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Resilience – and collapse – of local food systems in conflict affected areas; reflections from Burkina Faso

Christophe Béné [a,*], Elodie Maître d'Hôtel [b], Raphaël Pelloquin [b], Outman Badaoui [c], Faroukou Garba [c], Jocelyne W. Sankima [c]

[a] The International Center for Tropical Agriculture (CIAT) and Wageningen Economic Research Group, The Netherlands
[b] MOISA Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), France
[c] World Food Programme (WFP) Burkina Faso Office, Burkina Faso

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ABSTRACT

Armed conflicts are among the major disruptions affecting local food systems in low- and middle-income countries, having devastating effects on populations' food security. The understanding of the mechanisms linking conflicts to food insecurity is limited, however, by a lack of data on how these conflicts affect the different actors of local food systems. In this study, we aim to address this gap, using empirical data from the northeast region of Burkina Faso where an active conflict is occurring. The objective is to document and analyze the impacts of that conflict on the functioning of the local food system and more specifically on the resilience of the traders that operate from Sebba, the capital of the Yagha province. The analysis reveals, first, the magnitude of the disruption. On average, these local food traders experienced a 40%-50% contraction in their activities compared to the situation prior to the conflict. Not all operators are affected with the same intensity, however. Transporters appeared to be impacted more severely than retailers/vendors. Econometric models are then used to explore the socio-economic characteristics of these different actors. The analysis shows that, contrarily to what is often observed with farmers, the level of assets did not seem to contribute significantly to traders' resilience. Instead, having recently relocated to Sebba appears more important to ensure the level of adaptability needed to respond to the rapidly deteriorating situation. The analysis also reveals that the resilience of the "positive deviants" (those operators who did better than the rest of the group) materialized essentially through their capacity to buffer more effectively shocks' impacts but it did not spare them from facing drastic contractions in their trade business. Eventually, the resilience of those positive deviants was not sufficient to maintain the resilience of the whole system. It ensues a catastrophic drop in the quantity of food traded (up to 50% for certain products), leading to the collapse of the system and a 10-fold increase in the food insecurity of the local population. The paper concludes by weighing the usefulness of the concept of resilience in the context of severe disruptions of the food systems (such as armed conflicts), emphasizing the risk that an unconditional promotion/adoption of that concept may reduce our ability to anticipate or even to envision collapse scenarios. On the brighter side, our analysis demonstrates that collecting specific information about the food system operators can help predict, and possibly prevent, such collapses.

1. Introduction

Food insecurity affects the lives of millions of people across the world. According to the 2022 Global Report on Food Crises (GRFC, 2022), at least 193 million people across 53 countries and territories were facing acute food insecurity (IPC/CH Phase 3 or above)[1] in 2021, a

[1] The IPC Acute Food Insecurity Reference Table for Household Groups is a standardized scale that integrates food security, nutrition, and livelihood information at household level into a common classification of the severity of acute food insecurity outcomes, and is used to highlight priority areas and populations in need of emergency response https://fews.net/IPC.

nearly 40-million increase compared to the previous high reached in 2020, itself already following an almost 20-million rise from 2019 estimate (GRFC, 2021).

Amongst the various shocks and stressors that are at the root of those food insecurity crises, armed conflicts and political insecurity are ubiquitous. Data show for instance that people in conflict-affected areas are up to three times more likely to be food insecure than those who live in more stable low- or middle-income countries. In effect, protracted conflicts have been at the origin of six of the 10 worst recent food crises – in the Democratic Republic of the Congo, Yemen, Afghanistan, the Syrian Arab Republic, Nigeria and South Sudan (FSIN, 2021). Overall, 60 percent of the 815 million undernourished individuals live in countries affected by violent conflict (Martin-Shields and Stojetz, 2019).

A substantial number of studies investigating the impacts of conflicts on people's food insecurity and/or malnutrition are available in the literature (e.g., Dabalen and Paul, 2014; Brück et al., 2019; Corley, 2021). For their majority, those studies rely on household data mixed with conflict information, looking at one or more of the following three domains: impact on agricultural production (e.g., Nillesen, 2007; Arias et al., 2019; Koren and Bagozzi, 2017; George et al., 2021), coping strategies (e.g., Rockmore, 2020; Fernández, Ibañez, and Peña, 2014; Menon and van der Meulen, 2015; Ogbozor, 2016), and outcomes on local population, generally measured in terms of food security and nutrition (e.g., Guerrero-Serdan, 2009; D'Souza and Jolliffe, 2013; Dabalen and Paul, 2014; Brück et al., 2019; Bar-Nahum et al., 2020). As such, those studies adopt a form of "black box" model, documenting essentially the impact of armed conflicts on the two extremities of the food systems: at one end, the producers and their activities (farming, fishing, livestock raising); and, at the other end, the consumers and the effects on their nutrition and food security (D'Souza and Jolliffe, 2013; Dabalen and Paul, 2014; Bar-Nahum et al., 2020). Much less has been documented about the 'middle' of the food systems and in particular the ways the actors operating in that part of the food system (transporters, processors, retailers, vendors) are affected by, and try to mitigate, the effects of armed conflicts on their activities (Delgado et al., 2021). Yet, we argue that, in order to be able to plan and implement effective interventions aiming at maintaining or protecting local population's food security in the face of armed conflicts, it is critical to better understand not just how agriculture and producers are affected by those conflicts and how this, eventually, translates into households' food insecurity. It is also critical to open the black box and analyze in greater detail how the actors *within* the food systems behave and manage to cope and adapt (or not) to the disruptions induced by those armed conflicts.

Against this background, the objective of this paper is to document more thoroughly the impacts of conflicts on the functioning of local food systems and, more specifically, to explore how some of the key actors of those local food systems – in particular the transporters and the retailers – operate when they are facing repeated episodes of insecurity and armed attacks.

To tackle this endeavor, we build upon the emerging literature on resilient market systems (e.g., CARE, 2016; Downing et al., 2018) and food systems resilience in low- and middle-income countries (Béné, 2020; Tschunkert and Delgado, 2022), and we use the current situation on the ground in Burkina Faso (DCAF, 2021; FEWSNET, 2022) as a concrete case study from which empirical data and lessons can be generated. The study focuses more specifically on two groups of key actors at the core of these disrupted food systems: the transporters and the retailers, and the geographic focus of the analysis is Sebba, the provincial capital of the Yagha region in the north-east part of the country.

The research questions that guided the study are the following ones: (i) what have been the impacts of the armed attacks on the economic activities of the transporters and retailers operating in Sebba; (ii) were all these actors affected the same way, and if not, who have been doing better; (iii) can those actors who have done better, be considered as "more resilient" than the others; and (iv) what have been the

consequences of the disruptions of the local food system on the food security of the local populations and how did it play out in the context of the important groups of internally displaced populations that have settled in Sebba?

In this paper, food system resilience is defined as "the ability of different individual and institutional actors of the food system to maintain, protect, or successfully recover the key functions of that system despite the impacts of disturbances" (Béné et al., 2023, p.2). In the particular context of this study, the main disturbances under consideration are the impacts of the armed attacks that have been taking place in the northern and eastern parts of Burkina Faso since 2019, and the key function of the food system we are specifically interested is the ability of the system to ensure and maintain the availability and affordability of sufficient, nutritious and safe food for all. Finally, note that no attempt is made in the paper to rigorously measure or quantify food system resilience. For such attempts, see, e.g. Béné et al. (2023).

The rest of this paper is organized as follows: section 2 provides a succinct description of the rapidly degrading situation in Burkina Faso as per 2022, with a specific focus on the Yagha province; section 3 presents the methodology, sampling and data that were collected and analyzed; section 4 summarizes the key-findings, while section 5 revisits these findings in light of the current literature, highlighting in particular important remarks in relation to the resilience of local food systems in the context of armed conflicts; section 6 concludes.

2. Background – security situation in northern part of Burkina Faso

Between 2017 and 2022 the security situation in Burkina Faso degraded very rapidly, with a sharp increase of reported attack and fatalities (Fig.1 left). Armed conflicts, originally located in the northern part of the country at the border with Mali, spread progressively toward the eastern and central parts of the country. The number of violent events increased greatly and translated into significant displacements of population, observed mainly in the northeast part of the country (Fig.1 right). In June 2022, the internally displaced populations (IDP) in Sebba, the city capital of the Yagha province, was estimated to be around 12,000 people, representing between 40 and 59 % of the autochthone population (CONASUR, 2022).

The degradation of the security situation in the north and northeastern part of the country was accompanied by a parallel degradation in the food security of the local population, as illustrated by the rapid changes recorded in the Acute Food Insecurity Phase IPC 5-stage system between end 2017 and mid-2022 (Fig.2).

In the Yagha province, the evolution of the number of persons estimated to be food insecure over the period 2018–2022 (Fig.3 left) follows the regional trend and confirms that the situation has been worsening very rapidly. The visual correlation with the reported number of armed attacks in the Yagha province since 2018 (Fig.3 right) suggests potential causality between the two phenomena. Without more precise information about the actual impacts of the armed attacks on the local food system, those causal relationships remain, however, purely hypothetical. The data collected through the pilot study presented in this study will permit to explore these causal mechanisms in greater depth.

3. Data and methods

The survey was aimed at documenting how the Sebba food system, which ensures the food supply of the city capital of the Yagha province, had been affected directly by the conflict and the high insecurity that prevailed in the whole region, but also how the local food system responded to the massive influx of displaced people that arrived from other part of the province and settled in Sebba circa 2020 (cf. Fig.1 right). As part of this investigation, we also explored the existence of "positive deviants" amongst the actors of the food systems -where the concept of positive deviants (Marsh et al., 2004; Herington and Fliert,
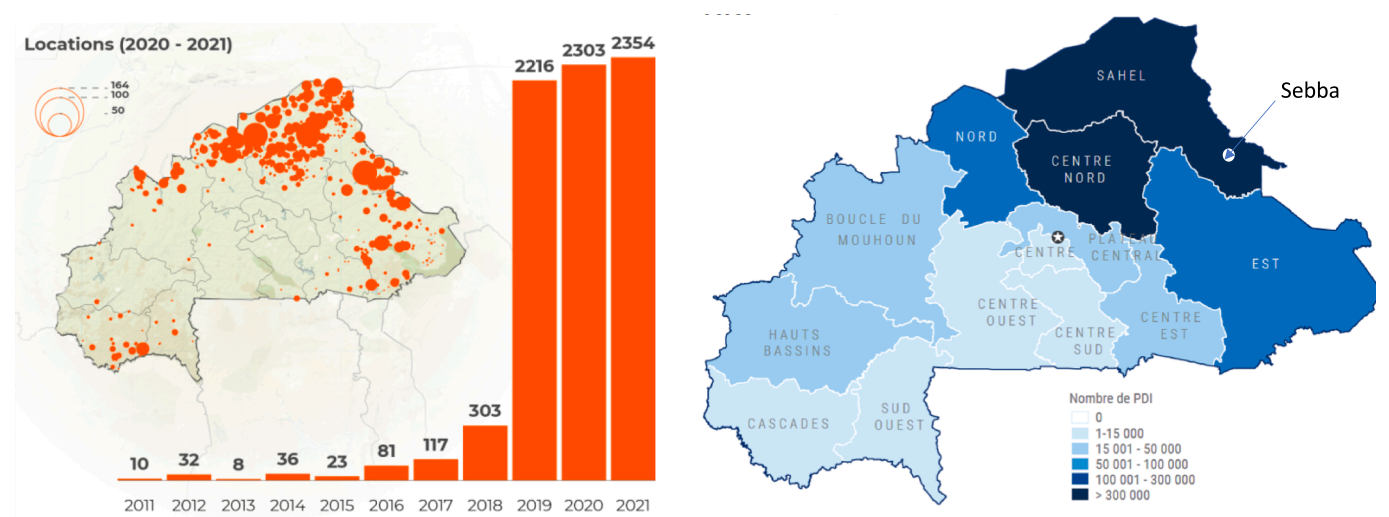
Fig. 1. Left: reported fatalities in Burkina Faso 2011–2021; Right: number of Internally Displaced Persons in Feb 2021 (source: fatalities data: OpenStreetMap and ACLED – Aljazeera, 2022; IDP data: OCHA, 2021).
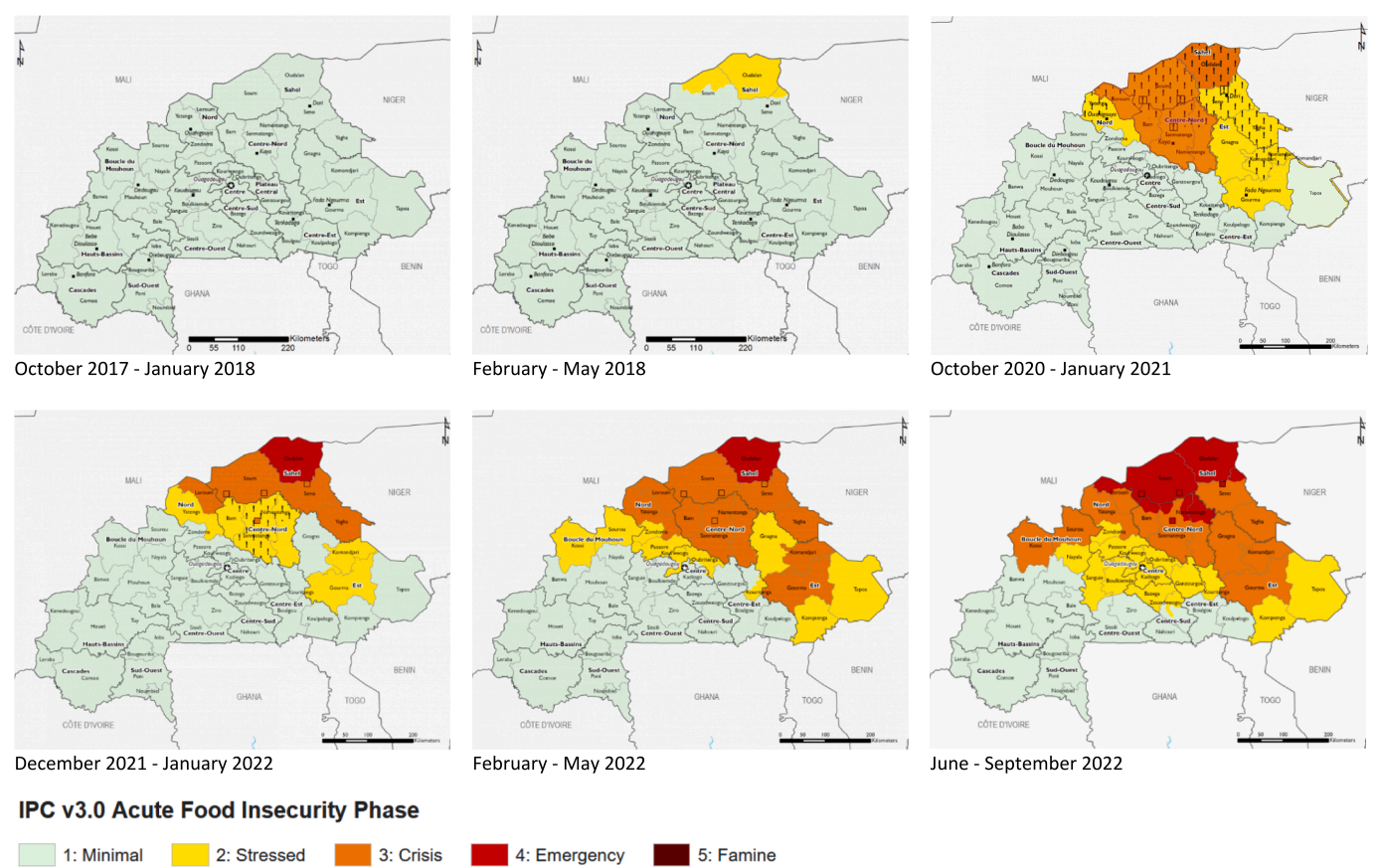

Fig. 2. Evolution of the food insecurity in the northeastern part of Burkina Faso between 2017 and 2022 as monitored through the IPC system. Note that the inter-annual degradation trend is complexified by intra-annual fluctuation between harvest season (October-January) and lean season (April September). Source: FEWSNET.

2018) refers here to those, amongst the food system operators, who appear to cope better than their fellows in the face of armed conflict. The objective was to determine whether the presence of those positive deviants could contribute to building, or to maintaining, some degree of resilience within the food system as a whole, after the start of the crisis.

We focused our sampling effort on the two groups of actors which are expected to be particularly important for the maintenance of the food security of displaced and urban populations of Sebba, namely the transporters and the retailers operating from Sebba. In the rest of this paper, we propose to use the term 'traders' to refer to those two groups of actors together and use their specific names (transporters *vs.* retailer/vendors) when distinctions between the two groups are relevant. In our analysis, 'transporters' refers to the group of individuals who self-defined themselves as deriving the main part of their income from
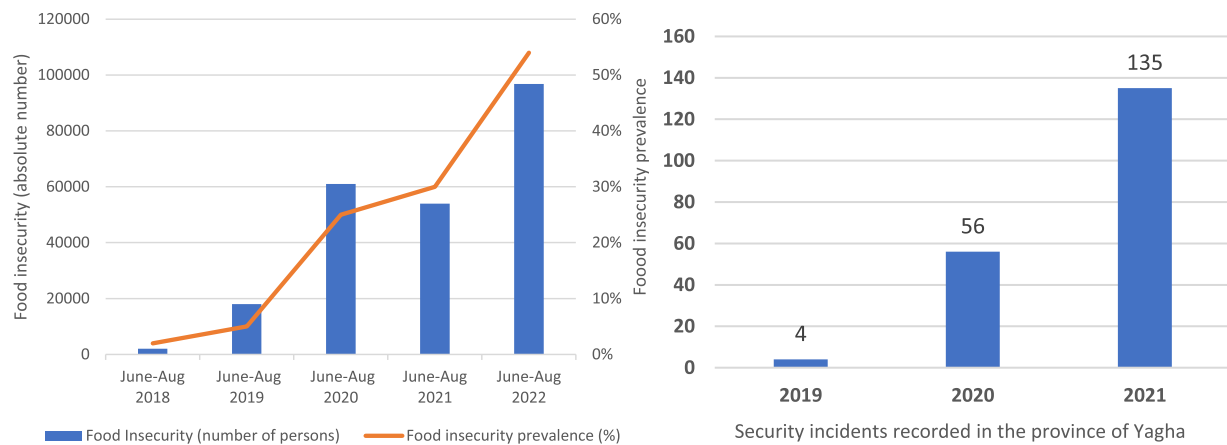
Fig. 3. Left: prevalence of food insecurity in the Yagha province; Right: occurrence of security incidents in the Yagha province (source: ACLED and Cadre Harmonisé).

activities related to the transport or fret of food products, while 're-tailers' refers to the individuals deriving the main part of their incomes from food retailing and/or selling. The latter includes large and well-established wholesalers/merchants as well as more informal and smaller actors such as street vendors. We acknowledge that for some individuals, the distinction between transporters and retailer/vendors may be somewhat artificial as some retailers may also be involved in fret activities (or vice versa). In all cases, the difference was made by the respondent themselves, using their main source of income as differentiating criterion.

In term of sampling strategy, the ambition was to be as exhaustive as possible. Enumerators were therefore instructed to interview every single food trader that was seen operating in the city of Sebba. In total, 263 individuals (198 retailers and 65 transporters) were identified and interviewed through face-to-face interviews. The survey took place in May 2022, and traders were invited to answer on the status of their economic activity in 2022 and one year before. The main strength of our data is that we made an exhaustive census of all traders operating in Sebba, i.e., we offer first-hand evidence about a critical process for which very little had been documented. The main limitation, however, is that, because of serious difficulties accessing the field, it was not possible to collect panel data – we relied therefore on self-reported data to document the changes between 2021 and 2022.

The questionnaires included series of questions related to the socio-demographic status of the respondents in 2021 (their gender, ethnic groups, matrimonial status, family size, education), their professional history (when and where they started their business as transporter or retailer/vendor), whether they were operating elsewhere before moving to Sebba, and if so the reason of their relocation to Sebba. The questionnaire also included questions regarding the actors' financial wealth. However, because of the sensitivity of the information -especially in the context of high risk of armed robbery or even kidnapping, no information was collected on the actual composition and values of the respondents' incomes. Instead, an indirect proxy for the financial size of their business was computed, using the values and numbers of transport assets or vehicles they owned in 2021.[2]

Another module of the questionnaire explored the food traders' perception about, and direct exposure to, armed attacks, and the self-assessed impact of those attacks on various aspects of their economic activities. The year 2021 and the rapid afflux of IDP that occurred in

Sebba over that period was used as a time marker (before/after) in the structuration of the research timeline and in particular to explore how food traders have been coping over time.

As mentioned earlier, special attention was devoted to identifying potential positive deviants. Questions were included with the aim of determining whether, or not, the behaviour and strategies of those positive deviants would differ from the rest of the traders. Based on the literature available on household adaptation and resilience (e.g., Sarker et al., 2013; Bahinipati, 2015; Chamdimba et al., 2021; Myeki and Bahta, 2021), some basic hypotheses were considered about the existence of those positive deviants. In particular, one could assume that the financial assets or the level of revenues of those actors might offer some degree of protection that could be used to strengthen their ability to buffer/mitigate shocks (i.e., their resilience) and play an important role in the context of crises/insecurity. Another hypothesis revolves around the professional experience and the number of years those actors have been operating from Sebba; it is indeed possible that those who were established in Sebba long before the insecurity crisis starts are better equipped to mitigate the effects of disruption (possibly because they have stronger business connections than the newly established traders). A counterhypothesis that builds on the literature on adaption suggests, on the contrary, that the most adaptive and reactive agents could be those younger, more risk-takers, actors who have just arrived and have 'less to lose' than the older, long-established traders (Muema et al., 2018; Khanal et al., 2019).

Three regression models were used to test those different hypotheses and more broadly to investigate what socio-economic factors may explain the relative success of the positive deviants. Model [1] (a probit model) explores the determinants for traders to declare doing better in 2022 than in 2021. Model [2] (also a probit model) explores the determinants of the change in weekly sales between 2021 and 2022; and model [3] (OLS model) considers the factors determining relative change in weekly sales between 2021 and 2022 (see Table 1). For all three models, the explanatory variables that were considered are the different variables characterizing the socio-demographic and economic status of the actors in 2021, i.e., prior to the massive influx of IDP to Sebba.

Finally, a series of questions assessing the implications of the disruptions of the food traders' activities on the food system itself and, in particular, on the supply of specific food items to the local population of Sebba, was included in the questionnaire. Because they are part of the main food basket of the local population in the region, the following food items were included in the questionnaire: cereals, tubers, legumes, fruits, vegetables, eggs, meat, milk, fish, cooking oil, sugar, and condiments.

The questionnaire was designed using Kobo online toolbox and data

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[2] This type of tangible assets was chosen because it was recognized that vehicles (truck, pick-ups, tricycles, motorbikes, bicycles, carts, etc.) are assets that can be owned by transporters and retailer, thus offering an index of wealth common to both groups.

Table 1

Variables used in the different models to explore positive deviants' determinants amongst traders.

Dependent variables
Model [1]: Doing better in 2022 than in 2021 (i.e., being a positive deviant). Binary variable (yes = 1; no = 0)
Model [2]: Change in weekly sales between 2021 and 2022. Binary variable (increase = 1; otherwise = 0)
Model [3]: Relative change in weekly sales between 2021 and 2022 – continuous variable

Explanatory variables for all three models
Main economic activity in 2021. Binary variable (retailer/vendor = 0; transporters = 1)
Experience: number of years of activity in Sebba as in 2021. Continuous variable
Gender. Binary variable (man = 0; woman = 1)
Age. Continuous variable
Wealth: value of transport assets (log-transformed) in 2021. Continuous variable
Family size: number of family members in 2021. Continuous variable
Weekly sales: values of weekly sales in 2021. Continuous variable[§]

Note (§): the variable 'weekly sales' was not used as explanatory variable in model [3] for endogenous reasons.

was collected using electronic tablets. Data was analysed using Stata (version 15).

4. Key findings

4.1. Who are the food systems actors?

The food traders' socio-demographic information that was collected through the survey is compiled in Table 2. On average, the individuals engaged in food system activities are young (38-year old for the retailers and 34-year old for the transporters). The totality of the transporters who were interviewed were men while for the retailers, data indicates that slightly less than a quarter of the respondents were women. Statistical test confirms that gender and activities are not independent (Pearson Chi2(1) = 17.34; $Pr < 0.001$).

The majority of the food traders (66 %) are from the Peulh ethnic group, which is also the main ethnic group in the region, followed by the Gourmanche (13 %) and Mossi (10 %). No major discrepancies were

observed between the two groups (transporters and retailers) in terms of ethnic origins.

4.2. Wealth differentiation amongst food traders

Table 3 displays the computation of the individual food traders' transport asset values (used as a proxy for those actors' business wealth) and compares those statistics between different groups, using Kruskal–Wallis rank test (due to the non-normality of the data). The table shows that retailers have a statistically higher level of transport assets than the transporters ($H(1) = 7.128$; $P = 0.07$). No significant difference was found between men and women wealth values ($H(1) = 0.281$; $P = 0.593$) (note that the test was run amongst retailers only as no women were amongst the 65 transporters we interviewed). No difference was observed either between the groups of traders who have been operating in Sebba before the crisis started and those who moved to Sebba after ($H(1) = 0.014$; $P = 0.907$), even though the difference between the two groups is relatively significant (almost 1 million FCFA, which represents a 22 % difference). In contrast, when experience is considered irrespective of the location of work, the groups of food traders with a long experience (more than 10 years) are characterized by higher levels of assets than their younger fellows and the difference is significant ($H(1) = 4.222$; $P = 0.039$).

4.3. Impact of the armed conflict on traders' life and business

Data indicates that 17 % of the transporters and 19 % of the retailers have relocated to Sebba since the substantial raise in the level of insecurity in the province. From a food system (resilience) perspective it was therefore important to determine whether those food traders had decided to move for the same reasons than the rest of the IDPs -essentially because of the sharp increase in number of armed attacks and the degradation in the general security in the region- or because they saw the afflux of IDP in Sebba as a business opportunity.

Fig.4 shows that the main reason reported by the food traders who moved to Sebba since 2021 is the high level of insecurity across the region (mentioned by 84 % of the respondents). This first reason is followed closely, however, by the perceived opportunity offered by the flux of displaced people (81 % of the respondents). The third major

Table 2

Socio-demographic characteristics of the food traders included in the survey.

	Retailers	Transporters	Total food traders
Number of obs	198	65	263
Mean age	38.4	34.0	37.3
Stand Dev	8.9	8.2	9
Min	16	20	16
Max	62	65	65

	Retailers		Transporters		Total traders	
Gender	Freq	Percent	Freq	Percent	Freq	Percent
Men	154	78 %	65	100 %	219	83 %
Women	44	22 %	0	0 %	44	17 %
Total	198	100 %	65	100 %	263	100 %

	Retailers		Transporters		Total traders	
Ethnic origins	Freq	Percent	Freq	Percent	Freq	Percent
Mossi	22	11 %	5	8 %	27	10 %
Peulh	125	63 %	48	76 %	173	66 %
Gourmanche	24	12 %	9	14 %	33	13 %
Tamachek	3	2 %	1	2 %	4	2 %
Gourounssi	3	2 %	1	2 %	4	2 %
Haoussa	10	5 %	0	0 %	10	4 %
others	11	6 %	1	2 %	12	5 %
Total	198	100 %	65	100 %	263	100 %

Table 3

Food traders' transport asset values (2021 values).

Values of transport assets (in million FCFA)	N	Mean	Min	Max	Kruskal–Wallis
Retailers	196	4.21	0	39.60	
Transporters	64	3.82	0.17	36.00	
Difference		−0.39			$P = 0.07$***
Value of transport assets (in million FCFA)					
Men	152	4.26	0	39.60	
Women[§]	44	4.06	0	19.40	
Difference	196	0.20			$P = 0.593$
Value of transport assets (in million FCFA)					
Settled in Sebba after 2021	48	3.36	0	20.40	
Settled in Sebba before 2021	211	4.29	0	39.60	
Difference		−0.93			$P = 0.907$
Value of transport assets (in million FCFA)					
Less than 10 years of experience	155	3.03	0	39.60	
More than 10 years of experience	105	5.74	0	20.40	
Difference		− 2.79			$P = 0.039$**

Note: (§) the group of 65 transporters we interviewed did not included any woman.
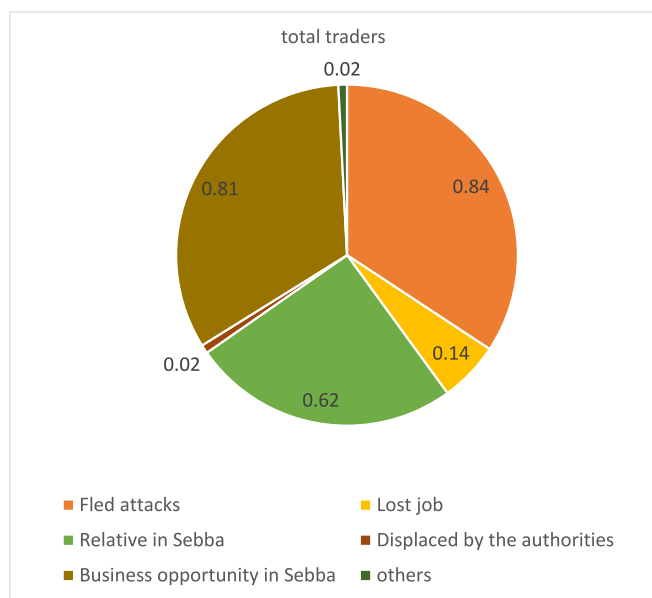
Fig. 4. Main reasons reported by food traders for moving to Sebba.

reason is the presence of family relatives in Sebba (62 %). Note that multiple answers to this question were allowed, which explains the greater than 100 % total figure. More detailed data analysis (not shown) also reveals that amongst those transporters and retailers who reported insecurity as the main reason for their move to Sebba, 79 % also reported to have been directly victims of some of these attacks. No statistical difference was found however between the two groups with respect to the role of insecurity in their decision to move to Sebba (Pearson Chi2 (1) = 0.0042; Pr = 0.94), or in the proportion of transporters or retailers who reported to have been (or a member of their family) a direct victim of an armed attack (39 % and 48 % respectively, Pearson Chi2(1) = 1.7277; Pr = 0.19).

When asked whether their own business was doing better or worse than before the start of the insecurity crisis, 58 % of the retailers and 76 % of the transporters consider their businesses were now doing "badly" or "very badly" (Fig.5). In that regard, transporters seem to struggle more than retailers (Table 4). While transporters reported a reduction of 11 % in the number of employees and a reduction of 36 % in the number of hours worked per week, the reductions were only 1 % and 7 % for the retailers. In terms of weekly revenues, the reduction was significant for both groups: 49 % for the transporters and 40 % for the retailers. Finally, transporters reported a reduction of 220 km in their weekly travel (-49 %).

We then explored whether the sudden influx of displaced populations in Sebba could have played a particular role in the success (or the failure) of the different actors. We were interested in particular to determine whether the large number of IDP had been perceived mainly as an 'economic opportunity' or on the contrary as a 'major additional disruption' for those food actors operating from Sebba. The results are displayed in Table 5. The table indicates that for the vast majority of the retailers (75 %) and for almost all the transporters (91 %) the influx of IDP was perceived neither as an opportunity, nor as a threat/constraint for their business.

4.4. Who are the positive deviants?

Thirty-two percent of the retailers and 20 % of the transporters claimed they are doing "better" or "much better" compared to before 2021 (cf. Fig.5). The next part of the analysis focused therefore on these positive deviants. For this, we looked at which socio-demographic and economic factors may be associated with their positive deviance,

keeping in mind the initial assumptions highlighted earlier, namely that this deviance could be positively associated with either the economic prosperity of the actor's business, or with their professional experience (proxied through the number of years in business). To test these hypotheses, we used the three econometric models [1], [2], and [3] presented earlier. The results of the analysis are displayed in Table 6.

The results show strong consistency across the three models, suggesting that the findings are robust. The three models indicate in particular that positive deviants are more likely to be found amongst retailers rather than transporters, and amongst those who arrived more recently in Sebba, even if model [2] and model [3] also indicate that older traders have a higher probability to have experienced some slight increase in their weekly sales between 2021 and 2022. The analysis also show that traders with higher asset endowment have higher propensity to see themselves as doing better (model [1]) but not necessarily to have experienced an increase in their sales (models [2] and [3]); on the contrary, traders with higher sales before the crisis are less likely to declare themselves as doing better (model [1]) or as having increased their sales between 2021 and 2022 (model [2]). Overall, this indicates that the hypothesis regarding the potential role of wealth (assets and/or current revenues) on the capacity of actors to buffer the effects of armed conflicts on their economic activity is not confirmed. Likewise, the hypothesis that years of previous experience in Sebba could play a positive role in helping actors dealing with economic disruption is not corroborated by the data.

A final step in this part of the analysis was to assess the extent to which positive deviants actually differ (or not) from the rest of their food system fellows. For this, we compared their individual performances (before and after 2021) with those of the other food traders. The result of the comparison is shown in Table 7. The analysis reveals that for all performance domains except the number of km traveled per week, the difference is always statistically significant, confirming that positive deviants indeed diverge from the other food traders in terms of economic performance. The fact that the amplitude of the negative change is also systematically smaller for the positive deviants than for the rest of the group suggests that positive deviants are characterized by a higher ability to buffer the effects of the crisis than the rest of their fellows.[3]

The data reveals, however, that, with the exception of the number of employees, for which a slight positive difference is observed, all the other indicators show a decrease in their values after 2021 -even for the positive deviants. This indicates that everyone -including those positive deviants- experienced a contraction in their activities following the crisis.

4.5. Implications for the local food system

The final step in the analysis was to assess the impacts of the contractions in traders' activities on the local food system and its function to deliver food. For this, we compiled the proportion of food traders who were actively involved in the trade of specific food products and reported a severe reduction in the trading of those items (transport or sell) as a consequence of armed attacks. Results are shown in Fig.6. The data indicates that 100 % of the respondents who had been involved in cereals trading reported a reduction in their activities. The next most affected food products were cooking oils, sugar, and legumes, with more than 50 % of the traders involved in those products reporting severe reduction in their activities. The least affected products were meat, milk, tuber and fish. Even for those products, however, at least 25 % of the traders still reported severe disruptions. For all the other products, the proportion of traders reporting severe disruption was above 30 %.

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[3] This result also demonstrates *a posteriori* that the self-assessment approach that was used initially, where individual actors were asked to share their own (subjective) perception about how they are doing compared to their fellows, appears consistent with their actual performances.
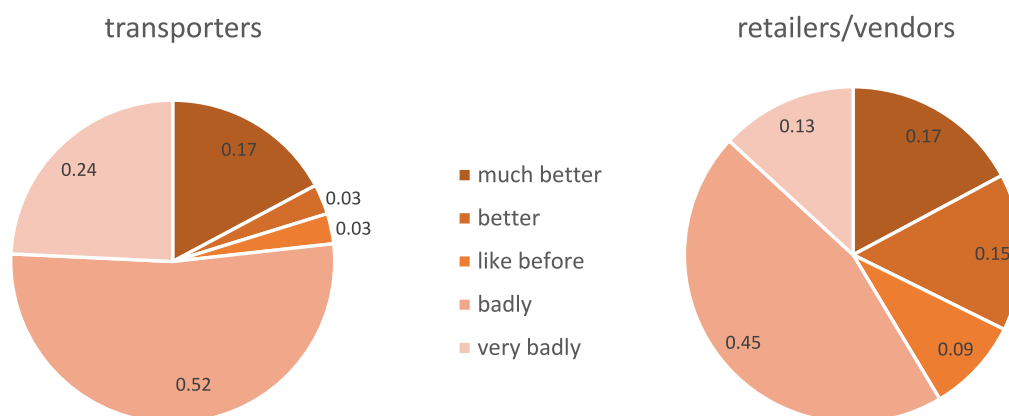
Fig. 5. Status of the traders' business after 2021 (self-assessed). The figures show the percentages of answers to the question: "how is your business doing compared to before 2021" using a pre-coded 5 level answer system from "very badly" to "much better".

Table 4
Comparison of the business status for retailers and transporters before|after the security situation started to degrade.

	Retailers		Transporters	
	Mean	RD[1]	Mean	RD[1]
Number of employees before|after 2021	2.29|2.27		1.88|1.66	
Difference	−0.03	−1%	−0.21	−11 %
Number of worked hours per week before|after 2021	69|64		84|54	
Difference	−5	−7%	65	−36 %
Weekly sale revenues before|after 2021	378,862|229,117		298,385|152,408	
Difference	−149,745	−40 %	−145,977	−49 %
Weekly travel before|after 2021			408|187	
Difference			−220	−49 %

Note: (1): RD = relative difference (in %).

Table 5
Perceived impact of the Internally Displaced Persons on the local food system actors.

For your business, do you consider the influx of displaced populations as…	Retailers		Transporters		Total	
	Freq (N)	Percent (%)	Freq (N)	Percent (%)	Freq (N)	Percent (%)
A very good opportunity	14	7 %	2	3 %	16	6 %
A small opportunity	23	12 %	1	2 %	24	10 %
Does not change anything	142	75 %	53	91 %	195	79 %
A source of small problem	8	4 %	1	2 %	9	4 %
A serious threat for your business	2	1 %	1	2 %	3	1 %
Total	189	100 %	62	100 %	241	100 %

For the four food items for which the largest proportions of traders reported disruptions (cereals, cooking oil, sugar and legumes) we then analyzed in greater details the data. This was done by breaking down the answers between the two groups of actors (transporters and retailers) and computing the average relative difference reported in each group (those differences were also computed for the item with the lowest report of disruption, that is, egg). Results are displayed in Table 8. They show that amongst the traders reporting a decrease in their cereal activities, those reductions represented on average a 22 % fall in terms of quantities of cereals sold and 36 % in terms of cereals transported. For eggs (with the smallest proportion of traders reporting some disruption), those disruptions still represent respectively a 37 % and 43 % reduction in the quantity of eggs sold or transported. Overall, the disruptions vary between 3 % (for legumes sold by retailers) and 50 % (for legumes distributed by transporters). Table 8 also reveals that the difference in food traded or transported before and after 2021 are all statistically (highly) significant (with the exception of sugar and legume sold and eggs transported). Importantly, the reported reduction in quantities is always larger for the transporters than for the retailers (36 % versus 22 % for cereals; 38 % versus 18 % for cooking oil; 34 % versus 12 % for

sugar; 50 % versus 3 % for legumes), suggesting again (as in Table 4) that transport is the part of the food system functions that is the most disrupted by the armed conflict.

5. Discussion

5.1. Beyond the impacts of armed conflicts on agriculture

Armed conflicts are one of the principal drivers of food insecurity and malnutrition in low- and middle-income countries, leading to devastating short and longer-term effects on local populations. On a global scale, out of the 155 million people who were assessed to be acutely food insecure in 2020, 100 million lived in conflict-affected countries (FSIN, 2021). The impact of those conflicts on the nutritional status of the most vulnerable groups is daunting. Breisinger and his colleagues (2015) estimate for instance that over the past 25 years, the number of stunted children in conflict-affected countries in the Global South increased from an estimated 97.5 million (equivalent to 46 % of all stunted children in LMICs) to 112.1 million (equivalent to 65 % of all stunted children).

Table 6
Determinants of positive deviance.

Dependent variables:	Self-declaration as 'going better' than before (1 if yes, 0 if no) PROBIT [1])		Increase in weekly sales in the last year (1 if yes, 0 otherwise) PROBIT [2]		Relative changes in weekly sales in the last year (%) OLS [3]	
Activity (1 if transporter)	−0.547***	−0.529**	−1.337***	−1.243***	−0.290***	−0.218**
	(0.212)	(0.234)	(0.291)	(0.316)	(0.0857)	(0.0903)
Experience in Sebba (years)	−0.0346**	−0.0357**	−0.0417***	−0.0423**	−0.0146**	−0.0196***
	(0.0141)	(0.0172)	(0.0145)	(0.0181)	(0.00574)	(0.00626)
Gender (1 if woman)		0.113		−0.111		0.0327
		(0.267)		(0.270)		(0.115)
Age (years)		0.0114		0.0272**		0.0100*
		(0.0116)		(0.0126)		(0.00494)
Log of owned assets[(§)]		0.149**		−0.0760		−0.0336
		(0.0709)		(0.0770)		(0.0270)
Family size[(§)]		0.000827		−0.0243		0.00192
		(0.0279)		(0.0275)		(0.0107)
Weekly sales[(§)] (FCFA)		−4.04e-07**		−7.35e-07**		
		(1.93e-07)		(3.13e-07)		
Constant	−70.12**	−73.82**	−84.56***	−85.80**	−29.57**	−39.80***
	(28.32)	(34.73)	(29.28)	(36.70)	(11.55)	(12.67)
R^2					0.06	0.08
Pseudo R^2	0.03	0.08	0.11	0.17		
Observations	241	232	263	248	242	234

*significant at 10%; ** significant at 5%; *** significant at 1% - Variables defined in Table 1; standard errors between (). Note: (§) before the security situation deteriorated in 2021.

Table 7
Comparison between the positive deviants and the other transporters and retailers, following the degradation in security in 2021.

	Obs (N)	Mean	*p*-value
Change in number[(1)] of employees amongst positive deviants	80	0.4	
Change in number of employees amongst the other transporters and retailers	135	−0.56	
Difference		0.96	< 0.001***
Change in weekly sale revenues amongst positive deviants (in FCFA)	86	−62,901	
Change in weekly sale revenues amongst the other transporters and retailers	141	−259,284	
Difference (in FCFA)		196,383	0.004**
Change in number of working hours for positive deviants	87	−16	
Change in number of working hours for the other transporters and retailers	146	−21	
Difference		5	0.069*
Change in number of clients amongst positive deviants	68	−13	
Change in number of clients amongst the other transporters and retailers	100	−49	
Difference		36	0.006***
Change in number of km traveled per week by positive deviants	14	−172	
Change in number of km traveled per week by the other transporters	43	−260	
Difference		−88	0.244

*significant at 10%; ** significant at 5%; *** significant at 1% - Note (1): "change in number" refers to changes observed in the indicators between before and after 2020.

A large body of literature has documented how armed conflicts undermine food security and nutrition in multiple ways: conflicts directly destroy crops, livestock, agricultural infrastructure and farmers' assets (Nillesen, 2007; Koren and Bagozzi, 2017; Arias et al., 2019; Rockmore, 2020). But they can also induce displacement, create fear and uncertainty about meeting future needs, damage human capital, and contribute to the spread of disease (Justino, 2012; Minoiu & Shemyakina, 2014; Tranchant et al., 2019).

Despite the effects of armed conflicts being widely highlighted in the literature, the identification of the mechanisms linking conflict exposure to food insecurity and malnutrition remains poorly understood, partially due to problems of endogeneity. Martin-Shields and Stojetz (2019) argue for instance that structural factors at both macro- and micro-levels, e.g., state capacity and household income, are often correlated with both food security and conflict outcomes. These "confounding" factors thus complicate causal analyses of the mechanisms linking conflict and food security.

In addition to those measurement issues, the understanding of the relationship between armed conflicts and food insecurity is also limited by a lack of data and information on how insecurity actually affects food systems operations. While armed conflicts can threaten the food security

of households indirectly by disrupting trade and markets, leading to increased food prices or decreased household purchasing power (see Justino, 2009; D'Souza and Jolliffe, 2013; Ihle and Rubin, 2013; Bar-Nahum et al., 2020; Murigani et al., 2022), the bulk of the empirical work implemented so far has focused on the effects of armed conflicts on the agricultural sector and their actors (Nillesen, 2007; Arias et al., 2019; George et al., 2021). Much less has been done on the mid-stream actors (processors, transporters, retailers, vendors) or even on food systems *per se*.[4]

Yet we know that armed conflicts do not just destroy harvest and wreck agricultural or community assets. Conflicts also disrupt food

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[4] It is revealing to notice for instance that a literature scanning using Web of Science™ search option: {AB = ("food system" AND ("armed conflict" OR "fragile state" OR war) NOT Ukraine)} returned only 16 hits, none of which actually discussing the issue of how food systems are impacted by armed conflicts. A further search including "resilience" in the search option returned only one result (an historical review of global food regime changes and the adaptiveness, transformability, and resilience of the local food system in Lebanon – Mukahhal et al., (2022).
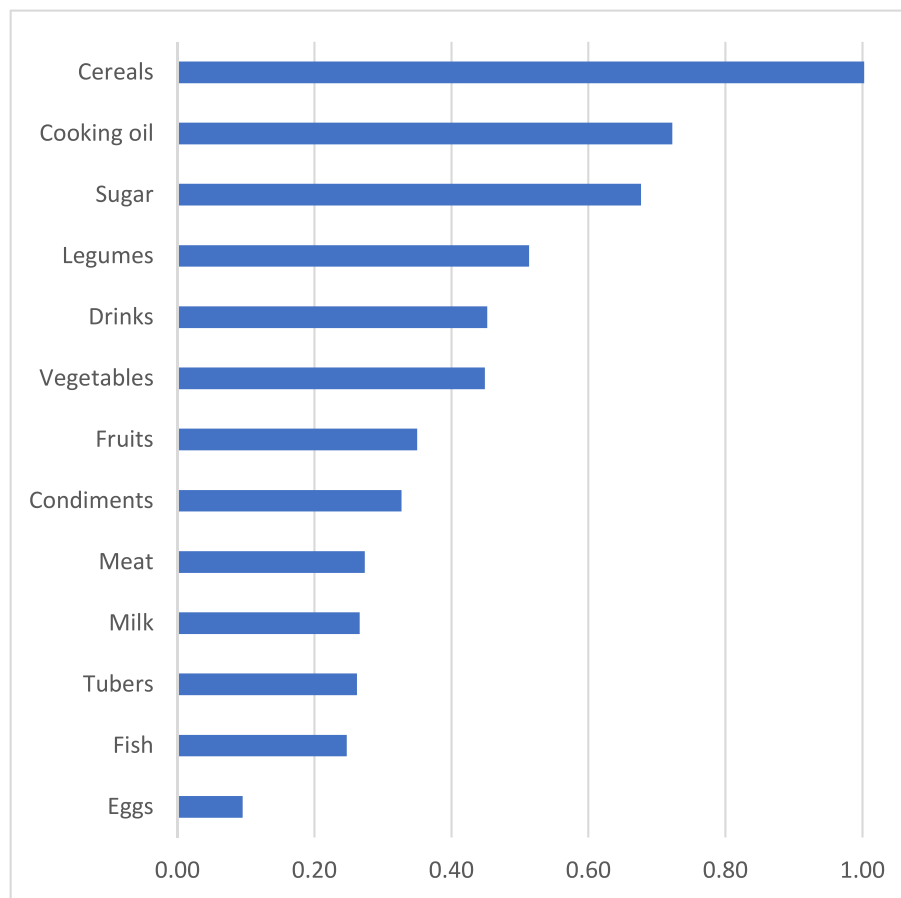
Fig. 6. Proportion of food traders reporting reduction in trade of various items as a consequence of armed attacks.

supply chains and local food markets, force transporters to change routes and retailers or vendors to shift to less perishable merchandises or to relocate to safer places. Beyond those noticeable effects, other less visible but equally detrimental disruptions happen throughout the system, including increase in transaction costs for all actors, exposure to more extorsions and corruptions, spread of food safety issues due to longer transit or disruption in electricity supply, weakening of market mechanisms, poorer governance, loss of networks and poorer access to information (Fernández et al., 2014; Béné, 2020). Finally in many instances, food systems disrupted by armed conflicts also need to adjust to an important reconcentration of the local population and IDP in fewer locations -often main or secondary urban centers which are perceived as more secure. All those different factors affect food system actors to various degrees and in different ways, preventing them from operating efficiently, and eventually eroding the resilience of food systems on which local populations -including IDP- depend on for their food security and nutrition (Adong et al., 2021; Delgado et al., 2021). The disastrous situation faced by the Palestinian population in Gaza since the beginning of the Israelian attack in Oct 2023 is a vivid illustration of this adverse dynamic.

5.2. Preliminary insights from Sebba food system

In this study, we aimed to address this knowledge gap. Using the rapidly deteriorating situation of the northeast region of Burkina Faso as our empirical case study (Figs. 1 and 2), we conducted research with the objective to document more thoroughly the impacts of the conflict on the functioning of the local food system and its actors around the capital of the Yagha province, Sebba. To structure our work, we referred to the concept of resilience as recently proposed in the food security literature

(Constas et al., 2014; Béné et al., 2016; Ansah et al., 2019) although we did not intend to measure resilience as such. Instead, we focused our attention on two groups of actors (the transporters and the retailers) operating from Sebba, with the premise that those are "keystone actors" in the operating of the local food system. The ambition was to determine how and to what extent these actors were affected and had to adapt/adjust their activity to the high level of insecurity affecting the area, while at the same time responding to the massive influx of IDP in Sebba. In this context, we looked for the potential presence of "winners" (or positive deviants) amongst the local transporters and retailers and were interested to determine whether those positive deviants could contribute to build or to maintain some level of resilience at the food system level after the start of the crisis. Note finally that this analysis complements a parallel study that explores the factors helping local food system actors in their attempts to buffer the effects of armed attacks. That parallel analysis found in particular that individuals' social networks play an important role in mitigating armed attack effects (Maitre d'Hotel et al., 2023).

Our empirical analysis revealed several important findings. First, it confirmed the magnitude of the economic contraction that has affected the food system and its actors in the region. The data showed that the reduction in weekly revenues was substantial for all traders (Table 4). This was accompanied by a loss of more than 145,000 FCFA (approximately USD245) in average revenues per week, and a reduction by half of the number of km traveled per week for the transporters. In terms of quantities of food products transported or traded, the data suggested that overall, the disruptions can reach 50 % (Table 7).

Not all actors were affected with the same intensity, however. Across the different analyses, transporters systematically appear to be impacted more severely than retailers. For instance, while retailers reported a 40

Table 8
Differences in quantities of specific food items traded or transported by individual actors before and after 2021.

Item sold/transported by individual actor	before 2021	after 2021	diff	*p*-value
Cereals sold (kg per week)	1 985	811	−1 175	0.01**
Average relative difference [1]			−22 %	0.02**
Cereals transported (kg per week)	4 548	2 073	−2 475	0.001***
Average relative difference			−36 %	0.003***
Cooking oil sold (litres per week)	314	84	−231	0.072*
Average relative difference			−18 %	0.036**
Cooking oil transported (litres per week)	814	338	−476	<0.001***
Average relative difference			−38 %	0.002***
Sugar sold (kg per week)	258	114	−145	0.014**
Average relative difference			−12 %	0.154
Sugar transported (kg per week)	1 509	831	−678	<0.001***
Average relative difference			−34 %	<0.001***
Legume sold (kg per week)	537	166	−371	0.012**
Average relative difference			−3%	0.821
Legumes transported (kg per week)	2 326	1 068	−1 259	< 0.001***
Average relative difference			−50 %	< 0.001***
Egg sold (pallets per week)	34	19	−15	0.074*
Average relative difference			−37 %	0.011**
Eggs transported (pallets per week)	53	25	−28	0.217
Average relative difference			−43 %	0.185

*significant at 10%; ** significant at 5%; *** significant at 1% - Notes: (1): Average relative difference refers to the relative differences computed for each actor and averaged across the whole group.

% reduction in weekly revenues, the reduction reported by the transporters was close to 50 %. Fifty eight percent of the retailers reported that their businesses were doing"badly" or "very badly" but this number was up to 76 % for the transporters (Fig.5). In parallel, the reported reductions in quantities of food traded were systematically larger for the transporters than for the retailers (Table 7). Although it was not possible for us to formally test it, one potential explanation for this consistent pattern could be the fact that transporters, by the nature of their main activity, are exposed to higher likelihood of attack on the roads than retailers operating in Sebba. Faced with this increased risk of attack, a strategy for the transporters is to reduce the frequency of their travel. The reported decrease by 220 km in the transporters' average weekly travel corroborates this hypothesis (Table 4). Overall, this observation is consistent with previous findings that established that actors are impacted according to their dependence on their environment, and notably to their need to access roads (Brück et al., 2019).

5.3. Zooming in on the positive deviants

The data also allowed us to explore more thoroughly the behaviour of the positive deviants -those actors who, at first sight, appeared more resilient than their fellows. The analysis confirmed that the choice of the term "positive deviants" (Herington and Fliert, 2018) was justified, as those traders appear to perform 'better' than the rest of the group. A series of econometric models was used to determine what socio-demographic or economic characteristics may contribute to their relative success (Table 6). The analysis revealed that in contradiction to what is often assumed in the case of farmers (Sarker et al., 2013; Bahi-nipati, 2015; Chamdimba et al., 2021; Myeki and Bahta, 2021), the level of assets or revenues of those traders did not seem to contribute significantly (in a statistical sense) to their resilience. Instead, the number of years spent in Sebba appeared more prominent, but in a negative way, suggesting that – as it is also observed in other domains (e.g., Muema et al., 2018; Khanal et al., 2019; Acevedo et al., 2020) – being a new comer with little routine, fewer old habits and perhaps fewer assets to lose, may be instrumental to ensure the agility and adaptability required to respond quickly to a new, challenging situation. This result is not necessarily completely intuitive, however, as years of experience or ownership of assets are often presented as important resilience capacities in the literature (Acevedo et al., 2020).

The next analysis reveals that, although these positive deviants display performance that are statistically not as bad as the rest of the

traders (Table 7), their resilience did not save them from facing substantial contractions in their trade business. Eventually, the resilience displayed by those positive deviants at individual level was, therefore, not sufficient to maintain the resilience at the whole system level. What followed was an abrupt decline in the quantity of food traded by the actors operating from Sebba (Fig.6), and subsequently a rapid deterioration of the food security situation for the local population (Fig.2). In sum, the contraction of the system and the reduction in the ability of the food system actors to operate, combined with the fact that Sebba population was at the same time being multiplied by two due to the sudden influx of IDP, is likely to have created the 'perfect storm' that triggered the collapse of the local food system and led to an upsurge in the number of food insecure households. In effect, between 2018 and 2022, the prevalence of food insecurity in the province increased 10-fold, from less than 5 % in 2018 to 54 % in 2022 (Fig.3).

5.4. Expanding the analysis of the relation between armed conflicts and food insecurity

Through these empirical findings, the paper emphasizes the benefits of expanding the analysis of the relation armed conflicts → food insecurity beyond the usual focus on farmers' behaviour and consumers coping strategies. Our results suggest in particular that the degradation in food security in conflict affected areas is not just the result of the reduction in farmers' cultivated areas or of the impact of higher prices on local population' purchasing power; it is also – and perhaps to an even larger degree – related to the changes in strategies adopted by the other actors of the local food system (transporters, retailers, vendors). We saw in particular how local transporters were more severely affected than the other groups, and how the overall insecurity in the Yagha province forced all the actors to drastically reduce their activity, leading eventually to a massive contraction in the volume and diversity of food products traded locally.

Overall, our analysis demonstrated therefore the importance of moving beyond the 'black box' nature of the current model proposed in the literature by disaggregating the cascade of disruptions that affect all the different actors and documenting the nature and level of perturbations that are taking place *within the whole food system*. In doing so, the analysis advanced the current understanding beyond what we already knew about the two extremities of the food system (producers and consumers) and provided quantitative information about the "missing middle" and the overall resilience of the system (see below).

5.5. Limitations of the study

In this paper, we used several strategies to adapt to the challenge of collecting data in the context of active, ongoing, armed conflict zones. Those included (1) using short questionnaires, (2) administrating the questionnaires to all the operators identified in a census with smartphones rather than tablets or paper (which are more visible), (3) refraining from collecting sensitive data such as incomes and assets to avoid raising suspicion/risk, and (4) using retrospective data instead of repeated surveys to capture changes. Those strategies may have some implications for the analysis. The main strength of the approach is that we made an exhaustive census of all operators working in the capital city of a province severely hit by armed conflicts. In doing so, we collected a comprehensive set of data and information that is very rarely available in the existing literature, and, thus, offer first-hand evidence about critical dynamics for which very little is known or documented. The main limitations of the approach, however, are that it was not possible to collect panel data, and that we conducted a longitudinal survey instead, where all operators identified in the census were invited to report about their past situation relying on self-assessed recall techniques. We believe the retrospective information generated through those questions is trustable, however, as data about assets deterioration and household composition families are information that are easy to memorize, and therefore subject to limited memory bias. Besides, while self-reported data may be subject of recall issues (e.g., Petróczi et al., 2011), the literature also provides ample evidence that, when appropriately designed and implemented, tools based on self-reported data are reliable sources of information – see, e.g., Sobell et al., 1992; Bernard and Seyoum Taffesse, 2014; Lockwood et al., 2015.[5] These self-reported techniques have also been used successfully in recent resilience analyses (Béné et al., 2017; Smith and Frankenberger, 2022).

5.6. Resilience (and collapse) of local food systems, some further reflections

Framed as "resilience", the apparent capacity of a local food system to continue operating under stress or despite severe disruptions offers an attractive narrative. It is therefore not surprising that this concept of resilience constitutes one of the most active fields of applied research at the present time in relation to food security crises (TANGO, 2012; von Grebmer et al., 2013; Winderl, 2014; Maxwell et al., 2017; d'Errico et al., 2018; Ansah et al., 2019; Béné et al., 2020) and that it has been widely adopted by many international/UN agencies and NGOs as a critical element in their humanitarian and/or development discourse (USAID, 2012; WFP, 2013; DFID, 2018).

Embracing this resilience narrative unconditionally may, however, turn out to be more delicate or even misleading in some cases, as the term conveys the idea that, somehow, the system is coping, no matter what. While it might be correct that "at first sight" a system is still operating -at least for a while-, it does not necessarily imply that it delivers optimally its functions or that everyone does cope equally. This debate about the potential dangers or limitations of an all-embracing, unconditional adoption of the resilience discourse is not new (see e.g., Cannon and Muller-Mahn, 2010; Davidson, 2010; Béné et al., 2014; Leichenko et al., 2015). In our case, first, we saw that not all local food system actors displayed the same ability to deal with the disruptions. While some were doing better (the positive deviants), many others experienced substantial drops in their economic activities. In sum, the resilience of a few often masks the struggle of the many. Second, even for those who seemed to do better, their professional resilience may have been secured at the cost of other (more personal) dimensions. Our data reveals that 79 % of the traders who reported insecurity as the main reason of their relocation to Sebba had also reported to have been direct victims of some attacks. Individual wellbeing and sense of security may be amongst the first things that people accept to give up in order to continue operating. In essence, livelihood resilience might sometimes be achieved at the cost of people's wellbeing (Coulthard, 2012). This seems to have been the case for many of the food system actors we spoke to. Third, and more importantly, inherent to the concept of resilience is also the recognition that this resilience is not limitless and that there is a threshold beyond which the system, if pushed further, is likely to collapses (Connelly et al., 2017; Rubiños and Anderies, 2020). While this scenario -and its irreversibility element- is something that is relatively well admitted and discussed in disciplines such as ecology (Folke et al., 2004) or climate change (Solomon et al., 2009; McKay et al., 2022), it is much less debated in the growing literature on humanitarian and food security crisis. Admittedly, for those latter disciplines, we are still in the 'advocacy phase', trying to anchor more firmly the concept of resilience in the mainstream narrative of the development industry and perhaps not completely ready to embrace, along with it, its collapse corollary. Yet, it is clear in the case of the Sebba food system that eventually the limit of the system's resilience has been reached. This last point raises the obvious question of whether it is possible to identify in advance these catastrophic events. Our view is that engaging in such exploratory quest is probably futile since both theoretical and empirical literature across disciplines have long recognized that the resilience outcomes of a system are highly system-, case-, and possibly time-, specific (Carpenter et al., 2001; Connelly et al., 2017). In other terms, the threshold beyond which a system would collapse today is likely to be different from the threshold beyond which the same system would collapse in the future (Béné and Doyen, 2018). This means that, in the case of a food system exposed to armed conflicts, it would probably be very difficult to anticipate precisely if and when that system is about to break down. We argue, however, that this study does offer some avenues on how to improve our capacity to anticipate those catastrophic scenarios. At present, most information systems used in routine by governments and international humanitarian agencies to monitor and assess food security crises (such as the Integrated Phase Classification (IPC) initiative or the WFP Food Security Monitoring System)[6] focus their efforts on households' nutritional and food security status, often complemented by surveys of key national or sub-national/regional markets. Those surveys, which are designed to measure prices of major, nationally-relevant, staples and food items, do not record however direct information about shocks and the way local food actors respond to those shocks. Our work shows that in addition to these prices' information, a component that focuses on the dynamics of the food system itself and documents how its actors cope and respond (or not) to the disruptive effects of armed attacks could offer critical insight into the situation *before* those disruptions may eventually lead to a complete collapse of the system.[7]

In the case of the Sebba food system, we argue that, had the collected information been shared with the local authorities and the international community sufficiently in advance, it is reasonable to assume that those would have been able to predict, and perhaps prevent (or at least, mitigate), the collapse of the food system as it unfolded before our eyes in 2022.

6. Conclusion

Amongst the various shocks and stressors that are at the root of recent or current food insecurity crises, armed conflicts and political insecurity are prominent. Understanding the linkages between food

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[5] Lockwood et al., (2015), for instance developed psychometric scales for adaptive capacity dimensions. They then test the internal consistency (reliability) and validity (how well the construct is defined by the measures) of the data, using factor analysis. Their analysis confirms the "adequate evidence of validity and reliability" of the approach.

[6] https://fews.net/IPC.

[7] https://www.wfp.org/food-security-analysis.

insecurity and violent conflicts is therefore paramount ahead of the final years leading to the 2030 SDGs deadline.

By carefully documenting the relationship between the emergence of armed attacks in the Yagha province in northern Burkina Faso and the nature and magnitude of the disruptions that the crisis generated among the different groups of food system actors operating locally, we were able to better understand and anticipate the dynamics of the system. We showed in particular how the presence of some positive deviants among food traders was not sufficient to maintain the resilience of the whole system, and how as a result, the system eventually collapsed, leading to rapid deterioration of the food security. By mid-2022, the prevalence of food insecurity in the Yagha province was estimated to be more than 50 %.

Palestine, Syria, Mali, Niger, Somalia, Ethiopia, Afghanistan, etc., the list of countries where local food systems' resilience needs to be better understood and strengthened in the face of armed conflicts, is long. Our analysis paves the way to investigations in these regions where war and protracted conflicts occur, with the ambition to build the empirical knowledge necessary to design and implement more effective humanitarian interventions aiming at building (back) local food systems' resilience.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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