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Microcredit, training and rural food security in Burkina Faso: an analysis of complementarity

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Abstract

In rural Sahelian communities, access to finance alone may not protect food consumption when economic activities and markets are exposed to multiple shocks. This study examines how microcredit, financial education and environmental training are associated with food security in Burkina Faso. We analyze data from the 2022 GLO-NET Burkina Faso endline survey, conducted by the Representation of the Food and Agriculture Organization of the United Nations (FAO) in Burkina Faso, for 1 732 households in 166 villages. The Food Consumption Score (FCS) is the primary outcome, and the Dietary Diversity Score (DDS7) is the secondary outcome. We estimate ordinary least squares (OLS) models with province fixed effects to control unobserved differences across locations and use municipality fixed effects in robustness checks. Standard errors are clustered by village to account for within-village correlation. The microcredit coefficient is not statistically significant. The interaction between financial education and environmental training, however, is positive and significant for the FCS, including in models with municipality fixed effects. These findings suggest examining the mix of services offered alongside rural finance rather than prioritizing credit alone.

1. Introduction

Food security requires more than the availability of food within a given area. It depends on people having physical and economic access, at all times, to sufficient, safe and nutritious food. Research on rural Burkina Faso examines both own-farm and purchased food sources (Fraval et al. 2020). For rural households, access is shaped by income and own food production, as well as markets, prices, mobility and the ability to cope with shocks. These factors interact particularly strongly in Burkina Faso. In the Nord, Sahel and Est regions, climate variability threatens production, while insecurity disrupts travel, trade and access to services. Additional liquidity can help households under these conditions. It may nevertheless offer little relief if the financed activity is interrupted, markets become inaccessible or loan repayments fall due before the expected income materializes.

Microcredit may ease rural liquidity constraints. Its economic rationale rests on a well-established rural market imperfection: incomplete information, lack of collateral and risk can lead lenders to ration credit even when productive investment opportunities exist (Stiglitz and Weiss 1981). By easing this constraint, microcredit can finance inputs and economic activities or help smooth consumption. Empirical findings, however, are mixed. Average effects on consumption and welfare are often modest, with substantial variation across recipients and contexts (Angelucci et al. 2015; Crépon et al. 2015; Meager 2019; Van Rooyen et al. 2012). Under high uncertainty, debt may impose an additional constraint when investments fail to generate the expected income (Brickell et al. 2020; Fenton et al. 2015).

These findings raise a broader question: resources matter, but so does households' ability to use them. This distinction lies at the heart of Sen's (1999) capability approach, in which welfare depends not simply on available resources, but on the ability to convert them into valued functionings. In the context of food

security, the approach distinguishes access to credit from the capabilities required to plan expenditure, safeguard livelihoods and adapt practices to risk.

Some microfinance institutions provide training alongside loans. This study measures self-reported receipt of microcredit, financial education and environmental training over the preceding five years; the operational definitions are provided in Section 3.2. Human capital theory views training as an investment that may increase knowledge and improve decision-making (Becker 1964). Financial education may help households budget, plan for repayment obligations and balance consumption and investment. Environmental training may provide knowledge relevant to resource protection and the adaptation of rural activities. Participation does not necessarily translate into practical skills, however. Training content and intensity, together with opportunities to apply what has been learned, remain critical (Kaiser et al. 2022; Karlan and Valdivia 2011; Waddington et al. 2014).

We examine how the types and combinations of financial and nonfinancial services received by rural households are associated with food security in Burkina Faso. The analysis distinguishes microcredit, financial education and environmental protection training, and tests for complementarity between the two types of training when received jointly rather than separately. Complementarity is defined as a joint association that exceeds the sum of the separate associations on the model's additive scale.

This study contributes to literature in three ways. First, it distinguishes credit from the nonfinancial services that may accompany it, whereas much of the food security literature focuses on access to finance. Second, it distinguishes separate from joint receipt of training and explicitly tests for complementarity, rather than treating all training as a single category. Third, it examines these relationships in localities in Burkina Faso where climatic, economic and security risks make it uncertain whether finance will translate into consumption. Given the observational, cross-sectional nature of the data, the estimated coefficients are interpreted as conditional associations and adjusted differences between groups, not causal effects. Accounting for local heterogeneity allows these patterns to inform questions for further policy evaluation.

2. Theoretical framework, literature and empirical propositions

2.1. Resources, capabilities and human capital

The analysis draws on two theoretical perspectives. The first is the capability approach. A given resource does not create the same opportunities for every household: the ability to use it depends on household characteristics, knowledge, the surrounding environment and the constraints faced (Sen 1999). A loan received when markets are functioning may support investment or consumption. In a village where travel is difficult or economic activity has been interrupted, the same loan may generate no return while still requiring repayment. Food security therefore depends on both the resources available and households' capacity to convert them into outcomes.

The second perspective is human capital theory, which treats education and training as investments in knowledge, skills and decision-making capacity (Becker 1964). From this perspective, nonfinancial services are more than incidental additions to a loan. Financial education may influence how households plan expenditure, manage debt and build savings. Environmental training may broaden the knowledge they can draw on to preserve natural assets or adapt their activities. In either case, applying that knowledge depends on the assets available, the training content and the practical feasibility of adopting the proposed practices.

The two perspectives are complementary. Sen emphasises the ability to turn resources into real opportunities, while Becker explains how training builds capabilities. Together, they suggest that although credit may ease liquidity constraints, food security outcomes also depend on the capabilities that shape the use of credit and household decisions more generally.

2.2. Microcredit and food security

Microcredit may support food security through investment, income diversification or consumption smoothing. Positive associations have been reported in Bangladesh and Benin (Bidisha et al. 2017; Islam et al. 2016; Mounirou and Lokonon 2022). Evidence from Burkina Faso links inventory credit, which combines finance and storage, to increased grain stocks; less robust estimates among direct users suggest improvements in self-sufficiency and dietary diversity (Le Cotty et al. 2023). This example suggests that the outcome depends less on credit in isolation than on how it is integrated into a scheme aligned with the agricultural cycle.

Other studies warrant greater caution. Several randomised trials find changes in economic activity or investment without consistent improvements in average consumption (Angelucci et al. 2015; Attanasio et al. 2015; Crépon et al. 2015). Meager's (2019) synthesis confirms modest average effects and substantial heterogeneity. In sub-Saharan Africa, Van Rooyen et al. (2012) likewise report mixed findings. When returns are low or delayed, loans finance immediate needs or shocks disrupt economic activity, repayment may force trade-offs that reduce consumption (Brickell et al. 2020; Namayengo et al. 2018). More broadly, the outcomes of interventions intended to protect consumption also depend on the dimension of food security considered. In Senegal, Diouf et al. (2022) show that emergency food aid can improve food access and reduce reliance on extreme coping strategies without necessarily improving dietary diversity or nutritional quality. The expected association between microcredit and food security is therefore ambiguous and may vary with the indicator used.

2.3. Training, management and adaptation

Financial education aims to develop the knowledge and behaviours needed to manage household budgets, risk and debt. In Africa, Tinta et al. (2022) identify financial literacy as one of the factors shaping individuals' financial inclusion and resilience. The meta-analysis by Kaiser et al. (2022) also finds average improvements in knowledge and some behaviours, although results vary with training content and the target population. Within microfinance, business training changes practices more consistently than income outcomes (Karlan and Valdivia 2011). Its potential links to food consumption

include planning, consumption smoothing and the management of financial commitments. Gundersen and Garasky (2012), Carman and Zamarro (2016), Millimet et al. (2018) and Twumasi et al. (2023) report associations between financial capabilities and food security, although selection among better-resourced households is not fully accounted for.

In rural Sahelian economies, adaptation also draws on knowledge of natural resources. Boyd et al. (2013) and Yusuf et al. (2024) emphasise the combined role of knowledge, institutions and capabilities in resilience to environmental crises. Agricultural learning programmes can improve the adoption of practices and productivity, but their performance depends heavily on implementation and context (Davis et al. 2012; Waddington et al. 2014). The available measure is broad: it records only whether at least one household member received environmental protection training from a microfinance provider. Without information on content or delivery, it would be inappropriate to equate this training with a specific agroecological programme.

2.4. Complementarity between capabilities

Multidimensional interventions seek to ease several constraints simultaneously. Nonfinancial components may contribute to microfinance programme outcomes (McKernan 2002), although their integration involves organisational trade-offs and does not guarantee immediate economic gains (Karlan and Valdivia 2011; Lensink et al. 2018). Programmes combining assets, training, savings and support illustrate this logic more broadly (Banerjee et al. 2015).

The two types of training examined here may support different stages of the same decision. Financial management facilitates planning and choices between competing uses of resources, while environmental knowledge may guide livelihood protection or adaptation. Their combination could therefore be associated with better consumption outcomes than either type received separately. We assess this using adjusted comparisons across four training categories and an interaction term between the two training indicators. A positive interaction indicates statistical complementarity on the additive scale.

3. Data and methods

3.1. Survey and analytical sample

The data come from the 2022 GLO-NET Burkina Faso endline survey, conducted by the Representation of the Food and Agriculture Organization of the United Nations in Burkina Faso as part of the Global Network Against Food Crises Partnership Programme in the Sahel. The programme covers the Sahel, Nord and Est regions, among others. The multistage sampling design used provincial quotas for beneficiary and nonbeneficiary households, allocation across municipalities, sampling from accessible villages and systematic household selection. The dataset includes 1 917 households in 167 villages. We used complete-case analysis, retaining only observations with valid data for all variables of interest: food security indicators, services and covariates. Excluding incomplete records yielded an analytical sample

of 1 732 households in 166 villages, retaining 90.3% of the original dataset (Table 1). Missing values for services were not imputed. The comparisons in Appendix A1 show differences in observed characteristics between retained and excluded households. These differences raise concerns about selection into the analytical sample but do not identify the missing-data mechanism.

Table 1
Construction of the analytical sample

Step	Reason	Excluded	Remaining
0	Available dataset	-	1 917
1	Incomplete food consumption frequencies	53	1 864
2	Financial or environmental training data unavailable	122	1 742
3	Missing or invalid microcredit data	2	1 740
4	Household size missing or greater than 36	8	1 732
Note: reasons are hierarchical and mutually exclusive.			

Source: author's calculations using the 2022 GLO-NET Burkina Faso endline survey conducted by the FAO Representation in Burkina Faso.

3.2. Services and food indicators

Microcredit is coded as one if at least one household member reports receiving a microfinance loan during the preceding five years, and zero otherwise. This measure provides no information on loan size, terms or use. Two additional questions record whether at least one household member received financial education from a microfinance provider and whether at least one member received environmental protection training from a microfinance provider. These responses define four mutually exclusive categories: no training, financial education only, environmental training only and both types of training. The last category identifies households reporting receipt of both types.

The primary food security outcome is the FCS. It combines weekly consumption frequencies for eight food groups, capped at seven days, using World Food Programme weights (World Food Programme 2008). The secondary outcome, the Dietary Diversity Score (DDS7), counts seven food groups consumed at least once over the same period. It is distinct from the conventional Household Dietary Diversity Score (HDDS), which covers twelve groups and uses a twenty-four-hour recall period (Food and Agriculture Organization of the United Nations 2012). An alternative FCS based on mean frequencies within food groups is used solely for sensitivity analysis. Appendix A6 details the construction of these indicators.

3.3. Empirical strategy

We estimate a multivariable OLS model to examine the relationships between access to training, access to microcredit and household food security. The primary outcome, the FCS, is a quantitative measure spanning a wide range of values (0 to 112), supporting the use of linear regression. We also use OLS for

the secondary outcome, the Dietary Diversity Score (DDS7), despite its discrete, bounded range (0 to 7), for two reasons. First, coefficients are directly interpretable as differences in score points, allowing straightforward interpretation of adjusted mean differences (Angrist and Pischke 2009). Second, the linear specification allows complementarity between interventions to be tested on an additive scale (Ai and Norton 2003). This test would be more complex and less readily interpretable in a nonlinear model, such as Poisson regression.

3.3.1. Main specification and control variables

The baseline model estimates the association between each training category and each food security outcome for household i. The main specification is:

$$Y_i = \alpha + \beta_F F_i + \beta_E E_i + \beta_B B_i + \delta C_i + X_i' \gamma + \mu_v + \epsilon_i$$

Here, Y_i denotes the food security outcome (FCS or DDS7). We include three mutually exclusive indicators (F_i, E_i and B_i) for financial education only, environmental training only and both types of training, respectively. Households reporting no training are the reference group. The indicator C_i captures access to microcredit. The vector X_i' contains household socioeconomic covariates: household size and the household head's sex, literacy status and years of education. Following Wooldridge (2010), these controls were selected as socioeconomic characteristics that may account for observed differences between households. Their inclusion does not establish exogeneity or eliminate unobserved confounding.

3.3.2. Accounting for spatial structure and inference

The main specification includes fixed effects (μ_v) for the seven provinces to absorb shared institutional and agroecological characteristics. We also estimate a specification with fixed effects for the sixteen municipalities as a robustness check. The term ϵ_i denotes the disturbance. Standard errors of the estimated coefficients are clustered by village across the 166 villages to allow for within-village error correlation (Cameron and Miller 2015).

3.3.3. Testing complementarity and territorial restrictions

We use two complementary approaches to assess whether the joint association of the two types of training exceeds the sum of their separate associations. First, post-estimation linear contrasts compare the estimated association for receipt of both types of training (β_B) with the associations for financial education only (β_F) and environmental training only (β_E). Second, we estimate an alternative model that includes separate indicators for receipt of each type of training (Fin_i and Env_i), together with their interaction:

$$Y_i = \alpha + \theta_{Fin} Fin_i + \theta_{Env} Env_i + \theta_{FE} (Fin_i \times Env_i) + \delta C_i + X_i' \gamma + \mu_v + \epsilon_i$$

The interaction coefficient, θ_{FE}, is the difference between the association for joint receipt and the sum of the associations for each type received separately. A positive, statistically significant θ_{FE} indicates

complementarity on the additive scale (Mairesse and Mohnen 2010). To limit extrapolation due to a lack of geographic overlap, we re-estimate each contrast using only municipalities in which the relevant categories are both represented. The resulting coefficients are interpreted as conditional associations.

4. Results

4.1. Group characteristics

Among the 1 732 households, 1 343 report no training, 89 report financial education only, 88 report environmental training only and 212 report both types. Receipt of both types is thus more common than receipt of either type alone. Approximately 70% of financial education recipients also report environmental training, and approximately 70% of environmental training recipients also report financial education. Households receiving both types have the highest unadjusted mean FCS and DDS7 scores. They also differ in access to microcredit and several observed characteristics (Table 2).

Table 2
Descriptive statistics by training combination

Variable	None	Financial only	Environmental only	Both types of training
Number of households	1 343	89	88	212
FCS	37.938 (14.983)	35.629 (11.781)	36.165 (12.710)	45.493 (18.612)
DDS7	4.515 (1.419)	4.764 (1.138)	4.591 (1.573)	5.146 (1.518)
Microcredit	4.2%	75.3%	10.2%	22.6%
Household size	10.176	8.910	11.182	8.948
Male household head	89.5%	84.3%	89.8%	84.9%
Literate household head	22.0%	65.2%	26.1%	40.6%
Household head’s years of education	4.574	4.034	6.886	4.406
Note: means; standard deviations in parentheses for the FCS and DDS7.				

Source: author’s calculations using the 2022 GLO-NET Burkina Faso endline survey conducted by the FAO Representation in Burkina Faso.

4.2. Main associations

With province fixed effects, receipt of both types of training is associated with an FCS 2.888 points higher than that of households receiving no training; the association is significant at the 10% level. With municipality fixed effects, the estimated difference is 3.227 points and remains significant at the same

level. Neither type received separately has a robust positive association with the FCS. The coefficient for financial education only is not statistically significant, while that for environmental training only is negative and significant at the 10% level in the municipality fixed-effects specification.

Financial education only is positively associated with the DDS7 in both specifications. For households receiving both types of training, the positive association is significant only at the 10% level in the model with municipality fixed effects. The microcredit coefficient is negative in all four models, but none of these estimates is statistically different from zero. The results therefore establish neither a food security advantage nor a disadvantage associated with credit.

Table 3
Adjusted associations between services and food security

Variable	FCS Province	FCS Municipality	DDS7 Province	DDS7 Municipality
Financial education only	-1.619 (2.251)	0.161 (1.772)	0.350* (0.204)	0.462** (0.200)
Environmental training only	-2.348 (2.474)	-3.744* (2.238)	-0.102 (0.290)	-0.438* (0.236)
Both types of training	2.888* (1.715)	3.227* (1.756)	0.223 (0.159)	0.304* (0.164)
Microcredit	-1.972 (2.204)	-2.283 (1.839)	-0.170 (0.216)	-0.180 (0.189)
Observations	1 732	1 732	1 732	1 732
R^2	0.167	0.255	0.197	0.257
Villages	166	166	166	166

Notes: OLS with household covariates and the indicated fixed effects. Reference category: no training. Village-clustered standard errors in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.10.

Source: author's calculations using the 2022 GLO-NET Burkina Faso endline survey conducted by the FAO Representation in Burkina Faso.

4.3. Contrasts and complementarity

The contrasts qualify these findings. For the FCS, the estimated difference between households receiving both types of training and those receiving environmental training only is 5.236 points with province fixed effects and 6.970 points with municipality fixed effects; the latter is significant at the 1% level. Receipt of both types is not statistically distinguishable from financial education only. For the DDS7, only the comparison with environmental training only shows a clearly positive difference in the municipality fixed-effects specification.

The interaction term tests complementarity on the additive scale. Its estimated coefficient is 6.855 FCS points with province fixed effects and 6.810 with municipality fixed effects; both are significant at the 5% level. The interaction is not significant for the DDS7. Evidence of complementarity thus concerns the weighted frequency of consumption captured by the FCS, rather than a general increase in the number of food groups consumed.

Table 4
Contrasts between training categories and test of complementarity

Test	FCS Province	FCS Municipality	DDS7 Province	DDS7 Municipality
Both types of training – none	2.888* (1.715)	3.227* (1.756)	0.223 (0.159)	0.304* (0.164)
Both types of training - financial only	4.507 (2.817)	3.066 (2.592)	-0.128 (0.265)	-0.158 (0.277)
Both types of training - environmental only	5.236* (2.855)	6.970*** (2.612)	0.324 (0.307)	0.742*** (0.242)
Financial × environmental interaction	6.855** (3.306)	6.810** (3.046)	-0.026 (0.333)	0.280 (0.308)

Notes: same sample, covariates and standard error clustering as in Table 3. ***** p < 0.01; ** p < 0.05; * p < 0.10.**

Source: author's calculations using the 2022 GLO-NET Burkina Faso endline survey conducted by the FAO Representation in Burkina Faso.

4.4. Robustness checks and supplementary findings

Three checks address the main finding. The interaction remains positive and significant when municipality fixed effects replace province fixed effects. It also remains positive when the alternative FCS based on within-group means is used: 6.374 points with province fixed effects and 7.332 points with municipality fixed effects (Appendix A2). Estimates restricted to municipalities where both comparison groups are represented mainly confirm the advantage of receiving both types of training over environmental training only. They still show no statistically significant difference relative to financial education only (Appendix A4).

We also conduct two supplementary analyses. Of the 212 households reporting both types of training, 48 report receiving microcredit and 164 do not. The adjusted differences in FCS and DDS7 associated with credit remain negative, but are not statistically significant under any of the geographic specifications considered (Appendix A3). An exploratory decomposition of the FCS indicates that the difference between households reporting both types of training and those reporting none is driven mainly by the pulses and oil components. These differences remain statistically significant after Benjamini–Hochberg correction (Benjamini and Hochberg 1995), although they do not establish a nutritional mechanism (Appendix A5).

5. Discussion and policy implications

The absence of a statistically significant association between microcredit and food security is consistent with the cautious conclusions of the literature. Microcredit trials often find more changes in economic activity than in average consumption (Angelucci et al. 2015; Attanasio et al. 2015; Crépon et al. 2015), while Meager (2019) emphasises heterogeneous household trajectories. Our finding does not establish that credit is ineffective. Rather, in this sample and conditional on the included controls, no favourable difference in food security can be statistically attributed to credit. Where markets, travel and production may be disrupted, the pathway from loans to income, and from income to food consumption, may break down at several stages. This interpretation is consistent with Sen's distinction between having resources and being able to convert them into outcomes.

Financial education alone shows a different pattern: it is not associated with the FCS, but is associated with slightly greater dietary diversity. This is consistent with studies linking financial management capabilities to food security (Carman and Zamarro 2016; Gundersen and Garasky 2012; Millimet et al. 2018; Twumasi et al. 2023). It also accords with Tinta et al. (2022), who identify financial literacy as a determinant of financial resilience in Africa. The comparison requires caution, however, because their study examines individuals' financial resilience, whereas ours concerns household food security indicators. The finding also remains difficult to interpret: our measure records training participation, not demonstrated skills, and provides no information on timing or intensity. Human capital theory suggests a plausible pathway, but cannot substitute for evidence on the learning process.

Environmental training alone is not favourably associated with food security, and its coefficient is negative in some municipality fixed-effects specifications. This does not imply that environmental protection harms food security. Evaluations of agricultural learning programmes show that the outcomes of knowledge transfer depend on content, support and the feasibility of adopting the practices taught (Davis et al. 2012; Waddington et al. 2014). The survey question is broad. We do not know whether training addressed soil, water, energy or other topics, or whether households had the assets needed to apply this knowledge in productive decisions. This interpretation is also consistent with recent research on African households' resilience to climate change (Yusuf et al. 2024). Training can deliver the expected outcomes only when households have the means to put what they have learned into practice.

The most distinctive result is the positive interaction between financial education and environmental training for the FCS. It supports the possibility that different capabilities reinforce one another within the same decision-making process. Financial management helps households allocate scarce resources, while environmental knowledge may expand the options available to protect or adapt livelihoods. This interpretation is consistent with research on nonfinancial microfinance services and multidimensional interventions (Banerjee et al. 2015; Lensink et al. 2018; McKernan 2002). It nevertheless requires caution. Receipt of both types of training is not statistically distinguishable from financial education alone. As shown in Section 4.1, receipt of the two types of training substantially overlaps. The interaction

may therefore partly reflect selection into an integrated service package, a particular provider or households with characteristics not captured by the available variables.

The difference between the FCS and DDS7 also warrants attention. The FCS combines consumption frequencies with food-group weights, whereas the DDS7 records only whether each group was consumed. Results may therefore differ according to the dimension of food security measured. Diouf et al. (2022) report a similar sensitivity to the indicator in Senegal: the intervention improves some dimensions of food access and coping strategies, without comparable improvements in dietary diversity or nutritional quality. In our study, complementarity may be apparent when households consume certain foods more frequently, even if the number of food groups consumed does not increase. The decomposition, particularly the findings for pulses and oil, is consistent with this possibility (Appendix A5). It remains exploratory because the data do not measure consumption quantities, individual dietary intake or nutritional status.

For rural policy, the findings do not imply that credit should automatically be replaced by a standard training package. A broader approach is needed. Microfinance institutions and their partners would benefit from documenting service content, sequence and intensity, then separately measuring knowledge, practices, economic outcomes and food security outcomes. Financing terms also matter in areas facing multiple risks: repayment schedules, grace periods, savings, insurance or restructuring may be more appropriate than a uniform product. The findings justify testing integrated service packages, but are insufficient to presume their effectiveness.

Two limitations should guide interpretation. First, the cross-sectional data do not account for selection into services or unobserved factors; the coefficients are not causal. Second, training is self-reported, with no information on content, intensity or quality. The five-year recall period for services and seven-day recall period for food consumption also prevent a clear assessment of exposure timing and temporal sequence. A prospective evaluation should follow the entire pathway: service allocation and content, knowledge acquisition, changes in practices, income, consumption and resilience to shocks.

6. Conclusion

Using the 2022 GLO-NET Burkina Faso endline survey, this study examined associations between microcredit, training and household food security with geographic fixed effects and village-clustered standard errors.

Three main findings emerge. Microcredit has no statistically significant positive association with either outcome. Training received separately yields mixed results: financial education is associated with slightly greater dietary diversity, whereas environmental training alone is not favourably associated with either score. The interaction between the two types of training is positive and significant for the FCS and remains stable with municipality fixed effects. However, receipt of both types is not statistically distinguishable from financial education alone, and there is no statistically significant evidence of complementarity for the DDS7.

These findings support further evaluation of integrated rural service packages combining credit, budgeting and sustainable practices. They do not establish that such packages improve food security or outperform liquidity provision alone.

Declarations

Competing interests

The author declares no financial or non-financial competing interests that are directly or indirectly related to this work.

Ethics approval

This study is based exclusively on the secondary analysis of anonymized survey data. The author was not involved in the recruitment of participants or in the primary data collection and had no access to personally identifiable information. No additional ethics approval was required for this secondary analysis.

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Author Contribution

H.W. conceived the study, developed the theoretical and methodological framework, conducted the statistical and econometric analyses, interpreted the results, and prepared the tables and figures. H.W. wrote, reviewed, and approved the final manuscript and assumes full responsibility for its content.

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Data availability

The data analysed in this study are secondary survey data from the GloNet project conducted in Burkina Faso in 2022. The data are not publicly available because their dissemination and reuse are subject to

authorization by the data owner. Requests for access should be addressed to the Food and Agriculture Organization of the United Nations, subject to its applicable data-access procedures.

References

1. Ai C, Norton EC (2003) Interaction terms in logit and probit models. Econ Lett 80(1):123–129. https://doi.org/10.1016/S0165-1765(03)00032-6
2. Angelucci M, Karlan D, Zinman J (2015) Microcredit impacts: Evidence from a randomized microcredit program placement experiment by Compartamos Banco. Am Economic Journal: Appl Econ 7(1):151–182. https://doi.org/10.1257/app.20130537
3. Angrist JD, Pischke JS (2009) Mostly harmless econometrics: An empiricist's companion. Princeton University Press, Princeton
4. Attanasio O, Augsburg B, De Haas R, Fitzsimons E, Harmgart H (2015) The impacts of microfinance: Evidence from joint-liability lending in Mongolia. Am Economic Journal: Appl Econ 7(1):90–122. https://doi.org/10.1257/app.20130489
5. Banerjee A, Duflo E, Goldberg N, Karlan D, Osei R, Parienté W, Shapiro J, Thuysbaert B, Udry C (2015) A multifaceted program causes lasting progress for the very poor: Evidence from six countries. Science 348(6236):1260799. https://doi.org/10.1126/science.1260799
6. Becker GS (1964) Human capital: A theoretical and empirical analysis, with special reference to education. National Bureau of Economic Research
7. Benjamini Y, Hochberg Y (1995) Controlling the false discovery rate: A practical and powerful approach to multiple testing. J Roy Stat Soc: Ser B (Methodol) 57(1):289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x
8. Bidisha SH, Khan A, Imran K, Khondker BH, Suhrawardy GM (2017) Role of credit in food security and dietary diversity in Bangladesh. Econ Anal Policy 53:33–45. https://doi.org/10.1016/j.eap.2016.10.004
9. Boyd E, Cornforth RJ, Lamb PJ, Tarhule A, Lélé MI, Brouder A (2013) Building resilience to face recurring environmental crisis in African Sahel. Nat Clim Change 3(7):631–637. https://doi.org/10.1038/nclimate1856
10. Brickell K, Picchioni F, Natarajan N, Guermond V, Parsons L, Zanello G, Bateman M (2020) Compounding crises of social reproduction: Microfinance, over-indebtedness and the COVID-19 pandemic. World Dev 136:105087. https://doi.org/10.1016/j.worlddev.2020.105087
11. Cameron AC, Miller DL (2015) A practitioner's guide to cluster-robust inference. J Hum Resour 50(2):317–372. https://doi.org/10.3368/jhr.50.2.317
12. Carman KG, Zamarro G (2016) Does financial literacy contribute to food security? Int J Food Agricultural Econ 4(1):1–19. https://doi.org/10.22004/ag.econ.231358
13. Crépon B, Devoto F, Duflo E, Parienté W (2015) Estimating the impact of microcredit on those who take it up: Evidence from a randomized experiment in Morocco. Am Economic Journal: Appl Econ

7(1):123–150. https://doi.org/10.1257/app.20130535

14. Davis K, Nkonya E, Kato E, Mekonnen DA, Odendo M, Miiro R, Nkuba J (2012) Impact of Farmer Field Schools on agricultural productivity and poverty in East Africa. World Dev 40(2):402–413. https://doi.org/10.1016/j.worlddev.2011.05.019
15. Diouf A, Ndiaye MF, Faye C (2022) Emergency food aid and household food security during COVID-19: Evidence from a field survey in Senegal. Afr Dev Rev 34(4):556–569. https://doi.org/10.1111/1467-8268.12675
16. Fenton A, Paavola J, Tallontire A (2015) Microfinance and climate change adaptation: An overview of the current literature. Enterp Dev Microfinance 26(3):262–273. https://doi.org/10.3362/1755-1986.2015.023
17. Food and Agriculture Organization of the United Nations (2012) Guidelines for measuring household and individual dietary diversity. FAO
18. Fraval S, Yameogo V, Ayantunde AS, Hammond J, De Boer IJM, Oosting SJ, Van Wijk MT (2020) Food security in rural Burkina Faso: The importance of consumption of own-farm sourced food versus purchased food. Agric Food Secur 9:2. https://doi.org/10.1186/s40066-020-0255-z
19. Gundersen CG, Garasky SB (2012) Financial management skills are associated with food insecurity in a sample of households with children in the United States. J Nutr 142(10):1865–1870. https://doi.org/10.3945/jn.112.162214
20. Islam A, Maitra C, Pakrashi D, Smyth R (2016) Microcredit programme participation and household food security in rural Bangladesh. J Agric Econ 67(2):448–470. https://doi.org/10.1111/1477-9552.12151
21. Kaiser T, Lusardi A, Menkhoff L, Urban C (2022) Financial education affects financial knowledge and downstream behaviors. J Financ Econ 145(2):255–272. https://doi.org/10.1016/j.jfineco.2021.09.022
22. Karlan D, Valdivia M (2011) Teaching entrepreneurship: Impact of business training on microfinance clients and institutions. Rev Econ Stat 93(2):510–527. https://doi.org/10.1162/REST_a_00074
23. Le Cotty T, Maître d'Hôtel E, Subervie J (2023) Inventory credit to enhance food security in Burkina Faso. World Dev 161:106092. https://doi.org/10.1016/j.worlddev.2022.106092
24. Lensink R, Mersland R, Vu NTH, Zamore S (2018) Do microfinance institutions benefit from integrating financial and nonfinancial services? Appl Econ 50(21):2386–2401. https://doi.org/10.1080/00036846.2017.1397852
25. Mairesse J, Mohnen P (2010) Using innovation surveys for econometric analysis. In: Hall BH, Rosenberg N (eds) Handbook of the economics of innovation, vol 2. Elsevier, Amsterdam, pp 1129–1155
26. McKernan SM (2002) The impact of microcredit programs on self-employment profits: Do noncredit program aspects matter? Rev Econ Stat 84(1):93–115. https://doi.org/10.1162/003465302317331946

27. Meager R (2019) Understanding the average impact of microcredit expansions: A Bayesian hierarchical analysis of seven randomized experiments. Am Economic Journal: Appl Econ 11(1):57–91. https://doi.org/10.1257/app.20170299
28. Millimet DL, McDonough IK, Fomby TB (2018) Financial capability and food security in extremely vulnerable households. Am J Agric Econ 100(4):1224–1249. https://doi.org/10.1093/ajae/aay029
29. Mounirou I, Lokonon BOK (2022) Can micro-credit improve food security? Evidence from Benin-West Africa. J Developing Areas 56(2):155–167. https://doi.org/10.1353/jda.2022.0021
30. Namayengo FM, Antonides G, Cecchi F (2018) Microcredit and food security: Evidence from rural households in Uganda. J Afr Econ 27(4):457–482. https://doi.org/10.1093/jae/ejx043
31. Sen A (1999) Development as freedom. Oxford University Press
32. Stiglitz JE, Weiss A (1981) Credit rationing in markets with imperfect information. Am Econ Rev 71(3):393–410
33. Tinta AA, Ouédraogo IM, Al-Hassan RM (2022) The micro determinants of financial inclusion and financial resilience in Africa. Afr Dev Rev 34(2):293–306. https://doi.org/10.1111/1467-8268.12636
34. Twumasi MA, Essilfie G, Ntiamoah EB, Xu H, Jiang Y (2023) Assessing financial literacy and food and nutritional security relationship in an African country. Heliyon 9(9):e19573. https://doi.org/10.1016/j.heliyon.2023.e19573
35. Van Rooyen C, Stewart R, De Wet T (2012) The impact of microfinance in sub-Saharan Africa: A systematic review of the evidence. World Dev 40(11):2249–2262. https://doi.org/10.1016/j.worlddev.2012.03.012
36. Waddington H, Snilstveit B, Hombrados JG, Vojtkova M, Phillips D, Davies P, White H (2014) Farmer Field Schools for improving farming practices and farmer outcomes: A systematic review. Campbell Syst Reviews 10(1):1–335. https://doi.org/10.4073/csr.2014.6
37. Wooldridge JM (2010) Econometric analysis of cross section and panel data, 2nd edn. MIT Press, Cambridge
38. World Food Programme (2008) Food consumption analysis: Calculation and use of the Food Consumption Score in food security analysis. WFP
39. Yusuf SA, Salami AO, Akin-Olagunju OA, Adeyemo TA, Dada EO (2024) Household resilience to climate change in the big three African economies. Afr Dev Rev 36:503–518. https://doi.org/10.1111/1467-8268.12776
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