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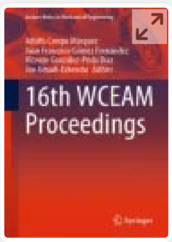

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Managing Assets to Facilitate Circularity and Sustainability of Food Systems

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Abstract

The United Nations Zero Hunger Challenge focuses on finding solutions to achieve the 2030 SDG 2 targets, albeit in a manner that is consistent with the precepts of circular economy. Sustainable solutions to food accessibility, security and continuous improvements in nutrition will invariably depend on effective distribution as well as the reverse loops of food waste management. Food systems encompass physical assets within value networks that are inextricably interwoven within societal structures, the natural environment and ecology. Given that societal structures are conventionally delineated in terms of governance, industrial and commercial sectors of endeavor, as well as within local, regional and global jurisdictions, it is paramount that natural assets (e.g., land, vegetation) and engineered assets (e.g., equipment, machinery, infrastructure) are effectively managed to facilitate circularity, security and sustainability of value networks that underpin systems of food production and distribution, nutrition improvements and food waste management. This paper highlights the need for proper management of land and engineered assets. The discourse emphasizes a 'whole-of-life' approach to physical asset management that takes into account both the forward and reverse logistics processes of food systems so as to concurrently conform to circular economy precepts and sustainable development imperatives.

1 Introduction

sustainability of systems of food production and distribution, nutrition improvements and food waste management. Invariably, solutions towards a hunger-free future as envisaged in the targets of the second Sustainable Development Goal (SDG 2) will depend on how we manage the inextricable interweaving of societal traditions, cultures, economic and physical structures, as well as the natural environments and ecologies of the delineations of the various locations that encapsulate our respective food systems. In principle, SDG 2 specifies that food systems must deliver food and nutrition security for present and future generations at the global, regional, national, local and household delineations. This requires the alignment of synergies that exist within value networks of governance, industrial and commercial actors, agents, entities and organizations towards circularity, resiliency and sustainability of food systems. In practice, the operationalisation of food systems depends on concurrent and proper management of both our natural assets (e.g., land, vegetation) and the assets (e.g., infrastructure, machinery) that we engineer and deploy to facilitate our ability to enjoy nature's endowments.

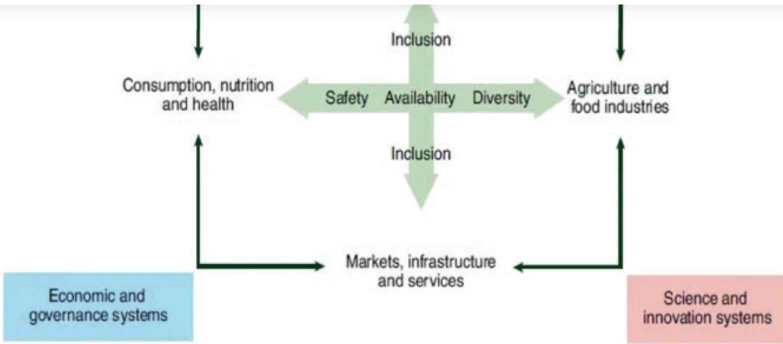
Heightened concerns for the increasing and unprecedented effects of climate change tend to clamour discourse about food systems, often resulting in perplexing policies and practices, especially regarding how we manage the physical assets (i.e., land, improvements and food waste management. There is much discourse in public forums and popular media emphasizing the adverse and devastative effects of events like climate change, unfavourable weather patterns, pandemics, regional conflicts and socio-political strife on food systems with corresponding impoverishment of affected communities. The volatility, uncertainty, ambiguity, and complexity associated with these events invariably impose exogenous and endogenous stresses on the value networks, especially on the physical assets that facilitate the operationalisation of food systems. Geopolitical tensions, globalized markets and associated socio-economic and technological disparities seem to accentuate exclusivity instead of inclusivity. Some proposals towards tackling the hunger crises include, for example, demands for increased funding of food programmes, promotion of urban agriculture and reduction in food waste (re: [2]). Curiously, existing discourse tends to be superficial regarding the pragmatic operationalisation of the proposed solutions.

Adopting the view that sustainable solutions towards a hunger-free world demand holistic pragmatism, this paper highlights the need for proper management of land and engineered assets, given that these constitute the fundamental, intrinsic, and substantive components and elements that facilitate the operationalisation of sustainable systems of food production and distribution, nutrition improvements and food waste management economy precepts and SDG 2. Section 3 discusses a circular 'whole-of-life' approach to the management of engineered assets deployed in both the forward and reverse logistics processes of food systems. Some concluding remarks are provided in Sect. 4, emphasizing that land, engineered assets, and processes deployed in food systems should be managed in accordance with circular economy precepts towards achieving sustainable development imperatives.

2 Food Systems Within Circular Economy and SDG 2

There is an understanding that conventional *take-produce-consume-discard* economic growth approaches to food systems have not only caused adverse impacts on the natural environment and ecology but also, that the embedded policies and practices of the legacy models have not proffered effective solutions towards a hunger-free future as envisaged in the targets of SDG 2 (re: [4,5,5,6,7,8,9]). Figure 1 illustrates a conceptualisation of the food system highlighting climate, health, governance, economics, commerce, science and innovation as inextricably interwoven, that is, non-exclusive but integrated exogenous and endogenous drivers of food systems.

Fig. 1.



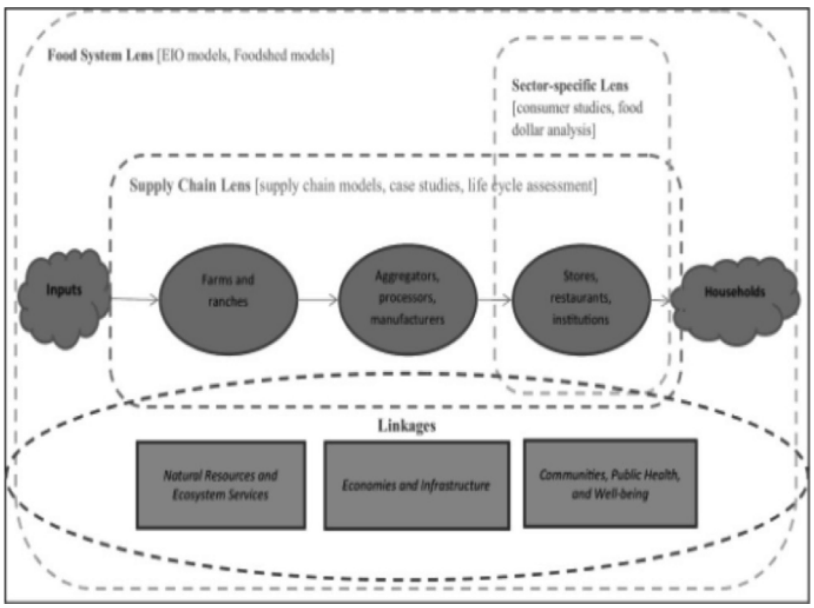
A conceptualisation of food systems (source ref: [9])

Another conceptualisation of food systems is discussed in detail in [10]. Figure 2 illustrates the value networks implicit in food systems as viewed from supply chain and sector-specific lenses. Interestingly, the perspectives depict the conventional *take-produce-consume-discard* model where behavioural entities like farms and farmers, aggregators, manufacturers, trucking companies, wholesalers, grocery stores, and households utilise land and various engineered assets like infrastructure, equipment and mobile machinery (e.g., irrigators, grain elevators, mills, trucks, shopping plazas and shops) in the forward loop of food production, processing, distribution.

It is intriguing that the supply chain lens in Fig. 2 depicts the consumption of food, especially by households, as the terminal point of the chain. Furthermore, 'natural resources and ecosystem services', 'economies and infrastructure', and 'communities, public health, and wellbeing' are depicted as linkages as viewed from the overall perspective of the food system. Interestingly, reverse loop in accordance with circular economy precepts and sustainability imperatives.

Notwithstanding the views from the supply chain, sector specific and food system lenses, extant discourse tends to be muted regarding the exploitation of the forward loop entities and assets to operationalise the reverse loop that includes waste handling, water recycling and reuse, as well as rehabilitation of land and vegetation.

Fig. 2.



Value network conceptualisations of food systems (source ref: [10])

The authors in [9, 11] surmise that "there is an accelerating momentum worldwide to adopt [integrated] systems approach to" food production and distribution, nutrition improvements and food waste management. The value networks implicit in the food vegetation control through to farming, production, aggregation, processing/manufacturing, distribution, consumption, waste management and water recycling, as well as processes that involve various actors, agents and institutions representing governance, science, technology and innovation fraternities and persuasions. The combinations of upstream processes (e.g., vegetation control, farming and harvesting); downstream processes (e.g., processing/manufacturing and distribution); and reverse processes (e.g., waste handling, water recycling/reuse, land restoration and vegetation rehabilitation) coupled with the preferences and values of behavioural entities, eventually manifest in various delineations and perspectives of food systems.

As discussed in detail in [11], and also cited in [12], Fig. 3 represents a conceptualisation of food systems taking into consideration the precepts of circular economy and SDG 2 targets. The cited authors surmise that food systems can contribute to SDG 2 well beyond the sole objective of eradicating hunger, i.e., “food and nutritional security cannot be achieved without combating impoverishment and reducing the effects of environmental degradation.”

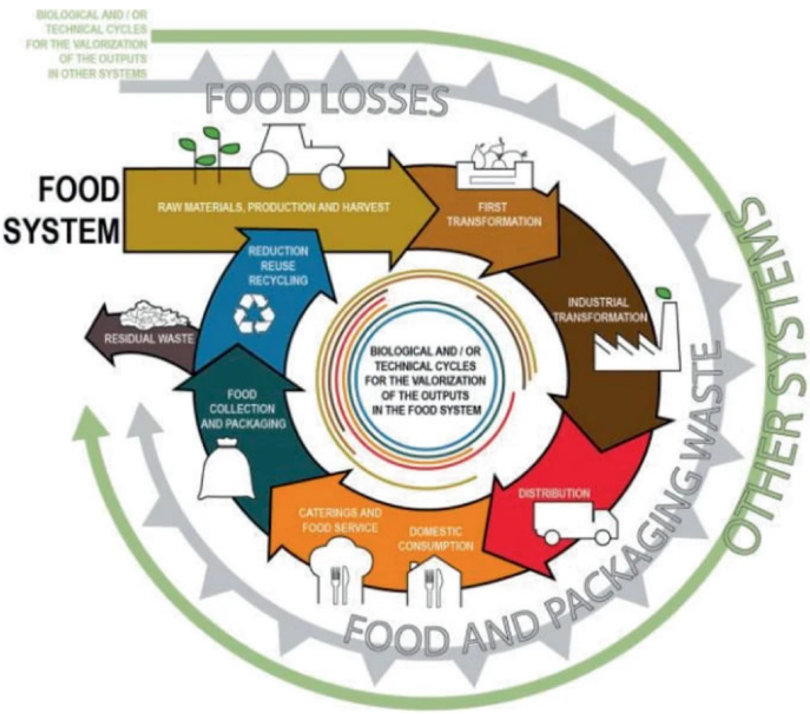
Fig. 3.

Food systems in the context of circular economy and SDG 2 (re: [11]).

Following their systemic interpretation of 40 case histories in the context of SDGs, the authors in [13] argue that the food system can be a fertile ground for the implementation of circular economy precepts. According to the authors in [13], agricultural production is responsible for about 30% of green-house gas emissions. The economic value of wasted food and the estimated environmental and societal costs of this waste worldwide amount to 2 600 billion dollars annually (re: [14]).

The precepts of circular economy require eliminating waste generated in food systems through, for example, (i) the re-use of excess food by changing diets toward more diverse and more efficient consumption patterns, and (ii) proper handling and recycling of by-products as inputs into the upstream and downstream processes. Thus, where dematerialisation is not possible, circular energy through reuse, repair, rehabilitate, refurbish and recycle and strategies (re: [15, 16]). These circular economy strategies are pertinent to how land and engineered assets are managed towards achieving sustainability imperatives, given that these assets are fundamental, intrinsic elements and substantive components of food systems (see the illustration in Fig. 4).

Fig. 4.

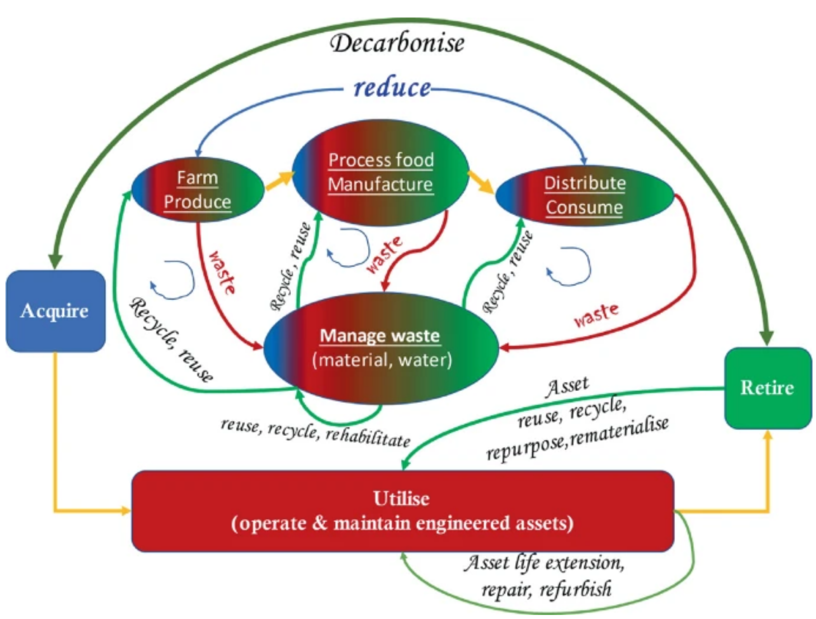


Engineered assets within a circular economy depiction of food systems (source ref: [13])

3 Managing assets within food systems

In the context of this paper, land, mineral resources, water, and vegetation constitute natural endowments as secondary assets. Organisations of socio-economic and political structures constitute the behavioural entities and tertiary assets of food systems. In spite of their respective vagarious behaviours, public and private organisations (that is, the behavioural entities) have the responsibility to manage the primary, secondary, and tertiary assets in a manner to ensure that food systems comply with circular economy precepts and sustainability imperatives. Notwithstanding the paramountcy for effective management of mineral resources and water, and without diminishing or vitiating the significance of land administration and vegetation control, this section of the paper discusses the importance of managing the engineered assets embedded within food systems according to circular economy precepts and sustainability imperatives.

Fig. 5.



The picture in Fig. 5 illustrates that engineered assets are not only fundamental but also, they underpin the operationalisation of food systems. An extensive range of assets (e.g., plows, seeders, irrigators, harvesters, food processing and manufacturing machines, mobile vehicles, through to ovens, stoves, and cutlery; and trash collection/compactors, wastewater treatment plants, etc.) are deployed in food systems. Engineered assets are *acquired*, *utilised* and *retired* (re: [17]) to facilitate the operationalisation of the value networks inherent in food systems. (The colour shades of blue, red and green in the oval shapes depict the relative durations of the *acquire*, *utilise* and *retire* asset life stages within the forward and reverse processes of the respective food systems).

When assets are acquired, the circular economy precepts must form part and parcel of the capital investment considerations ab initio. For example, the capital decision and plan should take into consideration opportunities for partnering to minimise funding/financing, technology, socio-political risks, with special emphasis on investment in assets that impose minimal environmental and ecological footprint. Coopetition provides opportunities to share assets across value networks and supply chains (re: [18]). Although the acquisition stage in the life of an asset may be relatively short, however, decisions about the possibilities of reuse (plus adaptive reuse), recycling, and repurposing according to the forward and reverse loops within food systems (re: [19]). In principle, the acquisition and utilisation of refurbished assets should reduce the need to extract raw materials to manufacture new assets.

Given that the utilisation stage constitutes the longest period in the life of an engineered asset, the philosophy, plans and schedules for operating and maintaining assets should be in consonance with the forward and reverse processes of food systems. For example, the maintenance of assets must be prioritised and regularly executed so that the life of assets can be extended to support increased utilisation through the forward and reverse logistics processes of food systems. Furthermore, assessing the condition of an engineered asset through the forward and reverse loops of the food system should facilitate decisions on life extension and repair, or a decision that an asset has reached current use end-of-life.

Retirement implies terminating current deployment and use, manifested by the decommissioning of an asset, and consequent upon a decision that an asset has reach the end of *design-*, *economic-*, *service-*, or *useful-*life, as the case may be. Subsequently, information about the condition of the asset and statutory regulations may then lead to the choice to either reuse, recycle, re-purpose, or *re-materialise* the asset (ideally, disposal at the end-of-life, an engineered asset may be divested dependent on the condition, insurance policies, statutory regulations, valuation and taxation rules. Collaboration and effective communication of asset condition information through real-time databases can improve sustainability performance in implementing circularity by all stakeholders across the value networks of the food system.

4 Concluding Remarks

There is increasing recognition of the need to adopt an all-inclusive approach to support and promote circular and sustainable food systems within global, regional, national, local, and even household delineations. Behavioural entities and stakeholders like farmers, food sector industrial and commercial firms, governments, and consumers must play necessary and effective roles in shaping the future of systems of farming, food production/manufacturing, distribution, consumption as well as food related waste management, water recycling, land and vegetation rehabilitation. From an asset management viewpoint, it is paramount to embed circular economy principles during the acquisition, utilisation and retirement stages of engineered assets to facilitate the optimisation of decarbonisation across the value networks of food systems concomitant with reduction in environmental/ecological footprint.

Fortunately, 4IR technologies now make it feasible to set up an integrated system (re: [20]) to manage engineered

There is no doubt that technologies such as digital ledgers (i.e., blockchain), IoT, virtual (i.e., augmented and extended) reality, and artificial intelligence will be increasingly exploited to facilitate digital twinning plus real-time data, information and decision-making about assets that underpin food systems. This paper has highlighted the significance of adopting circularity principles to manage engineered assets deployed within food systems. Future contributions to the discourse will include specific case studies of engineering asset management within the forward and reverse loops of the value networks of food systems according to circularity precepts and sustainability imperatives.

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