Cambridge Global Food Security Symposium Thursday 6th July 2023

Towards a Better Food System: challenges and opportunities

Emerging livestock systems:
animal, human and socioeconomic risks of pig production in Myanmar

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GLOBAL FOOD SECURITY

Emerging Livestock Systems

Animal, human and socio-economic risks for pig meat production in Myanmar

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ZELS

Emerging Livestock Systems

Pig production in Myanmar as an example

- Emerging livestock systems (ELS) arise from demographic change & increased demand for animal products
- ELS risks poorly understood but food-borne zoonoses biggest burden on health of global poor
- Myanmar predicted to support the world's most rapid increase in pig production by 2030.
- Risks for pigs & pig meat supply chains include:
  - Pig diseases and zoonoses (food-borne and occupational)
  - Antibiotic stewardship and resistance
  - Socio-economic: production costs and losses

Myanmar profile

- Population 51m (2019) with 15m in urban areas, increase by 7m in coming years.
- 2021 military coup and civil war resulted in 13% decline in GDP/head since 2019
- Spending on education & health <3% GDP in 2022
- Global Climate Change Risk index (in top 3)
- Severe risk from Transboundary Animal Diseases (ASF, CSF, FMD, HPAI), emerging infectious diseases, AMR.

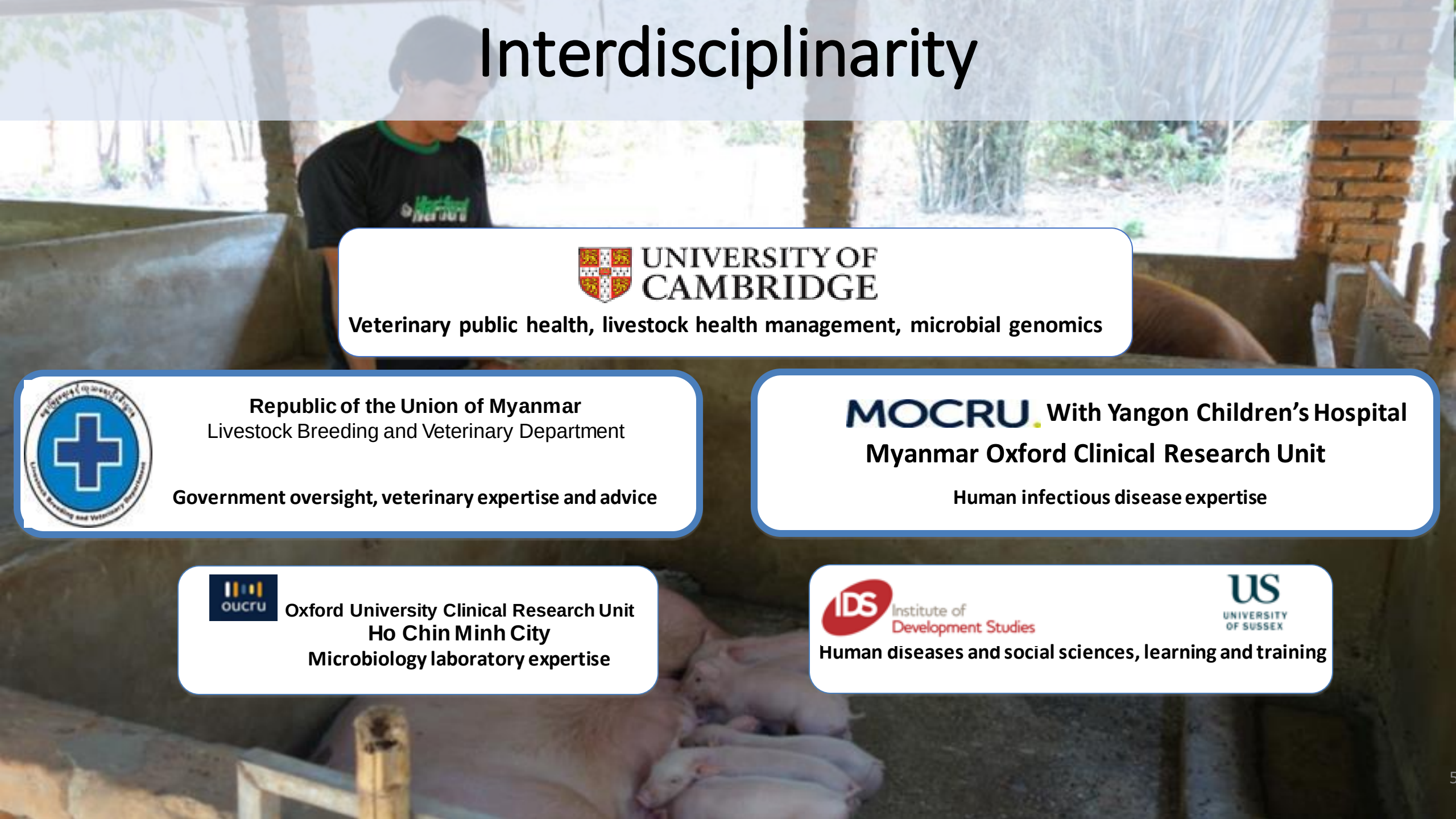
THE WORLD BANK
IBRD • IDA

Myanmar Pig Partnership (2015 – 2021)

1. An interdisciplinary study of risks of production and supply of pig meat in Yangon Region:
    - Worked in 3 Townships (peri-urban – S. Dagon; rural – Taikkyi; intensive livestock zone – Hlegu). Large intensive farms, smaller semi-intensive farms, backyard farms; also slaughterhouses and retail points.
    - Social sciences study of socio-economic factors and people's understandings and practices related to animal and human health
    - Survey of zoonotic bacteria, antibiotic resistance, farm production indicators and the uptake of preventive health practices at 2 sampling windows (2016-17 and 2019-20).

2. Study outputs and impacts also aimed at:
    - Providing evidence to prioritise government legislative programmes and regional initiatives
    - Piloting culturally relevant training for supply chain actors
    - Building expertise in interdisciplinary methods

Interdisciplinarity



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Veterinary public health, livestock health management, microbial genomics

Republic of the Union of Myanmar
Livestock Breeding and Veterinary Department

Government oversight, veterinary expertise and advice

MOCRU **With Yangon Children's Hospital**

Myanmar Oxford Clinical Research Unit

Human infectious disease expertise

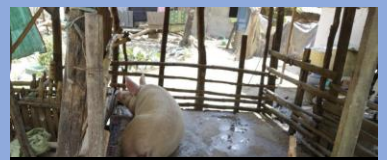
oucru **Oxford University Clinical Research Unit**
Ho Chin Minh City
Microbiology laboratory expertise

IDS Institute of Development Studies

US UNIVERSITY OF SUSSEX

Human diseases and social sciences, learning and training

Yangon's pig meat supply chains and influencers of intensification

	FARM	TRADER	SLAUGHTER	RETAIL
SYSTEM VARIANT	 Intensive: >3500 pigs n=2  Semi-intensive: 30-70 n=10  Backyard: <10 n=8	 Local brokers Township traders	 Large urban slaughterh. 900 pigs/night n=1 Township slaughterh. 2-4 pigs / night n=9 Village slaughterer 1 pig / night	 Rural wet market n=15  Urban wet market n=15  Supermarket n=15
INTENSIFICATION RISK FACTORS FOR DISEASE	Scale and density Sourcing improved genetics Feed (swill v. commercial diet) Insufficient skills & regulation Antibiotics without vet skills	Supply chain length Volume of trade Poor truck clean/disinfect	Scale (throughput) Inadequate hygiene skills Inadequate regulation Marginalised workers Waste management	Scale No traceability No chilling Inadequate hygiene skills Inadequate regulation
EXTERNAL INFLUENCERS	**Urbanisation**	**Consumer demands**	**Commercialization**	**policy/regulatory change** **climate change…**

Snapshot of farm characteristics: disease & biosecurity

	Backyard	Semi-intensive	Intensive
			
Size (total no. pigs)	4 – 9	9 - 29	3,500 – 8,000
Feed	**Kitchen waste**	**Commercial diet +antibiotic**	**Commercial diet +antibiotic**
Water	**Surface (pond, river)**	Bore hole	Bore hole
Manure disposal	Environment / fertilizer	Environment / fertilizer	Biogas
Dead pig disposal	**Burial / river**	**Burial / river**	Biogas
Preventive health			
• **Biosecurity - external**	**None**	**Weak**	Implemented
• **Biosecurity - internal**	**None**	**Weak**	**Weak**
• **Vaccines (different products)**	**1 (Classical Swine Fever)**	**1-2 (CSF + PRRS virus)**	>4 (CSF, FMD, ADV, PRRSV…)
Disease burden	**High and unpredictable**	**High and unpredictable**	**Quite high**
Veterinary support	Little access, rely on traditional treatments	Limited access, rely on 'pig experts', private and gov vets	In-house vets and feed-company vets
Survival: birth to slaughter	**50-70%**	**50-70%**	**70-80%**

Socio-economic factors, perceptions of risk, structural barriers to change

- Farmers' understanding of disease risks and prevention was weak, especially for zoonotic transmission.

- Structural constraints prevent backyard and semi-intensive farmers from acting on existing knowledge:
  - Absence of affordable credit (commercial feed, vaccines)
  - Limited access to veterinary support – preventive health, diagnostics, treatments,
  - Market driven value chain with ineffective government oversight
  - Household: time constraints of primary employment/household role.

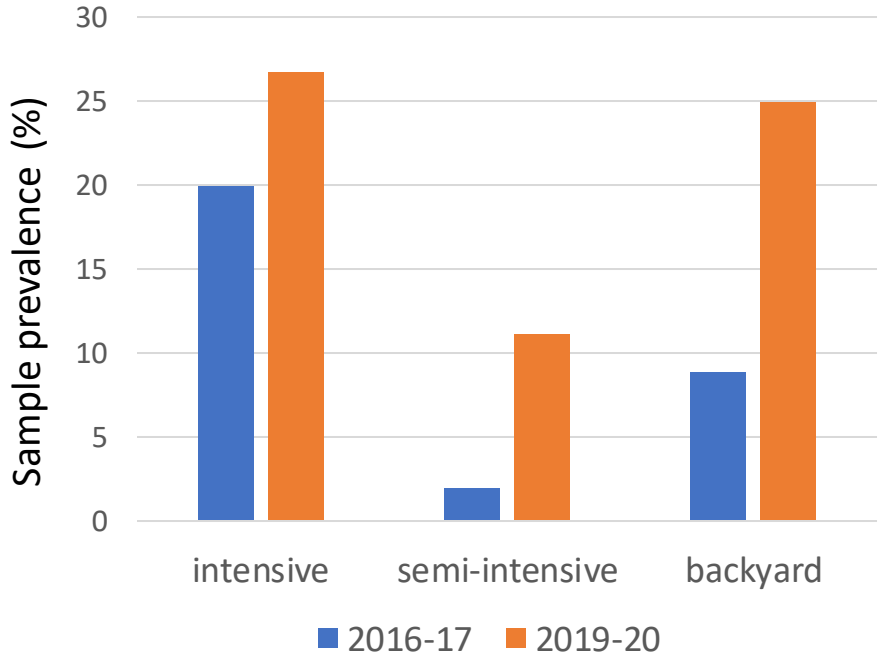
- Risky behaviours as a consequence
  - Marketing of sick pigs: Sold cheaply for human consumption
  - No stewardship of antibiotics – ineffective regulation, availability, labelling, lack of expertise.
  - Feeding pigs inadequately cooked kitchen waste
  - Pig health biosecurity: must accept risky uncleaned traders' trucks, lack of quarantine / fencing. Boar rental without quarantine. Unhygienic informal castration.

Ebata et al. 2020. Prev Vet Med

Microbiological surveys: farms, slaughter and retail

Increasing prevalence of subclinical food borne zoonotic bacteria over sampling timeframe

Multidrug resistant Salmonella prevalence increased in farm samples: 2016-17 – 2019-20

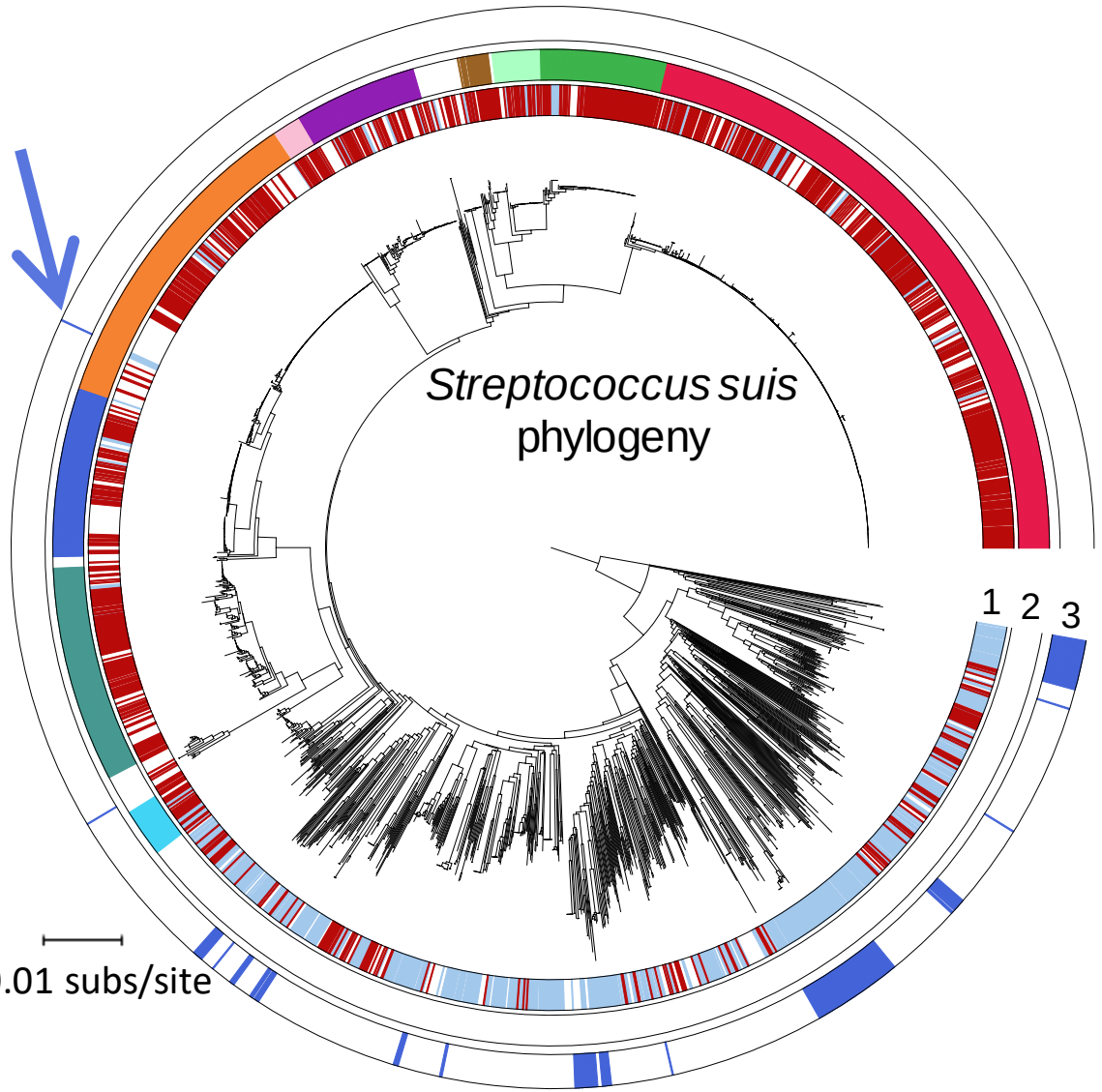


MDR Salmonella prevalence in boots swab and drain samples from 2 intensive , 10 semi-intensive and 6 backyard farms in Yangon region, 2016-17 and 2019-20

NB sample number ranged from 16 - 150 per category

- High / increasing Salmonella prevalence on farms:
  - Very high Salmonella prevalence in back-yard farms – 72% (kitchen waste, human waste, surface water, kept with poultry).
  - Multidrug resistant Salmonella prevalence increased across all farm types (see left); Colistin resistance >95% prevalence in all farm types.
- Gross cross-contamination at slaughter:
  - Carcass prevalence for Salmonella 52% (n=90) v. 28% gut prevalence in same pigs. Esp. large slaughterhouses
- Supermarket-sold pork had highest Salmonella prevalence (89% of samples, n=45)
  - Contaminated non-chilled source meat, poor hygiene. Rural wet markets had lowest prevalence (53%) – shorter supply chain ('social sanctioning')
- Antimicrobial usage frequency increased on intensive & semi-intensive farms.

Emergence of disease-associated *Streptococcus suis* in intensive production in Myanmar?



Core genome phylogeny of 3076 global isolates of *S. suis*

- *Strep. suis* is a global commensal of pig tonsils. Some strains able to cause disease in pigs & humans - these are widespread in all intensive pig producing countries
- Disease associated lineages almost absent from Myanmar…
- Only 1 isolate of 451 collected from tonsils of Myanmar pigs was identified as disease associated.
  - Isolate came from large intensive farm with history of imported genetically improved breeding pigs from Thailand.

1. Disease/Carriage isolates

Disease-associated isolates

Carriage isolates

2. Disease-associated lineages

1 2 3 4 5

6 7 8 9 10

3. Myanmar isolates

Gemma Murray, 2023. submitted

Interventions and impact

- **Capacity building for AMR surveillance**
  - Refurbished Yangon Vet Diagnostic Lab, with training and protocols.
  - Data underpinned Myanmar AMR National Action Plan & new legislation restricting in-feed antibiotics in slaughter-pigs (2020)

- **Implemented framework and resources to boost vets' knowledge in preventive pig diseases and zoonoses**
  - Nationwide training & resources for government vets – in person and on-line.
  - Planned first international pig vet conference with Yezin Vet School and Myanmar Vet Assoc. Aborted Feb 21.

- **Pilot extension training for farmers, with training of trainers:**
  - Focus on farm productivity (pig survivability, biosecurity, economics…)
  - Piloted 2 forms of farmer intervention for study farms – advisory (instructional) and participatory (facilitated peer learning), 2018-20.
  - Identified ways to optimize motivation by farm type

- **Stakeholder workshops including FAO, WHO and regional NGOs**
  - Final workshop cancelled on request of UK FCDO in Spring 2021

Yangon LBVD Vet Diagnostic Lab team

Participatory Farm Management Workshop

Veterinary Advisory Visit – adapted to farm type.

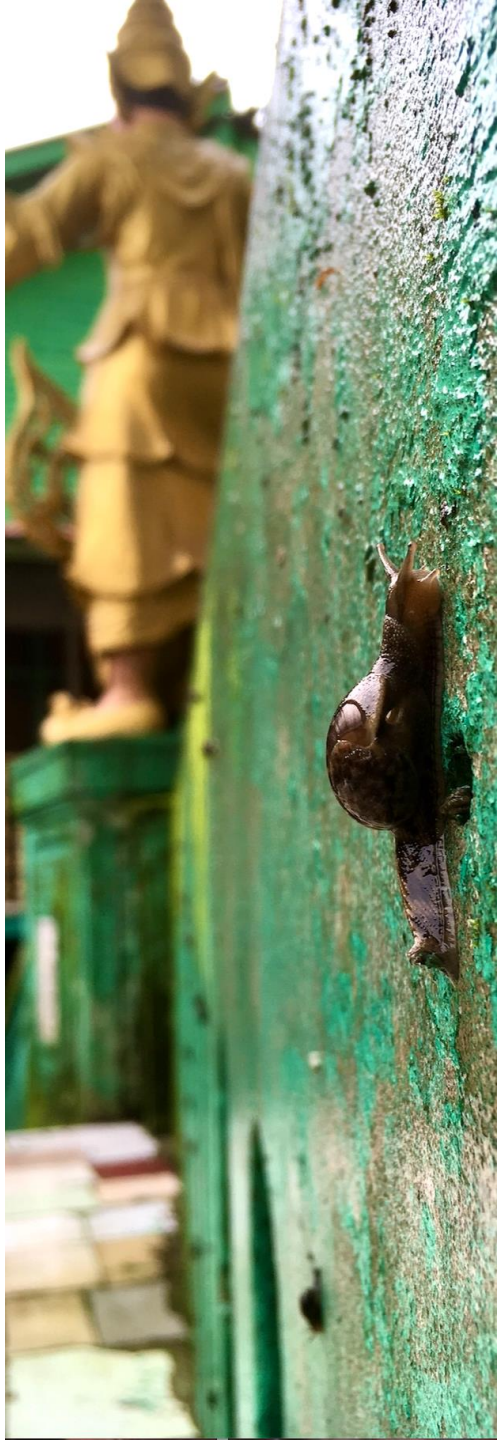
Conclusions

- Yangon's pig meat supply chains present significant risks

- Structural factors limit farmers and other supply chain actors' ability to mitigate risks

- Risks presented by farm categories differ under intensification:
  - Backyard: High zoonotic burden, close interaction of pigs with humans; most economically and nutritionally vulnerable but least able to change.
  - Semi-intensive: eager to change to improve profitability, restricted by structural factors.
  - Intensive: high scale of production influences many consumers, in-house vets facilitate high levels of antibiotic use, importation and amplification of emerging zoonoses (*S. suis*).

- Project outputs to support risk mitigation (truncated by military coup):
  - Evidence to prioritise regulatory overhaul, supported by UN FAO
  - Toolkits and blue-print for optimized knowledge-based training: vets, community animal health workers (CAHWs) and farmers



Myanmar Pig Partnership AGM, 2017. Bagan, Myanmar.

myanmarpigpartnership.org

Thanks and acknowledgements

Ye Tun Win
Min Then Maw
Hnin Thidar Myint
Hlaing May Than
Aung Zaw Moe
Myo Min
Thiri Su Wai + Aye Myat Su

AW (Dan) Tucker
James Wood
Alan Clarke
Duncan Maskell
Juan Hernandez
Gemma Murray
Lucy Weinert

Hoa Ngo
James Campbell
Trung Nguyen Vinh

Liz Ashley
Thel Hla
Aung Pyae Phyo
Thidar San

Hayley MacGregor
Michael Loevinsohn
Ayako Ebata
Khine Su Win

David Hadril

Funders of ZELS Programme

Department for International Development

MRC Medical Research Council

NERC SCIENCE OF THE ENVIRONMENT

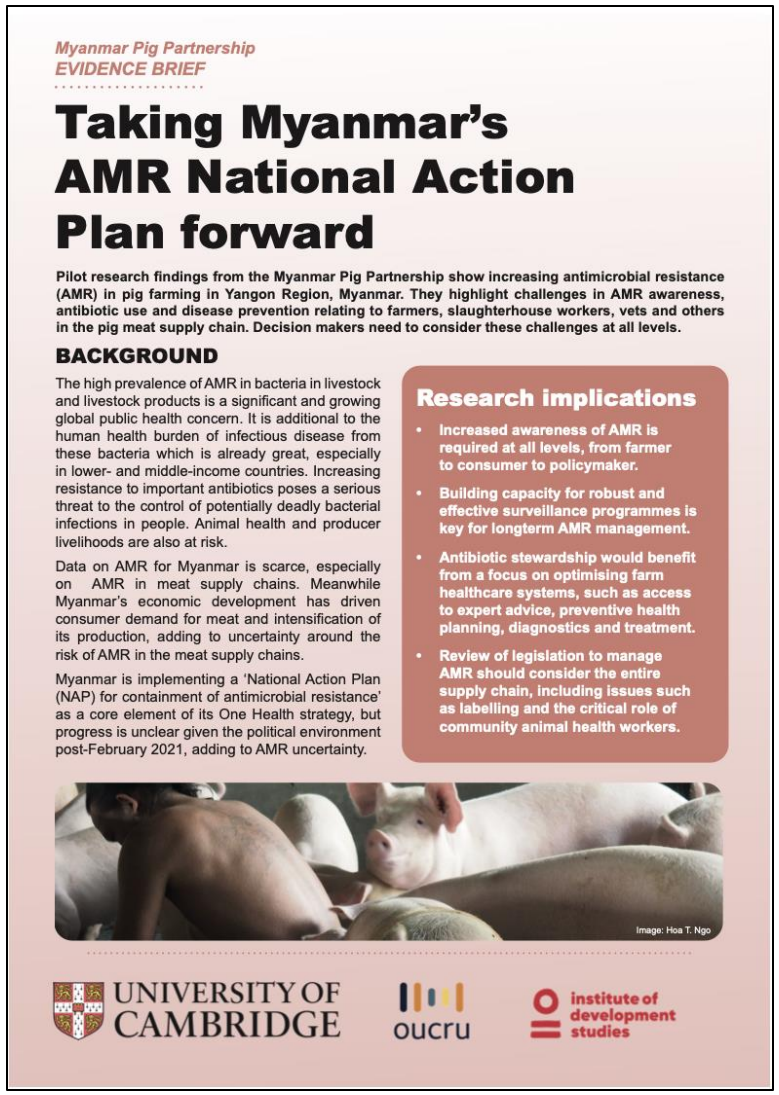
BBSRC 20 Years of Pioneering Great British Bioscience

[dstl]

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Evidence Briefs and further information

https://steps-centre.org/project/myanmar-pig-partnership/



Myanmar Pig Partnership
EVIDENCE BRIEF

Taking Myanmar's AMR National Action Plan forward

Pilot research findings from the Myanmar Pig Partnership show increasing antimicrobial resistance (AMR) in pig farming in Yangon Region, Myanmar. They highlight challenges in AMR awareness, antibiotic use and disease prevention relating to farmers, slaughterhouse workers, vets and others in the pig meat supply chain. Decision makers need to consider these challenges at all levels.

BACKGROUND

The high prevalence of AMR in bacteria in livestock and livestock products is a significant and growing global public health concern. It is additional to the human health burden of infectious disease from these bacteria which is already great, especially in lower- and middle-income countries. Increasing resistance to important antibiotics poses a serious threat to the control of potentially deadly bacterial infections in people. Animal health and producer livelihoods are also at risk.

Data on AMR for Myanmar is scarce, especially on AMR in meat supply chains. Meanwhile Myanmar's economic development has driven consumer demand for meat and intensification of its production, adding to uncertainty around the risk of AMR in the meat supply chains.

Myanmar is implementing a 'National Action Plan (NAP) for containment of antimicrobial resistance' as a core element of its One Health strategy, but progress is unclear given the political environment post-February 2021, adding to AMR uncertainty.

Research implications

- **Increased awareness of AMR is required at all levels, from farmer to consumer to policymaker.**
- **Building capacity for robust and effective surveillance programmes is key for longterm AMR management.**
- **Antibiotic stewardship would benefit from a focus on optimising farm healthcare systems, such as access to expert advice, preventive health planning, diagnostics and treatment.**
- **Review of legislation to manage AMR should consider the entire supply chain, including issues such as labelling and the critical role of community animal health workers.**

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Myanmar Pig Partnership
EVIDENCE BRIEF

Training paths to improve health and livelihoods for Myanmar pig farmers

The Myanmar Pig Partnership piloted two approaches to farmer training in Yangon Region: one participatory, one more advisory. The work offers useful practical advice which can help inform further initiatives. It also highlights the limitations training interventions alone offer.

BACKGROUND

Economic development in Myanmar has been accompanied by growing demand from Myanmar people for livestock products, including pig meat. Better understanding of how different pig farming systems and practices that attempt to meet this new demand affect disease spread between pigs, and from pigs to people, could help to identify safer and more efficient pig production practices. This could result in healthier pigs and people and less precarious livelihoods for farmers.

However, changing farming practices requires effective farmer training offering suitable information and motivation for any change. This is in addition to the removal of structural barriers that may in any case prevent change.

The Myanmar Pig Partnership undertook pilot activities and analysis of different training approaches in different scales of pig farming in Yangon Region to better understand how training could influence changes in farmer practices to decrease disease risk. It also explored other barriers affecting change on pig farms, such as inadequate availability of veterinary expertise and affordable credit to support livestock production. This was important to appreciate the limitations of training alone.

Research implications

- **Training topics should be relevant and address what incentivises farmers.**
- **The desired change should be feasible, so structural barriers to change must be considered when setting objectives.**
- **Training delivery must be inclusive so marginalised groups such as women can participate.**
- **Clear, understandable explanations will increase the likelihood of change.**
- **Multi-target training programmes that address interdependent people, e.g., farmers, traders and veterinarians, could have synergistic outcomes.**
- **A wider, multisector approach to deliver change, including a strengthening of veterinary health and social protection systems, is needed alongside farm-level intervention.**

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Myanmar Pig Partnership
EVIDENCE BRIEF

Pig meat and food safety in Myanmar: evidence to support practice

Research findings reveal that disease-causing bacteria, including *Salmonella*, are widespread on pig farms of all sizes in Yangon Region, Myanmar, as well as in pig meat sold to consumers in the city and rural areas. This evidence provides a snapshot of how intensification in pig production can affect food safety – and points to potential responses.

BACKGROUND

Foodborne disease (FBD), in particular gastro-intestinal (GI) disease, places a heavy burden on the most vulnerable people in poorer countries. According to the World Health Organization, in 2010 in southeast Asia, FBD accounted for 150 million illnesses, 175,000 deaths and the loss of 12 million years due to ill health (DALY, Disability Adjusted Life Years).

Myanmar's agriculture development strategy for 2019-2023 acknowledges food safety management as below international standards. The UN Food and Agriculture Organization's Myanmar programming framework 2017-2022 prioritiseses capacity strengthening for formulating food safety policy and implementation.

The bacteria *Salmonella enterica* and *Streptoccus suis (Strep.suis)*, both associated with pigs, pass to people through food and work exposure. *Salmonella* causes GI disease in people, occasionally life-threatening. *Strep. suis* causes severe illness, including meningitis. Both are reported to be significant among pigs and people in southeast Asia, but little is known of the FBD burden in Myanmar specifically, or of the contribution from pig meat – the second greatest source of animal protein in Myanmar.

Research implications

- **Improving food safety will require training retailers, slaughter workers and traders in aspects of food contamination not detectable by sight alone.**
- **Investment in stricter hygiene controls in pig processing, and related review of legislative controls, should be prioritised.**
- **The supermarket sector needs extra focus to ensure it is not left behind in implementing internal food safety management systems and practices.**
- **Food safety awareness initiatives aimed at consumers are justified given the high level of contamination of retail meat. These could catalyse positive change for rural/shorter pig-supply chains through social sanctioning.**

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Sustainable production through farmer producer organisations and digital platforms

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Director of Research and Head of the Centre for International Manufacturing
Department of Engineering
University of Cambridge

6th July 2023
GFS Symposium, Cambridge, UK

Context

- Competing policy regimes
  - East Punjab policies and the Indian Federal laws
  - East and West Punjab – alternative policy landscapes
- Declining returns for small-holders
  - Reducing size of land-holding'
  - Commoditisation leading to low/negative margins
- Opportunity for value-adding crops
  - Require capability upgrading
  - Require scale to manage sustainable resource-use (0.5m decline in groundwater level per year)
  - Can address the challenge of sustainable livelihoods

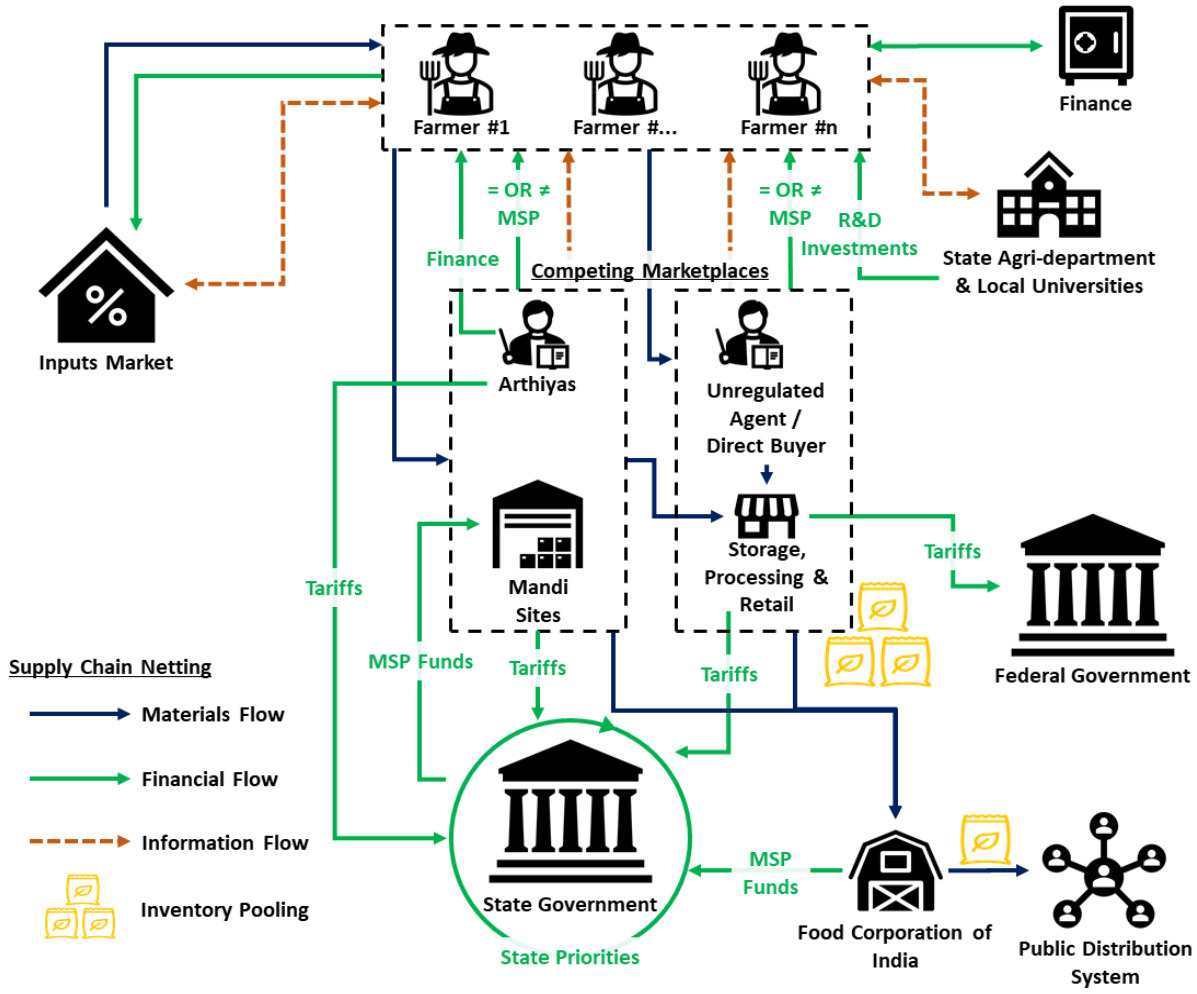
Policy Interventions in Food Supply Chains

The role of Farmer Producer Organisations and Digital Platforms on Bargaining Power and Equity

'…. the farmer, is the only man in our economy who has to buy everything he buys at retail – sell everything he sells at wholesale – and pay the freight both ways'

22nd September 1960

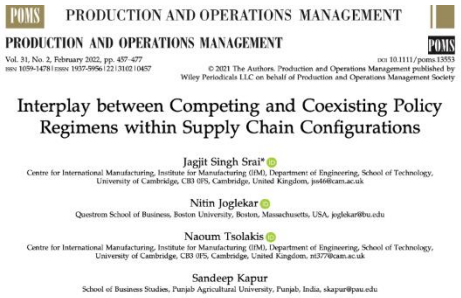
Competing Policy contexts



Source: Srai, J.S., Joglekar, N., Tsolakis, N., Kapur, S. (2022). Interplay between Competing Policy Regimen in Supply Networks. *Production and Operations Management* https://doi.org/10.1111/poms.13553

Context – Policy landscape
(Competing policy regimen in East Punjab)

Source: Srai, J.S., Joglekar, N., Tsolakis, N., Kapur, S. (2022). Interplay between Competing Policy Regimen in Supply Networks. *Production and Operations Management*, https://doi.org/10.1111/poms.13553



Changing dynamics and equity scenarios in the Indian agriculture supply chain system

Equity considerations	Mandi system	Federal leverage	Farmer producer organizations (FPOs)	FPOs as digital platforms
Equity and Bargaining Power in the Supply Chain				
▪ Farmers	⟷			
▪ Intermediaries	↑ (regulated)			
▪ Major Retailers	N/A			
Equity and Welfare Implications				
▪ Local Government	↑ (local state tariff income)			
▪ Federal Government	↓?↑ (food security)			

Symbol key: "⟷" – neutral effect; "↑" – increased equity; "↓" – decreased equity; "?" – uncertain equity outcomes; "↑?↓" – optimization achieved depends on objectives and parameters that are set; N/A – Not Applicable.

- FPOs have attractive dynamics – costs/margin, access to supply chains, responsible resource-use
- Digital FPOs offer even lower transaction costs and greater scale
- Emergent questions – *What is the optimal size of FPOs?; Influencing factors? Policy Implications?*

Why FPOs, challenges, influencing factors, open questions

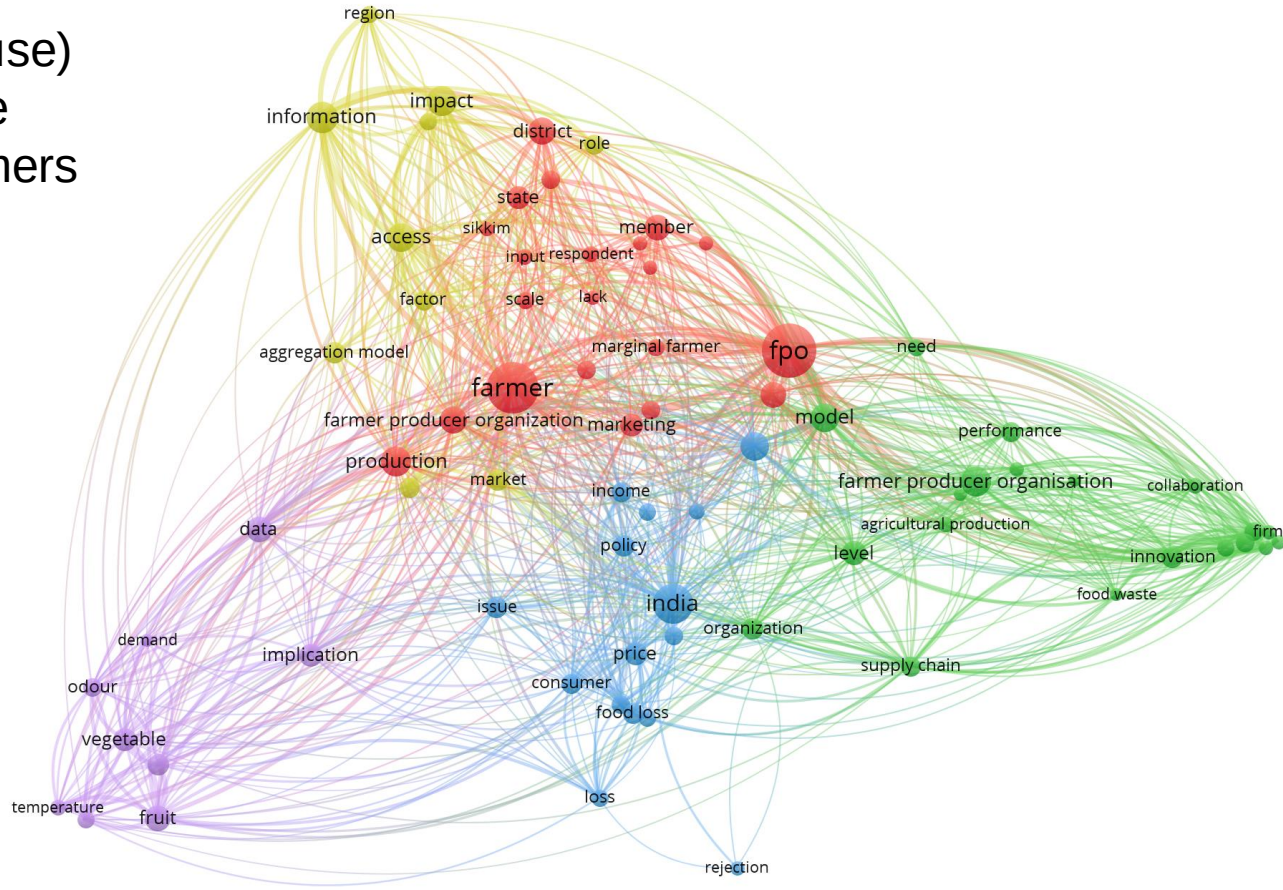
Farmer Producer Organizations (FPOs) offer;

- offer sustainable agriculture (responsible resource use)
- equity between supply chain stakeholders and scale
- Enhanced revenue to smallholder marginalized farmers

But FPOs have both adoption challenges and tepid performance.

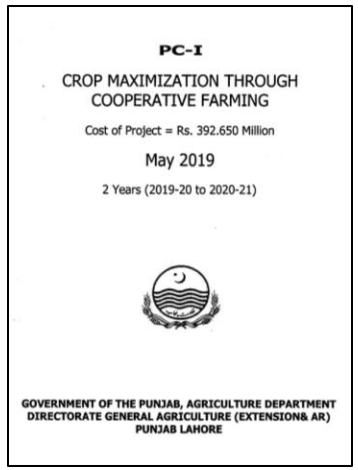
Emergent questions –

- *What is the optimal size for a FPO?*
- *What are the influencing factors?*
- *Impact on policy development?*



Bibliometric analysis based on: VOSviewer 1.6.18

Alternative policy landscapes



PC-I

CROP MAXIMIZATION THROUGH COOPERATIVE FARMING

Cost of Project = Rs. 392.650 Million

May 2019

2 Years (2019-20 to 2020-21)

GOVERNMENT OF THE PUNJAB, AGRICULTURE DEPARTMENT
DIRECTORATE GENERAL AGRICULTURE (EXTENSION& AR)
PUNJAB LAHORE

East Punjab Policy development: Stakeholder engagement, formal policy inputs and adoption: Has lead to formal **Punjab "Policy Notification"**

Newton Fund

GCRF Global Challenges Research Fund

TIGR²ESS Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies

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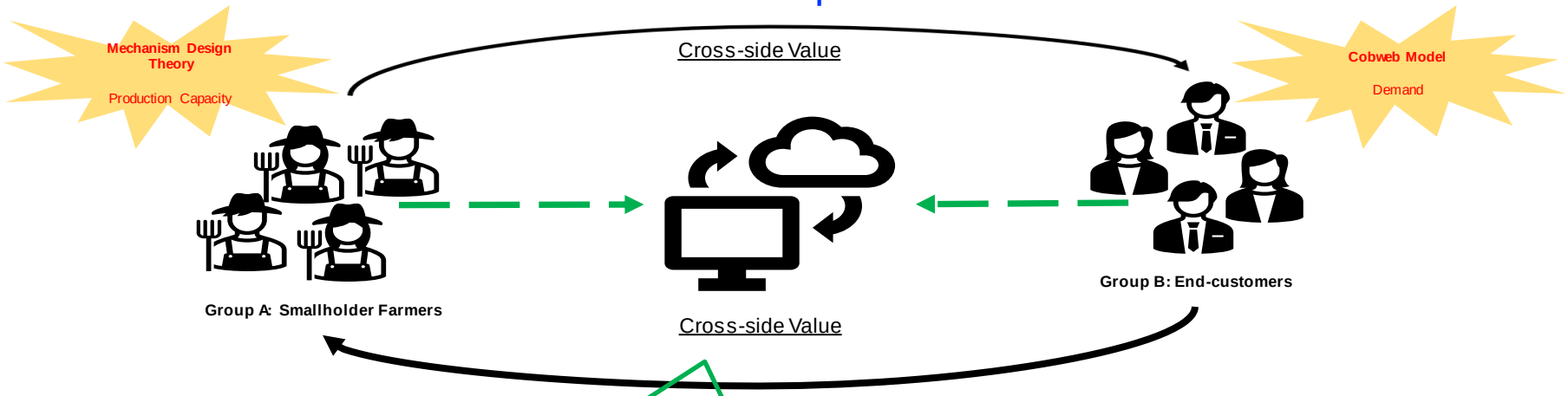
IfM Centre for International Manufacturing

Theoretical Approach

FPO as a B2B platform

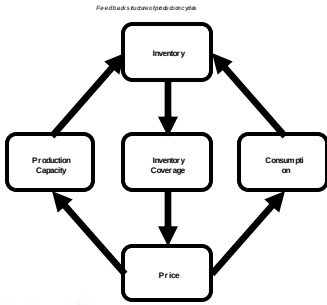


Same-side Value
- Enrichment of production
- Diversification of commodities /product/service
- Productivity efficiency
- Production complementarity
- Fair remuneration

- Supply-demand coordination
- Limited crop/commodity waste
- Social welfare
- Reduced transaction costs (no intermediaries / no Arthiyas)

Same-side Value
- Accessibility to a portfolio of offerings
- No lost sales
- Avoid paying the price mark-up

- **Mechanism design theory** "allocation mechanisms associated with **incentives** and **private information** and which are optimal for **different participants**, say sellers or buyers.
- By using game theory, mechanism design can go beyond the classical approach and, for example, explicitly **model how prices are set**.
- In game-theoretic terms, the bargaining problem is a special case
  - gains from trade, parties are free to reach explicit agreements.

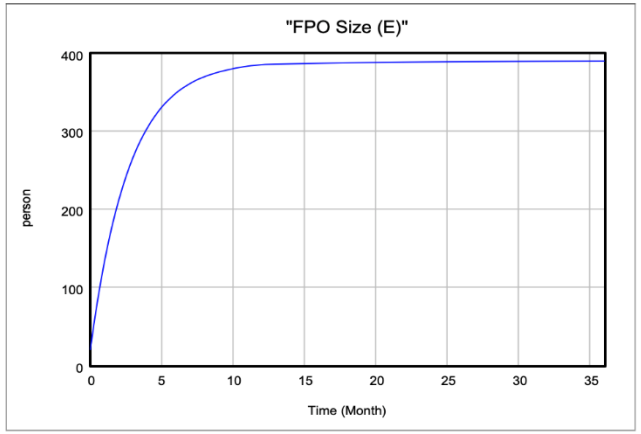


Ref: Meadows, D.L., 1970. *Dynamics of Commodity Production Cycles*. Wright-Allen Press.

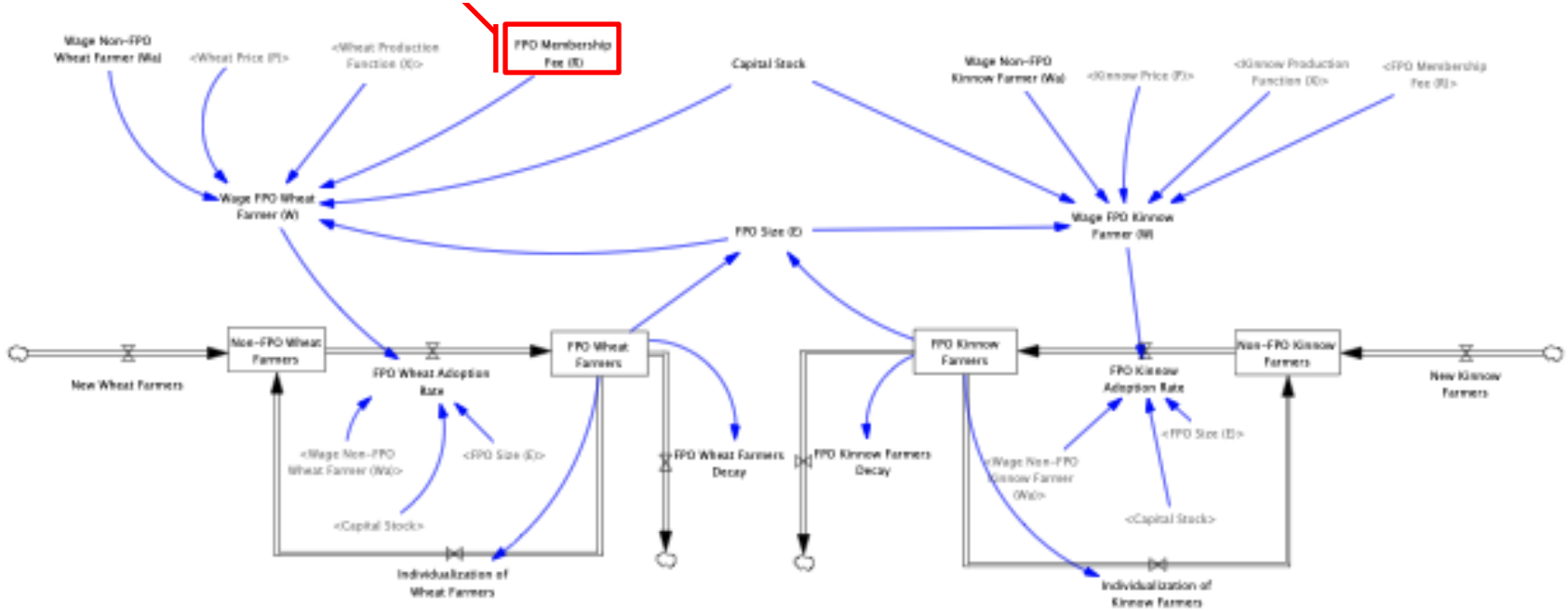
Model Building

- **Initial model**
  - Model Calibration
  - Design of Experiments
  - Simple example – Joining fee

Membership Fee Impact on FPO Size



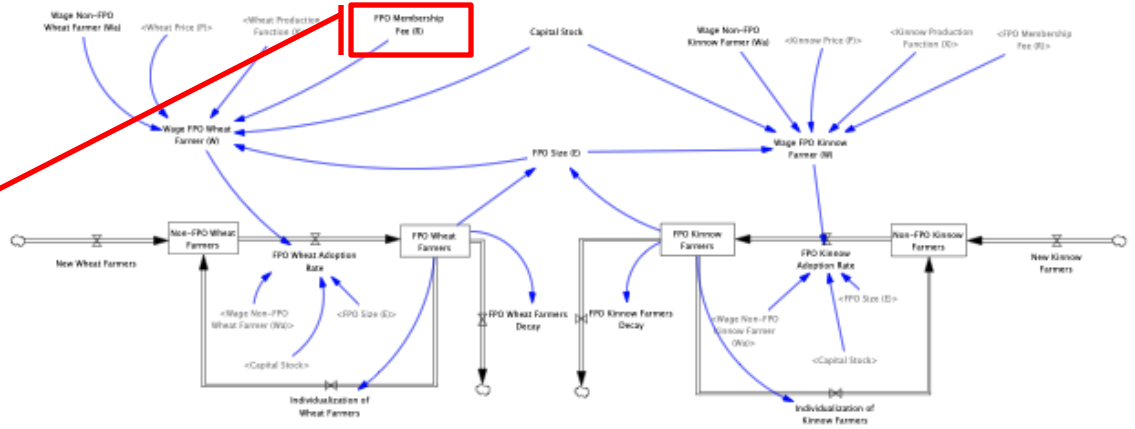
FPO Membership Fee



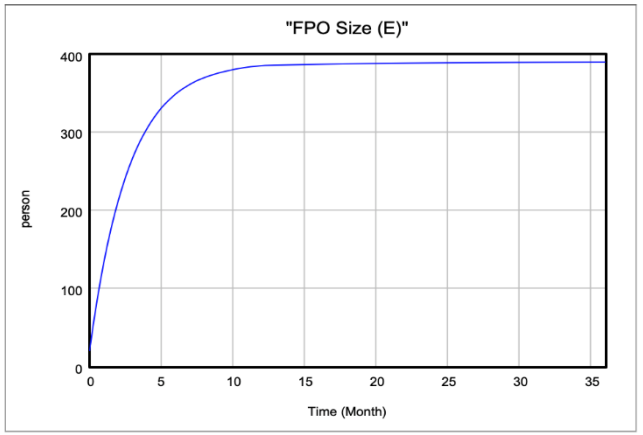
Model Building

"Flight simulator"

FPO Membership Fee



Membership Fee Impact on FPO Size Stability



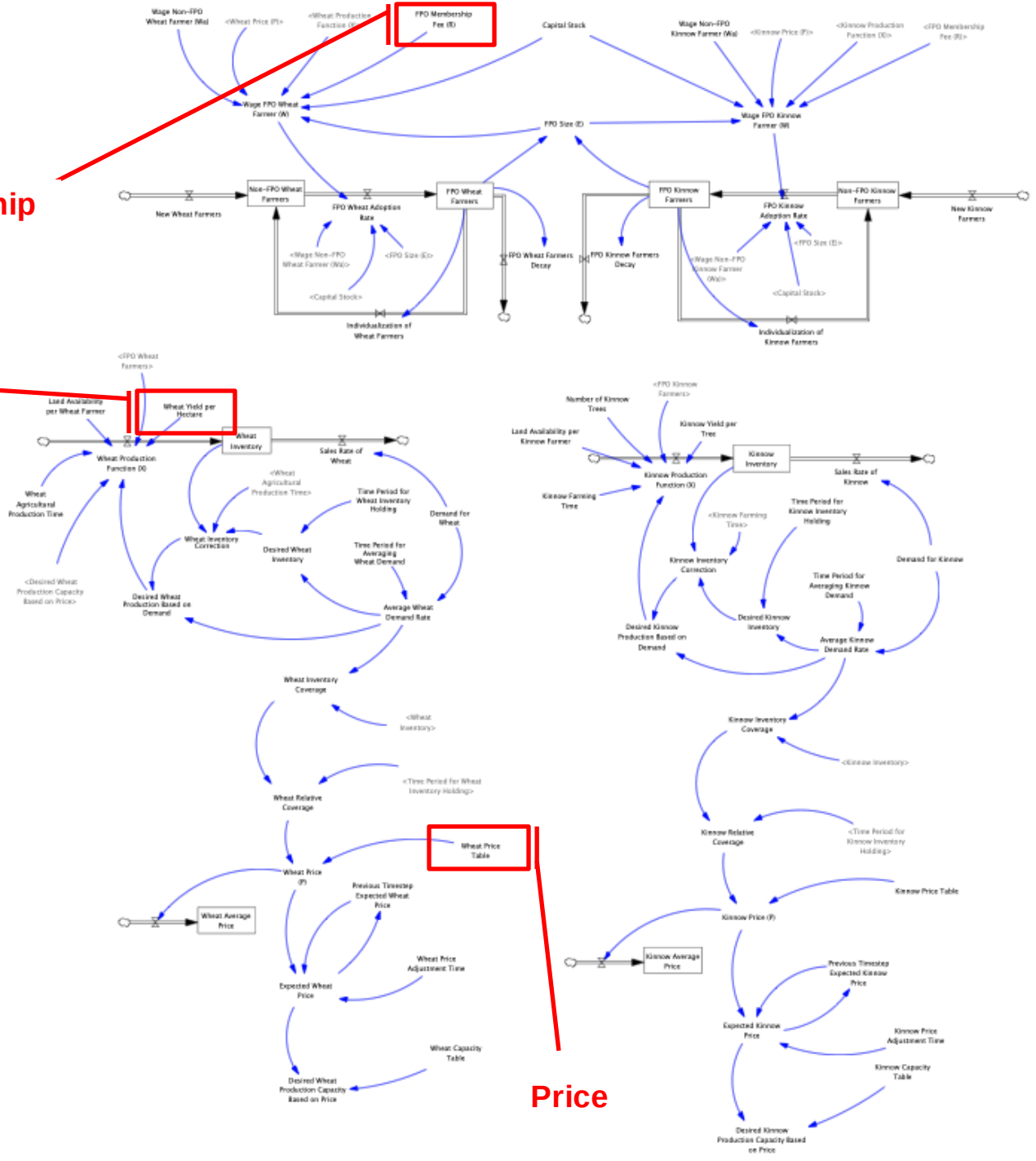
- **Next Steps**:
  - Model Calibration
  - Design of Experiments
  - Simple example – Joining fee
- **Target product**
- **Implications for Policy**

Model Building

"Flight simulator"

FPO Membership Fee

Yield per Hectare

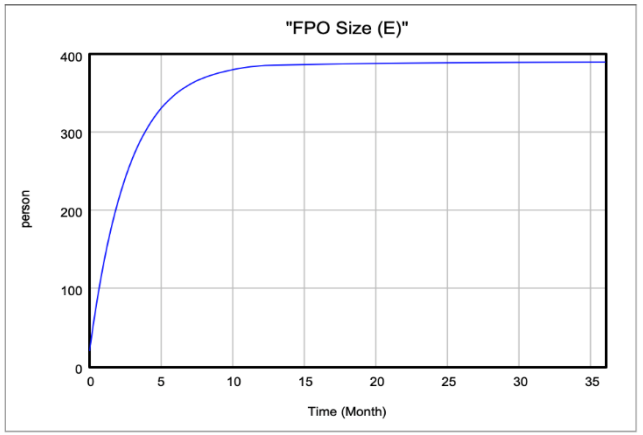


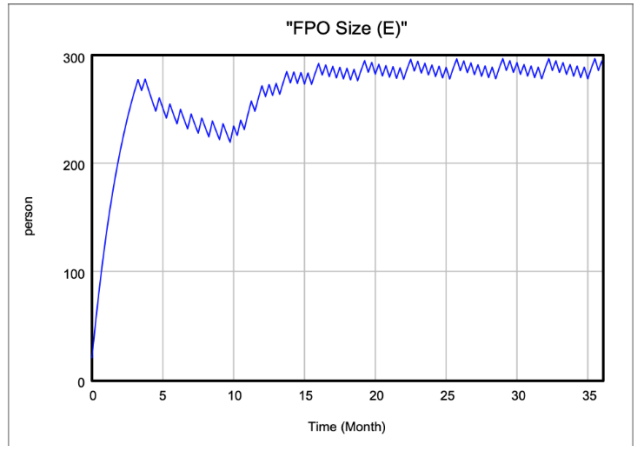
Price

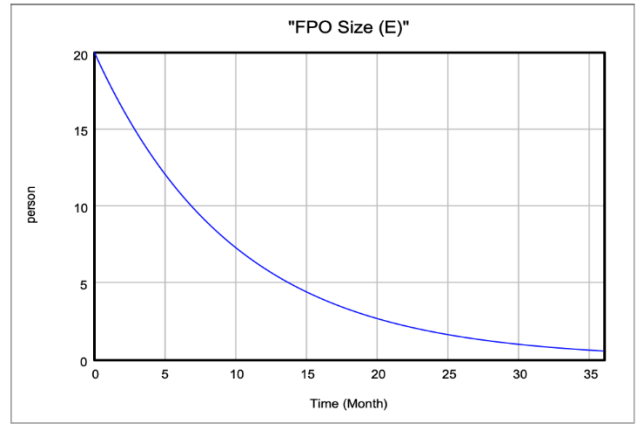
- **Next Steps**:
  - Model Calibration
  - Design of Experiments
  - Simple example – Joining fee

- **Implications for Policy**

Membership Fee Impact on FPO Size Stability







UNIVERSITY OF CAMBRIDGE
Department of Engineering

Initial findings and next steps

FPOs as organisational constructs for sustainable livelihoods and food production

- FPO development is heavily influenced by policy instruments that dictate operational and scale requirements -> ***these parameters are often arbitrarily set***
- Tradeoffs between short-term viability and long-term efficiency, resource efficiency and revenue generation -> ***equity and responsible resource-use implications***
- Multi-sided market theory (platform economics) suggest ***digital platforms enable multi-side scale benefits that increase FPO viability***

Next steps: Comparing East Punjab, India (through the TIGR^{2}ESS project) and follow-on research on FPOs in West Punjab, Pakistan (Newton award)

  - Drawing on crop production and trade-related time-series data (e.g., multiple crop prices, yield) explore specific products e.g. citrus fruits (Kinnow) – are we above/below optimality?
  - Test generalizability of our research findings in alternative policy landscapes and inform future policy instruments -> that empower smallholder farmers, design-in equity for improved livelihoods (welfare) and enable responsible resource-use

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