/Harpinder-Final.pdf> (similarly, the TEEB AgFood framework, discussed below, also focuses on ecosystem services).

¹⁷⁶ SANDHU, SUSTAINABLE FOOD TRUST, *supra* note *, at 10.

¹⁷⁷ *Id.*

¹⁷⁸ *Id.* at 12-15.

¹⁷⁹ *Id.* at app. A, p. 27.

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 this lens.

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.”¹⁸⁰ The Protocol is applicable across sectors, but the NCC also developed targeted guides, including the food and beverage sector.¹⁸¹ The Protocol is intended for use by the firm or company as a decision-maker.

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.¹⁸² The Protocol guides the user in crafting their assessment such 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, value-chain boundary (upstream, direct operations, or downstream), chosen value perspective (business or societal), which types of values to be considered (qualitative, quantitative, or monetary), baselines, scenarios, and time horizons.¹⁸³

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.”¹⁸⁴ 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.¹⁸⁵ The Protocol also references databases that can be used to source valuation data.¹⁸⁶

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

¹⁸⁰ NCC, NATURAL CAPITAL PROTOCOL, *supra* note *, at 2.

¹⁸¹ NCC, NATURAL CAPITAL PROTOCOL: FOOD AND BEVERAGE SECTOR GUIDE, *supra* note *.

¹⁸² NCC, NATURAL CAPITAL PROTOCOL, *supra* note *, at 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? Take action – how will you apply your results and integrate natural capital into existing processes?” *Id.* at 4-5.

¹⁸³ *Id.* at 30.

¹⁸⁴ *Id.* at 2.

¹⁸⁵ *Id.* at 84-87.

¹⁸⁶ *Id.* at 89.

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.¹⁸⁷ Acknowledging that there is no standard methodology for assigning monetary value to natural and social capital, the framework seeks to provide guidance for an accounting of these values.¹⁸⁸ The framework focuses on six principles, with guiding questions, to aid in utilizing this accounting in decision making: boundaries, materiality, completeness, time, valuation, and confidence.¹⁸⁹ 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).¹⁹⁰

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.¹⁹¹ Furthermore, they acknowledge that there is no common methodology for valuation.¹⁹² Finally, they note that some impacts or dependences cannot be monetized due to human values.¹⁹³

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 is 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 the externalities and impacts that need to be accounted for.¹⁹⁴ “[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.”¹⁹⁵ The framework is

¹⁸⁷ ACCOUNTING FOR SUSTAINABILITY, NATURAL AND SOCIAL CAPITAL ACCOUNTING: AN INTRODUCTION FOR FINANCE TEAMS (2014), available at <https://www.accountingforsustainability.org/en/knowledge-hub/guides/Natural-social-capital.html>.

¹⁸⁸ *Id.* at 4.

¹⁸⁹ *Id.* at 11-12.

¹⁹⁰ *Id.* at 18.

¹⁹¹ *Id.* at 14.

¹⁹² *Id.*

¹⁹³ *Id.*

¹⁹⁴ TEEB AGRIFOOD, INTRODUCTORY NOTE ON VALUATION FRAMEWORK 1 (2016), available at <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.” TEEB, TEEB FOR AGRICULTURE & FOOD INTERIM REPORT 27 (2015), available at <http://www.teebweb.org/agriculture-and-food/interim-report/>.

¹⁹⁵ TEEB, TEEB FOR AGRICULTURE & FOOD INTERIM REPORT, *supra* note *, at 31.

divided according to stages within a typical agricultural value chain and by both invisible and visible flows.¹⁹⁶ Visible flows are those that are captured in traditional System of National Accounts (SNA) accounting.¹⁹⁷ Invisible flows are those that are not captured by SNA accounting, such as ecosystem services inputs and negative or positive externalities.¹⁹⁸

The framework also extends the traditional value accounting methodology (mere addition and subtraction), noting that issues such as equity and resiliency are not captured this way.¹⁹⁹ 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.”²⁰⁰

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.”²⁰¹ “[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.”²⁰²

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 does provide an approach to ensuring that the relevant impacts are included. Like other frameworks, it does not assign valuation methodologies.

i. **FAO, Methodology for Valuing the Agriculture and Wider Food System Related Costs of Health (MARCH)**

In order to support the TEEP AgriFood Framework, the Food and Agriculture Organization of the United Nations developed a methodology for valuing health related impacts stemming from food systems.²⁰³ 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.”²⁰⁴ The output of this framework is in monetary terms, allowing it to be easily comparable to other factors.

f. *SEEA Central Framework*

The SEEA Central Framework is the first international statistical standard for environmental-economic accounting. It was adopted by the United Nations Statistical

¹⁹⁶ TEEB AGRIFOOD, INTRODUCTORY NOTE, *supra* note *, at 1.

¹⁹⁷ *Id.* at 2.

¹⁹⁸ *Id.*

¹⁹⁹ *Id.* at 3.

²⁰⁰ *Id.*

²⁰¹ *Id.* at 4.

²⁰² *Id.* at 1.

²⁰³ FAO, 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.

²⁰⁴ *Id.*

Commission in March 2012.²⁰⁵ The framework “describes the interactions between the economy and the environment, and the stocks and changes in stocks of environmental assets.”²⁰⁶ At its core, the framework is an accounting system, providing guidance on how to organize the relevant stocks and flows.²⁰⁷ It includes guidance on valuing those natural resources that can fall into traditional SNA methods. However, “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. Addressing this issue in future revisions of the SEEA may provide further guidance in answering key questions such as the impact of environmental regulations on economic growth, productivity, inflation and jobs.”²⁰⁸

g. TruCost’s Valuation Methodology

TruCost’s valuation methodology²⁰⁹ describes methods for the monetary valuation of natural capital for the following: global warming potential,²¹⁰ environmental pollution (acidification, smog formation, toxicity potential),²¹¹ eutrophication potential,²¹² water consumption,²¹³ land use change,²¹⁴ and abiotic depletion.²¹⁵ 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) Valuing impacts and dependencies through economic modelling.²¹⁶ For each, TruCost relies on a different set of valuation methodologies, as are applicable.²¹⁷

h. Assessment of Available Frameworks

The frameworks described above are not a comprehensive list of those currently available today, however they do 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,

²⁰⁵ UNITED NATIONS, SYSTEM OF ENVIRONMENTAL-ECONOMIC ACCOUNTING 2012: CENTRAL FRAMEWORK (2014), available at http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf [hereinafter SEEA CENTRAL FRAMEWORK].

²⁰⁶ *Id.* at 1.

²⁰⁷ *Id.*

²⁰⁸ *Id.* at viii.

²⁰⁹ TRUCOST, TRUCOST’S VALUATION METHODOLOGY (May 2015), available at http://www.gabi-software.com/fileadmin/GaBi_Databases/Thinkstep_Trucost_NCA_factors_methodology_report.pdf.

²¹⁰ *Id.* at 15.

²¹¹ *Id.* at 25.

²¹² *Id.* at 34.

²¹³ *Id.* at 45.

²¹⁴ *Id.* at 55.

²¹⁵ *Id.* at 63.

²¹⁶ *Id.* at 11.

²¹⁷ *Id.* at 12-13.

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

i. Blockchain

Blockchain is 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, and practically impossible to alter a record once the block representing the transaction has been added.”²¹⁸ Currently, the most

²¹⁸ Phil Godsiff, *Blockchain Could Challenge the Accepted Ways We Shape and Manage Society*, THE CONVERSATION, Jan. 26, 2016, <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

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.²¹⁹ While blockchain is a technology that can facilitate data sharing, it is still subject to many of the legal and privacy concerns, described below.

IV. Challenges

Food producers and governments are increasingly integrating impact valuation techniques into their everyday decision making and sustainability reviews. However, much of these applications only apply concepts or are limited in their comprehensiveness, i.e., very few actors rely on complete impact valuations for products, ingredients, or manufacturing processes. This could be indicative of the limitations in current information and valuation methodologies, in understandings of the functionality of these complete analyses, or in legal and regulatory schemes.

a. Information Availability and Acquisition

The data required to conduct robust LCC analyses is extensive – requiring information on each ingredient through every stage of processing, with the life cycle crossing geographic boundaries that could affect availability of information.²²⁰ Although there is increasing availability in LCA databases, relying on data from multiple sources could pose problems where methodologies and assumptions do not match.²²¹

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.²²² However, it is difficult to quantify the stages after the point of sale because of highly variable consumer behavior that is difficult to document.²²³

Assessing the impacts of environmental and social externalities requires data spanning diverse affected parties, geographies, and time scales – and often encompass 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.

(Oct. 31, 2015), <https://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine>.

²¹⁹ 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/>.

²²⁰ Nemecek et al., *supra* note *, at 614.

²²¹ *Id.* “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.” *Id.* at 615.

²²² Nemecek et al., *supra* note *, at 615.

²²³ *Id.*

b. Legal Barriers

Data acquisition and sharing between parties is also currently hindered by legal barriers. 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, consumers, and so on. 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 that 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.

Implementation of impact valuation might also be hindered by legal and regulatory structures. For example, federalism might restrict widespread implementation of supporting regulations. Reporting requirements might also be blocked due to unfair burdens on small businesses. Legal discrimination concerns might also impede implementation.

These barriers can be removed, however. 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 to both the development of impact valuation methodologies and their implementation is a critical research task.

c. 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, applications to food systems are lagging. It is essential that these frameworks be developed for specific application to the food system.

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. If all else in the impact valuation follows a framework, yet valuation, a complicated task even without involving both social and environmental impacts, remains unbridled, these impact valuations 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 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.

d. Theoretical Barriers

The comparison of social and environmental capital, alongside economic capital, can pose 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 compromises are needed.”²²⁴ Lack of understanding regarding how to make these tradeoffs can serve as 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).²²⁵

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.”²²⁶

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.”²²⁷ 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 amongst 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. Public procurement and eco-labelling applications require impact valuation at the end product level. Civil society is aiming at policy leverage points such as livestock consumption, sugar taxes, food waste, etc. 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

²²⁴ *Id.* at 614.

²²⁵ Smith et al., *supra* note *, at 250.

²²⁶ EY, TOTAL VALUE, *supra* note *, at 9.

²²⁷ NCC, NATURAL CAPITAL PROTOCOL, *supra* note *, at 82 (citations omitted).

required for product level valuation given the potential legal risks? Who would operate and govern a trusted information systems 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 not exposed?

V. Conclusion

In summary, 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 would argue that impact valuation methodologies are not at this moment fit for more specific use in regards to applications such as public procurement or Pigovian taxation. Given the wide range of methodologies and their imprecision it would appear to be difficult to use them for regulatory limits, measuring compliance, comparison of vendors' products, or litigation.

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 and 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.