Coping with climate shocks: The complex role of livestock portfolios

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Alejandro Acosta, Animal Production and Health Division (AGA), FAO

Francesco Nicolli, University of Ferrara and FSR Climate (European University Institute)

Panagiotis Karfakis, Agricultural Development Economic Division (ESA), FAO

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Coping with climate shocks: The complex role of livestock portfolios

Alejandro Acosta [a,*], Francesco Nicolli [b,d], Panagiotis Karfakis [c]

[a] Animal Production and Health Division, Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, 00153 Rome, Italy
[b] Department of Economics and Management, University of Ferrara, Via Savonarola 9, 44121 Ferrara, Italy
[c] Agrifood Economics Division, Food and Agriculture Organization of the United Nations (FAO), Viale delle Terme di Caracalla, 00153 Rome, Italy
[d] Florence School of Regulation – Climate, European University Institute, Italy

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ABSTRACT

The effects of climate change are alarming, with projections suggesting that weather events will become more extreme and frequent, affecting households in regions that are already highly vulnerable. This study explores the role of livestock as a household coping strategy against climate shocks. Using quantile regression analysis, we examine the potential of different animal species to buffer the effects of drought on income and consumption. We assemble a unique global dataset that combines household-level socioeconomic information with a multi-scalar climatic drought index. Our study confirms the significant, yet context-dependent, role of livestock portfolios as a buffering mechanism against the effects of drought on household income and consumption. The effect is driven by the specific type of animal species, length of the shock, and socioeconomic features. These findings could assist the design of livestock-oriented policy interventions. The novel contributions of this study include the first cross-country analysis of the buffering effect of livestock against drought; use of the standardized precipitation-evapotran spiration index as a multi-scalar drought indicator -; and a uniquely extensive dataset allowing for the analysis of interactions.

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The LPL is a platform that serve as science-policy interface between decision makers, researchers, and practitioners to support the identification of evidence based policy instruments to enhance the contribution of the livestock sector to the achievement of SDGs' targets.

Objective & Main Results

Assess the role of livestock assets, in particular small-ruminants, as ex-ante coping strategy against external shocks.

Our study show that the role of the **livestock portfolio** as a **buffering mechanism** tends to be **context-specific** and varies depending on the **length of the shock**, the **composition of the livestock portfolio**, household **socioeconomic features**, and the specific **regional conditions**.

Small ruminant, and goats in particular, can help rural farmers to mitigate the adverse effect of a climate shock.

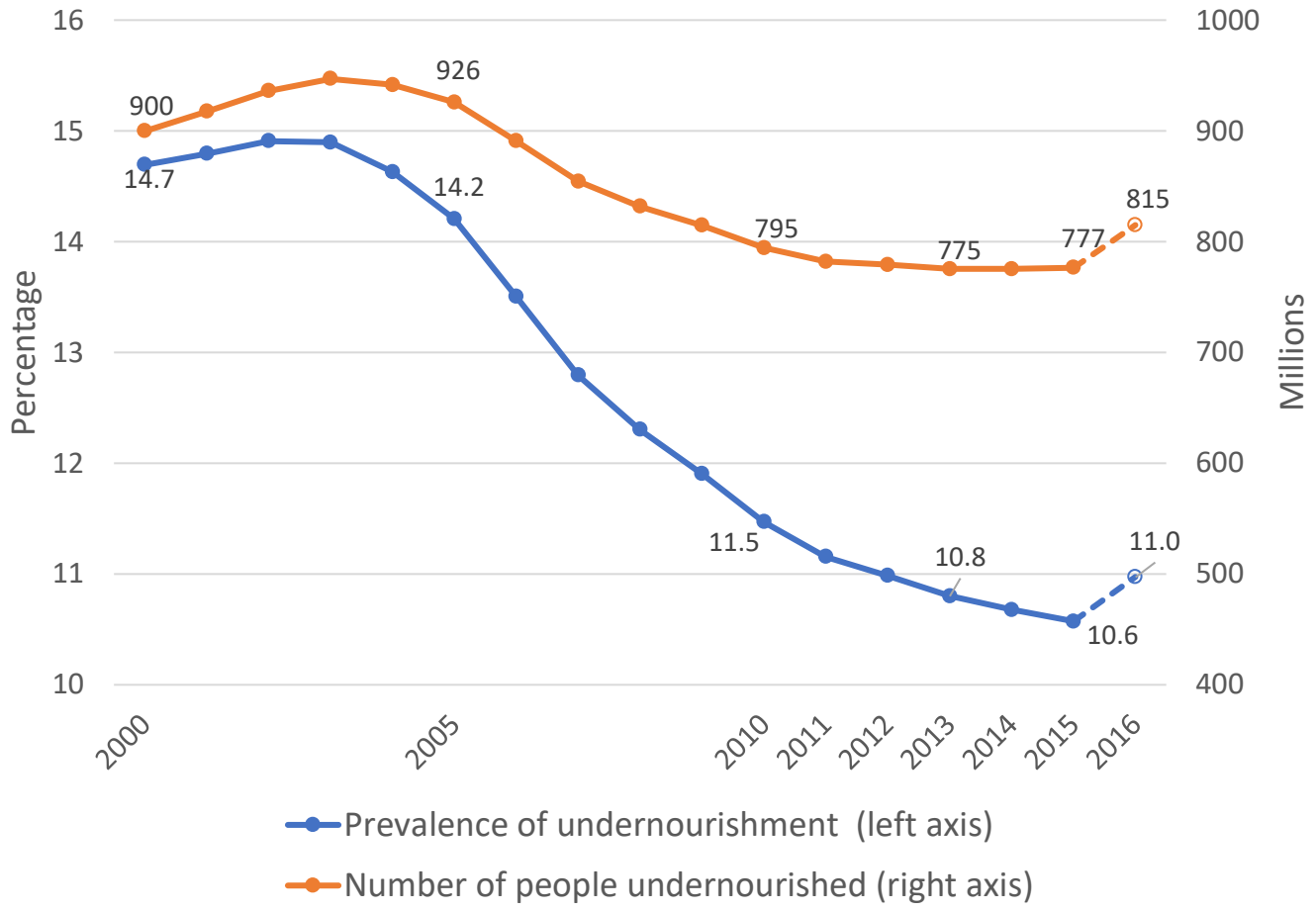
Key message

- The achievement of many of the SDGs will require targeted policy interventions.
- Some of these actions should be oriented to strengthen rural households' resilience capacity.
- Protecting livestock assets, in particular small ruminants, should be among the key policy interventions.

- By 2030, build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters.

- By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

Number of undernourished people in the world



Source: FAO, The State of Food Security and Nutrition in the World, 2017

The number of people suffering hunger increased from 777 million in 2015 to 815 million in 2016.

Major causes involved the presence of external shocks:

- ✓ Droughts
- ✓ Floods
- ✓ Pests and diseases
- ✓ Conflicts

(FAO, 2017)

Coping with multiple, more frequent, and more severe external shocks.

Exogenous shocks to income and consumption can be devastating for poorly equipped **low-income households**.

This is particularly true for **rural households** in areas where formal and informal **safety nets are absent** and there is **no financial support**.

Difficulties are magnified when shocks hit all members of a community **simultaneously**, as is the case with climate shocks.

Common coping strategies

EX-ANTE:

- Precautionary savings to smooth consumption.
- Diversification into income-generating activities.

EX-POST:

- Selling productive assets during hard times.
- Using formal or informal safety nets.

How significant are livestock assets as resilience strategy for rural households?

Heterogeneous effect of drought on animals

- The **vulnerability** of livestock to high temperatures can **vary** according to species, genetic potential, life stage, management, production system, and nutritional status.
- **Small ruminants** – thanks to their ability to graze and utilize a wider range of poor-quality foraging – are generally **more resilient** to droughts in comparison with larger ruminants → coping strategy.
- **Goats** are more **tolerant** to **thermal stress** than cows because of their greater sweating rate and lower body weight to surface area ratio → greater heat dissipation.

Diversification as a possible coping strategy

Livestock portfolio diversification is significantly associated with a **shorter period of food deficit** and **better dietary intake** under severe drought.

POSSIBLE COPING STRATEGY (WITH A DIVERSIFIED PORTFOLIO):

In the short run (immediately after the shock):

- Selling small animals (Sheep, Poultry or goats)
- Saving productive assets (Cattle or other animal for draught power) for the long run

A possible chain of reaction

- Farmers tend to first **rely on stocks of grain** to ensure consumption and preserve their livestock assets.
- Livestock holders are usually forced to **first sell small animals**, such as poultry, pigs, sheep, and goats
- **Major livestock assets**, such as cows, are left to be **sold if the drought becomes more severe**.
- Finally, some rural households respond to the income shock by **migrating** to seek jobs in **non-agricultural sectors**.

Data

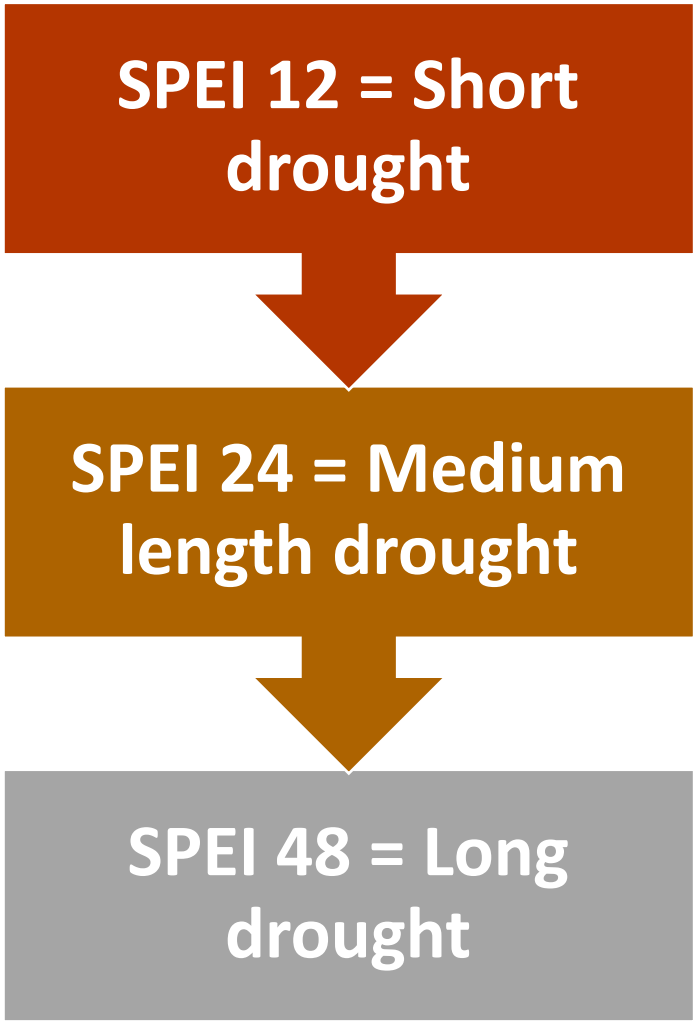
- We assembled a unique and original dataset of more than 150,000 observations from **19 countries** spread across **4 continents**.
- We merged household-level **socioeconomic** information across the world from the FAO Smallholders Dataportrait with a multi-scalar **drought index** from the Global SPEI data-base.
- Information is not equally distributed across continents, with most respondents originating from Africa and Asia.

Socio-economic Data

Variable name	Variable Description
Income	Total gross household income (Const. 2009 Int. $). It "consists of all receipts whether monetary or in kind (food, goods and services) that are received or produced by the household or by the individual members of the household at annual level, but excludes windfall gains and other such irregular and typical onetime receipts". Log in the analysis.
Consumption	Per capita household consumption expenditure (Const. 2011 Int. $). It consists of all expenditures whether monetary or in kind (for food, goods and services) that are spent by the household or by the individual members of the household at annual level. It excludes irregular and typical onetime expenditures. Log in the analysis.
Agricultural income	Share of income from farm activities, which includes crop production, crop by-products (only when it is possible to distinguish it from crop production), livestock and livestock by-products.
Non-agricultural income	Share of household's income from non-agriculture economic activities.
Male labour availability	Number of males in the households with age from 14 to 60 years
Female labour availability	Number of females in the households with age from 14 to 60 years
Food production	Share of food produced and consumed in household
Education	Education of the household head (yrs.)
Household size	Number of persons per household
Female head	Female headed household
Age head	Age of head of household
Married head	Head of household married
Widow head	Female head of household is widow
Cattle	Livestock Unit – Cattle
Sheep	Livestock Unit – Sheep
Goats	Livestock Unit – Goats
Pigs	Livestock Unit – Pigs
Poultry	Livestock Unit – Chicken

Standard Precipitation and Evapotranspiration Index (SPEI)

- The SPEI, is a multi-scalar index which measures drought severity according to **intensity** (temp.) and **duration** (length).
- The SPEI includes in its calculation temperature data, as extreme **high temperatures** dramatically **increased evapotranspiration** and, consequently, **intensify drought** intensity.
- We exploit three indices— **SPEIs 12, 24, and 48**—in the analysis
- Time scales **below 12 months** show a **high frequency** of drought and moist periods of **short duration**. **Longer time scales** account for droughts of **longer duration** and **lower frequency**.



Main variables of interest

- **Income.**
- **Consumption.**
- **SPEI** is a proxy for severe drought (the 5% worst drought).
- **Livestock Unit (LU)** is measure of livestock that allow comparisons and is easier to interpret than heads of livestock.

A step-wise approach

1. What is the effect of a climate shock on a rural household's income / food consumption level?

2. Are households' owing livestock assets more resilient to climate shocks?

3. Does a diversified livestock portfolio that includes small-ruminants have a significant effect?

Econometric specification

$$\ln(O_{it}) = \alpha_i + t_t + \beta_1 SPEI_{it} + \beta_2 Cattle_{it} + \beta_3 SPEI_{it} * Cattle_{it} + \beta_4 S\&G_{it} + \beta_5 SPEI_{it} * S\&G_{it} + \beta_6 Pigs_{it} + \beta_7 SPEI_{it} * Pigs_{it} + \beta_8 Poultry_{it} + \beta_9 SPEI_{it} * Poultry_{it} + \gamma_{it} X_{it} + \varepsilon_{it}$$

Where:

O_{it} is total **consumption** or **income** of household *i* in year *t;*

α_i is a set of country dummy variables;

t_t is the year fixed effect;

$SPEI_{it}$ is the severe **drought** dummy derived from the SPEI index;

Poultry refers to the total poultry LU, *Pigs* represents pigs, *Sheep* represents sheep, *Goats* represent goats, and *Cattle* represents cattle.

Effect of climate shocks

Using this regression framework, we estimate:

the **direct effect** of the climate shock;

the **direct effect of** livestock species and income or consumption;

the **buffering effect** of different livestock species on an extreme climate event.

Quintile regression

- We used a **quintile regression** analysis to investigate the role of the rural household livestock portfolio as a buffering mechanism against drought.
- This mean that we replicate the analysis in **5 fub-samples** of the population divided by **income** level.

Income effect of livestock portfolios as a buffering mechanism.

SPEI	SPEI 12		SPEI 24						SPEI 48	
Income	Quintile 1	Full Sample	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	Full Sample	Quintile 1	Full Sample
Cattle	0.022***	0.014***	0.022***	0.028***	0.038***	0.047***	0.005	0.014***	0.023***	0.014***
	[0.001]	[0.004]	[0.001]	[0.001]	[0.001]	[0.001]	[0.004]	[0.004]	[0.001]	[0.004]
Sheep	0.062***	0.082***	0.060***	0.029***	0.029***	0.011	0.143***	0.083***	0.053***	0.079***
	[0.011]	[0.011]	[0.011]	[0.009]	[0.008]	[0.009]	[0.052]	[0.011]	[0.011]	[0.011]
Goats	0.103***	0.019	0.103***	0.091***	0.076***	0.049***	0.003	0.019	0.106***	0.020
	[0.004]	[0.020]	[0.004]	[0.003]	[0.003]	[0.003]	[0.018]	[0.020]	[0.004]	[0.020]
Pigs	0.067***	0.037***	0.067***	0.100***	0.104***	0.095***	0.009	0.037***	0.067***	0.037***
	[0.003]	[0.013]	[0.003]	[0.002]	[0.002]	[0.002]	[0.013]	[0.013]	[0.003]	[0.013]
Poultry	0.071***	0.062***	0.067***	0.116***	0.169***	0.178***	0.024	0.062***	0.072***	0.063***
	[0.008]	[0.017]	[0.008]	[0.006]	[0.006]	[0.006]	[0.036]	[0.017]	[0.008]	[0.018]
SPEI	−0.125***	−0.137***	−0.251***	−0.285***	−0.279***	−0.287***	−0.234**	−0.255***	−0.108***	−0.067***
	[0.023]	[0.018]	[0.022]	[0.017]	[0.016]	[0.018]	[0.102]	[0.022]	[0.023]	[0.022]
SPEI*Cattle	−0.004	0.004	0.060**	0.064***	0.072***	0.072***	0.052	0.078*	−0.020***	−0.011**
	[0.006]	[0.007]	[0.025]	[0.020]	[0.018]	[0.021]	[0.118]	[0.047]	[0.004]	[0.005]
SPEI*Sheep	−0.136*	−0.244***	0.093	−0.133	−0.256*	−0.199	1.076	−0.114	0.247***	0.115**
	[0.075]	[0.069]	[0.188]	[0.152]	[0.138]	[0.155]	[0.890]	[0.132]	[0.073]	[0.055]
SPEI*Goats	0.270***	0.334***	0.213***	0.277***	0.266***	0.233***	0.557**	0.326***	0.167***	0.180***
	[0.049]	[0.047]	[0.054]	[0.044]	[0.040]	[0.045]	[0.256]	[0.055]	[0.040]	[0.046]
SPEI*Pigs	0.025	0.116*	0.057	0.064	−0.026	−0.069	0.389	0.118*	0.002	0.097*
	[0.075]	[0.062]	[0.078]	[0.063]	[0.058]	[0.065]	[0.372]	[0.061]	[0.070]	[0.056]
SPEI*Poultry	0.228**	0.317**	1.726***	1.987***	2.001***	2.050***	−0.060	1.504***	−0.039	0.009
	[0.095]	[0.154]	[0.174]	[0.141]	[0.128]	[0.144]	[0.826]	[0.437]	[0.029]	[0.051]
Observations	136,405	136,405	136,405	136,405	136,405	136,405	136,405	136,405	136,405	136,405

Direct effect of LU on Income

- The contribution to income of livestock portfolios **differs** by **animal species** and **income quintile**:
  - The species with the **highest** income **contribution** is **goats**, followed by **poultry**, **pigs**, **sheep** and, finally, **cattle**.
  - The magnitude of the livestock contribution tends to **increase** from the **poor group** to the **richest ones** (with exceptions).
  - This supports previous evidence suggesting that livestock contributes more to the income of wealthier households than to the income of poorer households.

Direct effect of SPEI on Income

- A **severe drought** can have a significant and **devastating** effect on the income level of a rural household.
- Its magnitude, however, **depend** on the **length** of the drought index. **Medium length** drought (SPEI 24) have the **strongest effect**.
- The effect of long drought is smaller → households might implement other coping mechanisms (e.g. migration; shift to off-farm labour).

A medium length drought is expected to reduce, on average, the income of a poor farmer of approximately the 25%.

Buffering mechanism

During a drought, **poultry and** goats have the **greater buffering effect**.

During a **short length** drought, the buffering capacity of **poultry is higher** than that of **goats**; however, the **opposite** is true during a **longer drought**.

In the short run, households might prefer to sell liquid assets, whereas goats are more weather-hardy and can thus provide greater value over a longer drought.

A medium length drought is expected to reduce the income of a poor farmer of the 5% only, if he/she increases the number of goats by 1 LU (10 animals).

The effect of Cattle

The buffering effect of **cattle** was **negative** under a **short drought**, but **positive** under a **longer drought.**

This result suggests that in the **short-term** (12 months), households might make use of **income to maintain their cattle**.

However, when the drought stretches beyond a certain time threshold (24 months), households might start **selling cattle** as a **destocking** strategy.

Interpretation

Households face a **trade-off** between **using livestock** assets to either smooth the effect of the shock, or **protect future** income generation capacity.

Cattle are **less liquid** than other livestock assets, and a household that sells in a hurry might obtain a reduced price.

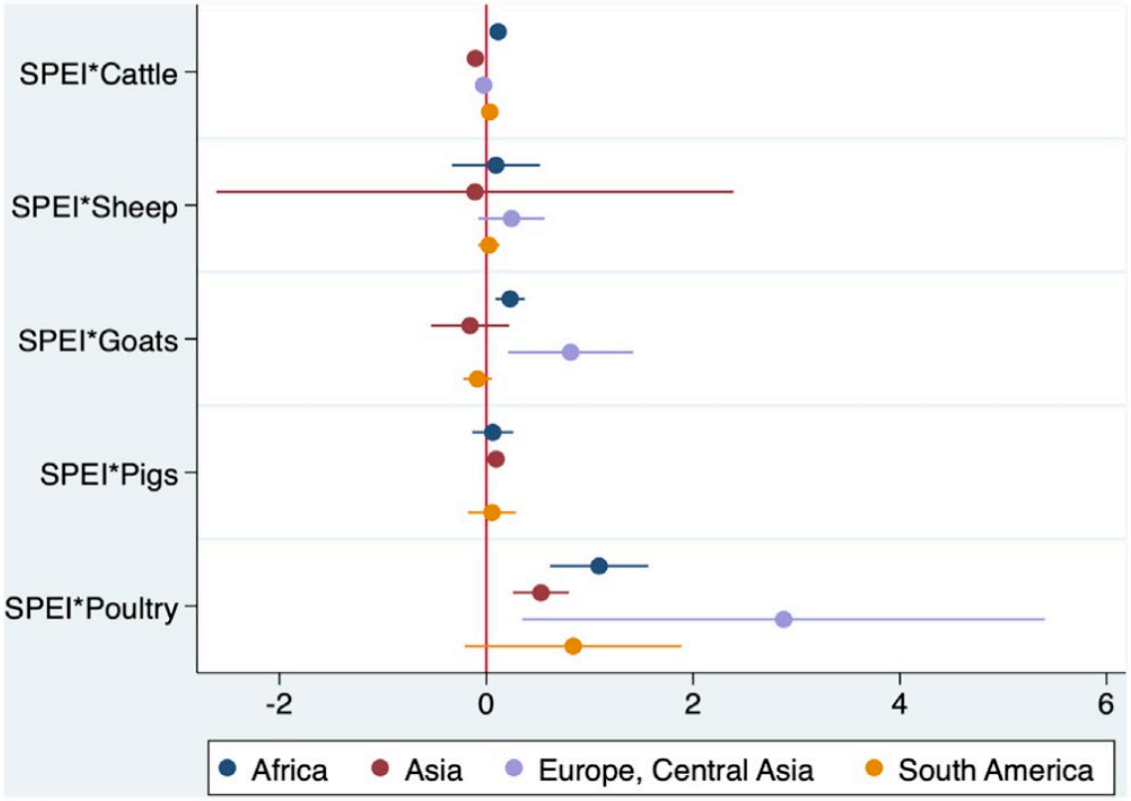
Households tend to make use of **store-of-value assets** (e.g., goats) **first**, whereas they hold on to **key productive** or **investment assets** (e.g., cattle) for as **long** as possible.

Consumption – Main results

- The **consumption** and income effects were similar.
- The **climate-livestock interactions** are **positive** and significant for most species, demonstrating the **capacity** of livestock portfolios to **smooth** a **consumption shock**.
- The **buffering** effect **varies** by **species** and **drought length**.
- For example, under the first quintile and a 24-month drought, **only small species** such as **poultry**, **goats**, and **pigs** show significant consumption buffering → Households might prefer to first use small species as a consumption buffering mechanism.

Regional robustness check

- The relevance of different species varies among regions.
- In **Africa**, **sheep** contribute the most to income, followed by **pigs**, **goats**, poultry, and cattle.
- In **Asia**, **cattle** contribute the most, followed by pigs and poultry.
- In **Europe** and **Central Asia**, **poultry** is the largest contributor, followed by sheep, goats, and cattle.
- In **South America**, **poultry** is the largest contributor, followed by pigs, goats, cattle, and sheep.



Policy implications

- Strengthening households' resilience will be fundamental to eradicate poverty and end hunger.
- Livestock assets – especially small ruminants – can help to reduce the negative effect of a climate shock.
- Animal diseases, like PPR, can be a major threat not only to small ruminants but also to eradicate poverty and end hunger.

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Thank you

For more on this Topic:

Acosta, A., Nicolli, F., Karfakis, P., 2021, Coping with climate shocks: The complex role of livestock portfolios, *World Development*, 146, 105546, https://doi.org/10.1016/j.worlddev.2021.105546.

Francesco Nicolli

Francesco.Nicolli@unife.it