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Combatting Hunger, Malnutrition and Food Insecurity - A Scourge of Global Drylands: A Narrative Review

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ABSTRACT

This article is a Narrative Review that sieves through available information, summarizes trends and reports on published efforts to minimize the impact of factors contributing to food insecurity in the world's drylands. Statistical data, comments by specialists (both foreign and domestic) and the results of our own observations are synthesized here. There are three main themes: 1) The policy and practice around the protection of agricultural land and national food security through a series of case studies from Africa. 2) Diverse responses to heightened food safety anxiety associated with climate change and an increasingly disembedded food system and disrupted supply chains. 3) The marginalization of small-scale, including subsistence farmers (and their knowledge) through the vertical integration and modernization of agricultural production. Food security is a major issue in the world's drylands that occupy over 42% of the land surface. Multiple global stressors of climate change, drought, famine and war make it increasingly difficult to meet the dietary needs of large sections of the population. Here we discuss the nature of food security (and insecurity), its global drivers, and opportunities to enhance food security, with an emphasis on drylands. Examples are drawn largely from the African continent. We show that food security is complex, multi-faceted and largely intractable. Improved food security will require greater integration among sectors involved in food supply, access and availability, sustained involvement by governments and financial institutions to support existing food programs, and a greater emphasis on climate smart agriculture and indigenous knowledge, particularly at the local scale. A multidisciplinary approach is critical, with specialists in food science, agriculture, engineering, logistics and economics all playing a role in tackling this long-standing challenge.

Keywords: SDG2, livelihoods, climate variability, mortality rates, stunting, pastoralism, food-water-energy nexus.

INTRODUCTION

Drylands (Pravalie, 2016 [1, Squires et al. [2] are under constant threat from multiple stresses and challenges resulting from complex interactions among natural processes of droughts, floods, and human-induced activities such as overgrazing, land clearing and unsustainable irrigation. These stresses ultimately lead to land degradation and acute food insecurity (Stavi et al. 2021a [3]). The ability to feed an increasing global population is a major issue for society,

governments, institutions and policy makers. Food security occurs when the population has sufficient nutritious food to meet its basic dietary needs (FAO, 2006 [4]). Yet across the world, millions of people have insufficient food to meet their daily needs. In 2017, 125 million people from 51 countries faced severe food insecurity (Thalheimer et al. 2019 [5]). The majority of these people live in drylands, where they depend heavily upon natural resources for their livelihoods, either by growing crops, gathering food plants, or raising livestock. The Global Food Security Index, a semi-quantitative model that assessing global food security, indicates that the most vulnerable region is Sub-Saharan Africa. The UN's Hunger Map (WFP 2021[6]) identifies Africa as the hotspot of world hunger. Food insecurity is fuelled by local forces such as demographic pressure associated with population acceleration, poverty, high dependence on subsistence rain-fed agriculture, and civil conflict. Large numbers of people across the globe are undernourished, infant mortality is high, and children are often the most at risk (Gundersen and Kreider 2009 [7], Seppelt [8]).

Yet drylands have supported human populations for centuries, despite their environmental sensitivity, perceived fragility, and the prevailing negative perceptions that they are wastelands (Hoover et al. 2020 [9]). Global dryland communities have had a long history of adapting to climate variability and adjusting to changing land use patterns (Squires and Gaur, 2020 [10]). However, the pace of change and other human-induced stresses (economic, social, cultural) has grown continuously, often exceeding human and ecosystem tolerance levels. Consequently, centuries-old adaptive knowledge and livelihood strategies practiced in drylands no longer suffice or are inefficient (Boko et al., 2007[11]). For example, systems of resource management such as the Hima conservation system in the Middle East, have largely broken down due to colonialisation (Gari 2006 [12]). These lapses are particularly noticeable with increasing urbanization and the creation of new peri-urban settlements (Feng, Squires and Zhu, 2021[13]). Efforts to reduce the vulnerability of drylands populations, therefore, must reinforce their risk management and coping strategies *apropos* food security by augmenting existing adaptation mechanisms and supplementing them with new options that are tailored to the unique local contexts. In this paper, we discuss the nature of food security (and insecurity), its global drivers, and opportunities to enhance food security, with an emphasis on drylands. We draw heavily on examples from drylands in the African continent to describe the enormity of the issue and some strategies that we believe are important to support the human population in global drylands.

THE FOUR PILLARS OF FOOD SECURITY

Food security is a complex issue requiring input from a diverse range of disciplines from environmental, nutritional, agricultural, demographic, socio-economic, political, and technological fields. Food insecurity manifests itself at global, regional, national and local levels (FAO 2023[14]), and its effects are not uniformly distributed. At continental scales, areas of extreme risk occur in Africa, and regionally, food insecurity is prevalent in many areas of global conflict such as Palestine, Syria, Yemen, Sudan and Ethiopia (Weldegiargis et al. 2023[15]). For the most vulnerable people, often pastoralists and subsistence farmers, lower agricultural output means lower incomes, a lower standard of living, lower health outcomes, and the need to sacrifice additional income and other assets to meet their nutritional needs. The World Food Summit in 1996[16] recognised four pillars of food security: i) food availability, ii) stability of

production and supply, iii) food utilisation and iv) access (Figure 1 [17]). Recent studies indicate that regional changes in climate and land degradation have already affected the production of many staple crops in drylands.

For example, in Sub-Saharan Africa, maize and sugarcane yields have declined by 6% and 4%, respectively over the past decade. Cassava yields have declined in Eastern Africa, with total calorie production declining by almost 12% in South Africa. Total calorie yields in sub-Saharan Africa have declined due to altered climates (Masipa 2017 [18]). Higher temperatures lead to increased heat stress on livestock, reduced animal production, and loss of pastoral earnings (Bogale and Erena 2022 [19]). Continued changes in rainfall patterns are likely to affect crop quality (Kogo et al. 2021[20]), but some of these problems may be overcome by focussing on perennial crops (Leisner 2020 [21]).

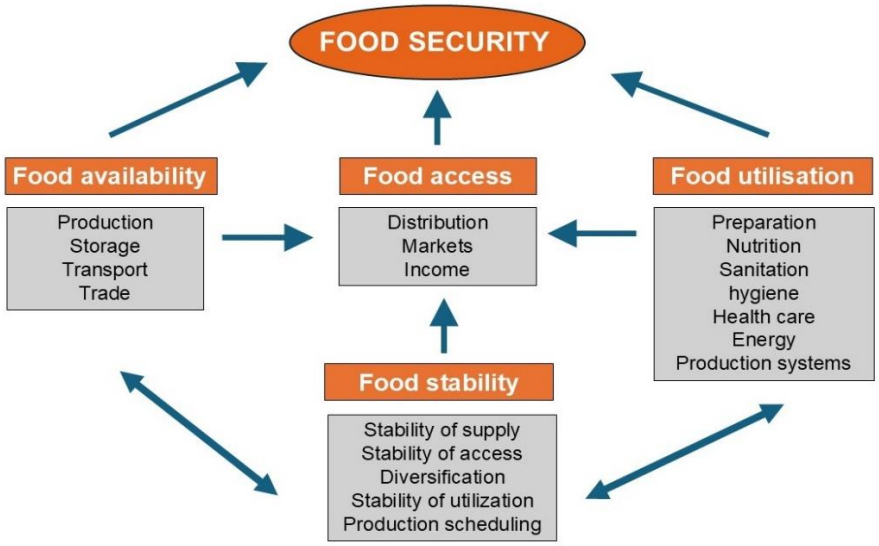

Figure 1: The four pillars of food security. Food security is heavily dependent on the production, use, supply and storage of food. nutritional value and this must be considered along with the other indicators (Adapted from Burchi et al. 2011)

Food utilization is particularly susceptible to changing climates and land degradation. Lower yields can lead to nutritional issues, often for people already on a low caloric intake (Tadesse and Ardalan 2014 [22]). Reduced yields can create a vicious cycle of hunger and disease. This is exacerbated by the fact that the ability of the health care system to cope with infectious diseases and pandemics is likely to be limited in dryland areas, particularly those in the Global South (Keim, 2008 [23]). Access to improved sanitation and clean drinking water goes hand in hand with food utilisation. Farm holdings in drylands are typically dominated by resource-poor, small-scale operations with limited investment in novel agricultural technologies (Mortimore et al. 2009 [24]). Access to food depends on farmer access to markets, the ability to raise capital, distribution patterns, and the vagaries of market price fluctuations (Burchi et al. 2011 [25]). Climatic variability resulting from more frequent and intense weather events can also disrupt government food security programs and strategies, creating fluctuations in food availability, access and utilization (Hirwa et al. 2022 [26]).

GLOBAL FOOD SECURITY IN DRYLANDS – THE CURRENT SITUATION

According to the World Economic Forum and the State of Food Security and Nutrition in the World report (FAO, IFAD, UNICEF, WFP and WHO, 2024 [27]), an additional 122 million people have been pushed into hunger since 2019. In 2023, access to food was unpredictable for nearly 30% (2.4 billion) of the global population, and more than 2 billion people lack sufficient dietary iron, vitamin A, zinc and folate (Passarelli et al. 2024 [28]). The growth and development, cognitive skills, educational capabilities, and lifelong earning potential of up to half of entire dryland communities have been reduced (Agbadi et al. 2017 [29], Maestre et al.2016 [34]; Wahlqvist et al. 2011 [31], Willet et al., 2019 [32]). These issues require urgent action, yet compounding crises such as the global COVID pandemic have delayed the attainment of UN Sustainable Development Goal 2 (SDG2) to eradicate world hunger by 2030.

More than a quarter of a billion people in the world's drylands now face acute levels of hunger. Despite a growing number of studies addressing world food security, most have tended to focus on agriculture and crops, with far fewer studies using the terms pasture, pastureland or rangelands (e.g., Asrat and Anteneh 2020 [33]). However, more recent studies have focused on drylands (e.g., Stavi et al. 2021a & b, [34, 2] Thalheimer et al. 2019 [4], Hirwa et al. 2022 [26]). Global food security in drylands has gained attention, but most research findings are couched in terms of climate change. Information focusing on dryland pastoralism is disproportionate and meagre considering the vast numbers of dryland dwellers in Africa, Asia, the Middle East, Latin America and the Caribbean and those in hyper-arid (Martínez-Valderrama et al., 2020 [35]) cold arid mountainous regions or high latitude drylands north of 60o where permafrost prevails (Figure 2).

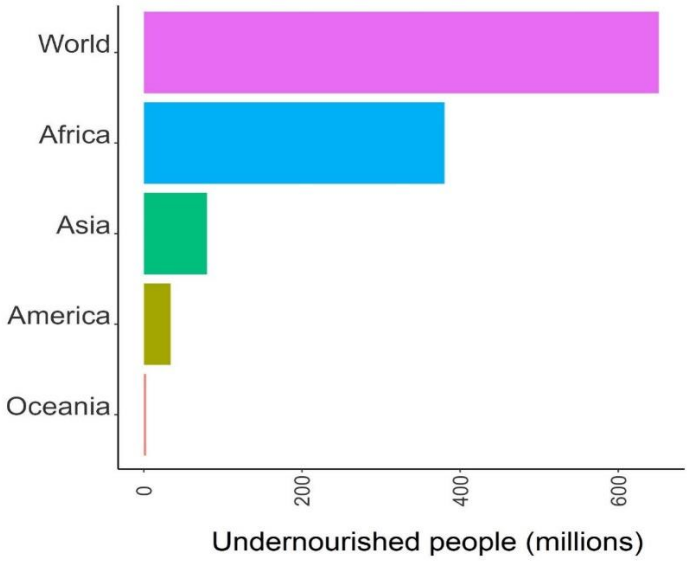

Figure 2: Number of undernourished people in drylands by continent
(Source: FAO 2023)

GLOBAL DRIVERS OF FOOD INSECURITY IN DRYLANDS

The drivers of food security in drylands are many, complex and highly interconnected, but can be summarised broadly as environmental (changes in climate and the productive potential of

the land), economic (dependence on small scale subsistence production), and social (population increase, war and social upheaval). All aspects of food security are potentially affected by climate change (IPPC 2022 [36]), including food access, utilization and price stability (Stavi et al. 2021b [34]). Higher temperatures, shifting seasons, more frequent and severe weather events, flooding, wildfires, drought and disease outbreaks make it harder to maintain yields. Globally, a 2°C rise in average global temperature could put 200 million people at risk of hunger. A 4°C rise could increase this to a staggering 1.8 billion (WFP 2021 [37]). Regionally, droughts are also catastrophic. For example, the Horn of Africa has faced four successive seasons of drought, its most severe in 40 years, potentially putting millions of people at risk of starvation (OCHA 2023 [38]). Climate change also disrupts food production and reduces food safety, limiting local food availability and increasing food prices, and these effects are most strongly felt by the poor. Importantly, the adverse effects of climate change impede progress towards improving future food security. As food reserves around the world have been allowed to decline over recent decades, there needs to be a renewed emphasis on replenishing food reserves and ensuring supply chains. Recent Russian aggression in Ukraine has focussed attention on the fragility of global food supply chains (Akhand 2024 [39]). Addressing the need to provide nutritionally adequate diets for the world's people in response to changing climates is a critical policy need (Thalheimer et al. 2019 [4], Kanter et al. 2015 [40]).

Socioeconomic factors are a major cause of food insecurity, foremost among them is unsustainable population growth. Globally, population numbers continue to increase towards 9 billion by 2050, while higher incomes in the Global South will lead to increased demand for more and better food, placing additional pressure on global food production. The Global Report on Food Crises (GRFC 2023 [41]) indicates that over a quarter of a billion people in Africa, many of them from dryland regions, are facing acute hunger, with economic shocks and the outbreak of conflict and war contributing to the increase. The number of people from 15 countries in West Africa and the Sahel facing high levels of acute food insecurity reached a new record of 41.4 million in 2022, 40% more people than in 2021. Ten of the 15 countries had 3 million people in the Emergency phase (Figure 3 [42), double that of 2021. The poor security conditions that prevail in many dryland countries across the globe have hampered transhumant movements of pastoralists, concentrating livestock in smaller areas, and resulted in the depletion of pasture and water points, deterioration in livestock body condition, and an increase in clashes between farmers and pastoral communities over land use. This is often exacerbated by drought, leading to conflict over access to water and feed as pastoral conditions deteriorate (Unfried et al. 2022 [43]). This has caused economic and food losses. For example, in April 2022, insecurity stranded more than 1.3 million livestock in several border areas in West Africa, including the Tahoua region in the Niger and the tri-border Liptako Gourma area of Mali, Burkina Faso and the Niger (OECD 2022 [44]). War and geopolitical conflict are key drivers of acute food insecurity (GRFC 2023 [41]). Years of conflict in a number of African drylands (the Sahel, West, Central, Southern and Eastern Africa) have led to the collapse of economic activities, erosion of livelihood opportunities and incomes, and extremely high levels of forced displacement, depriving people of the resources to cope with or to withstand additional shocks. During the 2022 peak, a record 7.34 million people were affected in Africa. Many African countries have experienced worsening acute food insecurity and malnutrition since 2020, underpinned by a complex interplay between conflict and weather shocks amid

high socioeconomic vulnerability, which have severely constrained household food availability and access. Migration is a commonly used strategy in drylands to cope with environmental change (Ionesco et al. 2017 [45]) and to escape war and famine (Neumann 2020 [46]). However, migration has its own structural problems associated with racialized stigma, isolation, and limited access to health care and social services (Carney and Krause 2020 [47]), which often exacerbate food insecurity (Crush and Ramachandran 2024 [48]).

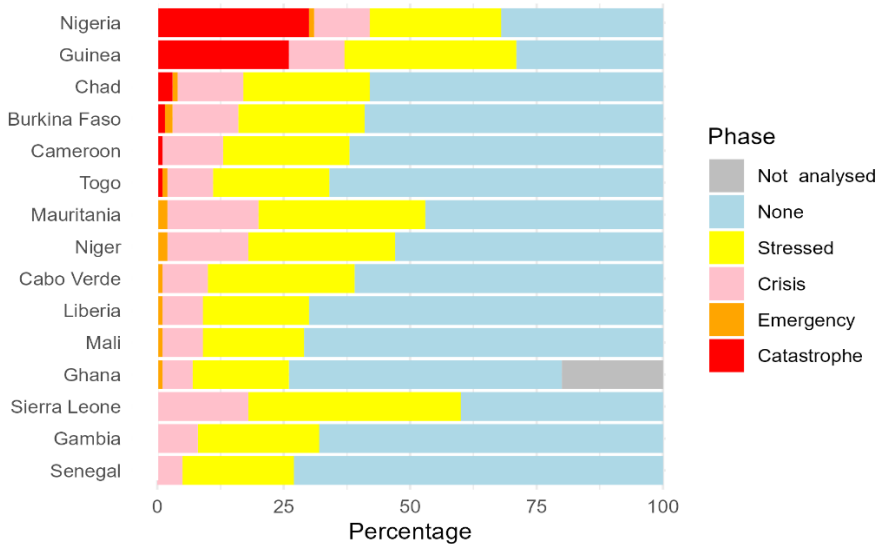

Figure 3: Snapshot of food security situation in selected West African and Sahelian countries in 2022. Source: Cadre Harmonise, March 2022

TOWARDS GREATER FOOD SECURITY IN DRYLANDS

The global food security challenge is straightforward. By 2050 the demand for food will be up to 70% greater than it is today. The world will need to feed more than 9 billion people. The United Nations has set ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture as the second (Zero Hunger) of its 17 (SDGs) for the year 2030 (UN 2023 [49]). To achieve these objectives requires addressing a host of issues, from gender parity and ageing demographics to skills development and global warming. Planning is critical. Dryland users, pastoral practitioners, planners and policymakers will need to work together to advocate for and promote transformational change in the management of dryland food production and distribution systems. Meeting the world's demand for more and better food while sustaining ecosystem services will be critical. Given the few remaining opportunities for expanding the global agricultural areas, these needs will be quite a challenge to meet. No single intervention can resolve the challenges of food security in drylands. Nonetheless, we see three main areas where we need to focus efforts to improve food security as we move to a hotter, drier and more fractured world.

Understanding and Improving Integration Among Sectors

Improved integration among sectors requires several, among them, improvements in supply chains, a greater focus on local production, and greater interaction among different sectors to improve governance and decision making (*sensu* nexus approach, Liu et al. 2018 [50]).

Improving supply chains is drastically needed to reduce post-harvest food losses, improve hygiene in food distribution channels, and create better links between production and consumption centres. The recent COVID-19 pandemic had a dramatic negative effect on food supply chains in Sub Saharan Africa (Nchanji et al. 2021 [51]). An example of a successful program is the Nigeria Rural Access and Mobility Project (World Bank 2012 [52]). Through World Bank funding, rehabilitation and construction of rural roads in north-central Nigeria there was improved market access for 1.5 million farmers, reducing their transport costs, improving profits, and contributing to improved food security and nutrition (World Bank 2012 [52]).

One way to obviate the need for complex supply chains is an emphasis on local production and consumption (Mkhize et al. 2023 [53]), where smallholder farmers play a crucial role (Squires et al. 2019 [54]). Rural and urban people in developing countries rely heavily on the efficiency of their local smallholder farmers to satisfy their food needs. Small holders across Asia, Africa and Latin America collectively, produce more than half the world's food from rainfed crops and pastures in drylands (Squires et al. 2019). Much of this food is for home consumption, but significant amounts are used to nourish others. Unfortunately, small holders are under appreciated. There is potential to utilise small-scale agricultural plots in urban and peri-urban areas to sustain urban societies (Nichols et al. 2020 [55]). Women tend to dominate small subsistence agriculture, so programs to promote small-scale. local production will require policies that empower women and small farmers (Fonjong and Gyapong 2021 [56]).

A cross-sectorial approach is needed to maintain global food security, such as adopting the water-energy-food (WEF) nexus approach (Rasul 2016 [57]). The Nexus approach identifies mutually beneficial responses that are based on understanding the synergies of water, energy, and agricultural policies. It also provides an informed and transparent framework for determining the appropriate trade-offs and synergies that maintain the integrity and sustainability of ecosystems. Successful implementation of the Nexus approach requires breaking down traditional 'silos' in which policy making takes place. Coupling water-energy-food systems is particularly important in disaster relief situations such as widespread famine and post-conflict reconstruction scenarios (He et al. 2019 [58]). Both natural disasters and armed conflict often lead to dire food shortages and internal displacement. Nexus approaches are increasingly being used in drylands to identify the risks and opportunities to aid decision making during droughts, and to exploit technological advances that improve crop yields Pardoe et al. 2017 [68], Dagninet and Adugnaw, 2020 [69]

Sustained, Long-Term Financial Support

The continuation of long-term global food programs is critical to support food security. There are many examples of food relief supported by the World Bank through the Global Agriculture and Food Security Program (https://gafspfund.org), which was launched in 2010 following a major food crisis. For example, there is evidence that the scaling up of humanitarian aid by the World Food Program during civil strife in Mali in 2012 had important positive impacts on the food security targeted population (Tranchant et al. 2019 [64]

There will be a growing need for sustained, sufficient adaptation funding to help people cope, and much of this will need to come from overseas direct investment and be directed to poverty alleviation. The financial needs of smallholder farmers must be met. Adaptation to worsening food insecurity is most effective if investments began early. Farmers, particularly smallholder farmers, will need resources to identify and to invest in new crop varieties and animal breeds, irrigation, food storage, and transport infrastructure. African governments are renewing efforts to improve investment opportunities, but complex political economies and instabilities make this challenging (Langyintuo 2020 [65]). The private sector will be an important source of both information and financial resources, supplemented by local and national research and extension programs. Access to capital in developing countries can be provided in various ways, for example, as is being done under the Comprehensive Africa Agriculture Development Program compact in Africa (Woodhouse et al. 2017 [66]). Development projects and microfinance initiatives by private and nongovernmental organizations can be undertaken that specifically target smallholder food producers.

Indigenous Knowledge and Climate-Smart Agriculture

In the future we will need to be co-producing and mobilizing indigenous and local knowledge, technologies and practices to improve nutritional status, livelihoods and social well-being for dryland agropastoral system-dependent livelihoods. This is already happening in drylands, but the pace of change will need to increase to keep up with changing climates. Indigenous knowledge is critical. For example, farmers in the Sahel are using traditional water harvesting techniques ('Zai') whereby crops are planted into pits containing animal dung and crop residue (Danjuma et al. 2015 [67]). In Sub-Saharan Africa, farmers plant nitrogen-fixing trees to enhance soil fertility and food production (Girard et al. 2021 [68]). Other smart systems include improved early warning drought monitoring (Funk et al. 2019 [69]) as well as practices such as crop rotation, zero cultivation, the use of green manures (Oyawole et al. 2020 [70]), drought and crop monitoring, big data platforms, and greater access to remotely-sensed imagery for planning (e.g., Pardoe et al. 2017 [71]).

CONCLUSIONS

This paper does not aim to provide definitive answers, yet intends to scrutinize the data and re-examine the current discourse around responses to SDG2. There is discussion on equity and sustainability issues, with particular emphasis on food security and sovereignty; water and energy security; environmental protection; socio-economic protection and unbalanced geopolitical power of the key stakeholders.

Of all the challenges to be faced by humans in the coming decades, none is more frightening than the prospect of tens of millions of people dying or left incapacitated by food insufficiency while millions more are denied access to the minimum daily intake of food staples that supply energy, nutrients, essential minerals and vitamins. The magnitude of the tasks to meet the food needs of the burgeoning population is daunting and will require radical new thinking about diets (including those based on insects) and on production, distribution and food waste prevention, particularly those in those large dryland cities in Africa, Asia and elsewhere. Greater attention must be paid to governance reform (Feng, Gaur, and Squires (2018) [72]. Humans will face an existential threat if changes are not adopted soon.

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