Impact of Peste des Petits Ruminants for sub-Saharan African farmers: a bioeconomic household production model

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July 31, 2020

Abstract

Peste des petits ruminants (PPR) is a contagious disease affecting small ruminants. It has been targeted by the global community for eradication within the next 10 years. Implementing eradication requires significant financial efforts, human resources, coordination among actors, and individual commitments. The objective of this study is to estimate the cost of PPR at household level, thereby providing economic information about the potential benefits for small ruminant keepers of PPR control and management strategies. Fifteen Sub-Saharan countries are included in this study, for which publicly available household level data assembled by FAO were used. We built a bioeconomic model to estimate the impact of PPR for a standardized theoretical area where each household raises an average herd comprising either 6 goats or 3 sheep and their offspring. We then used the outputs of the model to estimate the income loss due to PPR at household level. We constructed different income scenarios to account for the variability of small ruminant income in total annual income. The household income losses ranged from 0.6 to 44.8 percent of the total annual income. The percentages vary depending on the income scenario and on the gross annual economic impact of PPR on small ruminant production, which ranges from 25 to 80 percent based on the results of the bioeconomic model. Regardless of the income scenario, households in lower income quintiles are relatively more affected by PPR than households in upper quintiles. As expected, the more small ruminant production contributes to household income the greater the impact. We provide here estimates that may help, from a policy perspective, identifying the most relevant strategies and tailoring them at regional level to mitigate PPR impacts.

Introduction

Peste des petits ruminants (PPR), or sheep and goat plague, is a contagious disease mainly affecting small ruminants. It has been targeted by the global community for eradication within the next 10 years (OIE & FAO, 2015). The causal agent is the PPR virus, an enveloped RNA virus, belonging to the genus Morbillivirus (Kumar et al., 2014). PPR disease occurs in three forms. The super-acute form, more frequently observed in goats and especially in newborn kids, leads to sudden death (occurring within a few hours) with the main signs being severe hyperthermia and congested mucous membranes. In the acute form, which is the classical form of PPR, symptoms are identical to those observed in the super-acute form but evolve over a longer period. Nasal discharge becomes mucopurulent and obstructs the nostrils, erosive and ulcerative lesions are observed on the gums, tongue, inner side of the cheeks, palate and even the larynx. The tongue is covered with a foul-smelling whitish coating. Respiratory signs, such as increased frequency and cough, and diarrhea are also observed. Abortions are noticed. Two evolutions are possible: death in eight to ten days, or healing with life lasting immunity. The sub-acute PPR form is the less sever and frequent in selected regions and certain disease-resistant species (sheep). In this form, the disease progresses over ten to fifteen days with inconstant clinical signs and has to be confirmed by a laboratory test. The sub-acute form of PPR does not result in any mortality.

PPR affects all small ruminants, but goats are much more susceptible than sheep and, among them, Guinean city breeds (West African dwarf goats, Kirdi goats, lagoon goats) are more susceptible than the Sahelian breed (Albina et al., 2013; Simon M. Kihu, Gachohi, et al., 2015; Kumar et al., 2014). Other domestic and wild animals, such as cattle and wild ruminants, are also susceptible to the PPR virus (Albina et al., 2013; EFSA, 2015; Marashi et al., 2017; Munir, 2014). Yet, control of the infection in small ruminants is thought to prevent disease outbreaks in other species as observed with rinderpest following its control in cattle (Fournié et al., 2018).

PPR is a fast-expanding disease in developing countries and pervasive in African countries, where small ruminants support the livelihoods of a large share of households. In the coastal African countries, PPR manifests in sporadic outbreaks with high mortality, around 70 to 80 percent, and follows a 4 to 5 year-cycle of appearance that corresponds to time necessary to reconstitute a naive population. In most other African countries PPR is endemic and always present in the small ruminant population. In either case, PPR negatively affects livestock keepers' livelihoods and, more in general, the small ruminant economy (Albina et al, 2013).

The economic impacts of PPR have been assessed at local, country and global level, largely based on estimates of mortality cost, weight loss, abortion, reduced wool and milk production, treatment and veterinary costs. In Turkana county of Kenya, the economic losses of PPR outbreaks were estimated, using data collected through participatory epidemiological appraisal techniques, from US$ 15 to US$ 19.1 million (Simon M. Kihu, Gitao, et al., 2015). In Nigeria, Akerejola *et al* . estimated annual losses of US$48–96 million or US$1.6–3.2 per animal due to PPR (Akerejola, Schillhorn Van Veen, & Njoku, 1979). In India, the economic losses associated with PPR, estimated from household survey data, ranged between US $653 and $669 million per year (Bardhan et al., 2017). At a global level, the OIE/FAO report on global PPR control and eradication contends that annual losses associated with PPR ranges between US$1.2–1.7 billion, though no any detail is provided on the data behind this figure (OIE & FAO, 2015). Jones *et al* . used FAOSTAT data to estimate annual PPR losses, associated with different mortality rates, between US$0.8 and US$ 2.6 billion (Jones et al., 2016). This paper contributes to this literature by providing estimates of the costs of PPR at household level in a sample of 15 sub-Saharan African countries, which is essential to appreciate the incentives households might have to participate in and support any interventions aimed at detecting, controlling and eradicating PPR. Indeed, the literature so far has generated estimates of the PPR impact per animal, and presented results at different levels of aggregation. To our knowledge, this is one of the first attempts to estimate the cost of PPR relative to household's livelihoods.

Material and methods

Data sources

We used publicly available, nationally representative household survey data assembled by the FAO Rural Livelihoods Information System (RuLIS) as well as data from FAOSTAT in representation of fifteen sub-Saharan African countries: Burkina Faso, Cameroon, Cote d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Senegal, Uganda and Tanzania.

FAO RuLIS (FAO, 2020) consists of a database of more than 100 harmonized cross-country comparable indicators, mostly computed from household surveys and disaggregated by gender, rural/urban area, expenditure and income quintiles, share of income from agriculture and farm size. Indicators are organized in ten clusters, including Income, Poverty, Employment, Social Protection, Land, Livestock, Inputs, Infrastructure and Services, Shocks and Migration and Sample Characteristics.

From RULiS we extracted indicators on the number and the share of households keeping small ruminants, the average number of small ruminants per household and by quintile, and the average income per household and by quintile. The indicators refer to the year the survey was conducted in each country, which varies across our sample.

FAOSTAT provides time-series and cross-sectional agricultural-related data for 245 countries and territories starting from 1961 to the most recent year available (Food and Agriculture Organization (FAO), 2020). Data are clustered in 15 domains, such as macro-indicators, population, agricultural production, inputs, trade, prices, investment and other. We extracted from FAO indicators on the total number of household per country, the total number of goats and sheep, small ruminant meat, milk wool production and prices. Extractions from the FAOSTAT were performed by country and for the survey RuLIS survey data were available.

Bioeconomic model

Model characteristics

We estimated the impact of PPR for a household raising an average herd comprising either 6 goats or 3 sheep and their offspring, which is the average herd size for small ruminants in the sample countries reported in RuLIS. This enabled to simulate several plausible scenarios regarding the epidemiological setting i.e., situation of outbreak or endemic PPR as well as the seroprevalence of PPR.

We first defined a scenario where PPR is not present in the area. We calculated the yearly total output from the herd as the sum of milk production (kg), wool production (kg), adult meat production (kg), and young stock meat production (kg). We set a level of voluntary culling of adults at 20%, i.e. each year 20% of all adult animals are slaughtered.

PPR generates losses through increased mortality of adult animals and young stock, reduced weight at slaughter, reduced milk and wool yield, and reduced prolificity as well as treatment cost and production adjustment cost. We calculated the total yearly output for an average PPR infected herd according to 3 epidemiological parameters: mortality and morbidity rates for an exposed herd and herd seroprevalence. We did not take into account treatment and production adjustment costs, for which data were not available.

In both settings, with and without PPR, we calculated the annual gross household income derived from goat or sheep herd by multiplying the quantities of milk, meat, and wool potentially sold by the unitary commodity prices (US$) available in FAOSTAT.

The gross impact (Gross_imp) of PPR was calculated by subtracting the annual gross output value from a herd experiencing PPR to the annual gross output value from a PPR free herd, (Eq. 1).

Eq. 1: $\text{Gross}_{\text{-imp } i} = (\text{Q}_{\text{milk } i} * \text{P}_{\text{milk } i} + \text{Q}_{\text{meat } i} * \text{P}_{\text{meat } i} + \text{Q}_{\text{wool } i} * \text{P}_{\text{wool } i})$ PPR free - $(\text{Q}_{\text{milk } i} * \text{P}_{\text{milk } i} + \text{Q}_{\text{meat } i} * \text{P}_{\text{meat } i} + \text{Q}_{\text{wool } i} * \text{P}_{\text{wool } i})$ PPR infected herd

i {sheep, goat}

Results are presented in absolute value (US$, Gross_imp) as well as in relative terms (Gross value of production in PPR infected herd over Gross value of production in PPR free herd, Gross_imp%), for two epidemiological settings: endemic PPR, and non-endemic PPR..

Model parametrization

Calibration of the model was performed by using data extracted from the literature (Muhammad Abubakar, Ali, & Khan, 2008; Akerejola et al., 1979; IEMVT, 1950; Kumar et al., 2014; Meyer, Faye, & Karembe, n.d.; A Missohou, Bonfoh, & Kadanga, 1998; Ayao Missohou, Nahimana, Ayssiwede, & Sembene, 2016; Protection, 2018). Production parameters for goat and sheep are reported in table 1.

The impact of PPR in exposed herds in PPR endemic areas is reported in table 2, where mortality and morbidity rates were set at 13 and 18% for sheep and 20 and 25% for goats. In case of PPE in non-endemic areas, mortality rates were assumed to be within 20 and 34% for sheep and between 28 and 52% for goats, and morbidity rates within 25 and 47% for sheep and between 35 and 65% for goats.

Regional seroprevalence of PPR has been reported in several research papers (M Abubakar & Munir, 2014; Muhammad Abubakar et al., 2008; Njue et al., 2018; Nkamwesiga et al., 2019; Opasina & Putt, 1985; Sow et al., 2008; Waret-Szkuta et al., 2008). For our purpose, we increased the prevalence from 0 to 0.7, to show the impact of extreme values of PPR prevalences.

Impact of PPR on total household income

We used the estimates of gross impact (Gross_imp%) computed in the bioeconomic model as a calibration parameter to estimate the impact of PPR for households (HHs) in different income quintiles.

For each country, RuLIS provides nationally representative, ready-made indicators on non-farm and agricultural household income by quintile. We split agricultural income in two components: a first component corresponding to small ruminants farming activities, and a second component corresponding to all other agricultural activities. As no statistics are available on the share of agricultural income originating from small ruminants, we modeled four scenarios (S1 to S4), in which small ruminant income contributes 10, 20, 50 and 90 % to total agricultural income, respectively.

For each income quintile, assuming no any goat and sheep is infected by PPR, we calculated the income from small ruminant activities for the sub-sample of small-ruminant keeping households as follows (Eq. 2):

Eq. 2: $SR\_inc = Ag\_inc/k$

$k\{0.1, 0.2, 05, 0.9\}$

We then calculated the small ruminant income in case of PPR by multiplying the calculated income from small ruminants farming activities in absence of PPR by Gross_imp%, for the four scenarios (Eq. 3).

Eq 3: $SR\_inc_{\text{ PPR infected herd}} = Gross\_imp\% * SR\_inc_{\text{PPR free}}$

We computed the agricultural income for a household with either PPR infected or non-infected small ruminants according to equations 2 and 3, assuming that the agricultural income from non-small ruminant activities is not affected by PPR outbreaks. We then calculated the total annual household income by summing non-farm income and agricultural income. We finally calculated the annual income losses associated to PPR by subtracting the total income with PPR to the total income in the absence of PPR. We expressed the income losses associated to PPR as percentage of total annual income.

We report the results for an average situation, as well as for four countries, representative of four agro ecological and epidemiological situations i.e., Ethiopia, Malawi, Mali, Rwanda, for which data were relatively recent and available.

Results

Descriptive statistics of small ruminant-keeping households in sub-Saharan African countries

Among the 15 countries included in our analysis, the median share of households owning small ruminants was 32% (9 to 51%) **(Table 3)** . The average number of sheep and goats per household owning small ruminants is 3 and 6, respectively (2.5 to 22.8). The average annual total income per household owning small ruminants was $2,943, with the average annual agriculture income being $1,613. For the households surveyed, the average value of production from livestock activities was $493 per annum, ranging between $35 and $2,389 per year. The average non-farm income was $1,159 per year.

The share of agriculture income in the total income of households owning small ruminants was comprised between 12 and 93%, depending on the country.

The breakdown by income quintile indicates that the average annual total income per household owning small ruminants for income quintile is $1,552, $1,954, $2,420, $2,960, and $4,355 for income quintile 1,2,3,4 and, 5 respectively (**Table 4**). The average share of agriculture income in the total income is 60%, 54%, 47%, 39%, and 26% for income quintile 1,2,3,4 and 5 respectively.

Summary statistics for all countries are provided in supplementary material.

Gross annual impact of a PPR in non-endemic areas

The outputs of the bioeconomic model show that the gross annual impact of a PPR outbreak for a farmer keeping 3 adult sheep is estimated between $127 and $243, depending on the severity of the outbreak. This represents a gross impact of 30 and 57% of the small ruminant income, respectively.

The gross impact of a PPR outbreak for a farmer keeping 6 adult goats is estimated between $303 and $572, depending on the severity of the outbreak. This represents a gross impact of 41 and 76% of the small ruminant income, respectively.

Losses due to mortality (decrease of the number of animals sold (adults and young), milk and wool production by adults) represents more than 80% of the total losses, regardless of the species.

Gross annual impact of PPR in endemic areas

The outputs of the bioeconomic model show that the gross annual impact of PPR in endemic setting for a farmer keeping 3 adult sheep is $108 and $131 for prevalence rates of 10 and 35%, respectively. This represents a gross impact, of 26 and 31% of the small ruminant income, respectively.

The gross impact of endemic PPR for a farmer keeping 6 adult goats is $267 and $315, for regional prevalence rates of 10 and 35%, respectively. This represents a gross impact of 36 and 42% of the small ruminant income, respectively.

Regardless of the species, the greatest costs stemmed from increase of adults' mortality, followed by the increase of inter kidding interval. Mortality decreased the amount of meat sold as well milk production, the latter representing the most important production loss (**Figure 1**).

Figure 1: distribution of the losses due to PPR per category for sheep and goat in the endemic scenario.

In both situations (endemic PPR and non-endemic PPR), the impact varied depending upon regional PPR prevalence (**Figure 2**).

Figure 2: Evolution of gross impact (%) for sheep and goat herds in function of the seroprevalence of PPR.

Impact of PPR on total annual household income

Average impact for 15 sub-Saharan countries

The total income losses varied between 0.6 and 44.8% of the total annual household income.

The percentages varied depending on the scenario, and the impact of PPR on small ruminant production, modeled between 25 and 80% of small ruminant income based on the findings of the bioeconomic model. Regardless of the scenario, households in the lower quintiles are relatively more impacted by PPR than households in the upper quintiles. The higher the contribution of small ruminant production to agricultural income, the greater the impact. Results are presented in **table 5** and **Figure 3** .

Figure 3: Impact of PPR on total household income per income quintile (1 to 5). In the scenarios S1, S2, S3 and S4, 10, 20,

50 and 90% of the agricultural income comes from small ruminant farming activities, respectively. Results are expressed in percentage of total income.

Impact for Ethiopia, Malawi, Mali and Rwanda

The total income losses varied between 1.1 and 49.5%, 0.9 and 57.5%, 0.6 and 44.8% , and 0.3 and 25.8% of the total annual household income for Ethiopia, Malawi, Mali and Rwanda, respectively. Results are depicted in **Figure 4** and supplementary tables.

Figure 4: Net impact of PPR on total household income per income quintile (1 to 5), in Ethiopia (panel a), in Malawi (panel b), in Mali (panel c), in Rwanda (panel d). In the scenarios S1, S2, S3 and S4, 10, 20, 50 and 90% of the agricultural income comes from small ruminant farming activities, respectively. Results are expressed in percentage of total income.

Discussion

Bioeconomic model

We estimated the gross impact of PPR to range from $127 to $243, in the case of outbreak for a farmer keeping 3 adult sheep, and to range from $108 to $131 for endemic PPR. We found that the gross impact for a farmer keeping 6 goats to range from $303 and $572 and to range from $267 to $315 endemic PPR. Our findings are slightly higher than those reported in the literature: Opasina & Putt (1985) estimated the loss per animal from $3.8 to 14.6, but they only accounted for mortality losses; FAO (2008) estimated the loss due mortality and reduced meat and milk production at $8 per animal; Abubakar and Munir (2014) estimate the loss per animal in Pakistan at $33. In all estimates, consistently with our results, mortality was the most important factor explaining production losses, as associated to a decrease of milk production, weight losses and reduced sale of adult animals and young stock.

We parametrized our bioeconomic model according to available data in the literature. Production parameters and impacts of PPR at the animal or herd level made up a first set of parameters. Prevalence rates were a second set of parameters. Indeed, prevalence of PPR significantly vary depending on the location and agro-ecological setting of the countries and different levels result in different of PPR both in endemic and non-endemic settings.

Household impact

We modeled the impact at the household level for different plausible biologic and socio-economic scenarios. We focused our study at the household level, as small ruminants may represent a source of nutrients, a source of income, and "mobile banks" for the household. For example, milk play an important role in terms of food security (Simon M. Kihu, Gitao, et al., 2015). In addition some authors report the sociocultural importance of small ruminants, emphasizing their as gifts for traditional religious purposes (S M Kihu et al., 2013).

First, we considered a diversity of epidemic situations, by varying the prevalence of PPR. Second, we assessed the impact of PPR on several types of household, by considering their income quintile and the share of small ruminant income in their agricultural and total annual income. The percentages used in the scenarios mimicked the importance of small ruminants production observed in the RuLIS dataset.

We present estimated impacts of PPR for an average situation (based on 15 countries) as well as for four countries i.e., Ethiopia, Mali, Malawi, and Rwanda. We focused on these four countries, as they enable us to show a difference in our model outputs as they are quite diverse, with little commonalities in terms of agro-ecological conditions and livestock production systems. Mali and Ethiopia are two large countries, while Malawi and Rwanda are much smaller. Annual total income ranged from US$1,424 to US$ 3,125, and the share of agricultural income in the total income ranged from 24 to 65% (**table 3**). In a recent meta-analysis, PPR prevalence was estimated at 25% in Ethiopia (Ahaduzzaman, 2020). in Mali, individual PPR prevalence was reported to be 42.6%, with high variations between regions (5.5 to 59.1%) (Kamissoko et al., 2013). Malawi is considered to be free from PPR, even though the virus was identified in epidemiological surveys (Kamwendo, 2016). PPR is suspected to be present but has not been reported in Rwanda (Torsson et al., 2016). Also, sociological and structural factors may affect PPR prevalence and control options (Bryony Anne Jones, Muhammed, Ali, Homewood, & Pfeiffer, 2020; Kardjadj & Luka, 2016). For example, in many western African countries such as Mali, and Central African countries such as Rwanda, small ruminant husbandries are usually small scaled. To calculate the impact of PPR on total household income, we used RuLIS and FAOstat databases. One limitation lies in the availability of recent data at the country level and possible inconsistency in the surveys conducted in every country.

Another limitation of our study is that we modeled the impacts of PPR in the short run, and with a single market. Given the potential losses associated with PPR, particularly in case of outbreak, it is likely that the disease would have short and long run repercussions on the markets of small ruminants' products as well as on other livestock and secondary markets. In case of endemic disease however, losses are probably entirely born by the producers, with small changes on commodities' prices. How PPR would affect supply and demand is a relevant question, which requires different analytical tools and parameters such as elasticity, but may not be able to show the impacts at the household level.

Overall, the total income losses varied between 0.6 and 44.8% of the total household income. This important variability suggests that benefits of managing PPR would be considerably different and may be envisioned at a regional level and the challenges to get households' support in implementing interventions to manage and control the disease. In any case, coordinated approaches are likely to optimize long-term benefits of PPR management.

Our findings present at a microeconomic scale the impact of PPR, which has been mostly studied at the macroeconomic scale (Akerejola et al., 1979; Bardhan et al., 2017; Bryony A. Jones et al., 2016; Singh & Prasad, 2008) .

In conclusion, PPR remains an important threat to rural populations' welfare. From a policy perspective, identifying the most relevant strategies and tailoring them at regional level would help mitigate PPR impacts (Bryony Anne Jones et al., 2020). Recourse to massive vaccination could probably decrease drastically the economic impacts of PPR for small ruminants' keepers, though the overall impact on household income and welfare risk remaining marginal.

Data availability

The primary data that support the findings of this study are publicly available at www.fao.org .

The data extracted for this study are available in the supplementary material of this article.

Ethical statement

Not applicable.

Conflict of interest

None to declare.

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Parameter	**Ewe**	**Goat**
Interkidding interval (year)	0.58	0.75
Interkidding interval range (year)	-	0.63-1.14
Prolificity (no/y)	1.30	1.46
Prolificity range	1-1.5	1.2-2
Average kid production per year (no/y)	2.23	1.95
Adult live weight (kg)	41.67	36.36
Slaughter weight (kg)	25.00	20.00
Average live adult meat production per year (kg/y)	8.33	7.27
Carcass yield (%)	40.00	45.00
Kid live meat production per year (kg/y)	31.76	27.74

Parameter	Ewe	Goat
Average milk production per year (L/y)	75.00	100.00
Milk production range (L/y)	50-140	40-140
Average wool production per year (kg/y)	0.20	0.00
Wool production range (kg/y)	0.05-0.5	

Table 1: Production parameters used in the bio economic model.

Parameter	Ewe	Goat
Average live adult meat production per year (kg/y)	5.58	5.82
Kid live meat production per year (kg/y)	21.28	18.59
Average milk production per year (L/y)	30.00	50.00
Average wool production per year (kg/y)	0.17	
Increase of interkidding interval (y)	0.58	0.42
Average kid production per year (no/y)	1.11	1.25

Table 2: Impact of PPR in exposed herds in PPR.

Country

Year of survey

Number observation

Number and share (%) of household owning small ruminant

Number and share (%) of household owning small ruminant

Average number of small ruminants per household owning small ruminant

Average annual total income of household owning small ruminant (USD)

Average agricultural income of household owning small ruminant (USD) and share in the total income (%)

Average agricultural income of household owning small ruminant (USD) and share in the total income (%)

Average annual gross income from livestock of household owning small ruminant (USD)

Average total value of production from livestock activities

of household owning small ruminant (USD)

Average nonfarm income of household owning small ruminant (USD)

Burkina Faso

2014

10,800

-

-

-

-

-

-

-

-

-

Cameroon

2014

10,303

955

(9)

6.1

6,028

5,602

(93)

2,327

2,389

-

Cote d'Ivoire

2008

12,600

1,163

(9)

6.9

10,325

8,696

(84)

5,847

587

-

Ethiopia

2014

4,769

1,757

(37)

5.7

1,103

686

(62)

285

455

333

Ethiopia

2015

4,550

1,756

(39)

8.3

1,424

868

(61)

355

820

472

Ghana

2013

16,772

4,645

(28)

8.7

3,432

2,091

(61)

271

340

1,770

Kenya

2005

13,212

4,198

(32)

8.9

2,656

959

(36)

483

1,150

1,139

Malawi

2004

11,280

2,340

(21)

4.1

448

181

(40)

19

35

167

Malawi

2011

12,271

2,358

(19)

4.2

999

615

(61)

92

112

305

Malawi

2013

4,000

779

(19)

4.0

2,175

1,219

(56)

156

183

646

Mali

2014

3,804

1,596

(42)

11.2

3,525

2,299

(65)

321

803

777

Mozambique

2008

10,832

1,807

(17)

4.7

1,954

1,312

(67)

362

373

-

Niger

2011

3,968

2,029

(51)

22.4

1,338

204

(15)

155

284

1,585

Niger

2014

3,617

1,593

(44)

21.9

2,103

259

(12)

32

145

1,622

Nigeria

2013

4,796

1,541

(32)

22.8

4,078

2,161

(53)

135

226

1,901

Nigeria

2016

4,612

1,524

(33)

9.8

3,255

1,478

(45)

175

284

1,612

Rwanda

2013

14,419

4,719

(33)

2.5

2,508

601

(24)

203

434

1,793

Senegal

2011

5,953

2,124

(36)

13.3

3,681

1,293

(35)

335

520

-

United Republic of Tanzania

2009

3,265

643

(20)

7.0

2,188

985

(45)

244

255

1,202

United Republic of Tanzania

2010

3,924

739

(19)

8.9

2,666

1,219

(46)

341

407

1,460

United Republic of Tanzania

2013

5,004

879

(18)

11.3

3,189

1,532

(48)

773

871

1,041

Uganda

2009

2,975

1,199

(40)

4.9

3,015

1,192

(40)

185

326

1,635

Uganda

2011

2,712

1,049

(39)

4.5

3,162

1,343

(42)

220

330

1,660

Uganda

2012

2,818

1,241

(44)

4.8

2,563

1,047

(41)

157

315

1,309

Uganda

2013

3,117

1,047

(34)

4.1

2,820

860

(30)

110

178

744

Table 3: Descriptive statistics per country included in the study.

Quintile

Share of household owning small ruminant (%)

Average house size of household owning small ruminant

Average annual total income of household owning small ruminant (USD)

Average agricultural income of household owning small ruminant (USD) and share in the total income (%)

Average agricultural income of household owning small ruminant (USD) and share in the total income (%)

Average annual gross income from livestock of household owning small ruminant (USD)

Average total value of production from livestock activities

of household owning small ruminant (USD)

Average nonfarm income of household owning small ruminant (USD)

1

40

7.8

1,552

966

(60)

202

322

489

2

40

6.9

1,954

1,077

(54)

233

387

808

3

36

6.3

2,420

1,137

(47)

252

414

1,102

4

29

5.9

2,960

1,111

(38)

267

462

1,629

5

18

5.4

4,355

1,075

(26)

270

512

2,698

-

24

6.7

1,771

978

(54)

202

330

751

Table 4 : Descriptive statistics per quintile (average of the 15 countries included in the study).

Quintile

Impact of PPR

on small ruminant income

Average loss of annual total income per

household owning small ruminant

Average loss of annual total income per

household owning small ruminant

Average loss of annual total income per

household owning small ruminant

Average loss of annual total income per

household owning small ruminant

S1 (10%)

S2 (20%)

S3 (50%)

S4 (90%)

1

-25%

1.6%

3.1%

7.8%

14.0%

1

-30%

1.9%

3.7%

9.3%

16.8%

1

-35%

2.2%

4.4%

10.9%

19.6%

1

-40%

2.5%

5.0%

12.4%

22.4%

1

-60%

3.7%

7.5%

18.7%

33.6%

1

-80%

5.0%

10.0%

24.9%

44.8%

2

-25%

1.4%

2.8%

6.9%

12.4%

2

-30%

1.7%

3.3%

8.3%

14.9%

2

-35%

1.9%

3.9%

9.6%

17.4%

2

-40%

2.2%

4.4%

11.0%

19.8%

2

-60%

3.3%

6.6%

16.5%

29.8%

2

-80%

4.4%

8.8%

22.0%

39.7%

3

-25%

1.2%

2.3%

5.9%

10.6%

3

-30%

1.4%

2.8%

7.0%

12.7%

3

-35%

1.6%

3.3%

8.2%

14.8%

3

-40%

1.9%

3.8%

9.4%

16.9%

3

-60%

2.8%

5.6%

14.1%

25.4%

3

-80%

3.8%

7.5%

18.8%

33.8%

4

-25%

0.9%

1.9%

4.7%

8.4%

4

-30%

1.1%

2.3%

5.6%

10.1%

4

-35%

1.3%

2.6%

6.6%

11.8%

4

-40%

1.5%

3.0%

7.5%

13.5%

4

-60%

2.3%

4.5%

11.3%

20.3%

4

-80%

3.0%

6.0%

15.0%

27.0%

5

-25%

0.6%

1.2%

3.1%

5.6%

5

-30%

0.7%

1.5%

3.7%

6.7%

5

-35%

0.9%

1.7%

4.3%

7.8%

5

-40%

1.0%

2.0%

4.9%

8.9%

5

-60%

1.5%

3.0%

7.4%

13.3%

5

-80%

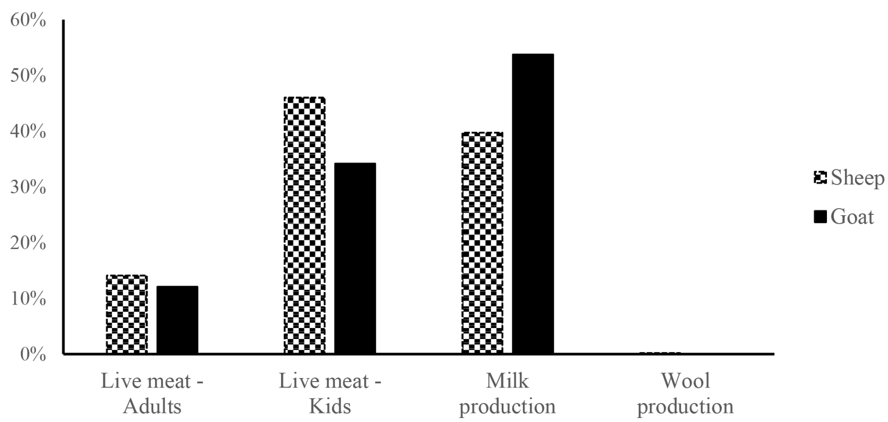
2.0%

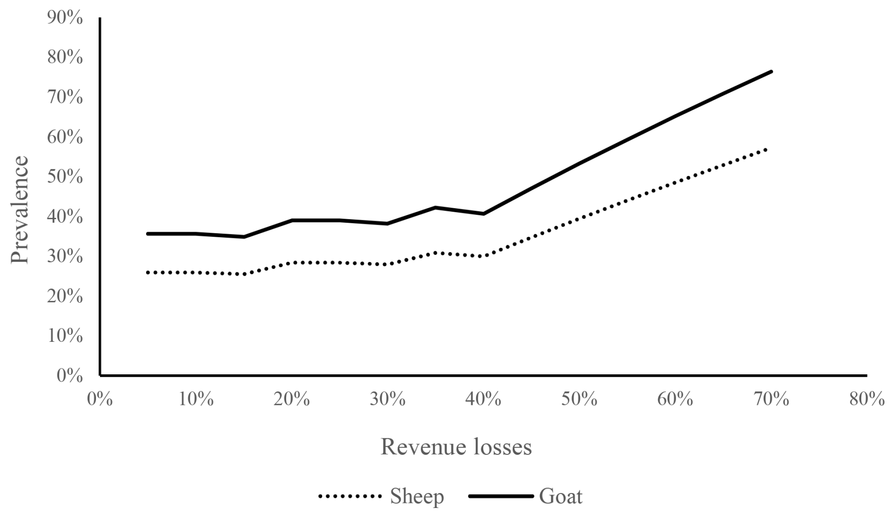
3.9%

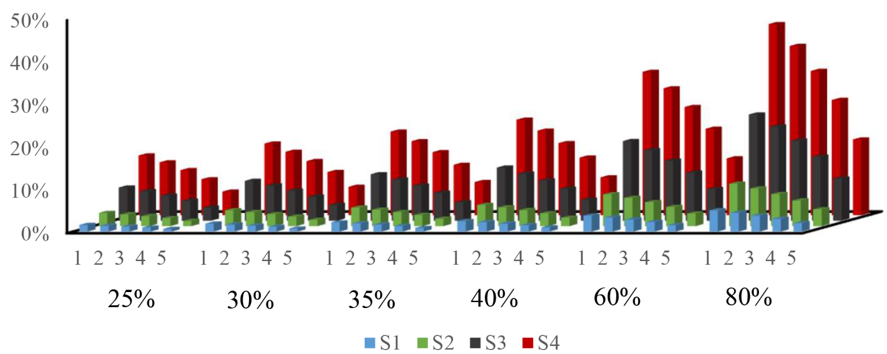
9.9%

17.8%

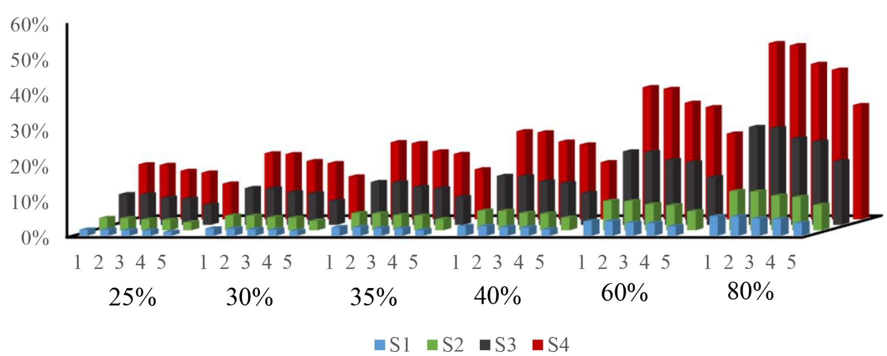
Table 5 : Average impact of PPR on total annual income in function of the quintile. The impact of PPR on small ruminant income ranges from -25 to -80%. In the scenarios 1 to 4, 10, 20, 50 and 90% of the agricultural income comes from small ruminant farming activities, respectively. Results are expressed in percentage of total income.



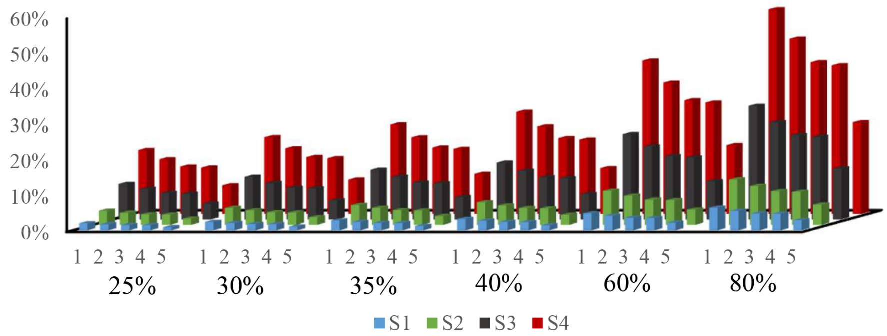

Prevalence
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
Revenue losses
Sheep
Goat


0%
10%
20%
30%
40%
50%
1 2 3 4 5
25%
30%
35%
40%
60%
80%
S1
S2
S3
S4

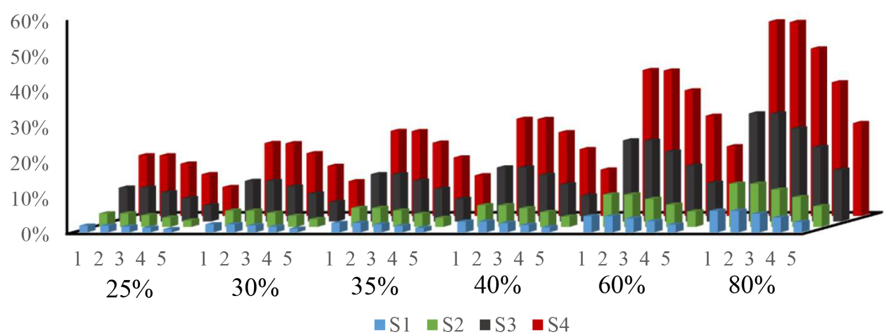
(a)


0%
10%
20%
30%
40%
50%
60%
1 2 3 4 5
25%
30%
35%
40%
60%
80%
S1
S2
S3
S4

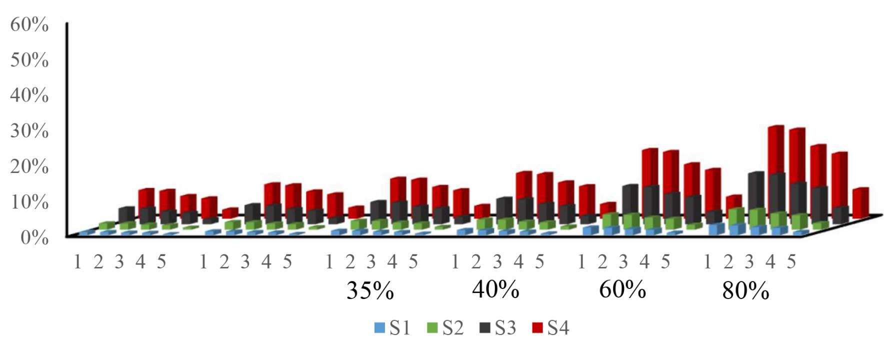
(b)


60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
25% 30% 35% 40% 60% 80%
S1 S2 S3 S4

(c)


60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
25% 30% 35% 40% 60% 80%
S1 S2 S3 S4

(d)


60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
35% 40% 60% 80%
S1 S2 S3 S4