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Food and Sustainability:

The Sustainable Food System Index

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Resumo

Transições sustentáveis têm se tornado os princípios orientadores do século de hoje, com sistemas alimentares em seu núcleo. Alimentação e nutrição ilustram uma necessidade humana básica, inevitável para qualquer organismo vivo e, profundamente entrelaçada com o ecossistema. Assim, sistemas alimentares representam esforços predominantes ao focar na Agenda 2030. Em consonância com a apresentação de processos socio-ecológicos complexos, fortemente afetados por interrelações entre componentes naturais e humanos em curso, três categorias identificam-se como essenciais aos sistemas alimentares sustentáveis: segurança alimentar, estabilidade e resiliência do ecossistema, e bem-estar sociocultural. Em combinação com o objetivo da pesquisa de avaliar o grau de desempenho de sustentabilidade de sistemas alimentares decorrentes, foi criado um Índice de Sistema Alimentar Sustentável (SAS). O SAS mede a sustentabilidade do sistema alimentar em 33 países dentro de 3 categorias e 9 dimensões ao empregar 39 indicadores, 65 sub-indicadores e 38 sub-sub indicadores. Os resultados mostram o grau variável de sistemas alimentares sustentáveis entre países nos indicadores selecionados. O resultado geral do índice destaca a Suécia como líder, seguida de perto por França e Reino Unido, enquanto como retardatários ilustram Etiópia, Nigéria e Índia. Com sistemas alimentares sendo apanhados em círculos viciosos com o ecossistema e meio-ambiente, regiões economicamente pobres são particularmente vulneráveis devido a suas baixas dependências em sistemas de agricultura. Os resultados do SAS fornecem mais insights no estado da sustentabilidade dos sistemas alimentares analisados nas categorias de segurança alimentar, estabilidade e resiliência do ecossistema, tanto quanto de bem-estar sociocultural e, deve servir como fundação para futuras pesquisas sobre sistema alimentar sustentável.

Palavras-chave: sistema alimentar sustentável, transição sustentável, desenvolvimento sustentável, índices compostos, alimentação segura, estabilidade do ecossistema, bem-estar sociocultural

Abstract

Sustainable transitions have become the guiding principles of today's century with food systems at the core of it. Food and nutrition illustrate a basic human need, inevitable for any living organism, and deeply entangled within the ecosystem. Thus, food systems represent predominant endeavours when aiming towards Agenda 2030. In line with displaying complex socio-ecological processes, heavily affected by ongoing interrelations among human and natural components, three categories identify as crucial for sustainable food systems – food security, ecosystem stability and resilience and sociocultural wellbeing. In combination with the research aim of assessing the sustainability degree of performing food systems in place, a Sustainable Food System Index (SFSI) has been established. The SFSI measures food system sustainability across 33 countries among 3 categories and 9 dimensions by employing 39 indicators, 65 sub-indicators and 38 sub-sub-indicators. The results display the varying degree of sustainable food systems among performing countries across selected indicators. The overall index score highlights Sweden as the front runner, closely followed by France and the United Kingdom, while laggards illustrate Ethiopia, Nigeria and India. With food systems being caught in a vicious circle with the ecosystem and the environment, economically poor regions are particularly vulnerable due to its smallholder dependency on agricultural systems. The SFSI outcomes provide more insights into the sustainability's state of analysed food systems in the categories of food safety, ecosystem stability and resilience, as well as sociocultural wellbeing and might serve as foundation for future sustainable food system research.

Keywords: sustainable food systems, sustainable transition, sustainable development, composite indices, food security, ecosystem stability, resilience, sociocultural wellbeing

Table of contents

List of tables

List of figures

List of abbreviations

BCFN	Barilla Centre for Food and Nutrition
BRIC	Brazil, Russia, India, China
CFA	Confirmatory Factor Analysis
CIAT	International Centre for Tropical Agriculture
CO2	Carbon Oxide
CSD	Commission on sustainable development
EFSA	European Food Safety Authority
EPI	Environmental Performance Index
FAO	Food & Agriculture Organisation
FLO	Fairtrade Labelling Organisation International
FSI	Food Sustainability Index
GFSI	Global Food Security Index
GHG	Greenhouse gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GMO	Genetic Modified Organism
GR	Green Revolution
HLPE	High Level Panel of Experts
HPI	Happy Planet Index
IMO	International Maritime Organisation
INCD	International Network for Cultural Diversity
MDGs	Millennium Development Goals
N2O	Nitrous Oxide
NCD	Non-Communicable Disease
N-Cycle	Nitrogen-cycle
NEF	New Economic Foundation
NGO	Non-governmental organisation
NNR	Nordic Nutrition Recommendation
NSEG	Nigerian Economic Summit Group
P-Cycle	Phosphorus-cycle
PM	Particulate Matter
R&D	Research & Development
SAFA	Sustainable assessment of food and agricultural systems
SD	Sustainable Development
SDGs	Sustainable Development Goals
SFSI	Sustainable Food System Index
SO2	Sulphur Oxide

UAE	United Arabic Emirates
UN	United Nations
USD	US Dollar
WB	World Bank
WHO	World Health Organisation

1 Introduction

At the beginning of this research the underlying statement of problem and the resulting purpose of research are introduced, followed by illustrating the organisational framework of the research project.

1.1 Statement of the Problem

With people, often interchangeably referred to as population, playing a fundamental role within sustainable development, especially when aiming towards achieving the United Nations outlined Agenda 2030, its continuous growth is of significance. According to the United Nations, Department of Economic and Social Affairs, Population Division (2017, p. 1), the world's population had reached the 7.6 billion mark by mid-2017. In 2030 the estimated population is expected to hit 8.6 billion, while in 2050 already 9.8 billion people are expected on Planet Earth. In 2100 even 11.2 billion. In accordance, a process of modernisation in line with novel technologies, as well as innovations, is affecting whole industries and areas, which further enable rapid and vast economic growth. While simultaneously, the phenomenon of globalisation allows unlimited cross-border-movements of goods, services and people, the worlds' systems are changing. Production systems are becoming more economically efficient by focusing on economic of scale and scope, characterised through high-quantity production, in less time, with minimised costs. Additionally, international trade has enabled almost unlimited access to goods and services on a global scale and has caused societal value shifts, especially in affluent economies, from consuming out of need to consuming out of desire. Overall, current society, in line with food systems, is characterised by overproducing, on one hand, while concurrently over consuming, as well as wasting, on the other. Increasing demands, due to population growth, as well as demographic changes are shifting cultural values, altering attitudes, behaviour, and tastes. And to make matters worse, the endless crave for economic growth and development, which has been misleadingly limited to an increase in GDP for numerous years - further emphasised by The Economist (2016) within the article "Why GDP is a poor measure of progress" - has been overriding the planetary health, tied to the environmental- and social dimensions. Through years of exploiting Earth' resources, the pressure on the ecosystem has hit a peak, evident in shifting closer to the Planetary Boundaries, eventually forcing human beings to transition towards a sustainable future.

The shift towards more sustainable patterns has become a crucial undertaking of the 21st century. With two out of nine planetary boundaries already beyond the 'zone of uncertainty', and two additional ones within the 'zone of uncertainty', a scene of destruction on Earth has become apparent. Weak climate carbon cycles, accelerating changes in climates, manifested in more extreme weather scenarios globally, further exemplified through the deterioration of Australian's Great Barrier Reef, exsiccation of the Gulf Stream, as well as the melting of polar caps, rising sea levels, and numerous more disastrous events, are becoming the new ‘ordinary’ (Stockholm Resilience Centre, 2018). Human’s deep relationships with personal- as well as broader contextual factors, which have tremendous behavioural impacts, and are affected by while simultaneously influencing societal values of materialism and wealth (Reisch, Eberle, & Lorek, 2017; Springmann et al., 2016). Hence, the behaviour of human beings and its impact on the ecosystem has been so excessive that the world shifted into a new geological epoch, from Holocene to Anthropocene (Waters et al., 2016), and therefore mankind could be identified as the major threat of the 21st century.

While various attributes are contributing to patterns of unsustainability, food, mobility and housing are considered as main drivers of the unsustainable demeanour. Food alone is responsible for around 30 percent of the emitted GHG emissions due to its highly unsustainable production- and consumption processes, resulting in severe biodiversity losses, as well as extensive deforestation as outcome of agricultural processes. Especially livestock for meat, eggs and milk products contribute to around 15 percent of the total global GHG emissions, while simultaneously occupying approximately 70 percent of the total agricultural area. Additionally, food systems require a vast amount of water, which is further complicating the issue of water scarcity. Food also represents a heavy polluter, through disrupting global nitrogen and phosphorus cycles. Moreover, next to land impacts, the marine ecosystem stability has been endangered for several years, due to excessive overfishing, in connection to frequently using the sea as waste disposal site, especially regarding plastic waste. Besides that, enormous inequalities are existent within the food system, exemplified through the ten biggest food companies earning more than 1.1 billion $ (Braun, 2007), while over one billion people, who are heavily relying on agriculture for livelihood, are forced to live below the poverty line. An identical situation is apparent in the food production chain, with current productions scales showing that would enable the feeding of more than 7 billion people. However, more than two billion are affected by micronutrient deficiencies, as well as obesity and overweight, while more than 800 million face hunger. Severe forms of malnutrition further cause health-issues, including non-communicable diseases (NCDs), such as heart conditions, strokes, diabetes, as well as different forms of cancer. While NCDs previously have mostly been limited to affluent societies, developing countries are now impacted by the “double-burden” of extreme hunger, plus malnutrition, plus obesity, plus overweight, and issues of NCDs (Garnett, 2016).

The topic of sustainability, in line with societal transitions, has gained a great amount of attention within previous years, exemplified through various outlined targets, such as the Sustainable Development Goals (SDGs), the Paris Agreement for Climate Change, as well as the Milan Protocol for Sustainable Food Systems. Food indicates a crucial determinant of achieving the outlined target, as it shares a connection to almost all 17 SDGs. Hence, the creation of more effective, long-lasting and sustainable food systems has been placed at the forefront of responsible production and consumption. Moreover, it has emerged as crucial turning point on the agenda towards societal transition (Dyen & Sirieix, 2016; Reisch et al., 2017).

1.2 Research Question and Purpose

The food system, in line with the way food is consumed, illustrates a very complex and dynamic field of research, which has been tremendously affected by various changes over the last year pinpointed by several studies (Díaz-Méndez & García-Espejo, 2017; Díaz-Méndez & van den Broek, 2017; Fourat & Lepiller, 2017, 2017; Minton, Spielmann, Kahle, & Kim, 2018; Noraziah & Mohd Azlan, 2012; Pfeiffer, Speck, & Strassner, 2017). The traditional way of consuming food has been altered due to personal- as well as broader contextual factors affecting human beings, and societies. Changes in life-styles, living spaces, work schedules, income, social norms, culture, as well as a growing number of opportunities to consume outside of home, combined with take away food and home delivery services, are considered as main drivers of these changes (Lund, Kjærnes, & Holm, 2017; Noraziah & Mohd Azlan, 2012; Pfeiffer et al., 2017). With growing emphasis placed on the topic of sustainability, numerous studies have been conducted, tackling different issues within the wide area of sustainability. In accordance to novel consumption patterns, which basically adapt the whole food consumption act, new trends have emerged surrounding the area of food with special focus being placed on health, nutrition, green- and environmental friendly food.

While the terminology of sustainability demonstrates high ambiguity, as well as complexity, individual pillars, including the environmental one have grown in importance (Lorenz & Langen, 2018). The strive for core values, including civil rights, social equality, respect for nature, human health concerns, animal welfare, agricultural sustainability, ecological sustainability, food justice and political empowerment, resulted in new movements, such as the “Green Movement”, as well as the “Slow Food Movement”. The Green Movement focuses particularly on environmentally friendly behaviour, in line with personal characteristics, food-related lifestyles, as well as behaviour, which further allows clustering consumer segments (Verain et al., 2012). Slow Food, on the other hand, highlights food that is good, clean and fair by emphasising the protection of the domestic biodiversity through knowledge hubs, in line with specifically adapted supply chains, regarding cultivation, breeding and processing. A particular focus within the slow food movement is placed on values of sustainable food (Snyder, Hu, & Zheng, 2018).

The incorporation of sustainability within food systems and among patterns of consumption is clearly on the rise, evident through novel, sustainable food trends, as well as movements. Consequently, the behaviour surrounding food and the consumption is affected by numerous personal- as well as broader contextual factors. However, current research is still lacking a standardised, universal understanding regarding the role of sustainability within the food system, in line with all elements and processes of it. Despite a rising number of policies implemented, in accordance to outlined indicators regarding sustainability and sustainable development, ranging from poverty to peace, justice to partnerships towards achieving defined sustainable goals, such as the SDGs, Paris Agreement, as well as the Milan Protocol, the topic of sustainability seems more relevant and apparent in theoretical terms, rather than in practical ones. The high complexity entangled with food systems, tied to the food system chains, which range from production to consumption, a shift towards more sustainable patterns indicates a difficult undertaking. Current policies commonly concentrate more on the "doing more better" approach by aiming towards increasing production- and distribution rates with less environmental impact. However, while this approach might demonstrate a good starting point, Garnett (2016) highlights its insufficiency, as this will neither enable achieving the Paris Agreement Goal, nor will it reduce the food security- and affordability issues. Planet's future, in line with the People living on it, is at stake; therefore, transforming current inefficient consumption systems to enable a sustainable future displays a pre-condition when trying to achieve the SDGs (Langen et al., 2017). Garnett (2016) further emphasises the impact of consumer behaviour and eating patterns on food production. What we eat is produced; hence a change in behaviour, as well as establishing so-called "win-win-diets" are required to move the food system away from the current stage of unsustainability. Overall, while various policies regarding concerns of sustainability have been implemented across countries, some nations are considered as forerunners in terms of societal transition. With more profound data collection regarding certain indicators, which allow tracking individual countries' processes in terms of achieving outlined goals, as well as the effectiveness of the implemented policies, the creation of a sustainable food system has gained in recognition on international, as well as national scale. In accordance to that, the following research is targeting the subsequent question(s):

How sustainable are the food systems across 33 selected countries in terms of food security, ecosystem stability and resilience, as well as sociocultural wellbeing assessed by the Sustainable Food System Index? Which countries are taking the lead and which countries are falling behind?

2 Sustainability and Food Systems

The following chapter provides insights into the terminology of sustainability by emphasising its emergence as concept in an international setting. This section additionally displays the evolution of food systems by conceptualising the terminology and laying out the specific actors and elements involved in this highly complex and dynamic field.

2.1 Sustainability

Sustainability has emerged as “in vogue” idiom of the 21st century, evident through its wide application among various sectors, ranging from architecture to fashion, to advertisement and marketing, mobility as well as tourism, on a global and international scale. Throughout the relatively recent history surrounding the terminology of sustainability, specifically around the genesis of the concept, it was more reserved for environmentalists and/or activists. However, with the current state of planetary health interconnected with human health, sustainability has emerged as crucial topic.

2.1.1 Arising Sustainability

The history of sustainability in a broad sense goes back to ancient Greece, the upswing of the Chinese civilization, and appears in beliefs of Confucius and the Taoists, who shared a deep bondage to the environment and nature, which is evident within their philosophies. Even within Hebrew Scriptures, as well as among Native Americans, the importance of achieving a balance and harmony among people and planet, has been commemorated (Banon Gomis, Guillén Para, Hoffmann, & McNulty, 2011). Human behaviour could be put into question since the arising of the first homo sapiens on terra. In line with the underlying value of “the survival of the fittest”, humans have subordinated survival and development to planetary resources and health. Evident in the agricultural methods of ancient Mesopotamians, who destructed fields by constant waterlogging and salinization processes; as well as in the Indus Valleys, which had been victimized through vast deforestations, resulting in severe erosion of soil. The Roman Empire, in addition, destroyed arable land by overgrazing to handle the increasing food demand as outcome of a rapidly growing population. As a matter of principle, the whole evolutionary process of civilization seems to be characterised through unsustainable behaviour, assumptively indicating the causes for the rise and fall of various societies (Ponting, 1990).

With sustainable attributes on the rise, the terminology slowly emerged among various areas. The incorporation within the biological dimension, finally enabled the formation of a physical concept, which in turn, represents the base of today’s societal understanding regarding the concept of sustainability (Dixon & Fallon, 2008). When famous economists, including Malthus and Solow, highlighted the material limits of Planet Earth, approaching on an accelerating rate as outcome of humans’ unbeneficial consumption patterns, in combination with a constantly growing population, which might cause economic stagnation in the long-run (Malthus, 1798), the so-called model of “Sustainable Economic

Growth" had established. The novel model emphasised replacing "whatever it takes from its inherited natural and produced endowment, with its material and intellectual endowment" (Solow, 1993, p. 163). Solow (1993) further elaborated the linkage of Earth' ending resources in relation to transitioning values, tied to changes in taste and interests, requires shifting back from current "yes-or-no" values, to "more-or-less" ones. With Meadows (1974) discussing the problematic unsustainable human behaviour within the book "Limits to Growth", which are evident in existing societal patterns through overusing resources, as well as goods and services, and contribute heavily to the environmental destruction, the landmark of the modern sustainability concept was carved in stone. Intensified environmental pressure, expediting the climatic change and global warming, leads to a rise in natural disasters, as well as larger social disparities. Unsustainable mannerism disfunctions the economic system on a long-term base; hence human beings have been forced to either continue the unsustainable behaviour, or shift towards a concept characterised by longevity and steadiness (Howarth, 2012). In dependence on Meadows (1974) concerns, Mill (2004, p. 595) depicted the frequently misconceived equation of economic wellbeing and planetary-, as well as human wellbeing by emphasising that economic empowerment and growth, might indeed enhance the economical state of the nation, which in turn, might increase the population, however, it does not necessary assure higher levels of satisfactions among the population itself.

Over the years, sustainable characteristics have become more important, apparent in various fields, which has intensified the ambiguity and complexity aligned to the concept and put the adequate terminological elaboration in dispute. Already the verb "sustain" exemplifies the equivocality regarding the meaning of sustainability, which tackles different notions, including borne-up, endure, and maintain (Howarth, 2012). With sustainability referring to something long-lasting, in a world frequently shaped by short-term values, the idea beyond sustainability usually emerges in unfavourable times, coined by scarcity and crisis. One of the finest examples illustrates Carlowitz (1713), a German tax accountant and mining administrator, who is considered as the father of sustainable yield forestry. When in 1700, the Saxonian mines had been exhausted, the whole existence of the mine industry was endangered and in line with it thousand livelihoods. As all issues were a result of unsustainable behaviour regarding the mining surroundings, including radical deforestation of trees, resulting in a lack of timber, Carlowitz introduced the concept, nowadays referred to as sustainable forestry through "sowing, growing and planting of seedlings", accompanied by "wild and planned cultivation of a once cut and barren land", in line with limiting the forest clearance to the natural reproduction rate (Carlowitz, 1713, pp. 105–106).

2.1.2 Conceptualising Sustainability

Planetary issues are deteriorating, linked to resource scantiness and soil erosion due to excessive agricultural and farming. In line with climatic changes, evident through increasing Earth temperatures, which accelerates the melting of polar caps, as well as convulsions and untypical weather conditions, agricultural losses are rising. By placing a heavy burden on agriculturally dependent regions, crisis have been precipitated, in line with economic stagnations and/or scenarios of de-growth. Consequently, the idea beyond sustainability has become more crucial within the political, economic, as well as ecological spheres. In line with that, various definitions have been established, most of them representing similar characteristics. However, only by linking the terminology of sustainability to development, the concept beyond today's idea of sustainability has evolved. Through the so-called "global agenda for change", also known as Brundtland Report, published by the World Commission on Environment and Development in 1987, the need for a multidimensional approach has been recognized. By aiming towards a development that "meets the needs of the current generation without compromising the ability of future generations to meet their own needs" today's most commonly applied definition of sustainability, tied to development has been established. Through a three-dimensional approach by incorporating the environmental, economic and social dimensions, the foundation of the concept of sustainability was carved in stone (World Commission on Environment and Development, 1987).

The concept of sustainable development is based on the triple bottom line, which refers to the three pillars, or in terms of Adams (2006), the three interlocking circles of sustainability, including environmental, economic and social attributes. Environmental sustainability refers to the "maintenance of natural capital" (Goodland, 1995, p. 10) and is frequently conceptualised as natural capital that aims towards more efficient and sustainable techniques by using nature as capital to do so. Additionally, environmental sustainability is deeply entangled with energy, water, biodiversity, transportation and waste (Anne Wiese & Wilson, 2015). Clean water, air and land represent the key duties when aiming towards the creation of a functioning and responsible socio-economic system, which in turn, is fundamental for a sustainability transition. Environmental sustainability indicates a subset of the ecological dimension, defined by Morelli (2011, p. 6), as

> a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity.

By displaying another sustainability pillar, frequently emphasised as the most powerful one of all, Bhattacharjee and Cruz (2015, p. 68) consider economic sustainability as "the true driver of decision making for firms". This "traditional" way of thinking is often based on the economic mindset of the neo-classic, and further enhanced by today's western values of materialism and capitalism, which places material possessions and capital affront of everything. While the economic dimension, indeed, takes a significant role when aiming towards development, the social and environmental spheres are essential as well, especially when aiming towards achieving the outlined SDGs, as well as the societal transition. However, the link between development and economics has already been established in the 18th century, with Adam Smith' book "The Wealth of Nations", by connecting a countries' wealth to its stream of goods and services, which would nowadays be referred to as Gross National Product (GDP) (Smith, 2003). Economic growth has been commonly framed as key for human development as exemplified in the works of all early founders of economics, ranging from William Petty, to Antoine Lavoisier, Adam Smith, David Ricardo, Robert Malthus to Karl Marx. While a certain economic situation preconditions a countries' wellbeing, tied to the people living in it; additional factors, such as public care and social organisations illustrate crucial components of human wellbeing (Anand & Sen, 2000) as further emphasised through Sen (1984) 's capability approach, which addresses the individuals' advantage aligned with the persons' capability to achieve valuable functions through-out the lifespan (Sen & Nussbaum, 2009).

The third pillar of sustainable development tackles the social dimension of sustainability, which has been subordinated for years in relation to the other two pillars. Hence, the literature field of social sustainability is relatively young and limited. Despite a frequent linkage to closed neighbourhoods and communities, further entangled with the environment and surroundings, the terminology of social sustainability is missing a precise elaboration. With novel terms in line with urban sustainability, social equity and sustainability of community, the research area has gained momentum (Dempsey, Bramley, Power, & Brown, 2011). However, knowledge regarding the social sustainability dimension is lacking, mainly as result of being subordinated for several years in relation to the other two pillars of sustainable development.

2.1.3 Developing Sustainability

With growing interests and importance surrounding the scarcity of earth' resources, sustainability was further incorporated in various declarations, including the Rio Declaration on Environment and Development, as well as "Agenda 21" at Rio's Earth Summit in 1992. While Agenda 21 indicates a blueprint of action, on a global, national and local scale through the United Nations' organizations, as well as governments and major groups, it aimed towards an inclusive approach of the environmental- and development dimension by establishing the Commission on Sustainable Development (CSD). Furthermore, it improved the terminology of sustainable development beneficially through achieving more comprehensibility for the household level. The Rio Declaration, on the other hand, consisting of 27 principles, introduced as soft law instrument, serves more as guideline towards sustainable development around the world, rather than an enforcing law. The outlined principles of the Rio Declaration have been integrated within various follow-up agreements, as well as national laws (Dodds, Schneeberger, & Ullah, 2012, pp. 1–9). As response to the growing environmental pressure, specifically implied by the industrialized and developed countries, the Kyoto Protocol was launched as extension of the 1992 UN Framework Convention on Climate Change. The international treaty illustrating a set of binding emission reduction targets for the committing parties was adopted on December 11, 1997 and had been put into force in February 16, 2005. In 2012, the first commitment period had ended and the Doha-Amendment was established as follow-up (French, 1998). In accordance with Ban Ki-Moon's words: "spare no effort to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty" (Nations, 2015, p. 3), a framework of eight goals and 21 targets had been established. The so-called Millennium Development Goals indicated an outcome of the United Nations Millennium Declaration, adopted by all UN members' states at the Millennium Summit in 2000 in New York City. Aligned with the vision of creating a future with less poverty across various dimensions, a crucial step regarding development has been made, tied to goals ranging from eradicating extreme poverty and hunger, achieving universal primary education, to promoting gender equality, reducing child mortality, over improving health of the people and the environment, as well as developing a global partnership. The MDGS terminated in 2015 and have been followed by the Sustainable Development Goals (Nations, 2015).

Sustainability has been a highly discussed topic among governmental and non-governmental organisations, enterprises, businesses and other stakeholders. With debates and Earth Summits, exemplified through Stockholm in 1972, followed by Rio 1992 and Johannesburg 2002, and Qatar in 2012, the debates about development, later connected to sustainable development, have been further enhanced and resulted in adapting novel declarations regarding sustainable development (United Nations, 2002). The Doha negotiations further emphasised the topic by establishing the "Doha Climate Gateway", which indicates a post Kyoto Protocol that had been outlined in the conference of Johannesburg in 2002. Further debates took place in Montreal, Canada in 2005, which were aligned with the so-called "Convention Dialogues", as well as in the Bali Conference in 2007, putting the Bali-Action Plan into place, the Copenhagen Climate Change Conference in 2009, which resulted in the "Copenhagen Accord", as well as the Climate Change Conference in Cancun in 2010, introducing the Cancun Agreements, the Conference in Durban, in 2011, the Bonn Climate Change Conference in 2012, as well as the Bangkok Climate Change Talks of 2012. All of which emphasised the concerns surrounding the global changing climate. The Doha Conference further displayed the 3rd Earth Summit after Rio and Johannesburg and followed the UN General Assembly Resolution A/RES/64/236 on December 2009 (Eni-ibukun et al., 2012).

With the phasing out of the MDGs in 2015, the United Nations General Assembly at the 2015 Conference in New York, established the Sustainable Development Goals (SDGs), frequently referred as Agenda 2030. The Post-2015-Development-Agenda consists of 17 Goals including 169 targets, which tackles sustainable development among the economic, social and environmental dimension. The 2030 Agenda further incorporates the outstanding targets of the MDGs by recognising human rights for everyone, in line with gender equality and female empowerment. The defined SDGs collectively aim towards establishing a pathway towards sustainable development by placing great emphasis on beneficial cooperation, which add value on a national, as well as international level. Moreover, the SDGs target fruitful contributions towards enabling beneficial outcomes for the current, as well as future generations (United Nations, 2015). Since its implementation in January 2016, various nations have established regional development programmes, such as the Baltic 2030 Action Plan, which aims towards fostering the collaboration and development of the Baltic regions, including Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Norway, Poland, Sweden and Russia, by providing a strategic framework through narrowing the 2030 Agenda of the SDGs down to a macro-regional level (Kampus, 2017). In addition to the Baltic region, various other regions have implemented a regionally adapted version of the 2030 Agenda, including countries like Saudi Arabia, as well as India.

Overall, sustainability, in line with the concept of sustainable development, might indicate a clear theoretical elaboration, in line with a precise definition, based on three dimensions. Anyhow, its utilisation is rather nebulous. Particularly, in governmental decision settings, the social- as well as the environmental spheres are constantly degraded. Anyhow, when trying to achieve the sustainable development goals, the incorporation of all outlined dimensions on an equal base might indeed be essential. The choices people make, as well as the social trajectories, are tremendously affected by the social surroundings of individuals (Adams, 2006) due to being ruled by interests, societal behaviour, mindsets and social rationalities. This further serves as guideline for the behaviour of individuals, in relation to their civic duties, public opinions, behavioural rules, social norms and so further. Thus, establishing an adequate understanding of a fluid theme that differs across societies and among individuals, demonstrates a highly challenging act. The social dimension though, possesses great powers, as exemplified through multiple political leaders, or societal spokesmen, such as Martin Luther King and Nelson Mandela, who transitioned whole societies into a certain direction. However, in some cases, the immense power of the social sphere might be applied in horrifying and unbeneficial ways, like the persecution of the Jews in the holocaust due to widespread propaganda (Banon Gomis et al., 2011). By creating new bondages towards physical characteristics, the research field has been further expanded (Dempsey et al., 2011). But, again, physical sustainability alone will not enable shifting away from deeply inherited patterns of unsustainability. In the end, there are numerous essential characteristics when aiming towards social sustainability, such as processes and structures, which in turn, allow, satisfying constantly changing needs of human beings, as pointed out by Eizenberg and Jabareen (2017).

2.2 Food System(s)

The next chapter points out the evolution of food systems by illustrating its point of emergence, followed by a conceptualisation of the terminology. In a next step, the development process of food systems is elaborated more in depth and the food environments are pinpointed.

2.2.1 Arising Food System(s)

Food displays an essential human need as it is inevitable for the functioning of any living and active cell. Human beings consist of living organism, which can be further constructed into cells, chemical compositions, organ systems and other physical characteristics. People's bodies therefore illustrate an intricated system composed of cells which further form into organ systems, each one assigned with a special function. With an endless need for energy, the consumption of different nutrients and foods demonstrate a necessity for maintaining physical, as well as mental health (Rutherford & Ahlgren, 2010). Consequently, the act beyond eating is crucial for human survival and is further contributing to the personal welfare and social welfare (Mintz & Du Bois, 2002). Food indicates a basic human requirement (Mintz & Du Bois, 2002) and is outlined, in accordance to Article 11 of the United Nations' General Assembly, as basic human right (Article 11 - The right to adequate food, 1999).

2.2.2 Conceptualising Food System(s)

Food systems are characterised by highly complex processes and relationships, which are further affected by various elements and activities, which are connected to the production and consumption of foods (Fischer & Garnett, 2016). As pinpointed by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (2017, p. 11):

> a food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes.

As food, tied to its systems, has merged into various fields, the number of existing definitions has increased concurrently over the last years. Sobal, Khan, and Bisogni (1998, p. 853) consider the food and nutrition system as transformational processes by turning "raw materials into foods" and "nutrients into health outcomes" through "systems within biophysical and sociocultural contexts". Despite, food systems being shaped by a high degree of complexity, numerous terminological specifications have elaborated the term in a more simplified style. However, food aligned with food systems, are far beyond elementariness. Functioning food systems consist of essential elements, such as food production, consumption and nutritional health. With food itself providing essential nutrients, next to sensations of pleasure, livelihoods, social traditions, and culture, it takes a crucial role in the lifespan of a human being (Sobal et al., 1998). Neff, Parker, Kirschenmann, Tinch, and Lawrence (2011, p. 1587) highlight the complexity of food systems due to its inclusion of all processes, entities, and relationships, from farm to fork, or from soil and seed to table, complemented by waste. Illustrating food systems in a more comprehensive way, along with its drivers, actors and elements, it is of fundamental importance to point out its constant interrelations among the involving factors, internally, as well as externally with other systems, including health, energy and transportation systems (HLPE, 2017).

2.2.3 Developing Food Systems

In accordance to a continuously growing population (UN DESA, 2017), in line with rapid economic growth, the need for food has synchronously enlarged. Aligned with societies becoming more affluent, particularly apparent in developing countries, dietary intakes are shifting towards a “new” normal, commonly indicated by an intensive consumption of animal proteins (Evans, 2009). As pointed out by Valin et al. (2014, p. 52), population- as well as income growth are the two major reasons for an increase in demand, the food demand has taken exorbitant scales. In according to the law of Bennett (1941), which states that growing income leads to increasing rates of animal proteins, as well as fats and oils, exemplified by China’s tremendous per-capita income growth, which transitioned the traditional Chinese diet towards modern consumption patterns. Modern consumption patterns, are further aligned with intensified consumption of animal-based foods, while simultaneously, the intake of grains including rice declines (Valin et al., 2014). Furthermore, commodity prices play a crucial role when consuming food, as outlined by Green et al. (2013) through analysing the elasticities of dietary staples. Again, products, including cereals, fats and oils showed less price sensitivity than livestock foods, such as meat, fish and dairy. Animal-sources foods demonstrate a type of luxury good; hence, its consumption increases with a rise in income, and controversy. Commodity food prices, therefore, are affecting food choices of individuals within developing countries, as well as in advanced countries. The demand of food and its consumption is depending on various attributes including geographic location, demographic characteristics, in line with the societal senescence, globalisation tied to trade liberalisations, urbanisation, marketing, religion, culture, consumer attitudes and interests (Kearney, 2010). Additional factors, including age, gender, physical activity, metabolism, as well as the amount of people inhabiting a certain region, contribute to the food system, aligned with food demand and consumption patterns (Valin et al., 2014).

Through changes in the global environment, particularly present within the late 90s, the research field surrounding the topic has enhanced its knowledge regarding food security, environmental stress and pressure, as well as other drivers. However, as an outcome of various failed attempts to conceptualise the food system, the existing approaches had to undergo a change. In accordance, the so-called food system approach, a novel, interdisciplinary food security research project has been established and introduced (Ingram, 2011). In line, Ingram (2011) and Nesheim, Oria, and Yih (2015) point out five main drivers of food system changes, including biophysical and environmental innovation, technology and infrastructure, political and economic, sociocultural and demographics, further complemented by Downs and Fanzo (2016) through adding the food supply chain, tied to its stages of production, storage and distribution, processing and packaging to retail and markets, the HLPE (2017) put forward a comprehensive conceptualisation of the food system and its elements.

Food System’ Drivers

Socio-economic drivers refer to changes in demographics, economics, socio-political- and cultural contexts, as well as science and technology (Ingram, 2011). Each component effects the food system, including its elements and activities differently. The HLPE (2017, p. 24), introduced five food system drivers, represented by the biophysical- and environmental, in line with natural resources, ecosystem services and climatic changes; in addition to political- and economic drivers displayed by leadership, globalisation, foreign investment and trade, food policies, land tenure, food prices and volatility, as well as conflicts and humanitarian crisis. Another driver represents the sociocultural dimension, in line with wellbeing, culture, religion, rituals, social traditions and women’s empowerment. Furthermore, innovation, technology and infrastructure display further contributors, while finally, the demographic sphere, aligned with population growth, urbanization and migration, as well as force displacement, illustrate another supporter of food systems. When targeting functioning food systems for the current and future generations, the adequate inclusion of the outlined drivers is crucial, especially when aiming towards sustainable and healthy nutrition and diets (HLPE, 2017).

Food Supply- and Value Chains

When adhering to outlined definition of a food system by the HLPE (2017, p. 11), it is encompassing all elements, ranging from the environment, people, inputs, processes, infrastructures to institutions, as well as the activities of food producing, processing, distributing, preparing and consuming. Thus, the food supply- and food value chain demonstrate a crucial and essential part of a food system (Downs & Fanzo, 2016; HLPE, 2017, 2014; Ingram, 2011; Nesheim et al., 2015).

The supply chain is commonly referred as the life cycle of a product by representing the processes and actors interconnected with a product ranging from its conception, through its production, consumption, to its disposal. The value chain, on the other hand, shares similar characteristics but is complemented by an extra value added at a certain point and time along the food chain. Each food value chain component is necessary for transforming the raw material into the final. In more simplified terms, the activities and actors included range from crop breeders, extension services to seed, agrochemical and farm machinery companies, farmers, agricultural labourers, and commodity producers. For the food storage and processing stage, packers, millers, crushers and refiners; as well as processed foods manufacturers and artisan are incorporated. Moreover, importers, exporters, brokers and wholesalers oversee the food distribution, transportation and trade; while the food retailing and catering is carried out by informal retailers, supermarket chains, restaurants and fast food companies. The final food supply chain stage displays food promotion and labelling and is supported by advertising and communication agencies. Food security issues of food availability, affordability, acceptability and quality are determined in the pre-production and production dimension of food the supply chain, are decisive for the further food consumption, in line with the dietary quality. The s complexity of the supply chain depends on the production systems. Multi-layered production systems include multiple actors and locations, simple production systems display only one stage, location and actor. While each actor takes a different part along the supply chain, all together contribute to the final product, as a chain refers to an interconnected system, each part affecting one another, on purpose or not. In addition, various cross-cutting inputs, as well as processes, like natural and human resources, technology, capital and policy, are contributing (Bloemhof & Soysal, 2017; HLPE, 2017).

Well-established supply chain management systems are responsible for overseeing the processes and relationships of a supply chain and are becoming fundamental for establishing functioning food systems (Bloemhof & Soysal, 2017). Hence, the incorporation of adequate food supply chain management systems is a critical endeavor (Soysal, Bloemhof-Ruwaard, Meuwissen, & van der Vorst, 2012). According to Lambert (2008, p. 2), supply chain management systems integrate “key business processes from the end-user through the original suppliers that provide product, services and information”, by further enhancing the value for customers and stakeholders. Soysal et al. (2012, p. 137) further emphasise the importance of the food supply management, which goes beyond objectives of reducing costs and enhancing responsiveness, by focusing on intrinsic components and processes additionally. Overall, an effective supply chain management tries to deliver goods and services, which consider respective customer demands in a responsible, efficient and sustainable way. Food supply chains are highly complex systems due to constraints in time to prevent spoilage, in combination with issues of contamination, weight to value ratios, packing requirements, fragility, as well as food waste and loss (Wakeland, Cholette, & Venkat, 2012).

Food supply- and/or value-chains have undergone major transitions over the last decades, across industrialized, and developing countries by shifting from small, local markets to international food markets. Consequently, the value chain is influenced by a wider range of actors across various countries. As a result, numerous internal factors affect the food system, including internal and external drivers, such as emerging trends, global dietary shifts and so further. While, on one hand, high nutrient foods like fruits, vegetables, dairy and meat have increased in demand, convenience foods, such as highly processed, packaged, and ready-to-eat have been consumed in higher numbers, as well. Aligned with dietary changes, traditional food chains have transformed from the process of traders buying from smallholder farmers and sell directly to consumers or small retailers, local stores or markets, to the modern food value chains. These function around domestic and multinational food manufacturers whose primary provider are commercial farms, which collaborate with modern supermarket outlets to sell the goods. Additionally, there are mixed versions of food value chains existing, such as modern-to-traditional, which works around domestic and multinational food manufacturers who use the traditional trader and retailer network as selling platform; and controversy, the traditional-to-modern type, which incorporates foods of smallholder farmers and traders as major selling goods within supermarkets and food manufactures. Modern-to-traditional value chains distribute processed and packaged foods and targets low income consumers across urban regions. Traditional-to-modern food value chains, in contrary, contribute positively to employment rates, which might raise the income. However, in this case, small holder farmers might face quality standard issues, which are easier to address by modern retailers (Downs & Fanzo, 2016).

Food Production

Production refers to a process and method applied to “transform tangible inputs”, such as raw materials, semi-finished goods, subassemblies, “and intangible inputs”, including ideas information and knowledge, “into goods or services” (Business Dictionary). The transformation itself is depending on the allocation and/or availability of resources, which are pre-conditioned to deliver a certain output (Business Dictionary). The process of food production converts natural resources into edible products, commonly referred to as foods, feeds, fibre and nutrition. Food manufacturing industries determine food production as they oversee the transformation of raw food products into valuable, marketable and competitive food items. The food production process depends on the used raw material. Fruits, vegetables and grains are processed after harvesting, while the processing of meat takes place immediately after the butchering procedure. Both forms result in food products, which are made available to the consumer level. The range of food production, again, differs from the severity of processing and varies from minimal to complicated processing methods. The minimal processing process consists mainly of simply actions, such as cleaning and packaging, while the more complicated to highly complex processes incorporate various elements, including additives, ingredients, as well as methodology. The intention beyond food production processes is the extension of the raw materials lifecycle as it allows the creation of food products with far longer shelf-lives, than the raw materials itself (Journal of Food Processing & Technology).

Food Consumption

With food itself displaying an essential need for survival of human beings, the act beyond consuming it is omnipresent (Mintz & Du Bois, 2002) and marks a major component in lifespan of a consumer. As pointed out by Christina Figueres at the EAT Forum 2018 in Stockholm: “No one, absolutely no one, can survive without food!”. The act beyond depleting a resource, which derived from the Latin word “consumer” is nowadays frequently referred to the verb consume, and contextualised through eating, drinking, ingesting, or buying something (Stevenson, 2010). The activity of consuming identifies a process which is deeply entangled in the human mindset and reflected in the behaviour. While consumption, particularly in the awakenings of the study field, assumed rational purchase behaviour, recent research highlighted the irrationality aligned with it. Tversky and Kahneman (1992) elaborate humans’ irrationality more in-depth in the “prospect theory”. They basically reinvented behavioural economics, circumstantiated through Kahneman’s (2012) Nobel prize-winning masterpiece “Thinking, Fast and Slow”.

The book summarizes a lifetime of research surrounding conscious and unconscious thinking and narrows down the mindsets and behaviour of human beings in an intellectual and comprehensible way. Their work transitioned the research field away from Bettman (1979) "information process model", which presented the consumer as logical mastermind, completely conscious and aware of his purchase decisions.

By widening the insights into consumer behaviour, different attributes and characteristics have been taken into consideration. With including spiritual- and phenomenological attributes, the so-called "experimental view" has emerged, in which consumption is outlined as a "subjective state of consciousness with a variety of symbolic meanings, hedonics responses, and aesthetic criteria" (Holbrook & Hirschman, 1982, p. 132). Hedonic consumerism, present in the experimental view, is interlinked with the ordinary, everyday practices. When incorporation the utilitarianism into the consumer research field, a novel focus area emerged by measuring energy intakes more accurately through calories, fluoride and gallons. However, the utilitarianism scratches more the surface of consumer behaviour, while the experimental perspective investigates more in-depth by considering the symbolic meanings beyond consuming, as well as the emotions aligned with it (Addis & Holbrook, 2001). Consumption is determined by factors which are beyond the obvious, entangled with culture, environmental settings, demographics and various others. Over the years, several authors have contributed with novel perspectives to the research field. Pilgrim (1957) contributed by linking food consumption to food perceptions, or in his terminology food acceptance. By connecting the food acceptance framework to three interlocking mechanism, such as the physiology as internal characteristic, which is in charge of evoking hunger and appetite; the sensations, which enable distinguishing among food as stimulus and organism receptor; and externalities, or environmental characteristics, such as attitudes and time. By emphasising the importance of preferences, tastes, favouritism and aversion, in line with learning effects through experiences, consumer attitudes might be transformed. Thus, Pilgrim's food acceptance framework represents a fundamental contribution to the research field in terms of assessing perceptions regarding consumerism.

2.2.4 Food Environments

Food environments are defined by the HLPE (2017, p. 28) as "physical, economic, political and sociocultural context in which consumers engage with the food system to make their decisions about acquiring, preparing and consuming food". Food environments describe the physical space in which food is obtained or purchased, frequently referred to as food entry points. Adequate infrastructural settings and features enable consumers to engage with these entry points, which share further connections to personal determinants, political and social drivers, which determine food choices based on characteristics of income, education, skills, values and norms. Hawkes et al. (2015, p. 2410) further emphasis the impact of food preferences on people's behaviour when consuming food, tied to the socio-economic status, which might indicate a barrier when accessing, preparing and consuming healthy diets. Food prices and presentation additionally influence people’s consumption choices. The food environment takes the moderating role among accustomed food preferences and eating behaviours. Food preferences are deeply inherited phenomenon, which have been mostly acquired in earlier life through parental eating behaviours, as well as the one’s of peers and role models. Preferences might be further shaped by restrictions in terms of food availability, as well as cultural- and social norms. Thus, shifting preferences is a difficult undertaking due to a high persistency and resistance to change (Hawkes et al., 2015).

3 Sustainable Food System(s)

The subsequent section outlines sustainable food systems by conceptualising the terminology in a first step, followed by developing the concept through pointing out sustainable food systems driver as well as the supply chain aligned to it. Further, the chapter elaborates sustainable food value chains as well as the environment sustainable food systems are shaped by. The final part introduces assessment tools and measures used in terms of sustainable food systems.

3.1 Arising Sustainable Food System(s)

With sustainability indicating a crucial undertaking of the 21st century, aligned with several outlined goals, on an international, as well as national level, the topic has gained in popularity, exemplified by merging as essential component into various fields. Currently, the globe is being more and more affected by catastrophic events, on a planetary-, local- as well as regional scale. While climatic changes, ocean acidification, as well as stratospheric ozone depletion indicate systemic planetary processes, global P and N cycles, atmospheric aerosol loadings, freshwater use, land use changes, biodiversity losses and chemical pollution illustrate aggregated local and regional processes. The need for action is becoming fundamental, in line with nine outlined planetary boundaries, of which three are according to Rockström et al. (2009) already in transgression. The consequences when transgressing planetary boundaries are still uncertain, however the potential unacceptable environmental changes that might arise should be reason enough to urge humans into a sustainable transition. With food systems being mainly responsible for deforestation, agricultural damage, as well as intensified land- and water usage, the contribution to the global greenhouse gas emissions adds up to approximately one quarter. Aligned to fatal biodiversity losses, as well as contamination of water and land, in connection to essential micronutrient wastage due to inefficient systems, while simultaneously around 800 million people face undernourishment, two billion lack necessary micronutrients, and additional two billions show signs of obesity and overweight; the current food systems do not deliver what they are supposed to (Sustainable Development Solutions Network, 2018). Food, in line with food systems have been categorized as "low-involvement product" for a long period of time and thus had been subordinated in relation to other themes. However, the role of food has become more striking than ever, for planetary- as well as for human health. With its deep entanglement with the overall ecosystem, since basically every food is either of plant- or animal origin, while simultaneously indicating a basic human need, nutrition and food carries great weight regarding human soundness and is decisive for the wellbeing of individuals. Food, in addition, accentuates culture and identity and is a major determinant of economic growth and livelihoods (World Health Organisation (WHO) Europe, 2018).

Food systems in place are coined by inequality, particularly in terms of distribution. With only a few benefiting from food system operations, exemplified by some giant corporations who are literally wallowing in money, others are struggling with food and nutrition security issues as the dullness of everyday life (World Health Organisation [WHO], 2018). On a global scale, approximately 793 million people were affected by undernutrition among the years of 2014 to 2016, especially located in South Asia, as well as other African countries. In 2016, the number of undernourished people within the southern Asian region added up to around 281 million. Sub-Saharan African regions, at the same time, accounted for approximately 218 million. Undernourishment indicates a severe concern in numerous regions all around the globe, and its effects range from adults, to adolescents, children and infants. In 2016, around 155 million children below five years indicated signs of stunting, while 52 million suffered from being wasted. More than half of the affected victims were located in Southern Asia (Affairs, 2017). In 2017, the amount of stunted children below the age of five added up to 151 million, while the number of wasted kids accounted for 51 million (WHO, 2018).

On the contrary, issues of obesity are pressuring rates reaching the 600 million marks, already in 2014. Obesity and overweight are specifically apparent among economically strong countries, including Oceania, New Zealand, Northern Africa, Western Asia, North America and Europe. While obesity and overweight illustrate prevalent phenomenon among adults as outcome of excessive consumption and calorie intakes over a long period of time, the number of children facing the same issues is reaching new peaks. In 2016, the amount of children being affected by obesity and overweight below the years of five, added up to around 41 million children globally (Food and Agriculture Organization of the United Nations [FAO], 2017a). In addition, approximately 213 million children and adolescents from five to 19 years were categorized as overweight in 2016, complemented by 124 million obese people. Over and above all, various parts of the world are affected by a so-called "double burden" of malnutrition, commonly affecting low-to-middle-income countries, such as Mexico, India, Egypt and Philippines, who have to deal with issues of overweight and obesity on one hand, while simultaneously carrying the burden of undernutrition and hunger, on the other hand (WHO, 2018). Individuals with signs of stunted growth, while at the same time being overweight, are accumulating in number. Nutrient-poor, but energy intensive foods illustrate the determining factor of the double burden. To make matters worse, despite several regions being tremendously influenced by different stages of malnutrition, about one third of all food produced on a global scale, in numbers around 1.3 billion tons per year, is being lost or wasted. It is becoming abundantly clear that our food systems, especially along distribution and consumption, is not functioning as it should (HLPE, 2014).

3.2 Conceptualising Sustainable Food System(s)

The way our food system has evolved is remarkable, in line with numerous innovations regarding agricultural practices, storage-, distribution- and retailing methods. Being able to feed a continuously growing population, aligned with diet improvements across the globe, has only been possible through technological enhancements. Anyhow, the constant intensification of food production methods, requiring a seemingly endless amount of earth resources has been eliding the environmental sphere for decades. The existing relationship of food systems, the environmental and the ecosystem are characterising a vicious circle. While food systems cause ecosystems instability and environmental degradation, which further result in climatic- and environmental changes, tied to unusual weather events, as well as floods, draughts, weather changes and cataclysms, what in turn, is leading to vast agricultural losses. Food systems are the major source of deforestation, biodiversity losses, as well as changes in land use. and require approximately 70 percent of global fresh water resources. Water and sea are therefore heavily affected by unsustainable patterns, exemplified by fishing practices which eradicate whole fish stocks and further damage the marine, as well as ecosystem stability. In terms of GHG the agricultural dimension takes the lion's share with crops and livestock contributing to around 15 percent of total GHG emissions, while simultaneously requiring about 70 percent of agricultural land. Once established as supplier of nutrition and energy, food nowadays indicates a booming business. While food systems, including agricultural processes, would produce enough energy to feed the whole planet, the unequal distribution, in line with unsustainable behaviour "jeopardize current and future food production and fail to nourish people adequately" (Fischer & Garnett, 2016, p. 1).

Effective food systems have been frequently limited to the dimension of food security, already emphasised within the Brundtland Report by dedicating a full chapter - "Food security: sustaining the potential" (World Commission on Environment and Development, 1987). Previous research illustrates mostly one-dimensional approaches through emphasising environmental issues, rather than sustainable ones. Sustainable food systems though are shaped by complexity and ambiguity; hence, finding an adequate definition, as well as adequate measurement tools, demonstrate a difficult undertaking. In respect, the HLPE (2014, p. 30), characterised the sustainability of food systems in terms of its "capacity to ensure the positive outcomes of a food system, food security now and for future generations". Therefore, assessments should go beyond one dimension, moreover, they should incorporate all three dimensions equally, while simultaneously enhancing the full picture by creating a more intertwined connection to the food security spheres, including availability, access, utilization and stability.

3.3 Developing Sustainable Food Systems

Food is accompanied by a tremendous power and displays the biggest employer on a global scale, specifically across economical poor regions in which food demonstrates the major share of the GDP (Chaudhary, Gustafson, & Mathys, 2018). On the other hand, effective food systems might guarantee economic security due to addressing malnutritional problems, while simultaneously keeping the environmental impacts low. In the long run, this might prevent the accelerating destabilisation process of world's resources, evident by shifting closer to the planetary boundaries (Steffen et al., 2015). Food has a unique force, underpinned by Dagfinn Hoybraten, secretary general of the Nordic countries of Ministers: "Food is not like any other political issue." Moreover, it is a representation of an individual origin, which is deeply entangled within culture and beliefs, further emphasised by Dr. Howard Frumkin at the EAT Forum 2018 in Stockholm. Culture represents an undeniable part of human beings, and so is food. Addressing current concerns regarding the food system is of great importance when aiming towards a sustainable future, especially due to food sharing an intimate relation to at least five out of the 17 SDGs, including goals number two, three, twelve, thirteen and fourteen, ranging from zero hunger, to good health and wellbeing, to responsible consumption and production, to live below water and live on land (Affairs, 2017).

3.3.1 Sustainable Food System Drivers

With the food system itself displaying a highly complex topic, heavily affected by its dynamic system relations among all involved actors and progresses, the add-on sustainability concerns are even further exacerbating the issue (Bloemhof & Soysal, 2017). As enhanced knowledge might result in more accurate and adequate actions, it might be beneficial for public policies. In line with that, the European Commission identified main drivers of the food system, such as global trends in population and affluence, volatility, availability and food prices, dietary changes, food wastage and loss, as well as changes in the supply chain (European Commission, 2016).

Emerging Global Trends

Global trends in population and affluence display main drivers of global food systems. While already in 2017, the world's population aggregated up to around 7.6 billion people, in 2030 the total number of people is expected to add up to 8.6 billion, while 2050 population estimates already account approximately 9.8 billion people. With the turn of the century, in 2100, the population estimates 11.2 billion people (UN DESA, 2017). A constantly growing population automatically leads to a higher demand for food (Rutherford & Ahlgren, 2010). However, the rapidly widening middle-class has increased the demand for special foods, in line with expectations towards more food varieties and improved food quality (Schor & Universiteit Antwerpen. Faculteit Politieke en Sociale Wetenschappen, 2002). The new consumerism shifted consumption patterns and social norms. Currently, societal food consumption is heavily animal-based, which exceeds the energy- and resource-level of plants, and hence is more resource intensive (International Center for Tropical Agriculture [CIAT], 2017).

Food Prices, Volatility and Availability

Food prices, volatility and availability are considered as drivers of the food system. Especially low-income countries are heavily affected by high food prices, due to larger income elasticities for lower income decile countries. Income elasticities refer to the change in intake on a percentage base as a result of a percentage change in income (Andrew Muhammad, Anna D'Souza, Birgit Meade, Renata Micha, & and Dariush Mozaffarian, Feburary 2017). The rising food prices are the outcome of numerous factors, including high oil prices among the years of 2008 to 2013, increasing demand for biofuels, price volatility in combination with other global trends (Dawe, Morales-Opazo, Balie, & Pierre, 2015). Current food prices are high, however, when analysing them over a period ranging from the 80s to now, peaks of food prices are evident in 2008 and 2011, the 90s and early 2000s had been marked by relatively low food prices, while the food prices of 2017 are equal with the prices of the 1980s. Overall food prices are estimated to maintain high. Meat and cereal prices are expected to decrease in real terms, while dairy products will increase within the next 10 years. Food volatility and fluctuations had been particularly apparent among 2007-08 as an immediate response to the financial crisis and reached the highest levels in 1970s when the energy and oil crisis took place. Future food prices are highly depending the question of how production methods will adapt to the scarcity of resources and the changing climate. While a changing climate might endanger the expansion of agricultural area, the arising pressure of international outlined targets, aligned with carbon-emission costs, might result in continuously inclining food prices (FAO, 2017b). With the close connection of food prices and affordability, high food prices might be highly unbeneficial for low income countries and might further endanger food security and nutrition.

Shifts in Diets

With modern food systems indicating more complexity and interconnections, novel and diverse foods are commonly incorporated into the systems to prevent seasonal shortfalls, while simultaneously enhancing consumers food choices (HLPE, 2017). With an increasing amount of people facing obesity or overweight issues, public health systems are jeopardized which in the long run might have severe implications on an economy. Growing rates of overweight and obesity are in general consequences of an energy imbalance, which might occur, on one hand, due to a lack in physical activity. Technological innovations allowed shifting away from labour intensive sectors, including farming and mining, to sectors characterised through a reduced labour intensity, like manufacturing and service. In addition, technology updated modes of transportation, leisure activities, production at home, in line with cooking, cleaning and child care. In combination with technological advances in the food system, the consumption of cheap and edible oils, highly processed foods, as well as foods with so-called empty calories, are increasing. With low- to middle-income countries more commonly converting to the “Western diet”, which is high in refined carbohydrates, fats, animal-sources foods, added sugars and salt, traditional diets rich in healthy grains, legumes, vegetables and fruits are vanishing (Popkin, Adair, & Ng, 2012). Moreover, western dietary patterns are fostering unhealthy and unsustainable patterns which increase the number of medical conditions, including type II diabetes, cancer, coronary mortality and other NCDs. Simultaneously, the eco-system health, aligned with the environmental dimension, is further pressured. (Meybeck & Gitz, 2017).

Food Wastage and Loss

High environmental and eco-system pressure is further exerted by food waste and loss. Despite one out of every sixth person being affected by undernutrition and hunger, in addition to 25 percent of all children under five years on a global scale facing chronic malnutrition (CIAT, 2017), around one third to one half of all food produced is being wasted (HLPE, 2014). According to the European Commission (2016), food loss and waste accumulates to approximately two billion tonnes worldwide. Future food waste scales are estimated to increase to around 126 million tonnes per year until 2020. While developed countries are particularly affected by food waste, frequently occurring at the retailer and consumer level, developing countries display higher rates of food losses at the farm or pre-marked stage as immediate outcome of natural disasters, droughts, poor road infrastructure, as well as lacking possibilities of refrigeration and storage facilities. With food loss and waste indicating a high contributor to the carbon footprint by being responsible for around 3.3. giga-tonnes of GHG emissions, it displays a major challenge of the 21st century. Moreover, if only one quarter of total food loss and waste would be saved, it would be sufficient to feed the world's hungry (The Economist Intelligence Unit, 2017).

Supply Chain Transitions

Supply chains are transitioning from a predominantly supply-driven system towards an increasingly demand-driven one. While the food supply chain is connected to Elkington (1998) concept of the triple bottom line, it aims towards establishing an intersection among the social, environmental and economic activities in which organisations delve into on an macroeconomic scale, while simultaneously contributing to the natural environment and societal concerns by strengthening the competitivity of firms to develop economic long-term benefits (Carter & Rogers, 2008). While a supply chain represents a product's life cycle including all processes and actors necessary to grow or create, produce, process, distribute, consume and dispose a good, each component included is required for transforming a raw material into a final product (Hawkes & Ruel, 2011; HLPE, 2017). With factors of traceability, quality and freshness becoming more important to consumers, in line with the pressure of constantly satisfying novel consumer desires, complemented by other global trends, the adequate control and regulation of a supply chain highlights a difficult undertaking (Soysal et al., 2012).

3.3.2 Sustainable Food Supply-Chains

Food supply chains display high system dynamics and complexity and are major determinants of food quality, safety and availability (Soysal et al., 2012) While food systems have the power to shape and influence processes, activities, actors and stakeholders, the agri-food sector is strongly influenced by arising global trends, such as globalisation. In 2015 already more than 60 percent of the global population has lived in cities, until now the number has already accumulated. Urbanisation increases the demand for meat, fish and dairy what in turn intensifies the carbon footprint. Climatic changes are further affecting the food supply chain by decreasing biodiversity, exemplified by 150 crops existing of which 12 contribute to 75 percent of global food production. As the practical implications lead to agricultural production outsourcing to cheaper regions, agricultural methods such as urban farming are becoming more frequently introduced. A more independent operational farming system might reduce external risks of price volatility, climatic changes and political instabilities, while simultaneously contributes to social functions. Moreover, urban farming might improve food distribution among cities by establishing short distance logistics. Specifically, with issues surrounding the current way of food distribution, heavily affecting food waste and carbon emissions, local supply chains might provide more flexibility, as well as sustainability (Bloemhof & Soysal, 2017).

According to Soysal et al. (2012, p. 137), the consciousness regarding sustainable system dynamics has increased, in line with governmental rules and regulations in terms of food safety and sustainability. By combining the intensive competitivity of the food sector to the complexity of its intrinsic food products and processes, by further merging it with sustainability, a novel concept has emerged (Soysal et al., 2012). In accordance, Carter and Rogers (2008, p. 368) have established a sustainable supply chain management, which is specified as “strategic, transparent integration and achievement of an organization’s social, environmental, and economic goals in the system coordination of key interorganizational business processes”.

However, sustainability and/or unsustainability go far beyond the apparent. While locally produced tomatoes in Sweden might seem more sustainable, the energy necessary to grow them would exceed the environmental damage caused when producing them with low energy requirements in Spain and importing them to Sweden. Similar, consuming organic food which has been transported via plane, is less environmental friendly than consuming non-organic foods. The same applies to locations and facilities with local facilities being not automatically more sustainable than outsourced facilities’ if the outsourced country might only use renewable energy for its supply chain processes. And finally, applying recyclable packaging is not equivalent with environmental friendliness when the additional energy required for transporting the packaging material to the facility exceeds the energy level necessary for non-recyclable packaging. In summary, the configurations and relations taking place in the food chain are above elementariness as each case might be unique. Therefore, certain trade-offs are crucial when targeting a more sustainable food supply chain (Wakeland et al., 2012).

3.4 Sustainable Food Value Chain

When addressing future sustainability and efficiency challenges, alternative materials, such as biomass, must be applied and transubstantiated into marketable products. Productivity rates need to be raised, while meanwhile energy supplies need to be reshaped by shifting away from resource intense methods towards a bio-based circular economy. Novel methods must be developed, which are based on converting biomass into food, feed, material and energy. Future food supply chains have to tackle resource efficiency and effectiveness within the food chain and among the supply chain networks, in addition to diminishing the environmental impact of packaging through increasing rates of recycling (Bloemhof & Soysal, 2017).

While production systems, which display the beginning of the food value chain, are decisive for food availability and affordability; the physical and economic accessibility of food is further determining the nutritional and dietary quality, as well as diversity of foods. This in turn, heavily influences the retail and market dimension, which on the other hand illustrates the end of the food value chain, and therefore is dependent and shaped by consumers, tied to their demands. Hence, the whole food value chain is surrounded by complex and dynamic interactions and relations among all parties involved. In a nutshell, the steps along the food value chain range from production, storage and distribution, processing and packaging, to the retail and markets dimension. However, each respective step along the supply chain is further entangled with other impacting factors. Therefore, the production is determined by the agricultural sector, which is aligned with the crops harvested, which is further a decisive characteristic of resilient food systems. These, in turn, are necessary due to the severe impact on agriculture and crops caused by the ongoing climatic changes, resulting in heavy natural disasters, and economic shocks. Resiliency in food systems is particularly highlighted by the CIAT (2017, p. 5), as it encapsulates the connection of environmental sustainability and food systems, and additionally refers to the stability related to the food production when being affected from climatic, environmental, economic or political shocks. However, the characteristic of resilience, is yet lacking a formal structure and concept.

With growing importance of enhancing food and nutrition security, the processing and packaging stage are essential as they are responsible for destroying toxins and foodborne microbes. Food and nutrition security further interrelates with storage and distribution, which is crucial when food is not immediately purchased or consumed. Overall, each step contributes in a different way to finalizing the product, and each decision occurring within a food value chain results in different outcomes for the involved parties (HLPE, 2017).

3.4.1 Sustainable Food Production

Janßen and Langen (2017, p. 1234) connect the terminology sustainable production to the quality of the processes when producing. The term therefore indicates a characteristic of credence, which provides cues to consumers through external stimuli, such as colour, size, price, brand name and country of origin. As cues transfer information, they might contribute to the consumers quality expectations towards a certain product. A frequently applied definition of sustainable production has been outlined by the Lowell Center for Sustainable Production (2018) by contextualising the terminology through the establishment of goods and services via systems and processes that are non-polluting, economically viable, conserve natural resources and energy, fulfil health standards towards workers, communities and consumers, while simultaneously being socially and creatively encouraging for the working people. Furthermore, sustainable production emphasises long-term success to meet the public concerns regarding the environment, aligned with a changing climate.

The Green Revolution

With the so-called Green Revolution (GR), which had been intentionally created as response to the previously outlined concerns regarding emerging trends and challenges, an increase in the productivity rate through technological spill overs across political and agro-climatic boundaries had been targeted. Shortly after incorporating innovative versions of crop germplasm within national agricultural programmes, productivity gains had been achieved. Particularly in lower income countries, a rapid increase in agricultural output was visible. As highlighted by Pingali (2012), between the years of 1960 and 2000, the yields within developing countries rose by 208 percent for wheat, 109 percent for rice, 157 percent for corn, 78 percent for potatoes, and 36 percent for cassava. With a focus placed on genetic improvements of high-yielding varieties due to time efficiencies, the crop intensity could be improved. In combination with other GR technologies, a significant shift within the food supply function resulted in decreasing food prices. Overall, the GR beneficially contributed to reduce poverty rates, as well as diminish hunger, while simultaneously prevented the conversion of thousand hectares of land into agricultural cultivation. However, unintended negative outcomes of the GR are related to the policies implemented. By concentrating more on rapid intensification of the agricultural systems, in line with increasing food supplies, the food security and nutritional issues had been commonly ignored (Pingali, 2012). Moreover, as not all farmers had been included within the GR through segregating around 15 developing countries, indicating a population over a million, the GR resulted in vast inequalities. Included farmers could increase their supplies by approximately three percent or more between the years of 1961 and 1981. The rapid growth due to intensive usage of fertilizers and irrigation expansions enabled a massive supply increase, what in turn, lowered the world food prices extensively. In 2000, the world grain prices, had been 40 percent below the prices of 1950. Consumers could profit from lower food prices, especially low-income consumers. However, farmers, which had been excluded from the GR, had been forced to lower the prices due to increasing competition, despite no benefits of improved technologies, in line with declining production costs (Evenson & Pingali, 2007). In summary, the main intention beyond the GR was based on reducing the poverty and increasing crop yield, which worked out as planned among the incorporated farmers as well as for consumers, which could benefit from lower the prices. Collateral damage, anyhow, could not be prevented, such as intense interregional disparities, aligned with severe environmental destructions (Pingali, 2012).

From Conventional to Alternative Agriculture

The agricultural sector illustrates one of the world’s biggest employers with more than one in three workers being salaried by it. Furthermore, it serves as livelihood supporter of more than 2.5 billion people among rural areas, while simultaneously contributing to social cohesion, preservations of cultural traditions and heritages. In addition, it produces approximately 23.7 million tonnes of food on a daily base, including grains, fruits, vegetables, tubers, cereals, and animal products. Moreover, the usage of water for the crop production adds up to 7.4 trillion litres, and 300.000 tonnes of fertilizers and its complete value is worth about USD 7 billion (FAO, 2017a, 2014). Conventional agricultural processes have been based on productivity boosts through technological innovations since the end of the Second World War through patterns of modernisation, mechanisation, specialisation, increased usage of chemicals, as well as governmental policies targeting a maximisation of food production. The main focus therefore has been placed on technological transfer (Tilman, Balzer, Hill, & Befort, 2011). However, with intensive pressure on the ecosystem through a continuously growing demand of food, emerging signs of climatarian changes heavily affected the yield outputs, which might only solved through technological approaches, including biotechnologies, such as genetic modified crops (Fedoroff et al., 2010).

While the GR affected only a part of the vulnerable regions the need for alternative agricultural methods has become more pressuring. Aligned with that, Shennan (2008) focuses on investigating biotic interactions within agroecosystems and how this might provide alternative agricultural production systems with increasing crop productivity levels, while simultaneously diminishing the environmental impacts. Moreover, ecosystem services, including weed, pest and disease management, as well as nutrient cycling and biodiversity conservation, in line with enhancing the understanding of the biotic interactions existing within the systems, might allow diminishing the pressure currently put on the environmental dimension (Shennan, 2008). Alternative agricultural methods are on the rise as exemplified by Petersen and Snapp (2015, p. 3) through presenting a few among the existing once, including organic and conservation agriculture, as well as agroecology, ecological and sustainable intensification, as well as sustainable framing systems. While the organic label assures certain methods of production, which further emphasis cultural, biological and mechanical practices, without endangering mechanical ones, as well as ecological balances and the conservation of biodiversity. Conservation agriculture, on the other hand, concentrates around the three principles of minimized soil disturbance, permanent soil coverage and an implementation of crop rotations. Agroecology refers to the design and management of sustainable agroecosystems, while ecological intensification applies ecological principles to design sustainable production systems, which indicate semi-closed systems through efficiently incorporating environmental inputs, without causing further harm. Moreover, sustainable intensification, concentrates on the production of more food with a reduced usage of additional land. The sustainable framing systems, in contrast, try to meet human needs, tied to food, feed and fibre through aiming towards increasing environmental quality, by reducing the amount of required resources, while concurrently sustaining the economic viability of agriculture by enhance the life quality of farmers, agricultural workers and the whole society. Currently, among the alternative agricultural methods, the sustainable intensification approach illustrates a highly discussed topic, indicated by ambiguity and dichotomy surrounding the theme. While some believe in its power to enable the necessary productivity increase, others raise voice to the drastic alteration of the agricultural system, which in turn, would further pressure the environment. However, sustainable intensification has emerged as crucial topic on the sustainable production agenda by emphasising the importance of reshaping the agricultural system of the 21st century (Petersen & Snapp, 2015).

Sustainable Agriculture

The idea of sustainable agriculture has already emerged within the Brundtland Report in 1987, aligned with the outlined concept of sustainable development (World Commission on Environment and Development, 1987). The concept of sustainable agriculture itself is based, like sustainable development, on three sustainable pillars, including environmental health, economic profitability and social and economic equity. It aims towards meeting the food and textile needs of the present, without limiting future generations to meet their own needs. In line to transitioning towards more sustainable agricultural patterns, practices contributing to social problems are emphasised through addressing the social- and environmental issues. Through applying a systematic approach, every stakeholder along the entire food system shares responsibility to act adequately. Ranging from farmers to policymakers to retailers, researchers and consumers. Each one with a unique role and an individual contribution towards a sustainable agricultural community (Feenstra, Ingels, & Campell, 2018). Sustainable agriculture represents an essential part of the sustainable development framework and is of crucial when aiming towards fulfilling the SDGs. Tied to the vision of creating "a world free form hunger and malnutrition, where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner", other attributes, such as food security, the elimination of poverty, as well as the utilisation and management of natural resources in a sustainable way, are becoming increasingly important (Food and Agriculture Organization of the United Nations (FAO) Council, 1988).

Humans are interdependent with the natural system, and are further impacted by its surrounding environment, while simultaneously demonstrating a part of it. The agricultural sphere represents the mechanism which applies natural resources, including land, water, biodiversity, forests, fish, nutrients and energy; in combination with environmental services, to create agricultural products, such as food, feed, fibre and fuel, while fulfilling the economic- and social services, such as food security, economic growth and poverty reduction, in connection to values of health and culture. Therefore, sustainable agriculture refers to a pre-condition when targeting sustainability which must be adjusted, innovated and improved continuously regarding its outlined strategies, technologies and policies, while further emphasising equality in gender and distribution. Nevertheless, sustainable agriculture still needs to achieve the necessary productivity- and production rates that would allow feeding the growing population respectively. Shifting towards sustainable agriculture requires the identification and balancing of benefits and trade-offs appearing within the system. Trade-offs take place among human and natural systems, exemplified through human's overconsumption of goods and services resulting in severe environmental damages; within both and over time due to subordinating long-term growth over short-term profits. Hence, when aiming towards the holistic picture of sustainability, synergies among livestock and crop productions might be of fundamental importance, exemplified through crops, who serve on one hand as feed for the livestock, while on the other, absorb greenhouse gases created by the livestock. Furthermore, livestock might positively accelerate the productivity of crops due to its manure, which in turn might replace the application of mineral fertilizers. However, while the theoretical conceptualisation seems to be easy, the practical approach is far beyond simplicity (FAO, 2014)

3.4.2 Sustainable Food Consumption

Food, eventually, has been places at the forefront of the sustainable transition, as the behaviour associated with the consumption of it, marks an essential role, when trying to achieve the outlined goals. Finding a balance among all dimensions, in connection to the food system and the consumption of it, is crucial (van Zanten et al., 2017). While the food chain, on one hand is affected by social, health and environmental related concerns, and reverse; the behaviour towards necessary nutrition and food, tied to dietary patterns, requires a change. Prospective dietary patterns should be healthy, while simultaneously environmental friendly and in respect with the planetary boundaries. To enable the required transition, the understanding regarding adequate diets, in accordance to the right nutrition and foods, must be enlarged. In addition, specific actions in terms of consumption need to undertake an update to allow the shift away from current unsustainable consumption patterns (Fischer & Garnett, 2016). Food consumption itself, illustrates only a part of the food system, however, with increasing demand for resource-rich foods, especially animal-sources foods, entangled with an economy behaving according to the principle of the economic equilibrium, the pressure on the supply side to put itself on par, intensifies. The elevating resource usages in turn, further pressures the environmental sphere. And while animal-based food might fulfil the required nutritional values partially; the overconsumption of it might accelerate issues of obesity, overweight, as well as chronical diseases (Garnett, 2014). Aligned with that, current patterns of consumption must shift towards more sustainability to reduce the pressure on the supply side, on one hand, while simultaneously contributing to the outlined SDGs and the overall food system, tied to the food supply chain, in which consumption illustrates an essential component.

3.5 Sustainable Food Environments

In accordance to the outlined definition of the HLPE (2017), a food environment consists of the following components, including proximity, affordability, promotion, advertising and information, as well as food quality and safety. While proximity, in line with availability and physical access, as well as affordability, tied to the economic access, are considered as the food entry points, the food environmental elements of promotion, advertising and information affects the food choices, which are further connected to convenience and desirability. The final component food quality and safety share a relationship to political, social and cultural norms and take an essential role when aiming towards a sustainable food system.

3.5.1 Food Availability

Food availability represents a dimension of food security and is determined by the amount of food produced, the stock levels, as well as the net trades (FAO, 2017b). Findiastuti, Laksono Singgih, and Anityasari (2018, p. 3) relate the terminology towards "providing food from farming activities without harming the environment". Food availability might indeed foster the transition towards sustainable diets. Sustainable diets are therefore ecosystem friendly through respecting the environment, as well as the biodiversity within it, while simultaneously providing adequate nutritional and healthy food and are furthermore aligned with the triple bottom line of sustainability by addressing the economic, environmental and social dimension, while positively contributing to the food and nutrition security issues (Burlingame, 2012, p. 83). The impact of nature on food is immense, particularly in developing regions, where smallholder farmers are depending on the harvest. With seasonality indicating the rhythm of nature, the environmental sphere, in line with agriculture and food is shaped by it (Devereux, 2009). Nature, aligned with its rhythm is therefore essentially contributing to food and nutrition (in)security and displays a decisive element of the food environment (Macdiarmid, 2014). Moreover, the availability of food is dependent on mobility attributes, in line with the distance among the food entry points, and the available modes of transportation, to health- and disability conditions, the purchasing power for buying nutritious foods, as well as the time, kitchen facilities and equipment available. Moreover, it is heavily depending on knowledge and skills, which are required to prepare and use food that is available and accessible within the food environment. As Herforth and Ahmed (2015) point out, food availability is sharing a bi-directional relationship to food consumption, as only food that is available can be consumed. Hence, when aiming towards sustainable food systems the reshaping of food environments is crucial in order to allow providing healthy and nutritious food, aligned with a sustainable diet, which is beneficiary for people and planetary health.

3.5.2 Food Affordability

With the relation of food accessibility and prices, it is further entangled with the nature and its natural rhythm. Devereux (2009) highlights the connectivity of food affordability with nature by pointing out the dependency of price on seasonality, which vastly affects food and nutrition security, especially among vulnerable regions. Smallholder farmers within numerous developing regions are livelihood reliant on single rainy seasons as the rain determines the quality and duration of their harvest. Hence, if enough rain is given, the harvests will provide enough grain for the upcoming year; while less or irregular rain will result in a scarcity of grain, what in turn, causes food prices to increase earlier and sharper. Therefore, the food prices are shaped by seasonality. While grain prices are at the bottom immediately after the harvest, due to supply exceeding demand; high prices are appearing when grain is becoming relatively scarce, shortly before the next harvest period would begin. With poorer households having less purchasing power, the price elasticity regarding food is lower in contrast to households with more financial capital. Consequently, seasonality, food prices and malnutrition are interrelated, evident in statistical evaluations of African regions regarding grain and millet prices and the rates of malnutrition. High food prices due to grain, corn, millet and other harvest foods being out of season increase the rate of malnourished children (Devereux, 2009).

In general, an average American household requires about 6.4 percent of the available budget for food, while the households among the poorest 20 percent, spends approximately 35 percent on food (United States Department of Agriculture, The Economic Research Service [USDA ERS], 2016). Determining adequate prices is a complex undertaking as the price is affecting numerous stakeholders. While consumers might benefit from lower prices, the environmental consequences might be unfavourable due to a higher amount of food waste occurring. In addition, low priced foods might be traced back to low production and processing costs, which again intensifies environmental pressure. Low cost practices, furthermore, depend on low wages and incomes for producers, employees and workers, which is unfavourable on the social level by creating inequalities. Hence, when aiming towards a sustainable food system transition through promoting sustainable diets, the price is pivotal (Meybeck & Gitz, 2017).

3.5.3 Promotion, Advertisement and Information

The promotional dimension, aligned with marketing campaigns, enforces great power and, in the long run, might shape consumer preferences towards more sustainability. Aligned with that, various governmental and non-governmental organisations are increasingly introducing food-based dietary guidelines, as well as nutrition and food labels on food products, as well as on menus in restaurants (HLPE, 2017). In accordance, the European Union established regulation no 1169/2011, which obliges to label, present and advertise foodstuffs, while simultaneously providing nutritional labelling for foodstuffs. The regulation was introduced in December 2014 and has been under application from December 2016 onwards. Regulation 1169/2011 assures a comprehensive and clear labelling of allergens, including soy, nuts, gluten, lactose listed among the ingredients for prepacked foods. In addition, it obliges restaurants and cafes, as well as any other location offering non-prepacked food, to display and inform about the possible allergies within the foods. Furthermore, it requests more specific labels and information regarding the origins of meat products, such as pigs, sheep, goats and poultry, regardless to the place of consumption (i.A. supermarket, butcher, online). Moreover, it expects to list all engineered nanomaterials among the ingredients, while specifically pointing out the vegetable origin of refined oils and fats (Regulation (EU) No 1168/2011, 2014). The regulation 1169/2011 had been complemented by two additional documents (Commission Notice on the application of the principle of quantitative ingredients declaration; Notice on the provision of information on substances or products causing allergies or intolerances, 2017).

Food- and Nutrition Guidelines

Food- and nutrition guidelines might provide another helpful tool to support societies transition towards more healthy and sustainable food. Dietary guidelines serve as nutrient informant by displaying outlined recommendations in a simplified version through symbols and easy applicable language. By informing consumers on frequently consumed foods, adequate portion sizes and behaviour when consuming, they can further display a base for public policies and school educational programmes; or be applied as public media campaigns. Currently, approximately 80 percent of WHO member states have already implemented dietary guidelines, while 42 percent incorporated nutrient-based dietary guidelines. Simultaneously, a majority of WHO country members promote healthier diets via awareness raising campaigns shown on the television. The campaigns frequently praise a higher fruit and vegetable intake and point out the health risks when overconsuming fats, sugars, salt and sodium. Some campaigns educate consumers regarding nutritional labels in terms of how to accurately interpret them, as well as how to control portion size (World Health Organisation (WHO) Europe, 2018). Dietary- and nutritional guidelines are commonly established on a national, poly-national or multinational level, exemplified by the number of different approaches existing.

The Belgian government, in collaboration with the Flemish Institute Healthy Living (2017), established two new models, the physical activity triangle and the food triangle, which demonstrate a complete revision of the Activity Food Guide Pyramid, which had been introduced in 1997. It had been developed according to extensive research conducted and guides people towards consuming healthier, more nutritious and sustainable food. Aligned with that, it encourages towards increasing plant-based meals on a daily base, while simultaneously tries to prevent people from over consuming ultra-processed foods. Additionally, the Activity Food Guide Pyramid points out the unnecessary overconsumption of food, in line with avoiding unnecessary food waste and loss on extensive scales. The triangle itself is divided into categories, illustrated by different colours with dark green representing plant-based foods which beneficially contribute to human health, light green which displays foods on an animal base with a favourable or neutral effect on human health, such as fish, yoghurt, milk, cheese, poultry and eggs, while orange represents foods from plants, as well as animals with severe unfavourable effects on human health, particularly when consumed in large amounts. The red category indicates highly processed foods consisting of a vast amount of sugar, fat and salt. Its consumption is recommended only in small portions. Regarding the beverage intake, the food triangle emphasis water as main beverage consumed on a daily base (Flemish Institute Healthy Living, 2017). Other food dietary guidelines are demonstrated by the Dutch “wheel of five”, the “Nordic Diet”, targeting Norway, Denmark, Sweden, Finland and Iceland; as well as the “Mediterranean Diet”. The “wheel of five” serves as national food-based dietary guideline combining health with sustainability, which has been launched in 2017 as awareness raising campaign, promoted through social media platforms by emphasising the cruciality of nutritional intakes, including legumes, whole-grain products, nuts and fruits. Through educating consumers by elaborating them the difference among legumes and vegetables, while simultaneously highlighting the importance of incorporating whole grains more frequent, emerging issues of sustainability, food safety and food temptations, in line with food choices are addressed. Sustainable and healthy food guidelines have been prioritised in Denmark through the “Gastro 2025” project, which aims towards establishing a gastronomic hub. Partly related to promoting the country as aspired touristic destination, while concurrently reshaping society towards more sustainable patterns (Halloran, Fischer-Møller, Persson, & Skylare, 2018).

More multi-national approaches are illustrated by “The Nordic Solution Menu” and the “Mediterranean Diet”. The Nordic Solution Menu represents a Nordic guide, incorporating Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Aland, that promotes sustainable food policies by targeting a contemporary food culture and identity. Through aligning the newest science and research to allow developing common guidelines which provide the adequate intake of energy and nutrients, the Nordic Solution Menu should enable unlimited growth, development, functions and health throughout all live stages (Halloran et al., 2018). The Menu has been established in accordance to the Nordic Nutrition Recommendations (NNR), which illustrate guidelines for dietary compositions and recommendations of nutritional intakes (Nordic Council of Ministers, 2014). Inspired by the NNR, novel campaigns and guidelines have been established and introduced among the Nordic countries over the previous years. The New Nordic Food Movement exemplifies one these novel approaches by promoting factors of locality, seasonality, organically and non-genetically manipulated foods (Orava, 2018).

Food recommendations and/or dietary guidelines are apparent the Mediterranean countries as well, like the Food Wheel in Portugal, which represents a guideline consisting of seven food groups, such as fats and oils, milk and dairy, meat, fish, seafood, eggs, pulses, potato, cereal and cereal products, vegetables and fruits (FAO). In France, the “Guides nutritions du Programme national nutrition santé (PNNS)” has been introduced in 2011 and had been launched in 2016. Again, it promotes local foods entangled with the French culture and emphasis the intake of fruits and legumes, calcium-rich foods, lean animal proteins, including white meats, fish, dairy and eggs, as well as whole grains, while furthermore highlighting adequate portion sizes and mindful consumption (Ancellin, 2002). Overall, among most Mediterranean countries, dietary food guidelines are established around traditional Mediterranean foods, frequently displayed in the so-called Mediterranean Diet Pyramid, which serves as guideline towards a healthy way of nutrition. The base of the dietary pyramid illustrates general positive contributors, such as physical activity, emotional balances through mindful eating, consuming and preparing, aligned with healthy cooking techniques and the adequate amount of water intake per day. The second level focuses on valuable and nutritious foods that should be consumed on a daily base within appropriate moderation. Emphasis is placed on localism, in line with culture, territory, customs and traditions. The Mediterranean food pyramid, again, recommends nutrition based on whole grain products, fruits, seasonal vegetables, and so further. Foods and beverages illustrated in the top level, such as red and processed meats, spreadable fats, sugar and sugary products, high amount of salts, ultra-processed foods, as well as industry made pastries, cakes, ice cream, confectionaries and alcohol, should be consumed in moderation (Aranceta Bartrina, 2016). While food and dietary guidelines and recommendations have been developed in various countries, the Mediterranean diet has been particularly highlighted due to its incorporation within the Food Sustainability Index (Barilla Center for Food & Nutrition [BCFN], 2018). While the traditional Mediterranean diet has been shaped by a long historical process ongoing for more than 5000 years, the terminology itself refers to commonalities regarding existing foods and nutrition among the Mediterranean regions. Based on values of localism, connected to the environmental sphere through seasonality; the economic dimension through supporting local farmers and producers, and the social sphere by emphasising the role of culture, customs and tradition when consuming food; in line with being considered as healthy and nutritious; promoted the Mediterranean diet as new sustainable diet (Dernini & Berry, 2015).

Sustainable Labelling and Certifications

While guidelines might provide the necessary information as well as recommendation for the public, complementary tools, such as labelling systems are required as well (Gomez, Werle, & Corneille, 2017). Public organizations particularly rely the promising role of labels, as they provide consumers with necessary information regarding their purchases. Food labels might help achieving public health objectives due to widening the consumers' knowledge in terms of the content of the product consumed. In combination with statements linking food, food components or the nutritional information of a product towards a desired stage of health, so-called health claims, might further tackle the outlined goals. Nutritional labelling and health claims, on an international scale are specified within the Codex Alimentarius, which displays a set of international standards, guidelines and texts regarding food products (Hawkes, 2004). With a growing application of food labels, various forms of labels have been established among several areas. Environmental and social labels are frequently limited to the production process, while certifications, on the other hand, represent either a product or a process, and find its application more in international settings when a direct relation among producers and consumers is missing. The most frequently applied social- and environmental are organic, fair-trade, and rainforest alliance labels. While the organic labels refer to the production method applied and aim towards enhancing the agro-ecosystem health of a farm, fair trade labels focus on key characteristics of equality, transparency, dialogue and respect, while simultaneously aiming towards improving trading and working conditions. The most recognised fair-trade labels display the German FLO, which consists of 20 labelling NGOs, the France Ecocert and the Swiss IMO, as well as various other alternative organisations such as GEPA, Oxfam VW and Alter Trade Group. Meanwhile, the Rainforest Alliance displays a founding member of the Sustainable Agricultural Network (SAN) which consists of numerous NGOs that target the conservation and development of the environment (Albert, 2010). The rising importance of eco-labels, in line with sustainability labels, which are commonly applied in the food area, is apparent through adding up to 463 existing eco-labels within 199 countries (Ecolabel Index).

3.5.4 Food Quality and Safety

Through global trends emphasising healthier, more nutritious and sustainable foods, the consumption of fruits and vegetables has gained in numbers. Aligned with various food- and nutritional guidelines established by public actors, as well as governments, specifically promoting an increasing intake of fruits, vegetables and legumes, food quality and safety concerns are growing concurrently. While these foods provide necessary nutrients, therefore contribute beneficially to human health, on one hand, they additionally indicate the major driver of foodborne illnesses (HLPE, 2017). Consumers nowadays are demanding more transparency regarding the food they consume. Hence, information regarding the ingredients, the origin of the food, the nutritional- and health effects, as well as the environmental impact are becoming more valuable (Kasriel-Alexander, 2015) While food quality and safety issues emerge along the whole food supply chain ranging from farm to fork and therefore concern all stakeholders involved (Grace, 2017), they heavily determine the food choices made by consumers, due to its relation to desirability and/or acceptability. Hence, adequate standards and control indicators are required to assure the quality of the food products, either based on its nutritional value, or on its way of production, such as organic, biological, without GMOs (HLPE, 2017).

In line with "novel processing technologies", enabling fresher, more natural, as well as less processed foods, higher safety standards and more environmental- and sustainable processes are shaped (Koutchma & Keener, 2015). However, due to foodborne diseases, connected to limited quality- and safety standards, mostly occurring in developing countries (Grace, 2017), more focus is placed on decreasing the costs of existing technologies to create more affordable and accessible solutions for developing countries. Due to the essentiality aligned with this topic, numerous policies and programmes have been established over the years, exemplified through improving food safety issues of mobile food vendors by creating specific licences regarding hygiene standards in Oakland (USA), as well as in Abidjan (Cote d' Ivoire). In Bangladesh, on the other hand, emphasis was put on traceability by establishing a common food traceability platform, which is mandatory for restaurants and food shops. Food security issues, in line with food safety and quality have also been tackled in the Brazilian city of Belo Horizonte, the African city Nairobi, as well as in the Dutch city Amsterdam and various other Canadian and United States cities, such as Detroit (International Panel of Experts on Sustainable Food Systems [IPES], 2017). In Europe, food safety and quality issues are frequently regulated through the European Food Safety Authority (EFSA), which has been established as independent organisation, which provides scientific based advices and risk communication to improve the credibility of the European food supply internally and externally (Geslain-Lanéelle, 2008). In summary, when aiming towards improving food quality and security issues, it is crucial to enhance food traceability and accountability by creating common food policies, as well as safety rules, which in turn, might allow creating stronger ties among consumers and producers, as well as increase food safety and quality, to enable the transition towards sustainable food systems (HLPE, 2017).

3.6 Assessment of Sustainable Food Systems

Food systems are decisive for the economic security of its involved stakeholders and actors, and simultaneously try to feed a continuously growing population. Sustainable food systems are not excluded from these tasks. However, they additionally must deal with emerging issues of malnutrition, as well as environmental concerns to keep a steady performance, while staying within the planetary boundaries. Transitioning towards a sustainable food system indicates a complex and difficult undertaking, and is heavily depending on national, as well as international pathways and policies.

3.6.1 Sustainable Food System Metrics

Numerous frameworks and tools to assess certain dimensions of sustainability have been established over the years, including the sustainable assessment of food and agricultural systems (SAFA). SAFA illustrates a global framework, developed by the FAO (2013), which evaluates the sustainability degree along the food and agricultural value chains. Through its international recognition as sustainability reference by including trade-offs, as well as synergies among all dimensions, it provides a tool to all stakeholders and actors involved in the food value chain. Overall, the SAFA guidelines allow assessing 21 topics addressing sustainability through 58 sub-themes. To enable an accurate measurement and tracking of sustainable progress made, 118 indicators have been established on a macro-level, exemplified by default indicators ranging from governmental themes, such as stakeholder engagement and sustainable management plans to environmental concerns, tied to water, land, biodiversity, material and energy issues, as well as animal welfare to the economic dimension represented by investments, and vulnerability, as well as metrics addressing the social wellbeing, including livelihoods, labour rights, equity and cultural diversity (FAO, 2013). However, despite a relatively comprehensive establishment of default sustainability indicators, customised indicators are required to evaluate the performance of intermediates more precisely. Adequate measurement and assessment is necessary for evaluating and tracking a progress. The selection of appropriate indicators to do so identifies a crucial undertaking when aiming for a successful transition towards sustainable food systems. Profound and comprehensive research in terms of sustainable food system(s) are lacking, mostly due to utilising linear or one-dimensional approaches, rather than focusing on the triple-bottom line and/or applying multi-dimensional approaches.

However, as literature tries to improve on a continuous base, the topic has been recently incorporated in multi-dimensional research to achieve more comprehensive and profound outcomes. Chaudhary et al. (2018) applied 25 indicators through seven dimensions for assessing the sustainability degree of a food system, aligned with food safety, sociocultural wellbeing, ecosystem stability, resilience, food nutrient adequacy, as well as food loss and waste, in line with a coherent set of indicators and data retrieved from existing indices and/or international organisations, such as FAO, WHO, WB and so further. Another extensive investigation was conducted by Gustafson et al. (2016) by establishing six metrics to investigate the food system, aligned with the food system security, including food nutrient adequacy, ecosystem stability, food affordability and availability, sociocultural wellbeing, food safety, resilience, as well as waste and loss reduction. For instance, to analyse the global foodborne illnesses indicators of major foodborne diseases, mortality, morbidity and disability-adjusted life years have been selected. The food safety dimension was assessed in dependency on the food security index, nutrient adequacy included the Nutrient Balance Score which ranks the national average intake of 25 selected food nutrients on a daily base and further compares it to daily recommendation values. Further, the Disqualifying Nutrient Score, based on similar functions had been included which measures the intake scale of four public health-sensitive food nutrients, such as sugar, cholesterol, saturated fat and total fats, and compares them to the maximal reference values recommended by each country. For the ecosystem dimension, selected indicators were based on the per capita carbon- and water footprint, the land- and biodiversity footprint, the gross domestic product to further investigate affordability. The study, conducted by Chaudhary et al. (2018) illustrate one of the most comprehensive and profound food system research, done so far (Chaudhary et al., 2018).

3.6.2 Sustainable Food System Indices

In 2013, already 106 countries have incorporated strategies regarding sustainable development within their national boundaries, complemented by approximately 120 voluntary sustainability standards, eco-labels, audit protocols, as well as codes of conduct, in addition to hundreds of frameworks and approaches created by international organisations, governments, civil societies, corporations and universities, the terminology and theme of sustainability is thriving. In line, adequate tools and quantification methods, including indicators and assessment metrics have been established and introduced within the growing research field. Indices, commonly referred to as composite indicators, are frequently applied in governmental settings by public policy makers as they enable illustrating complex topics in a more comprehensive and applicable manner. While composite indicators facilitate the investigation of complex systems, which might enhance the understanding of the topic by making it more perspicuous, they are aligned with certain disadvantages, as well. The simplification of complex dynamics might convey misleading messages, which further might result in policies implemented that do not match the real-world setting. However, in decision making settings, indices display popular tools, as they allow comparability, which is necessary for deriving outcomes and are pre-requisites in the process of policy creations (Thomas, Hombres, Casubolo, Kayitakire, & Saisana, 2017). In accordance, numerous stakeholders involved in the food system, including various organisations, governmental as well as non-governmental agencies, enterprises and businesses are aiming towards more effective and efficient food systems through shifting from quantity to quality, as pinpointed by Chung, Ichimura, Rankine, and Leost (2013).

In line, The Economist Intelligence Unit and BCFN has launched a novel assessment tool to investigate the sustainability of food systems. The so-called Food Sustainability Index (FSI) illustrates a mixed method approach through incorporating qualitative measures, as well as quantitative ones, and analyses the sustainability of the food system through three dimensions, including sustainable agriculture, nutritional challenges and food loss and waste. The FSI particularly aims towards setting a benchmark for sustainable food systems through allowing a comprehensive assessment over geographical coverage and time. While the first edition, published in 2016, assessed the food system sustainability of 25 countries, the follow-up 2017 version, already evaluated 34 countries. The FSI characterises a relatively comprehensive measurement tool as the three included pillars are further categorised among eight disciplines, which are scaled by 35 indicators The sustainable agriculture dimension is measured by the available water resources through indicators including water scarcity, sustainability of water withdrawal, trade impact; complemented by land resources, in line with land use, land ownership, agricultural subsidies, animal welfare policy indicators; as well as air, in line with the GHG emissions, measured by climate change mitigation and environmental impact of agriculture on the atmosphere. Nutritional challenges incorporate the life quality, life expectancy and dietary patterns aligned with the food system of the respective countries with indicators, including micronutrient deficiencies, prevalence of malnourishment, health life expectancy, impact on health, diet compositions, number of people per past food restaurant, and multiple others. The dimension of food loss and waste is clustered into food loss and end-user water by indicators of policy response to food loss, solutions to distribution-level loss, food waste at end-user level and policy response to food waste (BCFN, 2018).

Other composite indicators illustrate the Global Food Security Index (GFSI), which has been established by The Economist Intelligence Unit, and was first introduced in 2012. The GFSI investigates countries’ food security among 113 countries through the dimensions of affordability, availability and quality and safety. In 2017, the dimension of natural resources and resilience has been added to the construct. Like the FSI, the index utilises a mixed methods approach through qualitative and quantitative assessments and aims towards providing a benchmark regarding food security issues. The GFSI displays another comprehensive measurement tool by investigating beyond the obvious. Hence, rather than just assessing the state of hunger, the contributing factors towards food insecurity are analysed. In addition, the novel dimension of resilience, closely measures the intensity of a country’s exposure to the changing climate, in line with the vulnerability of its natural resources (The Economist Intelligence Unit; Thomas et al., 2017). Another comprehensive measurement tool is displayed by the Environmental Performance Index (EPI), which has been established by the Yale University. The EPI emerged as follow-up version of the Environmental Sustainability Index (ESI), which has been in application during the years of 1999 and 2005. As the ESI, like the FSI, analysed the environmental sustainability through relativizing the outcome to other countries, the EPI utilises an outcome-oriented approach to achieve higher levels of applicability for policy makers, advocates and other stakeholders (Yale University, 2018). The EPI assesses the environmental health and ecosystem vitality of 180 countries among 24 performance indicators across ten categories regarding the proximity of outlined environmental policy goals. Furthermore it emphasises best practices and further promotes the required sustainability shift (Hsu et al., 2016; Yale University, 2018).

Further sustainable measurement tools indicate the Happy Planet Index (HPI) by assessing the sustainable wellbeing of countries through four elements, including wellbeing, life expectancy, inequalities of outcome and the ecological footprint. While the wellbeing investigates the satisfaction of the residents located in the country on a scale from zero to ten, the life expectancy measures the average number of years a person is expected to live. The inequality of outcomes incorporates the inequalities among people within a country regarding the life expectancy and the wellbeing, and serves as adjustment factor, while the ecological footprint investigates the individual residents impact on the environment of a country. The index has been established by the New Economist Foundation (NEF) in 2006 and includes, by today, 140 countries (Jeffrey & Wheatley, Hanna, Abdallah, Saamah, 2016). Over the years various other tools and indices have been established, aligned with different targets, such as the Sustainability Compass, which aims towards establishing a common understanding of sustainability. In line with the four directions – North, East, South and West – the N in the Sustainability compass refers to the nature, while the E represents the economy, the S stands for society and the W for wellbeing. The Sustainability Compass functions as instrument that elaborates the topic of sustainability in a more simplified style and indicates a useful navigation of the sustainable development goals (AtKisson).

4 Methodology

The purpose of this research is to investigate the degree of sustainability among the selected countries' food systems by assessing identified categories and dimensions of sustainable food systems through suitable indicators.

4.1 Research Method

The first chapter of this project outlines the theoretical foundations of the main research topics, including sustainability, food system(s), as well as sustainable food system(s). In line with reaching the outlined planetary boundaries (i.A. to Rockström et al., 2009) by intensified pressure placed on the environmental sphere, including its resources, tied to ongoing trends of urbanisation, globalisation and modernisation, complemented by the contentious growth in population, the literature emphasises the importance of transitioning towards sustainable food system(s). The conceptualisation of sustainable food systems, aligned with its elements, actors, processes and activities involved is realized in the second part through a detailed emphasises and inauguration of the theme. The in-depth contextualisation of the topics in research is complemented by a methodological approach, which is outlined in the third chapter. Through the application of a modified sustainable composite indicator – Sustainable Food System Index (SFSI) – the sustainability degree of selected countries' food systems is assessed, illustrated in the fourth chapter, while the fifth chapter discusses the key findings of the composite indicator. The study is finalised within the sixth chapter through summarising the main findings, complemented by pointing out the limitations of the study and future research suggestions.

The main purpose of this research is to examine the sustainability degree of selected countries' food systems. Following the literature, specifically Gustafson et al. (2016) and Chaudhary et al. (2018), in combination with existing indicators, representative sustainable food system indicators could be identified which are further utilised through a composite indicator. The composite indicator is applied as measurement tool to determine the food system sustainability across three outlined categories. The outcomes of the study should provide insights into the sustainability degree of selected countries' food systems among the three categories of food security, resilience and ecosystem stability as well as sociocultural wellbeing. Economically strong countries are expected to reach relatively beneficial scores among the dimensions of food security and resilience, while economically weak and vulnerable countries might face food security issues, especially in terms of distribution, as well as food quality and safety. However, expected outcomes might differ due to the strong impact of the sociocultural dimension. Overall, the research outcomes should provide a benchmark regarding the food system sustainability among the three selected categories across performing countries.

Selecting a composite indicator as assessment tool offers some advantages, specifically when trying to assess highly dynamic and complex processes. First, they allow a mixed methods approach by combining qualitative assessment methods with quantitative, statistically gained data. Secondly, they enable a comprehensive and profound investigation of the food system in an empirical setting. Composite indicators further present a convenient tool for summarising complex and multidimensional realities, which might support decision makers in terms of policy establishments. Simplifying complex concepts further enhances the accessibility and applicability of the research setting, by allowing a comparison of each country's progress among certain dimensions and indicators, geographically, as well as over time (Thomas et al., 2017). Due to the limitations in data, specifically regarding food loss in previous years, this research compares only across geographic regions.

4.2 Sample

A composite indicator approach is used by introducing the Sustainable Food System Index (SFSI), which investigates food systems sustainability across the categories of food security, resilience and ecosystem stability, as well as sociocultural wellbeing. The key categories further consist of underlying dimensions, which are complemented by specific indicators, as well as sub-indicators. The selected categories represent crucial attributes of sustainable food systems as they consider the triple bottom line by addressing economic, environmental, as well as social issues. The choice of countries must be sufficient in order for the analysis to be meaningful. With the aim to cover a wide geographical area, countries from all continents, except Antarctica have been included. In addition, to fulfil the criteria of including income diversity selected economies range from high- to middle- to low-income countries. Moreover, they reflect approximately two thirds of the global population and generate around 85 percent of the world GDP. Furthermore, regional comparisons are provided, exemplified through countries based around the Mediterranean. As existing data regarding the selected categories and dimensions are a prerequisite of a composite index, missing data values was an impediment for some nations. The final selected countries for this research are displayed in the following Table 1 and arranged by geographic location.

Table 1
Selection of Countries (in accordance to The Economist Intelligence Unit & BCFN)

Africa	Ethiopia, Morocco, Nigeria, South Africa, Tunisia
Asia Pacific	Australia, China, India, Indonesia, Japan, South Korea
Europe	France, Germany, Greece, Hungary, Italy, Portugal, Russia, Spain, Sweden, Turkey, United Kingdom
South America and Caribbean	Argentina, Brazil, Columbia
Middle East	Egypt, Jordan, Israel, Saudi Arabia, United Arab Emirates
North America	Canada, Mexico, United States

4.3 Research Design and Index

The Sustainable Food System Index assesses three categories among nine dimensions, through 39 indicators, 65 sub-indicators and 38 sub-sub-indicators. Each dimension and indicator, including sub-indicator receives a weight, which allows the calculation of overall categorical value. For computing the overall value each of the three categories receives equal importance in weight.

The process beyond selecting adequate sustainable indicators to establish a comprehensive index is depending on addressing and fulfilling specified key requirements. Next to sharing a rigorous connection to the sustainability definition (Pezzey, 1992), the indicators need to be meaningful and representative among holistic fields. Hence, they are expected to be scientifically sound, sensitive to changes and measure the intended outcomes (Custance & Hillier, 1998), while simultaneously being unambiguous regarding selected units of measurement and variables (Welsch, 2005). To enable the quantification, the selected indicators need to meet the criteria of reliability, availability and measurability (Barrios & Komoto, 2006; Ramachandran, 2000). In addition, chosen indicators need to be process oriented, while simultaneously allowing the derivation of political objectives (Etsy, Garanoff, Ruth, & Camera, 2002). Finally, indicators are expected to be adequately normalised, aggregated, as well as weighted. In summary, normalisation allows comparing variables with each other, the weighting specifies proper interrelationships, while the aggregation via arithmetic or geometric mean creates proper functional relationships (Böhringer & Jochem, 2007). A similar procedure must be conducted when choosing adequate weights for the included dimensions and indicators, including the sub-indicators. As the choice beyond the weight selection is depending on the outlined set of objectives, in other words, is affected by subjectivity, concerns regarding the reflexivity might arise (Nardo, Saisana, Saltelli, & Tarantola, 2005).

A composite indicator reduces the complexity associated with the concept of Sustainable Food Systems and makes it easier to perceive and understand (Barrios & Komoto, 2006). The SFSI is scaled from zero to 100, with 100 indicating the maximum. Consequently, a higher index value is representative of a food system that has already started transitioning towards more sustainable patterns.

4.4 Measures and Variables

The methodological approach of this study is based on secondary data derived from existing indices and further integrated into a composite indicator consisting of three main categories. While the first category assesses the food security of a country, the second one targets the resilience and ecosystem stability, while the third one measures the sociocultural wellbeing.

4.4.1 Food Security

To assess the food security within the selected countries a modified version of the global food security index (The Economist Intelligence Unit) is applied. The food security category analyses the possibility of human beings to access healthy and nutritious food physically, socially and economically at all times in order to meet the nutritional limits required for a healthy and active life (Thomas et al., 2017). The food security within this study is investigated, in accordance to the GFSI, by the three dimensions of affordability, availability, as well as food quality and safety. The indicators chosen for the dimension of affordability are in line with those of the GFSI construct and include six indicators, ranging from food consumption as share of household expenditure, a national measure that takes the percentage of total household expenditure into account, to the proportion of population living under the poverty line, derived from the WB statistics, to GDP per capita and the agricultural import tariffs. The final indicators of the affordability dimension assess the presence of food safety net programmes, as well as the access to financing for farmers. Data for the last two indicators is originally retrieved through qualitative assessment on a scale from zero to four.

The second dimension of the food security category indicates availability, which investigates the sufficiency in terms of national food supply, as well as the supply disruption risk (The Economist Intelligence Unit). Availability further demonstrates the physical access to food which depends on the infrastructure and the surroundings of the food system (Devereux, 2009). The measurement of availability includes sufficiency of supply, public expenditure on R&D, agricultural infrastructure, volatility of agricultural production, political stability risk, corruption, urban absorption capacity, which refers to the ratio of a country’s real GDP growth rate and its urban growth rate and measures the country’s resources to handle the costs of urbanisation (Thomas et al., 2017) and food loss. While the terms food loss and waste are frequently interchangeably used, food loss addresses the pre-consumption loss, mainly due to supply chain inefficiencies, while food waste takes place at the retail or post-consumption stage (Hudson & Messa, 2017). The indicators have been chosen from the GFSI except for the food loss indicator, which consists of five sub-indicators – food lost as percentage of country's total food production, the ratio of total waste and total domestic supply quantity, the quality of policies to address food loss, as well as the road infrastructure quality and last but not least, the investments in transport with private transportation, all retrieved from the FSI, in line with the FAO. The sufficiency of supply is measured by two sub-indicators, displayed by the average food supply stated in calories per capita per day, and the dependence on chronic food aid, which utilises a qualitative approach based on a scale ranging from zero to two. The agricultural infrastructure is investigated by the sub-indicators of road- and port infrastructure, as well as existence of adequate crop storage facilities of which all are based on a qualitative assessment procedure. Additional indicators demonstrate the volatility of agricultural production through standard deviations, the political stability risk zero to 100, the level of corruption ranging from zero to four, as well as the urban absorption capacity which takes the GDP percentage real change.

The quality and safety dimension displays the final component of the food security category and assesses the nutritional quality and variety of a country's food intake (The Economist Intelligence Unit). Food quality and safety is a crucial element of food security and is of major importance, especially in developing countries due to the severe impact of foodborne illnesses (HLPE, 2017). Food safety therefore is commonly measured through outlined reference values within standards and controls (Grace, 2017). This dimension is assessed through indicators of diet diversification, nutritional standards including national dietary guidelines, national nutrition plans, nutrition monitoring and surveillance, micronutrient availability, in line with dietary availability of vitamin A, animal iron and vegetal iron, as well as protein quality. Food safety includes the existence of agencies to ensure safety and health of food, the percentage of population with access to potable water and the presence of a formal grocery sector. All indicators for the food security and quality dimension are chosen in dependence on the GFSI (The Economist Intelligence Unit).

4.4.2 Ecosystem Stability & Resilience

The second category of the SFSI is represented by ecosystem stability and resilience, which mark essential characteristics of a sustainable food system (Notre Dame Global Adaption Initiative, 2016). The category of resilience analyses the country's exposure to climate change, aligned with arising risks for fragile natural resources, including water, land and oceans. Resilience further addresses a country's response towards outlined risk in terms of adapting to it (The Economist Intelligence Unit). The dimensions within the category stem from the Global Food Security Index and range from exposure, measured through climatic changes, such as temperature rise, drought, flooding, storm severity, sea level rise, and commitment to managing exposure; to water, incorporating the agricultural water risk in quantity and quality; as well as land and oceans, respectively assessing soil erosion, grassland and forest change, in line with the eutrophication and hypoxia, further complemented by the marine biodiversity and the marine protected areas. Additionally, sensitivity is measured through indicators of food import dependency, as well as natural capital dependency, the country's strategy for disaster risk management, followed by the dimensions of adaptive capacity which investigates early warning measures and manages the national agricultural risk. The demographic stresses are assessed through indicators of population growth, tied to the degree of urbanisation.

The ecosystem stability analyses the overall state of a country's ecosystem through three dimensions of environmental health, ecosystem vitality and agriculture. The first two dimensions stem from the EPI (Yale University, 2018), while the indicators measuring agriculture have been retrieved from the FSI. The dimension of environmental health measures the environmental threats towards human health with air-quality indicators by assessing the household solid fuels, as well as the PM 2.5 Exposure and the PM 2.5 Exceedance. The water and sanitation indicator report the state of sanitation and drinkable water of a country, while the impact of heavy metals is measured through the sub-indicator of lead exposure. Ecosystem vitality, on the other hand, investigates a country's natural resource existence, as well as its ecosystem services. Ecosystems are captured within the vicious circle of food systems, ecosystems and the environment (Garnett, 2014). Thus, it illustrates an essential dimension when aiming towards a sustainable food system transition. Again, indicators and sub-indicators are derived from the EPI (Yale University, 2018) and include biodiversity and habitat, measuring marine protected areas, biome protection on a national and global level as percentage of the exclusive economic zone (EEZ), the species protection, as well as their representativeness, in line with the species habitat. For measuring the ecosystem vitality further indicators focus on the state of forests by assessing tree cover loss, as well as the state of fisheries through fish stock status, in line with the regional marine trophic index. A further indicator displays the CO2 emissions in total, as well as in power, the methane discharge, the N2O emissions, as well as the black carbon emissions. Additional indicators are represented by air pollution, water resources and agriculture.

4.4.3 Agriculture

The third dimension of ecosystem stability and resilience investigates the agricultural condition of a country since this is crucial for healthy and effective food systems. Moreover, agriculture is one of the biggest GHG emitters on global scale (Garnett, 2014). The dimensions and indicators chosen for measuring the agricultural condition of a country are based on the FSI (The Economist Intelligence Unit & BCFN) and incorporate the water footprint, agricultural water withdrawals as percentage of total renewable water resources and monthly water scarcity. The agricultural condition is further investigated through the land and the environmental impact of agriculture on land by utilising nitrogen efficiency ratios, agricultural land losses per year as cause of desertification and pollution and the average carbon content of soil. The dimension of land is assessed by sub-indicators of land use, which include arable land under organic agriculture, utilised agricultural land and the existence of sustainable urban farming initiatives. Further indicators of land investigate the impact of animal feed and biofuels on land and agricultural diversification. The dimension of air composes two indicators with the atmosphere impact and climate change mitigation. A higher value of the overall agricultural category is equivalent with more advances regarding sustainable agricultural processes.

4.4.4 Sociocultural Wellbeing

The third dimension of the composite illustrates sociocultural wellbeing, which measures the social aspects of sustainable food systems through the dimensions life quality, life expectancy and wellbeing. Indicators and sub-indicators selected for life quality, as well as life expectancy are in line with the FSI (The Economist Intelligence Unit & BCFN). Life quality assesses the prevalence of malnourishment among the overall population, in addition to the number of children being affected by stunting, wasting and/or underweight. Furthermore, it analyses the micronutrient deficiency regarding Vitamin A and Iodine. Life expectancy represents the healthy life expectancy through combining life expectancy at birth and the healthy life expectancy. Wellbeing refers to the happiness level of the overall population of a country, including domestic born and foreign born. The dimensions align with the World Happiness Index display life ladder, which assesses the most beneficial life outcome on a scale from zero to ten, social support, positive affects through emotions of happiness, laughter and enjoyment, negative affects through worries, sadness and anger. Further indicators assess the population's generosity, as well as the freedom to make life choices. With the world happiness report of 2018 emphasising particularly aspects of migration, its incorporation within the SFSI matches the ongoing trend of globalisation, which resulted in an increasing movement of people. Thus, when assessing the wellbeing of a whole population each individual indwelled within the population needs to be taken into account (Helliwell, Layard, & Sachs, 2018).

4.5 Weights

The process beyond categorical and indicator weighting depends on the selected sets of weights, which might range from expert-based weightings, uniform weightings, policy-driven weightings or outcome-based weightings. While expert-based weighting is based on the evaluation of professionals in the area investigated, the weighting of the respective indicators represents their expert based opinion (Sharpe & Andrews, 2012). Expert-based weights might provide selected indicators with a real-world perspective, which is of particular importance when utilised in policy-building settings (The Economist Intelligence Unit & BCFN). Another possible weighting procedure displays equal weighting, which - as implied by the name – places equal importance or weight on each component. The equal weight method is frequently used when information regarding the prominence of each indicator, which is commonly assessed through surveys, is missing. However, equal weights are rare in practical settings as most indices are developed in accordance to a unique set of indicators (Sharpe & Andrews, 2012). A similar weighting approach displays uniform weightings, which places neutral or equal importance on all indicators, as well as sub-indicators. The simplicity and objective judgment tied to this weighting approach is considered as major advantage. However, assigning each indicator with equal importance might create problems in the long run in terms of the indicators' meaningfulness (The Economist Intelligence Unit & BCFN). Other weighting methods are user weighting, which provides individuals with the opportunity to assign weights according to their own preferences. While this weighting is highly user-friendly and valuable for communication, problems might occur at the level of generalisation, especially when aiming towards implying the study outcomes within policies (Sharpe & Andrews, 2012). Further weighting options demonstrate policy-driven weighting, as well as the outcome-based weighting. Policy-based weighting places emphasis on indicators which might be affected and changed through policies, while outcome-based weighting, on the other hand, concentrates on the dimensions, or in the case of food systems, on the food pillars, which require more attention by distributing higher weights. While the policy-based method highlights the countries with the strongest and most effective policies, the outcome-based weighting points out nations who have already made significant improvements regarding some indicators (The Economist Intelligence Unit & BCFN).

For the SFSI, the overall score is computed via equal weighting of the respective categories, while the underlying dimensions and indicators apply either expert-based, policy-based or user-based weighting, depending on the included indicators, as well as sub-indicators. The total SFSI has been established in close dependency on existing indicators in order to provide more comprehensive and meaningful outcomes. The overall SFSI with its categories, as well as dimensions, indicators and sub-indicators, aligned with the respective weights applied, is elaborated in detail in Table 2.

Table 2
Sustainable Food System Index: Composition and Weighting

Category	Dimension	Indicator	Sub-Indicator	Sub-Sub-Indicator	Measurement Unit	Source	Weights
Food Security						The Economist Intelligence Unit	33.33%
	Affordability						40.00%
	[-]	Food consumption as a share of household expenditure			% of total household expenditure	National accounts, UN	22.22%
	[-]	Proportion of population under global poverty line			% of population living under $3.10/day 2011 PPP	WB, WDI	20.20%
	[+]	Gross domestic product per capita (US$ PPP)			US$ at PPP / capita	EIU	22.22%
	[-]	Agricultural import tariffs			%	WTO	10.10%
	[+]	Presence of food safety net programmes			Qualitative assessment (0-4)	Qualitative scoring by EIU	14.14%
	[+]	Access to financing for farmers			Qualitative assessment (0-4)	Qualitative scoring by EIU	11.11%
	Availability						44.00%
	[+]	Sufficiency of Supply				EIU scoring	23.42%
		[+]	Average food supply		Kcal/capital/day	FAO	73.33%

		[+]	Dependency on chronic food aid	Qualitative assessment (0-2)	WFP	26.67%
	[+]	Public expenditure on agricultural R&D		Rating 1-9	EIU estimates	8.11%
	[+]	Agricultural infrastructure			EIU scoring	12.61%
		[+]	Existence of adequate crop storage facilities	Qualitative assessment (0-1)	Qualitative scoring by EIU	22.22%
		[+]	Road infrastructure	Qualitative assessment (0-4)	EIU Risk briefing	40.74%
		[+]	Port infrastructure	Qualitative assessment (0-4)	EIU Risk briefing	37.04%
	[-]	Volatility of agricultural production		Standard deviations	FAO	13.51%
	[-]	Political stability risk		Rating 0-100; 100 = highest risk	EIU Risk briefing	9.91%
	[-]	Corruption		Rating 0-4; 4=highest risk	EIU Risk briefing	9.91%
	[+]	Urban absorption capacity		GDP (% real change) minus the urban growth rate	WB, WDI, EIU	9.91%
	[-]	Food loss				12.61%
		[-]	Food lost as % of country's total food production	%	FAO (Food Sustainability Index)	25.00%
		[-]	Total waste / total domestic supply quantity		FAO	25.00%
		[+]	Quality of policies to address food loss		FSI	17.00%
		[+]	Quality of road infrastructure		FSI	17.00%
		[+]	Investment in transport with private transportation	%	FSI	16.00%
	Quality & Safety					16.00%
	[+]	Diet diversification		%	FAO	20.34%
	[+]	Nutritional Standards			EIU scoring	13.56%
		[+]	National Dietary Guidelines	Qualitative assessment (0-1)	Qualitative scoring by EIU	34.62%
		[+]	National Nutrition Plan/Strategy	Qualitative assessment (0-1)	Qualitative scoring by EIU	30.77%
		[+]	Nutrition Monitoring & Surveillance	Qualitative assessment (0-1)	Qualitative scoring by EIU	34.62%
	[+]	Micronutrient availability			EIU scoring	25.42%
		[+]	Dietary availability of Vitamin A	Qualitative assessment (0-2)	FAO	33.33%
		[+]	Dietary availability of animal iron	Mg/person/day	FAO	33.33%
		[+]	Dietary availability of vegetal iron	Mg/person/day	FAO	33.33%
	[+]	Protein quality		Grams	EIU	23.73%
	[+]	Food Safety			EIU scoring	16.95%
		[+]	Agency to ensure safety & health of food	Qualitative assessment (0-1)	Qualitative scoring by EIU	32.14%
		[+]	Percentage of population with access to potable water	%	WB	42.86%
		[+]	Presence of formal grocery sector	Qualitative assessment (0-2)	Qualitative scoring by EIU	25.00%
Ecosystem Stability & Resilience						33.33%
	Resilience				The Economist Intelligence Unit	40.00%
	[-]	Exposure				21.82%
		[-]	Temperature rise	Index score; 0=least vulnerable	GFSI	21.43%

	[-]	Drought		0-5, where 5=most risk	GFSI	19.64%
	[-]	Flooding		Index score, 0=least vulnerable	GFSI	17.86%
	[-]	Storm Severity		US$m	GFSI	7.14%
	[-]	Sea level rise		Index score; 0=least vulnerable	GFSI	19.64%
	[-]	Commitment to managing exposure		0-13, where 13=all elements are included	GFSI	14.29%
[-]	Water					14.55%
	[-]	Agricultural water risk - quantity		0-5, where 5=highest risk	GFSI	80.00%
	[-]	Agricultural water risk - quality		0-5, where 5=highest risk	GFSI	20.00%
[+]	Land				GFSI	14.55%
	[+]	Soil erosion/organic matter		0-15, where 15=least constrained	GFSI	60.00%
	[+]	Grassland		Net emissions/removals (CO2), gigagrams	GFSI	20.00%
	[+]	Forest change		Change in forest area as % of total land area	GFSI	20.00%
[+]	Oceans					12.73%
	[+]	Eutrophication & hypoxia		0-2, where 2=healthiest oceans	GFSI	42.86%
	[+]	Marine biodiversity		%	GFSI	42.86%
	[+]	Marine protected areas		%	GFSI	14.29%
[-]	Sensitivity					10.91%
	[-]	Food import dependency		Ratio	GFSI	30.00%
	[-]	Dependency on natural capital		%	GFSI	20.00%
	[+]	Disaster risk management		0-7, where 7=best	GFSI	50.00%
[+]	Adaptive capacity					18.18%
	[+]	Early warning measurers/climate smart agriculture		0-2, where 2=best	GFSI	50.00%
	[+]	National agricultural risk management systems		0-6, where 6=best	GFSI	50.00%
[-]	Demographic stresses				GFSI	7.27%
	[-]	Population growth		%	GFSI	75.00%
	[-]	Urbanisation		%	GFSI	25.00%
Ecosystem Stability					Yale University	40.00%
[-]	Environmental Impact					40.00%
	[-]	Air Quality			EPI	65.00%
		[-]	Household Solid Fuels	Age-standardised Disability-Adjusted Life Years lost per 100.000 persons, or the DALY rate	EPI	40.00%
		[-]	PM2.5 Exposure	µg/m3	EPI	30.00%
		[-]	PM2.5 Exeedance	% of population	EPI	30.00%
	[-]	Water & Sanitation			EPI	30.00%
		[-]	Sanitation	Age-standardised Disability-Adjusted Life Years lost per 100.000 persons, or the DALY rate	EPI	50.00%
		[-]	Drinking Water	Age-standardised Disability-Adjusted Life Years lost per 100.000 persons, or the DALY rate	EPI	50.00%
	[-]	Heavy Metals			EPI	5.00%
		[-]	Lead Exposure	Age-standardised Disability-Adjusted Life Years lost per 100.000 persons, or the DALY rate	EPI	100.00%
[+]	Ecosystem Vitality				EPI	60.00%
	[+]	Biodiversity & Habitat			EPI	25.00%

		[+]	Marine Protected Areas	% of EEZ	EPI	20.00%
		[+]	Biome Protection (National)	% of EEZ	EPI	20.00%
		[+]	Biome Protection (Global)	% of EZZ	EPI	20.00%
		[+]	Species Protection Index	% of habitat	EPI	20.00%
		[+]	Representativeness Index	Unitless	EPI	10.00%
		[+]	Species Habitat Index	% of habitat	EPI	10.00%
	[-]	Forests			EPI	10.00%
		[-]	Tree Cover Loss	% of forested land	EPI	100.00%
	[+]	Fisheries			EPI	10.00%
		[+]	Fish Stock Status	% of catch	EPI	50.00%
		[+]	Regional Marine Trophic Index	Unitless	EPI	50.00%
	[-]	Climate & Energy			EPI	30.00%
		[-]	CO2 Emissions – Total	Unitless	EPI	50.00%
		[-]	CO2 Emissions – Power	Unitless	EPI	20.00%
		[-]	Methane Emissions	Unitless	EPI	20.00%
		[-]	N2O Emissions	Unitless	EPI	5.00%
		[-]	Black Carbon Emissions	Unitless	EPI	5.00%
	[-]	Air Pollution			EPI	10.00%
		[-]	SO2 Emissions	Unitless	EPI	50.00%
		[-]	NOX Emissions	Unitless	EPI	50.00%
	[+]	Water Resources			EPI	10.00%
		[+]	Wastewater Treatment	Weighted %	EPI	100.00%
	[+]	Agriculture			EPI	5.00%
		[+]	Sustainable Nitrogen Mgmt.		EPI	100.00%
Agriculture					The Economist Intelligence Unit and BCFN	20.00%
[-]	Agricultural Water				FSI	33.33%
	[-]	Water footprint		Mm3/year	FSI	37.31%
	[-]	Agricultural water withdrawals (% of total renewable water resources)		%	FSI	32.84%
	[-]	Monthly water scarcity		Number of month	FSI	29.85%
[-]	Agricultural Land				FSI	33.34%
	[-]	Environmental Impact of Agriculture on land			FSI	27.53%
		[+]	Nitrogen Use Efficiency	Ratio	FSI	31.75%
		[-]	Agricultural land lost yearly to desertification and pollution (%)	%	FSI	36.51%
		[+]	Average carbon content of soil (% of weight)	%	FSI	31.75%
	[+]	Land use			FSI	24.01%
		[+]	Arable land under organic agriculture (% of agricultural land)	%	FSI	29.82%
		[+]	Utilised agricultural area (% of total agricultural area)	%	FSI	29.82%
		[+]	Existence of sustainable urban farming initiatives	Score 0-2	FSI	40.35%
	[-]	Impact on land of animal feed and biofuels			FSI	22.25%
		[-]	First and second-generation biofuel production	KBOE/D	FSI	47.62%

			[-]	Land diverted to animal feed and biofuels	%	FSI	52.38%
		[-]	Agricultural Diversification			FSI	26.21%
			[-]	Top 3 crops (% of total agriculture production)	%	FSI	100.00%
	[-]	Agricultural Air				FSI	33.33%
		[-]	Atmosphere Impact			FSI	53.85%
			[-]	GHG emissions from agriculture	Gg CO2 eq	FSI	22.99%
			[-]	Animal emissions (% total agriculture emissions)	%	FSI	31.03%
			[-]	Fertilizer emissions (% of total agriculture emissions)	%	FSI	26.44%
			[-]	Land use net emissions/removals (% total CO2)	Gg CO2	FSI	19.54%
		[+]	Climate Change Mitigation			FSI	46.15%
			[+]	Implementation of agricultural techniques for climate change mitigation and adaption	Score 0-1	FSI	100.00%
Sociocultural Wellbeing							33.33%
	Life Quality					The Economist Intelligence Unit and BCFN	40.00%
	[-]	Prevalence of Malnourishment				FSI	54.29%
		[-]	Prevalence of undernourishment (% of population)		%	FSI	26.32%
		[-]	Prevalence of stunting (% of children under 5, height for age)		%	FSI	23.68%
		[-]	Prevalence of wasting (% of children under 5, weight for height)		%	FSI	23.68%
		[-]	Prevalence of underweight (% of children under 5, weight for height)		%	FSI	26.32%
	[-]	Micronutrient deficiency				FSI	45.71%
		[-]	Vitamin A deficiency (% of general population)		%	FSI	50.00%
		[-]	Iodine deficiency (% of gen. Pop.)		%	FSI	50.00%
	Life expectancy					The Economist Intelligence Unit and BCFN	20.00%
	[+]	Health life expectancy				FSI	100.00%
		[+]	Life expectancy at birth, total (years)			FSI	46.00%
		[+]	Healthy life expectancy (HALE)			FSI	54.00%
	Wellbeing					Helliwell et al.	40.00%
	[+]	Life Ladder			0-10; 10 = highest (imagine … top ladder represents the best for you?)	WHR (i.A. GWP)	16.67%

[+]	Social Support	Binary 0-1 (if you were in trouble, do you have relatives/friends you could count on to help you?)	WHR (i.A. GWP)	16.67%
[+]	Positive Affect (Happiness, Laugh, Enjoyment)	Average (Did you experience the following feelings a lot during the day?)	WHR (i.A. GWP)	16.67%
[-]	Negative Affect (Worry, Sadness, Anger)	Average (Did you experience the following feelings a lot during the day?)	WHR (i.A. GWP)	16.67%
[+]	Generosity	Have you donated money to a charity in the past month? (GDP/cap)	WHR (i.A. GWP)	16.66%
[+]	Freedom to make life choices	Are you satisfied/dissatisfied with your freedom to choose what you do with life?	WHR (i.A. GWP)	16.66%

4.6 Data modelling

Before data can be used and applied in further analysis, the dataset including its variables requires some quality checks, such as cleaning and preparation. As this analysis has used data from existing indices retrieved from international organisations, the dataset is assumed to meet the necessary quality requirements. Moreover, to enable data comparability, which is one of the main intentions behind a composite indicator, indicator scores require standardisation procedures. Food security indicator scores, including affordability, availability as well as food safety and quality are normalised through the min-max scaling approach. Indicators, in line with its sub-indicator(s), for which a higher score represents more beneficial outcomes, data has been normalised based on $x' = \frac{x - \min(x)}{\max(x) - \min(x)} * 100$, with x' representing the normalised value. $Min(x)$ and $\max(x)$, respectively, indicate the lowest and highest scores of the 34 countries for each indicator. This in turn implies that the highest data score of an economy will obtain a value of 100. The lowest in controversy will score zero. On the other hand, indicators for which high values represent unbeneficial impacts on the respective dimension and category (e.g. dependency on chronic food aid, corruption, etc.), normalisation has been based on $x' = \left(\frac{x - \max(x)}{\max(x) - \min(x)} * 100\right) * (-1)$. Again, $Min(x)$ and $Max(x)$ stand for the lowest and highest values among the 34 countries for the given indicator.

The normalisation of the sociocultural wellbeing category, assessed through life quality, life expectancy and wellbeing, as well as the ecosystem stability and resilience dimensions of resilience and agriculture, have used an identical procedure. Normalisation of the ecosystem stability dimension steaming from the ecosystem and resilience category, is based on the respective procedure applied within the EPI in order to keep the framework validity and reliability of the data. The environmental impact indicator of the ecosystem stability dimension has normalised its scores through log normalisations, while the ecosystem vitality indicators are either unitless or require specific calculations, exemplified through the indicator of tree cover loss, which applies the five-year moving average of food loss. More specific knowledge can be obtained from the Technical Appendix of the EPI (Yale University, 2018). Overall, the highest value among the range represents the most favourable outcome. In terms of GHG emissions, normalisation differs again, by dividing the scales by the size of the country's individual economy, measured by the GDP, to allow computing the carbon intensity. Other normalisation procedures, which divide the values by the units of population or area, apply percentage changes, develop trends over time or use weighted averages of the variables (Yale University, 2018).

Overall, the values incorporated within the final index are normalised on a scale from 0 to 100, with 100 identifying the most beneficial outcome. Through normalising all selected variables across the same scale, the aggregation of the variables is enabled, which further guarantees the comparability of the outcomes. For more detailed elaborations regarding the normalisation procedures applied among the individual indicators, please be referred to the original technical appendices of the FSI (The Economist Intelligence Unit & BCFN), GFSI (Thomas et al., 2017), as well as EPI (Yale University, 2018).

4.7 CFA and Reliability

In order to use the data for further analyses, confirmatory factor analyses are performed on the three categories of food security, ecosystem stability and resilience, as well as sociocultural wellbeing. In addition, the constructs reliability is tested through Cronbach's Alpha. As data is retrieved from existing indicators of international organisations, the required quality is assumed to be met.

4.7.1 Food Security

Affordability

The principal component analysis of affordability is described by one component of which the first two indicators explain 70 percent and 15 percent of the underlying variance. Food consumption as share of the household expenditure and the proportion of population under the global poverty line capture most of the dimensional variance. Respective factor loadings are highly satisfying, with exception to the agricultural import tariff indicator, which would reveal higher loadings as stand-alone indicator for component two. However, Cronbach's alpha values are very high, which supports the reliability of the dimension. With only a very small increase of the overall reliability score when excluding agricultural import tariffs, the indicator is retained to allow keeping the original indicator expert weightings.

Availability

The outcomes of the CFA of the availability dimension reveal that the indicators load on three components. While the first component explains around 35 percent of the variance, the second one describes additional 20 percent and the third one further 15 percent. Five out of eight indicators, including sufficiency of supply, public expenditure on R&D, agricultural infrastructure, political stability risk and food loss load on component one, while volatility of agricultural production and corruption connect to factor two. Urban absorption capacity represents a stand-alone indicator for component three. Overall factor loadings are highly satisfying, except for public expenditure on R&D with a factor loading below 0,6. However, reliability scores score high with a Cronbach's Alpha value of approximately 0,85. As eliminating the indicator of public expenditure would not result in any meaningful changes, the indicator is kept within the dimension and the overall SFSI.

Quality and Safety

Indicators of the quality and safety dimension load on two components with the first component explaining approximately 57 percent of the variance. Component two describes about 22 percent of the underlying variance. The indicator loadings are satisfactory with values above 0.78. Regarding the dimension's reliability, Cronbach's Alpha can be described as sufficient as well.

Overall, the dimensions selected for assessing food security fulfil the necessary quality checks, as supported through the respective factor loadings and Cronbach's Alpha values of each dimension, including its indicators and sub-indicators.

4.7.2 Resilience & Ecosystem Stability

Resilience

The CFA of resilience loads on six components, which explain approximately 77 percent of the variance. While indicators of water, ocean and demographic stresses load to one component, water to component two, oceans to component three and demographic stresses again to component one, the other indicators are more widespread. Adaptive capacity is explained by component one and four, sensitivity indicator one assessing the food import dependency loads to component five with the disaster risk management, which represents the sensitivity indicator number three. Sensitivity indicator one describes component one by assessing the dependency on natural capital. Indicators of land load to the components one and four, while the CFA for the indicators of exposure result in an exclusion of exposure two and three, assessing drought and flooding. For the indicators kept in the sample, temperature rise and sea level rise load to component six, component two represents the sea level rise which demonstrates exposure indicator number four. Component two is measured by storm severity, while the commitment to managing scores loads unified to component six as well. Due to highly unbeneficial factor loadings of exposure indicator two and three, referring to drought and flooding, the indicators have been eliminated. The conducted reliability test supports this decision by increasing Cronbach's Alpha value from 0.70 to 0.73. Hence, the dimension of resilience is approved in reliability as well.

Ecosystem Stability

The CFA of the ecosystem stability dimension illustrates that the first seven components explain around 83 percent of the dimensional variance. The whole dimension loads adequately on seven components with component one describing household solid fuels, both water and sanitation indicators, lead exposure, as well as air pollution indicator one with SO2 emissions, and wastewater treatment. Component two includes sub-indicator two to five of the biodiversity and habitat indicator. The species habitat index loads on component six, while marine protected areas load to component seven. Methane emissions, N2O emissions and black carbon emissions load to component three, while both CO2 indicators collectively load to component five. The factor loadings of most indicators are relatively satisfying, except for the indicator of tree cover loss, fish stock status and regional marine trophic index with negative loadings. However, due to the high reliability score indicated by a Cronbach's Alpha value of 0.86, the indicators of forests and fisheries will be retained.

Agriculture

The validity tested via a CFA reveals that the first three components explain around 70 percent of the dimension variance. While component one describes the water footprint, the impact on land of animal feed and biofuels, as well as the atmosphere impact; the monthly water scarcity and the environmental impact of agriculture on land load on factor two. Agricultural water withdrawals in percent of total renewable water resources, land use, as well as indicators of climate change mitigation load on component three. All factor loadings are relatively beneficial, except for agricultural diversification, which loads negatively on component two. Reliability is approved through a Cronbach's Alpha value of 0.73 when including all indicators and sub-indicators of the agriculture dimension.

4.7.3 Sociocultural Wellbeing

Life Quality

The CFA of the dimension life quality reveals that approximately 87 percent of the variance is explained by the first two components. Sub-indicators regarding the indicator prevalence of malnourishment load combined to component one. Vitamin A deficiency loads to component one as well, while healthy life expectancy loads as stand- alone indicator to component two. The overall factor loadings are highly satisfying with values ranging from 0.78 to 0.97. Reliability is approved with a high Cronbach's alpha value of around 0.90.

Life Expectancy

The dimension of life expectancy reveals only one component and this one explains around 99.56 percent of the dimension variance. The factor loadings are highly satisfying with values beyond 0.99.

Wellbeing

CFA of wellbeing reveals that around 56 percent of the dimension variance is explained by component one. All indicators correlate beneficially with component one supported through values above 0.70 for all indicators, except for the indicator measuring the negative affects including anger, sadness and worry, which displays a negative factor loading. However, this might be traced back to the inverse relationship with the overall dimension of wellbeing. When loading the wellbeing dimension of six components, the overall factor loadings increase in value as the indicators generosity, freedom to make life choices, positive affects, including happiness, laughter and enjoyment, as well as life ladder load more beneficial to component six. Regarding reliability, Cronbach's Alpha scores 0.66 which is rather unpromising. However, the reliability analysis reveals that the exclusion of wellbeing indicator four would raise the Cronbach's Alpha value up to 0.81. Thus, the sub-indicator assessing negative affects, such as anger, sadness and worry is eliminated.

4.8 SFSI 2018 – Key Findings

With the proof of the pre-requisite validity and reliability regarding the selected indicators, as well as sub-indicators, the overall quality of the composite indicator is guaranteed, which allows data to be used for further analysis. The SFSI consists of three dimensions with its indicators and sub-indicators, of which each one tackles the food system from a different angle. However, each category, in line with its indicators highlights a crucial component of sustainable food systems. In order to get a more detailed insight into the individual categories selected for the SFSI, respective indicators and sub-indicators are investigated more in depth in the following chapters. The country scores are categorised in four clusters ranging from the best performing nations to the ones urgently requiring improvement, as illustrated in Table 3.

Table 3
Performance Clusters

Best performance	Good performance	Moderate performance	Needs improvement
> 75	74. 9 – 60	59.0 – 40	< 40

The SFSI illustrates a composite indicator which assesses the degree of food system's sustainability in performing countries through considering food security, resilience and ecosystem stability, as well as sociocultural wellbeing. In terms of sustainable food systems, the country of Sweden sets the benchmark and illustrates the frontrunner with a value of around 84. France ranks second with a score of approximate 82 while the United Kingdom positions third, shortly followed by Germany. Mediterranean countries including Spain, Portugal, Italy and Israel achieve highly satisfying SFSI values beyond 75 as well, which ranks them ninth to twelfth. Greece and Turkey represent good performing countries with scores above 60, while other Mediterranean nations including Egypt and Morocco perform moderately and take the ranks 28th and 29th. Worst performing countries are Indonesia on position 30th, Nigeria on spot 31st, India 32nd. Ethiopia ranks last and therefore indicates the country with the least sustainable food system according to the overall SFSI index. With a value below 40, Ethiopia's food systems are highly vulnerable, and improvements are urgently needed. More detailed information regarding the top- and bottom ten countries' rank and score is demonstrated in Table 4, while the complete ranking is displayed in Appendix A.

Table 4
SFSI Score: Top 10 vs Bottom 10 Performing Countries

Rank	Country	Score	Rank	Country	Score
1	Sweden	83.618	24	Turkey	61.694
2	France	82.234	25	Jordan	60.312
3	UK	81.226	26	Tunisia	60.043
4	Germany	80.971	27	South Africa	57.104
5	Canada	79.972	28	Egypt	56.317
6	US	79.608	29	Morocco	55.068
7	Australia	78.323	30	Indonesia	52.843
8	Japan	77.952	31	Nigeria	44.172
9	Spain	77.741	32	India	42.736
10	Portugal	76.702	33	Ethiopia	36.639

4.8.1 Food Security

The security of food indicates a crucial undertaking of the 21st century, however, guaranteeing it illustrates a highly difficult process. In line with a constantly growing population, intense rates of migration, rising costs of living leading to increased shares of household incomes spent on food, political- as well as economical instabilities occurring globally, in combination with climatic changes and environmental destruction resulting in agricultural losses, the food security is at stake. The dimension of food security takes three major indicators into account, affordability, availability, as well as food quality and safety across 33 performing countries. Through three dimensions, 19 indicators and 19 sub-indicators, the food security across developing, as well as developed countries have been investigated. In line with different dimensions and indicators, countries might score better in one dimension than in another.

The SFSI 2018 in terms of food security reveals the degree of vulnerability of countries' food systems. Among the 33 investigated food systems, the most vulnerable ones are illustrated by Ethiopia with a score of around 28, closely followed by Nigeria with a value of 32. With values below 40 the countries food systems display a severe degree of insecurity. Thus, stabilising food systems through guaranteeing more food security is urgently required. India, Indonesia and Morocco rank 31st to 29th. With scores ranging from around 46 to 51, the countries perform moderately regarding food security. Good performers in the dimension of food security are turkey with a score of 61, Russia with 63, China with 64, as well as Hungary, Greece and South Korea with values ranging from 71 to 74. Best performing nations illustrate Japan, Israel, with values of approximately 77, as well as Portugal with around 79, and Germany with approximately 82. The least vulnerable country in terms of food security represents the United Kingdom with a score of 85, closely followed by United States, Austria, Sweden and Canada. The top- to bottom ten country rankings in terms of food security are illustrated in Table 5. The full ranking of the overall food security category as well as the respective dimensions is demonstrated in Appendix B.

Table 5
Food Security: Top 10 vs Bottom 10 Performing Countries

Rank	Country	Score	Rank	Country	Score
1	UK	84.947	24	South Africa	59.473
2	US	84.877	25	Colombia	56.661
3	Australia	84.478	26	Tunisia	54.825
4	Sweden	83.475	27	Jordan	53.593
5	Canada	83.412	28	Egypt	53.143
6	Germany	81.734	29	Morocco	50.572
7	France	80.842	30	Indonesia	48.466
8	Portugal	79.200	31	India	46.481
9	Spain	79.018	32	Nigeria	32.295
10	Italy	78.117	33	Ethiopia	27.537

When investigating the food security index dimension affordability more in depth, the SFSI highlights the countries' capacity to afford high quality food without feeling particularly pressured on the financial level. The dimension of affordability is led by the United Arab Emirates with a score of around 96, closely followed by the United States with approximate 95 and Australia with 91. Germany, United Kingdom and Sweden take the ranks four to six. Countries indicating scores below 40, therefore desperately requiring improvements, are India on the 31st rank with a score of less than 38 and Nigeria on spot 32 with l9. The most vulnerable country in terms of food affordability is Ethiopia with an alarming score of around 10.

Among the dimension of availability, which considers factors that are influencing and easing the access to food, while simultaneously examining a nation's capacity of producing and distribution food, the frontrunners are the United Kingdom with 83, followed by Canada, Sweden and Australia on rank two to four. Germany and Portugal rank sixth and seventh with values of around 74 and 73. The SFSI highlights the severe food availability issues among the country of Nigeria, which ranks last with a score of 39 and is therefore in urgent need of improvement. Ethiopia achieves a score of around 42 which places the country on the 32nd position. A similar value is reached by UAE on position 31st.

In terms of the food quality and safety dimension, the top performing country represent Portugal with a value of above 90, shortly followed by France with approximately 88. Greece ranks third with 86, just beyond Australia, Spain, Sweden and Canada with scores ranging from 84 to 86. Among moderate performers are Egypt, Tunisia, Colombia, Jordan, Nigeria, as well as India, with ranks from 24th to 31st. The least performing countries regarding food safety and quality is Indonesia with a value of around 37 on position 32 and Ethiopia with 29 on rank 33rd. A more detailed overview regarding the individual dimensional rank and the performing values of the top five-, as well as bottom five performers, is illustrated in Table 6 below.

Table 6
Food Security Dimensions: Top 5 vs Bottom 5 Performing Countries

Rank	Country	Affordability	Rank	Country	Availability	Rank	Country	Food Quality & Safety
1	UAE	95.891	1	UK	83.107	1	Portugal	90.524
2	US	95.247	2	Canada	79.033	2	France	88.276
3	Australia	91.393	3	Sweden	77.913	3	Greece	86.957
4	Germany	89.948	4	Australia	77.785	4	US	86.269
5	UK	88.954	5	US	74.945	5	Australia	85.598
29	Morocco	46.114	29	Colombia	51.305	29	Jordan	50.104
30	Egypt	40.551	30	Russia	50.545	30	Nigeria	46.233
31	India	37.742	31	UAE	44.242	31	India	43.113
32	Nigeria	19.427	32	Ethiopia	42.162	32	Indonesia	37.560
33	Ethiopia	10.690	33	Nigeria	38.924	33	Ethiopia	29.439

4.8.2 Ecosystem Stability & Resilience

Ecosystem stability and resilience consist of three dimensions, including resilience, ecosystem stability and agriculture. Resilience assesses a countries ability of meeting the needs of a constantly growing population, while simultaneously dealing with the intensified pressure placed on the environment because of changes in climate. The ecosystem stability, on the other hand, investigates the environmental health and ecosystem vitality of a nation and provides a benchmark of countries' environmental performance. The agricultural dimension measures the sustainability degree of the agricultural systems in place within the performing countries across water, land and air. Overall, ecosystem stability and resilience are assessed across 33 countries through three indicators, eight sub-indicators and 35 sub-sub-indicators. The outcomes of the composite indicator positions France on top with a score of around 82, closely followed by Sweden with 80 on rank two and Spain with about 78 on rank three. Germany, Italy and Portugal take the rank four to six, while Greece positions seventh with an overall value of around

75. The worst performer display UAE with 44 on rank 33rd, India on rank 32nd with a score of approximately46, Indonesia on place 31st with 50 and Saudi Arabia on position 30th. In comparison to the food security dimension, no performing country scores below the value of 40. Overall the values of the resilience and ecosystem stability category are relatively good, as even the worst performing countries score moderate values. More precise information regarding the individual countries ranks are displayed in Table 7, while the complete rankings can be retrieved from Appendix C.

Table 7
Resilience & Ecosystem Stability: Top 10 vs Bottom 10 Performing Countries

Rank	Country	Score	Rank	Country	Score
1	France	81.601	24	Morocco	62.071
2	Sweden	81.425	25	Mexico	58.899
3	Spain	78.181	26	Nigeria	58.742
4	Germany	77.580	27	China	57.995
5	Italy	75.723	28	South Africa	55.357
6	Portugal	75.166	29	Ethiopia	53.890
7	Greece	74.887	30	Saudi Arabia	52.428
8	Hungary	73.321	31	Indonesia	50.524
9	Canada	73.074	32	India	45.754
10	Japan	72.918	33	UAE	44.280

When investigating the SFSI dimension of resilience more in detail the top performer in resilience is Hungary on position one with a score of about 85, followed by Tunisia on rank two with a value of 81 and France on spot three with a score of 80. Sweden ranks fourth with a value of 80. Countries indicating good performance scores are Germany, Portugal, Russia, Italy and Japan, while India, South Korea, Mexico and Indonesia perform moderately. A laggard in terms of resilience represents the UAE with a value of around 34, positioning the economy on place 33rd. Further, the score below 40 highlights the nations urgent need of addressing this issue.

Ecosystem stability, which investigates the environmental performance of a country through the sub-indicators ecosystem vitality and environmental impact, positions France on the top with a score of 84. Sweden, United Kingdom, Spain, Germany, Italy, and Israel display best performers, while Japan, Australia, Portugal, United States and Brazil show good performances. Moderate scores are achieved by countries including Mexico, Argentina, Hungary, Jordan, China, as well as Nigeria. Ethiopia and India rank 32nd and 33rd, with scores below 40. Hence, these economies are in urgent need of increasing the environmental performances, tied to the ecosystem stability. In terms of agriculture, SFSI outcomes highlight the top sustainable agricultural performance of Sweden and Italy with the ranks one and two. Japan and Greece take position three and four, while France ranks ninth. Countries including Morocco, Egypt and Mexico, as well as Jordan, Argentina and China indicate good performance values, while the United States, India and Australia only show moderate sustainable agricultural values. Thus, the US ranks only 29th out of 33 countries, while Australia takes position 31st. The least performing nations display Tunisia on spot 32nd and the UAE on rank 33rd with a relatively low value of about 42. Thus, the alarming zone below 40 is just slightly missed. An overview of the dimensional rankings and performance scores are illustrated in Table 8.

Table 8
Ecosystem & Resilience Dimensions: Top 5- vs Bottom 5 Performing Countries

Rank	Country	Resilience	Rank	Country	Ecosystem	Rank	Country	Agriculture
1	Hungary	84.877	1	France	83.948	1	Sweden	85.459
2	Tunisia	81.071	2	Sweden	80.508	2	Italy	83.236
3	France	80.500	3	UK	79.953	3	Japan	82.422
4	Sweden	80.324	4	Spain	78.391	4	Greece	81.778
5	Canada	78.731	5	Germany	78.370	5	Hungary	80.725
29	Mexico	51.608	29	Nigeria	50.744	29	US	59.101
30	Israel	48.009	30	Indonesia	46.925	30	India	56.417
31	Saudi Arabia	43.969	31	South Africa	44.729	31	Australia	56.246
32	Indonesia	41.764	32	Ethiopia	39.246	32	Tunisia	54.732
33	UAE	33.900	33	India	30.569	33	UAE	42.149

4.8.3 Sociocultural Wellbeing

The sociocultural wellbeing of performing countries measures the three dimensions life quality, life expectancy and wellbeing. As the quality of life is greatly depending on adequate nutrition and sufficiency in terms of micronutrients, the dimension indicators assess the prevalence of malnourishment, next to micronutrient deficiencies. Life expectancy considers the healthy life expectancy, while wellbeing assesses the overall happiness of people living within the country, in terms of life ladder, social support, positive affects, generosity and freedom of life choices.

The overall SFSI outcomes regarding sociocultural wellbeing point out Australia as leading country with a value beyond 80, followed by Sweden on rank two with approximately 79. The United States are ranks third with a score of around 77, while the UAE takes the fourth position with 76. The UK, as well as Indonesia, Germany and Israel perform well. Moderate performance values illustrate Nigeria, Portugal, Spain, Hungary, Russia, India and Turkey. The least favourable sociocultural wellbeing scores are illustrated by Tunisia on spot 33rd with a value of less than 28, Egypt on 32nd with 33 and Greece with a score of 36 on position 31st. Detailed information regarding the top individual countries' position and score is demonstrated in Appendix D. The top- and bottom ten performers are illustrated in Table 9.

Table 9
Sociocultural Wellbeing: Top 10 vs Bottom 10 Performing Countries

Rank	Country	Score	Rank	Country	Score
1	Australia	80.752	24	South Africa	56.210
2	Sweden	78.724	25	South Korea	49.930
3	US	76.984	26	Jordan	49.480
4	UAE	76.384	27	India	47.786
5	UK	75.987	28	Ethiopia	46.076
6	Indonesia	73.310	29	Morocco	43.830
7	Germany	71.678	30	Turkey	42.844
8	Israel	69.204	31	Greece	36.238
9	Canada	67.227	32	Egypt	33.140
10	France	66.478	33	Tunisia	27.478

When investigating the individual dimensions of the sociocultural wellbeing more in depth, life quality, which measures the prevalence of malnourishment, in combination with micronutrient deficiencies, places South Korea on rank number one with a score higher than 97. The UK and Canada take rank two and three, while Japan ranks fourth. Among investigated countries, 25 out of 33 countries categorise as best performers. Russia, Egypt and South Africa represent good performing countries, while the performance of Morocco, Indonesia and Nigeria is moderate. Worst performers in terms of life quality indicator are India and Ethiopia with values below 25 for India and 14 for Ethiopia. With values of life quality far below the critical 40, the life quality enhancement among India and Ethiopia is decisive when aiming towards sustainable development and food systems. In terms of life expectancy Japan illustrates the values and positions as a front runner at the top. Italy and France follow on position two and three, while South Korea, Spain and Israel take position four to six. 16 out of 33 countries demonstrate best performers within this dimension. Good performing countries include Mexico, Argentina, Turkey, Brazil and Jordan, while moderate performance values are achieved by Russia, Egypt, Indonesia and India. Worst performing countries illustrate Ethiopia, South Africa and Nigeria ranking from 31st to 33rd. Among wellbeing, which measures the happiness of the people living within the country, including migrants, ranks Australia first a overall wellbeing value higher than 80. Sweden ranks second, followed by the US on position three. UAE and UK, as well as Indonesia follow shortly on position four to six. Countries like Portugal, Spain, Italy rank 18th, 19th and 21st across the 33 performing nations. Rank 33 is taken by Tunisia with a value of around 27. Egypt ranks 32nd with 33 and Greece positions 31st. More specific information regarding the dimensional ranks and values among the top five to bottom five is illustrated in Table 10.

Table 10
Sociocultural Wellbeing Dimensions: Top 5 vs Bottom 5 Performing Countries

Rank	Country	Life Quality	Rank	Country	Life Expectancy	Rank	Country	Wellbeing
1	South Korea	97.431	1	Japan	100.000	1	Australia	80.752
2	UK	96.638	2	Italy	94.347	2	Sweden	78.724
3	Canada	95.432	3	France	93.950	3	US	76.984
4	Japan	94.568	4	South Korea	93.657	4	UAE	76.384
5	US	93.821	5	Spain	93.553	5	UK	75.987
29	Morocco	58.696	29	Indonesia	52.330	29	Morocco	43.830
30	Indonesia	54.835	30	India	45.883	30	Turkey	42.844
31	Nigeria	49.801	31	Ethiopia	34.483	31	Greece	36.238
32	India	24.667	32	South Africa	26.656	32	Egypt	33.140
33	Ethiopia	13.366	33	Nigeria	0.000	33	Tunisia	27.478

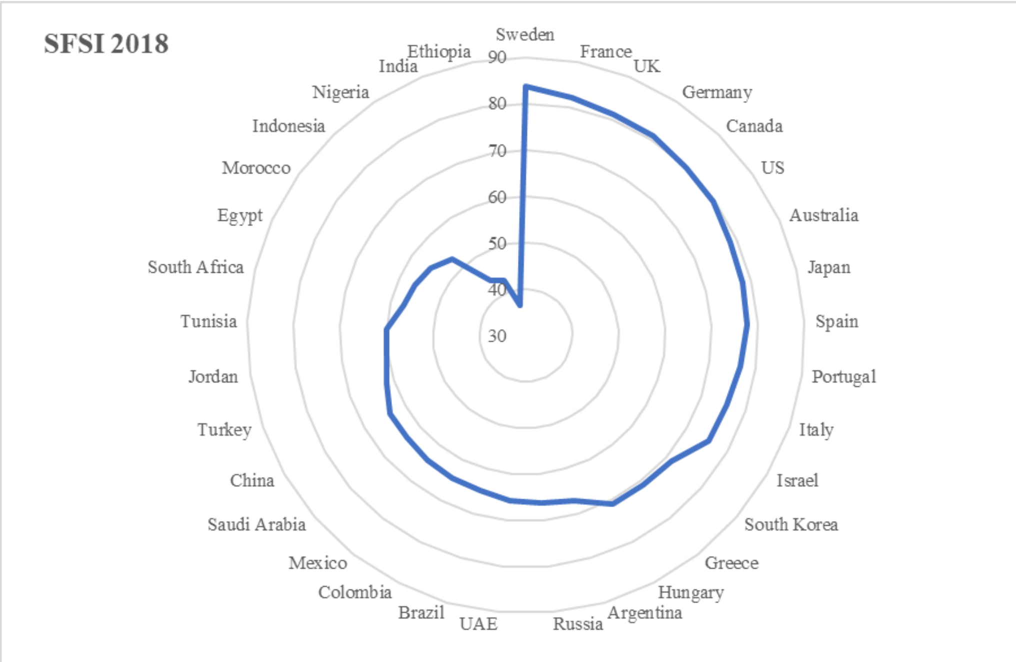
5 SFSI Outcome Discussion

The following chapter ignites a thematic discussion by combining knowledge gained from theory with the empirical outcomes retained by applying a composite indicator to investigate the performance in terms of sustainable food systems of 33 selected countries more in-depth.

With food and nutrition indicating inevitable human needs of fundamental importance for any living organism, the sustaining food systems has emerged as crucial theme among sustainable development, in line with the SDGs (Rutherford & Ahlgren, 2010). Food is pivotal for the individual's survival, and its relation to the planet is beyond all questions. Food systems illustrate one of the main greenhouse gas emitters and are a prime reason for intense deforestations, agricultural damages and water- as well as land degradation. While food has been framed as "low involvement product" for numerous years, its significance nowadays is more striking than ever due to its deep interlinkage with the overall ecosystem, in line with planetary- as well as human health. Food and nutrition are omnipresent characteristics of a country as it further accentuates culture, identity and determines the individual's livelihood and wellbeing, as well as economic growth (Sustainable Development Solutions Network, 2018). However, current food systems are coined by high unsustainability and inefficiencies in terms of environmental degradation and food security, pointed out by rising temperatures, sea levels as well as accelerating climatic changes, next to approximately one billion people facing severe undernourishment, while around one billion are affected by overnourishment and obesity. Simultaneously, approximately 1.3 billion tons of food per year is either lost or wasted (FAO, 2017a; HLPE, 2014; WHO, 2018). However, food systems hold tremendous power by illustrating the biggest employer globally and offer vast potential. Particularly across economical poor regions, food systems are of fundamental importance. Furthermore, food might secure the economic situation of countries, while simultaneously allow addressing malnutrition, as well as assuring the ecosystem's health, in line with the environment (Steffen et al., 2015). In addition, food systems represent highly dynamic processes and are heavily impacted by its drivers, including emerging global trends, food prices, volatility and availability, shifting dietary patterns, food wastages and loss, supply chain transitions as well as its environment, such as affordability, marketing, nutritional guidelines and certifications and labelling (HLPE, 2017).

Planetary- as well as human health is at stake, evident through the critical levels in terms of planetary boundaries, as well as the amount of people facing severe issues of malnourishment. Hence, transitioning towards more sustainable food systems is a crucial undertaking of the 21st century and is entangled with almost all outlined Sustainable Development Goals (Affairs, 2017). However, when aiming towards sustainable food systems, literature identified three major categories which are decisive for a successful transition. In line with these findings, the Sustainable Food System Index has been established which assesses the sustainability degree of performing countries food systems through the three categories of food security, ecosystem stability and resilience, as well as sociocultural wellbeing. By measuring the food systems of 33 countries across three categories, nine dimensions, 39 indicators, 65 sub-indicators and 38 sub-sub-indicators, the composite indicator should offer valuable clues to the performing countries' food system state. The outcomes of the overall SFSI highlight Sweden, France and the United Kingdom as the three top performers regarding the sustainability degree of food systems in place. Laggards in the overall SFSI represent Nigeria, India and Ethiopia. With food security indicating a major component of sustainable food systems, which is determining the country's food affordability, as well as availability, safety and quality, it comes as little surprise that economically strong countries such as Germany, Canada, US, Australia and Japan are among the top performers. In addition, Mediterranean nations including Spain, Portugal, Italy and Greece display satisfying values. For a graphical illustration of the overall SFSI outcome please refer to Figure 1.

Figure 1
Overall SFSI 2018



Sweden taking the lead in the Sustainable Food System Index it not surprising and might have been anticipated due to vast efforts and heavy investments placed on the theme of sustainability over the previous years. Already in 2015, the Country Sustainability Ranking had ranked Sweden the most sustainable country of the year. Emphasis has been placed on sustainable living, in line with enhancing the citizen's engagement through promoting values of solidarity. Thus, the nation's benchmark position in terms of sustainable food systems is well-deserved. In general, Nordic European countries are renowned for their progressiveness in terms of sustainability by toping once more the SDG Index of 2018 (Bertelsmann Stiftung & Sustainable Development Solutions Network [SDSN], 2018). However, Sweden's performance is outstanding by representing the frontrunner when considering the SDG Index of 2018

(Bertelsmann Stiftung & SDSN, 2018), as well as the SFSI Index of 2018, pointed up with values among the top four nations in all three categories of the SFSI. Sweden is specifically known for its excellent air-quality, which is reflected in the high category score of ecosystem stability and resilience. Especially among the agriculture dimension, the exceptional performance is approved by a high value. The distinctive agricultural sector of Sweden further contributes beneficially to the overall food availability score, in which agricultural aspects play a decisive part. Moreover, Sweden aims towards indicating the 1st fossil-fuel free nation soon. Thus, it comes by little surprise that Sweden indicates the country with the highest percentage of renewables, which is further enhanced through heavy investments with around 630 million USD in 2016 in solar, wind, smart grids and clean transportation. Furthermore, Sweden has introduced heavy taxed on petrol, diesel, as well as carbon, which further supports the economies shift towards more sustainable patterns. The engagement and solidarity of the Swedes is once more manifested in the high wellbeing score, as well as in the consumption behaviour with approximately 40 percent of Swedish citizens frequently purchasing eco-labelled food and products (Mansson, 2016; Paulin, 2018).

France's high rank is in accordance with the country's substantial sustainable progress taking place over the last years. The sustainable upwards trend has already been approved by taking the first position out of 34 performing countries in the Food Sustainability Index 2017, as well as the Environmental Performance Index 2018, in which France ranks second, after Switzerland. France displays particularly distinct scores in the category Ecosystem Stability and Resilience by taking on position one. This in turn, might be traced back to the intensive focus on food waste reduction and recycling, which serves as main contributor to the GHG emissions. France represents the first country introducing specific food waste legislation to fight the war on waste. Earlier this year, the nation banned supermarkets for throwing out unsold fruits and vegetables and forced restaurants to provide doggy begs for leftovers. Moreover, recycling has been placed as crucial component on the national agenda (Casey, 2017; The Economist Intelligence Unit & BCFN; Zachary Wendling, Jay Emerson, Daniel Esty, Marc A. Levy, & Alex de Sherbinin).

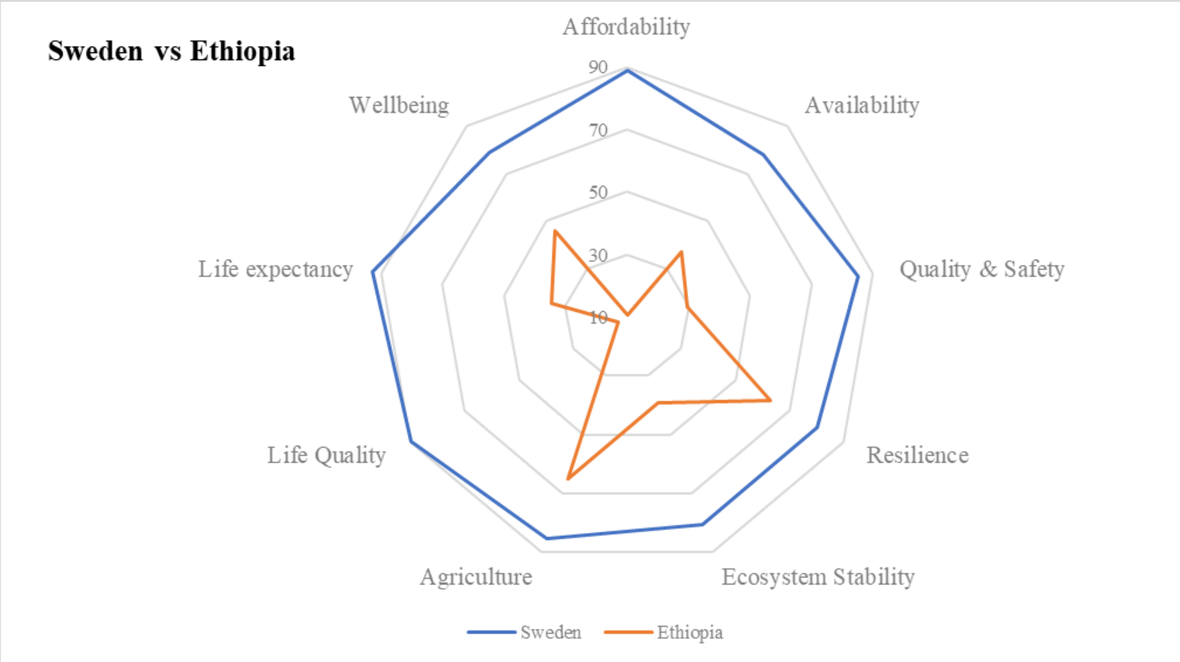
In contrast to Sweden and France, the third rank of the United Kingdom might have been more unforeseeable due expected difficulties in bilateral trading agreements as immediate consequence of the Brexit, which, in turn, heavily questioned the future of the UK. While the UK had showed beneficial progress in terms of overall sustainability, as well as food sustainability due to developing various food manifestos and reports, while simultaneously establishing novel visions and policies to ensure the future of food and farming, the Brexit was feared as major downturn (Lang, Millstone, & Marsden, 2017). However, despite heavy debates surrounding the sustainability future of the UK, diverse composite indicators have positioned the country among the top ten, approved by the FSI 2017 rank' ten and the EPI 2018's rank six (The Economist Intelligence Unit & BCFN; Zachary Wendling et al.). The SFSI 2018 even positions the country on rank three, supported by a strong value in the food security dimension, as well as a top five rank in the sociocultural wellbeing dimension. France only lags among the Ecosystem Stability and Resilience dimension which might be a result of the moderate values in terms of agriculture. This however, might be a result of unsustainable farming methods, a lack in biodiversity as well as the low participation rate of youth in farming (Food Ethics Council, 2017). In contrast, the UK scores highly satisfying in R&D and innovations, animal welfare regulations, food waste policies, recycling and agricultural use, property rights protection, and the adequate nourishment of the population (Food Ethics Council, 2017).

An interestingly good SFSI score is achieved by Israel with a value of around 76 placing the country on rank twelve. With position eleven in terms of food security, the sociocultural wellbeing places the country among the top ten performers. Israel's transition towards more sustainable patterns emerged more out of force due to the urgent need of solving arising water scarcity issues, specifically regarding drinkable water. In line with that, Israel has raised as "start-up nation", in line with various innovations, particularly in information and communication technologies. Nowadays, the country displays the top innovator in the field of clean technologies and provides the world's most environmentally recycled paper, cutting edge water storage solutions, sustainable healthcare programmes, energy conservation, as well as green construction. In addition, Israel's upwards trend is evident with promising sustainable food start-ups, such as TIPA which focuses on compostable bio-packaging, Bram Industries which uses cork instead of plastic to create daily utensils including drinking mugs, as well as Super Meat which has introduced the clean meat production by growing animal cells in the lab, rather than raising them on the farm (Mahadav, 2016). In summary, Israel has made substantial progress in terms of sustainability which intensively and beneficially contributed to the high value in the overall SFSI.

Laggards in terms of sustainable food systems display countries including Indonesia, Nigeria, India and Ethiopia. The ranks of Indonesia, Nigeria and Ethiopia are less surprising as these nations indicate economically poor regions. India's weak position despite representing a BRIC country which has faced vast economic growth over the previous years, once more, points out the severe issues of the country in terms of sustainability. However, India's poor performance comes by little surprise as already the EPI 2018 ranked India at position 177 out of 180 (Zachary Wendling et al.). The adverse conditions the country is facing is specifically apparent in terms of malnourishment with approximately 40 percent of children under five years of age, in combination around 15 percent of the adult's population being affected by undernutrition and hunger, in the year of 2016. The establishment of sustainable food systems in order to allow providing adequate nutrition and food to the general population displays a highly challenging task. However, with a great proportion of children showing signs of irreversible stunted and/or wasted growth, in line with very poor hygiene and sanitation standards bedevilling the situation, establishing sustainable food systems displays a contemporary issue that urgently requires attention (Ritchie, Reay, & Higgins, 2018). These issues become particularly clear within the quality of life dimension, as well as the country's overall food security. Across both dimensions, India is among the three worst performing countries. Overall, India faces challenges on multiple levels including nutrition, health, food safety and quality, as well as the constantly growing population. According to estimates, India might overtake China as the most populated country in 2050 with 1.6 billion inhabitants. In combination with scarcity in resources such as water, land and soil, a transition towards a sustainable food system is inevitable. While India's agricultural productivity has been improved through the Green Revolution which emphasised rapid productivity gains, the biodiversity was subordinated by devoting a great portion of agricultural land to wheat and rice varieties. However, when aiming towards meeting the key-macronutrients – protein, calories and fat - India is in desperate need of enhancing agricultural diversity, in line with a food system transformation (Ritchie et al., 2018).

Furthermore, substantial sustainable agricultural improvements are urgently required in Ethiopia with the country ranking last in the SFSI. Ethiopia represents the largest landlocked country among the African nations and its population accumulated to approximately 93 million people and is heavily challenged in terms of sustainable development. Starting in 2015, national development has been influenced by vast geopolitical issues which resulted in imposing the state of emergency over the country which had been resigned by now due to the new Prime Minister in charge Abiy Ahmed. In addition, changes in climate increasing the overall temperatures further noticeable in heat waves, higher water losses and droughts causing crop losses, intensifies the pressure on smallholder farmers and endangers the country's food and nutrition security even more (Solomon & Lehmann, 2017). These challenges are reflected in the general SFSI score as well as in the individual dimension values. Especially, the low score in terms of food security highlights once more the intense food and nutrition insecurity of Ethiopia. Thus, the last rank in the indicator affordability as well as food quality and safety, complemented by weak food availability rates, mirrors the capacity lack of buying adequate food, low sanitation and hygiene standards, insufficient storage methods, and the supply deficiencies tied to poor agricultural infrastructure, political instabilities and food loss. With the urgent need for sustainable food system enhancements, numerous potential solutions have been introduced recently tackling improved storage technologies which are climate- as well as nutrition smart (Tesfaye & Tirivayi, 2018); incorporating biochar systems to reduce the pressure on the country's national forest and woodlands, while simultaneously enhancing sustainable agriculture and supporting the rehabilitation of degraded land and agroecosystems, as well as utilizing sugar cane waste. Moreover, further emphasis are placed on rice as crucial crop for assuring the country's food security through increasing productivity rates (Solomon & Lehmann, 2017). A direct comparison among the top performer Sweden and Ethiopia is illustrated in Figure 2.

Figure 2
Dimension of SFSI: Sweden vs Ethiopia



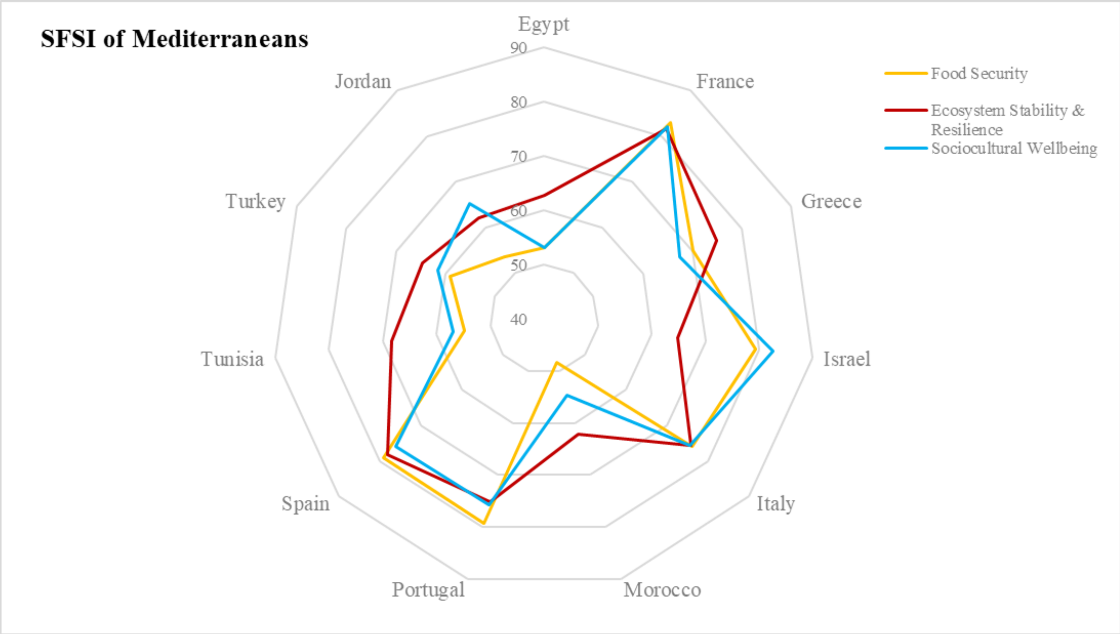
Similar challenges are faced by Nigeria, evident by taking position 31st out of 33 analysed countries in terms of sustainable food systems. Nigeria displays the most populous country in Africa with 180 million inhabitants and, analogue to Ethiopia, its development is shaped by severe poverty and food insecurity (Gesellschaft für Internationale Zusammenarbeit [GIZ], 2017). Furthermore, Nigeria's heavy dependency on urban farming methods is endangered by climatic changes and environmental degradations, what further negatively affects the livelihood of various smallholder farmers as well as their families. In combination with economic problems of 2017, due to the foreign exchange crisis, the operating costs, in line with inflation and the overall outputs, have been affected and urgently pressures the country towards a sustainable solution transition (The Nigerian Economic Summit Group [NSEG], 2017). According to the GIZ (2017), Nigeria lacks basic infrastructure facilities including potable water, energy and sanitation which is reflected in the low food security values, particularly among food affordability and availability with indicators assessing the food consumption as share of household expenditure, access to financing for farmers, as well as agricultural infrastructure, political stability risk and corruption. While Nigeria displays highly unbeneficial scores in almost all categories, the resilience and wellbeing values display moderate values adding up to approximately 60 to 65 and therefore positions the country in the middle field.

These inclined values might be due to the implementation of several programmes that have been aiming towards improving resilience in water, land, air, as well as among communities and households. The programme established by the GIZ (2017), targets the reconstruction of schools, health, water, energy and sanitary facilities, while simultaneously renewing the agricultural, as well as economic activities. Additional programmes display water use efficiency programmes and address the irrigation for rice to enable double cropping. Moreover, the INCD introduced a national programme for watershed-based integrated water resource management through increasing the use of rainwater and sustainable groundwater harvest to intensify the crop and livestock production (Ifejika Speranza, Ochege, Nzeadibe, & Agwu, 2018). Furthermore, Nigeria's government specifically asked for private sector investments in key areas to accelerate economic growth. Moreover, Nigeria recently partnered up with the energy concern Shell to improve the energy efficiency of the country by moving away from crude oil and fossil fuels towards natural gas indicates, which already indicates the fastest growing energy resource, next to hydropower which characterises the largest renewable energy source (Edomah, 2016). Thus, a corner stone for the sustainable transition has been set by recognising the country's severe sustainability issues.

Successful transitioning's towards sustainable food systems, specifically in affluent countries, might be heavily depending on adequate marketing and promotion campaigns, as well as governmental initiatives including food and dietary guidelines and/or recommendations. As highlighted by literature, dietary guidelines might be decisive for adapting more sustainable patterns due to enhancing consumers knowledge which might facilitate the point of purchase in a favourable way for the wellbeing of humans, as well as the planet (World Health Organisation (WHO) Europe, 2018). Notable dietary guidelines and recommendations are present among the Nordic countries, as well as among the Mediterranean region, tied to the Nordic Solution Menu and the Mediterranean Diet, of which both display multi-national approaches (Halloran et al., 2018). When investigating these two regions more in depth, the overall SFSI outcome seem to support the efficiency of the Nordic Solution Menu with Sweden displaying the front-runner across the 33 performing countries in terms of sustainable food systems in place. The effectiveness of the Mediterranean Diet, on the other hand, is more ambiguous with wide spreading values and ranks. While the European Mediterranean countries, Spain, Portugal and Italy rank 9th, 10th and 11th, the Arabic neighbour Morocco illustrates moderate scores and takes position 29th out of 33 analysed food systems. Other Mediterranean countries, such as Israel takes spot 12, Greece ranks 14th, while Turkey, Tunisia and Egypt take position 24th, 26th, 28th. Thus, dietary guidelines might support the sustainable food transition. However, as apparent in the case of Egypt and Morocco, guidelines and recommendations represent theoretically outlined "soft-laws" which guide people towards the aspired outcomes. But the utilisation of such guidelines is not compulsory.

In addition, the Mediterranean region indicates no homogenous group, already apparent when examining demographic characteristics of these countries, such as the income. The average per-head income of the France, Greece, Italy, Portugal and Spain, which illustrate the five northern Mediterranean countries display five times the income of the southern and eastern Mediterranean nations, including Egypt, Jordan, Lebanon, Morocco, Tunisia and Turkey. Additionally, population sizes differ widely, as well as economic and political stability, in line with governmental and institutional capacity (The Economist Intelligence Unit, 2017). Figure 3 graphically illustrates the differences among the Mediterranean countries in terms of the three SFSI categories.

Figure 3
SFSI Dimensions: Mediterranean Regions



6 Concluding Remarks

In the course of human existence, humanity frequently had to live through adverse times. With food illustrating a basic human need which is fundamental for survival, it takes a crucial role within the lifespan of everyone. While the term sustainability nowadays is omnipresent, the need for long-lasting and sustain solutions has commonly appeared in times of despair. Patterns of unsustainability have crossed the history of humans since ancient Greece and had already been apparent in the arising of the Chinese civilisation. Despite Malthus (1798) highlighting the dangers of a constantly growing population, already in the 1800s, through predictions of severe famine and hunger, humans could, once more, counteract to the assumptions made by Malthus with technological innovations and improvements in Know-how. Until now, the ubiquitously growth of the population has not caused the episodic famine Malthus was warning against. On the contrary, particularly in affluent societies, the production could be increased by 20 percent per individual, despite a doubling population size (UN DESA, 2017).

The 21st century food systems in place are coined by unsustainable behaviour across the social, economic and environmental dimension. Intensifying environmental pressures accelerate climatic changes which increases Earth' overall temperature, what in turn declines soil fertility, disrupts water cycles, aggravates the scarcity of resources, expands pathogen ranges and increases the number of extreme weather events. Simultaneously, population growth seems endless, in line with migration prevalently provoked by globalisation and modernisation. Of which altogether tremendously affects the food system (FAO, 2017b; HLPE, 2017). Today more than one billion people face undernourishment and hunger due to inefficiencies in distributional processes, rather than limitations in production. The amount of food produced would allow feeding more than seven billion people, however, the occurring over-consumerism in affluent and emerging societies, in combination with severe food waste and/or loss, has generated multiple forms of malnutrition. While malnutrition and hunger are particularly present in economically poor regions, such as the Sub-Saharan, issues of obesity and overweight are emerging in prosperous economies, like the United States. Economies, exemplified by China and India, which had emerged rapidly through swift economic growth face a particularly heavy double burden of malnutrition, characterised by under- and overnutrition taking place within the same country (CIAT, 2017).

Securing food is becoming exceedingly difficult. Despite the technological advances of the 21st century, in line with the digital revolution, the adequate feeding of the world population is still not guaranteed. With growing political instabilities and crisis, the prices, volatility and availability of foods are bedevilled (Dawe et al., 2015). With high food prices becoming the new normal particularly poor economical regions are heavily burdened by further impeding food security and adequate nutritional intakes. On the contrary, more economically strong regions are facing the consequences of rising food prices by increasing the consumption of cheap foods which are low in micronutrients, but high in energy and saturated fats. Thus, financially strong countries are challenged by a growing number of obese and overweight people, followed by a higher number of NCDs, which in the long run might jeopardise existing health systems (Popkin et al., 2012). Simultaneously, economic poor regions are heavily burdened by a growing number of children below five affected by stunted growth and wasting, which in the long term will eliminate the children's chance for appropriate human development for good. Overall, approximately one billion people are overweight and obese, while around the same amount is undernourished. In spite of every sixth person facing hunger (CIAT, 2017), approximately one third of all produced food is wasted (HLPE, 2014) While food waste occurs at enhancing rates in developed countries at the consumer level, underdeveloped and emerging countries are heavily affected by food loss due to lacking adequate storage facilities and refrigerators (The Economist Intelligence Unit, 2017). Food represents the core of the 2030 Agenda for SD and connects to almost all outlined goals (The Economist Intelligence Unit, 2017). Food systems demonstrate one of the main drivers of global GHG emissions. In line with agricultural processes occupying approximately 70 percent of all arable land, the transition towards sustainable food systems is more urgent than ever. However, with food being deeply entangled in human identity, as well as cultural norms and beliefs, a sustainable shift illustrates a complex undertaking (Affairs, 2017).

Overall, food systems are shaped by highly dynamic processes and drivers, internal as well as external. The European Commission (2016) outlined several main drivers of food systems, such as global trends, volatility, availability, food prices, dietary changes, food waste and loss, as well as supply chain changes. When targeting a sustainable food system transformation, the highlighted factors are decisive and must be taken into consideration. With increasing attention placed on food systems resulting in a widening research field, numerous indicators have been identified, such as SAFA, the global framework for sustainable assessment of food and agricultural systems (FAO, 2013), as well as other composite indicators, including the Global Food Security Index (The Economist Intelligence Unit), the Environmental Performance Index (Zachary Wendling et al.), as well as the Food Sustainability Index (The Economist Intelligence Unit & BCFN). Literature identified three crucial categories of sustainable food systems, including food security, ecosystem stability and resilience, as well as sociocultural wellbeing. In dependency on the outlined categories, a composite indicator has been established which assesses nine dimensions, 39 indicators, 65 sub-indicators and 38 sub-sub-indicators across 33 countries.

The Sustainable Food System Index highlights the progressiveness of the North with Sweden taking the lead in 2018, closely followed by two economically strong countries with France and the United Kingdom on position two and three. In contrary, economically weak countries, including Ethiopia and Nigeria, rank at the bottom. Overall, the sustainable food system index allows comparing the outcomes among respective dimensions and indicators and emphasises the substantial need of specific nations to tackle the severe issues of unsustainability. While economically poor regions, commonly located in the Sub-Saharan region, as well as in South- and Eastern Asia, must deal with arising food insecurity, emerging countries, such as India and China need to tackle the vast inequalities existing within the country borders, particularly in terms of income and distribution. Economically strong countries, on the other hand, must focus on improving agricultural processes, as well as patterns of consumption, including food waste and loss. In addition, novel technologies are urgently required in order to adequately substitute scarce resources, such as land, water and energy. To do so, public, as well as private investments are required, in combination with governmental policies, incentives, awareness raising campaigns, educational programmes and medial support. Numerous countries have already taken on the fight against unsustainable food systems, such as France which indicates the first country to emplace binding laws to prevent supermarkets, as well as restaurants from wasting food (Casey, 2017); Sweden with heavy investments in renewable energy to become the first fossil free nation (Paulin, 2018), in combination with increasing emphasis placed on topics of food and food systems via the Eat Foundation; as well as Israel as frontrunner in sustainable clean technologies (Mahadav, 2016).

It is due to the human greediness, in line with the desire for endless growth and profit that has pushed the planet towards its boundaries. Therefore, it is now in human hands to pour oil on troubled water by straightening what has been done wrong. And food might indeed illustrate the one thing that could fix both, the planetary-, as well as the human health.

6.1 Limitations

Critical reflections are necessary in every study in order to point out research limitations. Despite, the best intentions, limitations might occur in terms of the methodological assessment via composite indicator. Composite indicators offer several benefits by allowing the illustration of complex multi-dimensional processes in a simplified manner, what in turn enables the benchmarking of countries according to their performance and efficiency. This again simultaneously facilitates communication by highlighting focus areas. However, composite indicators point out limitations as well. The oversimplification of complex, dynamic processes might provide misleading messages through simplistic conclusions, which in turn might result in non-robust policies. Furthermore, as a composite indicator displays aggregated values, the failure in one dimension might be compensated by high values in the other dimensions, which cannot be distinguished in the overall indicator score (OECD, 2008). Sustainable food systems are affected by a high degree of complexity, in line with ongoing dynamic processes, elements and actors involved. Thus, the utilisation of a composite indicator might oversimplify sustainable food systems, which might misleadingly reflect reality.

A further limitation is indicated by the weighting of the respective dimensions what can be in various ways. However, specific weighing types, such as the user-weighting, are relatively subjective. While this might be beneficial for the researcher as it provides him with the necessary freedom when selecting adequate weights; it might result in misleading generalisations (Sharpe & Andrews, 2012). Despite the intention of choosing the weights based on the original weightings, some weighting among the SFSI has applied the user-weighting method and therefore might be biased by a certain degree of reflexivity. A further limitation might be traced back to the normalisation process chosen for the data, which is based on min-max normalisation of all dimensions, except for Ecosystem Stability. Among this dimension, the original normalisation process was selected due to some indicators and sub-indicators requiring very specific normalisation methods. Hence, the original approach conducted by the Yale University (2018) has been considered as more appropriate and accurate in terms of the indicator outcome. Additional limitations of the composite indicators illustrate the mix of quantitative as well as qualitative data, depending on the respective indicator. The relatively little number of countries assessed could be another limitation. By increasing the number of investigated countries, the outcomes would be more accurate and meaningful.

6.2 Future Research

Future studies should extend this work by incorporating additional indicators into the SFSI in order to make the composite indicator more comprehensive. Moreover, a wider range of North European countries could be included as the Nordic region is specifically tackled by the "Nordic Solution Menu". Hence, this would allow investigating the impact of the dietary guideline more in depth. Furthermore, it would be of high interest to include actual consumption data of the respective countries, in line with more specific information regarding nutritional intakes. Combining the SFSI with dietary scenarios, including veganism, vegetarianism, pescetariansim, sustainable diets and standard carnivore might reveal interesting facts. Future studies could additionally conduct a time-series analysis to shed light on the progress countries have made in terms of sustainable food systems. Furthermore, future research could divide the indicator among quantitative and qualitative data to enhance the statistical accuracy and soundness of the indicator. And finally, further studies that utilise the SFSI might apply expert-based weighting, which would enhance the accuracy of the overall composite indicator.

6.3 Research Implications

The SFSI displays a composite indicator assessing three categories identified by research as crucial determining factors of sustainable food systems. By merging indicators of existing composite indices, the SFSI illustrates a comprehensive multi-indicator assessment tool measuring the sustainability degree of food systems across selected indicators. The multi-dimensional approach enables investigating food systems from various perspectives allowing to pinpoint areas in which progress has been made, and on the contrary, areas in which improvement and progress is urgently required. Moreover, the SFSI allows setting benchmarks and thus might reveal the advances made by some countries in specific indicators and/or the overall food system. The SFSI illustrates a novel composite indicator applied to measure the sustainability of food systems. However, due to lacking time series comparison, as well as outlined limitations in terms of data gathering, potential policy derivations should be taken with a pinch of salt.

While the SFSI indeed represents a multi-indicator assessment of food systems' sustainability degree, the 2018 version might be more recommendable as supportive foundation to build on for future sustainable food system research.

References

Adams, W. M. (2006). *The Future of Sustainability: Re-Thinking Environment and Development in the Twenty-First Century*. Report of the IUCN Renowned Thinkers Meeting. Retrieved from IUCN website: http://cmsdata.iucn.org/downloads/iucn_future_of_sustanability.pdf

Addis, M., & Holbrook, M. B. (2001). On the conceptual link between mass customisation and experiential consumption: An explosion of subjectivity. *Journal of Consumer Behaviour*, *1*(1), 50–66. https://doi.org/10.1002/cb.53

Affairs. (2017). *Sustainable Development Report 2017*. [S.l.]: United Nations (UN).

Albert, J. (Ed.). (2010). *Woodhead Publishing in food science, technology, and nutrition*. *Innovations in food labelling*. Rome, Cambridge, UK, Boca Raton, FL: Food and Agriculture Organization of the United Nations. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&AN=691345

Anand, S., & Sen, A. (2000). Human Development and Economic Sustainability. *World Development*, *28*(12), 2029–2049. https://doi.org/10.1016/S0305-750X(00)00071-1

Ancellin, R. (2002). *La santé vient en mangeant: Le guide alimentaire pour tous*. [Vanves], [Place of manufacture not identified]: INPES; Lenglet Imprimeurs.

Andrew Muhammad, Anna D’Souza, Birgit Meade, Renata Micha, & and Dariush Mozaffarian. (Feburary 2017). *The Influence of Income and Prices on Global Dietary Patterns by Country, Age, and Gender* (No. 225). Retrieved from Economic Research Service website: https://www.ers.usda.gov/webdocs/publications/82545/err-225.pdf?v=42796

Anne Wiese, A. P. S., & Wilson, J. P. (2015). The triple bottom line. *International Journal of Retail & Distribution Management*, *43*(4/5), 432–447. https://doi.org/10.1108/IJRDM-11-2013-0210

Aranceta Bartrina, J. (2016). Guías alimentarias para la población española (SENC, 2016); la nueva pirámide de la alimentación saludable. *Nutrición Hospitalaria.* Advance online publication. https://doi.org/10.20960/nh.827

AtKisson. The Sustainability Compass: Introduction and Orientation. Retrieved from https://compassu.wordpress.com/2012/03/28/learning-to-use-the-compass/

Banon Gomis, A. J., Guillén Para, M., Hoffmann, W. M., & McNulty, R. E. (2011). Rethinking the Concept of Sustainability. *Business and Society Review*, *116*(2), 171–191.

Barilla Center for Food & Nutrition. (2018). Towards a Common Agri-Food Policy: Policy Recommendation Paving the Way to Sustainability. *Barilla Center for Food & Nutrition*.

Barrios, E., & Komoto, K. (2006). Some approaches to the construction of a sustainable development index for the Philippines. *International Journal of Sustainable Development & World Ecology*, *13*(4), 277–288. https://doi.org/10.1080/13504500609469679

Bennett, M. K. (1941). Wheat in national diets. *Wheat Studies, Food Sea. Inst., Standford Univ., Calif*, *18*, 35–76.

Bertelsmann Stiftung, & Sustainable Development Solutions Network. (2018). *Global Responsibilities: Implementing the Goals*. SDG Index and Dashboards Reports 2018. New York: Pica Publishing ltd. Retrieved from http://www.sdgindex.org/assets/files/2018/01%20SDGS%20GLOBAL%20EDITION%20WEB%20V9%20180718.pdf

Bettman, J. R. (1979). Issues in Research on Consumer Choice. *Assoociation for Consumer Research*, *6*, 214–217.

Bhattacharjee, S., & Cruz, J. (2015). Economic sustainability of closed loop supply chains: A holistic model for decision and policy analysis. *Decision Support Systems*, *77*, 67–86. https://doi.org/10.1016/j.dss.2015.05.011

Bloemhof, J. M., & Soysal, M. (2017). Sustainable Food Supply Chain Design. In Y. Bouchery, C. J. Corbett, J. C. Fransoo, & T. Tan (Eds.), *Springer Series in Supply Chain Management: Vol. 4. Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy* (Vol. 4, pp. 395–412). Cham, s.l.: Springer International Publishing. https://doi.org/10.1007/978-3-319-29791-0_18

Böhringer, C., & Jochem, P. E.P. (2007). Measuring the immeasurable — A survey of sustainability indices. *Ecological Economics*, *63*(1), 1–8. https://doi.org/10.1016/j.ecolecon.2007.03.008

Braun, J. v. (2007). *The world food situation: New driving forces and required actions*. Washington, DC: Internat. Food Policy Research Inst.

Burlingame, B. (2012). *Sustainable diets and biodiversity - Directions and solutions for policy research and action: Proceedings of the International Scientific Symposium Biodiversity and Sustainable Diets United Against Hunger*. Rome: FAO.

Business Dictionary. Production. Retrieved from http://www.businessdictionary.com/definition/production.html

Carlowitz, H. C. v. (1713). *Sylvicultura Oeconomica, oder hauswirthliche Nachricht und naturmässige Anweisung zur wilden Baumzucht … zugleich eine gründliche Nachricht von den in Sächss. Landen gefundenen Turff, dessen Beschaffenheit, nutzen, etc*: Johann Friedrich Braun.

Carter, C. R., & Rogers, D. S. (2008). A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, *38*(5), 360–387. https://doi.org/10.1108/09600030810882816

Casey, R. (2017, December 7). France named Europe's top country for food sustainability thanks to war on waste. *The Independent*. Retrieved from https://www.independent.co.uk/news/world/europe/france-food-sustainability-waste-recycling-economist-intelligence-unit-study-a8096326.html

Chaudhary, A., Gustafson, D., & Mathys, A. (2018). Multi-indicator sustainability assessment of global food systems. *Nature Communications*, *9*(1), 848. https://doi.org/10.1038/s41467-018-03308-7

Chung, R. K., Ichimura, M., Rankine, H., & Leost, P. (2013). *Shifting from quantity to quality: Growth with equality, efficiency, sustainability and dynamism*. Bangkok, Thailand. Retrieved from ESCAP website: www.unescap.org/esd

Custance, J., & Hillier, H. (1998). Statistical issues in developing indicators of sustainable development. *J. R. Statistic. Soc. a.*, *3*(161), 281–290.

Dawe, D., Morales-Opazo, C., Balie, J., & Pierre, G. (2015). How much have domestic food prices increased in the new era of higher food prices? *Global Food Security*, *5*, 1–10. https://doi.org/10.1016/j.gfs.2015.01.001

Dempsey, N., Bramley, G., Power, S., & Brown, C. (2011). The social dimension of sustainable development: Defining urban social sustainability. *Sustainable Development*, *19*(5), 289–300. https://doi.org/10.1002/sd.417

Dernini, S., & Berry, E. M. (2015). Mediterranean Diet: From a Healthy Diet to a Sustainable Dietary Pattern. *Frontiers in Nutrition*, *2*, 15. https://doi.org/10.3389/fnut.2015.00015

Devereux, S. (2009). *Seasonality and Social Protection in Africa*. Working Paper (No. 011). Retrieved from https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/2346/FAC_Working_Paper_011.pdf?sequence=1&isAllowed=y

Díaz-Méndez, C., & García-Espejo, I. (2017). Eating out in Spain: Motivations, sociability and consumer contexts. *Appetite*, *119*, 14–22. https://doi.org/10.1016/j.appet.2017.03.047

Díaz-Méndez, C., & van den Broek, H.-P. (2017). Eating out in modern societies: An overview of a heterogeneous habit. *Appetite*, *119*, 1–4. https://doi.org/10.1016/j.appet.2017.05.003

Dixon, J. A., & Fallon, L. A. (2008). The concept of sustainability: Origins, extensions, and usefulness for policy. *Society & Natural Resources*, *2*(1), 73–84. https://doi.org/10.1080/08941928909380675

Dodds, F., Schneeberger, K., & Ullah, F. (2012). *Review of implementation of Agenda 21 and the Rio Principles: Synthesis*. Sustainable Development in the 21st century (SD21). Retrieved from United Nations website: https://sustainabledevelopment.un.org/content/documents/641Synthesis_report_Web.pdf

Downs, S., & Fanzo, J. (2016). Managing value chains for improved nutrition. In M. Eggersdorfer (Ed.), *Good nutrition: perspectives for the 21st century* (pp. 45–59).

Dyen, M., & Sirieix, L. (2016). How does a local initiative contribute to social inclusion and promote sustainable food practices?: Focus on the example of social cooking workshops. *International Journal of Consumer Studies*, *40*(6), 685–694. https://doi.org/10.1111/ijcs.12281

Ecolabel Index. Ecolabels. Retrieved from http://www.ecolabelindex.com/ecolabels/

The Economist (2016, May 9). Why GDP is a poor measure of progress. *The Economist*.

The Economist Intelligence Unit. Global Food Security Index: Methodology. Retrieved from https://foodsecurityindex.eiu.com/Home/Methodology

The Economist Intelligence Unit. (2017). *Fixing Food: The Mediterranean Region: Building Sustainable Food Systems through Capacity-Building and Co-operation.*

The Economist Intelligence Unit, & BCFN. *Food Sustainability Index Methodology*.

Edomah, N. (2016). On the path to sustainability: Key issues on Nigeria's sustainable energy development. *Energy Reports*, *2*, 28–34. https://doi.org/10.1016/j.egyr.2016.01.004

Eizenberg, E., & Jabareen, Y. (2017). Social Sustainability: A New Conceptual Framework. *Sustainability*, *9*(1), 68. https://doi.org/10.3390/su9010068

Elkington, J. (1998). Partnerships fromcannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management*, *8*(1), 37–51. https://doi.org/10.1002/tqem.3310080106

Eni-ibukun, T. A., Allan, J., Antonich, B., Appleton, A., Kosolapova, E., Kulovesi, K., & Recio, E. (2012). Summary of the Doha Climate Change Conference: 26 November - 8 December 2012. *Earth Negotiations Bulletin - a Reporting Service for Environment and Development Negotiations*, *12*(567). Retrieved from http://www.iisd.ca/climate/cop18/enb/

Etsy, D. C., Garanoff, I. M. E., Ruth, B., & Camera, M. (2002). *Pilot Environmental Performance Index: An Initiative of the Global Leaders of Tomorrow Environment Task Force, World Economic Forum 2002*. Annual Meeting 2002.

Commission Notice on the application of the principle of quantitative ingredients declarationRegulation (EU) No 1169/2011 (European Commission.).

Regulation (EU) No 1168/2011 *Official Journal of the European Union*, European Commission 13.12.2014.

European Commission. (2016). Sustainable Food. Retrieved from http://ec.europa.eu/environment/eussd/food.htm

Notice on the provision of information on substances or products causing allergies or intolerancesRegulation (EU) No 1169/2011 (European Commission 2017).

Evans, A. (2009). *The feeding of the nine billion: Global food security for the 21st century : a Chatham House report*. *A Chatham House report*. London: Chatham House.

Evenson, R. E., & Pingali, P. (Eds.). (2007). *Handbooks in economics: Vol. 18*. *Handbook of agricultural economics: Volume 3: Agricultural development: farmers, farm production and farm markets*. Burlington: Elsevier. Retrieved from http://site.ebrary.com/lib/alltitles/docDetail.action?docID=10185776

Fedoroff, N. V., Battisti, D. S., Beachy, R. N., Cooper, P. J. M., Fischhoff, D. A., Hodges, C. N., . . . Zhu, J.-K. (2010). Radically rethinking agriculture for the 21st century. *Science (New York, N.Y.)*, *327*(5967), 833–834. https://doi.org/10.1126/science.1186834

Feenstra, G., Ingels, C., & Campell, D. (2018). *What is sustainable agriculture?* Sustainable Agriculture Research and Education Program. California. Retrieved from UC Davis Agricultural Sustainability Institute website: http://asi.ucdavis.edu/programs/sarep/about/what-is-sustainable-agriculture

Findiastuti, W., Laksono Singgih, M., & Anityasari, M. (2018). Indonesian sustainable food-availability policy assessment using system dynamics: A solution for complexities. *Cogent Food & Agriculture*, *4*(1). https://doi.org/10.1080/23311932.2018.1455795

Fischer, C. G., & Garnett, T. (2016). *Plates, pyramids, and planets: Developments in national healthy and sustainable dietary guidelines : a state of play assessment*. Rome, Italy, [Oxford]: Food and Agriculture Organization of the United Nations; Food Climate Research Network, University of Oxford.

Flemish Institute Healthy Living. (2017). *The food triangle and physical activity triangle: how and why?*

Food and Agriculture Organization of the United Nations. Food-based dietary guidelines. Retrieved from http://www.fao.org/nutrition/education/food-dietary-guidelines/regions/portugal/en/

Food and Agriculture Organization of the United Nations. (2013). *SAFA Sustainability Assessment of Food and Agriculture Systems: Indicators*. Rome, Italy.

Food and Agriculture Organization of the United Nations. (2014). *Building a common vision for sustainable food and agriculture: Principles and approaches*. Rome: Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization of the United Nations. (2017a). *Building resilience for food and food security*. *The state of food security and nutrition in the world: Vol. 2017*. Rome: FAO.

Food and Agriculture Organization of the United Nations. (2017b). *The future of food and agriculture: Trends and challenges*. Rome: Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization of the United Nations (FAO) Council. (1988). *Report of the FAO Council* (94). Rome.

Food Ethics Council. (2017). *Sustainable Food Systems: How does the UK measure up?* Retrieved from Food Ethics Council website: https://www.foodethicscouncil.org/uploads/publications/sustainability_index_2017_WEB.pdf

Fourat, E., & Lepiller, O. (2017). Forms of Food Transition: Sociocultural Factors Limiting the Diets' Animalisation in France and India. *Sociologia Ruralis*, *57*(1), 41–63. https://doi.org/10.1111/soru.12114

French, D. (1998). Kyoto Protocol to the United Nations Framework Convention on Climate Change. *Journal of Environmental Law*, *10*(1), 215–224. https://doi.org/10.1093/jel/10.1.215

Garnett, T. (2014). *Changing what we eat: A call for research & action on widespread adoption of sustainable healthy eating.*

Garnett, T. (2016). Policy Briefing: sustainable and Healthy Eating Patterns? *Discover Society*. Retrieved from https://discoversociety.org/2016/09/06/policy-briefing-sustainable-and-healthy-eating-patterns/

Gesellschaft für Internationale Zusammenarbeit. (2017). *Strengthening Resilience in North-East Nigeria.*

Geslain-Lanéelle, C. (2008, November). *Food Safety in Europe: Objectives and Strategy of EFSA', The European Food Safety Authority: a European and Danish perspective, Copenhagen.*

Gomez, P., Werle, C. O. C., & Corneille, O. (2017). The pitfall of nutrition facts label fluency: easier-to-process nutrition information enhances purchase intentions for unhealthy food products. *Marketing Letters*, *28*(1), 15–27. https://doi.org/10.1007/s11002-015-9397-3

Goodland, R. (1995). The Concept of Environmental Sustainability. *Annual Review of Ecology and Systematics*, *26*(1), 1–24. https://doi.org/10.1146/annurev.es.26.110195.000245

Grace, D. (2017). *Food safety in developing countries: research gaps and opportunities*. White Paper. Nairobi, Kenya. Retrieved from International Livestock Research Institute website: http://hdl.handle.net/10568/81515

Green, R., Cornelsen, L., Dangour, A. D., Turner, R., Shankar, B., Mazzocchi, M., & Smith, R. D. (2013). The effect of rising food prices on food consumption: systematic review with meta-regression. *BMJ (Clinical Research Ed.)*, *346*, f3703.

Gustafson, D., Gutman, A., Leet, W., Drewnowski, A., Fanzo, J., & Ingram, J. (2016). Seven Food System Metrics of Sustainable Nutrition Security. *Sustainability*, *8*(3), 196. https://doi.org/10.3390/su8030196

Halloran, A., Fischer-Møller, M. F., Persson, M., & Skylare, E. (2018). *Solutions Menu - A Nordic guide to sustainable food policy*: Nordic Council of Ministers.

Hawkes, C. (Ed.). (2004). *Nutritional labels and health claims: the global regulatory environment*. Nutrition Labelling. Geneva, Switzerland: World Health Organization.

Hawkes, C., & Ruel, M. T. (Eds.) 2011. *Value Chains for Nutrition*. Conference Paper 4: IFPRI.

Hawkes, C., Smith, T. G., Jewell, J., Wardle, J., Hammond, R. A., Friel, S., . . . Kain, J. (2015). Smart food policies for obesity prevention. *The Lancet*, *385*(9985), 2410–2421. https://doi.org/10.1016/S0140-6736(14)61745-1

Helliwell, J. F., Layard, R., & Sachs, J. (2018). *World happiness report 2018*. *Canadian Public Documents Collection*. New York, NY: Sustainable Development Solutions Network.

Herforth, A., & Ahmed, S. (2015). The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. *Food Security*, *7*(3), 505–520. https://doi.org/10.1007/s12571-015-0455-8

High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. (2014). *Food losses and waste in the context of sustainable food systems*. Rome, Italy. Retrieved from High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security website: http://www.fao.org/3/a-i3901e.pdf

High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. (2017). *Nutrition and food systems*. Rome.

Holbrook, M. B., & Hirschman, E. C. (1982). The Experiential Aspects of Consumption: Consumer Fantasies, Feelings, and Fun. *Journal of Consumer Research*, *9*(2), 132. https://doi.org/10.1086/208906

Howarth, R. (2012). Sustainability, Well-Being, and Economic Growth, *5*(2), 32–39.

Hsu, A., Alexandre, N., Cohen, S., Jao, P., Khusainova, E., Mosteller, D., . . . et al. (2016). *2016 Environmental Performance Index*. New Haven. Retrieved from www.epi.yale.edu

Hudson, U., & Messa, M. (2017). *Position Paper On Food Losses and Waste*. Retrieved from Slow Food website: https://www.slowfood.com/sloweurope/wp-content/uploads/ING_position_paper_foodwaste_6.pdf

Ifejika Speranza, C., Ochege, F. U., Nzeadibe, T. C., & Agwu, A. E. (2018). Chapter 12 - Agricultural Resilience to Climate Change in Anambra State, Southeastern Nigeria: Insights From Public Policy and Practice. In N. Zinyengere, T. F. Theodory, M. Gebreyes, & C. I. Speranza (Eds.), *Beyond Agricultural Impacts* (pp. 241–274). Academic Press. https://doi.org/10.1016/B978-0-12-812624-0.00012-0

Ingram, J. (2011). A food systems approach to researching food security and its interactions with global environmental change. *Food Security*, *3*(4), 417–431. https://doi.org/10.1007/s12571-011-0149-9

International Center for Tropical Agriculture. (2017). *CIAT Strategic Initiative on Sustainable Food Systems*. California. Retrieved from https://cgspace.cgiar.org/bitstream/10568/79795/5/SUSTAINABLE_FOOD_SYSTEMS_CIAT_STRATEGY_DOCUMENT.pdf

International Panel of Experts on Sustainable Food Systems. (2017). *What makes urban food policy happen? Insights from five case studies.* Retrieved from International Panel of Experts on Sustainable Food Systems (IPES) website: http://www.ipes-food.org/images/Reports/Cities_full.pdf

Janßen, D., & Langen, N. (2017). The bunch of sustainability labels – Do consumers differentiate? *Journal of Cleaner Production*, *143*, 1233–1245. https://doi.org/10.1016/j.jclepro.2016.11.171

Jeffrey, K., & Wheatley, Hanna, Abdallah, Saamah. (2016). *The Happy Planet Index 2016.*

Journal of Food Processing & Technology. Food Production. Retrieved from https://www.omicsonline.org/scholarly/food-production-journals-articles-ppts-list.php

Kahneman, D. (2012). *Thinking, fast and slow*. London: Penguin Books.

Kampus, K. (2017). Realizing the Vision: The Baltic 2030 Action Plan. *Councils of the Baltic Sea States*. Retrieved from http://www.cbss.org/wp-content/uploads/2017/06/Baltic-2030-AP-Final-approved-by-the-CBSS-Foreign-Ministers-20.06.2017-1.pdf

Kasriel-Alexander, D. (2015). *Top 10 Global Consumer Trends for 2016.*

Kearney, J. (2010). Food consumption trends and drivers. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *365*(1554), 2793–2807. https://doi.org/10.1098/rstb.2010.0149

Koutchma, T., & Keener, L. (2015). Novel Food Safety Technologies Emerge in Food Production. *Food Safety Magazine*.

Lambert, D. M. (2008). *Supply chain management: Processes, partnerships, performance* (3. ed.). Sarasota, Fla.: Supply Chain Management Institute.

Lang, T., Millstone, E., & Marsden, T. (2017). A Food Brexit: time to get real: A Brexit Briefing. *University of Sussex Science Policy Research Unit*.

Langen, N., Bauske, E., Dubral, R., Göbel, C., Speck, M., Engelmann, T., . . . Teitscheid, P. (2017). Interventions to Guide Consumers towards Sustainable Nutrition out-of-home – the Perspective of Caterers vs. Guests. Advance online publication. https://doi.org/10.18461/pfsd.2017.1736

Lorenz, B. A., & Langen, N. (2018). Determinants of how individuals choose, eat and waste: Providing common ground to enhance sustainable food consumption out-of-home. *International Journal of Consumer Studies*, *42*(1), 35–75. https://doi.org/10.1111/ijcs.12392

Lowell Center for Sustainable Production. (2018). Sustainable Production Defined.

Lund, T. B., Kjærnes, U., & Holm, L. (2017). Eating out in four Nordic countries: National patterns and social stratification. *Appetite*, *119*, 23–33. https://doi.org/10.1016/j.appet.2017.06.017

Macdiarmid, J. I. (2014). Seasonality and dietary requirements: will eating seasonal food contribute to health and environmental sustainability? *The Proceedings of the Nutrition Society*, *73*(3), 368–375. https://doi.org/10.1017/S0029665113003753

Mahadav, M. (2016). Israel's Burgeoning Sustainable Innovation. Retrieved from https://www.huffingtonpost.com/momo-mahadav/israels-burgeoning-sustai_b_13346284.html

Malthus, T. R. (1798). *An Essay on the Principle of Population*. Newburyport: Dover Publications. Retrieved from http://gbv.eblib.com/patron/FullRecord.aspx?p=1889373

Mansson, M. (2016). Sweden - the world's most sustainable country: Political statements and goals for a sustainable society. *Earth Common Journal*, *6*(1).

Meadows, D. H. (1974). *The limits to growth: A report for the Club of Rome's Project on the Predicament of Mankind* (2. ed.). New York: Universe Books.

Meybeck, A., & Gitz, V. (2017). Sustainable diets within sustainable food systems. *The Proceedings of the Nutrition Society*, *76*(1), 1–11. https://doi.org/10.1017/S0029665116000653

Mill, J. S. (2004). *Principles of political economy* (1st ed.). *Great minds series*. Amherst, NY: Prometheus Books.

Minton, E. A., Spielmann, N., Kahle, L. R., & Kim, C.-H. (2018). The subjective norms of sustainable consumption: A cross-cultural exploration. *Journal of Business Research*, *82*, 400–408. https://doi.org/10.1016/j.jbusres.2016.12.031

Mintz, S. W., & Du Bois, C. M. (2002). The Anthropology of Food and Eating. *Annual Review of Anthropology*, *31*(1), 99–119. https://doi.org/10.1146/annurev.anthro.32.032702.131011

Morelli, J. (2011). Environmental Sustainability: A Definition for Environmental Professionals. *Journal of Environmental Sustainability*, *1*(1), 1–10. https://doi.org/10.14448/jes.01.0002

Nardo, M., Saisana, M., Saltelli, A., & Tarantola, S. (2005). *Tools for Composite Indicators Building*.

Nations, U. (2015). *Millennium development goals report 2015*. [Place of publication not identified]: United Nations Pubns.

Neff, R. A., Parker, C. L., Kirschenmann, F. L., Tinch, J., & Lawrence, R. S. (2011). Peak Oil, Food Systems, and Public Health. *American Journal of Public Health*, *101*(9), 1587–1597. https://doi.org/10.2105/AJPH.2011.300123

Nesheim, M. C., Oria, M., & Yih, P. T. (Eds.). (2015). *A Framework for Assessing Effects of the Food System*. Washington (DC).

The Nigerian Economic Summit Group. (2017). Looking Inwards: Will Nigeria tread the path of Economic Recovery and Growth in 2017?: NSEG Research. *Economic Policy Review*, *16*(1).

Noraziah, A., & Mohd Azlan, A. (2012). The food consumption and eating behaviour of Malaysian urbanites: Issues and concerns. *GEOGRAFIA OnlineTM Malaysia Journal of Society and Space*, *8*(6), 157–165.

Nordic Council of Ministers, N. C. o. M. (2014). Nordic Nutrition Recommendations 2012. *Nordic Nutrition Recommendations 2012*, *5*(11), 1–3. https://doi.org/10.6027/Nord2014-002

Notre Dame Global Adaption Initiative. (2016). ND-Gain Country Index.

OECD. (2008). *Handbook on constructing composite indicators: Methodology and user guide*. Paris: OECD. Retrieved from http://www.sourceoecd.org/9264043454

Orava, H. (2018). Sustainable Growth the Nordic Way: Web Magazine. Retrieved from http://nordic-way.org

Paulin, S. (2018). Sustainable Living in Sweden. Retrieved from https://sweden.se/nature/sustainable-living/

Petersen, B., & Snapp, S. (2015). What is sustainable intensification? Views from experts. *Land Use Policy*, *46*, 1–10. https://doi.org/10.1016/j.landusepol.2015.02.002

Pezzey, J. (1992). *Sustainable Development Concept*: The World Bank.

Pfeiffer, C., Speck, M., & Strassner, C. (2017). What Leads to Lunch—How Social Practices Impact (Non-)Sustainable Food Consumption/Eating Habits. *Sustainability*, *9*(8), 1437. https://doi.org/10.3390/su9081437

Pilgrim, J. F. (1957). The components of food acceptance and their measurements. *The American Journal of Clinical Nutrition*, *5*(2), 171–175.

Pingali, P. L. (2012). Green Revolution: Impacts, limits, and the path ahead. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(31), 12302–12308. https://doi.org/10.1073/pnas.0912953109

Ponting, C. (1990). Historical Perspectives on Sustainable Development. *Environment: Science and Policy for Sustainable Development*, *32*(9), 4–39. https://doi.org/10.1080/00139157.1990.9929051

Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews*, *70*(1), 3–21. https://doi.org/10.1111/j.1753-4887.2011.00456.x

Ramachandran, N. (2000). *Monitoring sustainability: Indices and techniques of analysis*. New Delhi: Concept Publ.

Reisch, L., Eberle, U., & Lorek, S. (2017). Sustainable food consumption: An overview of contemporary issues and policies. *Sustainability: Science, Practice and Policy*, *9*(2), 7–25. https://doi.org/10.1080/15487733.2013.11908111

Ritchie, H., Reay, D., & Higgins, P. (2018). Sustainable food security in India-Domestic production and macronutrient availability. *PloS One*, *13*(3), e0193766. https://doi.org/10.1371/journal.pone.0193766

Rockström, J., Steffen, W., Noone, K., Persson, A., Chapin, F. S., Lambin, E., . . . Foley, J. (2009). Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society*, *14*(2). Retrieved from http://www.ecologyandsociety.org/vol14/iss2/art32/

Rutherford, F. J., & Ahlgren, A. (2010). *Science for all Americans*. New York: Oxford University Press. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=176326

Schor, J. B., & Universiteit Antwerpen. Faculteit Politieke en Sociale Wetenschappen. (2002). *Understanding the New Consumerism: Inequality, Emulation and the Erosion of Well-being*: Faculteit Politieke en Sociale Wetenschappen, Universiteit Antwerpen. Retrieved from https://books.google.pt/books?id=ngNjHAAACAAJ

Sen, A. (1984). The Living Standard. *Oxford Economic Papers*, *36*, 74–90.

Sen, A., & Nussbaum, M. C. (Eds.). (2009). *Studies in development economics*. *The quality of life: A study prepared for the World Institute for Development Economics Research (WIDER) of the United Nations University ; [papers derive from a conference that took place at the WIDER in Helsinki in July 1988]* (Reprinted.). Oxford: Clarendon Press.

Sharpe, A., & Andrews, B. (2012). *An Assessment of Weighting Methodologies for Composite Indicators: The Case of the Index of Economic Well-being*. Ottowa, Ontario.

Shennan, C. (2008). Biotic interactions, ecological knowledge and agriculture. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, *363*(1492), 717–739. https://doi.org/10.1098/rstb.2007.2180

Cannan, E. (Ed.). (2003). *The Wealth of Nations* (Bantam classic ed.). New York NY: Bantam Classic.

Snyder, F., Hu, Z., & Zheng, X. (2018). Slow Food in Europe, the USA and China: A Comparative Perspective. *SSRN Electronic Journal.* Advance online publication. https://doi.org/10.2139/ssrn.3167906

Sobal, J., Khan, L. K., & Bisogni, C. (1998). A conceptual model of the food and nutrition system. *Social Science & Medicine (1982)*, *47*(7), 853–863.

Solomon, D., & Lehmann, J. (2017). *Socio-economic scenarios of low hanging fruits for developing climate-smart biochar systems in Ethiopia: Biomass resource availability to sustainably improve soil fertility, agricultural productivity and food and nutrition security*: Federal Institute for Geosciences and Natural Resources (BGR-Germany). Retrieved from http://ecommons.cornell.edu/bitstream/1813/55321/2/Socio-economic%20scenarios%20.pdf

Solow, R. (1993). An almost practical step toward sustainability. *Resources Policy*, *19*(3), 162–172.

Soysal, M., Bloemhof-Ruwaard, J. M., Meuwissen, M.P.M., & van der Vorst, J.G.A.J. (2012). A Review on Quantitative Models for Sustainable Food Logistics Management. Advance online publication. https://doi.org/10.18461/IJFSD.V3I2.324

Springmann, M., Mason-D'Croz, D., Robinson, S., Garnett, T., Godfray, H. C. J., Gollin, D., . . . Scarborough, P. (2016). Global and regional health effects of future food production under climate change: A modelling study. *The Lancet*, *387*(10031), 1937–1946. https://doi.org/10.1016/S0140-6736(15)01156-3

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., . . . Sörlin, S. (2015). Sustainability. Planetary boundaries: Guiding human development on a changing planet. *Science (New York, N.Y.)*, *347*(6223), 1259855. https://doi.org/10.1126/science.1259855

Stevenson, A. (2010). The Oxford dictionary of English. *Oxford Reference Online Premium*. Retrieved from http://www.oxfordreference.com/view/10.1093/acref/9780199571123.001.0001/acref-9780199571123

Stockholm Resilience Centre. (2018). *The nine planetary boundaries*. Retrieved from Stockholm Resilience Centre website: http://www.stockholmresilience.org/research/planetary-boundaries/planetary-boundaries/about-the-research/the-nine-planetary-boundaries.html

Sustainable Development Solutions Network. (2018). Pathways Towards Sustainable Land-Use and Food Systems. Retrieved from http://unsdsn.org/news/2018/01/05/pathways-towards-sustainable-land-use-and-food-systems/

Tesfaye, W., & Tirivayi, N. (2018). The impacts of postharvest storage innovations on food security and welfare in Ethiopia. *Food Policy*, *75*, 52–67. https://doi.org/10.1016/j.foodpol.2018.01.004

Thomas, A.-C., Hombres, B., Casubolo, C., Kayitakire, F., & Saisana, M. (2017). *The use of the Global Food Security Index to inform the situation in food insecure countries*. *EUR, Scientific and technical research series: Vol. 28885*. Luxembourg: Publications Office.

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. *Proceedings of the National Academy of Sciences of the United States of America*, *108*(50), 20260–20264. https://doi.org/10.1073/pnas.1116437108

Tversky, A., & Kahneman, D. (1992). Advances in prospect theory: Cumulative representation of uncertainty. *Journal of Risk and Uncertainty*, *5*(4), 297–323. https://doi.org/10.1007/BF00122574

United Nations. (2002). *Report of the World Summit on Sustainable Development: Johannesburg, South Africa, 26 August - 4 September 2002*. New York: UNITED NATIONS.

United Nations. (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. *United Nations*. Retrieved from https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

Article 11 - The right to adequate food, United Nations General Assembly 1999.

United Nations, Department of Economic and Social Affairs, Population Division. (2017). World Population Prospects: The 2017 Revision: Key Findings and Advance Tables. *United Nations, Department of Economic and Social Affairs, Population Division*.

United States Department of Agriculture, The Economic Research Service. (2016). *Percent of consumer expenditures spent on food, alcoholic beverages, and tobacco that were consumed at home, by selected countries, 2015*. Food Expenditure Series 2016.

Valin, H., Sands, R. D., van der Mensbrugghe, D., Nelson, G. C., Ahammad, H., Blanc, E., . . . Willenbockel, D. (2014). The future of food demand: understanding differences in global economic models. *Agricultural Economics*, *45*(1), 51–67. https://doi.org/10.1111/agec.12089

Van Zanten, H., Hornborg, S., Ziegler, F., Tetens, I., Leip, A., Kuiper, M., & Boer, I. de. (2017). Baseline sustainability assessment of the current state of livestock/fish and fruit/vegetables supply chains: Deliverable No. 5.1. *SUSFAN*.

Verain, M. C.D., Bartels, J., Dagevos, H., Sijtsema, S. J., Onwezen, M. C., & Antonides, G. (2012). Segments of sustainable food consumers: A literature review. *International Journal of Consumer Studies*, *36*(2), 123–132. https://doi.org/10.1111/j.1470-6431.2011.01082.x

Wakeland, W., Cholette, S., & Venkat, K. (2012). Food transportation issues and reducing carbon footprint. In J. I. Boye & Y. Arcand (Eds.), *Food Engineering Series. Green technologies in food production and processing* (pp. 211–236). New York: Springer. https://doi.org/10.1007/978-1-4614-1587-9_9

Waters, C. N., Zalasiewicz, J., Summerhayes, C., Barnosky, A. D., Poirier, C., Gałuszka, A., . . . Wolfe, A. P. (2016). The Anthropocene is functionally and stratigraphically distinct from the Holocene. *Science (New York, N.Y.)*, *351*(6269), aad2622. https://doi.org/10.1126/science.aad2622

Welsch, H. (2005). Constructing Meaningful Sustainability Indices. In C. Böhringer & A. Lange (Eds.), *ZEW Economic Studies: Vol. 31. Applied Research in Environmental Economics* (Vol. 31, pp. 7–22). Heidelberg: Physica-Verlag Heidelberg. https://doi.org/10.1007/3-7908-1645-0_2

World Commission on Environment and Development. (1987). Our Common Future: Report of the World Commission on Environment and Development.

World Health Organisation. (2018). *World health statistics 2018: Monitoring health for the SDGs*. Geneva: World Health Organisation (WHO).

World Health Organisation (WHO) Europe. (2018). *Better food and nutrition in Europe: a progress report monitoring policy implementation in the WHO European Region*. Marmorvej, Copenhagen. Retrieved from WHO website: http://www.euro.who.int/__data/assets/pdf_file/0005/355973/ENP_eng.pdf?ua=1

Yale University. (2018). *2018 Technical Appendix*. Environmental Performance Index (EPI). Retrieved from Yale University website: https://epi.envirocenter.yale.edu/downloads/epi2018technicalappendixv02.pdf

Zachary Wendling, Jay Emerson, Daniel Esty, Marc A. Levy, & Alex de Sherbinin. *2018 Environmental Performance Index (EPI).*

Appendix A: Sustainable Food System Index Ranking

Table 11
Sustainable Food System Index: Ranking

Rank	Country	SFSI
1	Sweden	83,618
2	France	82,234
3	UK	81,226
4	Germany	80,971
5	Canada	79,972
6	US	79,608
7	Australia	78,323
8	Japan	77,952
9	Spain	77,741
10	Portugal	76,702
11	Italy	75,744
12	Israel	75,571
13	South Korea	71,392
14	Greece	70,869
15	Hungary	70,862
16	Argentina	67,250
17	Russia	66,252
18	UAE	65,795
19	Brazil	64,994
20	Colombia	64,702
21	Mexico	64,151
22	Saudi Arabia	63,800
23	China	63,711
24	Turkey	61,694
25	Jordan	60,312
26	Tunisia	60,043
27	South Africa	57,104
28	Egypt	56,317
29	Morocco	55,068
30	Indonesia	52,843
31	Nigeria	44,172
32	India	42,736
33	Ethiopia	36,639

Appendix B: Food Security Ranking

Table 12
Food Security: Ranking

Rank	Country	Food Security
1	UK	84.947
2	US	84.877
3	Australia	84.478
4	Sweden	83.475
5	Canada	83.412
6	Germany	81.734
7	France	80.842
8	Portugal	79.200
9	Spain	79.018
10	Italy	78.117
11	Israel	77.115
12	Japan	76.843
13	South Korea	74.335
14	Greece	72.417
15	Hungary	71.531
16	Saudi Arabia	70.627
17	UAE	68.647
18	Brazil	65.131
19	Mexico	64.751
20	Argentina	64.459
21	China	63.853
22	Russia	63.330
23	Turkey	61.145
24	South Africa	59.473
25	Colombia	56.661
26	Tunisia	54.825
27	Jordan	53.593
28	Egypt	53.143
29	Morocco	50.572
30	Indonesia	48.466
31	India	46.481
32	Nigeria	32.295
33	Ethiopia	27.537

Table 13
Food Security Dimensions: Ranking

Rank	Country	Affordability	Rank	Country	Availability	Rank	Country	Food Quality & Safety
1	UAE	95.891	1	UK	83.107	1	Portugal	90.524
2	US	95.247	2	Canada	79.033	2	France	88.276
3	Australia	91.393	3	Sweden	77.913	3	Greece	86.957
4	Germany	89.948	4	Australia	77.785	4	US	86.269
5	UK	88.954	5	US	74.945	5	Australia	85.598
6	Sweden	88.884	6	Germany	74.806	6	Spain	85.548
7	Canada	87.991	7	Portugal	73.723	7	Sweden	85.247
8	France	86.609	8	France	72.895	8	Canada	84.007
9	Japan	85.399	9	Spain	71.649	9	Italy	82.713
10	Italy	84.639	10	Italy	70.517	10	Israel	81.165
11	Spain	84.513	11	Israel	70.037	11	South Korea	80.971
12	Saudi Arabia	84.046	12	South Korea	69.942	12	Japan	80.729
13	Israel	83.281	13	Japan	67.651	13	Germany	80.253
14	Portugal	80.695	14	Greece	66.433	14	UK	79.987
15	Hungary	79.022	15	Hungary	64.911	15	Brazil	74.336
16	South Korea	76.512	16	Egypt	62.260	16	Russia	73.804
17	Russia	73.204	17	Saudi Arabia	62.112	17	Mexico	72.161
18	Greece	73.182	18	China	61.908	18	Argentina	72.117
19	Brazil	69.843	19	Mexico	59.958	19	Hungary	71.006
20	Argentina	67.660	20	Argentina	58.764	20	China	68.757
21	Mexico	67.059	21	South Africa	58.272	21	Turkey	67.774
22	China	64.031	22	Turkey	57.741	22	UAE	67.653
23	Turkey	62.238	23	Brazil	57.500	23	Saudi Arabia	60.496
24	South Africa	62.208	24	India	55.650	24	Egypt	59.549
25	Colombia	61.801	25	Morocco	53.724	25	Tunisia	59.540
26	Jordan	55.419	26	Tunisia	53.477	26	Colombia	58.537
27	Tunisia	54.422	27	Jordan	53.202	27	South Africa	55.938
28	Indonesia	49.152	28	Indonesia	51.808	28	Morocco	53.052
29	Morocco	46.114	29	Colombia	51.305	29	Jordan	50.104
30	Egypt	40.551	30	Russia	50.545	30	Nigeria	46.233
31	India	37.742	31	UAE	44.242	31	India	43.113
32	Nigeria	19.427	32	Ethiopia	42.162	32	Indonesia	37.560
33	Ethiopia	10.690	33	Nigeria	38.924	33	Ethiopia	29.439

Appendix C: Ecosystem Stability & Resilience

Table 14
Ecosystem Stability & Resilience: Ranking

Rank	Country	Resilience & Ecosystem Stability
1	France	81.601
2	Sweden	81.425
3	Spain	78.181
4	Germany	77.580
5	Italy	75.723
6	Portugal	75.166
7	Greece	74.887
8	Hungary	73.321
9	Canada	73.074
10	Japan	72.918
11	Russia	71.722
12	UK	71.673
13	Tunisia	68.313
14	US	67.240
15	Australia	65.151
16	Israel	64.904
17	Turkey	64.604
18	Argentina	64.536
19	Colombia	63.061
20	Egypt	62.755
21	Brazil	62.199
22	South Korea	62.173
23	Jordan	62.074
24	Morocco	62.071
25	Mexico	58.899
26	Nigeria	58.742
27	China	57.995
28	South Africa	55.357
29	Ethiopia	53.890
30	Saudi Arabia	52.428
31	Indonesia	50.524
32	India	45.754
33	UAE	44.280

Table 15
Ecosystem Stability & Resilience Dimensions: Ranking

Rank	Country	Resilience	Rank	Country	Ecosystem Stability	Rank	Country	Agriculture
1	Hungary	84.877	1	France	83.948	1	Sweden	85.459
2	Tunisia	81.071	2	Sweden	80.508	2	Italy	83.236
3	France	80.500	3	UK	79.953	3	Japan	82.422
4	Sweden	80.324	4	Spain	78.391	4	Greece	81.778
5	Canada	78.731	5	Germany	78.370	5	Hungary	80.725
6	Spain	78.133	6	Italy	76.964	6	Portugal	80.166
7	Russia	77.406	7	Israel	75.007	7	South Korea	80.099
8	Germany	76.317	8	Japan	74.685	8	Turkey	79.161
9	Portugal	75.924	9	Australia	74.126	9	France	79.109
10	Greece	72.727	10	Greece	73.601	10	Germany	78.526
11	Italy	70.725	11	Canada	72.179	11	Israel	78.487
12	Turkey	68.966	12	Portugal	71.907	12	Spain	77.856
13	US	67.359	13	US	71.190	13	Russia	76.229
14	UK	67.118	14	Colombia	65.220	14	Colombia	75.649
15	Argentina	66.884	15	Russia	63.786	15	Indonesia	75.243
16	Japan	66.398	16	Morocco	63.466	16	Morocco	74.095
17	Nigeria	65.936	17	Tunisia	62.346	17	Egypt	72.500
18	China	63.793	18	South Korea	62.299	18	Mexico	71.902
19	Jordan	63.679	19	Egypt	61.213	19	Jordan	71.050
20	Brazil	63.153	20	Brazil	60.700	20	Argentina	70.251
21	Ethiopia	63.013	21	Mexico	59.687	21	South Africa	67.552
22	Australia	60.628	22	Argentina	59.331	22	Ethiopia	64.934
23	South Africa	59.886	23	Hungary	58.063	23	Saudi Arabia	64.927
24	Egypt	59.424	24	Jordan	55.981	24	UK	64.226
25	India	55.608	25	UAE	55.724	25	Canada	63.548
26	Morocco	54.665	26	Saudi Arabia	54.638	26	Brazil	63.292
27	Colombia	54.608	27	Turkey	52.963	27	China	60.870
28	South Korea	53.083	28	China	50.759	28	Nigeria	60.350
29	Mexico	51.608	29	Nigeria	50.744	29	US	59.101
30	Israel	48.009	30	Indonesia	46.925	30	India	56.417
31	Saudi Arabia	43.969	31	South Africa	44.729	31	Australia	56.246
32	Indonesia	41.764	32	Ethiopia	39.246	32	Tunisia	54.732
33	UAE	33.900	33	India	30.569	33	UAE	42.149

Appendix D: Sociocultural Wellbeing

Table 16
Sociocultural Wellbeing: Ranking

Rank	Country	Socio Cultural Wellbeing
1	Australia	80.752
2	Sweden	78.724
3	US	76.984
4	UAE	76.384
5	UK	75.987
6	Indonesia	73.310
7	Germany	71.678
8	Israel	69.204
9	Canada	67.227
10	France	66.478
11	Colombia	66.094
12	Argentina	64.071
13	Mexico	63.947
14	Saudi Arabia	62.027
15	Japan	60.241
16	Brazil	60.026
17	Nigeria	59.359
18	Portugal	59.206
19	Spain	59.114
20	China	58.202
21	Italy	57.332
22	Hungary	56.782
23	Russia	56.416
24	South Africa	56.210
25	South Korea	49.930
26	Jordan	49.480
27	India	47.786
28	Ethiopia	46.076
29	Morocco	43.830
30	Turkey	42.844
31	Greece	36.238
32	Egypt	33.140
33	Tunisia	27.478

Table 17
Sociocultural Wellbeing Dimensions: Ranking

Rank	Country	Life Quality	Rank	Country	Life Expectancy	Rank	Country	Wellbeing
1	South Korea	97.431	1	Japan	100.000	1	Australia	80.752
2	UK	96.638	2	Italy	94.347	2	Sweden	78.724
3	Canada	95.432	3	France	93.950	3	US	76.984
4	Japan	94.568	4	South Korea	93.657	4	UAE	76.384
5	US	93.821	5	Spain	93.553	5	UK	75.987
6	France	91.768	6	Israel	92.863	6	Indonesia	73.310
7	UAE	91.074	7	Sweden	92.759	7	Germany	71.678
8	Israel	90.666	8	Canada	91.870	8	Israel	69.204
9	Sweden	89.806	9	Australia	91.076	9	Canada	67.227
10	Germany	87.691	10	Greece	91.076	10	France	66.478
11	Australia	87.084	11	Portugal	90.084	11	Colombia	66.094
12	Greece	86.948	12	UK	90.084	12	Argentina	64.071
13	Colombia	86.930	13	Germany	88.401	13	Mexico	63.947
14	Portugal	85.125	14	US	81.066	14	Saudi Arabia	62.027
15	Italy	84.446	15	UAE	76.510	15	Japan	60.241
16	Spain	84.188	16	China	75.423	16	Brazil	60.026
17	China	82.766	17	Mexico	74.723	17	Nigeria	59.359
18	Argentina	81.019	18	Argentina	73.636	18	Portugal	59.206
19	Jordan	80.951	19	Hungary	73.239	19	Spain	59.114
20	Brazil	80.577	20	Tunisia	70.366	20	China	58.202
21	Tunisia	79.830	21	Turkey	69.373	21	Italy	57.332
22	Turkey	76.271	22	Morocco	68.673	22	Hungary	56.782
23	Mexico	76.171	23	Brazil	67.983	23	Russia	56.416
24	Saudi Arabia	75.954	24	Colombia	65.904	24	South Africa	56.210
25	Hungary	75.951	25	Saudi Arabia	65.800	25	South Korea	49.930
26	Russia	73.921	26	Jordan	65.507	26	Jordan	49.480
27	Egypt	71.757	27	Russia	57.879	27	India	47.786
28	South Africa	71.679	28	Egypt	55.496	28	Ethiopia	46.076
29	Morocco	58.696	29	Indonesia	52.330	29	Morocco	43.830
30	Indonesia	54.835	30	India	45.883	30	Turkey	42.844
31	Nigeria	49.801	31	Ethiopia	34.483	31	Greece	36.238
32	India	24.667	32	South Africa	26.656	32	Egypt	33.140
33	Ethiopia	13.366	33	Nigeria	0.000	33	Tunisia	27.478