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Review Article

Food, Nutritional or Agricultural Resilience: Synthesis of Research

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Abstract: At the end of this review, it emerges that food resilience has several scientific and institutional definitions. It is applied in several disciplines and contexts requiring better anticipation and management in the event of water pollution, drought, pandemics, economic crises, climate change, etc. Many tools and indicators make it possible to analyze food resilience: Assessments of Food Security in Emergency Situations, Measurement and Analysis of the Resilience Index, Analysis of Household Capacities and Vulnerabilities, Index of Survival Strategies and Vulnerability level,… Early Warning Systems help limit the loss of lives and livelihoods due to hazards and disasters. Some identify five key capacities of a food system: anticipation, prevention of the effects of expected shocks, ability to immediately cope with the effects of shocks, adaptation and the ability to transform the entire system. For others, it is the ability to assess, manage and control risks, identify problems, set priorities and take action. Depending on the context, American or European cities are developing food resilience measures by ensuring food security, developing new markets for local producers, promoting sustainable production methods, creating canteens, etc. In Africa, household food resilience strategies are multiple: changing their diet, increasing their food supplies, reducing the number of consumers or fasting if there is food shortage, diversification of agroeconomic activities, social food safety nets, etc. Gender and governance issues are essential to strengthen food resilience. In perspective, it is important to take systematic, cross-sectoral and large-scale actions to achieve sustainable and resilient food value chains.

Keyword: Resilience, Food insecurity, Strategies, Measurement tools, Gender, Governance.

INTRODUCTION

In 2014, FAO noted that the concept of "resilience" and its concrete applications in food security and nutrition, both in policy development and in their implementation, has become a topical issue for stakeholders. humanitarian and development. This issue has grown in importance as nutrition is gaining renewed attention, as indicated by the growing number of countries and partners joining SUN (Scaling Up Nutrition) and responding to the Zero Hunger challenge launched by the Secretary General. United Nations (FAO, 2014). Also, the many recent researches devoted to food resilience deserve particular attention to this concept, in the context of climatic, environmental and health challenges to be met by humanity. (Adji B, 2016; PNUD, 2017; FAO, 2018a ; Mihoreanu L *et al*., 2019 ; Faucher A *et al*., 2020 ; Béné C *et al*., 2021; Conseil National pour la Résilience Alimentaire, 2021, Nicholas-Davis P *et al*., 2021).

This bibliographic synthesis is carried out within the framework of an ongoing doctoral thesis whose theme is "Pollution of the Ebrié lagoon and measures of resilience of the riparian populations in the municipality of koumassi (Abidjan)." It aims to analyze the various studies dealing with food resilience and should highlight aspects insufficiently studied for further study. food resilience analysis tools and indicators (iv) early warning systems, (v) food resilience criteria, (vi) territorial food resilience measures, (vii) food resilience strategies in Africa, (viii) link between resilience and gender, (ix) governance for food resilience and (ix) perspectives for food resilience.La présente synthèse bibliographique est basée sur des sources de données secondaires telles que : des livres publiés ou édités, des articles des revues scientifiques, des sites Web, des magazines et des rapports annuels. Les mots-clés de cette recherche sont les titres des différents paragraphes discutés ici.

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1. Approach to defining food resilience

The concept of resilience was first used in mechanical engineering in the 1940s. It was then taken up by environmentalists in the 1960s to denote the ability of an ecosystem to respond to shock by resisting possible damage. and recovering quickly (Torrens Resilience Institute, 2009). According to Holling C S (1973), resilience is the ability of a system to respond to trauma returning to a state of equilibrium. But resilience is, on the one hand, difficult to define and assess (Davoudi S, 2012; Lallau B, 2014) because, on the other hand, it involves development policies based on recourse to social protection and the principle of food sovereignty (Lallau B, 2014). Béné C *et al*., (2012) distinguish in resilience, an absorption capacity (neutralization of shocks), an adaptation capacity (structural adaptation to shocks) and a transformation capacity (change of foundations following shocks). Initially referred to the ability to recover and rebound, resilience has increasingly been seen as the ability to learn and adapt, then now as the ability to anticipate and prevent, thanks to early warning systems (Lallau B, 2014). In many cases, resilience is seen as the only means capable of overcoming the uncertainty of today's world (Davoudi S, 2012). The links between "resilience" and "food security" have already been emphasized in the 1990s (Maxwell S & Smith M, 1992). Since the presentation of the Right to Food Report to the UN Human Rights Council by Schutter in 2008, these links have become firmly established in international development policy agendas (WFP, 2011; EU, 2012 ; USAID, 2012; FAO, 2013a). Resilience is institutionalized in the field of food insecurity and is thus imposed on all, as the ultimate weapon against hunger (Lallau B, 2014). Thus, food resilience is not only a question of food security but also a question of the economic, environmental and social sustainability of the local food model (Cap Rural, 2021). In this vein, territorial food resilience is increasingly mentioned. Already in 2003, Berkes F *et al*., defined territorial resilience, in a broad sense, as the capacity of a system, territorial or organizational, to react dynamically to changes, not opposing them, but incorporating and exploiting the positive potential. Here, then, resilience does not mean simply returning to an initial state, but the restoration of functionality through change and adaptation. The concept of territorial resilience can be seen in a broader sense, as the level at which territories or cities can resist changes, before reorganizing themselves into a new system of relationships, structures and processes. This also applies, and above all, to the issue of food and urban food planning (urban food planning) (Dansero E *et al*., 2015). In France, for the National Council for Food Resilience, the food resilience of a territory is based on three pillars: food production, respect for ecosystems and access to local food (Conseil National pour la Résilience Alimentaire, 2021). A food system includes all the processes, actors and activities associated with food production and the use of food, from cultivation and harvesting to transportation and consumption (Van Berkum S *et al*., 2018). According to Tendall D M *et al*., (2015), the resilience of food systems occurs at multiple levels, from individuals to national food systems, to global value chain networks. Piters B S *et al*., (2021) indicate that the resilience of food systems is their ability to produce desired outcomes in the face of shocks and stressors. It involves multiple types of resilience such as agricultural, economic, political and social resilience.

In addition, several institutions have adopted the concept of resilience to adapt it to their operations. Find below some institutional definitions of resilience.

UNISDR (United Nations International Strategy for Disaster Reduction): resilience is the ability of a system, community or society potentially exposed to hazards to adapt, by opposing resistance or by resisting modifying, in order to achieve or continue to function properly, with acceptable structures. The resilience of a social system is determined by the capacity of this system to organize itself effectively in order to learn from past disasters to better protect itself and to reduce risks more effectively (UNISDR, 2005).

DFID (Department of International Development): "Disaster resilience is the ability of countries, communities and households to manage change, maintaining or transforming living standards in the face of shocks or stresses - such as earthquakes , drought or violent conflict - without compromising their long-term prospects " (DFID, 2011).

FAO (Food and Agriculture Organization of the United Nations): "Resilience is the ability to prevent disasters and crises or to anticipate, absorb, adapt or recover from those that have an impact on nutrition , agriculture, food security and food safety (and associated public health risks) in a timely, efficient and sustainable manner. This includes the protection, restoration and improvement of the structures and functions of threatened food and agricultural systems" (FAO, 2013a).

EU (European Union): "Resilience is the ability of an individual, household, community, country or region to resist, adapt and recover quickly from stress and stress. shocks, such as droughts, violence, conflicts or even natural disasters" (EU, 2012).

USAID (US Agency for International Development): "Resilience is the ability of individuals, households, communities, countries and systems to mitigate, adapt and recover from shocks and stresses in a way that reduces chronic vulnerability and facilitates inclusive growth" (USAID, 2012).

PNUD (United Nations Development Program): "Resilience is the process of transformation to strengthen the capacity of people, communities and

countries to anticipate, manage, recover and transform after shocks" (UNDP, 2013).

UNISDR (United Nations International Strategy for Disaster Reduction): "Resilience is the capacity of a system, community or society exposed to dangers to resist, absorb, adapt and recover from the effects of a hazard, in a timely and effective manner " (UNISDR, 2009).

Resilience Alliance: "Resilience is the ability of a system to absorb disruption and reorganize itself as it undergoes change" (Resilience Alliance, 2002).

For the FISCRCR (International Federation of Red Cross and Red Crescent Societies), resilience is the capacity of individuals, communities, organizations or countries exposed to disasters and crises and to factors of vulnerability under - related to: anticipating, reducing impact, coping with, and recovering from the effects of adversity without compromising long-term development potential (FISCRCR, 2012).

2. Food, nutritional or agricultural resilience in the face of what?

The concept of resilience has been applied in several disciplines and in a wide range of contexts where it is necessary to anticipate and best manage change and uncertainty. The situations which require the development of resilience (food, nutritional or agricultural) are listed below.

In Côte d'Ivoire, Koné B *et al*., (2006) studied the vulnerability and resilience of riparian populations linked to the pollution of lagoon waters in the Abidjan metropolis.

According to Torrens Resilience Institute (2009), resilience began to gain popularity among humanitarian and development actors after the financial, food and fuel crises of 2008 which led to the search for new approaches to tackle poverty. In 2009, the World Health Organization (WHO) identified unhealthy diets as the biggest threat to global health (WHO, 2009). However, disasters and food insecurity are directly linked. Thus, floods, hurricanes, tsunamis and other hazards destroy agricultural, aquaculture and livestock infrastructure, property, as well as means and production capacity. They disrupt access to markets, trade and food supplies. Drought, pests and plant diseases (caused by locusts and processionary caterpillars), animal diseases (African swine fever) and food contamination have a direct economic impact by reducing or destroying agricultural production, (...). Economic crises (increase in food prices) lead to a decrease in real income, forcing the poorest to sell their goods. This results in a decrease in food consumption, an impoverishment of the diversity of the diet and more difficult access to quality food (FAO, 2013b et c, FAO, 2018a). The impacts of climate change lead to malnutrition and reduced livelihoods, especially among the most vulnerable and poor (ACF, 2013).

Initially mobilized against the "disaster" (Revet S, 2009, 2011), resilience is now perceived as a new, highly innovative tool in the fight against poverty and hunger (Lallau B, 2014). As the concepts of nutrition and resilience are closely related, reducing malnutrition is crucial for building resilience. Nutritionally secure households are better able to resist, endure longer, and recover from shocks faster (FAO, 2014).

Natural hazards and disasters (Lallau B, 2014), climate change and climate variability, which lead to higher temperatures or promote extreme weather events such as droughts or floods, will further exacerbate risks along food value chains (PNUD, 2017).

With rapid urbanization comes a sharp increase in demand for energy, transport, buildings, water and, of course, food. Meeting the demand of an ever-growing population, in particular the demand for food, is a real challenge (Tendall DM *et al*., 2015; PNUD, 2017).

According to several studies, the first retrospective assessment of the impacts of COVID-19 on a global scale indicates that the restrictions have very negatively affected food accessibility, employment and the related purchasing power. The crisis has exposed some key vulnerabilities in food value chains, which have proven to be less resilient to the impacts of COVID-19 response measures (Faucher A *et al*., 2020; Béné C *et al*., 2021; Conseil National pour la Résilience Alimentaire, 2021).

In short, Piters B S *et al*., (2021) categorize into four groups the different shocks and stressors that overlap or often interact to lead to increased food and nutrition insecurity globally. These are (1) climate change, variability and extremes (e.g. erratic rainfall, droughts), (2) conflict and insecurity (e.g. displacement, civil unrest, terrorism), (3) economic downturns and market disruptions (eg, food price spikes of 2008), and (4) other unexpected shocks (eg, sudden locust outbreak, pandemic).

3-Tools and indicators for analyzing food, nutritional or agricultural resilience

Many tools or approaches have been used, depending on the situation or the intervention organization, to analyze or measure the food, nutritional or agricultural resilience of populations.

The Emergency Food Security Assessment (EFSA) was developed by WFP (World Food Program) (PAM, 2005). The objective of an EFSA is to determine (i) whether, following a shock or crisis, there is (or will exist) a nutritional or food security problem that the

people and communities concerned cannot cope with without assistance; and, if so, (ii) the type of assistance required and (iii) whether government and other national organizations and their resources can meet the needs, or whether international assistance is required (PAM, 2005).

The result of an EFSA should be a concise report. It presents the conclusions of the analysis (causes of food insecurity and corrective measures), identifies and quantifies possible unmet needs, as well as future prospects and risks for food security, and proposes planning scenarios with advantageous answer options or not. WFP's partners for the implementation of ESASU are the UN agencies (FAO, UNICEF, UNHCR, UNDP, WHO, etc.).

In 2009, Twigg (2009) proposed to measure disaster resilience according to the five pillars set out in the hyogo 2005-2015 framework for action (see Table 1). Disaster resilience can be measured through indicators or characteristics, as part of the monitoring, evaluation and learning system.

Table 1: Five pillars of the hyogo 2005-2015 framework for action to measure disaster resilience

Process	**Results**
Training and capacity building	Hyogo Framework for Action
Vulnerability and Capacity Assessment	Risk governance
Preparation and action plans	Risk Assessment
Community awareness	Knowledge and education
Mitigation activities	Risk management and vulnerability reduction
Community early warning system	Disaster preparedness and response

Source: ACF (2013)

However, Twingg's approach is qualified by ACF (2013) who believe that it is possible to assess the resilience of communities, but these measures must be specific to the geographic location and type of hazard.

After WFP, FAO developed RIMA, the Resilience Index Measurement and Analysis tool (FAO, 2016). RIMA is based on a list of contextualized factors that make a household resilient to a specific effect. In relation to food security, these factors may include: income and access to food, access to basic services, agricultural assets, non-agricultural assets, agricultural practice and technology, social safety nets (SSN), climate change, environment favorable institutional structure, stability, adaptability ... RIMA can be adapted for outcomes other than food security.

Improvements were made to the RIMA (I) to result in the RIMA-II. Thus, the new RIMA-II methodology makes it possible to design, implement, monitor and evaluate assistance to poor populations more effectively, while meeting their priority needs. RIMA-I and RIMA-II answer questions such as: who are the most deprived populations? where should investments be geographically concentrated? what dimensions of resilience should be strengthened? To what extent have the interventions strengthened or reduced the resilience of the target populations? (FAO, 2016). Nutrition indicators such as income, access to food and stunting are also used to assess the reduced resilience of populations and their high vulnerability (FAO, 2018a).

For the implementation of RIMA, FAO collaborates in particular with international organizations (IFAD, UNDP, UNICEF, WFP, IFPRI (the International Food and Policy Research Institute, and World Bank), regional organizations (EU, IGAD, CILSS) and universities (eg Florence, Cornell, Tulane, Tufts).

Other community-based tools have been designed to measure or assess resilience. First, there is the participatory methodology of BRAPA (BRACED participatory assessments) which was developed by a consortium of partners from the BRACED program (Strengthening resilience and adaptation to extreme climate events and disasters) in 2015. It is a method of assessing the vulnerabilities and capacities of communities in the face of climate-related risks, with an emphasis on stresses and shocks. BRAPAs focus on four themes: gender equality; dissemination of climate information; media possibilities; and resilience. Several (75) BRAPAs were carried out in the different project areas in Burkina Faso, using tools such as climate risk analysis, stakeholder analysis, community resource mapping, problem analysis tree, timelines and seasonal calendars (OXFAM, 2017).

Then, can also be cited as resilience assessment tools, the EPCV (Assessment of Capacities and Vulnerabilities) with differentiation according to sex (in BF, Vanuatu), the HEA (Analysis of the Household Economy) with differentiation according to sex (BF, Nigeria, Uganda), HVCA (Household Capacity and Vulnerability Analysis) (in Nigeria, Uganda), GALS (Gender Action Learning System) OXFAM, 2017).

Finally, the index of survival strategies and the level of vulnerability which is an indicator for analyzing household adaptation strategies to food shortages was used by Mulumeoderhwa M F *et al*., (2020) in the Democratic Republic of Congo, in South Kivu.

In France, the National Council for Food Resilience uses a combination of six indicators to analyze the food resilience of territories (Conseil National pour la Résilience Alimentaire (2021):

- The adequacy between production and the needs of a territory. This indicator assesses the capacity of a territory to meet the food needs of its population (cereals, fruits and vegetables, oilseeds, meats, etc.). territory, as well as its evolution;
- The land policy (agricultural surface and artificialization) is the indicator comparing the agricultural surface and the food needs of a population, taking into account the policy of artificialization of soils. Artificialization is a loss of the natural function of a soil, linked to urbanization and to human uses of natural and agricultural spaces. Artificialization threatens agriculture, food production and ecosystems;
- Sustainable agricultural practices constitute the indicator that assesses the level of implementation of sustainable agricultural practices in the territories. Agricultural practices are one of the keys to long-term food resilience, taking into account current imperatives and challenges without compromising the ability of future generations to meet their own needs. These practices must preserve the environment and natural resources, as well as the health and well-being of the species cultivated;
- The presence of local distribution networks is the indicator illustrating the density of food distribution in direct sales (in France). Access to local supply circuits is also provided via large-scale distribution networks or through digital players.
- The presence of processing equipment reflects the density of food processing equipment (slaughterhouses, mills, vegetables, collective meat cutting workshops, cereal mills, vegetables, canning factories). Processing equipment is an essential link in short local food chains. They are at the interface between producers, breeders, artisans, traders, restaurateurs or operators of collective catering, and allow the first transformation of agricultural products before they are placed on the market.

4-Surveillance systems and early warning systems (SAP) in food, nutritional or agricultural resilience

Food and nutrition security surveillance systems have been designed and implemented in communities and countries exposed to shocks and stresses. They are used to inform or warn key actors and authorities about food and nutrition situations. It is a key element of disaster prevention that helps reduce the loss of human life and the economic and material effects of hazardous phenomena (ACF, 2013, OMM, 2018, 2018b).

Likewise, AMPs are at the heart of measures that limit the loss of lives and livelihoods due to hazards and disasters. EWS are made up of a series of organized surveillance mechanisms or actions that collect information about potential hazards in a given location in order to trigger, in a timely manner, coordinated responses. EWS are used in all sectors involved in disaster risk reduction including food security, agriculture and health, adaptive architecture, among others, to provide communities, governments, NGOs (Non-Governmental Organizations) and humanitarian actors, the information that allows them to act effectively and efficiently. For an EWS to work effectively, local, national and regional authorities, as well as vulnerable groups, need to put in place an integrated and comprehensive framework that specifies the roles, responsibilities and relationships of each of the actors within the system. Four basic elements are necessary to develop a complete and effective EWS: knowledge of risks, monitoring and alert service, dissemination and response capacity (i.e. arrangements made in relation to early warning received). Any insufficiency of any of the above elements could mean the failure of the entire system (OCHA & FAO, 2014; OMM, 2018a, 2018b).

Better integration of nutrition-related information into agriculture and food information systems (SAP) has several benefits for better threat monitoring, context analysis and root cause analysis (FAO, 2018b).

5-Criteria for food / nutritional resilience or a food system

During the 2010s, there was a great political awareness on the importance of designing more resilient local food systems, with regard to the different forms of crisis (economic, food, energy, social) that cities are in the process of confronting. In this sense, the great disruption of the New Food Equation (Morgan K & Sonnino R, 2010). According to ICLEI (International Council on Local Environmental Initiatives) (2013), to be considered resilient, a food system should be:

- Diversified: characterized by urban spaces and diversified agro-food sectors, which can bring urban and peri-urban agriculture closer to that outside the city, by strengthening biodiversity, conservation of seed varieties and ecosystem services;
- Distributed: marked by food production distributed in different areas, in order to strengthen relations between the city and the territory;
- Natural: contributing to better management of natural resources and water and reducing the impacts of climatic phenomena;
- Innovative: having innovative solutions for closing cycles of urban metabolism increasing resilience, with a variety of social responses, but also in terms of technology and projects, etc.;
- Social: can maximize the benefits for the population, increasing employment opportunities, sustainable management of local resources,

supporting the awareness of more vulnerable consumers and expanding awareness of food choices ;

- Inclusive: because resilience is strengthened by the participation of a variety of public and private actors and by the active participation of the population (ICLEI http://resilient-cities.iclei.org/bonn2013/program/ urban-food-systems-forum/resilient-urban-food- systems-in-brief/).

Following the concepts used by the Organization for Economic Co-operation and Development (OECD), FAO and the United Nations Summit on Food Systems Scientific Panel, there are five key capacities that together determine the capacity of food systems. to withstand shocks and stressors: (i) anticipation (Ability to manage risks and plan strategies to cope with shocks when they occur), (ii) prevention (Preventive actions to mitigate the effects of shocks or expected stressors), (iii) absorption (ability to cope immediately with the effects of shocks and stressors), (iv) adaptation (ability to adapt strategies and actions while maintaining stable functioning of the system) and (v) transformation (ability to transform the whole system) (Piters B S *et al*., 2021).

Resilience exists at several levels and concerns individuals, households, community, system and / or society (ACF, 2013). According to the FISCRCR, (2012), first, a resilient community is informed (able to assess, manage and control the risks to which it is exposed), healthy, organized (able to identify problems, 'prioritize and act). In addition, it is connected (links with external actors who provide advice and support), invested in the development of local risk reduction policies. Finally, a resilient community has infrastructure and services, has economic opportunities, and can manage its own natural resources.

The international research group Resilience Alliance (2007) has defined four dimensions in which the concept of urban resilience is applicable: (i) urban metabolic flows (food inputs and outputs), (ii) governance networks (relationships between institutions, producers and consumers), (iii) social dynamics (improving networking and social cohesion through food education and public health initiatives; bringing the population closer together and participating in agricultural practices and food production) and (iv) built space (relationship between built and open spaces, with the role of urban and peri-urban agriculture, etc.).

Territorial food resilience requires a good knowledge of local resources: food supply, local actors, food flows ... It also requires supporting local initiatives and partnerships as well as cooperation between territories. Finally, it is based on a multi-criteria approach to food. Food resilience is thus a question of political and citizen choices, democratically discussed, in which dependencies are chosen and controlled. (Cap Rural, 2021).

6-Food resilience measures of the territories: case of certain American and European cities

The COVID 19 crisis has revealed that the global food system is vulnerable: the closure of borders has affected the availability of food in urban centers, farmers in particular in Europe have faced a labor shortage, the cessation of exports agricultural products have resulted in waste (Faucher *et al*., 2020). This is why it is urgent to make food systems more resilient in the long term, in particular the resilience of territories to COVID 19 (Cap Rural, 2021).

In Île de France, Vachelard V *et al*., (2020) recommend, as a measure of resilience for agricultural actors, to reduce dependence on local short circuits and encourage local production. Because sustainably feeding the population by guaranteeing access, for all and at all times, to healthy and quality food is a major challenge in the densest and most populated French region. However, the current food system is limited by its dependencies.

Faucher A *et al*., (2020) and the National Council for Food Resilience (Conseil National pour la Résilience Alimentaire, 2021) presented food resilience measures developed in some American and European cities. It was about:

- Ensure food security for vulnerable populations, (i) in Azuay (Ecuador), by buying and selling agricultural products at a lower cost from local producers, by the public authorities, (ii) in Valparaiso (Chile), by distribution by the State to families, "health baskets" made up of pasta, legumes, oil, flour and other essential toiletries, in (iii) Marseille (France) by funding food aid structures or buying and distributing directly fruits and vegetables, (iv) in Lecco (Italy), by setting up a food card system in order to offer the most vulnerable families more affordable food prices ;
- Developing new markets for local producers in certain communities such as Bordeaux, Lyon, Marseille (France), Guanajuato (Colombia), Valparais (Chile) have made it easier to put producers in contact with consumers and job seekers;
- Diversify agricultural food production in certain urban centers by preserving and strengthening cooperation with their hinterland by maintaining a diversified local agriculture and giving priority to family farming;
- The collective organization of producers;
- Develop and strengthen a resilient and healthy food supply and distribution network, accessible to all in communities, relying on local and organic production;

- School canteens, a food safety net, allowing students to benefit from a complete and healthy daily meal;
- The knowledge of stakeholders through the establishment of local governance, essential to build a resilient food system. It promotes the mutual understanding of actors, develops their ability to create synergies and partnerships without forgetting bonds of trust and solidarity in the event of a crisis;
- Confirm citizen dynamics in favor of sustainable food.
- Respect for ecosystems, an essential key to long-term food resilience (preservation of agricultural land necessary for food production and essential for resilience). , that of consumption habits (reduction of consumption and production of meat and less intensive farming practices in order to achieve national carbon neutrality commitments) and improvement of food autonomy. This last action involves the preservation of agricultural land and the reorientation of part of the existing production towards local demand (The Shift Project, 2021).
- According to Cap Rural (2021), making food systems more resilient in the long term, in particular the resilience of territories to COVID 19, we must:
- Reasoning and sizing the nourishing spaces on the scale of the territory (the nourishing territories are based on long-term food planning and food security is a pillar of resilience. Guaranteeing this security in the long term therefore calls for reasoning in terms of planning);
- Strengthen the dynamics of re-territorialization of food (relocation of food is one of the main drivers of resilience of the territories);
- Act in favor of sustainable production methods.

7-Food, nutritional resilience strategies in Africa

Food insecure households use four types of consumption coping strategies: (i) change their diet, (ii) increase their food supply using short-term strategies that are not sustainable over time. long period; (iii) if the food available is still insufficient or inadequate to meet food needs, households can try to reduce the number of people they have to feed by sending some of them elsewhere (sending children home from home). " a neighbor when the neighbors are eating), (iv) manage the deficit by reducing the portions served or the number of meals, favoring certain family members or fasting entire days) (Fleuret A, 1986 ; Corbett J, 1988; Rahmato D, 1988; FAO, 2005 ; Maxwell D & Caldwell R, 2008).

In Mauritania, in order to cope with drought and other shocks such as rising food prices, households have put in place compensation strategies. The most talked about is the change in eating habits and in particular the decrease in the quantity, quality and number of meals. Households not only reduce their food expenses, but also resort to family loans or migrate to do exceptional jobs (PAM et UNICEF, 2006). Rural households are less resilient than urban households due to differences in access to basic services, coping capacity, and asset ownership. Poor harvests and serious diseases weaken the resilience capacity and food security of households, especially in the south of the country (FAO, 2018b). On the other hand, in Niger, the main strategies that households have more recourse to are as follows: reducing the food ration; unusual recourse to the consumption of wild plants, going one or more days without eating; the sale of animals and land due to food insecurity (PNUD, 2009).

According to Save the Children (2009), it is important to link food and agriculture interventions with social protection measures in order to improve nutrition and build resilience. Indeed, social protection interventions are increasingly used in a current climate of economic uncertainty, food price volatility and the increasing frequency of extreme weather events. Social protection programs increase food expenditure and dietary diversity.

According to OXFAM (2011), food resilience measures can translate into an approach to agricultural development focused on small-scale food producers, significant efforts for natural disaster risk reduction, social networks through friends , family, and religious and community groups that poor people generate on their own for considerable resilience, link agricultural and food interventions with social protection measures.

In the eastern region of the Central African Republic, Laissus P and Lallau B (2013) found that households have diversified their activities: the multiplication of small businesses, the sale of picked fruits or bundles of wood) to cope with insecurity. food. Sometimes, households accept being hungry to preserve their future means of production and livelihood (N'da L, 2014).

In addition, FAO (2014) recommends several measures to obtain food resilience: strengthen household livelihoods and promote food diversification, incorporate nutrition education actions to improve dietary practices, link agriculture and " food to other sectors that address health, water and sanitation (FAO, 2014, 2018b).

For Madre Y (2015), strengthening food resilience involves, on the one hand, reducing losses in agricultural production itself and waste throughout the food chain (from farm to fork). On the other hand, we must share the available food resources more equitably (in the world) and combat the nutritional imbalance that causes many health problems (obesity) (Madre Y, 2015 ; PNUD, 2017). En plus, Madre Y (2015) préconise de nouvelles façons pour produire plus de

nourriture : désenclaver de nouvelles terres agricoles et réaliser des gains de productivité.

A UNDP study in 2017 identifies good practices to be adopted to enable the transition to sustainable and resilient food value chains in sub-Saharan Africa, based on the examination of externalities and negative environmental consequences in six value chains (meat and dairy products, rice, cassava, maize, pulses and mango, in several arid countries (Burkina Faso, Ethiopia, Ghana, Kenya, Malawi, Niger, Nigeria, Uganda, Senegal, Swaziland and Tanzania). Three lines of action can facilitate the transition to sustainable and resilient food systems (PNUD, 2017):

- Diversification of agricultural activities by maintaining several sources of production and varying crops in different agricultural landscapes and over time, using crop rotation, intercropping or mixed farming;
- Sustainable intensification of agriculture which combines best agricultural practices in order to optimize production from inputs, including land and water, while minimizing externalities and negative consequences, such as pollution or deforestation ;
- Use of non-farm livelihoods and market diversification by diversifying sources of income by engaging in new activities in order to improve economic resilience and access to markets.

FAO (2018b) and Mentz-Lagrange S and Gubbels P (2019) suggest taking into account nutrition, nutrition education, EWS, gender and equity issues, and agroecology in strengthening the resilience of farmers in Africa, especially in the Sahel.

Social safety nets or social assistance programs are non-contributory benefits, in cash or in kind, aimed at supporting poor or vulnerable people. It is this non-contributory form that is favored in Africa. They take into account social food safety nets. These seek to integrate the essential components of food security: availability and access to food, nutrition and stability over time to sustainably fight against hunger (Grain de sel, 2020).

Below are some examples of adaptation strategies by specific actors in the agricultural sector value chain in Rwanda, with the advent of COVID 19. Some market vendors sold their products at home or varied the products. for sale depending on what could be bought from the farmers. In addition, shift work was introduced to reduce the number of saleswomen in the market. As for small local carriers, as door-to-door deliveries became more frequent during the restrictions, they were collaborating with new professional partners and working more with digital platforms. Exporters sorted their products according to their ripening speed in order to avoid rotting, in anticipation of prolonged quarantines to undergo (Initiative Réaction et Résilience COVID-19 pour les chaînes de valeurs alimentaires en Afrique, 2021).

Tables 2 and 3 outline strategies for coping with food insecurity in Africa.

Table 2: Adaptation strategies by level of severity to food insecurity

Type of strategy	Observed behavior
Level 1 strategies: Adaptive (small-scale crises)	Relies on cheaper / less preferred foods
	Reduction of food intake (number and size of meals)
	Reduction of expenses related to the purchase of non-food or non-essential products
	Increased consumption of staple foods versus other foods
	Low reduction in dietary diversity
	Borrowing food or money to buy food
	Slight sale of asset stocks (with the hope of being able to renew)
	Short-term atypical migration, short distance
Level 2 strategies : Distress (medium-amplitude seizures)	Harvests of unripe crops
	Consumption of the seed reserve for the next season
	Significant reduction in dietary diversity
	Collecting or hunting foods with low nutritional content
Level 3 strategies: survival (acute crises)	Substantial reduction in food consumption (e.g. reduction in consumption of adults for the benefit of children)
	Large-scale migration in search of food
	Total sale of goods

Source: ACF (2009), Adapted from Hunger Watch

Table 3: Use of adaptation strategies by households in South Kivu (Democratic Republic of Congo) to food insecurity

Strategies	Frequencies of use			
	Each day	Never	Rarely	Often
Decrease in food intake / Feed active members	32%	10.5 %	41%	16.5%
Faire manger les membres actifs	-	67%	19.5%	13.5%
Buying food on credit	-	68.5%	17%	14.5%
Obligation to eat certain foods	-	58.5%	26%	15,5%
Sale of production goods	-	15%	28%	57%
Do without health services	-	39%	18.5%	43.5%
Spend the night or the day without eating	-	71%	16.5%	12.5%

Source: Mulumeoderhwa M F *et al*., (2020)

8-Resilience and gender

According to the International Food Policy Research Institute, women in developing countries play a key role in the three pillars of food security, namely: food production, economic access to food and nutritional security, despite enormous cultural, social and economic constraints. the role of women in Burkinabé society in general, and in the management of food security in particular, has never been a passive role and has evolved enormously with the recurrence of food crises. These women have always participated "not only in terms of food processing and water supply, but also as providers of food (grains and animals)" (l'Institut International de Recherche sur les Politiques Alimentaires, 1995; Diarra Dok M *et al*., 2013).

In Burkina Faso, Mali and Niger, all women ensure resilience by regularly taking charge of lean periods. Women's participation in food begins where that of family or men's production ends. In principle, the woman takes over with her own production and, when she does not have it, with income from small daily income-generating activities. Resilience cannot be thought of without rural women. The capacity of women to negotiate or influence decision-making within the household improves household food security, in particular through: (i) the diversification of foods comprising the stock, by the introduction of many foods that are not available. not necessarily produced locally; (ii) increasing the duration of food stock availability, through sparse management of the millet produced (and depending on the preparation methods); (iii) better organization in terms of supply planning, because it is rare to decide and contribute together for an expense (OXFAM, 2014).

Table 4 below shows decision-making by area according to gender in an African community in the Sahel (OXFAM, 2015).

A sine qua non for Oxfam's work towards building resilient development is gender and power analysis. It is vital for the resilience context analysis to understand how shocks and events a ect men, women, boys and girls di erently, how vulnerability differs, and how power and gender shapes the ability to cope, adapt and change. It's not just about collecting gender-disaggregated data, it's also about who conducts the context scan, who provides the information, who talks to communities and other stakeholders (OXFAM, 2017).

Addressing gender and equity issues is essential, as improving access to and control over resources and inputs for women or the most marginalized groups in a community is an essential part of policies and strategies aimed at to build resilience, food security and nutrition (FAO, 2018b).

In her work, Pepper A (2019) examines the integration of a gender perspective in EWS is essential in order to prevent and manage crises more equitably. There are gaps at the national and regional levels. In many subsistence farming systems, women have primary responsibility for producing food crops. Typically, they are also responsible for home gardens that meet household needs (FAO, 2015; Bizikova L, 2020; Bizikova L *et al.*, 2020).

Cultural traditions and social structures often leave women poorer and more prone to malnutrition than men. This situation also concerns pregnant and breastfeeding mothers, who often need additional specific foods (FAO *et al*., 2018). As a result, women are up to 11% more likely than men to report food insecurity. Food insecurity is more prevalent among women not only in terms of the global average, but also in all regions of the world (FAO *et al*., 2017).

Table 4: Decision-making by domain according to Gender

Domain	Who makes the decisions
Agricultural	The two members interviewed agree on the fact that the head of the household decides, alone, the distribution of working time in the different fields and / or plots, the cultivation operations to be carried out, the harvest and the sale. However, they contradict each other in relation to the crops to be installed. The husband says they make decisions together on this matter, while his 1st wife says he is the one to decide. This contradiction could be explained by the relative freedom of women to choose crops on their personal plots.
Breeding	The decision-making power concerning the only small ruminant in the household rests with the head of the household. However, the woman can decide to buy poultry on her own.
Marketing / sale of products	In this area, almost all the decisions are made by the head of the household except the decision related to the sale of the products of the gathering which can also be taken by the members who practice it, in particular the women.
Achat des produits alimentaires	With the exception of the elements used in the manufacture of the sauce, the decision of which is reserved for women, all other decisions belong solely to the head of the household according to the two respondents.
Schooling and Child Marriage	The schooling of children is a parental decision (father and mother). The same is true for child marriage, but this time they take into account the choice of their daughters and sons.
Investments	The head of household declares that decisions regarding investments in agriculture are taken by him alone and that non-agricultural investments are made by members who have the means. As for his 1st wife, she reports that other members of the household participate in decisions concerning agricultural investments.
Income	The head of the household and his 1st wife agree on the fact that only the head of household makes the decisions concerning the household income. As for personal income, the head of the household alone decides what to do with it, while his 1st wife still reports that other members participate in the decisions made on his own income. In addition, the head of household declares that all members participate in making decisions on donations or transfers of money, while his 1st wife declares that these decisions are made between the two spouses.
Expenses	Both say they only incur essential expenses (basic food, clothing and urgent health care) and that this decision rests solely with the head of the household.
Natural resource management	Both agree that this responsibility rests primarily with the village chief.

Source: OXFAM (2015)

9-Governance for the resilience of a food system

According to OXFAM (2011), governance for a resilient food system requires resilient state governance, and a particular emphasis on peacebuilding and other approaches to conflict prevention and resolution. This is especially important in the area of natural resource governance, because of the intensification of competition over land and water. The access of poor people to natural resources can be in conflict with others and a reason for the displacement of people. Thus, the role of the state is essential, both from the point of view of its accountability and legitimacy to its citizens, and of its capacity to manage shocks and promote other sources of resilience. Likewise, institutional strengthening and good governance contribute to disaster risk reduction in all agricultural sectors. The objective is, first, to get countries to have appropriate legislation, policies, standards and institutional frameworks for disaster risk reduction in agriculture and related sectors. Then, it is necessary to strengthen the institutional capacities of the countries for their implementation (FAO, 2013a).

ACF (2013) advocates strengthening support to communities through responsible and effective governance in achieving resilience in the food system of communities. The aim is to increase the capacities of communities and institutions, to favor the development of an interactive link between authorities and communities, while amplifying and strengthening governance capacities.

Rightly, Piters B S *et al*., (2021) find that most food systems around the world do not deliver all the expected results. Over time, many food systems lose levels of agency, storage capacity, connectivity, or diversity. One of the main causes of a food system's failure to evolve in the desired directions is its governance.

10-Future prospects for food resilience in Africa and food resilience in the age of the Anthropocene

To capitalize on the many lessons learned and ensure the necessary transition to sustainable and resilient food value chains, it is essential to undertake systematic, cross-sectoral and large-scale actions. With this in mind, the UNDP proposed a framework for action articulated around four areas of intervention (pillars), which are mutually reinforcing and all encourage the creation of sustainable and resilient food systems (PNUD, 2017):

- The “information” pillar sensitizes actors in the value chain, including small farmers and small and medium-sized enterprises, and provides them with the knowledge, technology and know-how necessary to establish food systems and value chains sustainable and resilient. This pillar takes into account communication systems and networks (including education and the media) that consolidate, harmonize and share information and knowledge, and monitor progress;
- The “resources” pillar concerns the useful public and private financial means throughout the value chain to strengthen its environmental sustainability and its resilience. This aims to make value chains more respectful of the environment, innovative financing, banking systems and donations, micro financing, etc.);
- Policies, associated laws and regulations, play a key role in removing obstacles to the sustainability and resilience of food value chains. An insufficient regulatory framework or complex administrative procedures are obstacles;
- 'Implementation support 'helps, through capacity building and technical assistance, to materialize systemic models aimed at creating sustainable and resilient food value chains. Further important aspects are the development of infrastructure (good roads) and the facilitation of infrastructure investments for sustainability and resilience.

The implementation of each of the four pillars requires an inclusive, collective action-oriented multi-stakeholder platform to facilitate the transition to sustainable and resilient food systems and chains (PNUD, 2017).

In addition to studies in sociology, geography, political science and economics, research on organization and management has an important role to play in shedding light on the organizational, governmental and strategic issues that accompany the changes in our food systems (Elmes M B, 2016; Beacham J, 2018; Böhm S et al., 2020) at the time of the Anthropocene (Valiorgue B, 2020). The Anthropocene is a geological term meaning "the era of the human." The food of tomorrow must be resilient. It will be designed for our territories, adapted to their specificities.

Tomorrow, agriculture will be more efficient in inputs and more resistant to changes (climate, etc.). The logistics circuits will be shorter and better organized, the productions of the territories more diversified, the processing closer to the farm and the trades better valued. All links in the food value chain will be complementary (Conseil National pour la Résilience Alimentaire, 2021).

CONCLUSION

This bibliographic synthesis aims to analyze the various studies dealing with food resilience and should highlight aspects that have been insufficiently studied for further study. Food resilience has been widely discussed in recent years, from various angles, by researchers or international organizations, in situations of crises or multiple and complex changes. The information presented here concerns both measurement tools and indices as well as food resilience strategies, not to mention governance. It appears that food resilience strategies in Africa differ from those in developed countries. In addition, studies relating to food resilience strategies, in situations of pollution of rivers, seem very insufficient. This calls for further work in this regard.

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