



## Research article

# Drought, hunger and coping mechanisms among rural household in Southeast Ethiopia

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## ABSTRACT

Protracted and prolonged droughts lead to famine and substantial decline in agricultural productivity that contribute to food insecurity and hunger in sub-Saharan Africa which needs to explore the risk coping strategies to better target risk mitigation. The main research question of this paper was to analyze ex-post coping strategies and their determinants in rural Ethiopia. We use a cross-section data collected in 2013 from vulnerable rural households in Rayitu district, Bale Zone of Oromia Regional State. Using population-proportionate to size (PPS) sampling technique, a total number of 1,402 households in the district participated in this study. The data were analyzed using a three-stage least squares (3SLS) method. Our analysis confirms that rural households in Rayitu district experience drought and are vulnerable to the consequences of shocks. As a response, rural households adopt interdependent risk coping strategies. This supports the notion of addressing the problem of risk through integrated rural development strategies (and policies) to help the poor to improve the vulnerability to shock and help to escape out of poverty. In addition, we found that the risk coping strategies that households adopt are influenced by the resource holdings and income levels of the rural households, their access to product and financial market, and their socio-demographic characteristics. Hence, we argue that strategies and interventions to improve the livelihood of the poor and to support the vulnerable ones should be targeted to fit to the needs and priorities of households.

## 1. Introduction

Recurrent droughts, price volatilities and other shocks can bring substantial negative effects for livelihood [1, 2, 3]. These effects include food insecurity, malnutrition, exhaustion of productive assets and landlessness, decline in human capital, chronic poverty and poverty traps, health problems and deaths [1,4,5]. Protracted and prolonged droughts lead to famine and substantial decline in agricultural productivity, and this in turn leads to food insecurity and hunger [4,6,7]. The situation is worse in sub-Saharan Africa, as a result the number of malnourished people continue to increase [1,6,8]. The rising of temperatures and other climate factors resulting in increased variability of precipitation and extreme climatic events such as droughts, floods, and shifting of seasons [9]. Therefore, analyzing the effects of drought on food security; and possible coping mechanisms continue to appear as an important research area.

Ethiopia experienced a number of major famines since the 1960s, which often have disastrous consequences [4,10,11]. Rural and urban households also face a couple of price volatility hikes in the last couple of decades [12,13]. These shocks often lead to food shortage, hunger and humanitarian problems [14, 15, 16]. In countries like Ethiopia, weak market based mechanisms to mitigate risk, inadequate responses to humanitarian problems, and existing poverty can lead to long term development catastrophe and crisis [17, 18, 19]. Rural households use complex set of ex-ante risk mitigation and ex-post coping strategies [20, 21, 22]. Examples of ex-ante risk mitigation strategies include livelihood diversification, increase in biodiversity, irrigation, etc [11,23,24]. Nonetheless, the adaptive capacity of vulnerable areas and households is often low, and households should rely on ex-post coping strategies [4,6, 25]. These ex-post coping strategies include informal consumption insurance; network based risk-sharing arrangements, ex-post labor supply and migration responses, loan and insurance, shifts in dietary choices [4, 25, 26, 27, 28]. The choice of coping strategies is situation specific, and it

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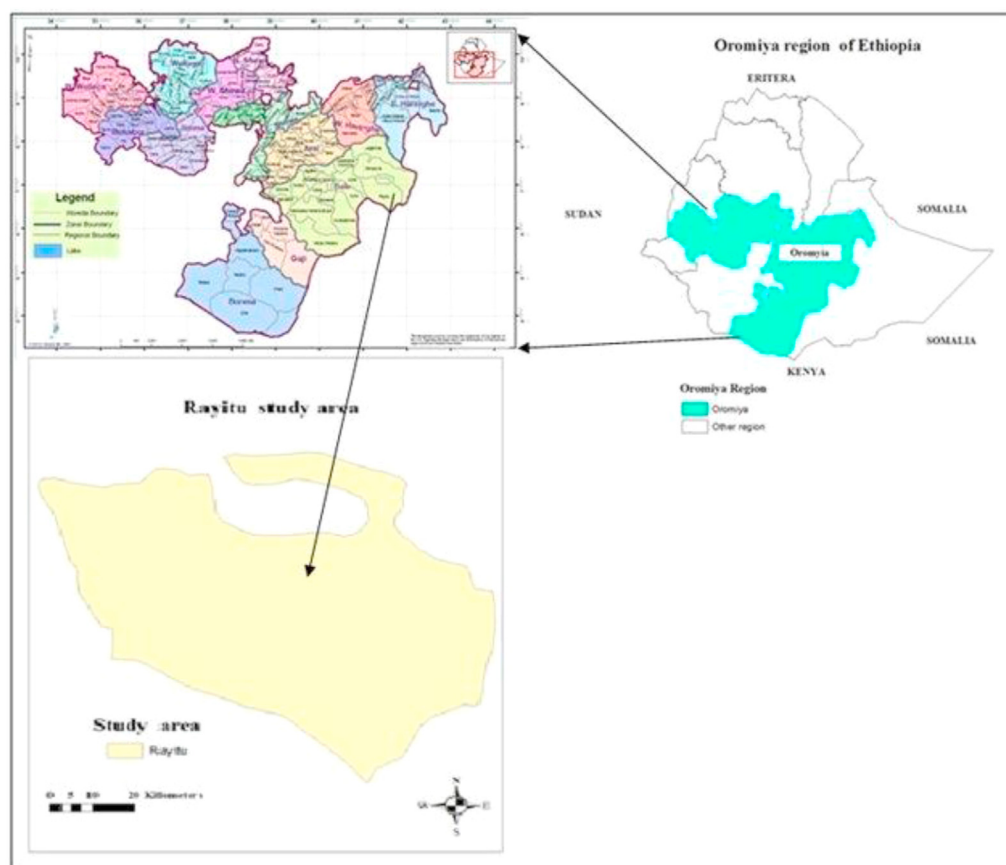
is vital to bear in mind that these coping strategies are not costless in terms of wellbeing [4,26].

Evidences in Ethiopia and sub-Saharan Africa document that shocks are detrimental and often pose often consumption shortfalls for the poor [8,16,20,29]. As a response, households need to design coping strategies to meet consumption requirements [17,20]. On the other hand, different studies report that idiosyncratic shocks have little effect on consumption, and families often have multiple responses for consumption smoothing [29]. These risk coping mechanisms as a response to consumption shortfalls include labor (more working hours, other livelihood activities, diversification, migration), aid and credit (formal or informal), sale of productive assets (livestock, houses, land), consumption related (consume less, food composition changes) [5,28,29]. Risk coping mechanisms can also differ across countries and regions, type of shocks, wealth categories, etc [28,29]. For instance, finding of previous empirical study highlight, the rich can move to a different income generating options at times of shocks [29]. On the other hand, poor households are likely to go for consumption rationing and often rely on public food aid [5,28,29] indicate that labor responses as coping strategy in Amazonian tropical forests are largely determined by the environment and household characteristics. The existing empirical evidences do focus on a specific risk coping response (for instance, labor response [28], or food rationing vs. other income generating response [29]) in the household. Hence, it is vital to analyze different responses of households at times of shock, and the interdependence between coping strategies. Exploring the risk coping strategies and the determinants of these coping strategies is pertinent to better target risk mitigation and coping strategies. Risk coping strategies can also be specific to the context, given the macro and microeconomic situation. The main research question of this paper was to analyze ex-post coping strategies and their determinants in rural Ethiopia.

## 2. Methods

### 2.1. Study area and design

The study area is well known for climatic shocks followed with livelihood shocks for the community. A cross sectional study was conducted in Rayitu district, lowlands of Bale Zone of Oromia Regional State. Bale Zone occupies the southeastern part Oromiya Regional State (Figure 1). It has different climatic zones ranging from semi-arid to afro-alpine moorland. The livelihood profile of Oromia region showed that the zone is categorized into two livelihood systems: Bale pastoral and Bale agro-pastoral livelihood zones. The zone is characterized by pastoralism and agro-pastoralism which are the main land use systems and livestock's are the main assets of the community. Data were collected from Rayitu district, which is one of the 20 districts in Bale pastoral livelihood zone. It is a lowland dry agro-ecology with a temperature range of 18–42 °C and rainfed dependent mixed crop and livestock production predominates, and the area suffers a food deficit every year. The rainfall pattern is bimodal type (March–June and September–October) with erratic distribution of rain with an average annual rainfall of about 450 mm [30, 31, 32]. Drought and livestock disease which are climate related hazards recurrently affecting the Rayitu woreda pastoralist. Due to recurrent drought the woreda is facing with water shortage for both human and livestock consumption. Rayitu woreda is known to be chronically food insecure mainly drawn from climate change related calamities [32]. Ten kebeles (i.e. lowest grassroots administrative unit of Ethiopia) were selected randomly after obtaining their lists. The allocation of individuals to Kebeles was made on the basis of population-proportionate to size (PPS) sampling technique. Once the number of households in the kebeles was identified, the households with the target population to be interviewed were picked randomly from the



**Figure 1.** Administrative map of the study area.  
Source: Teshome Abate (July, 2012).

household list of the kebele administration. A total number of 1,402 households participated in this study.

### 2.2. Method of data analysis

The dependent variable in this study was ex-post risk coping mechanisms. The independent variables used were socio-demographic and economics characteristics, infrastructure and service related characteristics of the household. Data were analyzed using Statistical Package for Social Science (SPSS) version 20. Correlation analysis was used to analyze the association between independent and dependent variables. A simple descriptive statistic such as percentage and frequency were applied to analyze the sample respondents. The pairwise correlation coefficient between risk coping strategies was described.

After an exogenous shock, households vulnerable to shock are expected to adopt coping mechanisms. Following previous empirical studies [28,29], the likelihood of adopting a certain coping strategy as a response to an exogenous shock ( $Y_i$ , Eq. (1)) can be estimated by a linear function as:

$$Y_i = f_i(R_i, S_i, H_i) + e_i \tag{1}$$

Nonetheless, multiple risk mitigation options are possible, and the empirical procedure should be flexible enough to allow analyzing them as joint decisions. For this, the application of a three stage least squares technique, or seemingly unrelated regression is required [33, 34, 35]. This requires simultaneous estimation of risk coping mechanisms, the following equation ( $Y_{1i}$  to  $Y_{4i}$ , Eq. (2)) as:

$$\left. \begin{aligned} Y_{1i} &= f_1(R_i, S_i, H_i) + e_{1i} \\ Y_{2i} &= f_2(R_i, S_i, H_i) + e_{2i} \\ Y_{3i} &= f_3(R_i, S_i, H_i) + e_{3i} \\ Y_{4i} &= f_4(R_i, S_i, H_i) + e_{4i} \end{aligned} \right\} \tag{2}$$

$Y_{1i}$  to  $Y_{4i}$  in Eq. (2) are the major risk coping mechanisms of household  $i$  as a response to an exogenous shock. Similarly, ( $R_i$ ), ( $S_i$ ) and ( $H_i$ ) respectively represent vectors of the resource endowments, access to service and infrastructure and socio-demographic characteristics of rural households. In these equations, we assume that  $e_{1i}$ ,  $e_{2i}$ ,  $e_{3i}$  and  $e_{4i}$  are error terms with covariance different from zero [33,35]. Alternatively, we also estimate equations from (2) using Seemingly Unrelated Regression – SUR by assuming interdependence between the equations [34]. The Breusch-Pagan test of independence in the SUR rejects the null hypothesis of no interdependence between the coping mechanisms. The statistically significant correlations between the error terms in the equations suggest the use of three-stage least squares (3SLS). This indicates that the simple ordinary least squared (OLS) estimation is likely to be biased. We present the determinants of risk coping mechanisms in a step wise regression.

### 2.3. Summary statistics

Results in Table 1 shows the summary statistics of the food sources for the sample households at harvesting time (December–February) and at hunger season (March–May). About 61% of sample households are dependent on own production for staple food at harvest time. Around 20% of the sample (n = 218) rely on market (purchase) as their source of staple food at the harvest season. The remaining 18% of the sample

households are dependent on food aid at the time of harvest (Table 1). This indicates that a substantial proportion of the sample households face difficulties to get adequate food even at the time of harvest.

Table 1 also shows that 38.5%, 35% and 26.5% of the sample households depend on own production, purchased food, and food aid respectively. There is a significant decrease in the proportion of households that rely on own production at the hunger season. On the other hand, this shows a substantial increase in the proportion of households that are dependent on purchase and food aid as their main source of food during hunger season. This reveals the fact that a significant proportion of the households are vulnerable to drought, and food insecurity is an important concern in the study area. In addition, a significant proportion of households rely on food aid during in the drought season (Table 1).

In this study, rural households were asked to list ex-post coping strategies used by the household. Furthermore, they were asked to rate the frequency of application of their coping strategies in a range from 1 (never) to 5 (everyday). The reference period was the last four weeks prior to the date of the interview. We report the complete list of ex-post risk coping strategies with the percentage of people who employ these strategies at least once in a week in Table 2. We also report the rank of each these risk coping strategies in the study area based on the frequency of application.

In this paper, we analyze the interdependence between the major risk coping mechanisms and their determinants. To reduce methodological complications for the empirical analysis, we restrict ourselves to analyze the first four risk coping strategies. Figure 2 shows the major coping strategies at times of food shortage by sample households in Rayitu district in Ethiopia in the reference period.

The most frequently used coping strategy by sample households is consumption of less preferred and less expensive foodstuffs. About 40% of the sample households use this coping strategy at least once in a week (Figure 2 & Table 2). Borrowing food from relatives and neighbors is the second most important ex-post risk coping strategy, and about 31% of households practice it at least once in a week at the time of food shortage. Consuming seed stocks and feeding children first before adult members ranked third and fourth respectively, with about 27% of the sample households practice them at least once in a week. The intensity of application of ex-post risk coping strategies by a substantial proportion of households indicate that these households are highly vulnerable, and their food security condition can deteriorate even in minor shock.

Other ex-post risk coping strategies include limit size of food at meal times, purchase food on credit, reduce the number of times of meals, gathering of wild fruits, hunting or harvesting of immature crops, feeding working members of the family first, sending members to eat elsewhere and skipping the day without eating are among the frequently used coping strategies as a response to food shortage (Table 2). And these ex-post risk coping strategies for consumption shortfalls are practiced by more than 25% of the sample households at least once in a week.

Table 3 summarizes the demographic, socio-economic, infrastructure and service related characteristics of the household. About 87% of the sample household heads are illiterate. Sample households have an average family size of about 6 people, cultivated land of about 1 ha, livestock of around 6 in TLU (Tropical Livestock Unit), and an average self-reported annual income of about 9,128 Eth.Birr (Exchange rate 1 USD = 21 Ethiopian Birr (ETB)). Their houses are located on average about 3 h and 1.4 h further away from the market and the source of drinking water respectively.

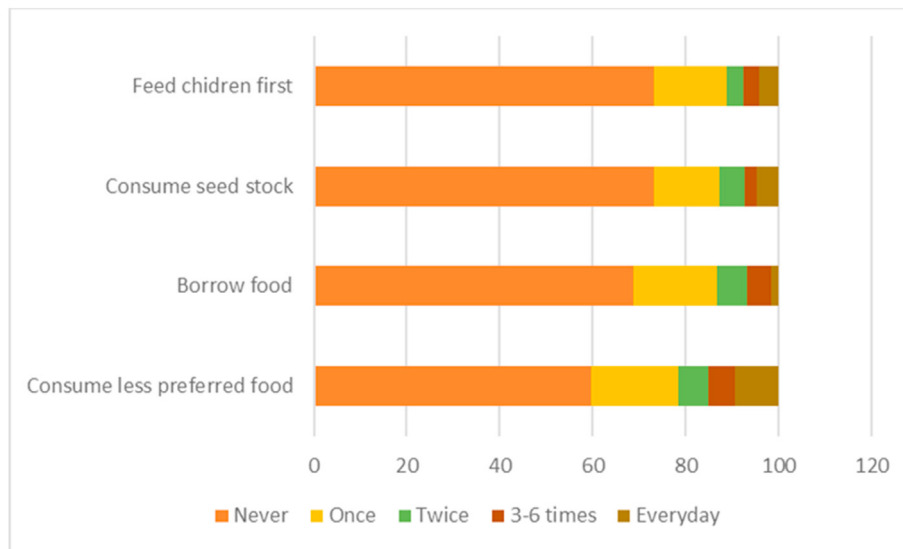
**Table 1.** Food source in hunger season among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

Food source	Harvest period		Hunger season	
	N	% (std. dev.)	N	% (std. dev.)
Own production	662	61.46 (48.69)	427	38.50 (48.69)
Purchase food	218	20.24 (40.19)	386	34.98 (47.67)
Relay on food aid	197	18.29 (38.67)	394	26.56 (44.18)

**Table 2.** Full list of coping strategies to shock among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

Coping strategies	Never (%)	Once per week (%)	Twice per week (%)	3-6 times per week (%)	everyday	Mean <sup>++</sup>	Rank
Consume less preferred and less expensive	59.68	18.81	6.48	5.67	9.36	1.862	1
Borrow food, help from relatives & friends	68.74	17.93	6.58	5.32	1.44	1.527	2
Consume seed stock	73.29	13.85	5.58	2.52	4.77	1.516	3
Feed children first	73.11	15.74	3.60	3.51	4.05	1.496	4
Limit size at mealtimes	72.88	16.22	3.96	3.60	3.33	1.483	5
Purchase food on credit	70.99	18.92	4.68	3.96	1.44	1.459	6
Reduce number of meals	75.67	13.64	4.49	4.76	1.44	1.426	7
Gather wild fruits, hunt or harvest immature crops	79.87	11.23	3.86	3.86	1.17	1.353	8
Feed working members first	80.40	12.05	2.70	3.60	1.26	1.333	9
Send members to eat elsewhere	85.64	9.61	1.97	1.89	0.90	1.228	10
Skip the day without eating	82.05	9.16	3.95	3.86	0.99	1.326	11

Note: <sup>++</sup> 1 = Never, 2 = Once per week, 3 = Twice per week, 4 = 3–6 times per week, 5 = Everyday.



**Figure 2.** Coping strategies with intensity of use among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

**2.4. Ethical considerations**

The study was performed with the approval of Ethical clearance from the respective zonal health office and verbal consent was obtained from each study participants. All methods were carried out in accordance with the approved guidelines and regulations. The participants were briefed about the objectives and importance of the research before the commencement of interviews. Prior to initiating the interview, the purpose of the study, manner of the questioning and confidentiality assurance was verbally communicated to the participants. The participants

were informed on having full rights to participate or not to participate in the study as well as to withdraw any time during the interview.

**3. Results**

As discussed in the previous section, we rank the list of coping strategies using the data of frequency of use of the strategies by sample households. We present the pairwise correlation coefficient between risk coping strategies in Table 4. Despite a variation in the magnitude of the correlation coefficient, the result confirms the strong interdependence

**Table 3.** Descriptive statistics of explanatory variables among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

Variables	Mean	Std dev.
Age (years completed)	25.875	5.609
Literacy (0 = illiterate, 1 = literate)	0.130	0.337
Family size	5.637	2.119
Cultivate land (in hectares)	1.055	1.058
Livestock (in TLU)	6.471	7.342
Average annual income (in Birr)	9128.164	10422.8
Distance to the market (in hours)	3.00	1.45
Distance to the drinking water source (in hours)	1.40	1.20

NB: at the time of study, exchange rate 1 USD = 21 Ethiopian Birr (ETB).

between risk coping strategies in the study area. Furthermore, the Breusch-Pagan test of independence in the SUR (with the Chi2 = 724.5 and Pr = 0.00) reject the null hypothesis of no interdependence between the coping mechanisms. The statistically significant correlations between the error terms in the equations suggest the use of 3SLS, and indicate that the simple OLS estimation is likely to be biased. In what follows, we present the determinants of risk coping mechanisms in a step wise regression. In Table 5, we show the relationship between resource entitlements and income with the major coping strategies.

The result in Table 5 indicates that the resource holdings and income of the households significantly determine the ex-post risk coping strategies. These relationships are consistent, except little variation with the magnitude of coefficients, on both the estimation methods. The intensity of use of the each of the major ex-post risk coping strategies (consumption of less-preferred and less-expensive food, borrowing of food, consumption of seed stocks, and feeding children first at times of food shortage) is inversely related with the livestock holding (in TLU) of households in the sample. In terms of the magnitude of the effect, the ownership of livestock has stronger effect ( $\alpha = -0.060$ ) on the practice of consuming less-preferred and less-expensive food. Livestock ownership has less strong effects ( $\alpha \leq -0.026$ ) on the other risk coping strategies.

Except in the case of borrowing food, income of the household is negatively associated with the intensity of coping mechanisms. The effect of income on ex-post risk coping strategies is less strong in magnitude, compared to livestock ownership and landholding. Similarly, landholdings of the households do positively influence the intensity of use of ex-post risk coping strategies except for borrowing food. The magnitude of effect of landholding is stronger ( $\alpha = -0.292$ ) on the consumption of less-preferred and less-expensive foodstuffs as an ex-post risk coping strategy.

In Table 6, we present the OLS and 3SLS estimation results of the relationships between ex-post risk coping mechanisms, resource holdings and infrastructure and access to services, and other socio-demographic variables. Like the estimation result presented in Table 6, the Breusch-Pagan test of independence in the SUR (with the Chi2 = 227.4 and Pr = 0.00) reject the null hypothesis of no interdependence between the estimation of the relationship between explanatory variables and ex-post risk coping mechanisms. This result suggests the use of 3SLS estimation for the inference purpose. The use of simple OLS may lead to biased coefficient estimates due to the strong correlation between the error terms of equations presented in (2) described under method of data analysis section.

As shown in Table 6, the relationship between resource holdings and income with coping mechanism remain the same when we include infrastructure, access to services and household socio-demographic variables. Livestock ownership is inversely related with the consumption of less-preferred and less-expensive foodstuffs ( $\alpha = -0.064$ ), borrowing of food ( $\alpha = -0.018$ ), consumption of seed stocks ( $\alpha = -0.033$ ), and feeding children first ( $\alpha = -0.019$ ). Likewise, income of the household is

negatively associated with the consumption of less-preferred and less-expensive foodstuffs and feeding children first. Landholding is positively associated with the intensity of practicing ex-post risk coping mechanisms with the exception of borrowing of food.

Similarly, we found strong relationship between ex-post risk coping mechanism, access to services and household socio-demographic variables. Distance to the market is negatively associated with the consumption of less preferred and less expensive food ( $\alpha = -0.204$ ), with borrowing of food from network members ( $\alpha = -0.093$ ), and feeding children first ( $\alpha = -0.151$ ) at times of food shortage. Similarly, access to credit (either formal or informal) is significantly and positively associated with the major household risk coping strategies ( $\alpha = 0.385$  for consumption of less-preferred and less-expensive food,  $\alpha = 0.446$  for the consumption of seed stocks, and  $\alpha = 0.287$  for feeding children first).

Demographic variables of the household are also associated with risk coping mechanisms. Age of the household head has negative effect on the practice of borrowing of food ( $\alpha = -0.034$ ) and feeding children first ( $\alpha = -0.021$ ) as a response to food shortage. Education has a positive and significant effect the consumption of less-preferred and less-expensive food items and consumption of seed stocks at times of food shortage as an ex-post risk coping strategy. In the estimation of these two ex-post coping mechanisms, households with literate heads are likely to have higher intercept compared to those with illiterate household heads. In the same way, family size positively influences the frequency of use of borrowing of food ( $\alpha = 0.053$ ) and feeding children first ( $\alpha = 0.093$ ) as ex-post risk coping strategy at times of food shortage.

#### 4. Discussion

Our analysis confirms that rural households in the district experience shock, and they are also vulnerable to shock. When rural households experience shock, consumption of less-preferred and less-expensive food, borrowing food from relatives and friends, consume seed stock, and feeding children first appear to be the major ex-post risk coping strategies. This result goes in line with previous findings in different parts of the developing world [5,28,29]. For instance, according to Harrower and Hoddinott (2005) [29] shows that poor rural households rely on credit or gifts from network members for consumption rationing in Mali. Similarly, Heltberg and Lund (2009) [5] documented the major responses for shock in Pakistan including consuming less or using labor as income source, reliance on saving and insurance, and assistance based (informal or formal).

Despite some improvements in food availability and access in the last couple of decades with economic progress and productivity growth in many countries, food insecurity remains a global concern [36,37]. This is particularly relevant in sub-Saharan Africa where the number of vulnerable people continues to rise [6,38,39]. Climate variability pose a substantial threat to the resource poor and vulnerable drier areas of

**Table 4.** Pairwise correlation coefficient between risk coping strategies among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

Coping strategies	Less preferred	Borrow food	Seed stock	Children first	Limit size	Credit purchase	Number of meals	wild fruits, hunting	Working members first	Send members	No eating
Less preferred											
Borrow food	0.462***										
Seed stock	0.539***	0.410***									
Children first	0.307***	0.416***	0.298***								
Limit size	0.265***	0.379***	0.315***	0.629***							
Credit purchase	0.435***	0.710***	0.487***	0.400***	0.352***						
Number of meals	0.298***	0.493***	0.371***	0.531***	0.471***	0.466***					
wild fruits, hunting	0.303***	0.648***	0.482***	0.429***	0.330***	0.690***	0.519***				
Working members first	0.282***	0.538***	0.365***	0.520***	0.419***	0.509***	0.649***	0.551***			
Send members	0.181***	0.433***	0.428***	0.402***	0.365***	0.467***	0.471***	0.589***	0.509***		
No eating	0.237***	0.539***	0.378***	0.468***	0.369***	0.549***	0.717***	0.552***	0.711***	0.532***	

Note: \*\*\* represent a significance level of the correlation between coping strategies at 1% probability.



**Table 5.** Relationship between resource entitlements, income and coping strategies among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

Coping mech.	Consume less preferred food		Borrow food		Consume seed stock		Feed children first	
	OLS	3SLS	OLS	3SLS	OLS	3SLS	OLS	3SLS
Model								
TLU	-.060*** (.007)	-.060*** (.007)	-.020*** (.005)	-.019*** (.005)	-.026*** (.006)	-.025*** (.005)	-.018*** (.006)	-.018*** (.006)
Land	.286*** (.050)	.292*** (.049)	-.038 (.039)	-.032 (.038)	.259 (.042)	.153*** (.041)	-.081* (.043)	-.081* (.043)
Income	-1e-05** (5e-06)	-1e-05** (5e-06)	-2e-06 (4e-06)	-2e-06 (4e-06)	8e-06* (4e-06)	8e-06* (4e-06)	-9e-06** (4e-06)	-9e-06** (4e-06)
N	752	749	752	749	754	749	752	749

Note: \*, \*\* and \*\*\* represent 10%, 5% and 1% probability levels.

**Table 6.** Relationship between resource entitlements, income, infrastructure, household characteristics and coping strategies among respondents in Rayitu woreda, Oromiya Region, Ethiopia.

Coping mech.	Consume less preferred food		Borrow food		Consume seed stock		Feed children first	
	OLS	3SLS	OLS	3SLS	OLS	3SLS	OLS	3SLS
Model								
TLU	-.063*** (.008)	-.064*** (.008)	-.018*** (.005)	-.018*** (.005)	-.034*** (.007)	-.033*** (.007)	-.019*** (.007)	-.019*** (.007)
Land	.261*** (.054)	.262*** (.053)	.052 (.037)	.058 (.036)	.243*** (.046)	.238*** (.045)	-.059 (.046)	-.057 (.045)
Income	-2e-05*** (7e-06)	-2e-05*** (7e-06)	-1e-06 (5e-06)	-6e-07 (5e-06)	6e-06 (6e-06)	6e-06 (6e-06)	-1e-05** (6e-06)	-1e-05** (6e-06)
Market dist.	-.202*** (.027)	-.204*** (.027)	-.098*** (.019)	-.093*** (.018)	-.019 (.023)	-.013 (.023)	-.152*** (.023)	-.151*** (.023)
Credit access	.395*** (.109)	.385*** (.108)	.012 (.075)	.017 (.073)	.435*** (.094)	.446*** (.091)	.273*** (.093)	.287*** (.092)
Age	-.002 (.012)	-.002 (.012)	-.035*** (.008)	-.034*** (.008)	-.003 (.011)	-.002 (.010)	-.020** (.010)	-.021** (.010)
Literate	.532*** (.160)	.523*** (.159)	.167 (.111)	.152 (.108)	.195 (.137)	.221* (.134)	-.173 (.137)	-.168 (.135)
Family size	.038 (.031)	.041 (.031)	.052** (.022)	.053** (.021)	-.017 (.027)	-.023 (.026)	.089*** (.027)	.093*** (.026)
N	521	519	521	519	523	519	522	519

Note: \*, \*\* and \*\*\* represent 10%, 5% and 1% probability levels.

sub-Saharan Africa, and many countries rely on international food aid [5,6,11,16,17]. Ethiopia is among the countries severely hit by climate change, and experience famines in the last few decades with disastrous consequences [15,16,20]. Households adopt ex-ante and ex-post risk coping mechanisms to mitigate and adapt shock [5,11,28]. Analyzing coping mechanism is vital to design policies and strategies that adequately target vulnerable household. We analyze the factors that influence household level of risk coping mechanisms at times of food shortage in rural area.

In this study, we do find evidence that resource holdings and income of the household are associated with ex-post risk coping strategies of vulnerable households at the time of food shortage. Livestock holding and income of the household are negatively associated to risk coping mechanisms, indicating the lower level of resilience of the poor. Poor households are vulnerable to shocks and rely on ex-post risk coping mechanism at time of food shortage. Asset holding and access to resources are crucial to determine food security, child malnutrition and the likelihood of escaping poverty trap [19,40]. At times of shock, resource poor rural households use consumption related coping mechanisms (for instance, consuming less preferred food). Conversely, rich rural households may have other means to cope with shock (e.g. non-farm income) and are less likely to use consumption rationing. This result is consistent with previous research where they show the higher likelihood of consumption rationing by poor households [5,29]. Parallel to this, Alem and Soderbom (2012) [12] show that price volatility adversely affected resource poor households in Ethiopia. Similarly, coping strategies are positively associated with landholding. This could be associated with the direct association of shock and food production (for instance, famine and crop failure). Rural households who predominantly rely on crop production will be severely hit by drought. When the hit is strong, households respond through consumption rationing. This calls for interventions on infrastructure that can help to sustain production (e.g. irrigation). Furthermore, our study confirms that these risk coping mechanisms are interdependent with each other. This tells that analyzing the risk coping strategies independently may bias the estimation. This supports the notion of addressing the problem of risk through integrated

rural development strategies (and policies) to help the poor to improve the vulnerability to shock and help to escape out of poverty.

Distance to the market and access to credit do also significantly determine the use of ex-post risk coping mechanisms. Distance to the market is negatively associated with household coping mechanisms except for the consuming seed stocks as a coping strategy. Similarly, access to credit (either formal or informal sources) is significantly and positively associated with the major ex-post risk coping strategies. In addition to the implications of infrastructure development and improved access to financial and output markets for improving capacity for adaptation to risk, this result highlights their role in shaping the ex-post risk coping mechanisms in rural Ethiopia. In this study, we have also got a significant relationship between demographic variables (age and literacy of the household head, and family size) and ex-post risk coping mechanisms in the sample households. A risk coping mechanism optimal to a large family might not be suitable for a small family. For instance, Takasaki et al. [28] show that the abundance of labor in the household is crucial to determine the risk coping strategy in Amazonian tropical forests. This implies that risk coping mechanisms are family characteristics dependent, and a household is likely to choose a risk coping mechanism that fits with the characteristic of the household.

## 5. Conclusion

In conclusion, using data from South East Ethiopia, we show that rural households are vulnerable to shock, and adopt interdependent risk mitigation strategies. Consumption of less-preferred and less-expensive food, borrowing food from relatives and friends, consume seed stock, and feeding children first appear to be the major ex-post risk coping strategies. These risk coping mechanisms are determined by resource holdings and income levels of the rural households, their access to market and credit, and can be shaped by their socio-demographic characteristics. Based on this empirical evidence, we argue that strategies and interventions to improve the food security condition and reduce the rural households' vulnerability to shock that leads to drought and hunger should be targeted to fit to the needs and priorities of households.

## Declarations

### Author contribution statement

Betemariam Gebre: Conceived and designed the experiments; Wrote the paper.

Habtamu Yesigat Ayenew; Sibhatu Biadgilign: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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### Data availability statement

Data will be made available on request.

### Declaration of interests statement

The authors declare no conflict of interest.

### Additional information

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