Synthèses

SUSTAINABLE FOOD SYSTEMS FOR FOOD SECURITY

Need for combination of local and global approaches

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Chapter 7

Agroecological innovations, food and nutrition security and food safety for small farmers: Africa-Europe perspectives

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In both the Global North and Global South, food, nutritional and even safety insecurity mainly impact the most vulnerable populations. Among those, the urban populations of working-class neighbourhoods in large and medium-sized cities are the most affected, as well as rural populations making their livings from small family farming, especially in Africa. However, in many situations, innovations (technological or organizational) are emerging and profound changes are under way, whether or not accompanied by incentivizing policies. We can thus observe a transformation in agricultural and food production systems, which are gradually or radically integrating more agroecological farming methods: a combination of crops and livestock, introduction of off-season market gardening, fruit arboriculture, and more.

These transformations are sometimes based on eliminating pesticide use, such as in organic farming. The changes, often guided by market considerations as well as societal expectations about the environment and health, are likely to have positive impacts on not only the environment but also producer and consumer health through healthier, safer and more diversified food (Dury et al., 2019; Bezner Kerr et al., 2021). In cities or on their outskirts, especially in Europe, the growing development of multifunctional urban agriculture can also have positive effects on the environment and the food and nutrition security of vulnerable populations. This includes community gardening in working-class neighbourhoods that creates multifunctional spaces, which then strengthens links with nature and social ties, well-being and educational aims (Lal, 2020).

These different elements led us to ask the following question: do these innovations contribute, directly or indirectly, to improving the availability and accessibility of quality

food products (with high nutritional, sanitary and organoleptic value) for farmers and practitioners of these forms of urban agriculture, thus helping to strengthen their food security? To study the existing links between farming methods and dietary diversity, we analysed three contrasting case studies in Africa and Europe and the obstacles encountered. We will first present the main methods and results of each of the three case studies before discussing the similarities and differences observed.

⏩ Presentation of case studies and main results

Diversity of farms and food diversity in the Sudano-Sahelian region

The study was conducted in the province of Tuy, in the Hauts-Bassins region in western Burkina Faso. The climate is tropical with two strongly contrasted seasons: a dry season from November to April and a rainy season from May to October. The main economic activity is agriculture, although gold ore mining, both industrial and traditional, is gaining in importance. Agriculture in this area is mainly family-run and rain-fed, based mostly on cotton-cereal rotations (maize, sorghum, millet). The harvest period is from October to January, which makes it possible to fill the granaries, harvest the shea (*Vitellaria paradoxa*) and locust bean (*Parkia biglobosa*) fruits from the agroforestry areas that will be processed and stored, and generate income that will ensure most of the household food supply during the year. Most farms also keep animals, but mainly for animal-powered transport or sale (including small ruminants and poultry) rather than for self-consumption. Some farms have orchards, especially mangoes, which are an important source of food during the lean season, not only for farms' own households but also for all families in the community. Some farms have access to lowlands where they can practice market gardening during the dry season from January to May, which allows farmers to have fresh fruit and vegetables for their self-consumption and to sell in local markets to other inhabitants of the region. The annual diet is thus based on basic foods that can be stored and bought locally throughout the year: cereals that women grind to make *tô* balls (maize, sorghum, millet); sauces and condiments; snacks (vegetables, fruits) that may be fresh or processed to be preserved; sumbala (fermented locust bean seeds), chilli peppers, dried fish, etc. Despite this careful management, in a constrained environment, the dietary diversity scores measured among women remain low (Lourme-Ruiz et al., 2016).

A longitudinal study was conducted on 300 farms across 12 villages in Tuy over a one-year period, from October 2017 to September 2018. The aim was to record farming practices and dietary diversity among women (24-hour diet recall) over a complete farming season, from the harvests of one year to the harvests of the following year.

We used the data collected to build a typology of farms, based on a principal component analysis (PCA), and an ascending hierarchical classification (AHC) on the basis of the following variables: cultivated area (total in ha, for cotton and legumes), equivalent-adult workers, number of draft oxen, income, Simpson's Diversity Index, (left-hand column of Figure 7.1, from bottom to top). It includes four types:

1. Medium-sized cotton-oriented but diversified family farms (type 1, n=95);
2. Small farms with land constraints oriented towards livestock (type 2, n=28);
3. Farms producing legumes (20% of crop rotation) with land constraints (type 3, n=68); and
4. Large family cotton farms (type 4, n=100).

Links were then established between these four types of farms and 15 specifically constructed indicators of the ecological practices (e.g., percentage of the agricultural area on which manure is spread; use of crop residues; doses of artificial fertilizers; density of trees in fields). These indicators were grouped into four types of practices (A, B, C, D), according to the PCA and AHC (middle column of Figure 7.1, top to bottom):

1. The use of artificial inputs (A, 169);
2. Agroecological practices involving an optimization of the use of manure and a high density of trees in the fields (B, 39);
3. Agroecological practices involving an optimization of manure and crop residues (C, 29);
4. Agroecological practices involving cereal-legume rotation and a minimization of tillage (D, 54).

These cross-linked typologies (farm type, groups of practices) were linked to the dietary diversity score of the women surveyed. The score was simplified according to the number of months during which the score is higher than the annual average (right-hand column Figure 7.1, from top to bottom): more than six months of the year (39); fewer than six months of the year (204); and no months of the year (48).

Figure 7.1 shows the links between these three pillars and illustrates the complexity that exists between agricultural systems, agroecological practices, and dietary diversity among women. While the two types of cotton-oriented farms (1 and 4) are unsurprisingly the two largest users of fertilizer (links with input supply chains through monitoring of the cotton sector), all types adopt agroecological practices. More specifically, the two cotton-oriented types mainly adopt practices related to the management of crop residues (C), while the two other types of small family farming, constrained by land tenure (type 2 and 3) adopt the whole range of agroforestry practices (B, C and D). The right-hand part of Figure 7.1, which shows the links between agricultural practices and dietary diversity, shows that the best and worst levels of food diversity can be obtained by any type of agricultural practice. However, we can note that for 23% and 24% of farms that are classified in type B and C, the agricultural practices are at the highest level of dietary diversity, while only 12% and 15%, of types A and D, respectively, achieve this level of diversity.

These results, which are quite complex to interpret, illustrate a striking fact: dietary diversity does not just depend on farm production or harvests; it is also a question of households having market access and earning a sufficient income to purchase diversified food products. However, what this graph seems to indicate is that, in this region of the world, cotton-oriented farms, even if they adopt agroecological practices, and in particular cereal/legume crop rotations, do not present the greatest dietary diversity over the course of the year. Conversely, small farms that are constrained in terms of land use adopt a wide range of agroecological practices that make it possible to achieve high levels of dietary diversity.

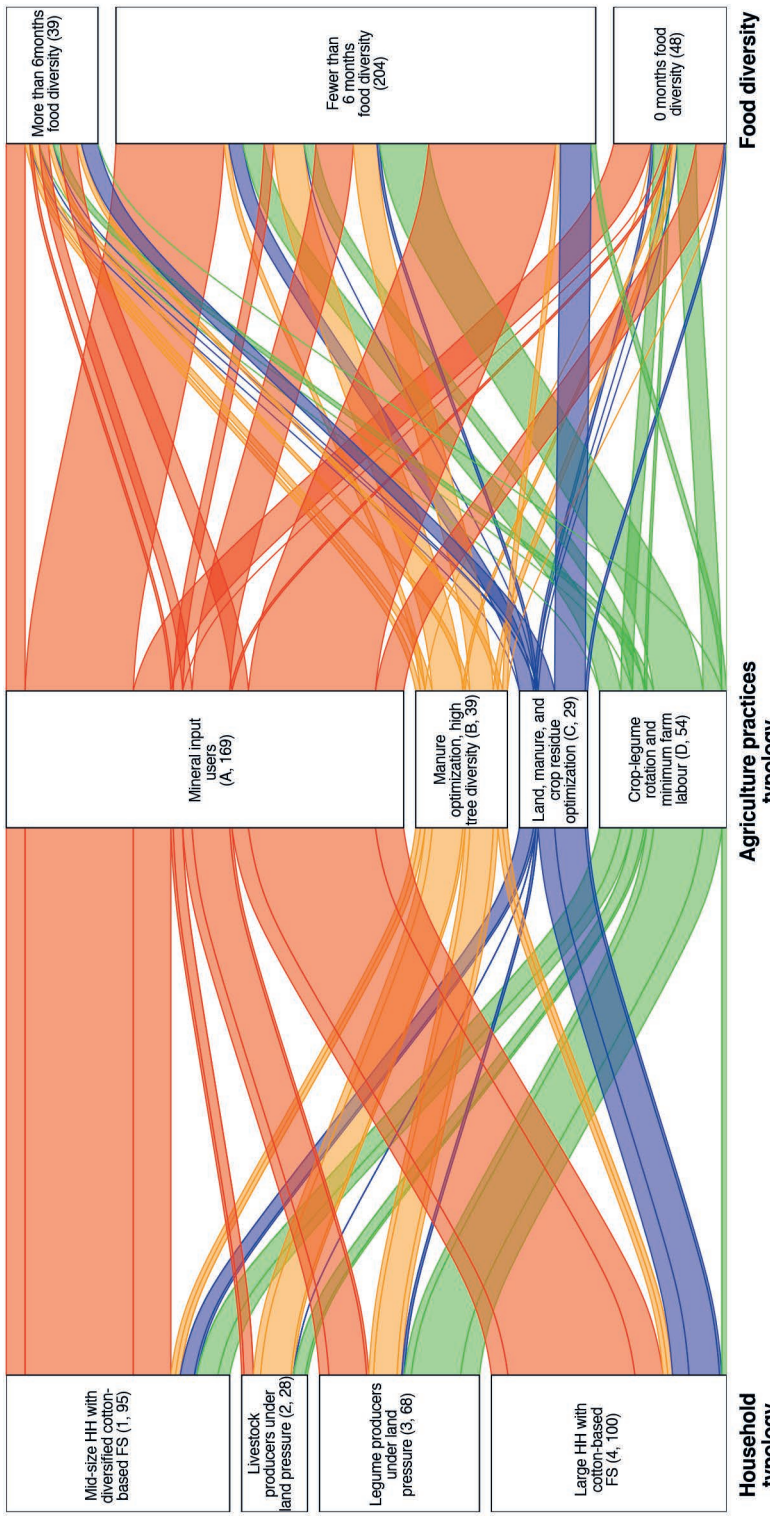

Figure 7.1. Links between the classes of household typologies, agricultural practices and dietary diversity for 300 farms in 12 villages in Tuy (Burkina Faso). The colours and line thickness indicate the size of the number of farms involved.

Beyond the preliminary results presented here, two complementary challenges remain: first, How to encourage all types of farms, and in particular those oriented towards cotton production, to adopt agroecological practices? And second, How can direct and ethical links be established between agricultural practices and dietary diversity, by making dietary diversity an explicit decision-making factor in the choice of agricultural practices, and by making it a family issue in the same way as agricultural yields? This concerns issues of decision-making between men and women, and thus of gender and power, regardless of the capital constraints of the farm.

New forms of organic farming in Africa and their contribution to the food security of farmers and the whole population

Organic farming is experiencing renewed development in Africa (Lernoud et al., 2019), but it covers very different realities. After conducting several workshops and surveys between 2015 and 2018 in Burkina Faso, Cameroon, Benin and Senegal with actors involved in organic production objectives, we created a typology of organic farming situations according to the innovations implemented by farmers. We then characterized the way that greening production methods through organic farming can directly or indirectly influence food security through self-consumption or higher incomes.

Typological characterization of organic farming and producers' innovation situations

Three main types of organic farming have been identified (De La Paix, 2020) to describe innovation situations that lead to greening of production methods and contribute to an 'agri-organic' transition:

1. Certified organic farming, aimed at international markets. It is implemented by multiple stakeholders (e.g., industrial entrepreneurs, civil servants) or companies already engaged in international markets (bananas, pineapples, cereals, and legumes, especially soyabeans to supply organic livestock). The production method mainly uses hired labour. This form of agriculture promotes its organic nature and complies with the specifications established by organic farming certification bodies at the production and processing levels. The markets targeted are clearly international (Europe, North America).
2. Organic farming described as 'natural', targeting local markets. We note here the term 'natural', which arose during workshops in Cameroon. It refers to agricultural and food systems that have existed for generations and where chemical inputs are not used, either by choice or because of financial or biophysical constraints. Often based on highly diversified systems (crop combinations, rotations, agroforestry, etc.), the products from these systems are most often very diversified: cassava, plantain, yam, fruits and vegetables (eggplant, tomato, etc.) and leafy vegetables (amaranth, vernonia, etc.), fruits and non-wood forest products. The term 'organic farming' is often not claimed. The targeted markets are local and sometimes regional (e.g., the Economic and Monetary Community of Central Africa – CEMAC). No third-party certification is applied; however, participatory guarantee system (PGS)

experiments are tested. These systems are built on trust between farmers, consumers and collectors. They are based on information systems related to the method of production, the geographical origin of the product and the social community. This form of agricultural production is predominantly family-run, sometimes with support from non-governmental organizations (NGOs).

3. Hybrid entrepreneurial organic farming, targeting the national market. This form of organic farming is the most heterogeneous. This type of agriculture often includes processing of products in various forms: juice, dried products such as macabo chips (*Xanthosoma sagittifolium*), flour, frozen foods (green beans), etc. The agricultural practices are slightly more intensive with the use of manufactured organic fertilizer or local biopesticides, while seeking to preserve a 'natural' character for the product. The 'organic' or 'natural' dimension of the product is highlighted, for example on packaging. In this type of farming, we also include agricultural systems inspired by specifications imposed by importing countries, such as healthy and sustainable agriculture in Senegal. These products are primarily aimed at the urban middle-class market. The actors associated with production or processing are entrepreneurs, sometimes organized in community groups (known as GICs) or small local cooperatives with or without the help of NGOs.

What these three types of organic farming have in common is that they do not use pesticides or chemical fertilizers. The elements of differentiation relate to the methods of production (family-run, employees), certification, and sectoral integration (industrial, artisanal, short networks) and the downstream recipient markets.

The attributes of food security linked to production system diversity

Using surveys carried out in the four countries studied, we attempted to characterize how the transition toward organic can directly or indirectly influence all aspects of food security.

Availability and access relating to the increase and diversification of production

The improvement in availability may be linked to an increase in the production of some agricultural goods, due to an increase in yields, but it can also be qualitative, through increased and easier access to more diversified products.

In areas that have undergone long-term intensive farming, which has reduced the fertility potential of agroecosystems, the changes brought about by organic farming are likely to restore the biological fertility of the soil. As a result, yields may increase, which is the case for coffee growing in western Cameroon.

In agroforestry areas that are mainly focused on cocoa and coffee production, the yields of these export crops are partly dependent on pesticide use. Eliminating pesticides as part of the transition to organic farming can be accompanied by an extensification of the plantation. The women who help harvest cocoa and coffee can then use the time thus freed up to produce food such as tubers, maize and other market garden crops (Temple and Fadani, 1997). The increase in the number of

species and varieties grown can lead to a potential dietary diversification. The effects can therefore be negative for the main crop (accessibility), but positive for food production (availability, nutrition).

Accessibility by increasing income

Certified organic farming can increase producers' income thanks to the higher sales prices obtained on some products exported to Europe such as soyabean (Burkina Faso) and fruits and vegetables (Cameroon). It also creates salaried employment that improves food security in areas where land access is poor.

In situations where the number of intermediaries is reduced, organic farming helps producers earn higher prices; it potentially improves the food accessibility indicator for producers and consumers alike. It also allows food autonomy to be preserved through self-production, which remains structurally significant in sub-Saharan Africa.

In contrast, in areas of specialized monoculture (e.g., cotton, banana, rubber tree), chemical pesticide use is very high. Transitioning to organic farming imposes technical and economic changes that can reduce main crop yields, farmers' incomes, and the use of hired labour. The consequences for the 'accessibility' attribute of food security via this 'local income effect' can therefore be negative.

Food uses in relation to nutritional and health security

Numerous studies show that organic farming increases the nutritional quality of products (Hunter et al., 2011; Baranski et al., 2014). This increase is particularly marked for fresh fruit and vegetables. However, little research is available on the subject in the African context.

Because organic farming is free of chemical pesticides, it also reduces the risks of diseases linked to the handling of pesticides by producers or residues on produce reserved for self-consumption, thus improving the overall health of producers. However, public health indicators are very rarely provided in poor areas of developing countries and very few explicitly relate to the link with pesticides. However, excessive pesticide use is common, especially in peri-urban market gardening areas where soil and irrigation water are very often heavily contaminated by pesticides and toxic heavy metals.

The regularity of supplies, in quantity and quality

Certified or hybrid organic farming is often the driving force of a small industry of processed products (e.g., fruit juice, dried products). These new products, which have a longer shelf life than fresh products, give people access to new products outside the typical seasons, thereby contributing to food security during the off season or in lean periods.

Natural organic farming, which relies on crop combinations, can strengthen the resilience of cropping systems to climatic variations and pressures on plant health (Branca et al., 2013). However, the variability in the quality of products resulting from diversified farming rarely meet the expectations of the agrifood industry that consolidates products through large-scale processing, or those of large-scale distribution, concerned with marketing very standardized products. Strengthening a

more decentralized artisanal industry, capable of making better use of this diversity, would contribute to develop this kind of agriculture.

Obstacles to the development of different types of organic farming

In certified organic farming, the main constraints are costs generated by third-party certification, the lack of technical assistance for farmers, and access to specific specific organic inputs. Finally, the smallest organizations can find it difficult to earn the loyalty of end buyers in destination markets due to strong competition in quality niche markets.

In 'natural' organic farming, the main constraints are inherent to the intensity of farm labour resulting from stopping the use of some pesticides. This mainly applies to herbicides such as glyphosate, used to kill weeds in the soil before growing most crops, or diuron and metolachlor, applied during the pre-emergence period for cotton crops. In addition, lower yields increase producers' sensitivity to post-harvest losses. Methods to protect against crop pests and diseases should be more integrated and complementary (genetics, cropping systems, plant fertility, mechanization, etc.).

The increase in the difficulty, intensity and amount of work imposed by organic farming requires either better remuneration for farmers or the activation of innovative processes by modifying cropping systems or introducing small mechanization interventions (weeding, irrigation, transport, and product processing).

With regard to hybrid organic farming, the main constraints relate to the structuring and consolidation of emerging niche markets. Another consideration is the difficulty of bringing about the emergence of certification systems, which secure the quality of processed products without incurring excessive additional costs.

However, some forms of organic farming structure the local collective actions (known as SPGs), or sectoral actions with new producer organizations. These changes can positively contribute to the food security of relevant populations, both directly and indirectly. Identification of all these collective actions and enhanced support of them through public policies and adapted research can help ensure effective transitions to organic farming systems.

The development of urban gardens in working-class neighbourhoods in Paris and Seville and food security

Allotment gardens were promoted in nineteenth-century Europe to encourage poor, urban working-class populations to produce their own food (Cabedoce & Pierson, 1996). Until quite recently, such gardens were virtually non-existent in predominantly rural countries and regions in Europe (such as Greece and Andalusia). Since the beginning of the twenty-first century, we have witnessed a triple evolution in western Europe: 1) the diversification of community gardening (shared gardens, allotment gardens for families in public housing estates) as a way to renew social ties and due to the interest of urban populations in ecological issues; 2) the emergence of urban community gardens in the countries most strongly marked by the 2008 crisis (Greece, Spain, Italy, Portugal); and 3) in all cases, the rise in agroecological practices in these

gardens, often governed by charters (in France, *Main verte* or *Jardinons au Naturel*) or municipal or national regulations. The problems of food insecurity in working-class neighbourhoods are also worrying: in France, 14% of households in these neighbourhoods were food insecure in 2012 versus 6.59% of the general population, and these figures rose further with the health crisis of 2020.

To analyse the potential food functions of these community gardens, a comparative study was carried out in 2016 on four garden sites in Paris (and the inner suburbs) and four sites in Seville in Andalusia. The sites vary by the date of creation of the garden (from 1991 to 2014) and their origin (created by family associations in Seville and social associations or social housing landlords in Paris). The survey concerned 14 gardeners in Paris and 17 in Seville on a voluntary basis.

First, semi-structured interviews were conducted to understand the gardeners' social status, level of food insecurity (by applying the criteria adapted by Bocquier et al., 2015), food purchasing habits, history of their access to the garden, along with their expectations of the garden and the crops selected. Second, the gardeners recorded the dates and amounts of produce collected (mid-May to the end of October in Paris, April to November in Seville) in a harvest log that had been previously designed and tested (Pourias et al., 2016). Third, the uses of this production were monitored (fresh consumption, conservation, or given away because sales were not authorized). Researchers conducted bimonthly visits throughout these periods to gather complementary information and record the gardening practices.

The results (Pourias et al., 2020) show varying socioeconomic statuses and levels of food insecurity between the two cities: in Paris, none of the 14 gardeners surveyed (five retirees, one unemployed person, eight employed people) suffered from food insecurity, despite often having low incomes. Although we acknowledge a possible methodological bias in our study (since volunteer gardeners may not necessarily be the most concerned by food insecurity), we noted a very limited presence of the most vulnerable people in these gardens, which is confirmed by discussions with the social housing landowners who know these individuals.[10] In Seville, four of 17 gardeners (10 retirees, four unemployed people, three employed people) did not want to answer this question, four said they 'sometimes did not have enough to eat, or not what they wanted' and nine were food secure. In Paris, most fruit and vegetables were bought in local markets (which were considered as attractive places for prices but also for socialization) and, secondarily, in supermarkets or discount supermarkets; in Seville, produce was mainly purchased in supermarkets and discount supermarkets, with proximity and prices the main considerations. In Paris, gardeners always had a prior interest in fresh fruit and vegetables and cooking before participating in a community garden, and their participation enabled them to have better access to new or expensive products. Meanwhile, in Seville six of the 17 gardeners said that the garden had changed the way they buy and eat by giving them access to a greater variety of products. In fact, 15 kinds of vegetables and fruits (not including aromatic

10. The reasons given were varied: lack of time (in the case of single parent families, for example), sociocultural factors such as poor command of French, the lack of practice in working together, health problems, etc.

herbs) were produced on average in the Parisian gardens and 31 in Seville; in both cases, community gardens favoured food diversity.

The survey confirmed the high variability in quantitative production between gardeners and cities: from 2 kg to 117 kg per gardener in Paris and 61 kg to 531 kg in Seville, i.e., from 0.2 to 5.8 kg/week per gardener in Paris versus 5.3 to 34.3 kg/week in Seville (according to its nutritional guidelines, the WHO recommends 2.8 kg/person/week, WHO, 2013).[11] These differences can be linked to the milder climate and the longer growing season in Seville, larger plot sizes (from 25 m^2 to more than 150 m^2) than in Paris (maximum 20 m^2), as well as the time devoted by the gardeners and their agricultural experience and knowledge, which were more significant in Seville. The contribution of this self-production to household food is, whether in Seville or in Paris, mostly seasonal but clear (Figure 7.2) and recognized, with a more substantial food provision function in Seville.

In both cities, the gardeners systematically highlighted the quality of their production (taste, freshness, and trust, because it is 'homegrown without any chemicals'). Some talked about 'exceptional products' 'that one never throws away' (unlike supermarket vegetables). Conservation (canning, freezing, jams) only concerns the largest 'producers' in both cities but giving away food was very common, both to family members in difficult situations as well as in external solidarity with neighbours.

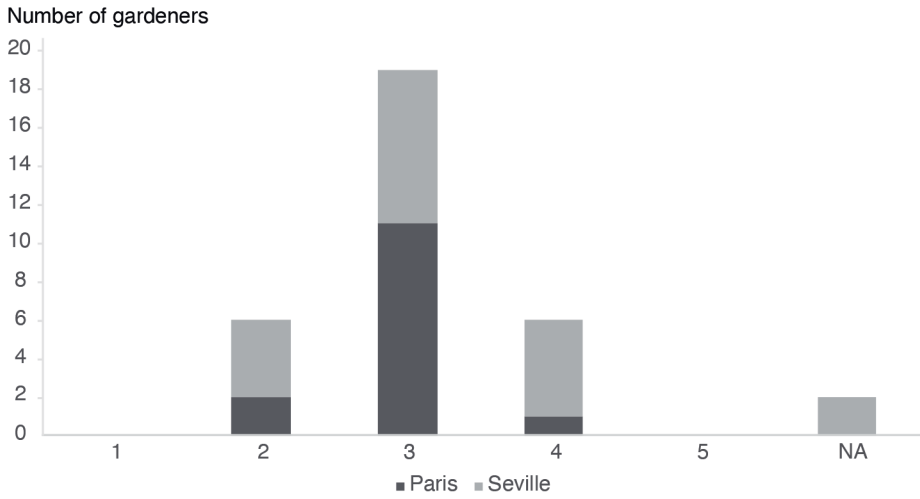

Figure 7.2. Extent of garden food production in Paris and Seville based on 33 gardeners' self-positioning on a gradient of 1 to 5 in 2016.

Each column represents the number of gardeners by classification (from Pourias et al, 2020). Gradients: 1) The food I produce in my garden is incidental, I almost never eat what I harvest; 2) I only occasionally consume the vegetables from my garden; 3) The food I produce in my garden covers 50% to 100% of my needs during the high season for at least one or a few products; 4) The garden allows me to cover all my vegetable needs during the high season (and occasionally out of season); 5) The garden covers all my vegetable needs year round (self-sufficiency).

11. https://www.who.int/news-room/fact-sheets/detail/healthy-diet

These findings are very similar to previous findings for all community gardens, whether or not they are located in working-class neighbourhoods (Pourias et al., 2016). With regard to working-class neighbourhoods, the relevance of these gardens for greater food security is consistent with the results observed in Greece (Partalidou and Anthoupolou, 2017) and Marseille (Martin et al., 2017), where even very low production is associated with significantly higher family consumption of fruit and vegetables. However, and in accordance with other researchers' findings, the very limited accessibility to these gardens among the most vulnerable populations should be noted. In addition, it was observed in Seville (but not in Paris) that the community garden could be a springboard for launching professional agricultural facility projects in agroecology and/or local sales;[12] these findings also agree with other observations (Segui et al., 2017).

These original infrastructures that make up urban gardens intended for food self-production can and should be integrated into development policies in working-class districts. The COVID-19 health crisis, which highlighted food and social problems in these districts, led the French Ministry of Agriculture to release 30 million euros at the beginning of 2021 to support community gardening in working-class districts. However, it is critical to note that self-production cannot be the only lever to guarantee food security for all and to restore food justice, which has been badly damaged in industrialized countries (Paddeu et al., 2018).

⏩ Conclusion

In this paper, we addressed several case studies, which relate to various agroecological and diversification transitions in both the Global North and the Global South, in urban as well as rural areas. The important point is that all these situations testify to positive effects, direct and indirect, on the attributes of food security (availability, accessibility, use, stability) for those who implement them. We offered an in-depth analysis of the nature of the links between productivity and food quality by specifying which components the changes in practices observed are likely to affect.

Availability, use and stability can thus be directly and positively influenced by the implementation of agroecological practices: agricultural diversification on farms in the Sahel and vegetable production in urban gardens directly provide easier access to a more diversified diet. Those who adopt these practices see increased availability, which in turn leads to better access and use (consumption in family meals). Stability also rises, with greater diversity in phenological cycles of the crops grown and even different forms of processing (drying, canning, etc.), improving the coverage of needs (in particular in micronutrients) over longer periods. Where they are used, 'organic' crop practices, whether certified or not, also offer better health outcomes, which can be undermined by the often massive and poorly controlled use of pesticides in peri-urban market gardening production (van Veenhuizen, 2006). They also allow access

12. Creation in 2016 near the Poligono district of a market gardening farm by three young people from the community garden and establishment of a small aquaponic production facility by a family in another garden, supported by the University of Seville.

to 'organic' products for urban populations who cannot afford certified products from branded networks in Europe.

The benefits of implementing agroecological innovations are also indirect, as these practices improve accessibility to a healthy and diversified diet in various ways. Thus, even if the direct increase in income (observed in the case of better market integration) does not systematically improve food security (controversies remain on this point, depending on the household's prioritization of food), the different types of organic farming identified generate new opportunities in Africa for employment and small-scale entrepreneurship. These opportunities can be located upstream of agricultural sectors, via the design, manufacture and marketing of new products (local biopesticides, small-scale mechanization, etc.). They can also be located downstream of the sectors in agrifood processing or specific logistics set up beyond the production activity (small processing units, logistical and transport activities, social groups, information systems, opening of new markets, etc.).

Some forms of organic farming structure collective actions on territories (SPGs) or sectoral actions in some sectors (new producers' organizations). These situations can be observed in both the Global South and the Global North in the case of allotments (new professional projects). While a thorough analysis of these new networks still needs to be performed, these networks certainly represent an important lever to improve the food security of relevant populations. Implementing networks of a different but complementary nature is also likely to generate positive synergies. The rise of 'organic farming' in Africa offers hope, but can only really benefit underprivileged populations in the long term if they manage to master the commercial levers, locally or for export. Thus, our studies show that the development of agroecological practices in fragile environments and in populations at risk can constitute an important lever to improve the food security of these populations. Additional research is, however, still needed to better understand the determining factors of food security and the nature of the complex links between production and food security in order to shed light on the necessary renewal of public agricultural and food policies.

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