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Investigating the effects of microcredit on the food security of rural households: Evidence from Zehak County, Iran

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Abstract

Microcredit plays a vital role in rural households' food security. However, to the best of our knowledge, the effects of microcredit on improving the food security of households have not yet been well studied and understood in Iran. Thus, the purposes of this is to analyze the success of microcredit programs on enhancing the food security of rural households in Zehak county using the propensity score matching method and bootstrap algorithm. For this purpose, two food security indices, including the Food Consumption Score (FCS) and the Household Food Insecurity Access Scale (HFIAS) are used. The results revealed that 100% of the households face food insecurity. The prevalence of food insecurity was 20.0%, 42.5%, and 37.5% for mild, moderate, and severe food insecurity, respectively. In addition, 30% of households are in poor status of food consumption. Our findings emphasize the positive and significant role of microcredit in improving food security. The findings demonstrated that microcredit decreased the HFIAS index of the recipient households by 24.31-27.81% and increased the FCS index by 25.87-31.45%. Therefore, policy-makers and decision-makers should promote and strengthen governmental and non-governmental organizations providing microcredit. It is also recommended to provide information and reduce collateral restrictions to increase households' access to microcredit.

Keywords: Propensity score matching, Bootstrap algorithm, Food security, Microcredit

1. Introduction

Since food security is important for human well-being, its realization is one of the most important goals of development plans at the national and international levels (World Bank, 2008; Dehbidi et al., 2022; Bahiru et al., 2023). Food security means that all people can obtain sufficient, safe, and nutritious food materially and economically at any time to meet their dietary needs and food preferences and live an active and healthy life. Therefore, food availability, food accessibility, food utilization, and stability over time are four important components to food security (Dehbidi et al., 2022).

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Food insecurity is one of the major global problems in the last two decades, especially developing countries. Food security is affected by climate change and extremes (Schillerberg and Tian, 2023; Kandel et al., 2024), resource consumption (Chowdhury et al., 2017; Liu et al., 2020), land degradation (Gomiero, 2016), population growth (Liu et al., 2020), and urbanization (Boltana et al., 2023). Among them, climate change seems to have a significant impact on activities related to food security in agriculture-dependent countries. The agricultural sector plays a vital role in food supply, i.e., food production, strongly influenced by climate variability (Ghalibaf et al., 2023). For this reason, the destructive effects of climate change are greater for the rural community and lead to an increase in food insecurity. In the long term, the adverse effects of climate change and other factors will pose major challenges to the nutrition and food security of rural communities (Ehtesham Majd et al., 2019; Salman et al., 2023).

Therefore, ensuring food security, especially in vulnerable rural areas, requires changing systems through government institutions, regional development institutions, and non-governmental organizations (Boltana et al., 2023). In this regard, microcredit is one of the key measures proposed to reduce food insecurity (Salima et al., 2023).

Microcredit is a form of microloans that are granted to poor rural households who usually lack collateral, verifiable credit history, and steady employment. In addition, they are micro-loans specifically intended for the creation and development of income-generating rural businesses. Microcredit has a high potential to enhance food security, improve living standards, and reduce poverty by supporting entrepreneurship and creating income-generating activities (Bakare et al., 2023).

In Iran, a new approach to microfinance was developed by the United Nations International Fund for Agricultural Development to provide access to formal and informal loans for the poor and low-income rural groups to create and develop rural businesses, empower them to cope with many shocks, improve livelihoods and food security, reduce vulnerability, and break out of the cycle of poverty. These programs have great potential to improve household food security by diversifying rural income-generating activities (Akbari and Danaie, 2018).

As a developing country, Iran faces the challenge of food insecurity, particularly in rural areas. Based on FAO, IFAD, UNICEF, WFP, and WHO (2022), 42.4% of Iran's population is affected by moderate or severe food insecurity. For this reason, ensuring food security has become one of the most important goals of Iran's national development plans in the last two decades. In this regard, various measures have been taken to improve rural households' food security, of which microcredit is one of the most important.

However, few studies investigated the effects of microcredit on household food security. These studies are divided into three groups. First, most of the studies revealed that microcredit increases the per capita consumption of calories, increases the number of meals and increases the access to food, which results in improving the food security of households (Islam et al., 2016; Devereux, 2016; Berhanu et al., 2021; Boltana et al., 2023), particularly female-headed households (Hamad and Fernald, 2012; Bocher et al., 2017; Haque, 2021; Kianersi et al., 2021; Wongnaa et al., 2023). Second, a small number of studies did not find a significant effect of the role of microcredit on improving households' food security, and they stated that receiving credit was not successful in improving households' food security (Banerjee et al., 2016; Seng, 2018; Mahmud et al., 2022; Salima et al., 2023). Third, a limited number of studies showed that excessive debt, loan repayment pressure, women's lack of control over the use of loans, and frequent loans with high-interest rates lead to food insecurity in households, especially with female heads (Ahmed et al., 2001; Develtere and Huybrechts, 2005; Aromolaran, 2010; Ganle et al., 2015; Namayengo et al., 2018).

In general, this study can contribute to the literature on the effects of microfinance programs on improving household food security in three ways. First, this study investigates the effects of implementing an effective economic program (such as microcredit) on reducing household vulnerability to food insecurity. Considering household food security is subject to change, it is necessary to examine the effects of food security improvement programs such as microcredit to predict future shocks and understand how households respond to food insecurity. Second, this study can help to understand why microcredit has positive and negative effects in different situations or times by generating empirical evidence and documenting the evaluation of its effects. Third, given that studies show that there is no consensus or global pattern on the effects of microcredit and that it can be beneficial or harmful, local policy-makers and decision-makers must see evidence of the effects of its implementation in a specific region. In this regard, this study can help local policy-makers gain a clearer picture and better understanding of the effects of implementing microcredit programs on improving the food security of rural households and take them into account when defining and changing their policies and programs.

Therefore, this study seeks to answer three key questions. First, what is the food security situation of the target rural households? Second, what factors influence the access of target households to microcredit? Third, has the microcredit program improved the food security of the target households?

2. Materials and methods

2.1. Study area and data

Zehak County is a poor county, which is located in the north of Sistan and Baluchestan Province and consists of two districts: Central and Jazinak, and four rural districts: Zehak, Khajeh-Ahmad, Jazinak, and Khamak (Figure 1). There are 20,055 households in this county, of which 16,817 are rural (Statistical Center of Iran, 2016). Rural households in Zehak face problems such as lack of financial resources, poverty, high vulnerability, and food insecurity. In addition, this county suffers from climatic events such as drought, excessive heat, low rainfall, and 120-day winds. Considering the high poverty and deprivation in this county, climate disasters have increased the vulnerability and food insecurity of households, particularly rural ones. The food security situation of rural households in this county indicates that a high proportion of households are in a state of food insecurity and use the most difficult strategies to cope with this situation (Okati et al., 2020). According to the document on economic development and employment generation in rural areas of Sistan and Baluchestan Province, one of the effective measures to reduce household vulnerability, create employment, improve food security, and diversify economic and production activities is to support the establishment and development of microfinance funds to increase rural households' access to microcredit (Ebrahimzadeh and Paidar, 2019). This county's most important organizations providing microfinance services include the Agricultural Bank, the Welfare Organization and, the Kara System (governmental organizations), the Barkat Foundation, and the Alavi Foundation (non-governmental organizations). The total microcredit payments to rural households from 1397 to 1400 was about 1459 billion rials, of which about 3 percent was paid by government organizations and 97 percent by non-governmental organizations. Therefore, conducting this study in the rural of Zehak County can be a suitable platform for evaluating the performance of microcredit programs on rural households' food security for appropriate and well-functioning local policymaking and planning.

To obtain the needed data the Stratified Random Sampling was applied. According to Cochran's formula, the sample size was estimated to be 376 rural households. A multidimensional questionnaire and semi-structured interview were used to obtain the necessary data to calculate food security indicators, socio-economic, and demographic characteristics, farm and livestock characteristics, and experiences of shocks.

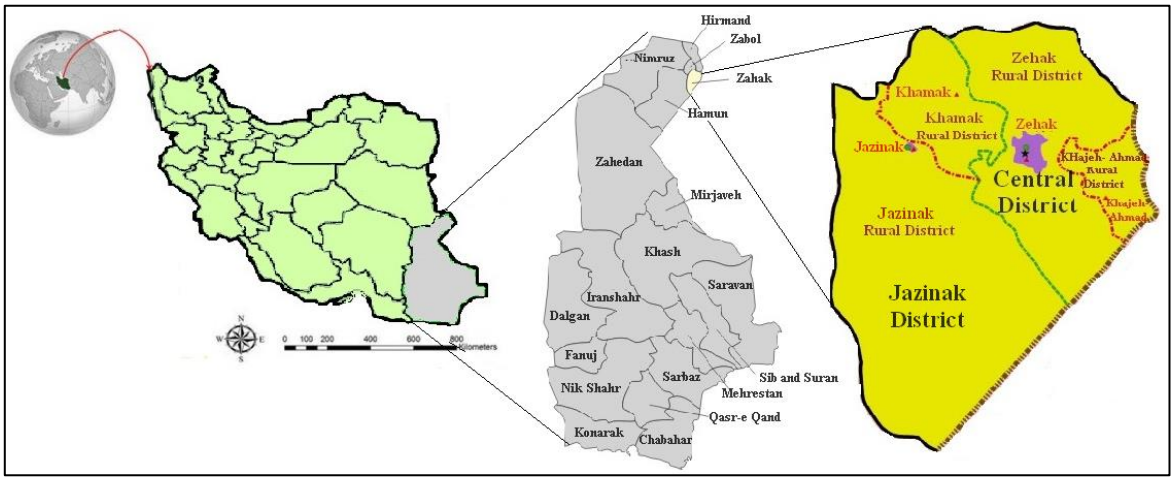

Fig. 1. Geographical location of the study area.

2.2. Food security index

Two food security indices, including the Household Food Insecurity Access Scale (HFIAS) and the Food Consumption Score (FCS), are used to understand households' food security status in this study. The HFIAS index was developed by the Food and Nutrition Technical Assistance II (FANTA) project between 2001 and 2006 (Coates et al., 2007; Salman et al., 2023). This index is measured based on a short questionnaire that determines the behavioral and psychological characteristics of households from access to food insecurity in 30 days (Kolog et al., 2023). The questionnaire consists of two types of questions: there are nine "occurrence" questions and nine "frequency of occurrence". The respondent is first asked whether he or she has experienced a certain situation (0= no, 1= yes) and if so, how often it has been experienced (1= rarely, 2= sometimes, 3= often). To calculate the HFIAS index, each of the nine questions ($Q_i a$) is given a score between 0 and 3, and finally the scores of all questions are summed together using equation (1). The calculated HFIAS score for each household ranges from 0 to 27, which indicates the degree of food insecurity experienced by households (Coates et al., 2007).

$$HFIAS score = \sum Q_i a, \qquad i = 1,2,\ldots 9 \tag{1}$$

The HFIAS questionnaire provides information on the Domains and Prevalence of household food insecurity (Table A1).

The FCS index was developed by the World Food Programme (WFP) in 1996. This index measures diet quality and food intake (Baumann et al., 2013). The respondent reports the frequency of household consumption of 8 different food groups (X_i) (i.e., staple foods with a weight of 2, meat and fish with a weight of 4, fruit with a weight of 1, vegetables with a weight of 1, dairy products with a weight of 4, pulses with a weight of 3, oil with a weight of 0.5, and sugar with a weight of 0.5) during a 7-day reference period. The frequency of consumption of

each food group is multiplied by an assigned weight (α_i) for each group and the resulting scores are summed to calculate the FCS using equation (2) (Jones et al., 2013):

$$FCS = \sum \alpha_i X_i , \quad i = (1,2,...,8) \tag{2}$$

The households are classified into three groups of food consumption: poor, borderline, and acceptable. The maximum score for a household is 112. This score can only be reached if a household consumes food from each food group every day (Baumann et al., 2013).

2.3. Propensity Score Matching

This study used the propensity score matching algorithms to investigate the effect of microcredit on food security indices. This method is included in the group of methods for assessing the impact of an action or policy on two groups, affected and unaffected. In other words, PSM is an intuitive approach to estimating the effects of implementing an action or policy, which broadly evaluates its success. This method has attracted the attention of researchers to evaluate the effect of development programs such as microcredit on households' food security and living standards (Berhanu et al., 2021; Mahmud et al., 2022; Boltana et al., 2023; Wongnaa et al., 2023).

The PSM method is one of the methods that can eliminate the problem of selection bias due to observed factors in the framework of observational data without functional and distributional assumptions (Gitonga et al., 2013). This method is based on the assumption that selection bias due to observed factors can be eliminated by matching each recipient household with one or more non-recipient households that are similar in observable characteristics. The PSM method identifies a causal relationship between microcredit receipt and outcome variables by comparing the means between recipient households (treatment group) and non-recipient households (control group) based on the Wilcoxon rank test (Gitonga et al., 2013; Luan and Bauer, 2016). This method does not require time series data to evaluate the success of a policy or action and can be estimated only with data from a single point in time (Sani Heidary et al., 2020). One of the important limitations of PSM is that it cannot exploit selection bias caused by unobserved factors (latent bias). In this regard, in the PSM method, the degree of sensitivity of the results to latent bias should be determined using the sensitivity analysis proposed by Rosenbaum (2002).

The matching method was conducted through two main stages to investigate the effect of microcredit on food security. The first stage is to determine the factors influencing the household decision to use microcredit using the logit model. This model is usually preferred

over the probit model for reasons such as a) simple interpretability of estimated coefficients; b) greater flexibility in fitting data; c) being resistant to outliers and providing more stable results (Greene, 2012).

A household may apply for microcredit based on its expected costs and benefits (Luan and Bauer, 2016; Boltana et al., 2023). The logit model can be written as follows:

$$AMC_i^* = \beta X_i + \varepsilon_i, \qquad \forall\, i = 1, 2, \ldots, N \tag{3}$$

where, AMC_i^* is the microcredit status of the household. AMCi equals one if the household took at least one microcredit in the previous 36 months and otherwise zero. X_i is a set of independent variables. ε_i is an error term following the normal distribution, and N is the number of households.

In the second step, recipients and non-recipients of microcredit were matched by their propensity scores using three matching estimators, including nearest neighbor, kernel, and radius matching. In the nearest neighbor method, each household in the control group is matched to the nearest household in the treatment group. C(Pi) represents the set of households in the control group matched to households in the treatment group, which have propensity scores Pj and Pi, respectively. Therefore, the nearest neighbor matching algorithm is defined as follows (Becker and Ichino, 2002):

$$C(P_i) = \min_j \left\| P_i - P_j \right\| \tag{4}$$

In the radius method, households in the control and treatment groups are matched within a certain distance of the propensity score of the treatment group household, Pi. Therefore, matching based on the radius method is defined as follows (Becker and Ichino, 2002):

$$C(P_i) = \left\{ p_j \,\middle|\, \left\| p_i - p_j \right\| < r \right\} \tag{5}$$

In equation (5), all propensity scores of control group households are matched with unit i of the treatment group household at a distance r from pi.

In core matching, each treatment group household is matched with a weighted average of each control group household that has a similar propensity score; but more weight is given to households with a closer propensity score. Assuming that T and C are the sets of treatment and control group households, respectively, and YiT and YjC are the observed outcomes for their groups, core matching algorithms are defined in standard terms as follows (Becker and Ichino, 2002):

$$T^K = \frac{\sum_{j \in C} Y_j^C G\left(\frac{p_j - p_i}{h_n}\right)}{\sum_{k \in C} G\left(\frac{p_k - p_i}{h_n}\right)} \quad (6)$$

The effect of microcredit on food security indices is estimated by the Average Treatment Effects on the Treated (ATT), which is expressed as follows (Luan and Bauer, 2016; Boltana et al., 2023):

$$ATT = E(Y^1|D = 1) - E(Y^0|D = 1) \quad (7)$$

where, E (Y1 | D=1) and E (Y0 | D=1) denote outcomes for microcredit accessed households and the hypothetical outcome that would have resulted if the accessed household had not taken microcredit, respectively.

The degree of sensitivity of the results to the bias caused by unobserved factors was investigated using the sensitivity analysis (Boltana et al., 2023).

This analysis can determine to what extent the existence of latent bias in the study will have no effect on the results (Rosenbaum, 2002). The odds ratio of two identical households i and j to receive the credit is defined as equation 8 (Guo and Fraser, 2014):

$$\frac{1}{\Gamma} \leq \frac{P_i(1-P_j)}{P_j(1-P_i)} \leq \Gamma \quad (8)$$

where, Pi/(1- Pi) and Pj/(1- Pj) represent the odds of households i and j receiving the credit, Γ denots the degree of a study's bias to latent bias. Sensitivity analysis at different values of Γ examines how changes in Γ lead to changes in the outcome of the participation effect in microcredit. A study is sensitive if values of Γ close to 1 can lead to very different inferences from the obtained results (i.e., the probability level at Γ=1 is significant). If larger values of Γ are required to change the inference, the study is insensitive (Guo and Fraser, 2014).

Additionally, the bootstrap algorithm was also used to improve the standard error of the PSM method (Austin and Small, 2014).

3. Results and Discussion

3.1. Descriptive statistics

Table (1) provides the descriptive statistics of variables for microcredit recipients and non-recipients. Of the 376 households' heads, 177 (47%) were microcredit recipients and 199 (53%) were non-recipients. Compared to non-recipient households, microcredit recipients are younger, more educated, have more people who can help them in times of crisis, have larger families, have lower dependency ratios, have more social interactions (in terms of membership

in social groups and the number of visits to agricultural extension services), have a higher level of awareness and access to information about strategies for adapting to climate change, have greater access to local markets, and have lower savings. Recipient households have larger agricultural land compared to non-recipients. They have experienced more shocks and have consequently been more exposed to various shocks; therefore, they have suffered greater losses in agricultural and livestock products. These households are located at a shorter distance from microcredit disbursing institutions.

Table 1. Descriptive statistics of variables, measurements, and expected signs.

Variables	Measurement	Non-recipient	Recipient	Expected sign
Age of household heads	Years	63.784	53.243	+/-
Membership of the head of the household in social groups	Number	1.829	2.960	+
Education of household heads	Years	4.864	6.740	+
Household size	Persons	4.719	6.198	+
The number of people known who could be asked for help	Persons	13.890	19.158	+
The contacts with agricultural extension	Number	4.055	7.881	+
Saving	Million Rials(IRR)	18.658	13.073	-
Dependency ratio: The ratio of household members without income to household income earners	(%)	0.423	0.278	-
Total land size	Hectare	3.262	6.090	+
Experience of various natural shocks in the last three years	Number	10.302	11.616	+
Cropsshock: The value of losses of agricultural products due to various shocks	Million Rials	98.719	118.446	+
Animalshock: Livestock lost due to various shocks	Number	4.025	6.616	+
Awareness of adaptation strategies	Quality: score from 1 to 3	1.714	2.678	+
Access to information on climate change	1=Yes; 0=No	0.428	0.718	+
Distance to the lending institution	Minutes	32.281	20.232	-
Access to the local market	1=Yes; 0=No	0.745	0.802	+
Number of observations	-	199	177	

3.2. Households' food security status

Table 2 provides the results of the HFIAS and FCS indices. Our findings show that 100% of the households experienced anxiety and uncertainty related to food insecurity. Also, approximately 94.7% of the households experienced insufficient and poor quality food, and about 80.0% suffered from insufficient food intake and its physical consequences. In addition, the results reveal that 100% of the households are food insecure, which 37.5% of them are in severe food insecure. The results of the FCS index indicate that 44.1% and 30.1% of the total households are at borderline and poor food consumption levels, respectively. Table 3 presents the regional analysis of food security. The results show that food insecurity is more in the central district than Jazinak district. Among the rural districts, food insecurity is more severe in Zehak Rural District.

Table 2. Summary information on household food insecurity access (a) domains, (b) prevalence, and FCS.

Index	Categories	Frequency	Percentage
HFIAD	Insufficient food intake and physical consequences	301	80
	Insufficient Quality	356	94.7
	Anxiety and uncertainty	376	100
HFIAP	severely food insecure	141	37.5
	moderately food insecure	160	42.5
	mildly food insecure	75	20
	food secure	0	0.0
FCS	Acceptable	97	26.8
	Borderline	166	44.1
	Poor	113	30.1

Source: research findings

Table 3. Summary of estimated values for HFIAS and FCS indices.

Region	Villages (Number)	Households (Number)	HFIAS	FCS
Central District	**28**	**278**	**17.10**	**24.00**
Zehak Rural District	20	212	17.80	23.00
Khajeh-Ahmad Rural District	8	66	16.30	25.00
Jazinak District	**16**	**98**	**13.75**	**27.75**
Khamak Rural District	9	53	13.30	28.50
Jazinak Rural District	7	45	14.20	27.00
Average scores of total observations	44	376	15.85	25.36
minimum scores of total observations	44	376	5.00	17.00
maximum scores of total observations	44	376	23.00	75.50

Source: research findings

3.3. Propensity score matching

Table 4 provides the logit model results. The findings reveal that a one percent increase in the age of the head of the household decreases the probability of access to microcredit by 6.1%. (Luan and Bauer, 2016; Sani Heidary et al., 2020), which showed that Older household heads have less access to innovations and financial information. However, this finding contradicts the results by Akotey & Adjasi (2016) for Ghana. A one percent increase in household savings leads to decrease the probability of access to microcredit by 8.5%. Similarly, the studies by Luan and Bauer (2016) in Vietnam and Sani Heidary et al. (2020) in Iran revealed that household savings are used to invest in future productions and meet essential needs. A one percent increase in the dependency ratio of households reduces the probability of their access to microcredit by 0.330%. Households with more dependents are generally exposed to more credit constraints. These findings is consistent to the results of Thanh et al. (2019) and inconsistent with the results of Li et al. (2011). The probability of receiving microcredit by households with high awareness of climate change adaptation strategies is 12.9% more than households with low awareness. This result is consistent the findings of with previous research (Luan and Bauer, 2016; Ojo et al., 2019), which indicated that microcredit is a critical tool for

improving adaptation strategies. However, our findings do not confirm the obtained results by Bakare et al. (2023).

A one percent increase in the household head's education increases the probability of access to microcredit by 1.4%. Similarly, the studies by Thanh et al. (2019) and Berhanu et al. (2021) revealed that educated household heads are more willing to receive microcredit to reduce the financial imbalance. The results reveal that a one percent increase in households' contacts with agricultural extension institutions increases the probability of microcredit access by 2.1%. In addition, a one percent increase in the number of helpers increases the probability of access of microcredit by 9.5%. These findings are similar to previous research (Luan and Bauer, 2016; Sani Heidary et al., 2020; Berhanu et al., 2021), which indicated that increasing the social connections of households through their connections with institutions leads to an increase in their information about important rural issues, particularly financial resources, and influences their demand for access to credit. Additionally, increasing the number of people who can help households in critical situations such as loan repayment leads to an increase in their demand for credit and can even be considered as social guarantors of households for credit-paying institutions. The results of these two variables emphasize the effective social communications and interactions of households, which facilitate their access to necessary resources, particularly credit.

A one percent increase in household size increases the probability of access to microcredit by 4.5%. The studies by Akotey and Adjasi (2016) in Ghana and Berhanu et al. (2021) in Ethiopia revealed that larger households have sufficient labor force to participate in rural micro-businesses, which increases the need for household credit to establish businesses. In addition, larger households have greater food needs for sustainable consumption and, therefore, require more financial resources for sustainable household food consumption, which microcredit can meet.

A one percent increase in household farm size increases the probability of access to microcredit by 5.1%. This result is consistent with previous studies (Luan and Bauer, 2016; Sani Heidary et al., 2020) which demonstrated that access to larger agricultural land increases the use of key inputs, which consequently increasing the need for capital and credit. A one percent increase of losses in the production of agricultural products and loss in livestock populations, the probability of households' access to microcredit increases by 1.3% and 2.3%, respectively. The greater the losses caused by various shocks, the more households use microcredit as an immediate tool to increase coping ability (Luan and Bauer, 2016; Berhanu et al., 2021).

316 **Table 4.** The results of logit model.

Variable		Coefficients (std. err)	Z-value	Marginal Effect
Age of household heads		-0.244	-2.07**	-0.061**
		(0.118)		
Saving		-0.339	-1.93**	-0.085**
		(0.176)		
Distance to the lending institution		-0.636	-0.82	-0.158
		(0.772)		
Dependency ratio		-1.326	-1.91**	-0.330**
		(0.695)		
Awareness of adaptation strategies	Medium	-0.196	-0.81	-0.049
		(0.244)		
	High	0.521	2.16**	0.129**
		(0.241)		
Education of household heads		0.055	2.15**	0.014**
		(0.026)		
The contacts with agricultural extension		0.084	2.03**	0.021**
		(0.041)		
The number of people known who could be asked for help		0.384	2.53**	0.095**
		(0.151)		
Household size		0.182	2.14**	0.045**
		(0.085)		
Total land size		0.205	3.59***	0.051***
		(0.057)		
Cropsshock		0.049	2.31**	0.013**
		(0.021)		
Animalshock		0.094	2.13**	0.023**
		(0.044)		
Experience of various natural shocks		0.090	0.94	0.022
		(0.096)		
Membership in social groups		0.031	0.38	0.008
		(0.082)		
Access to information on climate change		0.488	1.90*	0.120*
		(0.256)		
Access to the local market		0.311	1.20	0.077
		(0.293)		
Intercept		-3.492	-2.16**	-
		(1.615)		
LR chi2(17)		100.80***		
Pseudo R2		0.194		
Correctly classified (%)		76.06		
Hosmer–Lemeshow chi2(8)		5.55		
Prob > Hosmer–Lemeshow chi2		0.236		
Number of observations (No Credit)		199		
Number of observations (Credit accessed)		177		
Number of observations (All sample)		376		

317 Notes: *** Significant at P<0.01; ** Significant at P<0.05; * Significant at P<0.05.
318
319 The results show that the mean of bias decreased and covariates became insignificant after
320 matching. The bias percentage of covariates after matching has been significantly reduced
321 compared to before. (Figure 2). Visual inspection of propensity score distributions showed that
322 the common support condition was met, indicating a high overlap between microcredit
323 recipients and non-recipients (Figure 3). This shows that the matching of the two groups is
324 appropriate and the PSM results are highly reliable. In Figure 3, “On support” refers to the

households that were present in the compliance of the two treatment and control groups, and "Off support" refers to the households that were not present in the compliance of the two treatment and control groups.

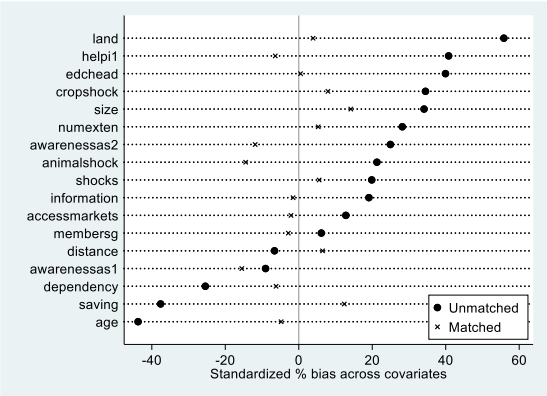

Fig. 2. Bias % of covariates before and after matching.

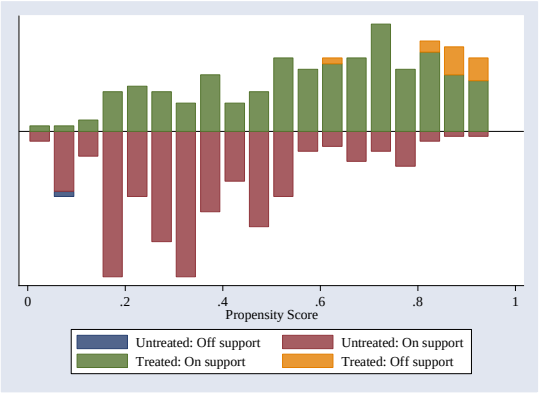

Fig. 3. The distribution of propensity scores (PS) and common support for estimating PS.

Table 5 provides the effects of microcredit on the HFIAS and FCS indices using three matching algorithms (nearest neighbor, kernel, and radius). The findings demonstrate that microcredit has a negative and significant effect on HFIAS for three matching estimators. Households receiving microcredit have lower food insecurity scores (9.80-9.99) than non-recipient households (12.95-13.83). Microcredit has reduced the HFIAS score by 24.3-27.8% for recipient households compared to non-recipient households. The findings indicate that microcredit has a significantly positively effect on FCS for all matching algorithms. The FCS score is higher for recipient households (45.82-46.23) than non-recipient households (35.17-36.56). This means microcredit has increased the FCS score by 25.9-31.4% for recipient households compared to non-recipient households. These results are consistent with the literature (Hamad and Fernald, 2012; Islam et al., 2016; Devereux, 2016; Bocher et al., 2017; Kianersi et al., 2021; Haque, 2021; Berhanu et al., 2021; Bahiru et al., 2023; Woleba et al., 2023; Kolog et al., 2023; Wongnaa et al., 2023; Boltana et al., 2023), revealing that microcredit through investing in income-generating activities, creating diverse income streams and safe networks, reducing vulnerability to health shocks, and improving the flow of information on household health and nutrition programs help to enhance of food security of households. However, some studies showed that microcredit has no significant effect on food security (Banerjee et al., 2015; Seng, 2018; Mahmud et al., 2022; Salima et al., 2023). In addition, other studies have shown that microcredit may push households into food insecurity situations by

creating excessive debt and loan repayment pressure (Develtere and Huybrechts, 2005; Aromolaran, 2010; Ganle et al., 2015; Namayengo et al., 2018; Ahmed et al., 2021).

Table 5. Impact of microcredit accessed on HFIAS and FCS indices.

Outcome	Matching	Controls	Treated	ATT	Bootstrap S.E.	T-stat	Matched observations		
							All sample	Credit accessed	No Credit
HFIAS	Neighbor	13.538	9.848	-3.690	0.649	-5.686***	369	171	198
	Kernel	12.954	9.797	-3.157	0.460	-6.864***	376	177	199
	Radius	13.834	9.986	-3.847	0.580	-6.635***	376	177	199
FCS	Neighbor	35.871	45.819	9.947	2.733	3.640***	369	171	198
	Kernel	36.564	46.023	9.458	2.530	3.738***	376	177	199
	Radius	35.168	46.229	11.061	1.587	6.970***	376	177	199

Note: Bootstrap S.E: Bootstrap standard error with 1000 times simulations. *** Significant at P<0.01.

3.4. Sensitivity analysis for hidden bias

Table 6 shows the results of checking hidden bias by sensitivity analysis. Our findings reveal that the effect of microcredit interventions on HFIAS and FCS indices does not change, and the households are allowed to differ in their odds of treatment by 200% ((3-1)*100)=200) at Γ= 3 in terms of unobserved covariates in both groups. Therefore, it can be concluded that the results of ATT for all output variables are not sensitive to unobserved hidden bias, and the estimated effect is a pure effect of using microcredit. This finding is consistent with the results of Berhanu et al. (2021) and Boltana et al. (2023).

Table 6. Sensitivity analysis of Outcome variables.

Gamma	HFIAS		FCS	
(Γ)	Significant-	Significant+	Significant-	Significant+
1	0.00	0.00	0.00	0.00
1.2	0.00	0.00	0.00	0.00
1.4	0.00	0.00	0.00	0.00
1.6	0.00	0.00	0.00	0.00
1.8	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
2.2	0.00	0.00	0.00	0.00
2.4	0.00	0.00	0.00	0.00
2.6	0.00	0.00	0.00	0.00
2.8	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00

Note: **Γ**: Log odds of unobserved differential assignment. Significant-: lower bound significance level. Significant+: upper bound significance level.

4. Conclusions

This study seeks to answer how microcredit plans lead to enhance the households' food security by developing the PSM method through the bootstrap algorithm. The findings emphasize the positive role of microcredit in reducing the HFIAS and increasing the FCS. However, a large number of target households are food insecure and do not have a good condition in terms of food consumption; because a significant number of them did not have access to or did not receive microcredit for various reasons.

The results showed that the access of households to microcredit was positively influenced by high awareness of adaptation strategies, access to climate change information, the household head's education, the number of helpers, the number of household contacts with agricultural extension institutions, household size, agricultural land size, the value of crop losses and the number of lost livestock. However, the household head's age, households' savings, and dependence ratio have a negative effect on the access of households to microcredit.

Based on these findings, this study proposes the following policy implications. First, non-governmental organizations and local social associations should be further promoted and strengthened to increase households' access to rural microcredit. In addition, they should be flexible in accepting natural guarantees such as agricultural land and household livestock and social guarantees such as membership in social groups to increase the level of households' access to microcredit. Second, non-governmental and governmental organizations providing microcredit should emphasize the organizing effective training programs to increase households' knowledge and skills. This leads to improved households' food security through individual development and collective participation. These organizations should target educated rural youth with suitable incentive programs. Educated youths have high capacities for correctly using microcredit in income-generating activities, which can provide a basis for improving food security in rural communities.

Although this study has provided several new insights about the effect of microcredit on food security, some limitations need to be considered in future research. First, future studies can expand the subject of this study using other food security indices such as the Household Dietary Diversity Score (HDDS) (Wongnaa et al., 2023; Borku et al., 2024), and other methods like the Endogenous Switching Model (Salima et al., 2023). Second, considering the limited data availability, this study uses a cross-section sample. Future research can achieve more comprehensive findings using panel data (Islam et al., 2016).

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Appendix

Table A1. Measurement of HFIAD and HFIAP.

Index	Category	Calculation
HFIAD	Insufficient food intake and physical consequences	Number of respondents to Q5 to Q9=1
	Anxiety and uncertainty	Number of respondents to Q2 to Q4=1
	Insufficient Quality	Number of respondents to Q1=1
HFIAP	Severely food insecure	Number of respondents to Q5a=3 or Q6a=3 or Q7a=1 or 2 or 3; or Q8a=1 or 2 or 3; or Q9a= 1 or 2 or 3.
	Moderately food insecure	Number of respondents to Q3a=2 or 3; or Q4a=2 or 3; or Q5a=1 or 2; or Q6a=1 or 2.
	Mildly food insecure	Number of respondents to Q1a=2 or 3; or Q2a=1 or 2 or 3; or Q3a=1 or Q4a=1.
	Food secure	Number of respondents to Q1a=0 or 1.

Note: Q1 to Q9 denotes occurrence questions, while Q1a to Q9a represents their frequency.
Source: Coates et al. 2007.

Table A2. Demographic background of the sampled households.

Variables	Group	Frequency	Percentage
Age of the household head	35-45	70	19
	46-55	100	27
	56-65	118	31
	65>	88	23
Education level of household heads	Not able to read and write	133	35
	primary education	84	22
	secondary education	102	27
	higher education	57	15
Sex of household head	Female	74	20
	Male	302	80
Economic activities of households	Farming	144	38
	Livestock farming	148	39
	shopkeeper	24	6
	Handicrafts	47	13
	Employee	13	3
Fields of Microcredit Receipts of Households	Consumption	38	10
	Working capital	56	15
	Agriculture	113	30
	Livestock	169	45
Loan size of households (Million Rials (IRR))			
Consumption	150-300	38	10
Working capital	350-500	56	15
Agriculture	450-700	113	30
Livestock	700-1000	169	45

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ارزیابی اثرات اعتبارات خرد بر وضعیت امنیت غذایی خانوارهای روستایی تحت تاثیر خشکسالی: مطالعه تجربی از روستاهای شهرستان زهک، ایران

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چکیده

اعتبارات خرد نقش حیاتی در امنیت غذایی خانوارهای روستایی دارد. با این حال، اثرات اعتبارات خرد بر بهبود امنیت غذایی خانوارها هنوز در ایران به خوبی مورد مطالعه و درک قرار نگرفته است. لذا این پژوهش با هدف بررسی موفقیت برنامه‌های اعتبارات خرد در ارتقای امنیت غذایی خانوارهای روستایی شهرستان زهک با استفاده از روش تطبیق امتیاز گرایش و الگوریتم بوت استرپ انجام شده است. برای این منظور از دو شاخص امنیت غذایی شامل مقیاس دسترسی به ناامنی غذایی خانوار (HFIAS) و امتیاز مصرف غذا (FCS) استفاده می‌شود. نتایج نشان داد که 100 درصد خانوارها با ناامنی غذایی مواجه هستند. شیوع ناامنی غذایی برای ناامنی غذایی خفیف، متوسط و شدید به ترتیب 20، 42/5 و 37/5 درصد بود. علاوه بر این، 30 درصد خانوارها در وضعیت نامناسب مصرف مواد غذایی قرار دارند. یافته‌های ما بر نقش مثبت و قابل توجه اعتبار خرد در بهبود امنیت غذایی تاکید می‌کند. نتایج نشان داد اعتبار خرد امتیاز شاخص HFIASخانوارهای دریافت‌کننده را بین 27/81-24/31 درصد کاهش و امتیاز شاخص FCS را بین 31/45-25/78 درصد افزایش داده است. بنابراین، سیاست گذاران و تصمیم گیران باید سازمان‌های دولتی و غیردولتی ارائه دهنده اعتبارات خرد را ترویج و تقویت کنند. همچنین ارائه اطلاعات و کاهش محدودیت‌های وثیقه برای افزایش دسترسی خانوارها به اعتبارات خرد توصیه می‌شود.