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The Food Security Concept: Definition, Conceptual Frameworks, Measurement and Operationalisation

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Abstract

The concept of food security appeared in policy forums and documents during the 1970s as a concern largely for developing countries. Today, food security stands centre stage in developing and developed nations. It is a multidimensional concept, which rests on the four pillars of availability, access, utilisation and stability. As our understanding of this complex concept deepens, there are persuasive arguments to add the elements of food agency, food sovereignty and food sustainability, to make it a six-pillar framework. The argument is that this framework better informs policy and global responses to short- and long-term food security challenges. One of the main challenges of the concept of food security is its measurement. This arises due to the fact that there are multiple units of analysis at macro, meso and micro levels. Even the pillars of food security are measured at different scales. This has resulted in the proliferation of hundreds of food security metrics and definitions. The currently accepted definition of food security encapsulates the complexity of the concept but does not assist in developing appropriate metrics. Development projects in Africa that state food security as an objective need to develop relevant food security definitions to guide the assessment of achieving that objective, otherwise measuring its success is reduced to an evaluation of increase in food production—yet we know food security goes beyond production.

Keywords: Africa; food agency/sovereignty; food security; food sustainability; measurement; operationalisation

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Résumé

Le concept de sécurité alimentaire est apparu dans les forums et documents politiques des années 1970 comme une préoccupation majeure pour les pays en développement. Aujourd'hui, la sécurité alimentaire occupe une place centrale dans les pays en développement et développés. Il s'agit d'un concept multidimensionnel qui repose sur les quatre piliers que sont la disponibilité, l'accès, l'utilisation et la stabilité. À mesure d'une meilleure compréhension de ce concept complexe, des arguments convaincants viennent ajouter des éléments d'agentivité, de souveraineté et de durabilité alimentaires, pour en faire un cadre à six piliers. L'argument est que ce cadre éclaire mieux les politiques et les réponses mondiales aux défis de sécurité alimentaire à court et à long termes. L'un des principaux défis du concept de sécurité alimentaire est sa mesure. Il est dû à l'existence plusieurs unités d'analyse aux niveaux macro, méso et micro. Même les piliers de la sécurité alimentaire sont mesurés à différentes échelles. Cela a entraîné la prolifération de mesures et de définitions de la sécurité alimentaire. La définition actuellement acceptée de la sécurité alimentaire résume la complexité du concept mais ne permet pas de développer des mesures appropriées. Les projets de développement en Afrique qui font de la sécurité alimentaire un objectif doivent élaborer des définitions pertinentes de la sécurité alimentaire afin de guider l'évaluation de la réalisation de cet objectif, au risque de voir la mesure de leur succès se réduire à une évaluation de l'augmentation de la production alimentaire—pourtant nous savons que la sécurité alimentaire va au-delà de la production.

Mots-clés : Afrique ; agentivité/souveraineté alimentaire ; sécurité alimentaire ; durabilité alimentaire ; mesure ; opérationnalisation

Introduction

Food security appeared in scholarly discourse around the 50s but in policy discourse around the 70s, when it was developed as a concept relevant to developing countries (Clapp *et al*. 2022). The food crisis of 2008, which was triggered not by a lack of food production but by structural issues in markets (Warr 2014; Wald and Hill 2016), thrust the concept right in front of policymakers in developed and developing countries (AFED 2014; Candel 2014; Hopma and Woods 2014; Jarosz 2014; Lang and Barling 2012; Wald and Hill 2016; Bobe, Procopie and Bucur 2019). Estimates show that about 902 million people were malnourished in the developing world in 2008 and that about 795 million people in the world (not necessarily in the developing countries) were undernourished between 2014 and 2016 (Boratyńska and Huseynov 2017; Leventon and Laudan 2017).

When micronutrient deficiency is considered, this number is even higher (Leventon and Laudan 2017). It is also estimated that 1 billion people in the world suffer from chronic hunger (McCarthy *et al*. 2018).

In Sub-Saharan Africa, 25 per cent of the population is chronically hungry (Ashley 2016). Compared to 2019, in 2020 about 57 million more people in Asia, about 14 million more in Latin America and the Caribbean and about 46 million more in Africa were affected by hunger. Partly due to the lasting effects of the Covid-19 pandemic on food security, about 660 million people may still face hunger in 2030 (FAO *et al*. 2021). Some 20 per cent of children in the developing world are undernourished and half of all child deaths worldwide have some association with poor nutrition (Ashley 2016; McCarthy *et al*. 2018).

Malnutrition in all its forms remains a global challenge. It is not yet possible for the impact of the Covid-19 pandemic to be fully accounted for; however, in 2020, it was estimated that 6.7 per cent (45.4 million) of children under 5 years of age were suffering from wasting, 22 per cent (149.2 million) were affected by stunting and 5.7 per cent (38.9 million) were overweight (FAO *et al*. 2021). The necessary development of policies that address this situation requires a consistent understanding of the food security concept, which has not been the case over time or across interest groups (Candel 2014).

After the 2008 food crisis, the food security debate globally focused on emergency relief, followed by food production, ahead of all other concerns like improved markets or sustainability. This was essentially triggered by the need to feed the 9 billion people anticipated to populate the planet by 2050, which would require a 70 to 100 per cent increase in food production (Fouilleux, Bricas and Alpha 2017). Private foundations and transnational corporations have joined efforts to meet this need. These include Dupont, The International Fertilizer Development Center, Olam International, the Bill and Melinda Gates Foundation (such as through its alliance with the Rockefeller Foundation's Alliance for a Green Revolution in Africa, AGRA), Syngenta, Yara, Monsanto, Coca-Cola and many biotechnology companies (Fouilleux *et al*. 2017). The diversity of interest groups adds more variations to our understanding of the food security concept since private companies are motivated by profit. It is the existence of these various understandings and the complex and multidimensional nature of food security (Maxwell and Smith 1992; Maxwell 1996; Young 2004; Jones *et al*. 2013; Candel 2014; Ike 2015; Burchi and De Muro 2016; Upton, Cissé and Barrett 2016; Fouilleux *et al*. 2017; McCarthy *et al*. 2018) that leads to the myriad definitions of food security.

Clapp *et al*. (2022) correctly observe that 'There have been many attempts to define food security as a concept and there exist several hundred definitions of it in the literature to date…'. Researchers report the existence of more than two hundred definitions in published writings (Maxwell and Smith 1992; Maxwell 1996; FAO 2003; Lang and Barling 2012; Shetty 2015; Ashley 2016; Zidouemba 2016; Gartaula *et al*. 2017). Maxwell (1996:169) lists thirty-two examples of definitions, which he argues reflect three paradigm shifts in food security thinking: from the global and the national to the household and the individual; from a food-first to a livelihood perspective; and from objective indicators to subjective perception. Food security is described in multiple ways (Wald and Hill 2016; Bobe *et al*. 2019), with economists generally perceiving it as a supply and demand relationship directly related to transfers and income growth (Boratyńska and Huseynov 2017).

There is an accepted and widely cited definition of food security (FAO 1996, 2000, 2006, 2009; Young 2004; Lang and Barling 2012; Clapp 2014; Hopma and Woods 2014; Warr 2014; Shetty 2015; Upton *et al*. 2016; Fouilleux *et al*. 2017; McCarthy *et al*. 2018), which states:

> Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. (FAO 2003:28)

This definition was officially established by the 1996 World Food Summit (Fouilleux *et al*. 2017) and officially reaffirmed by the Food and Agriculture Organization (FAO) in the 2009 Declaration of the World Summit on Food Security (Shetty 2015). This definition immediately raises the question of levels or scales of analysis. Food security can be discussed, conceptualised, analysed and operationalised at different scales—micro (individual), meso (household and community) and macro (community, national, regional and global) (Wald and Hill 2016; Fouilleux *et al*. 2017; Clapp *et al*. 2022).

The objective of this paper is to present concisely the food security conceptual frameworks, food security measurements and the operationalisation of the food security concept, as well as the associated challenges. We have not found a paper that accomplishes this in the literature. The following section describes the food security conceptual frameworks, after which there is a review of the different measurements of food security. Finally, a case study which illustrates the operationalisation of food security is presented, highlighting some of the challenges faced.

Food Security Conceptualisation Frameworks

The Four-pillar Food Security Conceptualisation Framework

It is generally accepted that the food security concept rests on four pillars: availability, access, utilisation and stability (FAO 2006; Hopma and Woods 2014; Ike 2015; Shetty 2015; Upton *et al*. 2016; Gartaula *et al*. 2017; McCarthy *et al*. 2018; Bertelli 2020; Clapp *et al* 2022). In this framework there is an inherent hierarchy, as follows: availability is necessary but not sufficient for access, which is necessary but not sufficient for utilisation, with all three being necessary for stability. The pillars are referenced, for example, by the Integrated Food Security Phase Classification (IPC) guidelines, which stress that field assessors should view these pillars as interacting with one another in a sequential manner (IPC 2021:31). The four pillars are almost always referenced in a specific order: availability, access, utilisation, stability (Clapp *et al*. 2022).

The FAO Food Security Policy Brief (2006:1) clearly lays out the four-pillar food security conceptualisation framework, as follows:

1. ***Food availability***: The availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports and including food aid.
2. ***Food access***: Access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet.
3. ***Utilisation***: Utilisation of food through adequate diet, clean water, sanitation and healthcare to reach a state of nutritional wellbeing where all physiological needs are met.
4. ***Stability***: To be food secure, a population, household or individual must have access to adequate food at all times without risking losing access to food as a consequence of sudden shocks.

Whether the four-pillar approach to conceptualising and defining food security sufficiently captures the full range of dimensions that matter for food security has recently been questioned. This has resulted in suggestions to incorporate two more dimensions, namely agency/sovereignty and sustainability to the food security definition, policy and analysis frameworks (Clapp *et al*. 2022).

The Six-pillar Food Security Conceptualisation Framework

Lang and Barling (2012:320) note that 'The history of food, a basic human need, is a long one of power politics, yet policy and scientific reports usually side-step the issue, preferring to offer themselves as neutral, leaving the

terrain to NGOs …'. Furthermore, for decades hunger and malnutrition have been linked with structural problems within food systems across the world. It is puzzling therefore that social movements, scholars and activists have not explicitly recognised and advocated for the inclusion of the politics of food systems, and therefore sovereignty, in the food security analytical framework (Wald and Hill 2016). The adoption of the six-pillar framework would address this concern.

As Lang and Barling (2012) point out, the inclusion of more civil society participation in the FAO's Committee on Food Security after the 2007–2008 food price crisis was probably one of the biggest steps towards considering food sovereignty as part of the food security concept. Clapp *et al*. (2022) stress that the need to shift the framing of food security to the six-pillar framework is urgent because the way in which governments and multilateral organisations conceptualise food security has important implications for food policy design and the implementation of food security programmes as well as for monitoring efforts. The urgency of this reframing lies in the current circumstances of rising global hunger. Clapp *et al*. (2022) also point out that, currently, food security assessments do not include agency and sustainability. This may be so because those two factors are excluded from the conceptualisation and definition of food security.

Agency and sustainability are important food security dimensions at the macro level, as follows: it is important 'to give formal recognition to agency and sustainability as dimensions of food security alongside the four established pillars since its recommendations influence policy and programs at both the national and international levels' Clapp *et al*. (2022:6). The explicit recognition of agency and sustainability will help to close the gap between the implementation of food policies on the ground and broad policy statements at national and international levels (Clapp *et al*. 2022). It may also assist smallholder producers in developing countries who have few frameworks for participation in food system decision-making and generally lose control of their food system beyond the farm gate.

Sustainability as a Food Security Dimension

The growing awareness of the interconnections between food systems and ecological systems, among other global systems, has encouraged the inclusion of sustainability as a dimension in the conceptualisation and analysis of food security (Clapp *et al*. 2022). Sustainability refers to food system practices that achieve the long-term regeneration of social, natural and economic systems while meeting the food needs of current generations, without detrimental

effects on the food needs of future generations. Sustainability is concerned with the connections between livelihoods, society, political economy and ecosystems in supporting food security and maintaining food systems into the distant future for the purposes of future generations (Clapp *et al*. 2022; Mapiye 2022).

Sustainability is enshrined in the UN's Sustainable Development Goals (SDGs), explicitly in SGD 2, which calls for more sustainable, healthier and more equitable food systems. Sustainability has been foregrounded because of the degradation of ecological systems, especially in light of climate change. Ecological systems deserve special attention in relation to the sustainability of food systems (Clapp *et al*. 2022; Mapiye 2022) and, therefore, food security because they provide the necessary material foundation for the production of food. It has been recognised that ecosystems have limits and therefore they need restoration.

It is clear from the extant literature that the major food production systems are not sustainable and that, although technology has improved short-term food security by enhancing the ability to produce food, largely through improved yields (Fischer, Byerlee and Edmeades 2009), technological development has generally worsened the sustainability of food systems (Clapp *et al*. 2022). Private companies, which are leading the technological frontier, are motivated by profit which often acts against sustainability. As a result, they often exclude or ignore the dissonant voices of civil society (Fouilleux *et al*. 2017) whose vision of global food systems often seeks to protect sustainability and the rights of smallholders in developing countries. Wald and Hill (2016) argue that current food security discourses are not adequate for ensuring sustainable and just food economies. Therefore, the world needs a solution to the paradox of increased food security coupled with decreasing sustainability, especially the sustainability of small-scale agriculture (Gartaula *et al*. 2017).

It also appears that we may need to pay more attention to what Jarosz (2014: 168) refers to as '… the geographic context and the political economy of development and underdevelopment'. These contexts become more and more relevant as the differences between the understanding of sustainable food systems and food preferences are shaped by environments. For instance, in the developed world, where there is a general overconsumption of meat, there is a movement to reduce the consumption of meat because it is perceived to be produced under environmentally unsustainable practices and systems that are insensitive to animal welfare (Neff *et al*. 2018; Sahlin 2022). However, in the developing world, there is a general underconsumption of meat and there are vulnerable groups, like lactating and pregnant women

and children, whose food security and health would benefit from consuming more, not less, animal source foods (Paul *et al*. 2021). Also, in developing countries, it is possible to reduce the negative environmental impacts of livestock by developing sustainable systems of producing meat rather than by reducing meat consumption (Farmer Angus, 2021; Paul *et al*. 2021; Mapiye 2022). Given this, it appears that the conceptualisation of sustainability and, therefore, food security is developing differently for the global North and global South. The question then is, where do these differences need to be captured? The answer is, probably in the sustainability dimension.

The arguments to include sustainability in the six-pillar food security framework are persuasive. But despite this, and even though agency and sustainability have become generally recognised as dimensions of food security in recent literature, they are not explicitly recognised in a systematic way at the international level (Clapp *et al* 2022). Clapp *et al* (2022: 3) lament that:

> 'In the absence of a formal adoption of a six-dimensional conceptualisation of food security in policy settings, the scholarly literature continues to utilise the four-pillar framework, sometimes with supplementary frameworks to capture missing elements.'

Meanwhile, the (mis)understanding or exploitation of the food security concept is leading to a new scramble for Africa through landgrabs (Jarosz 2014). These are justified through export ambitions and/or claims of improving (national) food security, yet they lead to the displacement of peoples who lose their income and ability to produce their own food and therefore end up being food insecure. Sometimes these landgrabs negatively affect sustainability either because of where the displaced population is settled or through the unsustainable practices of the land grabbers, or both (Fisseha 2022).

The Agency/Sovereignty Food Security Dimension

Fouilleux *et al*. (2017) observe that there is evidence of a fragmentation in global food security governance, with competition between some stakeholders that results in global governance failure while food insecurity persists on the ground. Given the unending hunger among society's least advantaged, the ever-widening inequalities (some of which were distinctly highlighted, although not necessarily all caused, by Covid-19) and the food security complexities that are implied in the definition of food security just described, the calls to expand the four-pillar framework to include agency and sustainability get louder (Clapp *et al*. 2022). The addition of

the agency dimension is often justified by the fact that there are power imbalances and inequalities at household, community, national and global levels, and these consistently constrain the ability of food systems to reduce poverty and achieve equitable and sustainable livelihoods (Clapp *et al*. 2022). The addition of agency is therefore, generally argued from a human development perspective.

Agency gives people the ability to address power imbalances (inequalities) in the food system and shape their own relationship with the food system. Even though we understand that there is no linear relationship between reduced inequalities and food security, we understand that poverty can be most effectively and sustainably eradicated by empowering the poor, who are vulnerable to food insecurity. This includes boosting the opportunities and capacities of the poor and vulnerable through the more equitable redistribution of resources like income, land and social protection, by using progressive and not regressive taxation, education, state infrastructure investments and related approaches (Neufeld, Hendriks and Hugas 2021). Wald and Hill (2016:205) also contend that the '… scale at which processes take place is intimately connected with struggles over the economy and society'. These processes expose the tensions, especially about resource control over food systems (global food chains versus smallholders in developing countries), between transnational corporations and civil society and their seemingly divergent visions of the future of food systems. One way to address this is the concept of 'glocalisation', a dynamic, hybridised scalar arrangement of global and local processes (Wald and Hill 2016).

Broadly defined and based on Sen, agency means a person has the freedom to do and achieve the pursuit of whatever goals or values he or she regards as important (Clapp *et al*. 2022). When interpreted in the context of food security, agency means the ability to exercise voice, make decisions and act upon them to improve one's own and the community's wellbeing. Agency has tended to focus on the fact that societal inequities deter people's ability to control their own circumstances, and this affects their ability to determine their own wellbeing. Agency, therefore, affects how people participate in their food systems and is concerned with issues of self-determination and autonomy, especially with reference to cultural acceptability and the upholding of human dignity (Clapp *et al*. 2022).

Proponents of the inclusion of food sovereignty in the conceptual framework of food security argue that farmers should have a stronger voice in shaping food institutions and systems (Clapp *et al*. 2022). They contend that decision-making should be more equitable and accountable to those

involved in the current food systems who are most adversely affected by their and our outcomes (Neufeld *et al*. 2021). The food sovereignty supporters also argue that it can give us a better understanding of the politics of scale (Wald and Hill 2016). Food sovereignty emphasises peoples' right to define the food systems that apply to them and their access to culturally acceptable foods (and, therefore, their own livelihood). The proponents argue that it is important to consider the whole process of production to final consumption—that is, where food is produced, who produces it, who controls the means of food production, where food is consumed and how food gets from the plant or field to the plate (Hopma and Woods 2014). Political mobilisation around peasant rights is the aim of this explicitly normative concept (Clapp 2014). Although it is often argued that agency and sovereignty can be oppositional, agency also is often perceived as necessary for the achievement of food sovereignty (Patel 2009; Clapp 2014; Wald and Hill 2016).

Food sovereignty is defined as '…the right of nations and peoples to control their own food systems, including their own markets, production modes, food cultures and environments …' (Wittman *et al*. 2010: 2). La Via Campesina (1996, an organisation which positions itself as a worldwide movement that defends small-scale sustainable agriculture and opposes corporate-driven agriculture, which it often accuses of causing inequality in (local) food systems (Leventon and Laudan 2017), states:

> Food sovereignty entails the sustainable care and use of natural resources especially land, water and seeds. We, who work the land, must have the right to practice sustainable management of natural resources and to preserve biological diversity. This can only be done from a sound economic basis with security of tenure, healthy soils and reduced use of agro-chemicals ... Peasants and small farmers must have direct input into formulating agricultural policies at all levels. This includes the current FAO World Food Summit from which we have been excluded. The United Nations and related organisations will have to undergo a process of democratisation to enable this to become a reality. (La Via Campesina 1996:2)

Thus, food sovereignty emphasises the 'right to have rights' (Hopma and Woods 2014:777) while taking cognisance of sustainability.

As Hopma and Woods (2014) note, La Via Campesina leaves it to individual communities, nations and regions to determine the meaning of food sovereignty based on their own set of unique circumstances. It thus avoids imposing a definition of food sovereignty on its participants. This raises the concern that food sovereignty has many interpretations and operational definitions which interact with different operational contexts

(Wald and Hill 2016; Leventon and Laudan 2017). But, one could argue, so does food security, hence the existence of the 200-plus food security definitions. However, in the 2007 Declaration of Nyéléni in Mali, La Via Campesina defines food sovereignty as the '… right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods and their right to define their own food and agriculture systems' (La Via Campesina 2007; Jarosz 2014:174; Leventon and Laudan 2017:23). This definition incorporates consumption and sustainability, the latter of which transnational food corporations, given their profit orientation, do not seem to pay much attention to.

Hess (2008), cited in Leventon and Laudan (2017:23), interprets food sovereignty as '… a form of localism, whereby sovereignty is regained over the economy. … Food sovereignty emphasises the positive synergies between agriculture, social justice, dignity and the conservation of nature', elements of which are clearly incorporated in the La Via Campesina definition, and which clearly link with sustainability.

The idea of food sovereignty as a dimension of food security is still debatable. Some argue that it should be included within the definition of agency (Clapp *et al*. 2022). Some actually view food sovereignty as an alternative approach to achieving food security at the local level by protecting the environment and biodiversity while delivering broader social values by using non-industrial agricultural production methods, which causes tensions between food security and food sovereignty (Hopma and Woods 2014). While this debate rages on, there are governments like those in Mali, Bolivia, the Dominican Republic, Venezuela, Senegal, Nicaragua and Ecuador that have already integrated food sovereignty into the legislation of their food security strategies (Leventon and Laudan 2017). This is despite the concern raised by Wald and Hill (2016) that theoretical impoverishment still characterises food sovereignty. It is important to analyse the impacts of capitalist developments and power relations on local ecologies and agricultural development (Jarosz 2014) and to incorporate the basis of these analyses into the definition and operationalisation of food security.

Yet fundamental questions linger. For instance, does adding more pillars to the conceptual framework of food security add to the plurality of pathways in which food systems can be transformed so as to address hunger? (Hopma and Woods 2014). If it is generally accepted that more pillars should be added, do they also have to be incorporated into the definition of food security as the other four pillars/dimensions have been, thus possibly adding to the 200-plus definitions of food security that already exist?

Measuring Food Security

Food security is notoriously hard to measure (De Cock *et al*. 2013; Ashley 2016; Clapp *et al*. 2022). For a long time, the FAO used two elements to assess food security. The first was food availability. Based on a Food Balance Sheet by food type, an estimate of calories of food produced was added to an estimate of calories of food imported and divided by the population. One could refer to this as the supply side. This was then compared to individual energy nutritional needs based on WHO standards, which require 2,500 Kcal per day for a working adult to be in good health. The second element used budget and consumption data from national surveys to compute a population's mean caloric consumption. This could be called the demand side. Food availability and consumption thresholds below which a population was deemed food insecure were then applied. Even though heavily criticised, these measures dominated food security measurement and debate probably due to their economy and simplicity. One major weakness of this approach is that annual changes often cannot be tracked due to the irregularity of the collection of national survey data (Fouilleux *et al*. 2017).

The 2008 food crisis led to heavy criticism of the FAO approach. As a result, new indicators, some introduced by private actors, and previously marginalised indicators, like International Food Policy Research Institute's Global Hunger Index, received more attention. In 2014 the FAO started using the Food Insecurity Experience Scale (FIES) by leveraging private data (Fouilleux *et al*. 2017). This approach was probably motivated by the United States Agency for International Development (USAID), which started collecting food security data from surveys that asked about peoples' food security experiences over the previous 12 months.

The metrics used to describe the global food security situation in the first paragraph of this article demonstrate the complexity of food security measurement. There is a profusion of food security metrics, which is a direct result of the copious food security definitions. Sometimes the results of the different measurements are not easy to reconcile, largely because they address different food security dimensions whereas most indicators focus on one aspect/dimension/scale of food security at a time (Upton *et al*. 2016). For instance, empirical evidence shows that estimates of the share of food-insecure households differ considerably depending on the metrics used. Jones *et al*. (2013) observe that the options of food security measurement are dizzying. Gartaula *et al*. (2017) mention that there are no less than 450 food security measurement indicators. As Ike (2015: 31) puts it: 'Each of the … food security measures has been developed based on a particular

understanding of the concept of food security and with a specific aim in mind. Each measures a different dimension of food security, while some measure a combination of dimensions.'

Measurement efforts have historically focused on food availability as an important policy issue (Fouilleux *et al*. 2017; Bertelli 2020). Warr (2014) asserts that the amount of food produced currently seems enough for everyone, leaving 'only' the problem of food distribution to individuals. However, as indicated by the food security dimensions, food security goes beyond availability and distribution. Thus, there is still a considerable amount of debate surrounding food security measurement (Bertelli 2020) and the subject is contentious and unclear (Upton *et al*. 2016) despite being high on the development agenda for the past seventy years (Bertelli 2020). Some of the metrics used to measure and describe food security status are described in the following section.

Food Security Measurement at National Level

Food availability is mostly assessed and measured at national level using measures that include but are not limited to prevalence of undernourishment; Global Hunger Index (GHI); Global Food Security Index (GFSI); The Integrated Food Security Phase Classification (IPC).

Prevalence of Undernourishment

Widely used by the FAO, this measures national food supply and therefore food availability. It is based on national food balance sheets that calculate food produced nationally minus exports plus imports minus nonfood uses. Assumptions in this calculation and the level of aggregation are problematic in describing food security, so complementary indicators—such as share of energy supply derived from cereals, roots and tubers; average supply of protein of animal origin; prevalence of undernourishment considering energy needs for higher amounts of physical activity—are used in interpreting the prevalence of undernourishment (Jones *et al*. 2013; Warr 2014; Upton *et al*. 2016).

Global Hunger Index (GHI)

Also used at national level, this index measures hunger using three equally weighted indicators: undernourishment (as a percentage of people in a population); child underweight (the proportion of children younger than 5 years who have a low weight for their age); and child mortality for those under 5 years. A 100-point scale is used to rank countries as having 'low'

to 'extremely alarming' hunger. Data for this index comes from the FAO (undernourishment), UNICEF (child mortality) and WHO and UNICEF (low weight for age). A major criticism of this measure is that some of the determinants of the child health and undernutrition indicators are not necessarily a direct function of food insecurity (Jones *et al*. 2013; Warr 2014; Upton *et al*. 2016; Lv *et al*. 2022).

Global Food Security Index (GFSI)

This index is sponsored by DuPont. The Economist Intelligence Unit developed it using thirty indicators that represent three food security domains: availability (ten indicators), affordability (six indicators) and quality and safety (fourteen indicators). It is also used to rank a country's food security status. It is recalculated quarterly to account for shifts in price data. The data is sourced from World Bank, the FAO, the World Food Programme (WFP) and the World Trade Organization (WTO). Expert panels and analysts from the academic, non-profit and public sectors provide scoring for the qualitative indicators used in the GFSI. A criticism of this metric is that, with thirty indicators, it has a high data requirement and is complex and difficult to interpret (Jones *et al*. 2013; Warr 2014; Upton *et al*. 2016).

The Integrated Food Security Phase Classification (IPC)

This is derived from a consultative process by experts who arrive at a consensus regarding the interpretation of evidence from multiple domains, including livelihood change, food consumption, nutrition and health, vulnerability and hazards. IPC was developed from the USAID-funded Famine Early Warning Systems Network (FEWS NET), which produces monthly food security updates for twenty-five countries. Using IPC, food insecurity is classified into phases, from 'minimal' to 'stressed', 'crisis', 'emergency' or 'famine', which can be applied to geographic units ranging from villages to provinces. An important data source for the IPC is WFP's Comprehensive Food Security and Vulnerability Analyses (CFSVAs) (Jones *et al*. 2013; Upton *et al*. 2016, IPC 2019).

Food Security Measurement at Household Level

Household-level food access metrics include but are not limited to: household consumption and expenditure surveys (HCES); the dietary diversity proxy; food consumption score (FCS); household dietary diversity score (HDDS); coping strategies index (CSI); United States Household Food

Security Survey Module (HFSSM); household food insecurity access scale (HFIAS); household hunger scale (HHS); and the Escala Latinoamericana y del Caribe de Seguridad Alimentaria (ELCSA), or Latin American and Caribbean Household Food Security Scale.

Household Consumption and Expenditure Surveys (HCES)

Although these surveys are not a metric in themselves, they are increasingly used as a source of data for food access. Usually, they measure access by estimating food acquisition and assume that acquisition equals consumption. However, acquired food could be lost, fed to animals, wasted, go bad or be gifted. Improvements are being made to this data source, which is important because these surveys are less costly to conduct compared to detailed dietary intake assessments. The surveys are becoming increasingly popular and have been adopted by many countries (Jones *et al*. 2013; Larsen and Lilleør 2014; Ike 2015).

The Dietary Diversity Proxy

This instrument has been demonstrated to correlate with anthropometry and household food security proxy indicators, such as per capita daily caloric availability, food expenditure, asset ownership, household income and education. Data on dietary diversity is easy to collect and therefore this metric is easy to use. However, there is no single definition of dietary diversity as it is a function of culture (Jones *et al*. 2013).

Food Consumption Score (FCS)

For this measure, households are asked to report on the frequency of consumption of eight food groups, which include foods like maize, rice, sorghum, cassava, potatoes, millets, pulses, vegetables, fruit, meat and fish, dairy products, sugar and oil. Each food group is assigned weights, which are determined by a team of food analysts based on their energy, protein and micronutrient densities—for example, meat, milk and fish = 4, pulses = 3, staples = 2, vegetables and fruits = 1, sugar and oil = 0.5. The frequency of consumption of a food group is then multiplied by the weight and summed for a household to get a food consumption score. The score is used to classify households using categorical variables. These describe households as poor (households that fall short of consuming at least one staple food and one vegetable each day of the week) and acceptable (households that are expected to consume oil and pulses daily, in addition to staples and vegetables). This is an easy-to-use indicator for which the data is also easy to collect.

Evidence from Africa shows that consumption scores correlate with asset indices, kilocalories consumed per capita per day and total monthly household expenditure. However, cut-off points for categories can sometimes underestimate food insecurity as measured by calorie consumption per capita. Furthermore, in areas where fruits are not easy to find, fruit consumption can be an indicator of food security, yet the low weighting of fruits does not reflect this. Even though the food consumption score is measured at household level, the WFP uses it to establish food insecurity prevalence in a country or region (Jones *et al*. 2013; Upton *et al*. 2016).

Household Dietary Diversity Score (HDDS)

This measure was developed by the Food and Nutrition Technical Assistance Project of USAID. Similar to the FCS, the person responsible for food preparation in the household is asked if any household member consumed food from any of the twelve food groups, namely, cereal grain staples, roots and tubers, vegetables, fruits, meat, eggs, fish, pulses and nuts, dairy products, oils and fats, sugar and condiments. Summing up the results produces a score between 1 and 12. There is evidence that there is an association between this metric and some indicators of food security like employment and income (De Cock *et al*. 2013; Jones *et al*. 2013; Ike 2015, Upton *et al*. 2016).

There are also household level food security measures based on participatory adaptation. These are context-specific metrics that use context-specific information from groups of stakeholders in the districts and communities where food security is being measured.

Coping Strategies Index (CSI)

This index was developed by WFP and the Cooperative for Assistance and Relief Everywhere (CARE) International. It is based on a generic list of strategies that households use to manage food access problems. Participants in focus groups are then asked to adapt the generic coping strategies to specific contexts. Respondents are asked about their relative use of coping strategies over the previous month. Once the coping strategies are identified, focus groups then attach severity weightings to the coping strategies. The information on severity weightings and the frequency of use of coping strategies is then combined to compute a final index score. The score is not very useful for interpreting the food security circumstance of a household, but when compared with other households and when computed over time for the same household/s it provides a very sound

indication of food security status and changes over time. Evidence from Africa shows that CSI correlates with other indicators of household food security, like total expenditure per capita. CSI uses rapid rural appraisal techniques that make it easy to use and cost-effective in comparison to indicators that require costly survey data collection procedures (Jones *et al*. 2013; Upton *et al*. 2016).

United States Household Food Security Survey Module (HFSSM)

This survey contains eighteen questions that ask households about their subjective experiences of four domains of food insecurity:

1. perceptions that the quality or quantity of accessible food is not adequate;
2. anxiety about household food supplies;
3. reduced food intake by children;
4. reduced food intake by adults.

The information is used to classify households as food secure, having low food security, or very low food security. This is a direct food-security experience measure that does not rely on second-generation food security indicators, like household income and expenditure. This metric has been adapted and used in sub-Saharan Africa, Latin America and South Asia, yielding results that show an association with other food security indicators like total expenditure per capita and total daily per capita food expenditure (Jones *et al*. 2013).

The Household Food Insecurity Access Scale (HFIAS)

This measure is a modification of the HFSSM above. Instead of asking twelve (and possibly eighteen) questions, HFIAS uses nine generic questions, including those that assess frequency, asking if the food (in) security condition was experienced often, sometimes or rarely. A score from 1 to 27 is calculated and a four-level categorical variable can be calculated that reflects the prevalence of food insecurity, which can be used for targeting, monitoring and evaluating food security programmes. Evidence shows that there is an association between this indicator and other food security indicators, like household per capita income and dietary adequacy. However, there are some questions about whether HFIAS measures the same constructs across contexts and cultures. This is because the food security aspects covered in questions 1 to 6 may be open to different interpretations across cultures and especially when translated to local languages; there may be no direct translations for some concepts, leading to questions about this

method's cross-cultural validity. There are also concerns about item ordering and severity calibrations (De Cock *et al*. 2013; Jones *et al*. 2013; Sharaunga, Mudhara and Bogale 2016; Ike 2015).

Household Hunger Scale (HHS)

This measure uses only the last three questions from HFIAS:

1. Question 7: Was there ever no food at all in your household because there were not resources to get more?
2. Question 8: Did you or any household member go to sleep at night hungry because there was not enough food?
3. Question 9: Did you or any household member go a whole day and night without eating anything because there was not enough food?

These questions are less open to interpretation than questions 1 to 6 of HFIAS. Also, a three-item scale, including the three frequency responses of never, sometimes and rarely, is used instead of the four-item scale used in the HFIAS. Evidence shows that this structure is more consistently understood across contexts and cultures and therefore has been found to have more cross-cultural validity. However, the three questions measure experiences about hunger, not food security, so HHS should be used in combination with other food security measures (Jones *et al*. 2013).

Escala Latinoamericana y del Caribe de Seguridad Alimentaria (ELCSA)

Translated into English as the 'Latin American and Caribbean Household Food Security Scale', this is a sixteen-item scale variation of the HFSSM, which has been adapted for and tested in Latin America and the Caribbean Islands and found to be regionally valid. This is the only regionally validated food security metric of its kind and raises questions about whether regions like sub-Saharan Africa and parts of Asia, where food insecurity is a persistent concern, need similar adaptations for regional comparability (Jones *et al*. 2013).

Anthropometry

It is important to emphasise that the metrics used to measure food access actually measure food acquisition, not actual consumption (Jones *et al*. 2013; Borlizzia, Delgrossib and Cafieroa 2017). They are also usually applied across contexts without adaptation (Jones *et al*. 2013). Regarding the metrics for food utilisation, anthropometry is considered the gold standard. Anthropometric indicators have been linked to morbidity and mortality outcomes, chronic disease and cognitive development. Anthropometry uses measures of height, weight, mid-upper arm circumference and measurements

of skinfolds, in combination with age and sex. The indices computed from these measurements—for example, body mass index (BMI)—are then compared to population standards. However, anthropometric indicators are influenced by access to health services, hygiene and the sanitation environment and not just by food intake. Also, they do not measure intra-household food distribution, and it is possible for a food-secure household to contain some members who are undernourished (Jones *et al*. 2013; Upton *et al*. 2016; Bobe *et al*. 2019).

Challenges of Measuring Food Security

It is important to note that individual and household-level data is costly and difficult to collect and is usually subject to quality concerns, especially for comparability and aggregability across groups. The variable definitions of food security, especially across countries, make international noncomparability a challenge. Also, data is rarely collected consistently over time. Worst of all, these challenges tend to be more prevalent where food security challenges are high (Upton *et al*. 2016), for instance in Africa.

The metrics reviewed display a distinct absence of one that concurrently addresses all four dimensions encapsulated in the accepted definition of food security. Upton *et al*. (2016), using complex econometric procedures, demonstrate how recent advances can be adapted to address all the elements in the accepted definition of food security. Although their effort is insightful and commendable, their method is complex and suffers from the data availability and aggregation issues that plague other food security measures. A simple, cost-effective measure of food security that satisfies all four elements in the accepted food security definition at the different scales remains elusive. Indeed, the question remains, is there a need for the development of such a measure, or would it be satisfactory to use different indicators depending on scale and or element/s of interest?

Upton *et al*. (2016: 135) observe that: 'A primary purpose of a precise, agreed definition is to provide a template for understanding the problem, designing solutions, targeting policies and assessing progress.' Assessing progress requires measurement and the use of indicators. However, it is difficult to develop a single indicator that covers all four food security dimensions (Ike 2015). Bertelli (2020), therefore, asks whether we should regard the currently accepted definition of food security as a comprehensive but diplomatic definition, but the operationalisation of which across the different food dimensions is challenging, if not impossible, especially in resource-poor areas where food security measurements really need to be undertaken because of the (high) prevalence of food insecurity.

Jones *et al*. (2013: 502) observe that: 'The definition's comprehensiveness, although well suited as a political tool to motivate action around food security and hunger on multiple fronts, may preclude its use as a guide for operationalising food security metrics.' Ksenofontov *et al*. (2018) also wonder whether, since the definition stipulates access to food by all and at all times, it is an ideal that cannot be realised in practice and therefore cannot be measured. Warr (2014: 521) observes that the problem with this definition is that it is non-quantitative and, based on this definition, 'It is not obvious how varying degrees of departure from full food security could be quantified … [yet] ... An operational definition of food security must support quantification'. Ike (2015) also supports this notion. The only meritorious aspect of this definition is that it introduces the several food security complexities (Young 2004), but food security still is often measured by looking at just one single dimension or a couple of dimensions at a time. For example, food supply interventions usually address food availability exclusively, even though ignoring food accessibility could fail to effectively reduce food insecurity (Bertelli 2020).

Even though they are not officially included in the conceptualisation of food security, there are metrics that measure agency and sustainability. Those that measure agency in relation to women include the Women's Empowerment in Nutrition (WEN) grid, the Women's Empowerment in Nutrition Index (WENI), the Women's Empowerment in Agriculture Index (WEAI), women's decision-making ability with respect to expenditure, the status of employment, perceptions of domestic violence, and the Women's Empowerment in Livestock Index (WELI). These mostly measure the participation of women in food system decision-making in relation to men (Clapp *et al*. 2022). Metrics that measure agency at macro, meso and micro levels could be developed—for instance, metrics that measure the empowerment of consumers over food purchase and consumption and those that measure the participation of farmers in local food system decision-making and governance, national food self-sufficiency, numbers and types of food producers and measures of domestic market concentration.

The measurement of the sustainability dimension happens already to some extent. For instance, the FAO tracks soil nutrient budgets, livestock patterns, fertiliser, pesticide and land use indicators, as well as food system indicators (Clapp *et al*. 2022). However, these factors need to be formally incorporated into food security assessments so as to inform food security policy formulation. The sustainability of diets can also be assessed, and this has led to metrics like Sustainable Nutrition Security (SNC) (Clapp *et al*. 2022). The challenge with the sustainability metrics is their ability

to move in opposite directions and thus they fail to provide a composite indication of whether a food system is becoming more or less sustainable over time.

Operationalisation of the Food Security Concept

After independence in many African countries the project approach to development was adopted and is still used particularly in the agricultural sector, which plays a central role in many African economies (Hofisi and Chisimba 2013). Many of these development projects aspire not only to improve the livelihoods of the beneficiaries but also to improve their food security status. For example, the South African government uses the project approach to develop and improve the food security and livelihoods (Sharaunga *et al*. 2016) of the previously disadvantaged Black smallholder farmers who contribute significantly to the national agricultural GDP. Although South Africa is considered food secure at the national level in terms of the availability of food (De Cock *et al*. 2013), Bobe *et al*. (2019) observe that many people in the world cannot access already available food. Even though access to sufficient food is a constitutional right in South Africa (Republic of South Africa 1996), De Cock *et al*. (2013) found that 53 per cent of the households in Limpopo Province, for instance, are severely food insecure. Clover (2003) corroborates this by observing that in some parts of the world, the number of undernourished people is growing. This is the case in some parts of Africa, where the problem of food security sometimes reaches crisis proportions. This is despite the fact that world food production has generally grown faster than the world's population. Therefore, in Africa food security is an important development objective.

The Limpopo IDC Nguni Cattle Development Project

One of the development projects at work in South Africa is the Limpopo IDC Nguni Cattle Development Project. The centrality of livestock to many smallholder communities in many developing countries, and especially in Africa, is unquestionable. This is true in the Limpopo Province where the project is being implemented (Mapiye *et al*. 2019). The smallholders who are beneficiaries of this project are largely subsistence farmers, but among them are farmers who, through different provincial efforts, are transitioning between subsistence and commercialisation. These are referred to as emerging (smallholder) farmers. Such projects that can generate household income and or create jobs are encouraged by the Department of Agriculture, Forestry and Fisheries (Republic of South Africa 2013).

The Limpopo IDC Nguni Cattle Development Project is described in detail by Mapiye (2017), Mapiye *et al*. (2019), Nkadimeng (2019) and Makombe (2022). Farmers who already have grazing and infrastructural capacities are selected for this project (Nkadimeng 2019). Since smallholder farmers generally do not have access to grazing land, the selected farmers are mostly beneficiaries of the South African land reform programme (Makombe 2018). When potential beneficiaries meet the selection criteria, they are given a herd of cattle which comprises thirty pregnant Nguni heifers/cows and a bull, a package worth about ZAR 370,000 (USD = ± ZAR 16 at time of writing) (Mapiye *et al*. 2019). Farmers who have sufficient land resources apply to be part of the project; their herds can be topped up to fifty pregnant cows/heifers and two bulls, a package worth an estimated ZAR 634,000 (Mapiye *et al*. 2019). After a period of five years, each beneficiary is expected to pay back exactly the same herd components, which are passed onto another beneficiary (Mapiye 2017; Mapiye *et al*. 2019; Nkadimeng 2019). The project started in 2006 with sixty-two beneficiaries (Mapiye 2017; Nkadimeng 2019), a number that is increasing through the livestock pass-on system (Makombe 2022). The Limpopo Department of Agriculture manages the livestock pass-on system on the project (Mapiye 2017). The objectives of the project include, among others, improving cattle production through the reintroduction of the Nguni breed into the province and improving food security.

Projects like the Limpopo IDC Nguni Cattle Development Project, where alleviating poverty and increasing food security nationally or among participating households are explicitly stated as overall intervention development objectives (Larsen and Lilleør 2014), are not uncommon in national development programmes. The question is how the achievement of the objectives can be assessed. In the case of the Limpopo project, given the farm sizes on which beneficiaries operate, which average 1,835 ha (Nkadimeng 2019), it is logical to assume that the project should be able to contribute to both national and household food security but more to national than household level. Thus, the food security impact of the project should be analysed at household and national levels.

The FAO (2003:25) explicitly states that: 'Whenever the concept of food security is introduced in the title of a study or its objectives, it is necessary to look closely to establish the explicit or implied definition.' Thus, to assess the achievement of the food security objective for the Limpopo project, two working definitions of food security (one at household and the other at national level) should have been developed at the start. These should have read something like, 'For the Limpopo IDC Nguni Cattle Development

Project the national food security objective is achieved when …'. Without a working definition/s to guide measurement, analysing the achievement of the food security objective is at best reduced to assessing the increase in production (Fouilleux *et al*. 2017), even though food security is understood to be more complex than this.

Since the indicators for measuring the achievement of food security at household level are not necessarily the same as at individual and national levels, the project should ideally have had two such statements—one defining the national objective and one the household food security objective. This is unless, of course, a priori the project was focusing on only one of the objectives. Having the appropriate number of definitions to assess achievement addresses one of the sources of ambiguities when analysing food security—that is, what the unit of analysis should be (Maxwell 1996). Should it be the individual, the household, the community, the nation, the region or the globe? Should it be the micro, meso or macro level? In the case of the Limpopo project, we have already posited that it should be the household and national levels, with the national taking precedence over the household. Hopefully, this discussion of how the Limpopo IDC Nguni Cattle Development Project's food security objective could be measured also demonstrates how impossible it is to use the accepted definition of food security to guide food security measurement. The accepted food security definition cannot be applied in its entirety to the Limpopo IDC Nguni Cattle Development Project, although the project can clearly accomplish food security objectives within the food availability and food access dimensions. Clearly, therefore, each project should develop or identify its own food security definition if improving food security is one of its objectives. Examples where a definition is developed based on needs are provided by Lang (2009) and Ksenofontov and Polzikov 2020).

Conclusion

Our understanding of the food security concept has not been consistent over time or across interest groups. This is demonstrated by the fact that there are more than two hundred definitions of the concept. The accepted and widely cited definition of food security was officially established by the 1996 World Food Summit and reaffirmed by FAO in the 2009 Declaration of the World Summit on Food Security. It captures the complexities of the food security concept and is based on the four pillars of food availability, food access, food utilisation and stability. However, there are persuasive calls to include food agency or sovereignty and food system sustainability to make a six-pillar food security conceptualisation framework. The

inclusion of more civil society participation in the FAO's Committee on Food Security after the 2007–2008 food price crisis marks a significant step towards considering food sovereignty as part of the food security concept. It also suggests that the participation of householders should be encouraged to gather on the ground concepts of food security.

Food security measurement is critical because it is only through this that we can compare different degrees of food security achievement and quantify varying degrees of departure from full food security so as to guide policy. But the measurement of food security is also problematic. This is because there is such a variety of scales to be measured—individual, household and community, and national, regional and global. As a result, there is a plethora of food security metrics—estimated at 450—and, predictably, the results of the different measurements often are not easy to reconcile. What should be agreed upon is how and what they measure, how to interpret it and, when differences occur, how to reconcile them. Thus, the search for a single metric that measures all the food security dimensions continues.

In Africa, where governments use projects as development vehicles, largely in the agricultural sector, some of the projects explicitly state food security as an objective. Given the complexity of the food security measurement terrain, it is important that such projects guide the measurement of the achievement of the food security objective.

The cultural validity of food security metrics is also questionable, partially due to the fact that it is sometimes not easy to find words that describe the important food security concepts in other languages. This applies very much to Africa. Thus, in Africa, where food insecurity sometimes reaches crisis proportions, the cultural validation of food security metrics is long overdue.

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