



# Macroeconomic impact assessment of peste des petits ruminants (PPR) in Ethiopia and Burkina Faso

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## Executive summary

Peste des petits ruminants (PPR) is a devastating livestock disease that predominantly affects small ruminants (sheep and goats), with morbidity and mortality up to 90%, and it significantly affect men and women whose livelihood depend on livestock. In this study, we highlight key findings from an assessment of the potential economy-wide impacts of PPR in Ethiopia and Burkina Faso. A pair of social accounting matrices (SAMs) of both countries were deployed and analysed through multiplier effects. A multiplier captures how a one monetary unit change in a sector may affect that sector and the overall economic activity in terms of gross domestic product (GDP), sectoral GDP, employment and household income. Our analysis considered a 5% shock in the value of small ruminant (SR) output to simulate the hypothetical outbreak whose prospective impacts are presented below.

## Key results

- In Ethiopia, the hypothetical 5% shock in the value of SR would reduce GDP at factor cost (before taxes) by 0.34%, or USD326 million, considering its 2019 GDP. Nearly 220,000 jobs (or -0.5% of total employment) would also be lost, with losses concentrated in the SR sector and some crop production sectors like sorghum, barley and maize. The value of lost downstream sectors outputs would range from -0.01% for public administration to -0.32% for other non-agricultural industries.
- In Burkina Faso, the same hypothetical shock would reduce GDP at factor cost by 0.62% (i.e. over USD98 million) considering the GDP in 2019. It would further cause a contraction in the value of SR by 5% while reducing maize and rice production value by over 0.5% and 0.65% for the other cereals. About 0.39% of all jobs (i.e. about 22,000 jobs would be lost) with losses concentrated in the SR sector and across various crop production sectors, including maize (0.49%), rice (0.51%) and other cereals (0.59%).

## Key recommendations

Based on these results, we recommend the following policies to attenuate PPR impact and also prevent it.

- In Burkina Faso, due to the significant downstream losses of jobs, public decisionmakers could invest in the cereal and SR production sectors through input distributions or by offering farmers low-interest loans to ensure national food security.
- In Ethiopia, SR job losses seem more significant than the downstream losses. Thus, we recommend the government invest directly into the SR sector by supporting either feed production, breeding programs, or offering low-interest loans to most affected farmers to boost their activities while creating new job opportunities.
- In both countries, preventive measures such as subsidized and targeted vaccination wherever PPR incidence is medium or high is highly recommended in alignment with each country's PPR control and eradication strategy.

## Introduction

### 1. Context and justification

In 2019, there were about 2.33 billion small ruminants (SRs) globally, of which 1.24 billion are sheep and about 1.09 billion are goats (FAOSTAT 2021). Asia holds almost half (47%) of the entire SR population, with Africa maintaining a 37% share. In Africa, populations of SR predominate in the Sahelian agro-ecological region in West Africa (35%) and East Africa's highlands (31%). Figure 1 below shows the steady growth of the SRs population across both regions over the last 10 years. Ethiopia and Burkina Faso are two highly representative countries of SR production systems from the two regions, respectively in East and West Africa. In addition to the above-mentioned regional trends, Figure 1 also shows some disaggregated trends of the SR population in Ethiopia and Burkina Faso over the last 10 years, highlighting steady rising numbers. The agricultural sector still plays an essential role in both countries' economies, with agricultural GDP estimated at 33.5% in Ethiopia and 20.2% in Burkina Faso in 2019. In 2019, the contribution of the livestock sector to GDP was 15–17% in Ethiopia (Zemedu 2015) and 18% in Burkina Faso (ARAA-CEDEAO 2021).

One of the numerous reasons explaining this growing SR population is how foundational their ownership is to the livelihood, food and nutrition security of millions of smallholder farmers for whom they often represent the most important asset (Wodajo et al. 2020; de Haan et al. 2015). SRs are often produced by smallholders, including women with limited resources and access to essential health services (de Haan et al. 2015). Furthermore, unlike other livestock species such as cattle, women have a lot of control over SRs ownership and are also involved in the

daily management of the health of the animals (Kinati et al. 2018), representing a valuable source of empowerment for women (Wodajo et al. 2020).

SR systems play multiple other livelihood functions, such as income-generating activity and raw materials for local and regional industries (Wodajo et al. 2020). They also serve various sociocultural roles such as dowries for weddings, gifts, charity and inheritances. For most herders, holding these animals often represents a reliable source of emergency funds for their obligations and personal uses. SRs are often assimilated to 'ATMs,' allowing their owners to access regular and immediate cash covering quick expenses on health, school fees, medicines, as well as farm and off-farm investment, social activities, and re-stocking (Kosgey et al. 2008; de Haan et al. 2015). In some communities, small ruminants ownership is an indicator of social status or wealth, facilitating access to certain financial services in formal and informal markets (Pica-Ciamarra et al. 2011). Overall, due to the SRs relatively small sizes, high mobility, and ease in buying and selling, their ownership represents one of the most significant wealth accumulation activities among smallholder households in sub-Saharan Africa (SSA) (de Haan et al. 2015). Hence, their ownership in many settings can provide an effective socio-economic buffer to farmers' hardship while also contributing to attaining various Sustainable development Goals<sup>1</sup> (SDGs) at macro and micro levels. However, farmers' ability to maintain this wealth and potentially escape poverty is threatened by highly infectious diseases such as the peste des petits ruminants (PPR).



1. <https://www.undp.org/content/undp/en/home/sustainable-development-goals.html>



PPR is a devastating livestock disease that predominantly affects SRs, namely sheep and goats, with significant impacts worldwide. It is endemic in most areas across Asia, the Middle East and Africa (Kumar et al. 2017). In a naïve population of sheep and goats, PPR morbidity and mortality can both reach 90%, with significant effects on herders whose livelihoods depend upon them. PPR also has substantial economic impacts at regional and national levels, though these effects have not been well articulated.

To date, the PPR literature has primarily focused on the effects of the disease at the household or production level, with little literature highlighting links between PPR and its impact at the national level. Previous research on other livestock diseases, such as Rift Valley fever (RVF), has highlighted the range of the downstream effects that can emerge from an animal disease impact assessment. For instance, Rich and Wanyoike (2010) found considerable negative livelihood impacts from the 2007 RVF outbreak in Kenya amongst ancillary service providers that arose when slaughterhouses were closed. Using a social accounting matrix (SAM), the authors further estimated downstream losses of USD32 million, representing approximately 0.1% in the value of national output. Thus, despite not being a zoonosis like RVF, similar estimates for PPR would still provide significant insight on how targeted or diffuse its impacts might be at a broader economic level.

## 2. Overview of PPR outbreak incidences and control strategies

In Africa, PPR was first reported and described in Côte d'Ivoire, a country bordering Burkina Faso to the north, in 1942 and has become endemic in most areas, especially in the Sahel. From 2015 to 2019, the World Animal Health Information System (WAHIS) indicates 3,166 PPR outbreaks were reported in Africa, from which 15% and 3.8% are respectively from the western and eastern regions (Zhao et al. 2021). With its high morbidity and mortality rates, PPR carries tremendous socio-economic impacts at several levels but mostly on poor farmers who depend upon them for their livelihoods. Because of its negative effects on the poor and their national economies, PPR has increasingly gained attention within the international community.

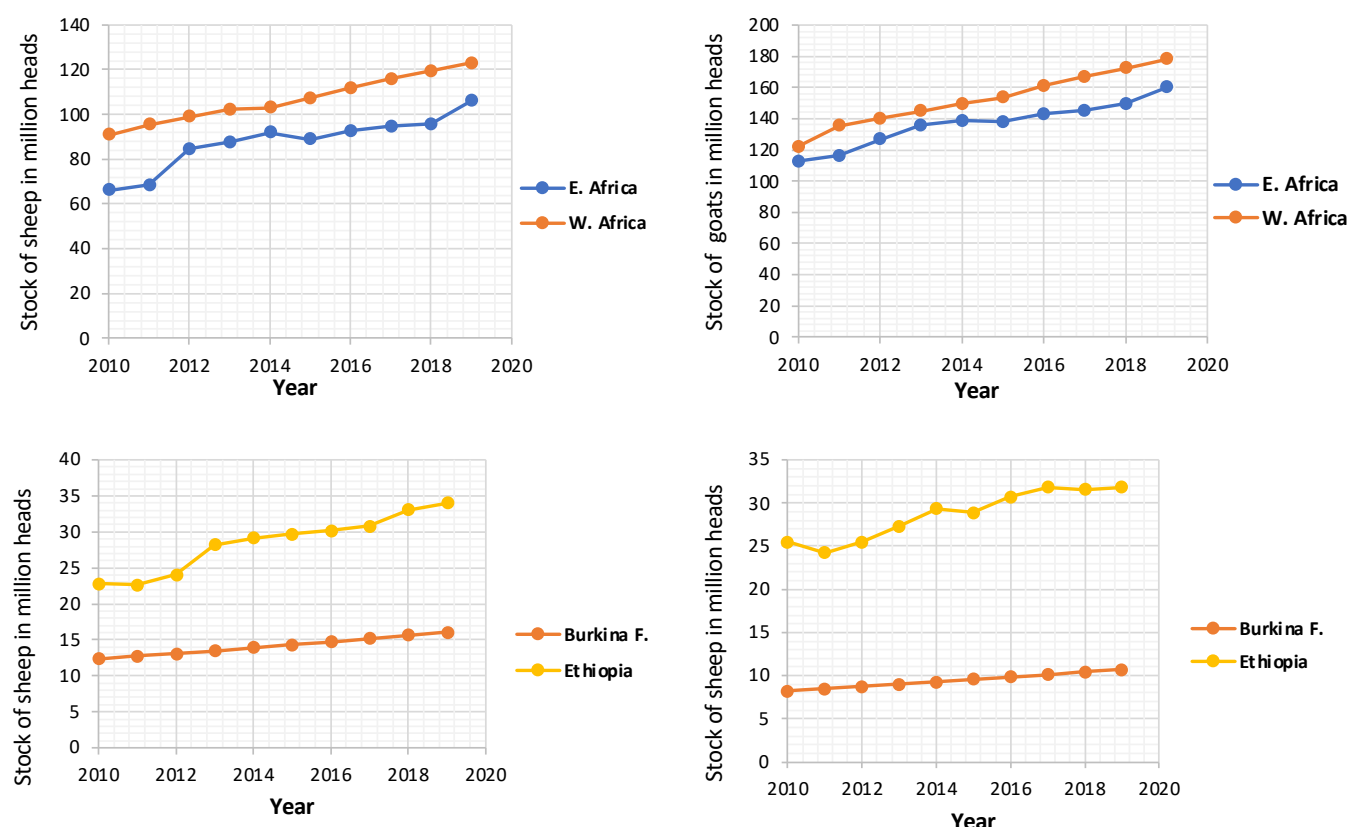
The World Organisation for Animal Health (OIE) and the Food and Agriculture Organization of the United Nations (FAO) have teamed up to develop a coordinated PPR Global Control and Eradication Strategy (GCES) aiming at PPR global eradication by 2030 (OIE and FAO

2015). The PPR GCES recommends a four sequential stepwise approach: assessment, control, eradication and post eradication. However, the pathway to their 2030 eradication goal requires the generation of enough evidence to quantify the disease's impact and support the design of its appropriate control measures. Given the successful global eradication of rinderpest and the availability of effective PPR vaccines, a vaccination strategy has also been identified as the primary prevention and control measure required for the PPR GCES Stage 2 and Stage 3 (Zhao et al. 2021; Roeder et al. 2013). The PPR GCES national vaccination strategy aims to vaccinate all SRs to reach 70% post-vaccination immunity at the flock level to break the epidemiological cycle of the virus.

However, in some countries such as Benin, Burkina Faso, Ghana and Nigeria, where PPR is endemic, vaccine doses deployed annually are still below 10% of the total population of SRs (Zhao et al. 2021). To address some of these shortfalls, from 2012 to 2014, the OIE implemented the Vaccine Standards and Pilot Approach to PPR Control in Africa (VSPA) project, in partnership with the Centre for International Cooperation in Agricultural Research for Development (CIRAD) and the African Union Pan African Veterinary Vaccine Centre (AU-PANVAC). One of the numerous outcomes of the VSPA project is the vaccination of 4 million SRs in Burkina Faso and Ghana. However, from 2015 to 2018 in Burkina Faso, despite the continuous growing outbreaks, the mass vaccination scales only covered 2.5%, 1.9%, 1.8% and 0.9% of the national sheep and goat population, respectively (Zhao et al. 2021).

In contrast, Ethiopia has made remarkable efforts in the PPR control and prevention in the past years, with the generous support of the European Union-led project Supporting the Horn of Africa Resilience (EU-SHARE PPR). Ethiopia has successfully vaccinated over 24.5 million SRs from 2016 to 2019, with vaccination being carried out more than once per year (FAO in Ethiopia 2019). Also, the country has enhanced the technical capacities of 2,361 veterinary officers on vaccine handling, along with its Animal Disease Notification and Investigation System (ADNIS) and Disease Outbreak and Vaccination Reporting (DOVAR) (FAO in Ethiopia 2019). Despite this extraordinary progress, PPR remains endemic in Ethiopia. According to the FAO in Ethiopia (2019) and the Ethiopian Ministry of Agriculture, one of the main challenges to the eradication of PPR in the country is the weak coordination and harmonization of disease surveillance and vaccination among countries of the Horn of Africa region.

Figure 1: Trends in sheep and goat populations in East and West Africa and Ethiopia and Burkina Faso, 2010–2019.



Source: Generated using FAOSTAT (2021) data.

## Methodology

As part of the Epidemiology and Control of the Peste des Petits Ruminants (ECo PPR) project activities, ILRI scientists deployed a pair of social accounting matrices (SAMs) for Burkina Faso and Ethiopia to quantify the prospective sectoral, downstream, and overall macroeconomic impacts of PPR. A social accounting matrix (SAM) provides a ledger of all monetary transactions and transfers that take place in an economy at a national (or regional) level in a given year (Sadoulet and de Janvry 1996; Cheong 2019). It displays how different economic agents, such as enterprises, households, governments, and the rest of the world, are linked and interact through their physical and monetary transactions (Cheong 2019).

Table 1 provides a visual representation of a SAM. As an accounting ledger, expenditures by an account (denoted in columns) from other accounts must equal revenues (indicated in rows) obtained from payments made by other sectors.

A SAM can be used to model the effects of a particular shock<sup>2</sup> or intervention at a national level. To do this, a SAM is transformed to compute a matrix of 'multipliers.' A multiplier captures how one monetary unit (e.g. USD1)

2. For an economy, a shock can either be positive (for instance, an increase in government spending or external investment) or negative (for example, a global economic recession or a sudden disease outbreak such as PPR).

infusion of investment or government spending into or from a sector changes sectoral and overall economic activity in terms of GDP, GDP per sector, employment (i.e. changes in the number of jobs) and household incomes (Cheong 2019). As more recently constructed SAMs are often quite disaggregated by commodity sectors and household groups, it is possible to tease out a range of impacts on specific sectors, labour classifications or income quintiles. For example, in animal health settings, SAM multipliers were used to quantify the benefits of rinderpest eradication (Roeder et al. 2013) and assess the potential returns to global PPR eradication (Jones et al. 2016).

The 2011 Ethiopia SAM (Ahmed, Tebekew and Thurlow 2017) and the 2013 Burkina Faso SAM (Ouattara 2017) were used for the analysis. Both SAMs are well disaggregated with 68 and 45 sectors for Ethiopia and Burkina Faso, respectively. The livestock accounts are also disaggregated, with the Ethiopian SAM distinguishing between sheep and goats as separate accounts. However, as no such distinction was made in the Burkina Faso SAM, the 'other livestock' account was used as a proxy for small ruminants. There is also a greater disaggregation of household accounts in the Ethiopia SAM, which divides households into income quintiles and further distinguishes between rural farm, and non-farm, households and urban ones.

To estimate the losses associated with PPR at the national level, we applied a 5% reduction in the value of SR (sheep and goat) output in each SAM. We justify this value in part based on the work of Jones et al. (2016). The authors found that the median mortality rate in an affected flock was 13.2% based on 18 peer-reviewed papers describing PPR outbreaks in nine countries, including Ethiopia. However, after controlling for the

length of epidemic cycles and various proportions of the SR population exposed each time, the authors ended up with an extrapolated annual mortality rate varying from 1.4% to 4.7%, which they assumed was still underestimated due to missing data in their estimation. Our estimate of 5% thus suggests a plausible assumption of the magnitude of PPR outbreaks.

Table 1: Basic representation of a social accounting matrix.

Incomes (Rows)	Expenditures (Columns)									
		Activities	Commodities	Labour	Capital	Households	Government	Savings-Investment	Rest of the World	Total
	Activities (A)		Domestic supply							Activities income
	Commodities	Intermediate demand	Transaction cost			Private consumption (C)	Government consumption (G)	Investment demand (I)	Exports (E)	Total demand
	Labour (L)	Value added							Foreign factor earnings	Factor income
	Capital (K)	Value added							Foreign factor earnings	Factor income
	Households (H)			Factor income to households (wages)	Factor income to households (rents)	Inter household transfers	Social transfers		Foreign remittances	Household income
	Government (G)	Production taxes/subsidy	Sales taxes and import tariffs			Direct household taxes	Within public sector transfers		Foreign grants and loans	Total government revenue
	Savings-Investment (S-I)					Private savings	Fiscal surplus		Current account balance	Total savings
	Rest of the World (RoW)		Import payments (M)	Factor income to RoW	Factor income to RoW	Foreign remittances paid	Government transfers to RoW			Foreign exchange outflow
	Total	Gross output	Total supply	Total factor spending	Total factor spending	Total household spending	Total government expenditure	Total investment spending	Foreign exchange inflow	

Source: Adapted from Breisinger, Thomas and Thurlow (2009).

## Results and discussion

In Ethiopia, we estimated that the proposed PPR outbreak would cause a contraction in the value of sheep and goat output by 3.26% and 3.74%, respectively. In contrast, maize, barley and sorghum production values would fall by more than 0.40%. Losses in downstream sectors (services, transport, etc.) would be more modest, ranging from -0.01% for public administration to -0.32% for other non-agricultural industries. These results indicate that the PPR outbreak would directly affect the SR production sector and some indirect effects on the rest of the economy through production linkages. The estimated output multipliers of less than 5% in the SR sector could be explained by a demand response captured here through a significant price effect. As expected, the income of farm households would be more affected by PPR than non-farm families, with the largest impact falling on the poorest. Among rural households, PPR would reduce the income of the lowest farm household quintile by -0.45%. This drop is larger than the impacts on the poorest non-farm households (-0.29%) and the wealthiest farm households (-0.27%). These results capture consumption linkages that resulted from the reduction in the value of SR supplies due to the PPR outbreak. In rural settings, SR ownership is foundational to households' livelihood, especially the poorest (De Haan et al. 2015).

From an employment standpoint, the model indicates a reduction of nearly 222,000 jobs or -0.53% employment in the SR sector and across other sectors of the economy. On a percentage basis, losses were highest in the sheep and goat sectors, which would shed 39,264 (-4.80%) and 36,850 (-4.84%) jobs, respectively, while the number of jobs in the enset would fall by 1.03% or 12,264. These results indicate the respective decrease in the value of each sectoral output productions due to PPR. Due to the various linkages in the economy, various impacts can happen within the SR sector and across the economy as a whole. For instance, supply of manure to the crop productions sectors and the demand for specific outputs such as feeds and other crop productions items would all fall, which would have direct and indirect effects on the labour force markets of their respective sectors by dropping the number of workers needed, respectively. At a macroeconomic level, our hypothetical PPR outbreak caused a reduction in GDP at factor cost (before taxes) of 0.34% and a drop in agricultural GDP of 0.47%. This result suggests that considering the Ethiopian GDP of USD95.91 billion in 2019 (World Bank 2020b), PPR would have caused a loss of USD326 million.

The same analytical framework applies to Burkina Faso. Here our analysis revealed larger impacts, but on a percentage basis, compared to Ethiopia. Our hypothetical PPR outbreak would reduce the value of SR production by 5%, while the value of output in crop sectors such as maize and rice each would fall by 0.49% and 0.51%. Estimated losses in downstream sectors (services, transport, housing, etc.) range from -0.01% for public administration to 0.44% for other non-agricultural industries such as restaurants and -0.48% for real estates. The main difference between the two countries' output multipliers is the 5% drop in the value of sectoral production output in Burkina Faso, which could also be explained by a demand response with no substantial price effect. Also, rural household incomes would be more affected by PPR (-0.55%) than urban ones (-0.45%). From an employment standpoint, about 0.39% of all jobs in Burkina Faso's economy (i.e. about 22,000, would be lost due to PPR). Nearly 130 jobs (or 4.21%) of the SR sector would be lost. Similarly, we estimated job losses of about 0.49% (2,410 jobs) in the maize sector and 0.59% (6,070 jobs) in other cereals production sectors. Overall, our hypothetical PPR outbreak would cause a reduction of 0.6% in both the GDP and agricultural GDP at factor cost. This result suggests that considering Burkina Faso's GDP of nearly USD16 billion in 2019 (World Bank 2020). PPR would generate reductions in national income of more than USD96 million. All these output, employment, and income multiplier results are summarized in Table 2 and Table 3 below for the two countries.

The magnitude of some of these results is likely to be underestimated because the agricultural sector is highly informal in SSA, and official data fail to capture all these types of economic activities. Also, we lack information on the gendered impacts of PPR from this assessment, as a factor, and household accounts are not disaggregated in this manner; there have been attempts to genderize SAMs, which could address these issues in future analyses (Ahmed, Tebekew and Thurlow 2017).

On a percentage basis, the larger impacts found using Burkina Faso's SAM could indicate that the country's economy might be relatively more exposed to PPR than Ethiopia. Even though the downstream effects estimated are not necessarily larger than those found in the livestock sector, their existence and magnitude confirm previous findings by Rich and Wanyoike (2010) in the case of the 2007 RVF outbreak in Kenya. For instance, in Burkina Faso, most jobs lost would happen in the cereal production sectors compared to the actual SR sectors. This highlights some of the downstream effects that may occur as a result of animal diseases which can be explained by the disproportional employment output ratio within its agricultural sector. Let us consider, for instance, Burkina Faso's agricultural employment-output

ratio (Re), which captures the number of workers needed to produce one monetary unit of sectoral output in a year. For every single one million XOF worth of production, the estimated Re ranges from 3.55 for maize, 4.03 for rice to the highest nationally, of 4.31 for legumes, while only 0.01 for SR. As a result, these crop production sectors would bear more job losses on a count basis due to their number of workers needed to produce a single XOF1 million worth of output compared to the SR sector.

Table 2: Output and employment multiplier estimates.

	Ethiopia (SAM 2011)		Burkina Faso (SAM 2013)	
	% change in the value of output	% change in the number of jobs	% change in the value of output	% change in the number of jobs
Sheep	-3.26%	-4.80% (39,264) <sup>3</sup>	-5%	-4.21% (128)
Goat	-3.74%	-4.84% (36,850)		
Maize	-0.40%	-0.6% (14,877)	-0.49%	-0.49% (2,410)
Other cereals	-0.33%	-0.52% (13,441)	-0.65%	-0.59% (6,070)

Source: Model simulations.

Table 3: Household income multiplier estimates

	Ethiopia (SAM 2011)			Burkina Faso (SAM 2013)	
	Rural farm household (HH)	Rural non-farm HH	Urban HH	Rural HH	Urban HH
Poorest Quintile	-0.45%	-0.29%	-0.36%	-0.55%	-0.45%
Quintile 2	-0.42%	-0.24%	-0.31%		
Quintile 3	-0.39%	-0.21%	-0.26%		
Quintile 4	-0.36%	-0.19%	-0.23%		
Quintile 5	-0.27%	-0.16%	-0.17%		

Source: Model simulations.

## Recommendations

Based on the above results, we make the following policy recommendations to attenuate PPR impact and prevent it. In Burkina Faso, due to the significant downstream losses of jobs, public decisions makers could invest in cereal production sectors to buffer PPR effects or make the SR production sector more appealing to expand

3. The information in brackets represent the actual number of jobs lost per sector.



its labour force. They could either support farmers by distributing input kits or otherwise offering them some low-interest loans to boost their agricultural activities, which would create new job opportunities. Unlike in Burkina Faso, our results in Ethiopia indicate that sectoral job losses would be more significant than the downstream sector losses. Ethiopian decision makers should then invest directly in the SR sector. They could run a distribution of SR and (or) feed to most affected herders or otherwise offer them some low-interest loans to boost their activities while creating new sectoral job opportunities. Creating these job opportunities and giving farmers access to low-interest loans to expand activities would also reduce losses in income due to PPR. For each of these attenuation policies, a feasibility study should be conducted to prioritize the most affected farmers. If implemented effectively, we would expect significant positive linkage from these policies into the rest of each country's economy. If possible, countries could simultaneously run both risk attenuation policies as SR farming often involves pastoral and agro-pastoral farmers, for whom PPR outbreak could lead to a double loss.

It remains critical for the countries also to address the prevention of the disease. Though our results do not lead to a specific risk preventive measure, we could recommend both countries' governments to run subsidized and targeted vaccination campaigns wherever PPR incidence is medium to high. Vaccination remains the most effective control strategy for PPR, and when it is implemented effectively, it carries significant economic return to countries (Jones et al. 2016). Ethiopia seems already on top of this preventive approach having vaccinated more than 24 million SRs in three years through the EU-SHARE project. In Burkina Faso, from 2013–2014, the VSPA project had a similar action on more than 3 million SRs. The same project had tested these four vaccination protocols for PPR control in Burkina Faso and Ghana: (i) no vaccination, (ii) free PPR vaccine without contribution to operational costs, (iii) free PPR vaccine with a partial contribution to the operational costs, and (iv) free PPR vaccine with a partial contribution to the operational costs and free distribution of anthelmintics. The third protocol was found to be the most effective (Zhao et al. 2021). This finding strengthens our recommendation on subsidizing PPR vaccination to hasten control of the disease, especially in high incidence areas. Similarly, other projects, namely the Regional Sahel Pastoralism Support Project (PRAPS), which was implemented in Burkina Faso, Mali, Mauritania, Niger, Senegal and Chad from 2015–2020, had also mobilized and administrated 72.8 million doses of PPR vaccine across these countries (Zhao et al. 2021).

Alternatively, we recommend further studies to conduct a micro levels impact assessment to deepen understanding of the problems surrounding the persistence of PPR. For instance, using a participatory approach in the context of the value chain could be beneficial because it could bring together various stakeholders to think collectively about the root causes of PPR and tailored policies for its control. For instance, recent animal diseases studies, e.g. the case of East Coast fever (ECF) in Zambia (Mumba et al. 2017) and African Swine fever (ASF) in Uganda (Ouma et al. 2018), have successfully used this participatory disease modeling approach to address the impact of these various animal diseases. Hence, similar studies applying the participatory process for PPR under different control simulation scenarios might offer significant insights toward its 2030 eradication goal.

## Conclusions

In this study, we assessed the potential macroeconomic impact of PPR in Ethiopia and Burkina using the SAM multipliers approach to provide the scale of its impacts on both countries' economies and suggest country-specific implementable solutions. We have reduced the existing literature gap between PPR and its macro-level impact by capturing both sectoral and downstream effects of the disease in both case studies.

PPR outbreaks affect the agricultural industry and the rest of the economy at various yet significant scales. Using a hypothetical 5% reduction in the value of SR due to the PPR outbreak, we found a decrease in SR production value by 5% in Burkina Faso and 3.5% in Ethiopia. Also, thousands of agricultural jobs would be lost due to PPR outbreaks in both countries' contexts. Rural and farm households' income would be more affected than non-farm and urban families. In aggregate, these various losses would mean a significant reduction in both nations' GDP. For instance, our results indicate a considerable GDP contraction at factor cost, i.e. 0.34% (USD326 million) and 0.62% (USD96 million) respectively for Ethiopia and Burkina Faso. Furthermore, this comparative study reveals that Burkina Faso would carry more downstream job losses than Ethiopia due to the disproportionate employment output ratio within its agricultural sector.

Based on this evidence, we recommend both countries' governments develop policies that attenuate these PPR impacts and prevent the risk of the disease in their respective cases. In Burkina Faso, due to the significant downstream losses of jobs, public decision makers could invest in crops and SR production sectors to buffer against PPR effects and ensure national food security.

In Ethiopia, sectoral job losses are more significant than downstream losses. Thus, we recommend the government invest directly in the SR sector by supporting SR breeding programs, feed production or offering the most affected herders low-interest loans to boost their activities to create new job opportunities. In addition, as a preventive measure, we recommend running subsidized vaccination in areas where PPR incidence remains high to alter the spread of the disease. Further studies could deepen these results by assessing PPR impact at more micro levels using a participatory approach in the SR value chain context.

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