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Assessing Refugee Preferences for SDG 2 (Zero Hunger) Solutions in Irbid Camp and Sakhra Region: Cultivated Roofs and Refrigerators as Food Banks Interventions

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Abstract: The issue of hunger is a pressing concern, particularly in impoverished pockets of Jordan and globally. Although significant, research efforts focused on pragmatic solutions to eradicate hunger, aligned with the Sustainable Development Goal (SDG) 2: Zero Hunger, are scant. The present study scrutinizes the preferences of refugees in Irbid Camp and Sakhra region, Jordan, for two potential hunger alleviation interventions - Cultivated Roofs (CRs) and Refrigerators as Food Banks ($RaFB$). Key research objectives include examining refugee choices in hunger reduction, the impact of demographic attributes on these preferences, and potential benefits and hurdles in implementing each solution. Surveys were conducted with 402 households, and the gathered data was analyzed using statistical tools like Chi-square and descriptive statistics. The results indicated that most (90%) preferred the $RaFB$ intervention over CRs (10%). Demographic factors like age, gender, educational attainment, and family size did not significantly impact the acceptance of CRs. However, education level significantly influenced the acceptance of the $RaFB$ intervention. $RaFB$ was largely favored due to its lower effort, cost, risk, cultural compatibility, and success in other regions than CRs. However, those with higher education levels were more likely to reject $RaFB$, potentially due to varied cultural perspectives or access to alternative solutions. The study also shed light on the primary advantages and challenges of implementing CRs and $RaFB$ projects, offering valuable insights to policymakers in designing future interventions.

Keywords: refugees, zero hunger, cultivated roofs, food banks, demographic profiles.

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1. Introduction

Food security is a pressing global challenge, particularly in refugee camps where access to adequate, safe, and nutritious food is often limited. The United Nations' Sustainable Development Goal (SDG) 2 aims to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture by 2030. Achieving this goal in vulnerable populations, such as refugees residing in camps and host communities, requires innovative and context-specific solutions that address these groups' unique needs and constraints.

Hunger and poverty pockets, like those in Irbid Camp and Sakhra region, often lack infrastructure and resources, exacerbating their inhabitants' already precarious food security situation. In addition to the immediate need for food assistance, there is a growing recognition that sustainable and long-term solutions must be sought to address food insecurity and promote self-reliance among refugee populations. One such approach is exploring alternative food production and storage methods appropriate for the camp environment.

In Jordan, the economic shock resulting from the coronavirus pandemic in recent years has deepened previous trends of poverty rates, despite governmental efforts to support the social safety net, which somewhat contributed to slowing the acceleration of poverty numbers. The poverty rate in Jordan is estimated at 24%, according to the latest study conducted by the General Statistics Department in 2021, an increase of 6% due to the repercussions of the coronavirus, while this percentage increases to 33% or more in some poverty pockets and camps.

Thirteen officially recognized Palestinian refugee camps in Jordan are serviced by UNRWA and are spread across six provinces. Sakhr region in Ajloun was selected because it is one of the poorest areas in Jordan, with poverty rates ranging between 28%-33% in some of its regions. The proportion of the population under 15 exceeds 40% in the governorate, and the unemployment rate is high. It is a rural area suitable for agriculture. On the other hand, the Irbid camp was chosen because poverty and unemployment rates exceeded 60%, and the camp lacked any developmental projects. The camp is home to more than 29,800 citizens living in a small area of 244,000 m2 that cannot be expanded.

All member states of the United Nations adopted the 17 Sustainable Development Goals (SDGs) in 2015, serving as a global call to action to eradicate poverty by 2030. The second SDG aims to eliminate hunger and malnutrition and achieve sustainable food production by 2030. This goal is premised on the idea that everyone should have access to sufficient nutritious food, which necessitates promoting sustainable agriculture on a broad scale, which includes supporting small-scale farmers and achieving equality in access to land, technology, and markets. It also requires international cooperation to ensure investment in infrastructure and technology to improve agricultural productivity, increase investment, and properly operate food markets.

Global evidence indicates that the number of hungry people worldwide is increasing, reaching 828 million in 2021, an additional 46 million compared to the previous year and an additional 150 million compared to 2019. This is according to the World Food Security and Nutrition Report for 2022 issued by the Food and Agriculture Organization of the United Nations. Hunger has risen over the past three years, returning to levels not seen in a full decade. This setback sends a clear warning that more needs to be done, and urgently, if we are to achieve the Sustainable Development Goal of eradicating hunger by 2030.

This research presents the findings of a study that investigated the preferences and demographic influences of refugees in Irbid Camp and Sakhra region for two proposed

interventions: Cultivated Roofs (CRs) and Refrigerators as Food Banks (RaFB). CRs intervention includes cultivating food crops on the roofs of houses inside the district, while RaFB intervention includes positioning community refrigerators to preserve and store food. In addition to assessing the overall preference for each intervention, the current research also surveyed the prospective advantages and challenges of employing these solutions in pockets of poverty across Jordan. Factors such as age, gender, education level, and family size were analyzed to determine their influence on the preferences of refugees for each project. By understanding the preferences and needs of refugees concerning food security interventions, this study aims to contribute to the development of contextually appropriate and sustainable solutions for achieving zero hunger in refugee camps and vulnerable areas. Furthermore, the insights gained from this research can inform policymakers and aid organizations in their efforts to design and implement effective food security strategies in these settings.

The study's problem lies in the poverty pockets in Jordan, especially in Irbid Camp and Sakhra region, which suffer from severe poverty and hunger and several Palestinian refugee camps (number of camps) whose members suffer from poverty. Therefore, the importance of the research is to shed light on the issue of hunger in refugee camps and poverty pockets and try to find pioneering projects that contribute to raising the economies of families and solving the problem of hunger and poverty. The current research aims to answer the following research questions:

RQ1: What is the overall preference among refugees for Cultivated roofs, refrigerators as food banks, or their ideas for achieving zero hunger in the camps and vulnerable areas (i.e., Irbid Camp and Sakhra region)?

RQ2: How does the demographic profile of refugees (e.g., age, gender, education level, and family size) influence their preferences for Cultivated roofs or refrigerators as food banks for achieving zero hunger?

2. Literature Review

The literature review section explores food security's broad and complex dynamics in refugee settings, focusing on implementing Sustainable Development Goal 2 (Zero Hunger) solutions in refugee communities. A deep exploration of various scholarly sources to understand the intersection of refugee experiences, food insecurity, and innovative interventions to combat hunger. Furthermore, the review illuminates the context of Irbid Camp and the Sakhra Region, shedding light on the unique challenges these regions face and the opportunities for sustainable interventions. In examining previous studies, we pay close attention to emerging themes, potential gaps, and the overall trajectory of research on food security among refugees. This literature review lays the groundwork for our research question: "How can we effectively implement and integrate cultivated roofs and refrigerator food banks within the refugee context, specifically in the Irbid Camp and Sakhra Region, and what are the preferences of refugees for these interventions?" Through the lens of the literature, we aim to frame this question within its broader thematic, regional, and theoretical context.

Labor market integration is defined in the study as the unrestricted participation of refugees in the private and public sectors, including self-employment, without experiencing legal barriers, exclusion, discrimination, or exploitation due to their refugee status. The research, grounded in the context of Syrian refugees in Jordan, underscores that successful labor market integration is contingent on the congruence of four viewpoints: (1) the perspective of the host state, embodied in legal regulations concerning refugee employment, (2) the refugees' perspective, relating to their labor market accessibility and the

obstacles they encounter, (3) the stance of the host community, reflected in their acknowledgement, endorsement, or responses to refugee employment, and (4) the donor perspective, represented by the involvement of international entities through development assistance or broad support for refugees' employment rights (Matarazzo & Najjar, 2020). Despite an upward trend in the average marriage age across several Middle Eastern nations, child marriage is reportedly increasing among specific communities in Jordan, particularly among refugees. The study delves into the viewpoints of Jordanian and Syrian adolescents regarding child marriage in the context of the Syrian crisis as constituents of both the refugee and host populations. The research utilized data from comprehensive interviews with 64 Jordanian and Syrian adolescents aged 15 to 19. The interviews comprised an adaptive, narrative discourse where participants reflected on their life histories, facilitated by constructing a visual timeline (El-Khani, Cartwright, Redmond, & Calam, 2021).

Assaad et al. (2023) uncovered labor market vulnerabilities faced by the youth in Egypt, Jordan, and Tunisia. The findings suggest that youth in these countries are disadvantaged concerning labor market outcomes. Notably, a significant portion of young men finds themselves in precarious employment situations, while women across all age groups are more likely to exit the labor market unless they are in formal employment. Moreover, youth initially entering the labor market into unstable jobs are less likely to transition into higher-quality employment over time. Factors such as family wealth, parental education, and the father's occupation emerged as key determinants of labor market outcomes and vulnerability, persisting even after an extended duration of work experience (Assaad, Ghazouani, & Krafft, 2023). Al-Khawaldeh. (2022) investigated the effectiveness of a program centered on psychosocial support in enhancing family empowerment among refugees in Jordan. It includes a sample of 32 refugees from the Irbid governorate, divided equally into an experimental group participating in the psychosocial support program and a control group not engaging in any intervention program. The researchers utilized the Family Empowerment Scale to gather pre-and post-test data in both groups and a follow-up test exclusively for the experimental group. The study highlights the potential role of psychosocial support programs in empowering refugee families in Jordan (Al-Khawaldeh, 2022).

Another research paper explores Syrian refugees' views on blended learning (BL) at the Arab Open University in Jordan and the influence of age and gender on these perceptions. Using a questionnaire, the authors gathered data from 93 Syrian refugees, revealing positive attitudes towards the BL approach and satisfaction with its transformative potential in achieving academic objectives without interfering with work and family commitments. The study showed no significant differences in perceptions of BL due to gender. However, older participants held a more favorable view of BL. The study also delved into the challenges refugees face when engaging in BL, ultimately recommending expanding BL methods, particularly for susceptible populations like refugees, while considering their articulated challenges (Alshboul et al., 2020). Also, another research examines the influence of the Syrian refugee influx on Land Use/Land Cover (LULC) changes in the Irbid district, Northwestern Jordan, between 1985 and 2021, a timeline inclusive of the Syrian civil war. The study relied on Landsat Thematic Mapper (TM) imagery for 1985 and 2004 and Landsat-8 Operational Land Imager (OLI) for 2013 and 2021. All image processing, calculations, and classification analyses were conducted on the Google Earth Engine (GEE) platform using the Random Forest (RF) approach. The analysis of the classified imagery allowed for comparing LULC before and during the Syrian crisis. The findings reveal an increase in urban and agricultural land during the influx of Syrian refugees, largely due to the surge in demand for land and housing. The refugees' dependence on agriculture as a primary livelihood activity also expanded agricultural lands. The refugee movement to the Irbid district has accelerated the building and construction processes (Al-Bilbisi et al., 2023).

The social integration of elderly refugees presents a unique set of challenges. Elderly refugees, as a vulnerable group within refugee communities, often face amplified difficulties due to the convergence of the struggles associated with aging and migration. This study focuses on their social integration in light of the increasing population of older adults and refugees. Key issues faced by elderly refugees include health and language barriers, social isolation, and bureaucratic complexities. Furthermore, female refugees face additional educational, language proficiency, income, and employment disadvantages. The study identifies language barriers, poverty, and foreign surroundings as major obstacles to social integration for elderly refugees. However, factors such as shared religion, characteristics of the host country, and established social networks could facilitate their integration. As such, it is essential to establish specific services and social work practices that mitigate these challenges and capitalize on facilitating factors to promote effective social integration for elderly refugees (World Bank, 2023).

Wardeh & Marques (2021) comprehensively analyzed the socioeconomic integration of the estimated 3.5 million Syrian refugees in Türkiye. This exploration provides invaluable insights into the strategies and policies for managing forced displacement, a pressing global issue. The discussion is sectioned into five primary segments: the paper first delves into the background and political complexity of the Syrian civil conflict. It then provides a demographic breakdown of the Syrian population in Türkiye, considering their numbers, movement patterns, regional composition, and characteristics. The third section discusses Türkiye's integration policy framework, concentrating specifically on labor market, education, health, and social protection policies.

The fourth segment offers a review of existing academic literature that examines the impact of the refugee influx on key outcomes for nationals and refugees. The paper outlines the main challenges encountered and lessons from the refugee crisis. Klassen (2022) presented a comprehensive evaluation of interventions in refugee camps to improve refugees' quality of life and ameliorate their conditions. Previous studies have discussed these interventions, yet there has been no formal systematic review and meta-analysis assessing the relative effectiveness of these strategies in alignment with sustainability and the 2030 Agenda. This study implemented an exhaustive search strategy to identify peer-reviewed articles that discussed interventions related to Sustainable Development Goals (SDGs) within a refugee camp context. Out of 1108 publications screened for relevance, 72 studies containing pertinent evidence were analyzed in detail. Data from these studies were subsequently compiled through meta-analysis to provide summary estimates of the effectiveness of current methods. The study determined that the health and education sectors were the most frequently addressed SDGs. Findings and recommendations from the included studies were classified into seven sectors: planning, development, and shelters. Health and well-being, education, water and sanitation, energy, and work and economic growth.

Meral (2022) examined global policy-making and implementation, especially concerning vulnerable refugee populations. It underscores the growing global consensus on the importance of meaningful refugee participation and a shift in discourse from vulnerability to empowerment in policy-making and humanitarian assistance. Utilizing Canada's interaction with the global refugee regime, particularly with refugee women, the paper contends that the persistent portrayal of refugee women as vulnerable impedes progress. It posits that for transformative policy to become a reality, refugee women must be recognized as competent participants and involved in all policy-making, implementation, and evaluation aspects. The paper suggests a feminist geopolitical framework to reorient focus away from states and institutions towards refugee women's individual experiences in global refugee policy-making. This shift could foster empowerment in policy and practice. Easton-Calabria & Hackl (2023) investigated the barriers to a comprehensive response

to a prolonged, large-scale urban displacement crisis, using Jordan as a case study. This research investigates the dynamics of inclusion and exclusion in the displacement response, scrutinizing the factors that drive exclusion among those affected by displacement, including aspects of humanitarian interventions. It further evaluates the degree of inclusivity within the displacement response and identifies elements that have hindered or facilitated a more inclusive approach during this urban displacement crisis. Abuhussein (2022) explored the unique circumstances of refugee entrepreneurs as differentiated from other categories of immigrants, primarily due to the distinct situations they face compared to non-forced immigrants. Critical differences exist between forcibly displaced individuals and other migrants that can influence their economic choices, including those related to entrepreneurial ventures. Socioeconomic heterogeneity is demonstrated significantly through individual refugee characteristics such as age, gender, and education levels. It is noted that existing research has not dedicated sufficient attention to gender-based studies or the experiences of refugee women entrepreneurs, particularly in entrepreneurship. Consequently, this investigation aims to examine the adversities and obstacles encountered by refugee women entrepreneurs and identify the present strengths and opportunities that could bolster their integration into Jordan's host economy.

The literature review has underscored the intersection of food security, refugee experiences, and the potential for innovative interventions such as cultivated roofs and refrigerators as food banks. This body of work highlights the significance of SDG 2 (Zero Hunger) and its importance to the well-being of refugee populations, particularly in areas such as the Irbid Camp and Sakhra Region. However, it also reveals gaps in the existing research, particularly concerning refugees' preferences and perspectives on these innovative food security interventions. As such, our study aims to bridge these gaps and contribute to a more nuanced understanding of how such interventions can be implemented in refugee settings, with direct input from the refugees themselves. By considering the refugees' preferences and ideas, we can develop more sustainable, effective, and context-specific strategies to combat hunger and ensure food security in these vulnerable communities.

3. Methodology

In this research, the descriptive-analytical approach is followed, where the social, economic, educational, health, and housing characteristics of 402 low-income families in the study community in Irbid camp and Sakhr region will be described, as well as analyzing the data related to social, economic, educational, and dietary patterns of the low-income families residing in these areas, and also analyzing their dietary and consumption patterns in addition to analyzing their attitudes towards the proposed entrepreneurial projects to reduce hunger and raise the economic level of families. Qualitative and quantitative methods will be used to analyze the data collected from the field, such as converting qualitative answers to quantitative ones, especially regarding entrepreneurial projects, and finding percentages and standard deviations for the quantitative data. Field survey tools, questionnaires, the Statistical Package for Social Sciences (SPSS), and Geographic Information Systems (GIS) software will be used to conduct various spatial analyses. Figure 1 illustrates the adopted study procedures within the current study.

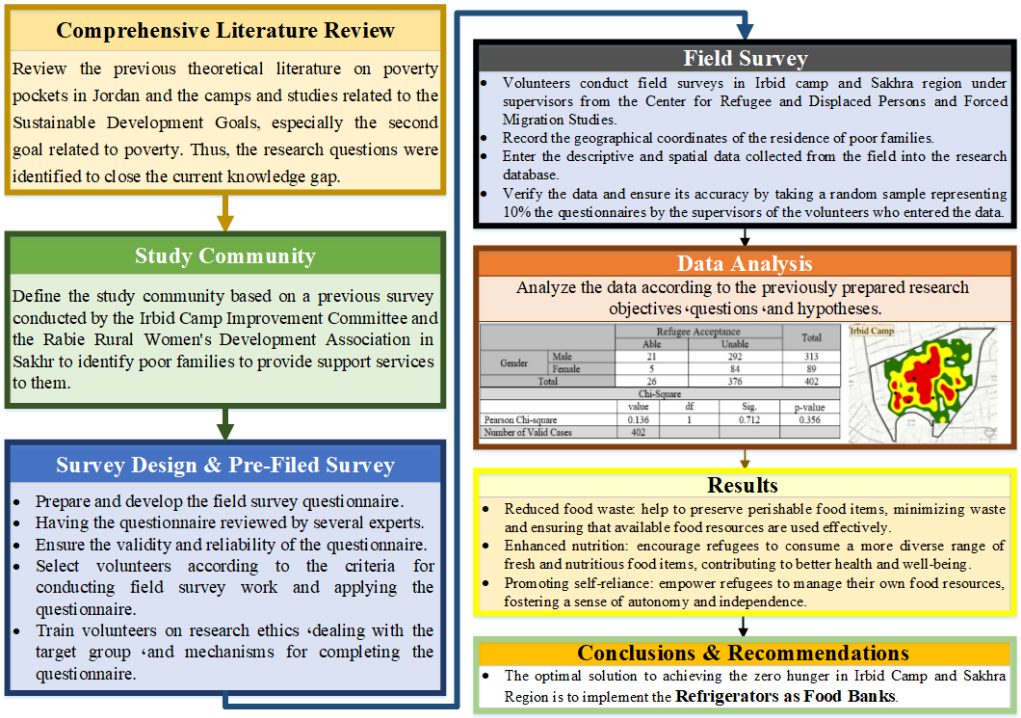
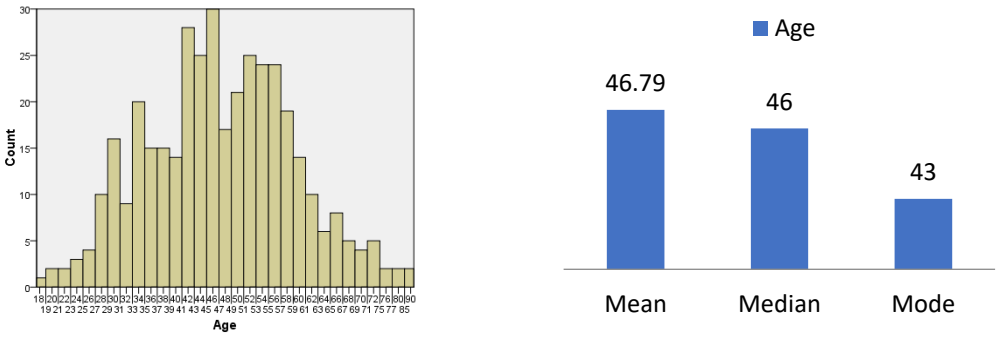


Figure 1. Research Methodology

4. Descriptive Statistics

This section outlines the demographic features of the study participants, including age, gender, the highest level of education, family size, and origin, in addition to their preferences for cultivated roofs (CRs) or refrigerators as food banks (RaFB). Such statistics offer a basis for interpreting the constituents of the targeted population in the study, suggesting perceptions into how these demographic attributes can be connected with their preferences for various interventions to achieve SDG 2 (zero hunger). More integrated, practical, and tailored strategies and interferences can be reached by robustly analyzing these factors. Thus, paving the road towards contemplating the distinctive needs and inclinations of the targeted groups, eventually improving the efficiency and accomplishment of the projected solutions. Figure 2 represents the demographic features of the surveyed sample, while Figure 3 represents the project preference.



(a) (b)

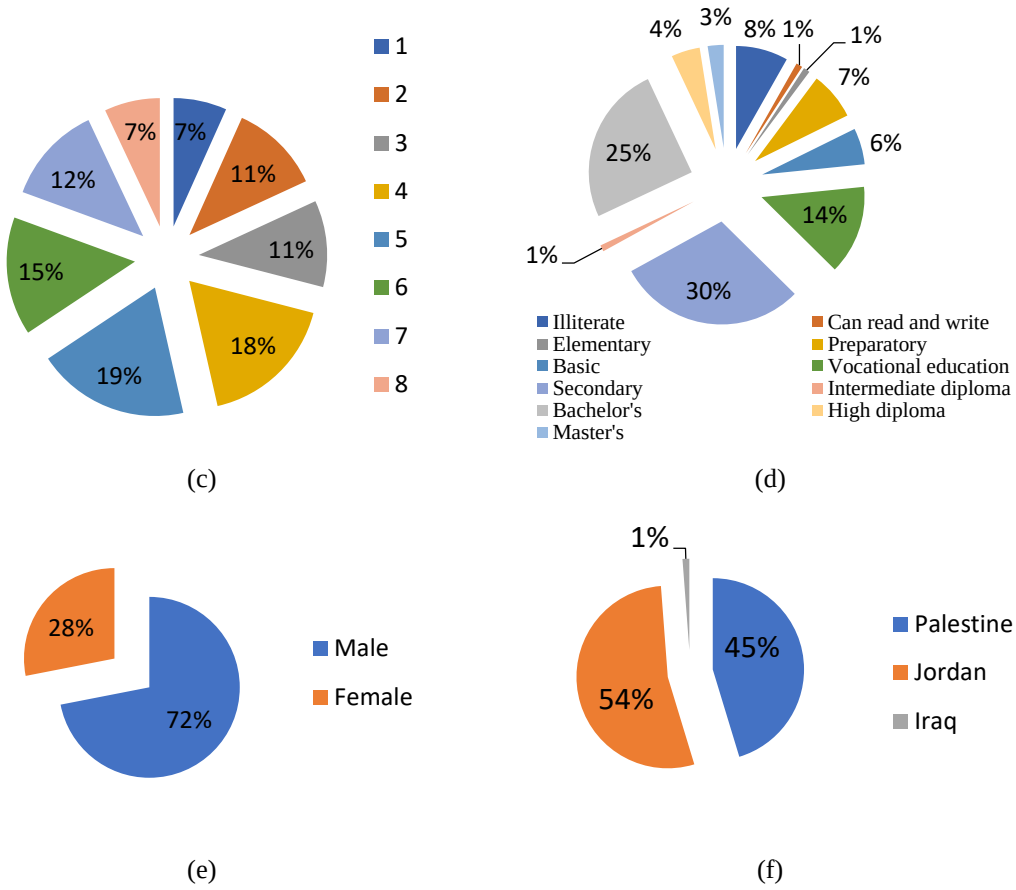


Figure 2. The demographic characteristics. (a) Age histogram. (b) Age mean, median, and mode in years. (c) family size in persons. (d) The highest level of Education. (e) Gender. (f) Origin.

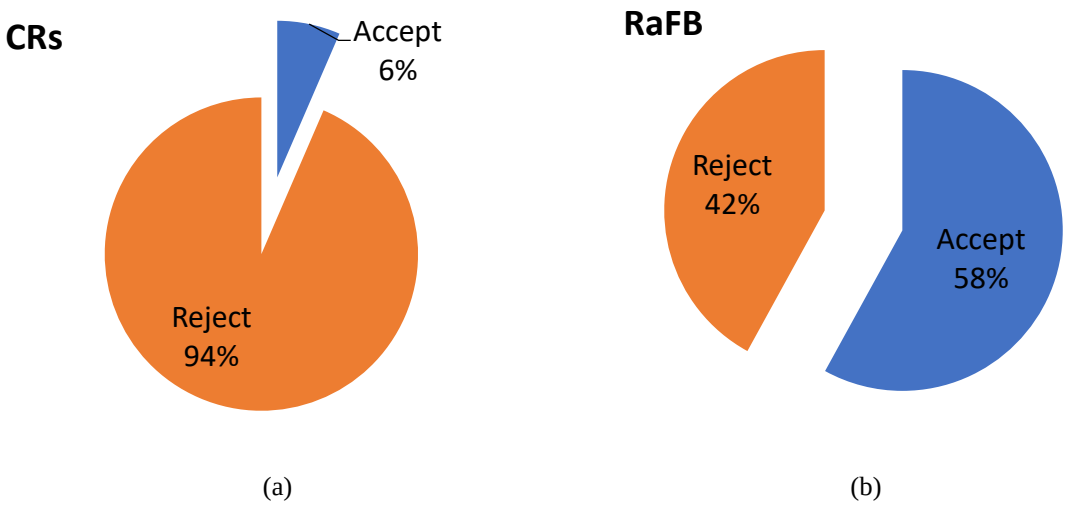


Figure 3. The zero hunger-related project statistics. (a) CRs and (b) $RaFB$.

5. Results and Discussions

The study aimed to determine the overall preference among refugees for cultivated roofs, refrigerators as food banks, or their ideas for achieving zero hunger in the camps and vulnerable areas, specifically in the Irbid Camp and Sakhra region. The results showed that 10% (26) of the refugees preferred cultivated roofs, while a significant major-

ity, 90% (233), preferred refrigerators as food banks, with some refugees suggesting alternative ideas such as opening a grocery store, a sewing lab for teaching and operation, a supermarket project, breeding, and rental of wedding and holiday supplies.

The lower preference for cultivated roofs (10%) can be attributed to various factors, including the unsuitability of camp buildings' roofs for cultivation, restrictions on roof usage in rented houses, lack of available land inside the camp, insufficient knowledge of roof cultivation among refugees, marketing challenges for agricultural products, the expense of materials and equipment required for roof cultivation, and difficulties in storing agricultural products due to rapid deterioration.

On the other hand, most refugees (90%) preferred refrigerators as food banks due to this solution's convenience, low risk, and cost-effectiveness, which does not require specific skills and aligns with the community culture. Additionally, refrigerators have been successfully implemented in other locations worldwide. Key factors contributing to the preference for refrigerators as food banks include convenience and accessibility, food preservation capabilities, security, storage capacity, fostering a sense of independence among refugees, and the potential for sustainability through renewable energy sources such as solar power.

To determine the project preference among refugees, an analysis was conducted to assess the receptiveness of refugees towards the two proposed interventions, with the results presented in Table 1. Based on these findings, it can be concluded that refrigerators as food banks (RaFB) are the predominant preference among refugees for achieving zero hunger in the studied hunger and poverty regions.

Table 1. Distribution of participants' acceptance of proposed interventions.

	Frequency	Percent
Cultivated Roofs (CRs)	26	10%
Refrigerators as Food Banks ($RaFB$)	233	90%
Total	259	100%

It is worth mentioning that there are some ideas from the refugees for achieving zero hunger rather than those proposed ones (e.g., opening a grocery store, a sewing lab for teaching and operation, supermarket project, breeding, and rental of wedding and holiday supplies). Such ideas pave the road towards future research for achieving zero hunger in poverty pockets across Jordan.

The influence of demographic factors, such as age, gender, education level, and family size, on refugee preferences for cultivated roofs, refrigerators as food banks, or their ideas for achieving zero hunger was investigated using various statistical tests. For the age attribute, no significant relationship was found between age and refugee acceptance of the cultivated roofs project nor the acceptance of refrigerators as food banks project. Such conclusions were extracted after testing the hypothesis shown in Table 2 for the CRs and the $RaFB$. In both cases, the $P - value$ was greater than the level of significance $\alpha = 0.05$, indicating the hull hypothesis (H_0) failed to be rejected, and no significant relationship between age and refugee acceptance of the CRs and RaFB projects. Thus, the lack of preference for the CRs and RaFB solutions was unrelated to the age attribute, suggesting that other variables may influence the two preferences.

Table 2. Hypothesis testing results assess the significance of the age attribute concerning the acceptance of the CRs and RaFB solutions.

CRs	
H_0:	No significant relationship exists between age and refugee acceptance of the cultivated roofs project.
H_1:	There is a significant relationship between age and refugee acceptance of the cultivated roofs project.

	Number	Mean of age	Std. deviation	95% Confidence Interval for Mean	Minimum	Maximum
Accept	25	48	11.55	(43.4 - 52.9)	18	72
Reject	357	47	12.04	(45.4 - 47.9)	19	90
CRs						
Sum of Squares	Df.	Mean Square	F	Significant	P-value	
50.5	1	50.5	0.350	0.554	0.277	
RaFB						
H_0:	No significant relationship exists between age and refugee acceptance of refrigerators as food banks project.					
H_1:	There is a significant relationship between age and refugee acceptance of refrigerators as food banks project.					
	Number	Mean of age	Std. deviation	95% Confidence Interval for Mean	Minimum	Maximum
Accept	226	47.7	11.80	(46.1 – 49.2)	18	85
Reject	156	45.5	12.21	(43.5 – 47.4)	19	90
RaFB						
Sum of Squares	Df.	Mean Square	F	Significant	P-value	
453.182	1	453.182	3.164	0.076	0.061	

For the gender and the family size attributes, no significant relationship was found between the gender and refugee acceptance of the cultivated roofs project nor the acceptance of refrigerators as food banks project. Such conclusions were extracted after testing the CRs and the RaFB hypothesis, as shown in Tables 3 and 4. In both cases, the P-value was greater than the level of significance $\alpha = 0.05$, indicating the hull hypothesis (H_0) failed to be rejected, and no significant relationship between gender or family size and refugee acceptance of the CRs and RaFB projects. Thus, the lack of preference for the CRs and RaFB solutions was unrelated to the gender or family size attribute, suggesting that other variables may influence the two preferences.

Table 3. Hypothesis testing results assess the significance of the gender attribute concerning the acceptance of the CRs and RaFB solutions.

CRs					
H_0:	No significant relationship exists between gender and refugee acceptance of the cultivated roofs project.				
H_1:	There is a significant relationship between gender and refugee acceptance of the cultivated roofs project.				
		Refugee Acceptance		Total	
		Accept	Reject		
Gender	Male	21	292	313	
	Female	5	84	89	
Total		26	376	402	
Chi-Square					
	p-value	Sig.	df	value	
Pearson Chi-square	0.356	0.712	1	0.136	
Number of Valid Cases	402				

RaFB					
H_0:	No significant relationship exists between gender and refugee acceptance of refrigerators as food banks project.				
H_1:	There is a significant relationship between gender and refugee acceptance of refrigerators as food banks project.				
		Refugee Acceptance		Total	
		Accept	Reject		
Gender	Male	183	130	313	
	Female	50	39	89	
Total		233	169	402	
Chi-Square					
	p-value	Sig.	df	value	
Pearson Chi-square	0.35	0.700	1	0.149	
Number of Valid Cases	402				

Table 4. Hypothesis testing results assess the significance of the family size attribute concerning the acceptance of the CRs and RaFB solutions.

CRs						
H_0:	No significant relationship exists between family size and refugee acceptance of the cultivated roofs project.					
H_1:	There is a significant relationship between family size and refugee acceptance of the cultivated roofs project.					
	Number	Mean of age	Std. deviation	95% Confidence Interval for Mean	Minimum	Maximum
Accept	26	5.15	2.167	(4.28 – 6.03)	1	8
Reject	376	4.56	1.942	(4.37 – 4.76)	1	8
CRs						
Sum of Squares	Df.	Mean Square	F	Significant	P-value	
8.466	1	8.466	2.211	0.138	0.069	
RaFB						
H_0:	No significant relationship exists between family size and refugee acceptance of refrigerators as food banks project.					
H_1:	There is a significant relationship between family size and refugee acceptance of refrigerators as food banks project.					
	Number	Mean of age	Std. deviation	95% Confidence Interval for Mean	Minimum	Maximum
Accept	233	4.61	1.945	(4.36 – 4.86)	1	8
Reject	169	4.59	1.986	(4.29 – 4.89)	1	8
RaFB						
Sum of Squares	Df.	Mean Square	F	Significant	P-value	
0.031	1	0.031	0.008	0.929	0.4645	

For the level of education attribute, no significant relationship was found between the level of education and refugee acceptance of the cultivated roofs project. Such conclusions were extracted after testing the hypothesis for the CRs, where the P-value was greater than the level of significance $\alpha = 0.05$, indicating the hull hypothesis (H_0) failed

to be rejected, and no significant relationship between the level of education and refugee acceptance of the CRs project. However, a significant relationship was found between the level of education and refugee acceptance of refrigerators as food banks project. Such conclusions were extracted after testing the hypothesis for the RaFB, where the $P-value=0.0395$ was lower than the level of significance $\alpha=0.05$, indicating the hull hypothesis is to be rejected, and there is a significant relationship between the level of education and refugee acceptance of the RaFB project. It was observed that refugees with higher educational levels were more likely to reject the solution to zero hunger by installing refrigerators as food banks. This might explain why the refugees with higher educational levels were more likely to reject the solution to achieving zero hunger by installing refrigerators as food banks. Refugees with higher educational levels may have different cultural beliefs, values, or expectations than those with lower educational levels. They may also have different perceptions of the effectiveness or practicality of the proposed solution. Alternatively, it could be due to socioeconomic status, prior experiences with similar interventions, or access to alternative solutions. Further research would be necessary to understand better the factors influencing the acceptance or rejection of the proposed solution by refugees with varying educational levels. Table 5 represents the hypothesis testing results for the level of education attribute with the two proposed projects.

Table 5. Hypothesis testing results assess the significance of the level of education attribute concerning the acceptance of the CRs and RaFB solutions.

		Refugee Acceptance for the CRs Project			Refugee Acceptance for the RaFB Project		
		Accept	Reject	Total	Accept	Reject	Total
Level of Education	Illiterate	0	33	33	16	17	33
	Can read and write	1	29	30	16	14	30
	Elementary	0	23	23	17	6	23
	Preparatory	5	56	61	38	23	61
	Basic	4	115	119	69	50	119
	Vocational education	0	1	1	0	1	1
	Secondary	13	91	104	56	48	104
	Intermediate diploma	2	16	18	15	3	18
	B.A	1	9	10	6	4	10
	High diploma	0	2	2	0	2	2
	M.A	0	1	1	0	1	1
Total		26	376	402	233	169	402

CRs					
H_0:	No significant relationship exists between the level of education and refugee acceptance of the cultivated roofs project.				
H_1:	There is a significant relationship between the level of education and refugee acceptance of the cultivated roofs project.				
Chi-Square					
	value	df	Sig.	p-value	
Pearson Chi-square	13.94	10	0.176	0.088	
Number of Valid Cases	402				
RaFB					
H_0:	No significant relationship exists between the level of education and refugee acceptance of refrigerators as food banks project.				

H_1:	There is a significant relationship between the level of education and refugee acceptance of refrigerators as food banks project.			
Chi-Square				
	value	df	Sig.	p-value
Pearson Chi-square	15.362	10	0.119	0.0395
Number of Valid Cases	402			

The previously illustrated results shed light on the potential benefits of implementing RaFB project, including (1) reduced food waste, where refrigerators can help to preserve perishable food items, minimizing waste and ensuring that available food resources are used effectively, (2) improved food security by providing a secure location for food storage, refrigerators can reduce the risk of theft or spoilage, enhancing overall food security in the poverty pocket regions, (3) enhanced nutrition, where access to refrigerated storage can encourage refugees to consume a more diverse range of fresh and nutritious food items, contributing to better overall health and well-being, (4) promoting self-reliance, where refrigerators can empower refugees to manage their own food resources, fostering a sense of autonomy and independence, (5) scalability, where efrigerators can be easily scaled up or down depending on the needs of the refugee population, making them a flexible solution to food storage challenges, and (6) achieiving environmental sustainability via the utilization of renewable energy sources like solar power, refrigerators can provide a sustainable and environmentally friendly option for food storage in refugee camps.

Also, the obtained results can be considered a solid foundation for determining the potential challenges of implementing the RaFB project, including (1) limited access to electricity, as many refugee camps face challenges in accessing reliable electricity sources, which could hinder the effective use of refrigerators as food banks, (2) cost and maintenance, as the initial cost of purchasing refrigerators and ongoing maintenance expenses can be significant, potentially limiting the feasibility of implementing this solution in some contexts, (3) cultural acceptance, where the acceptability of using refrigerators as food banks may vary across different cultural contexts, potentially impacting the success of the intervention, (4) logistics and transportation, as the transportation and installation of refrigerators in refugee camps may pose logistical challenges, particularly in remote or difficult-to-reach locations, (5) coordination and management as the effective operation of refrigerators as food banks may require robust coordination and management systems to ensure equitable access to food resources and prevent misuse or abuse of the intervention, and (6) security concerns, as ensuring the security of refrigerators and their contents may require additional resources and planning, particularly in contexts where theft or vandalism is a concern.

The implementation of refrigerators as food banks in refugee camps has the potential to contribute to achieving zero hunger through the preservation and secure storage of food resources. However, careful consideration of the context-specific challenges, including access to electricity, cost, cultural acceptance, and logistical factors, is crucial to ensuring the successful implementation of this intervention. Further research and investigation into the factors influencing refugee preferences and acceptance of different hunger alleviation strategies can provide valuable insights to inform the design and implementation of contextually appropriate and effective interventions.

5.1. Most Accessible Food Bank Location Selection

The implementation of refrigerators as food banks in refugee camps has the potential to contribute to achieving zero hunger through the preservation and secure storage of food resources. However, careful consideration of the context-specific challenges, including access to electricity, cost, cultural acceptance, and logistical factors, is crucial to ensuring the successful implementation of this intervention. Further research and investigation into the factors influencing refugee preferences and acceptance of different hunger alleviation strategies can provide valuable insights to inform the design and implementation of contextually appropriate and effective interventions.

5.1.1. Integrating Geographic Information Systems (GIS) in strategic decision-making processes can immensely augment the effectiveness and efficiency of resource allocation. To combat hunger and improve food accessibility, a deeper understanding of spatial distribution and population densities can be crucial. The following section of our research employs GIS, specifically Kernel Density Estimation (KDE), as an innovative approach to identify optimal locations for placing refrigerators to serve as food banks in both areas under study. KDE is a non-parametric way to estimate the probability density function of a random variable, which, in our context, would translate to an accurate representation of population density and food demand. This method aims to establish an optimal distribution of food banks to maximize reach and minimize food wastage. The subsequent analysis could potentially contribute to more strategic and evidence-based planning, and most importantly, it could bring us a step closer to ensuring food security for all.

5.1.2. Irbid Camp and Sakhrah Region Overview

The Irbid refugee camp and Sakhra sub-district are two locations in northern Jordan considered for our research. The former, Irbid refugee camp traces its roots back to 1951 when it was established to accommodate Palestinian refugees uprooted by the 1948 War. Situated near Irbid, the camp originally covered an area of 0.24 square kilometres and sheltered about 4,000 refugees. According to the Department of Palestinian Affairs' 2021 data, the camp now spans 244 dunums and provides shelter to 29,894 refugees (UNRWA, 2013).

On the other hand, the Sakhra region is part of the Al-Junaid municipality within the Ajloun Governorate. The sub-district encompasses several villages, including Sakhrah, Ibbin, Ibilin, Samta, Munif, Deir al-Barak, and Khirbet Fara. Covering a geographical expanse of 57.9 square kilometers, Sakhra is home to an estimated 39,480 residents (Department of Statistics & Ministry of Interior 2020).

5.1.3. Applying Kernel Density

With the GPS coordinates of the families mapped on ArcGIS, we utilized kernel density analysis to determine feature density near these coordinates. Kernel density analysis, applicable to point and line features, allowed us to identify regions with high family concentration and select optimal locations for establishing food banks, considering factors such as distance and accessibility. After applying the kernel density analysis, we segmented the results into three density-based categories: high, medium, and low. It was observed that mosques make for optimal food bank locations considering their accessibility and proximity to families. Since mosques remain open throughout the day and the distance between families and these mosques is less than 200 meters in the Irbid camp and less than 1 kilometer in the Sakhrah region, they serve as ideal locations for the food banks. Figure 4 demonstrates the application of Geographic Information Systems (GIS) in determining the optimal locations for the establishment of food banks, using a method known as Kernel Density Estimation, which helps visualize the concentration of families in the Irbid camp and Sakhrah region and aids in strategic planning for food bank placement.

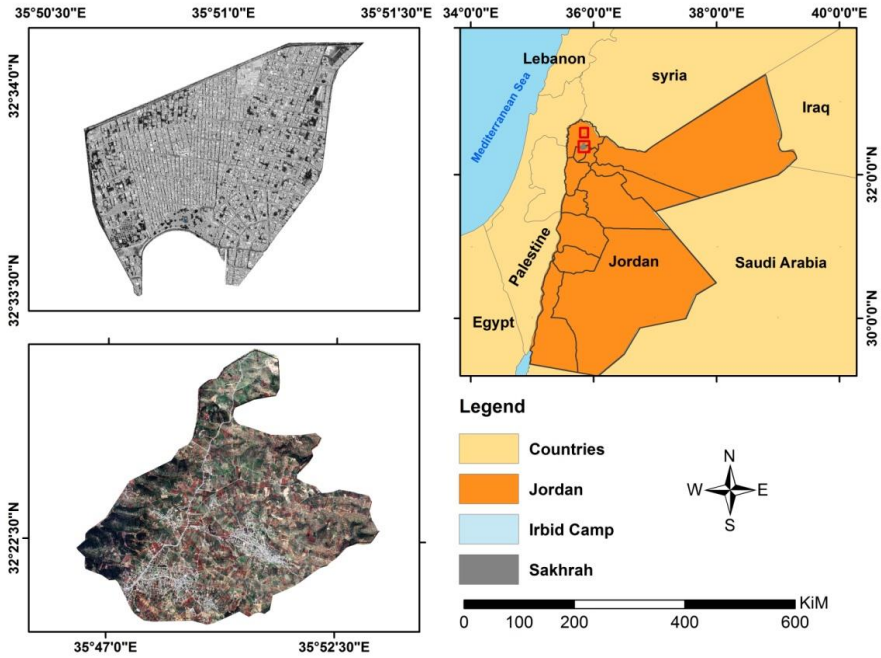


Figure 4. Utilizing Geographic Information Systems (GIS) for Optimal Location Identification of Food Banks via Kernel Density Estimation.

The most accessible location for the food bank within these areas is determined by applying the Central Feature selection method. This method involves calculating and aggregating the distances from the centroid of each feature to the centroid of all other features within the dataset. After considering weights, if specified, the feature with the shortest cumulative distance to all other features gets highlighted and transferred into a newly constructed output feature class. As shown in Figure 5, given their several logistical benefits, the suggestion has also been advanced to establish food banks at local mosques. The presence of electricity, a caretaker, and the regular opening five times a day, contribute to the mosques' suitability as accessible and operationally viable locations for the food banks.

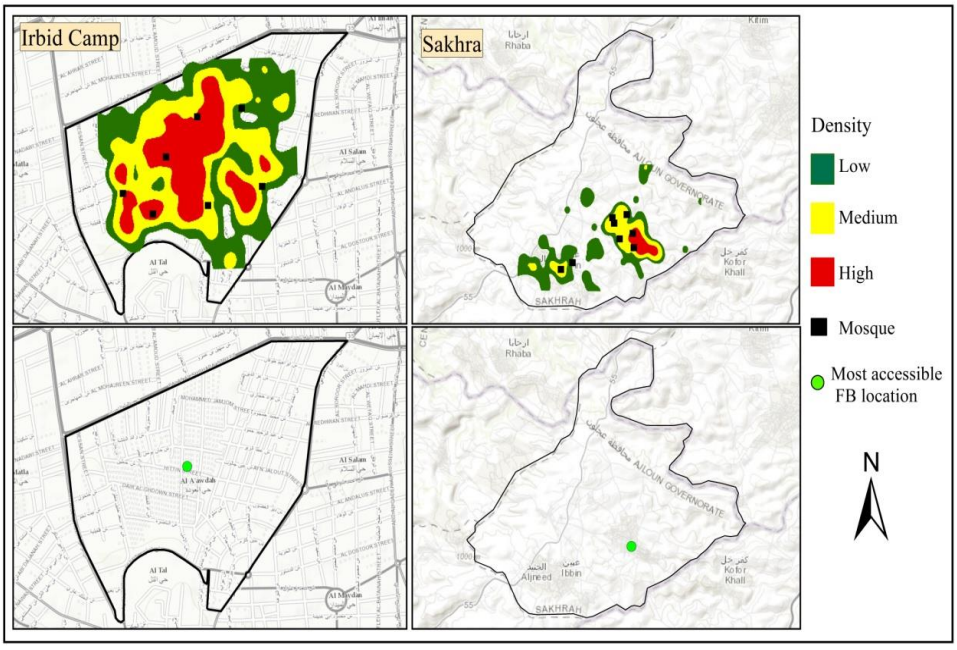


Figure 5. Utilizing Geographic Information Systems (GIS) for Optimal Location Identification of Food Banks via Kernel Density Estimation.

Cultivated Roofs and Refrigerators as Food Banks interventions. For instance, the main advantages and barriers facing the deployment of the projected interventions were highlighted. The CRs project benefits involve enhanced food production, reinforced nutrition systems, and augmented refugee self-reliance. Nevertheless, challenges with such intervention include the relatively high initial investment essential for substructure progress, enduring preservation expenses, roof stability, lack of freedom to use rented house roofs, insufficient knowledge in roof cultivation, and the high cost of materials and equipment, and the necessity of guidance and capacity building amongst refugees to guarantee efficacious execution. In comparison, the RaFB intervention offers the vantage of granting an immediate solution for food storage and preservation, decreasing food surplus, and staging food sharing amongst community members. Yet, possible encounters embrace acquiring a consistent energy source, confirming identifiable repairs and hygiene, and addressing prospective concerns associated with food safety and equitable access.

The current study's findings suggest that both CRs and RaFB have the potential to contextually appropriate and sustainable food security interventions in refugee camps. However, the demographic influences on project preferences highlight the importance of considering target populations' unique needs and characteristics when designing practical solutions for zero hunger within the pockets of poverty and implementing contextually appropriate and effective interventions and revealed that the RaFB is the most applicable and efficient solution vital for achieving zero hunger in the targeted communities.

6. Theoretical and Practical Implications

The current research has various theoretical and practical implications that can positively influence the robustness of the strategic planning for achieving zero hunger in the poverty pockets across Jordan. The theoretical implications include recognizing preferences, as the current study findings contribute to the current body of knowledge by judging the preferences of refugees in reaching zero hunger in camps and vulnerable areas. Thus, the conclusions can be employed to stem steered involvements that accommodate the refugee population's particular needs and preferences. Also, the research results are vital for highlighting the association between demographic factors such as age, gender, education level, and family size and the preferences of refugees for different approaches to achieving zero hunger. Such information can help policymakers and practitioners better understand the factors influencing refugees' preferences and develop tailored interventions. Moreover, the research results highlight the significance of involving refugees in decision-making and considering their preferences when designing interventions. Such an approach can empower refugees and foster a sense of ownership and responsibility in achieving zero hunger in their communities.

Furthermore, the current research has various implications that can be utilized to practically deploy the necessary intervention within vulnerable regions, including guiding policymakers, aid organizations, and other stakeholders in allocating resources more effectively. By prioritizing interventions that most refugees prefer (i.e., RaFB), they can ensure that the interventions are more likely to be successful and well-received by the target population. Also, the study highlights the importance of tailoring interventions to the specific needs and preferences of refugees, considering their demographic profile. Customized interventions are more likely to be successful and sustainable as they cater to the unique needs of the target population. Additionally, by identifying the challenges associated with implementing specific interventions (such as cultivated roofs), this study can help stakeholders better anticipate and address potential obstacles. This can lead to more effective and efficient implementation of interventions, maximizing their impact in achieving zero hunger.

Moreover, the study's findings can be used to inform capacity-building efforts among refugees. For example, by identifying the lack of knowledge in roof cultivation as one of the reasons for low preference for cultivated roofs, organizations can develop targeted

training programs to address this knowledge gap and build the skills necessary to implement this intervention. Furthermore, the study encourages innovation in addressing the issue of zero hunger in refugee camps and vulnerable areas. By exploring the preferences of refugees and their ideas for achieving zero hunger, the study can inspire the development of novel approaches and interventions that consider the unique needs and preferences of the refugee population.

7. Conclusions

The current study is designed to investigate the preferences of refugees in deploying viable interventions to achieve zero hunger in poverty pockets and vulnerable areas across Jordan. The research adopted an assorted-approaches method, blending quantitative surveys and GIS technologies, to generate in-depth statistics regarding the preferences of refugees and the demographic factors that affect these preferences. The study's outcomes stressed that refugees intensely preferred RaFB against the CRs intervention. The current research also sheds light on the function of demographic factors (e.g., age, gender, education level, and family size) in forming these preferences. The results also highlighted the potential advantages and challenges of applying each proposed intervention.

The current study's theoretical implications subsidize an enhanced comprehension of refugees' preferences in achieving zero hunger within their communities. Also, the role of demographic factors in shaping these preferences was illustrated in addition to the significance of involving refugees in the decision-making procedure. The current research's practical implications are critical to managing food allocation, informing the design of adapted involvements, highlighting the potential advantages and implementation challenges, supporting capacity-building strategies, and inspiring novelty in achieving zero hunger in the pockets of poverty and vulnerable areas in Jordan.

The current research underlines the necessity of prioritizing the voices and preferences of the targeted groups when planning, originating, and executing sustainable interventions to achieve zero hunger. By promoting a sagacity of proprietorship and accountability amongst refugees and tackling this populace's unique challenges, legislators, support groups, and other stakeholders can work together to advance more operative, practical, and sustainable interventions to alleviate hunger and guarantee food security for refugees and their communities.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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