Economic Returns to Progressive Disease Control

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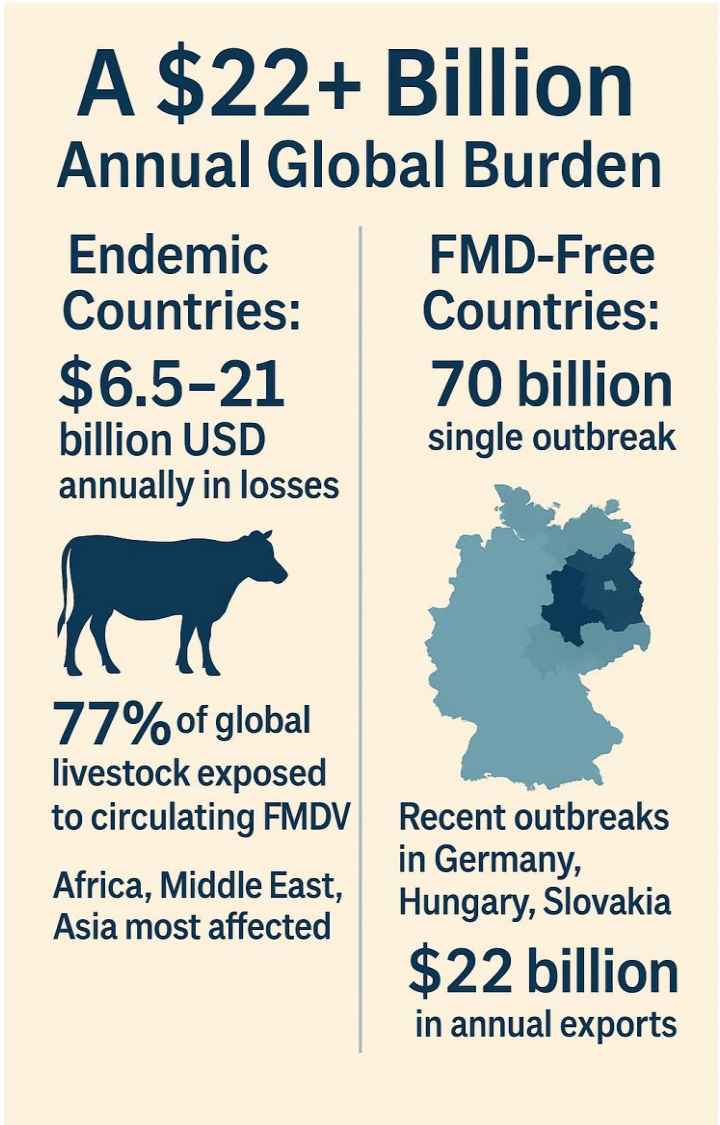
FMD Burden

- Foot-and-mouth disease (FMD) remains one of the most economically significant significant transboundary animal diseases affecting livestock systems worldwide. worldwide.
- While sporadic outbreaks in previously free regions often dominate international international attention due to their acute trade and market impacts, the persistent persistent endemic burden of FMD across large parts of Africa, the Middle East, and Asia East, and Asia represents a far more pervasive and structurally damaging challenge. challenge.
- Endemic FMD affects animal health, food security, and rural livelihoods across low- and low- and middle-income countries, imposing substantial production losses, distorting distorting market incentives, and constraining the development of livestock sectors. sectors.



Endemic FMD as a Systemic Challenge

Veterinary Perspective

Endemic FMD reflects broader broader limitations in surveillance, vaccination strategy, strategy, biosecurity, and governance. Repeated exposure exposure results in cumulative cumulative losses in milk yield, yield, growth rates, fertility, and and longevity, alongside increased morbidity-related management costs.

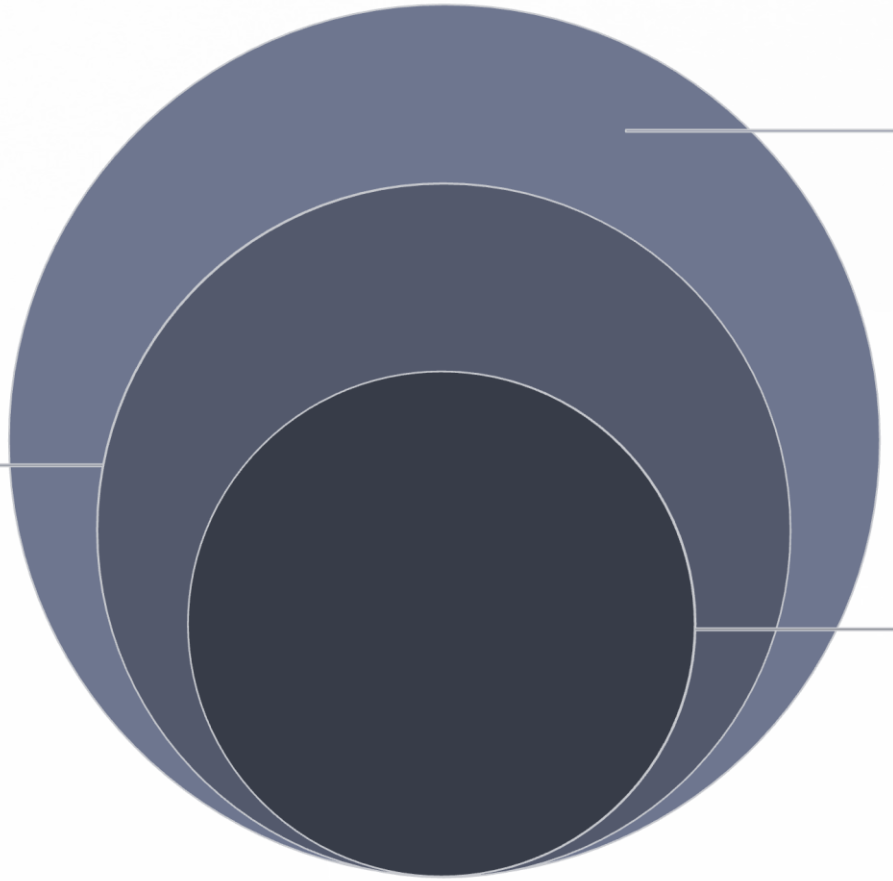
Development Constraint Constraint

Endemic FMD represents a systemic development constraint constraint rather than an isolated isolated veterinary issue. It erodes returns to public expenditure in veterinary services, undermines agricultural agricultural transformation strategies, and weakens animal animal health credibility in markets.

Investment Impact

For development partners and and financial institutions, endemic FMD constitutes a source of chronic inefficiency that that reduces the effectiveness of effectiveness of broader investments in productivity, value value chains, resilience, and poverty reduction.

How Endemic FMD Affects Livestock Systems



National Level

Constrained trade, lower competitiveness, locked low productivity

Market Level

Higher costs, altered supply, supply, price adjustments

Farm Level

Milk & meat losses, reduced growth, reproductive harm

The Economic Analysis Gap

Traditional Focus

Economic analyses of FMD have historically focused on outbreak scenarios in scenarios in high-income or export-oriented countries where incursions can incursions can trigger severe trade losses. These studies demonstrate demonstrate potentially catastrophic costs of FMD introduction into free free zones.

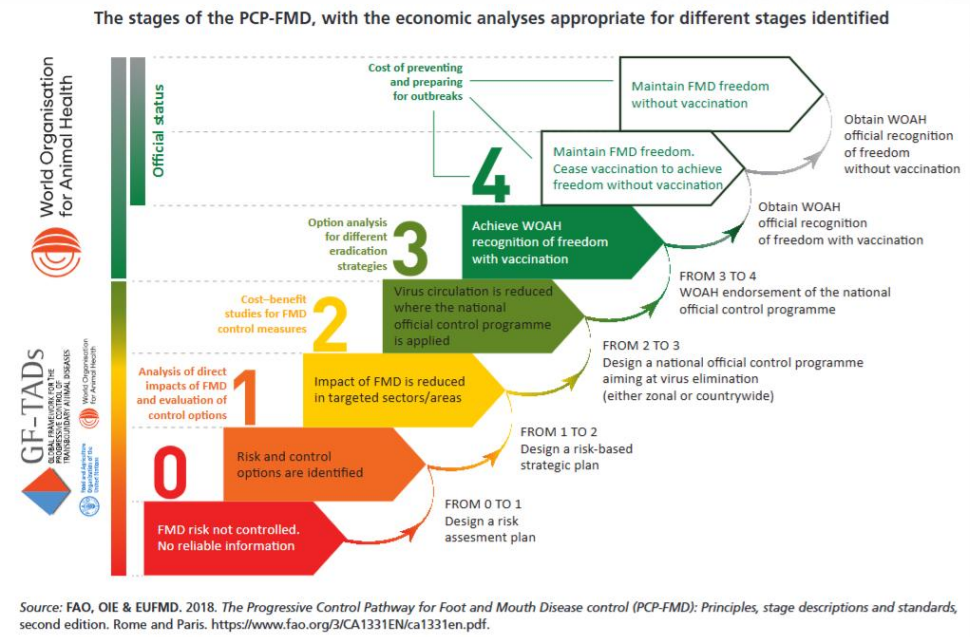
Endemic Reality

However, they provide limited guidance for the majority of countries where where FMD is endemic. The policy challenge is not how to recover from a rare from a rare shock, but how to reduce a persistent drag on economic performance.

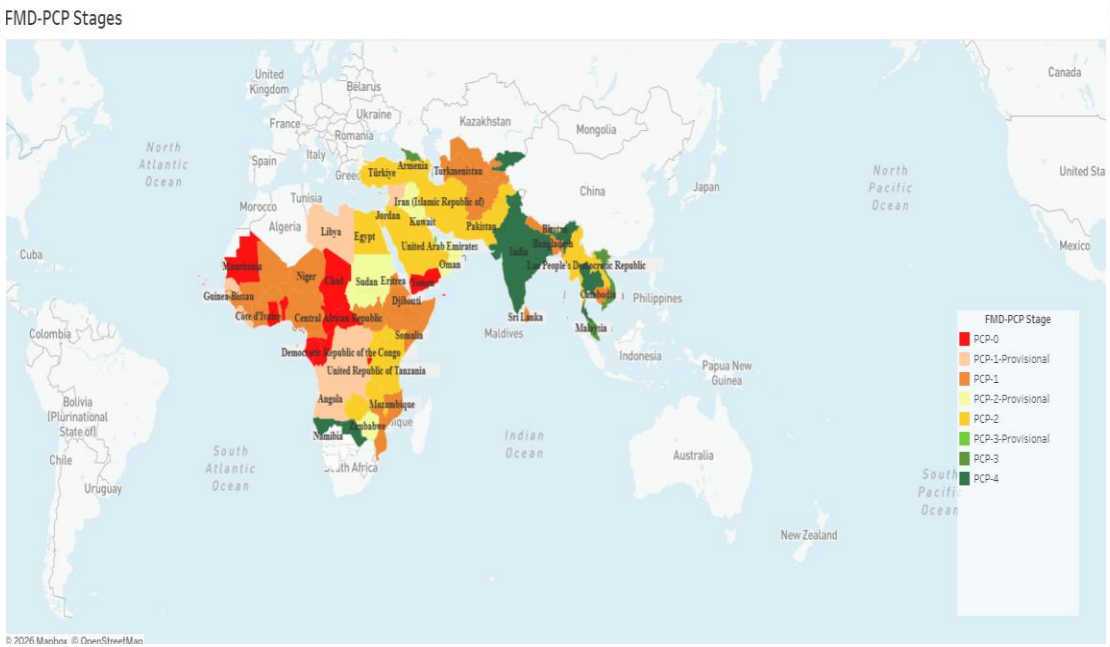
> In endemic settings, the relevant economic question is fundamentally different: **how do sustained investments in disease control alter long-run welfare-economic outcomes, market stability, and exposure to economic risk?**

The Progressive Control Pathway for FMD

The Progressive Control Pathway for Foot-and-Mouth Disease (PCP-FMD), provides a structured framework through which countries progressively strengthen surveillance, governance, and control measures.



Source: **FAO, OIE & EUFMD.** 2018. *The Progressive Control Pathway for Foot and Mouth Disease control (PCP-FMD): Principles, stage descriptions and standards,* second edition. Rome and Paris. https://www.fao.org/3/CA1331EN/ca1331en.pdf.



The PCP-FMD recognizes that disease control is not a binary outcome, but a gradual process shaped by institutional capacity, resource availability, and policy availability, and policy choices. More than 80 countries are currently implementing the PCP-FMD.

Evidence Gaps in PCP-FMD Economics

Limited Evidence

Empirical evidence on the economic implications of PCP-FMD progression remains remains scarce. Most discussions emphasize emphasize technical milestones with little little attention to measurable socioeconomic socioeconomic effects.

Critical Question

What are the economic returns, in welfare-economic and economic risk terms, to moving from one PCP-FMD stage to another?

Economic Risk Dimension

Most assessments focus on average outcomes rather than uncertainty and dispersion. Disease control investments are inherently risk-reducing, yet this dimension is rarely quantified.

Objectives

1

Estimate Societal Economic Welfare Losses

Estimate country-level societal economic welfare losses associated with endemic FMD in **milk** and **beef** markets using a transparent and comparable economic framework.

2

Assess PCP Relationship

Assess the relationship between PCP-FMD stage and societal economic economic welfare outcomes, including both absolute losses and losses and losses relative to national GDP.

3

Examine Dispersion

Examine how the dispersion and composition of welfare losses change change across PCP-FMD stages, with particular attention to economic economic risk and uncertainty.

4

Investment Frontier

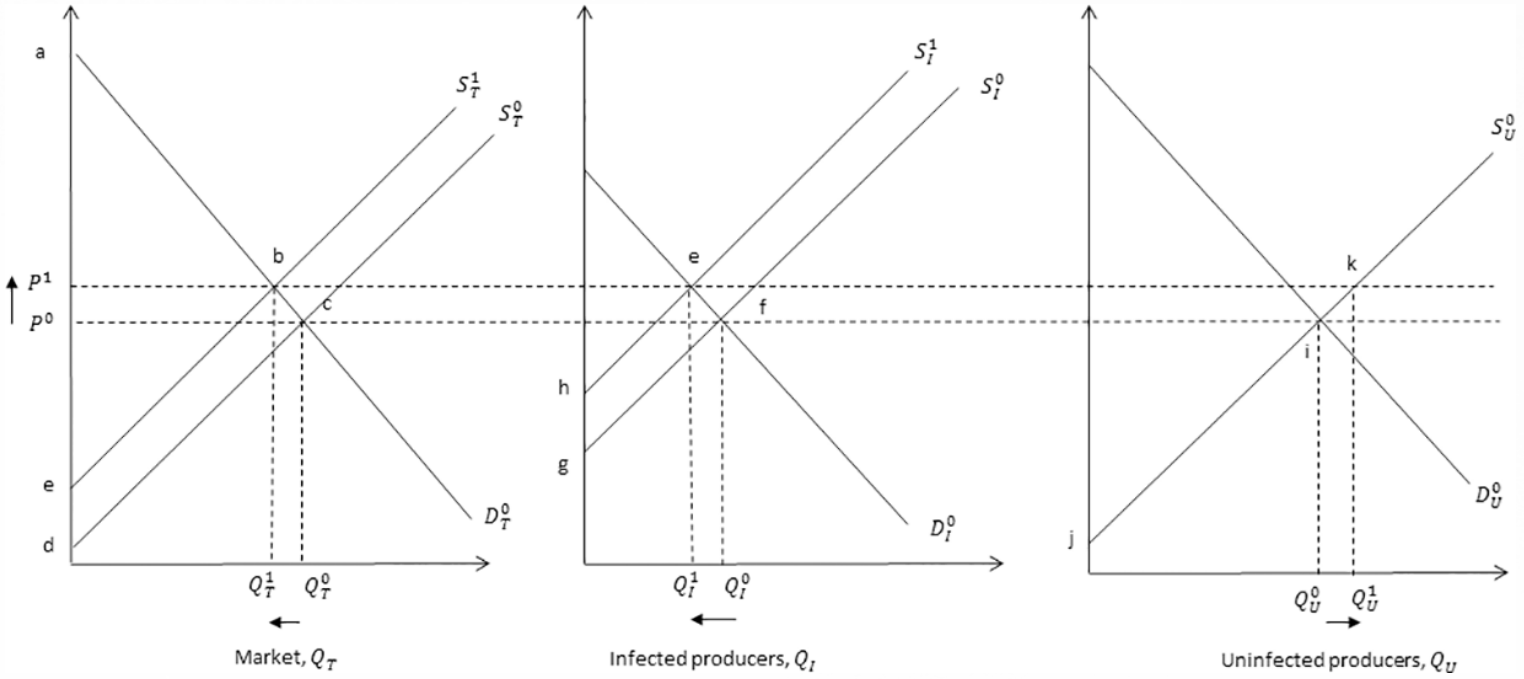
Introduce the concept of a PCP-FMD Investment Frontier, illustrating illustrating how progression along the PCP-FMD is associated with with simultaneous reductions in expected losses and economic economic variability.

Analytical Approach: Partial Equilibrium Model

FMD was modeled as an endemic production shock affecting livestock systems through two channels:

- biological production losses reducing effective output among infected animals,
- disease-related cost increases reflecting treatment, management inefficiencies, and control expenditures.

Both channels affect market equilibrium by **shifting supply supply upward and inward**, resulting in price changes and changes and quantity adjustments that redistribute welfare welfare between consumers and producers.



Source: Barratt et al (2018)

Data Sources and Components

Economic Welfare Loss Estimates

Estimates of FMD-related economic welfare losses constructed and disaggregated into **milk** and **beef** components, capturing **producer** and **consumer surplus surplus** effects.

PCP-FMD Classifications

PCP-FMD stage classifications drawn from GF-TADs assessments, with the most recent available stage used for each country.

GDP Data

National GDP data used to normalize welfare losses, losses, enabling interpretation of macroeconomic macroeconomic balance across countries of different sizes.

Country Metadata

Country-level metadata employed to support grouping, aggregation, and interpretation across PCP across PCP stages.

Type of data

Country-level input data include GDP, annual milk and beef production volumes, average producer prices, and estimated endemic FMD prevalence at the national herd level.

Data Harmonization

Production, price, and macroeconomic data were harmonized to ensure internal consistency and comparability across countries.

Societal Economic Welfare Metrics

Absolute Losses

Expressed in USD, capturing the scale of economic impact and aggregate exposure exposure (included infected producers, uninfected producers and consumers).

GDP-Normalized Losses

Expressed as percentage of GDP, capturing capturing economic vulnerability and macroeconomic relevance for meaningful meaningful cross-country comparison.

Logarithmic Transformation

Applied to mitigate influence of extreme scale scale differences and reveal order-of-magnitude patterns otherwise obscured.

Model Parameters and Assumptions

Production Losses and Costs

- Milk yield loss among infected animals: animals: 15%
- Beef output loss among infected animals: 8%
- Milk disease cost: USD 0.02 per unit
- Beef disease cost: USD 0.50 per unit

Supply and Demand Elasticities

- Milk supply elasticity: 0.2
- Milk demand elasticity: -0.3
- Beef supply elasticity: 0.1
- Beef demand elasticity: -0.4

Country	PCP Stage	GDP (USD Billion)	Milk Output (Million Tonnes Eq.)	Beef Output (Million Tonnes Eq.)	Milk Price	Beef Price	Prevalence
Mauritania	0	10	500	300	0.45	5.50	0.30
Mali	1	20	1,200	700	0.40	5.20	0.25
Niger	1	15	600	450	0.45	5.50	0.25
Nigeria	1	480	1,200	1,000	0.50	6.50	0.22
Benin	1	18	400	250	0.45	5.00	0.25
Côte d'Ivoire	1	70	350	200	0.50	5.80	0.22
Guinea-Biss	0	2	120	80	0.50	5.00	0.30
Guinea	1	16	300	200	0.45	5.20	0.25
Liberia	0	4	150	100	0.55	5.50	0.30
Sierra Leone	1	5	200	120	0.50	5.30	0.28
Cameroon	1	45	600	400	0.45	5.50	0.25
CAR	0	3	200	150	0.45	5.00	0.35
Chad	0	13	900	700	0.40	5.20	0.30
Eq. Guinea	1	14	100	80	0.55	6.00	0.20
DRC	1	60	800	500	0.45	5.00	0.30
Sudan	1	35	3,500	1,200	0.40	5.00	0.25
South Sudan	1	12	300	200	0.45	5.20	0.35
Eritrea	1	2	250	150	0.45	5.00	0.30
Ethiopia	1	160	5,500	750	0.40	5.00	0.25

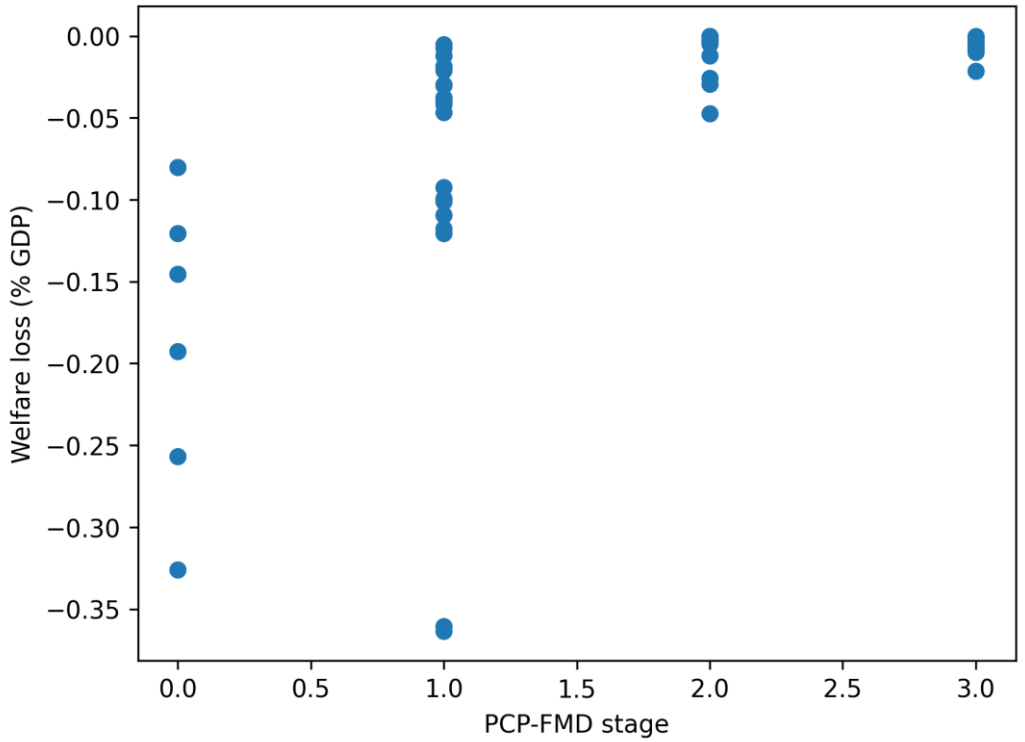
Country	PCP stage	Milk welfare loss (USD million)	Beef welfare loss (USD million)	Total welfare loss (USD million)	Welfare loss (% GDP)
Mauritania	0	-0.95	-13.59	-14.54	-0.15
Mali	1	-1.56	-21.98	-23.54	-0.12
Niger	1	-0.78	-14.13	-14.92	-0.10
Nigeria	1	-1.21	-24.31	-25.52	-0.01
Benin	1	-0.52	-7.85	-8.37	-0.05
Côte d'Ivoire	1	-0.35	-4.86	-5.21	-0.01
Guinea-Bissau	0	-0.23	-3.62	-3.85	-0.19
Guinea	1	-0.39	-6.28	-6.67	-0.04
Liberia	0	-0.29	-4.53	-4.82	-0.12
Sierra Leone	1	-0.33	-4.73	-5.06	-0.10
Cameroon	1	-0.78	-12.56	-13.35	-0.03
CAR	0	-0.53	-9.26	-9.78	-0.33
Chad	0	-1.71	-31.70	-33.40	-0.26
Eq. Guinea	1	-0.08	-1.61	-1.69	-0.01
DRC	1	-1.52	-22.64	-24.16	-0.04
Sudan	1	-4.55	-37.67	-42.23	-0.12
South Sudan	1	-0.79	-12.34	-13.13	-0.11
Eritrea	1	-0.48	-6.79	-7.27	-0.36
Ethiopia	1	-7.16	-23.55	-30.70	-0.02
Djibouti	1	-0.04	-0.80	-0.84	-0.02
Somalia	1	-1.70	-27.16	-28.86	-0.36
Uganda	1	-2.50	-14.58	-17.08	-0.04
Tanzania	1	-3.00	-19.43	-22.43	-0.03
Angola	1	-0.91	-15.70	-16.62	-0.02
Zambia	2	-0.66	-8.12	-8.79	-0.03
Mozambique	1	-0.49	-7.02	-7.52	-0.04
Zimbabwe	3	-0.26	-3.24	-3.51	-0.01
Namibia	3	-0.06	-2.50	-2.56	-0.02
Botswana	3	-0.03	-1.28	-1.31	-0.01
Libya	2	-0.53	-4.87	-5.41	-0.01
Egypt	2	-3.97	-13.00	-16.97	-0.00
Algeria	2	-1.38	-6.76	-8.14	-0.00
Iran	2	-4.10	-11.27	-15.37	-0.00
Iraq	2	-1.23	-8.03	-9.26	-0.00
Jordan	2	-0.12	-0.87	-0.98	-0.00
Kuwait	2	-0.04	-0.40	-0.44	-0.00
Saudi Arabia	2	-0.73	-3.61	-4.34	-0.00
UAE	2	-0.04	-0.38	-0.43	-0.00
Oman	2	-0.06	-0.75	-0.81	-0.00
Yemen	0	-1.56	-18.51	-20.06	-0.08
Lebanon	2	-0.07	-0.75	-0.82	-0.00
Palestine	2	-0.04	-0.36	-0.40	-0.00

Preliminary results

Country-Level Societal Economic Welfare Losses

- Estimated annual welfare-economic losses associated with endemic FMD vary FMD vary widely across countries in absolute terms, reflecting differences in the differences in the scale of livestock production, prices, and national economic economic size.
- However, when expressed relative to GDP, a clear and systematic pattern emerges across PCP-FMD stages. Countries at lower PCP-FMD stages (Stages 0-1) experience substantially larger economic welfare losses relative to GDP, often exceeding several tenths of a percentage point.

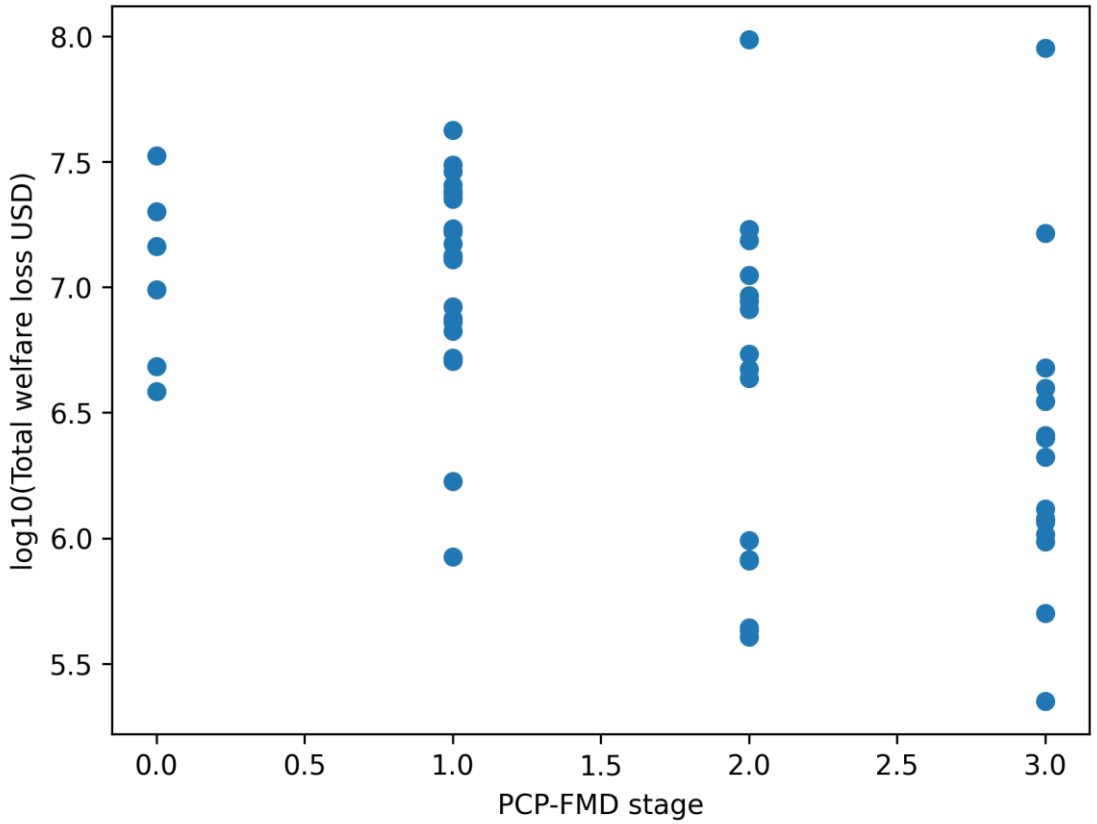
PCP-FMD Stage and Economic Welfare Losses



Key Observations

- Countries at PCP-FMD Stage 0 cluster at the upper end of the distribution, distribution, with consistently high welfare losses relative to economic economic output. As countries progress through Stages 1 and 2, welfare welfare losses decline sharply, with further reductions observed at Stage at Stage 3.
- The decline in welfare losses is not linear. The largest reduction occurs between Stages 1 and 2, suggesting that the transition from basic control to structured, risk-based programmes delivers particularly large economic gains.

Absolute Welfare Losses Across PCP Stages

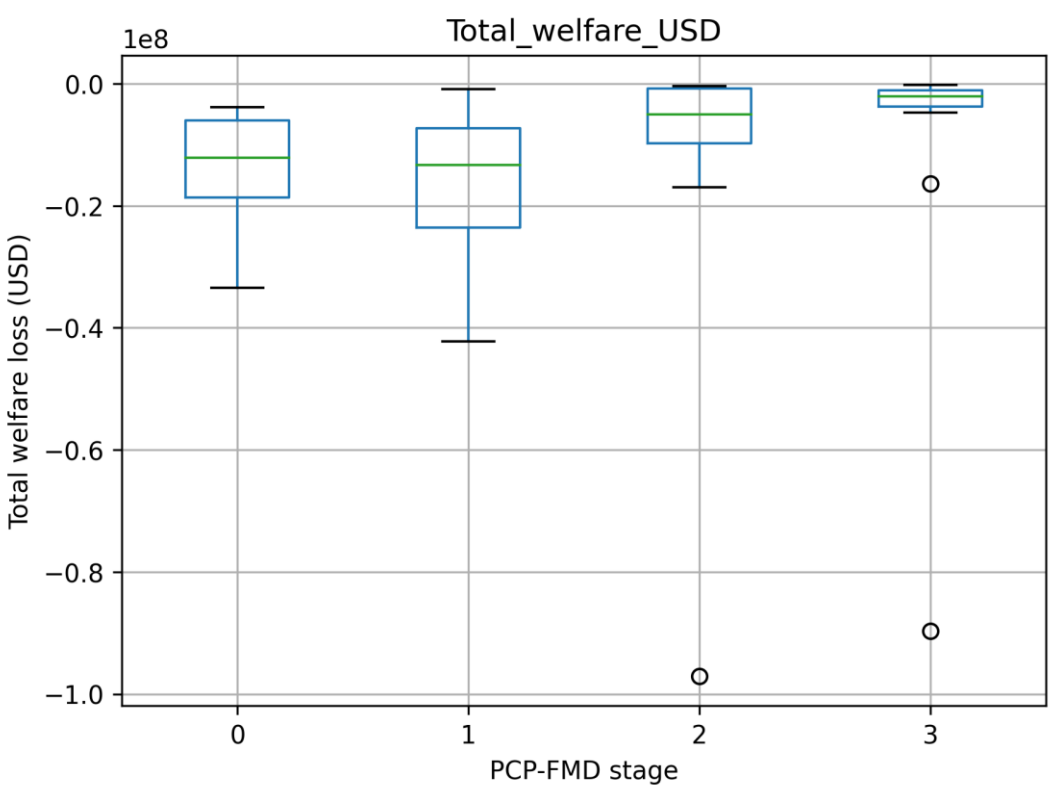


Scale-Adjusted Analysis

- The relationship between PCP-FMD stage and the logarithm of total welfare losses in absolute monetary terms reveals that the negative association remains clearly visible even after controlling for scale effects.

- This finding indicates that the observed relationship is not driven solely by driven solely by GDP size or production volume but reflects genuine genuine differences in the economic burden of endemic FMD across across stages of disease control maturity.

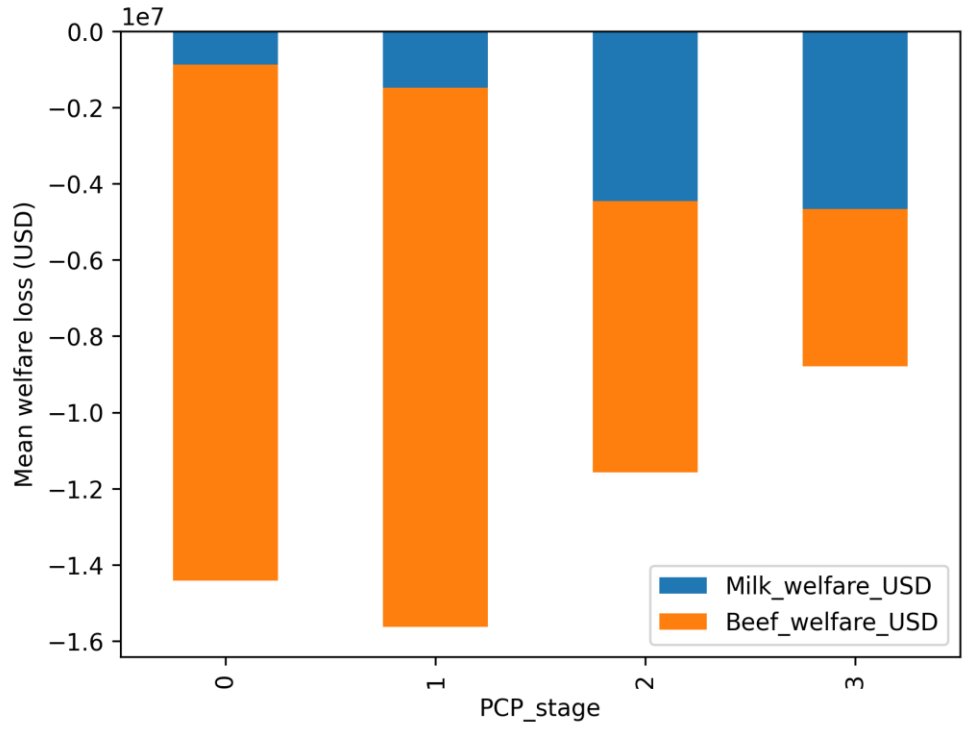
Distribution of Welfare Losses by PCP Stage



Key Observations

- The distribution of total welfare losses by PCP-FMD stage reveals two two features.
  - First, median welfare losses decline steadily with increasing PCP-PCP-FMD stage.
  - Second, and equally important, the dispersion of welfare losses losses collapses sharply as PCP-FMD stage increases.
- Countries at Stages 0 and 1 exhibit wide interquartile ranges and long upper tails, indicating substantial variability and exposure to extreme economic losses. By contrast, countries at Stage 3 display a narrow distribution with limited outliers.

Composition of Economic Welfare Losses: Milk vs. Beef



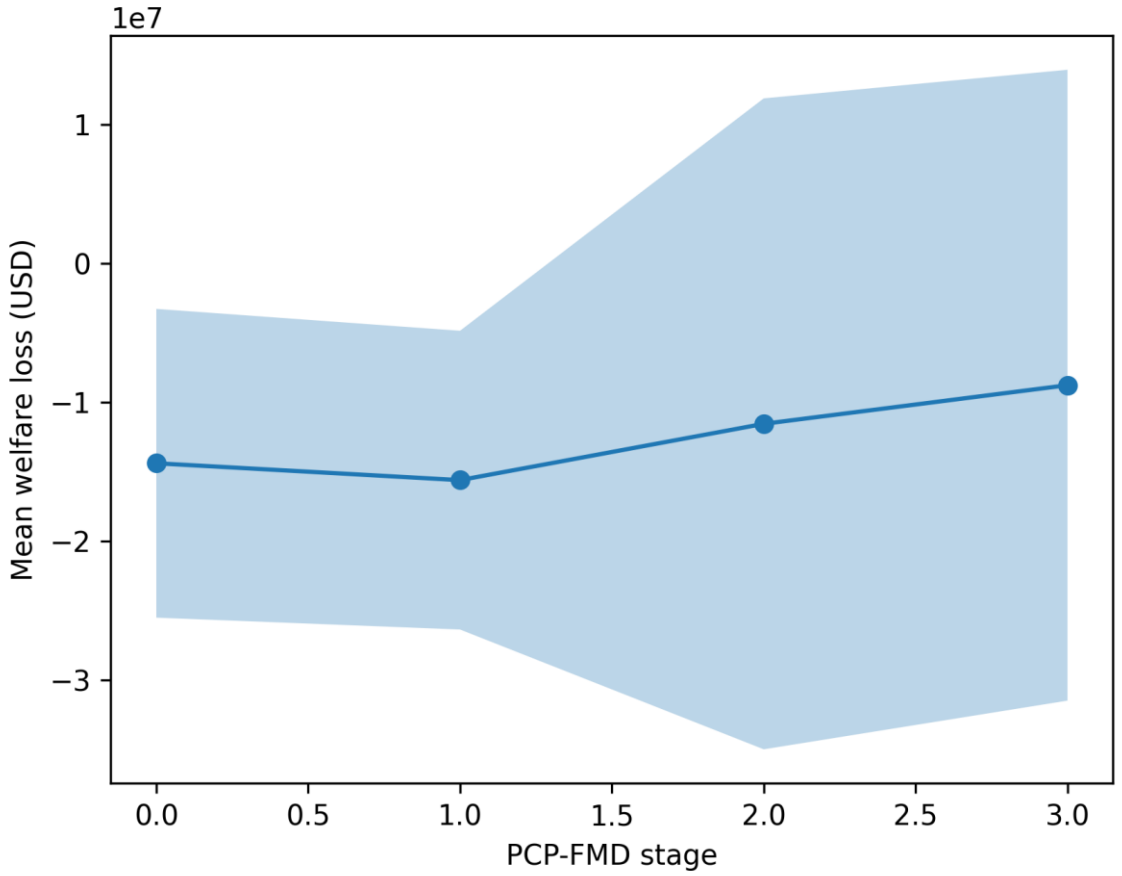
Lower PCP Stages

- Economic welfare losses are dominated by the beef sector, reflecting extensive production systems, higher exposure to animal movement-related transmission, and limited biosecurity.

Higher PCP Stages

- The relative contribution of beef losses declines, while milk losses account losses account for a larger share of the remaining welfare burden, possibly burden, possibly reflecting structural transformation in livestock systems systems (further investigations are needed!)

The PCP-FMD Investment Frontier



Key Observations

- Mean welfare losses decline as countries progress along the PCP-FMD pathway, indicating improved average economic outcomes.
- Variability in welfare losses increases at intermediate PCP stages, reflecting growing heterogeneity in implementation effectiveness.

> The PCP-FMD Investment Frontier therefore highlights a two-two-dimensional transition: improvements in expected welfare occur welfare occur earlier, while reductions in economic variability require variability require deeper consolidation of control capacity.

Policy Implications

Strategic Logic

The findings reinforce reinforce the strategic strategic logic underpinning GF-TADs TADs advocacy for sustained progression progression along the the PCP-FMD pathway. pathway. PCP-FMD milestones correspond correspond to economically meaningful thresholds thresholds in welfare welfare and risk reduction.

Critical Transition Transition

The pronounced reduction in welfare losses observed between PCP-FMD Stages 1 and 2 is particularly notable, implying that investments enabling enabling this transition transition may yield disproportionately large economic returns.

Development Investment

For development partners and financial institutions, the results support framing FMD control as a foundational investment that enhances the effectiveness of broader agricultural and rural development programmes.

Limitations

- Generic Analysis
- Partial Equilibrium Framework
- Endemic Steady-State
- Ordinal Indicator
- Aggregate Focus

Conclusions

Systematic Decline

Societal economic welfare losses decline systematically with increasing PCP-FMD stage, both in absolute terms and relative to national economic size.

Risk Reduction

PCP progression is associated not associated not only with lower lower expected economic welfare welfare losses, but also with changes in the distribution of outcomes and reduced economic economic uncertainty.

Investment Framework

The PCP-FMD Investment Frontier characterizes disease control maturity through joint joint changes in expected economic welfare losses and economic uncertainty.

Policy Rationale

Results provide an economic rationale for sustained progression along the PCP-FMD FMD pathway, supporting evidence-based prioritization of prioritization of transboundary transboundary disease control. control.

Acknowledgment

Analytical Foundations:

- Welfare-economic modelling of endemic livestock diseases
- Extension of these frameworks to TADs, incorporating trade and outbreak dynamics
- Further refinement through structured economic modelling (post-2018 developments)
- Informed by the FAO-WOAH GF-TADs and PCP-FMD, drawing on contributions from many colleagues and experts
- Grounded in country data, field experience, and regional expertise

Disclaimer:

- Work in progress – figures are not for quotation
- Views and interpretations are those of the author and do not necessarily reflect the official positions of FAO.

Thank you