

# 1 Systematic Review on the Impacts of Agricultural 2 Interventions on Food Security and Nutrition in Complex 3 Humanitarian Emergency Settings

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## 18 **Abstract**

19 Complex humanitarian emergencies are a main driver of food and nutritional insecurity. Agricultural  
20 interventions are key to improving nutrition and food security, and their positive impacts are well-documented in  
21 stable developing countries. However, it is unclear if their positive effects on food security hold in complex  
22 emergency settings, too. In this paper, we systematically review empirical articles that apply rigorous designs to  
23 assess the causal impacts of agricultural interventions on food security, nutrition, or health outcomes in complex  
24 humanitarian emergencies. We only find six articles matching these criteria, which have mixed results on dietary

25 diversity and food security, and little evidence on child nutrition. Our review underscores the need for more  
26 rigorous research on the impacts of agricultural interventions in complex humanitarian emergency settings.

27 **Keywords:** Systematic review, nutrition-sensitive, agriculture, food security, nutrition, health, complex and  
28 humanitarian emergency settings.

## 29 **Introduction**

30 Complex humanitarian emergencies involve violence (including political, economic, military and social violence)  
31 and are characterized by disease, hunger, and displacement [1, 2]. They are becoming increasingly severe and  
32 protracted, having caused the displacement of around 110 million people around the world in 2023 [3]. Complex  
33 humanitarian emergencies damage economic and social assets, limit access to land and water, destroy rural  
34 infrastructure and weaken markets, all of which have a detrimental impact on food production, consumption, and  
35 distribution [4]. Households in complex humanitarian emergency settings (CHES) thus have limited access to  
36 safe, affordable and nutritious food, a situation which is often compounded with a lack of access to clean water,  
37 essential health services, and optimal feeding practices [5]. Complex humanitarian emergencies, along with  
38 climate stresses, are hence major drivers of food insecurity and hunger [6, 7]. In fact, violent conflict has been  
39 identified as the most consistent predictor of under-5-year-old child malnutrition, with 80% of the world's stunted  
40 children living in countries affected by violent conflict [8]. Wars have far-reaching repercussions on agriculture  
41 along the supply chain, leading to deterioration of agricultural assets, irrigation systems, and infrastructure and  
42 reducing food production, agricultural growth, and worsening rural livelihoods [6, 9-10].

43 Agricultural and small-holder interventions targeting small-scale livestock, fish, crop or horticultural production  
44 have been flagged as a crucial tool to combat hunger to meet the 2030 Agenda for Sustainable Development 2  
45 (SDG2) [11], particularly due to their potential in improving income generation, purchasing power, dietary  
46 diversity and nutritional quality [12,13-19]. In the past decade, such interventions have increasingly been  
47 implemented in humanitarian and conflict-affected settings and are hypothesized to be key for building resilience  
48 and overcoming food insecurity [20, 4].

49 There is growing evidence for nutrition-sensitive agricultural interventions in stable developing settings. A  
50 number of systematic reviews in the past decade have investigated the impacts of agricultural intervention as an

51 integral component of improving food security and health in Low- and Middle-Income Countries (LMICs) [21]-  
52 [25](#)]. These reviews included a wide range of studies analyzing different types of agricultural support such as  
53 homestead food production, home vegetable gardens, biofortification, livestock and fisheries, dairy, and irrigation  
54 programs. Their findings were consistent in showing positive impacts of agricultural support on household  
55 production of agricultural goods, dietary diversity, and income [23, 24]. The most recent systematic review  
56 demonstrates the effects of nutrition-sensitive agricultural interventions on nutrition and health outcomes,  
57 especially for women and children [25]. Moreover, agricultural interventions were found to facilitate women's  
58 contribution to household food availability and accessibility and to moderately increase children's consumption  
59 of food rich in protein, vitamin A, and micronutrients [23, 24]. Investigating the role of agricultural support on  
60 women's empowerment along the causal pathways from agriculture to nutrition, Ruel et al identified an  
61 improvement in specific dimensions of women's empowerment including social capital, ownership, and decision-  
62 making [25]. However, there is no evidence for significant positive impact on downstream health outcomes such  
63 as child stunting, wasting, and underweight [21, 23, 25].

64 However, given that exposure to complex humanitarian emergencies shapes economic decision-making [26],  
65 production, marketing and consumption behavior [4, 20], and access to land and water [27], theorized and tested  
66 mechanisms from stable developing settings might not hold, or be relevant, in CHES. For example, in CHES,  
67 farmers may have restricted access to land and water resources potentially constraining them from taking up the  
68 interventions. Even when farmers access land and water, CHES can lead to loss of productive and livestock assets,  
69 crop damage, and agricultural labor shortages, which leads to low harvests [28]. At the same time, CHES limit  
70 access to output and value chain markets for selling agricultural produce, constraining income-generation and  
71 reducing the availability and supply of fresh produce in markets [4].

72 However, only one study included in the previous reviews was conducted in a setting affected by a complex  
73 humanitarian emergency [29]. Considering that a large part of the global burden of food insecurity, hunger and  
74 poor nutritional status occurs in such contexts, it is important to generate and compile evidence on what works in  
75 CHES if SDG2 is to be met. Additionally, because of the complexities of intervention design and implementation  
76 in CHES, lessons on whether and how agricultural interventions reduce hunger from stable settings cannot be  
77 generalizable or transferable [28].

78 To address this gap in the literature, the goal of this systematic review is to compile, summarize, and assess the  
79 rigor of existing evidence on the impact of nutrition-sensitive agricultural interventions on food security and  
80 nutrition outcomes in CHES. Any peer-reviewed journal articles or published reports identified through the search  
81 databases between the years 1980 and 2022, conducted in CHES with at least one type of agricultural intervention,  
82 with a comparator group and a focus on nutrition, health, or food security outcomes were included in the study.

## 83 **Methodology**

### 84 **Study design and search strategy**

85 In this systematic review, we define CHES to include those experiencing active armed violence or protracted  
86 episodes of violent conflict which lead to humanitarian emergency and forcible displacement. This also includes  
87 post-conflict settings, where active violence subsided but countries remain at high risk of relapse and the  
88 repercussions of the violence remain prevalent. We define nutrition-sensitive agricultural interventions as any  
89 program in the primary sector that addresses the underlying causes of food insecurity and/or malnutrition such as  
90 biofortification, homestead production, livestock and dairy, agricultural extension, irrigation, aquaculture, and  
91 value chains.

92 We start by identifying four key systematic reviews [[23-25](#), [30](#)] and an overview of reviews [[22](#)] published since  
93 2012 that focused on the impacts of agricultural intervention on food security and nutrition. We hand-searched  
94 the references in these reviews and identified 160 references to be screened for inclusion according to our  
95 definitions of complex humanitarian emergency settings. We then replicated the search of the most recent study  
96 conducted by Ruel et al. [[25](#)], which summarized key findings from studies focusing on the nutritional impact of  
97 agricultural programs. This review helped formulate the search strategy and identify the types of agricultural  
98 interventions to include in our review. To include all our search terms of interest, we added keywords on food  
99 security outcomes, conflict, and complex emergency settings. We then ran this search covering publications from  
100 2017 onwards to identify studies that focus on agricultural intervention and food security, nutrition, and health in  
101 populations affected by conflict and humanitarian emergency.

102 Search terms for nutrition-sensitive agricultural interventions are included in Table 1 and partially derived from  
 103 [22] and [25] to ensure that the results are comparable. We used standard systematic review guidelines, as outlined  
 104 in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement [31]. The list  
 105 of search terms used to identify articles for the review are presented in Table 1. The protocol was registered in  
 106 PROSPERO under CRD42022327049.

107 *Table 1: Search topics and terms used in the review of nutrition-sensitive agricultural programs on food security*  
 108 *in populations affected by humanitarian crises.*

Topic	Search terms
<b>Outcomes</b>	
Nutrition and food security	“nutrition* outcome*” OR “nutrition* status” OR “diet* diversi*” OR micronutrient* OR anthropom* OR food* OR macronutrient* OR nutrition* OR “food consumption*” OR diet* OR “food secur*” OR “food insecur*”
Health	health* OR morbidit* OR mortalit* OR prevalence* OR incidence* OR burden* OR disease* OR “health status*” OR “health outcome*”
<b>Interventions</b>	
Biofortification	biofortif* OR bio-fortif* OR “harvestplus” OR “harvest plus”
Homestead production	“homestead production” OR “homestead food production” OR “home garden*” OR “homestead garden” OR “vegetable garden*”
Livestock and dairy	(“livestock program*” OR “livestock production*” OR “livestock ownership” OR “dairy production” OR “dairy program” OR “dairy development” OR “animal husbandry” OR “poultry development” OR “poultry production” OR “poultry program” OR “organic farming” OR “livestock intervention*”) AND agriculture
Agriculture extension	“agricultur* extension” OR “agricultural commercialization” OR “horticulture”
Irrigation	(Irrigation OR “water management”) AND impact
Aquaculture	(Aquaculture OR fisheries or fishpond) AND agriculture
Value chains	“value chain” OR value-chain OR “value crop*” OR “value-crop*” AND (nutrition OR diet)

Nutrition-sensitive agriculture	("nutrition-sensitive" OR "nutrition sensitive") AND agriculture
Interventions	(program* OR polic* OR strateg* OR legislation* OR law* OR intervention* OR technique* OR planning OR practice* OR fiscal OR regulation* OR sustainable OR tax* OR subsid* OR procurement* OR incentive*) AND (agriculture)
Contexts	
Conflict	(Conflict* OR disaster* OR war* OR shock* OR humanitarian* OR emergenc* OR catastrophe* OR crisis OR crises OR violence) NOT "conflict of interest"
Refugees and migrants	refugee* OR UNHCR OR displace* OR "forced migrant*" OR "forced migration*" OR "forced displacement" OR "forcibly displaced"

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110 For each database search, we used Boolean operators "AND" to pair the search terms of the outcomes section  
 111 with the search terms of the context section with the search term of each type of intervention as listed in Table 1.  
 112 The operator "OR" was used for different synonyms of the same topic (for example, conflict OR crises OR  
 113 emergency). The "OR" was used to expand our outcomes search by adding all the relevant keywords of nutrition,  
 114 health, and food security. The same approach was used to add search terms related to complex humanitarian  
 115 emergencies. The "NOT" operator was used to exclude studies that only identified "conflict of interest" without  
 116 any specific conflict-related search term in the text.

117 We systematically searched published studies in the following databases: Scopus, PubMed, and Web of Science.  
 118 The search was carried out on 28 March 2022, restricted to peer-reviewed and impact evaluation articles published  
 119 in English language, and conducted in populations affected by CHES from 2017 onwards. Animal studies were  
 120 excluded from this review. The number of articles identified through the first stage are reported in Table 2, by  
 121 topic and databases. The search strategy was first piloted in Scopus on 5 March 2022. Given the considerable  
 122 number of studies included in the search results, the key terms for the outcomes (e.g, health, food security, and  
 123 nutrition) and those for the context (e.g., conflict and refugees, and migrants) as well as the intervention topic  
 124 (e.g, program and policy) were restricted to title, abstract, and keywords search. To ensure the inclusion of all  
 125 studies that discussed at least one type of agricultural program, each intervention type was searched for all fields  
 126 in the three databases. The same search strategy was replicated in the other databases and the results are shown  
 127 in Table 2.

128 In order to identify and capture unpublished relevant reports, we conducted a broad search on Google Scholar for  
 129 the impacts of agricultural intervention on food security and nutrition in populations affected by CHES. The first  
 130 60 studies identified were exported and added to the screening stage. We also searched ReliefWeb and filtered  
 131 for ‘evaluation and lesson learned’, yielding an additional 22 results. ReliefWeb was used given the focus of the  
 132 database on global crises and disaster-affected settings [32]. A parallel search was also conducted on the  
 133 International Initiative for Impact Evaluation (3ie) database to further identify high-quality impact evaluation  
 134 studies conducted in CHES.

135 *Table 2: Number of articles identified by the type of agricultural program and database.*

Type of agricultural programs	Scopus (9,263)	PubMed (371)	Web of Science (696)
Biofortification	249	7	25
Homestead food production system	237	3	13
Irrigation	3,395	40	51
Agricultural extension	1,435	36	34
Livestock and dairy	1,415	87	69
Aquaculture	1,848	76	170
Value chain	446	2	54
Nutrition-sensitive agriculture	93	4	6
Intervention	3,124	159	366

136

137 **Eligibility criteria**

138 We used eight criteria to determine eligibility for inclusion of full-text review: Any peer-reviewed journal article  
139 or published report written in the English language between the years 1980 and 2022 and conducted in CHES  
140 with at least one type of agricultural intervention, with a focus on nutrition, health, or food security outcomes  
141 were included. The review was limited to studies with a comparator, either between intervention and control  
142 groups or differences between pre- and post-intervention in the same group. Excluded studies included systematic  
143 or scoping reviews, literature review, or any study that did not use agricultural support for the sake of improving  
144 nutrition, food security, or health outcomes. Studies that implemented a program with agricultural support being  
145 one of its intervention components, were excluded from the review if the analysis did not assess the impact of  
146 agricultural support alone on the selected outcomes.

147 We defined studies as conducted in CHES if they met the following criteria: (1) the study was conducted in a  
148 country ranked among the 10 countries with the lowest political stability as measured by the political stability  
149 index (which measures “perceptions of the likelihood that the government will be destabilized or overthrown by  
150 unconstitutional or violent means, including politically-motivated violence and terrorism”) [33], and the  
151 intervention took place after the onset of the crisis as measured by this, or the country in which the study was  
152 conducted had an active humanitarian response from UNOCHA at the time of the intervention; and (2) the authors  
153 explicitly mentioned that the study was conducted in CHES, or had recently experienced episodes of complex  
154 humanitarian emergency and was still affected by the consequences of the crisis.

155 Included articles are classified into the following two categories: population living in (post-) conflict and  
156 emergency settings and populations living in protracted conflict settings. A detailed plan for inclusion and  
157 exclusion criteria is described in Table 3.

158 **[insert Table 3: Inclusion and exclusion criteria for the full-text review of nutrition-sensitive interventions]**

### 159 **Selection process**

160 The results found from our search were downloaded into the reference management EndNote X9 software and  
161 duplicate records were removed. The remaining studies were imported to Covidence software for title and abstract  
162 screening according to the inclusion/exclusion criteria as described in Table 3. First, the screening process trialed  
163 by MD and LH on 150 articles during a preliminary search yielded the inclusion of 2 articles and revealed a high



164 interrater agreement. Then, the same authors, in addition to a third reviewer BZ screened the remaining articles,  
165 and the papers selected for full-text review were retrieved for further examination. The inclusion criteria were  
166 applied against these papers independently by three reviewers (MD, LH, BZ). Disagreements were resolved by  
167 discussion and consensus with HG.

168 Finally, information was extracted from the eligible studies including author and title, year of publication, country  
169 and region (if available) of the intervention, type of crises, type of agricultural intervention, outcome indicators,  
170 study method, type of design, summary of the findings related to nutrition, food security, and health. We also  
171 extracted data on intermediate outcomes (agricultural productivity, assets and income) to clarify potential impact  
172 pathways. Data were also extracted on other adverse or unexpected findings, author's recommendations and  
173 limitations, and conclusion of the study.

#### 174 **Assessment of Risk of Bias**

175 The Cochrane Risk of Bias In Non-randomized Studies of Interventions (ROBINS-I) tool was used by two  
176 independent reviewers (MD and BZ) to assess the risk of bias [34]. Any disagreement in quality assessment of  
177 these studies were resolved by consensus discussion with HG.

#### 178 **Results**

179 A total number of 10,511 articles were identified in the first round of search in which 10,330 articles were  
180 identified through search databases, 88 articles from ReliefWeb and Google Scholar, and 93 articles from 3ie.  
181 Using EndNote, 1,187 duplicate records were excluded, and the remaining 11,434 articles were screened for title  
182 and abstract using the inclusion and exclusion criteria specified in Table 3. We added to the screening phase an  
183 additional 161 articles identified from the reference list of our key systematic reviews. A total of 179 articles were  
184 screened for full-text, and after reading carefully, 173 articles were excluded because they did not meet the  
185 eligibility criteria (reasons underlined in figure 1). For example, studies limited to agricultural production as an  
186 outcome without assessing food security and nutrition outcomes were excluded. Observational studies that did  
187 not include a comparator group or an agricultural intervention were also excluded from this review. Only 6 articles  
188 were identified to meet our eligibility criteria and were proceeded to data extraction. Our review was limited to  
189 peer-reviewed articles, working papers, and published reports.

190 **[Insert Figure 1: Search strategy flow diagram (adapted from [31](#))]**

191 **[Insert Table 4: Data extraction of the included articles]**

192 Table 4 presents the characteristics of the articles included in this review, by type of humanitarian setting. Studies  
193 were either conducted in areas affected by conflict or hosting displaced populations who fled complex  
194 humanitarian emergencies. A total of six articles (or four studies) were identified, from which three articles were  
195 conducted post-conflict and three articles in protracted humanitarian crises.

196 *Studies conducted in (post-) conflict settings.* Three articles resulting from the Jenga Jamaa II project on food  
197 security and child nutrition outcomes in two territories severely affected by previous conflict in the Democratic  
198 Republic of Congo (DRC) were reviewed [[35- 37](#)]. This community-matched quasi-experimental study aimed at  
199 increasing income of food insecure farmers through (1) farmers field school (FFS) and farmer-to-farmer (F2F)  
200 interventions, (2) the prevention of malnutrition in children under two approaches (PM2A); i.e., the promotion of  
201 home gardens complemented with a behavior change component to support young child nutrition, and (3)  
202 empowering food insecure women through women’s empowerment groups (WEG). The Jenga Jamaa II project  
203 was implemented by the Adventist Development and Relief Agency in South Kivu between the years 2011 and  
204 2016.

205 The first paper looked at the impact of FFS on food security and children’s anthropometry in post-conflict Eastern  
206 DRC [[37](#)]. The FFS intervention provided experience-based education on farming practices, crop handling,  
207 entrepreneurship skills, and delivered seeds and tools packages to farmers. Compared to the control group who  
208 did not receive any intervention, the beneficiary group that received the four-year FFS program had improvements  
209 in agricultural production techniques, such as weeding (96.2%), hoeing (95.9%), and row planting (92.7%)  
210 practices, the adoption of several marketing strategies including the use of joint negotiation (68.8%), and farmer  
211 business association levels (56.3%). Using propensity score weights to balance on baseline characteristics of the  
212 intervention and control groups, the intervention was found to significantly improve food security outcomes,  
213 including an increase in Household Dietary Diversity Score (HDDS) (+0.9 points) and a decrease in Household  
214 Food Insecurity Access Scale (HFIAS) (-4.6 points), but had no impact on child nutritional status such as stunting  
215 and underweight. Despite these reported benefits, the authors acknowledged that the impact pathways through

216 which the agricultural intervention affected food consumption was not fully understood mainly due to poor data  
217 quality on agricultural outputs and yields.

218 The second article from the same program focused on the multiple intervention components and showed that  
219 PM2A and WEG had similar positive results to the FFS component [36]. While the F2F intervention did not  
220 improve HDDS among the beneficiary group, a modest non-significant decrease in HFIAS was reported.  
221 However, despite the use of propensity scores to account for observable characteristics of a non-randomized  
222 design, selection bias relating to the willingness of farmers to participate in the intervention could have affected  
223 the results. Similarly to the previous article published by Doocy [37], this study was unable to demonstrate the  
224 mechanism underlying the improvement in food security outcomes and suggested that further research be  
225 conducted in this post-conflict setting.

226 The third article looked at the same Jenga Jamaa II project's components focusing on children's dietary diversity  
227 and nutrition [35]. Minimum dietary diversity among children was achieved for PM2A and FFS groups and only  
228 the PM2A group met the minimum meal frequency and acceptable diet targets, suggesting the importance of  
229 integrating a behavioral change component on children's diet and feeding practice as part of PM2A. However,  
230 the improvement in children's dietary intake was not necessarily translated into better nutrition, mainly due to the  
231 lack of precision in estimating birth dates to assess anthropometric data, and the low sample size which  
232 underpowered the study to detect changes in nutrition outcomes. Hence, this study recommended the need for  
233 future multi-component interventions targeting nutrition education, health, agricultural provision, and income  
234 generation to improve child diet and nutrition.

235 ***Studies conducted in protracted humanitarian settings (with war refugees).*** Three articles reported on studies  
236 conducted in protracted humanitarian crises. The first involved the assessment of an agricultural extension  
237 program that provides high quality agricultural inputs to internally displaced persons, returnees, and host  
238 communities, on food security and resilience indicators in North-East Nigeria using a repeated cross-sectional  
239 survey [38]. The program was implemented by the Food and Agriculture Organization (FAO) in 2017, and offered  
240 vegetables, cereals, and pulses kits to beneficiaries, and compared the changes in outcomes from baseline to  
241 endline. This study also compared the changes between beneficiaries and non-beneficiaries before and after the  
242 intervention to quantify the program's mean impact on food security outcomes (using a difference in difference

243 analysis). The results showed a significant improvement in the Food Consumption Score (FCS) (+5.4 points) in  
244 the beneficiary group as compared to the non-beneficiary group, with a particular increase among the Internally  
245 Displaced Populations (IDPs) and those residing in extreme conflict areas. In turn, the Reduced Coping Strategy  
246 index (RCSI) also significantly decreased among the beneficiary group (-0.9 point), particularly among those  
247 living in low conflict areas.

248 Findings from a working paper series undertaken by Leuvelde et al., [39] implemented the N2Africa programme  
249 and targeted smallholder farmers in South Kivu, the Democratic Republic of Congo, a province undergoing  
250 protracted violent conflict with constant exposure to adverse climatic conditions [39]. The program aimed at  
251 improving agricultural yields, food security, and income through the delivery and dissemination of advanced  
252 technology. This program, which was implemented in 2009, collaborated with local organizations including six  
253 local Non-Governmental Organizations (NGOs) who had prior experience in implementing agricultural  
254 development initiatives. The N2Africa intervention encompassed agricultural extension services and input  
255 subsidy program, where lead farmers with extensive experience in farming were selected from the community to  
256 work in a group of 15-30 farmers. All lead farmers received legume technology packages that included  
257 agricultural inputs for legumes of choice such as seed, fertilizer, and inoculant, among others. This program, in  
258 addition, provided training on plant spacing practices, education information on the nutritional benefits of legume  
259 consumption, as well as training on value-added processing of legumes to provide income opportunities  
260 specifically to women. Using a clustered-randomized design, villages were randomly selected to receive subsidy  
261 schemes with extension programs versus extension programs alone. Results showed that fertilizer and inoculant  
262 uptake significantly increased in villages that received the training with input subsidy compared to villages that  
263 received the training only. Using heterogeneous analysis, the study showed that villages with low proximity to  
264 market generally have low use of agricultural inputs, mainly due to increased cost of access. However, the increase  
265 in input use did not necessarily translate into better yields and food security, due to small sample size and low  
266 absolute use of agricultural inputs, limiting the study's power to detect an impact on input use and nutritional  
267 outcomes. The authors suggested the need for larger interventions that target changes in market structure to  
268 develop local supply chains and improve market access to agricultural inputs by lowering their costs. The paper  
269 also highlights the challenging conditions in which the program took place and questioned program fidelity and  
270 the ability to correctly track households who received input packages.

271 In South Sudan, a challenging and fragile context with refugees living in an ongoing protracted crisis, the United  
272 Nations High Commissioner for Refugees (UNHCR) livelihood project implemented between 2016 and 2018  
273 included two main interventions delivered to refugees in Maban and Unity refugee hosting areas: (1) an  
274 agriculture intervention that included training and inputs and (2) a business intervention that included vocational  
275 training and business support [40]. Using a randomized design, this project sought to compare those who received  
276 any livelihood intervention to those who received the same support plus increasing access to informal financial  
277 services through Village Saving and Loan Associations (VSLA). The results showed that household assets and  
278 income, access to markets and financial services, as well as food security, coping strategies, and recovery from  
279 shocks all significantly improved for refugees who participated in VSLAs combined with livelihood training as  
280 compared to agricultural training, business training, or other trainings (combination of skill training) alone.  
281 Qualitative work supported the conclusion that an integrated multi-component livelihood intervention improved  
282 household food security and nutrition outcomes, decreased credit use, increased savings, increased production  
283 and income generation. This in turn, increased households' engagement with local markets, improved their ability  
284 to cope with shocks, and alleviated tensions that existed between communities. However, more respondents were  
285 concerned about theft and lack of safe places to hold savings due to the absence of formal financial institutions,  
286 suggesting the urgent need for aid actors to expand refugee's economic inclusion in protracted crises.

287 Overall, we identified six eligible studies, from which three were conducted in post-conflict settings, and the  
288 remaining three were conducted in protracted humanitarian settings. All these studies implemented multi-  
289 component agricultural interventions, targeting vulnerable groups such as smallholder farmers, refugees, IDPs,  
290 returnees and host communities, including children. Five of these studies used quasi-experimental designs with  
291 no 'pure' control group. In addition, they highlighted that the impact pathways through which agricultural  
292 interventions affected food consumption were not fully understood, and called for further research to address this  
293 gap. Suggestions included incorporating nutrition training, targeting market structure and access, and lowering  
294 agricultural input costs.

295 Table 5 summarizes the outcome of the risk of bias assessment within the articles. Five articles were identified as  
296 having an overall moderate risk of bias [35- 39]. Only one article was additionally identified as being at serious

297 risk of bias mainly due to confounding [35]. A high degree of risk was mainly associated with bias due to  
 298 confounding.

299 *Table 5: Risk of bias assessment ROBINS-I tool.*

<b>Risk of bias domains</b>	<b>Doocy 2019 [35]</b>	<b>Doocy 2018 [36]</b>	<b>Doocy 2017 [37]</b>	<b>Baliki 2018 [38]</b>	<b>Leuvelde 2018 [39]</b>	<b>Vallet 2021 [40]</b>
Bias due to confounding	Moderate	Moderate	Moderate	Moderate	Moderate	Serious
Bias in selection of participants into the study	Low	Low	Low	Moderate	Low	Moderate
Bias in classification of the interventions	Low	Low	Low	Low	Low	Moderate
Bias due to deviations from intended interventions	Moderate	Moderate	Moderate	NA	Moderate	NA
Bias due to missing data	Moderate	Moderate	Moderate	Low	Moderate	Low
Bias in measurement of outcomes	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Bias in selection of the reported result	Low	Moderate	Low	Moderate	Low	Moderate
<b>Overall risk</b>	<b>Moderate</b>	<b>Moderate</b>	<b>Moderate</b>	<b>Moderate</b>	<b>Moderate</b>	<b>Serious</b>

300

### 301 **Discussion**

302 Our review of evidence unveiled only six articles published that assessed the effectiveness of agricultural  
 303 interventions on food security and nutrition in CHES, and none published before 2017. Clearly, this is a relatively  
 304 low number of articles identified as compared to the increasing number of countries in need of humanitarian

305 assistance and/or experiencing high political instability [33, 41]. Additionally, the geographic coverage of these  
306 studies was limited to Africa (one study in South Sudan and North-East Nigeria, and two studies in DRC), and  
307 none were from the Middle East, Asia, or South America.

308 Of these six articles, four were peer-reviewed and two were published reports, as compared with a relatively high  
309 number of peer-reviewed articles published from stable settings [23-25]. Our review applied stringent criteria for  
310 inclusion of studies and did not include observational designs that previous reviews considered which could  
311 explain the low numbers of studies identified. This indicates that although experimental and quasi-experimental  
312 designs are possible to implement in CHES, very little rigorous research linking agricultural interventions to food  
313 security and nutrition has been conducted in such settings, and the majority of studies were conducted in  
314 prolonged relief or recovery (protracted crises and post-conflict) rather than acute phases, highlighting a major  
315 research gap.

316 Homestead food production, agricultural extension, and livestock support alone or in combination were the only  
317 nutrition-sensitive agricultural interventions identified in CHES. These interventions were also common in stable  
318 settings, but the latter also often included development-oriented interventions such as biofortification, irrigation,  
319 and value chain support, alone or in combination to food production interventions. It is likely that agricultural  
320 input provision is the main agricultural intervention type implemented in CHES as it provides tangible assets to  
321 households, it is easy to distribute, and it generates immediate socio-economic and nutritional benefits. These  
322 interventions enable vulnerable households to establish and profit from small-scale local agricultural production  
323 during a crisis to improve their food security. Local production in CHES is essential to ensure adequate food  
324 supply particularly that the agricultural sector deteriorates significantly during complex humanitarian emergency  
325 periods [8].

326 The reviewed studies included the primary outcome indicators: food security, nutrition, and health. In addition  
327 we considered outcomes on the impact pathway: agricultural production, asset ownership, and income. Overall,  
328 the interventions showed a positive impact on the use of agricultural input and techniques, but no impact on  
329 agriculture production and yields [37-39]. Agricultural interventions increased income and savings and decreased  
330 the need to rely on credit but resulted in mixed evidence in regard to its impact in the sale of productive assets to

331 deal with income shocks [37, 40]. The majority of the interventions demonstrated a positive effect on household  
332 dietary diversity and food security, yet one study did not demonstrate any significant impact [39].

333 The studies also report a modest increase in children’s dietary diversity, yet only two articles investigated the  
334 impact on prevalence of stunting and underweight among children, where none find any detectable significant  
335 impact [35, 37]. In fact, Doocy et al. [35] finds that incorporating a behavior change communication (BCC)  
336 component led to an increase in children’s minimum diet diversity and minimum meal frequency, consistent with  
337 a recent meta-analysis that finds a positive impact of nutrition-sensitive agriculture on diet diversity in children  
338 in stable settings, that is augmented when interventions include BCC [42].

339 Our results are largely consistent with findings from previous reviews conducted on studies in stable developing  
340 settings, which demonstrate a positive effect on the use of agricultural inputs and practices, and some mixed  
341 evidence on food production, consumption, and dietary diversity [16, 17, 21-25, 42].

342 However, it is imperative to differentiate the underlying mechanisms through which agricultural interventions  
343 impact these outcomes across the two settings. Complex humanitarian emergencies are the main driver of food  
344 and nutritional insecurity [6]. Thus, the latent factors which affect the impact pathways and outcomes of  
345 agricultural interventions in CHES are also likely to be impacted by violent conflict itself. CHES-driven factors  
346 such as restriction to access land and water resources, loss of productive and livestock assets, agricultural, crop  
347 damages, and agricultural labor shortages driven by displacement of people from rural areas are essential  
348 determinants of these nutrition and welfare outcomes [28]. In addition, CHE limits access to output and value  
349 chain markets for selling agricultural produce, which limits income-generation, availability, and supply of fresh  
350 produce in markets [4]. Agricultural intervention in CHES, hence, are theorized to improve auto-consumption of  
351 livestock and crop produce but not local production and consumption. Conflict could also lead to poor child  
352 nutrition through the lack of accessibility, availability, and affordability of healthcare facilities, and access to  
353 healthcare was not accounted for in any of the studies that assessed child nutrition outcomes. Apart from Vallet  
354 et al., [40] who investigated the role of rural markets, the role of contextual factors and the potential mechanisms  
355 of action in CHES were insufficiently explored. In addition, exposure to conflict directly shapes decision-making  
356 and risk-taking [43- 44]. Displacement and population movement caused by conflict decreases farmer’s ability



357 and willingness to invest in agriculture and can influence household participation and uptake of these  
358 interventions, as well as how they benefit from it. These factors are not prevalent in non-CHES.

359 As a result, this review was not able to determine specificities of the impact pathways linking agricultural  
360 intervention to nutrition, food security, and health in CHES. Therefore, these mechanisms and their implications  
361 on outcomes along the causal pathway in CHES need to be better investigated in future studies.

362 Finally, the low number of rigorous studies in CHES could be explained by two factors: (1) the lack of funding  
363 towards agricultural interventions in CHES and (2) the scarcity of good quality data in these settings.

364 First, development funding timelines and objectives differ substantially from humanitarian funding which tends  
365 to focus on responding to immediate and acute relief rather than building long-term resilience. Therefore, funding  
366 allocations to agriculture in CHES make up a fraction of that allocated to development programs and their  
367 evaluation [\[45\]](#).

368 The lack of studies and data emanating from CHES may also result from the reluctance of participants to  
369 accurately report production, consumption, and income in challenging settings. For example, respondents may  
370 under-report due to fear of losing assistance or no longer qualifying to receive it [\[46\]](#). Another explanation that  
371 could apply to both types of settings, but is more accentuated in CHES, is the decrease in sample size mainly  
372 caused by attrition and access difficulties in the field, which could have prevented the identification of any effect.

373 And although we find a similar lack of impact as previous reviews with respect to child stunting and underweight,  
374 reasons identified by authors are different, and include measurement bias and the inability to correctly estimate  
375 children's dates of birth which are essential for the accuracy of anthropometric status indicators. Also, the constant  
376 movement of households, particularly of older children, who are often relocated to live with relatives can further  
377 decrease the sample of children available for follow up during surveys. It is also likely that in both types of  
378 settings, follow-up durations are not sufficient to identify an impact on anthropometric indices [\[35, 37\]](#). Impact  
379 evaluation studies are also challenged by a myriad of methodological, ethical, and practical challenges, especially  
380 in CHES [\[47, 48\]](#). Our review identified selection bias, spillover effect, attrition bias, information, recall,  
381 measurement biases, and non-random response as threats to internal validity. Moreover, many studies reported  
382 that data collected in such settings face logistical and practical challenges, which not only reduced sample sizes

383 and underpowered the studies to identify any effect but also limited the study's ability to measure, through process  
384 evaluation and intervention mapping, the implementation fidelity and the extent to which the impact could be  
385 attributed to the intervention itself [36- 39, 49].

386 It is possible and feasible to use and adapt existing tested methods implemented in research studies from stable  
387 developing settings, including the use of RCTs, yet there is a need for exploring novel approaches to conducting  
388 impact evaluation in complex humanitarian emergency settings, which address some of the contextual ethical and  
389 practical challenges [47-48, 50]. In contexts where traditional face-to-face household surveys are difficult to  
390 conduct, alternative remote-based tools such online or mobile surveys [51], crowdsourcing [52-53], geospatial  
391 data [54], satellite data, and remote sensing [55] can be used to measure and assess outcomes (e.g. plot or land  
392 area, land and water use, crop production and productivity and market access). In addition, various studies  
393 included in this review have underscored attrition rates, potentially leading to smaller sample size at follow-up.  
394 To overcome this common challenge, impact evaluations in these types of contexts could consider oversampling  
395 techniques to prevent loss of statistical power and maintain the robustness of research findings. The included  
396 studies could also be strengthened by adopting mixed-method approaches, particularly involving stakeholders,  
397 which can provide a more complete understanding of the complex nature of resulting behaviors, experiences,  
398 differential impacts, and potential unintended consequences.

399 To our knowledge, this systematic review is the first to explore the potential impact of agricultural interventions  
400 on food security and nutrition outcomes in CHES. Our analysis focused exclusively on studies that compared  
401 outcomes between different groups, or before and after the intervention within the same group, which  
402 strengthened our findings, compared to studies with no control or comparator group. However, this study is  
403 subject to several limitations. The review was limited to studies written in English as the inclusion criteria, which  
404 could have excluded relevant studies in other languages. Furthermore, the interventions of the included studies  
405 were carried out in three countries (DRC, Northeast Nigeria, and Sudan), which limited the generalizability of  
406 the review to other countries and regions. From the articles identified, four were subjected to moderate risk of  
407 bias while two were deemed to be at a serious risk of bias, lowering the certainty of evidence of the impact of  
408 agricultural interventions on food security and nutrition outcomes in CHES. Finally, considering the  
409 aforementioned limitations and the nature of the studies included, we were not able to conduct a meta-analysis.

410 **Conclusion**

411 Despite growing evidence on agriculture-nutrition linkages in low- and middle-income contexts, this review  
412 found little evidence of the impacts of agricultural intervention on food security and nutrition in complex  
413 humanitarian emergency settings, and the little evidence found offered a mixed picture. If agricultural  
414 interventions are to be considered as part of the toolbox to improve food security in these challenging settings,  
415 many more rigorous studies fulfilling this clear gap on the effectiveness of such interventions along their impact  
416 pathways are needed.

417 Particularly, there is a need for research from a range of geographical contexts and CHES intensities. This is  
418 crucial to fill the knowledge gaps on the role of agricultural and horticultural interventions on production,  
419 marketing, food consumption, nutrition, and child health. Contextual factors such as access to and availability of  
420 markets, land and water and healthcare services should be incorporated in the impact assessment as they are likely  
421 to moderate how agricultural interventions impact food security and nutrition.

422 **List of Abbreviations**

423	BBC	Behavior Change Communication
424	CCES	Conflict and Complex Emergency Settings
425	DD	Dietary Diversity
426	DRC	Democratic Republic of Congo
427	F2F	Farmer-To-Farmer
428	FAO	Food and Agriculture Organization
429	FCS	Food Consumption Score
430	FFS	Farmers Field School
431	FGDs	Focus Group Discussions
432	HDDS	Household Dietary Diversity Score
433	HH	Household
434	HFIAS	Household Food Insecurity Access Scale
435	IDPs	Internally Displaced Populations

436	KIIs	Key Informant Interviews
437	LMICs	Low- and Middle-Income Countries
438	NGOs	Non-Governmental Organizations
439	PM2A	Prevention of Malnutrition in Children under Two Approaches
440	PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
441	RCSI	Reduced Coping Strategy Index
442	ROBINS-I	The Cochrane Risk of Bias In Non-randomized Studies of Interventions
443	SDG2	Sustainable Development 2
444	UNHCR	United Nations High Commissioner for Refugees
445	VSLA	Village Saving and Loan Associations
446	WEG	Women's Empowerment Groups

447 **Declarations**

448 **Ethics approval and consent to participate:** Not applicable.

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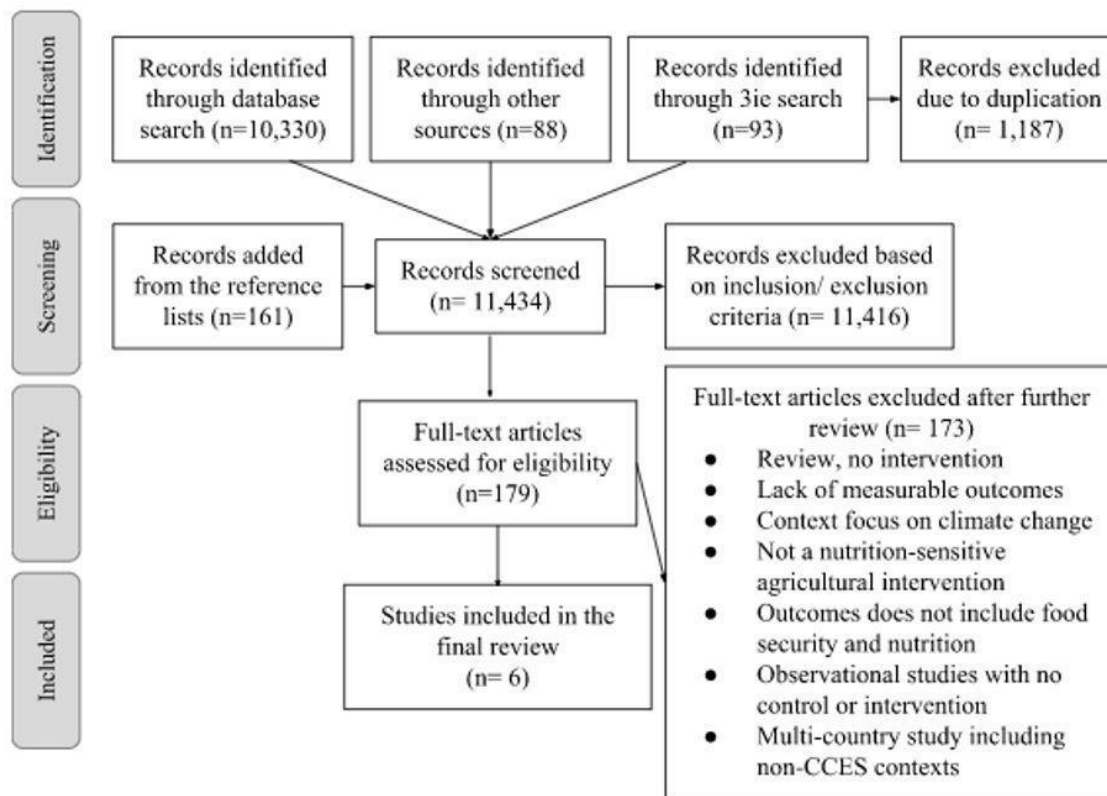
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614 *Figure 1: Search strategy flow diagram*



615

616 *Table 3: Inclusion and exclusion criteria for the full-text review of nutrition-sensitive interventions.*

Criteria	Inclusion	Exclusion
Publication type	<ul style="list-style-type: none"> <li>- Peer reviewed</li> <li>- Published papers and reports</li> <li>- Grey literature (working papers)</li> </ul>	<ul style="list-style-type: none"> <li>- Evidence/policy brief, conference</li> <li>- Unpublished abstract, study protocol</li> <li>- Meta-analysis, systematic or scoping review</li> </ul>
Publication year	1980-2022	<1980
Language	English	Others
Study type	<ul style="list-style-type: none"> <li>- Qualitative, quantitative, or mix-method design</li> <li>- Impact evaluation</li> </ul>	<ul style="list-style-type: none"> <li>- Literature review</li> <li>- Feasibility study</li> </ul>

Intervention	Any agriculture intervention used as a livelihood strategy for food or income of the household such as: <ul style="list-style-type: none"> <li>- Biofortification or harvest plus</li> <li>- Homestead production or vegetable garden</li> <li>- Irrigation or water management</li> <li>- Value chain/crop</li> <li>- Livestock and dairy</li> <li>- Agriculture extension or horticulture</li> </ul>	Any agriculture intervention not used as a livelihood strategy (e.g., leisure activity not intended for food or income of the household)
Comparator	-Studies comparing outcomes between different groups or difference before and after the intervention of the same group <ul style="list-style-type: none"> <li>- Cross-sectional studies comparing beneficiaries with non-beneficiaries</li> </ul>	- No comparator/control group
Outcomes	<ul style="list-style-type: none"> <li>- Food security</li> <li>- Health/disease</li> <li>- Diet and diet diversity</li> <li>- Micronutrient/macronutrient intake or status</li> <li>- Nutrition status/outcomes</li> <li>- Anthropometry</li> </ul>	<ul style="list-style-type: none"> <li>- Nutrition awareness, perception, attitudes</li> <li>- Food safety</li> </ul>
Settings	<ul style="list-style-type: none"> <li>- Countries classified with a high political instability index, or</li> <li>- Country received an active humanitarian response from UN OCHA at the time of the intervention, and</li> <li>- The authors explicitly mentioned that the study was conducted in CHES, or had recently experienced episodes of violent conflict (refer to Table 1 for the</li> </ul>	Stable or non-humanitarian (including LMIC who did not experience conflict or humanitarian crises)

full list of context-related search terms) and was still affected by the consequences of the crisis

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618 Table 4: Data extraction of the included articles.

Authors, year, study location	Type of intervention	Evaluation design	Outcomes measured	Findings	Conclusion
<b>Population living in (post-)conflict settings</b>					
<p><b>Doocy et al., 2019 [35]</b>  <b>Eastern Democratic Republic of Congo</b></p> <p><b>Evaluating interventions to improve child nutrition in Eastern Democratic Republic of Congo</b></p>	<p><b>Jenga Jamaa II include:</b></p> <ul style="list-style-type: none"> <li>- Income generation through FFS and F2F: training on agricultural methods, provision of seeds and tools, and farmers train other members in their community</li> <li>- Improve health and nutritional status of children &lt;5 years through PM2A: messages on child health, nutrition education and behavioral change, promote homegardens, monthly rations, and health system support</li> <li>- Empower FI women through WEG: meetings to deliver literacy, numeracy, business, marketing training, and the</li> </ul>	<ul style="list-style-type: none"> <li>- Community-matched quasi-experimental design</li> <li>- Communities receive one intervention versus multiple interventions versus no intervention</li> <li>- Program implemented between 2011 and 2016</li> <li>- 1312 children from 1113 HH participated</li> <li>- Surveys 3.5 years apart</li> </ul>	<p><b>Children's outcome measures:</b></p> <ul style="list-style-type: none"> <li>- DDS measured using 24h recall</li> <li>- Minimum dietary diversity achieved if child consume <math>\geq 4</math> food groups</li> <li>- Minimum acceptable diet met if child achieved both minimum meal frequency and dietary diversity</li> <li>- Stunting</li> <li>- Underweight</li> </ul>	<p><b>Children's food security:</b></p> <ul style="list-style-type: none"> <li>- Modest improvement in DD for PM2A and FFS interventions compared to control group</li> <li>- Increase in the minimum DDS in PM2A and FFS groups compared to the control group</li> <li>- Minimum meal frequency was met for the PM2A group as compared to the control group</li> </ul> <p><b>Children's nutrition:</b></p> <ul style="list-style-type: none"> <li>- No significant difference for stunting or underweight</li> <li>- Modest decrease in the prevalence of underweight among PM2A group and stunting among PM2A and FFS groups</li> </ul>	<p>PM2A and FFS groups yielded better child dietary measures and nutrition outcomes, particularly among the intervention with a behavioral change component (PM2A)</p>

	provision of goats and kits				
<p><b>Doocy et al., 2018 [36]</b>  <b>Eastern Democratic Republic of Congo</b></p> <p><b>Improving household food security in eastern Democratic Republic of the Congo: a comparative analysis of four interventions</b></p>	Same as above	Same as above but without considering children's sample	<p><b>Household's outcome indicators:</b></p> <ul style="list-style-type: none"> <li>- HDDS measured over the past 24 hours</li> <li>- Target dietary diversity achieved if HH consume <math>\geq 5</math> food groups</li> <li>- HFIAS</li> </ul>	<p><b>HH food security indicators:</b></p> <ul style="list-style-type: none"> <li>- Significant increase in HDDS for those who received WEG, PM2A, or FFS</li> <li>- Significantly lower HFIAS score for WEG, PM2A, and FFS interventions, with smaller gain in F2F</li> <li>- Pathway: WEG, PM2A indirectly improved food security through income generating activities and HH gardens</li> </ul>	<p>WEG, PM2A, and more specifically FFS interventions significantly improve HDDS and HFIAS, a lower impact was observed for F2F intervention</p>

<p><b>Doocy et al., 2017 [37]</b>  <b>Eastern Democratic Republic of Congo</b></p> <p><b>Food security and nutrition of farmer field schools in Eastern Democratic Republic of the Congo</b></p>	<ul style="list-style-type: none"> <li>- Same as above focusing on FFS program (one component of the Jenga Jamaa II project)</li> <li>- Combined with qualitative data (KIIs, FGD) after the end of the project</li> </ul>	<ul style="list-style-type: none"> <li>- Same as above</li> <li>- FFS beneficiary and controls were selected while the program was operating.</li> <li>- 388 beneficiaries and 324 controls were enrolled</li> </ul>	<p><b>Household's outcome indicators:</b></p> <ul style="list-style-type: none"> <li>- HDDS</li> <li>- HFIAS</li> </ul> <p><b>Children's outcome indicators:</b></p> <ul style="list-style-type: none"> <li>- Stunting</li> <li>- Underweight</li> </ul>	<p><b>Agricultural production techniques:</b></p> <ul style="list-style-type: none"> <li>- FFS increased the number of agricultural techniques, more specifically for weeding, hoeing, and row planting</li> </ul> <p><b>Use of marketing and financial services:</b></p> <ul style="list-style-type: none"> <li>- More HH used joint negotiation, farmer business association levels, and sales through agricultural collection centers.</li> <li>- Use of informal credit significantly decreased and use of savings increased</li> </ul> <p><b>HH food security:</b></p> <ul style="list-style-type: none"> <li>- HDDS and HFIAS significantly improved in FFS</li> </ul> <p><b>Children's nutrition:</b></p> <ul style="list-style-type: none"> <li>- No significant difference in the prevalence of child stunting and underweight</li> </ul>	<ul style="list-style-type: none"> <li>- This program diversified agricultural production, improved HDDS and HFIAS. However, the nutritional status of children did not improve</li> <li>- Increases in agricultural production alone are not enough to induce change in child's nutrition</li> </ul>
<p><i>Populations living in protracted crises and displacement</i></p>					



<p><b>Vallet et al., 2021 [40] South Sudan</b></p> <p><b>Where are the development actors in protracted crises? Refugee livelihood and food security outcomes in South Sudan demonstrate the potential for fragile settings</b></p>	<p>- UNHCR livelihood intervention include:</p> <ul style="list-style-type: none"> <li>- Agriculture: inputs and agricultural training</li> <li>- Small business: vocational training and business support</li> <li>- VSLA</li> <li>- Complemented with qualitative data (FGD, KIIs)</li> </ul>	<ul style="list-style-type: none"> <li>- Mix method approach</li> <li>- RCTs</li> <li>- Program implemented between 2016 and 2018</li> <li>- HH received livelihood training package alone (agriculture, small business development, or other types of trainings alone or in combination) versus the same training plus VSLA</li> <li>- Qualitative data collected at the end</li> </ul>	<p><b>Household's outcome indicators:</b></p> <ul style="list-style-type: none"> <li>- FCS</li> </ul>	<p><b>HH assets, income, access to market and financial services:</b></p> <ul style="list-style-type: none"> <li>- VSLA plus training has a significant impact on HH productive assets, income source, access to markets, and financial services as compared to one type of training only</li> </ul> <p><b>Food security, coping strategies and recovery from shocks:</b></p> <ul style="list-style-type: none"> <li>- Significant increase in food security, ability to meet food and non-food needs and recover from shocks for those who received livelihood plus compared to training only or other types of training only</li> </ul> <p><b>Other outcomes with potential health implications (qualitative work):</b></p> <ul style="list-style-type: none"> <li>- Livelihood program increased social cohesion by reducing refugee-host community conflict</li> <li>- Livelihood program decreased sexual and gender-based violence</li> </ul>	<ul style="list-style-type: none"> <li>- UNHCR program improved food security, livelihood, and income-generation in volatile and insecure settings.</li> <li>- The outcomes were much improved when the training was complemented with VSLA</li> </ul>
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<p><b>Baliki et al., 2018 [38]</b> <b>North-East Nigeria</b></p> <p><b>Drivers of resilience and food security in North-East Nigeria: Learning from the Micro Data in an Emergency Setting</b></p>	<p>FAO program includes the provision of quality agricultural inputs such as cereals, pulse and vegetable kits</p>	<ul style="list-style-type: none"> <li>- Quasi-experimental design with repeated cross-sectional surveys</li> <li>- Data collected from 5,807 HH at baseline and 5,991 HH at endline</li> <li>- Beneficiaries (intervention group) were compared to non-beneficiaries (control group with no intervention)</li> </ul>	<p><b>Household's outcome indicators:</b></p> <ul style="list-style-type: none"> <li>- FCS</li> <li>- RCSI</li> <li>- Resilience measured by the use of harmful livelihood strategies over the past 30 days</li> </ul>	<p><b>Food security indicators:</b></p> <ul style="list-style-type: none"> <li>- FCS improved significantly for the beneficiary group, particularly among IDPs and those residing in high and extreme conflict-affected areas.</li> <li>- RCSI significantly increased among the beneficiary group, particularly among HH residing in low conflict areas.</li> <li>- The program builds HH resilience, except for those who experienced a personal shock</li> </ul> <p><b>Other outcomes with potential health implications:</b></p> <ul style="list-style-type: none"> <li>- Intervention improved social cohesion by mitigating participant's concern about conflict between community members and local security</li> </ul>	<p>The provision of agricultural inputs increased FCS shortly after the intervention, and are likely to build resilience to shocks, especially among the most vulnerable</p>
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<p><b>Leuvelde et al., 2018 [39]</b>  <b>Eastern Democratic Republic of Congo</b></p> <p><b>Agricultural extension and input subsidies to reduce food insecurity. Evidence from a field experiment in the Congo</b></p>	<p>N2Africa include agriculture extension intervention and input subsidy programme</p>	<ul style="list-style-type: none"> <li>- Clustered-randomized experimental design</li> <li>- Compared villages who received extension program alone versus extension program + subsidy scheme</li> <li>- Program implemented in 2013</li> <li>- 265 HH received training only and 256 HH received training with subsidy</li> </ul>	<p><b>Household's outcome indicators:</b></p> <ul style="list-style-type: none"> <li>- Yields (kg/hectare)</li> <li>- HFIA</li> </ul>	<p><b>Use of agricultural inputs:</b></p> <ul style="list-style-type: none"> <li>- Fertilizer and inoculant uptake significantly increased in villages who received training + input subsidy compared to villages who received training only</li> </ul> <p><b>Food production:</b></p> <ul style="list-style-type: none"> <li>- No significant impact on beans and cassava yields</li> </ul> <p><b>Food insecurity:</b></p> <ul style="list-style-type: none"> <li>- No significant impact on food security outcome</li> </ul> <p><b>Market access:</b></p> <ul style="list-style-type: none"> <li>- Villages with low proximity to markets have lower use of agricultural inputs</li> </ul>	<ul style="list-style-type: none"> <li>-The intervention was successful in increasing the use of yields enhancing inputs: a new technology called inoculant and chemical fertilizers</li> <li>- The increase in adoption of agricultural input did not translate to better yield or food security</li> </ul>
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