Social system to support innovation adoption on (animal) farms in Southeast Asia: A systematic review

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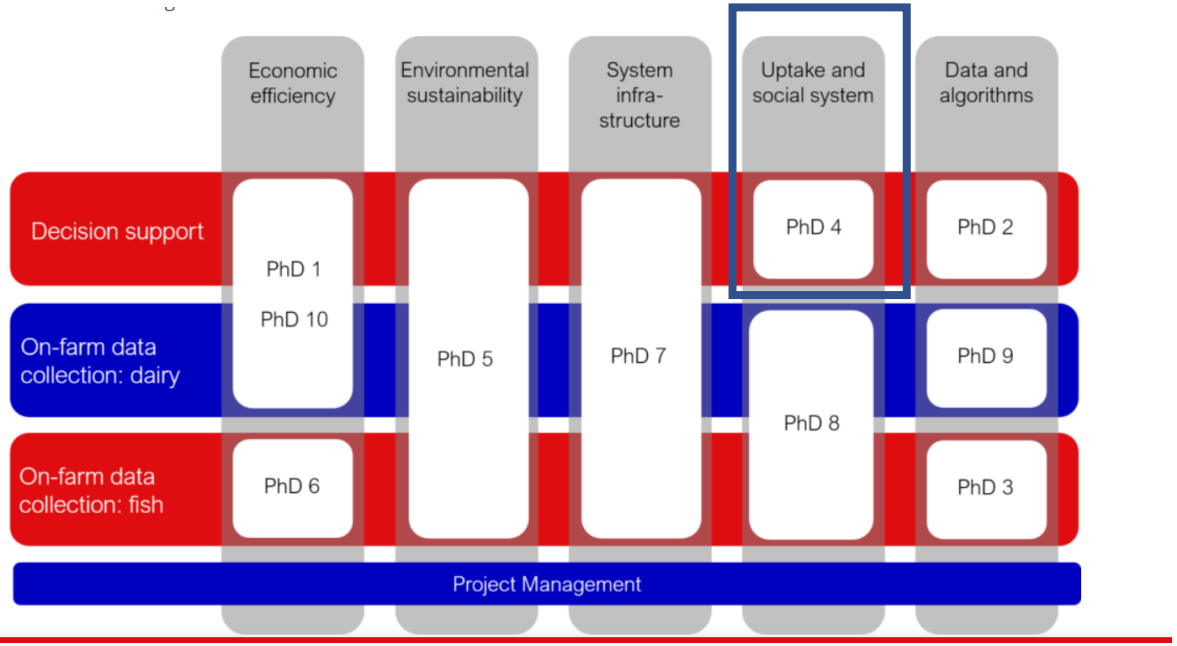
Promoting smart/ sustainable animal farming in Indonesia

Smart-In-Ag (short for Smart Indonesian Agriculture) is a joint research program between Wageningen University and Research in The Netherlands and IPB University in Indonesia, together with State Agriculture Polytechnic in Kupang, and the industrial partners: Single Spark, e-Fishery, WorldFish, and Dairy Pro Indonesia. It is funded by INREF and LPDP. Additionally, project partners add to the funding by in-kind contributions.



4-year research design

Develop a contextual framework

A case study in Indonesia

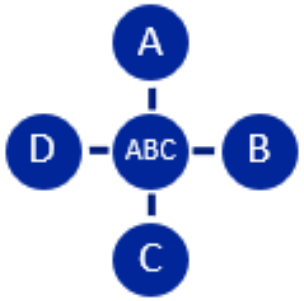
Social system on technology adoption

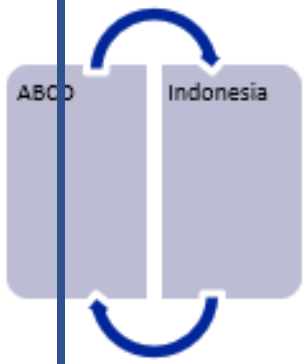
Testing the framework

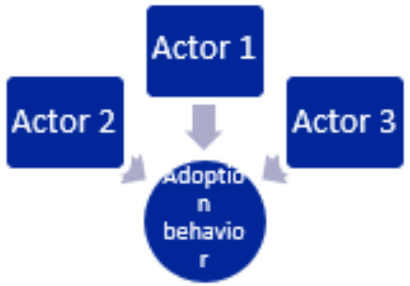
Zoom in on farmers behavior and social network

Identify enabling adoption factors

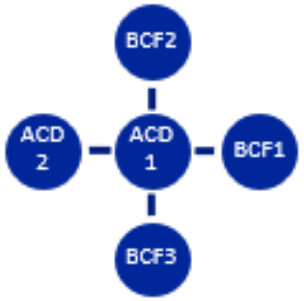
Improving the social systemframework







	Factors	Actors
Transition strategy	AB	1, 2



Background

- Many related studies are often concentrated on **individual** adoption **determinants** (Klerkx, Jakku, & Labarthe, 2019), and rely only on a predictive association, in Europe, North America, Australia, NZ (Caffaro, Roccato, Micheletti Cremasco, & Cavallo, 2019; Pierpaoli et al., 2013). > lack of answer to **How and Why**...and of studies in Southeast Asia
- There was a **lack of consideration for non-individual determinants and systemic (socio-institutional) issues** such as the role of (rural) stakeholders' networks and context of **interactions among adoption factors**.
  - Processes of (technology) innovation adoption are not linear and generally include a series of **feedback-loops/mechanisms** in the (social) system (Pathak et al., 2019).
- In Southeast Asia, limited resources on majority **small farmers** tend to make them often having less social interaction...

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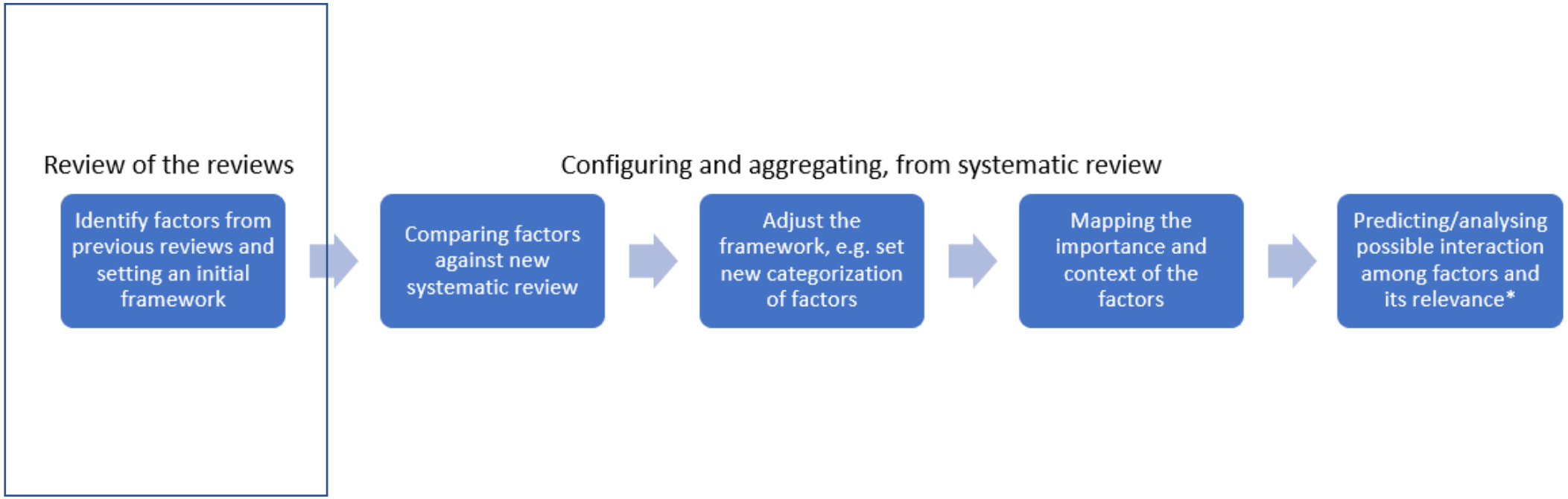
Research questions

What are socio-institutional factors/system that influence innovation adoption on (small) animal farms in Southeast Asia?

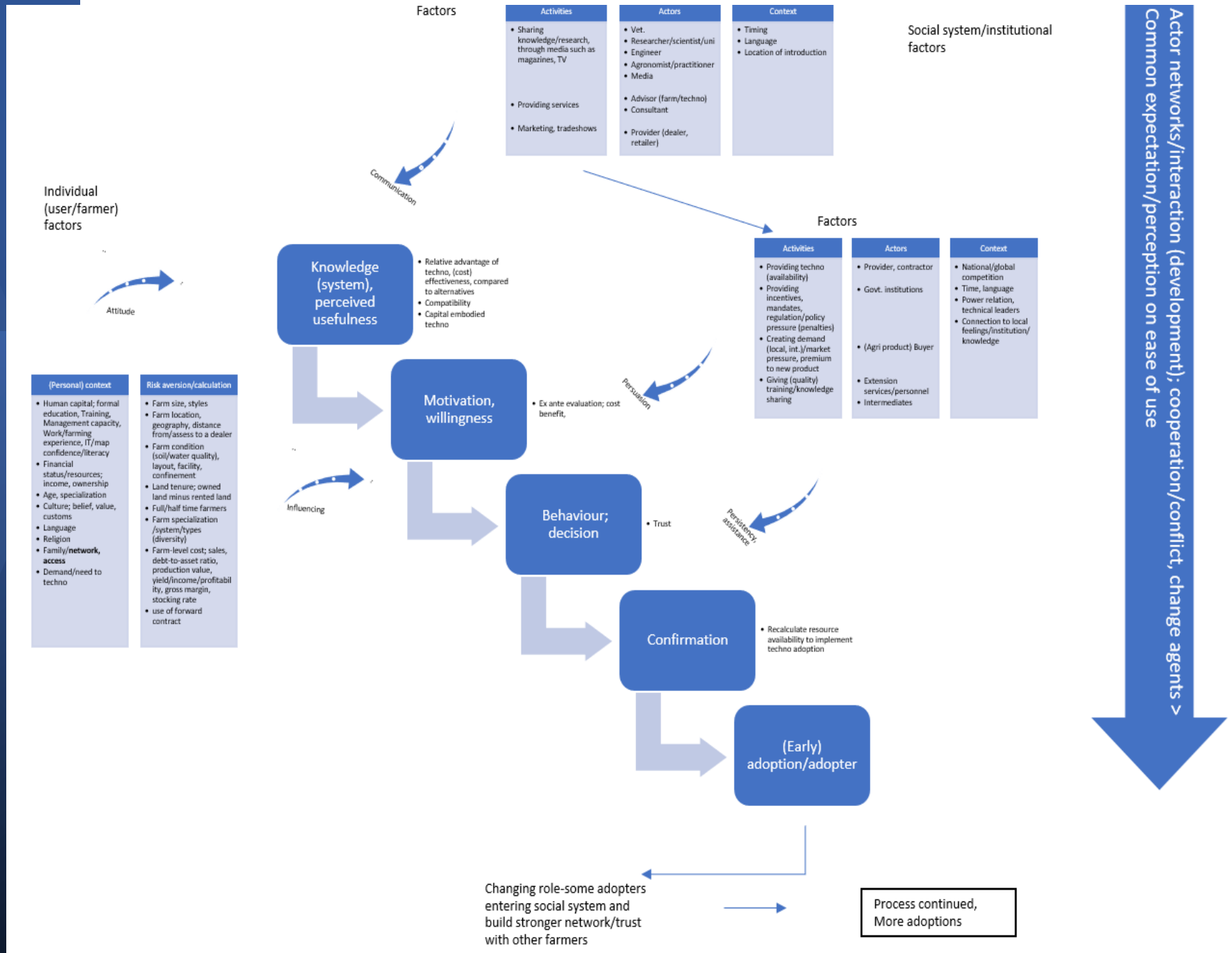
What is known about the interaction between factors?

Methods: Review processes



From 5 global review papers

Initial framework



Twenty-five factors - framework synthesis

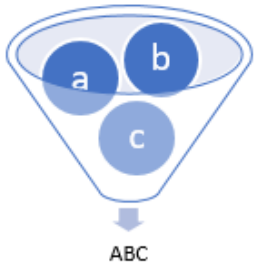
Individual factors
• Human capital; formal education, Training, Management capacity, Work/farming experience, IT/map confidence/literacy • Financial status/resources; income, ownership • Age, specialization • Culture; belief, value, customs • Language • Religion • Family/network, access • Demand/need to technology • Farm size, styles • Farm location, geography, distance from/assess to a dealer • Farm condition; soil/water quality, layout, facility, confinement • Land tenure; owned land minus rented land • Job status; Full/half time farmers • Farm specialization /system/types (diversity) • Farm-level cost; sales, debt-to-asset ratio, production value, yield/income/profitability, gross margin, stocking rate • Use of forward contract

Socio-insitutional factors
• Sharing knowledge/research, through media such as magazines, TV • Providing (consultancy) services • Marketing, tradeshows • Provision of technology, availability, ease of use • Providing incentives, mandates, regulation/policy pressure (penalties) • Creating demand (local, international)/market pressure, premium price to new product • Giving (quality) training/knowledge sharing • Actor networks/interaction; cooperation/conflict, change agents

Methods: Systematic review

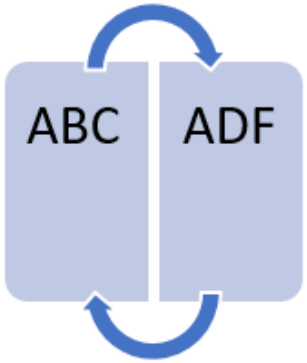
Review of the reviews

Identify factors from previous reviews and setting a framework



Configuring and aggregating, from systematic review

Comparing factors against new systematic review



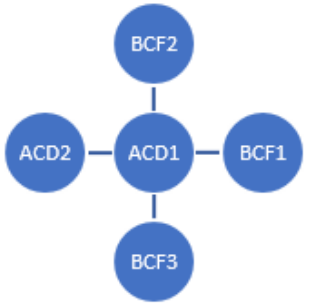
Adjust the framework, e.g. set new categorization of factors

ACD	BCF	CDG
•1 •2	•1 •2	•1 •2

Mapping the importance and context of the factors

	Level of importance	Country /techno /treatability
ACD	1	A, b
BCF	2	B, c

Predicting/analysing possible interaction among factors and its relevance*



Systematic review to Southeast Asian cases

1 AND
a. Livestock farming OR
b. Inland fishery
c. Dairy farming
d. Livestock agriculture
e. Livestock production
f. Animal production

2 AND
a. Technology adoption OR
b. Technology uptake
c. Technology transfer
d. Technology diffusion
e. Technology dissemination
f. Adoption barriers
g. Adoption factors
h. Uptake barriers
i. Uptake factors
j. Innovation adoption

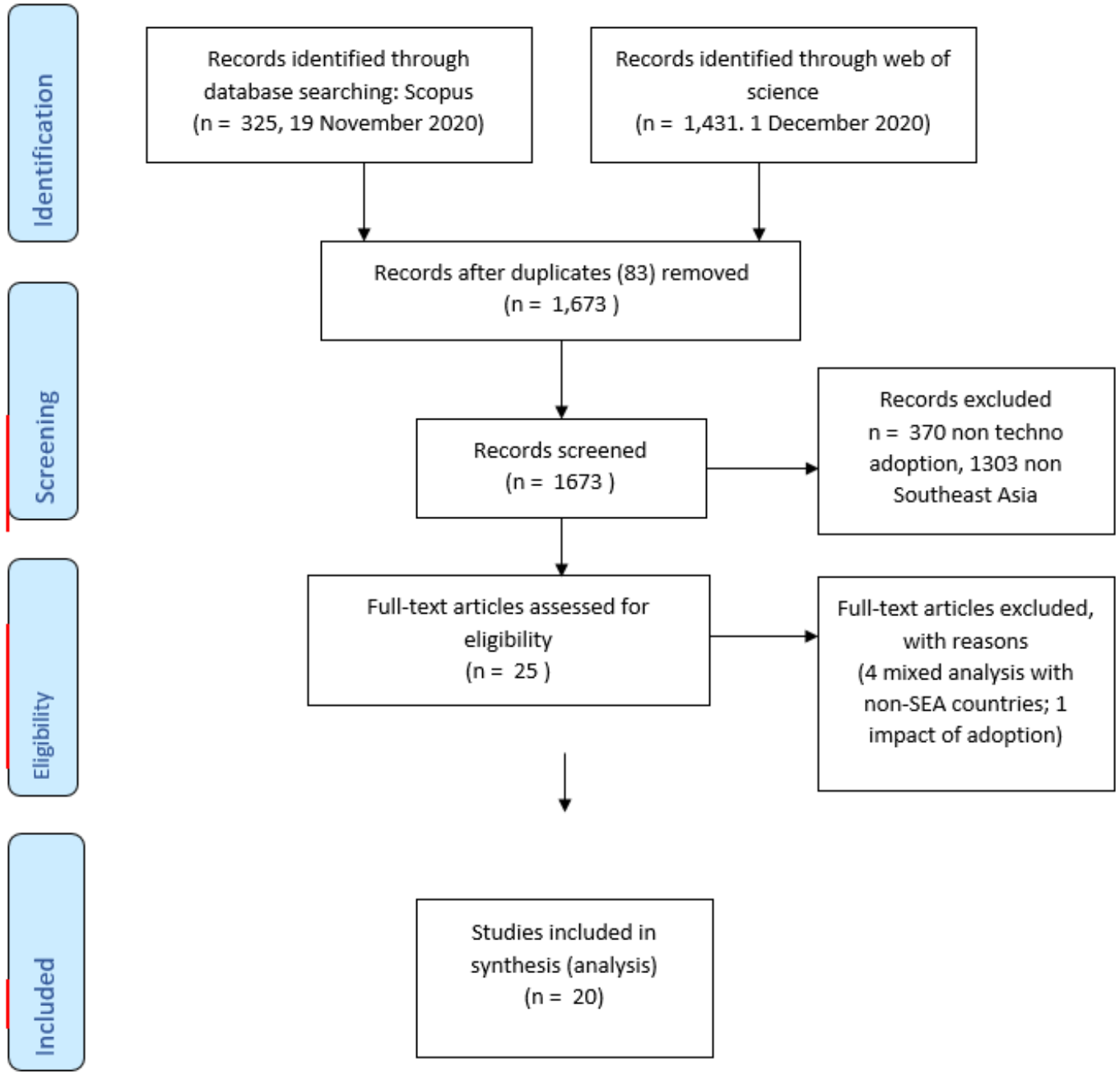
3
a. Institution OR
b. Mechanism
c. Organization
d. Actors
e. Stakeholders
f. Farmers
g. Peasant
h. Farmers behaviour
i. Socio technical system/transition

1 (a OR b OR...) AND 2 (c OR d OR ....) AND 3 (e OR f OR ....)

Database (peer reviewed journal articles)	Search in	Return results
Scopus	Title, Abstract ,Keywords	325, search done in 19 November 2020
Web of science	Title, Abstract ,Keywords/subject	1,431, done in 1 December 2020

Systematic review

Included if
Population: livestock farmers, smallholders, rural/livestock stakeholders
Intervention: Setting/context of papers are on technology adoption/diffusion/dissemination (including its knowledge exchange) in livestock farming
Comparison: adoption barriers/factors by farmers and/or social theories such as/related to social practice, stakeholders/farmers behaviour/behaviour change, systemic approach etc.
Empirical papers with case studies located in South east Asia
Year of publication after 2000



Data analysis

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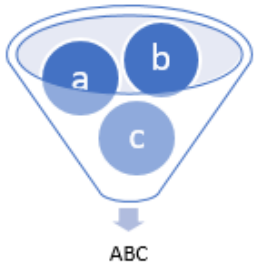

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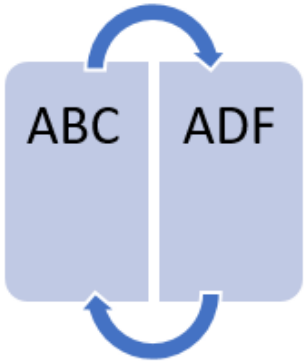

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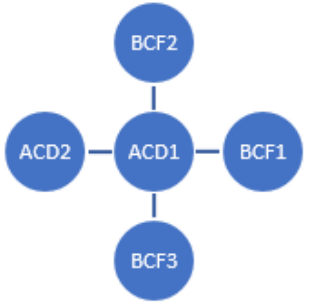

Results: 22 factors

Input:
Ecological factors;
Risk in climate change, (Env) stress/scarcity on/to land/soil/water/air/vegetation/ecosystems

Environmental cost to farmers' households

Input:
Social system/institutional factors

Environmental cost

Development of actor networks/interaction; cooperation, sharing expectation

Factors		Context
Activities	Actors	
Innovation characteristics; price, compatibility, trialability, availability observability, practicality/usability, credibility, other benefits	Techno provider, promotors, supporters/partners	Experiences from previous innovation, economic viability of to the alternatives
Providing quality learning of products and impact to inputs via training**, extension program, platform for peer learning, social care/counselling	Researcher/scientist/university, agronomist/practitioner, intermediaries, extension personnel*, farmers groups, local champions/successor	Timing, language, 'connection' to local feelings/institution/knowledge, experiences from previous projects, strong leadership/facilitation skills
Dissemination strategy: marketing, experimentation	Techno provider (dealer, retailer), contractor, govt, NGO, etc.	Location, structure of dissemination program (e.g. participant requirement)
Providing (consultancy) services, facilities for maintenance (M&E), veterinary services	(Farm/techno) advisor, technical expert/leaders, vet, engineer	Integration with other knowledge/skill services, and early training/experimentation
Supporting policies; mandates, regulation (food, health, env.), pressure/penalties?, advocacy, incentives, grant	National/provincial/local govt; agriculture agency, etc.	Inclusive participation, uncertainties (politics, power relation, bureaucracy)
Creating market demand/pressure (local/int.), premium price to the product,	Product Buyer, middlemen, govt	National/global competition, market orientation
Providing long/short-term credit/investment support	*Financial institutions/investor*	Lending procedures
Building capacity of local/institution, institutional arrangements,	Govt, CSOs, farmers/women groups,	Participation in the diffusion process

Input
Individual (user/farmer) factors:

Age, gender, women supports, family bargaining power
Household needs, future orientation: income, food
Human capital; education, training, farming experience
Attitude/vision to development, sustainability
Building Awareness
Social capital
Decision making process:
Communication
Perception about technology advantage
Culture; norms, local knowledge/practices, language
Time concern
Influencing
Financial resources; income / assets/ownership (incl. ICT tools)
Persuasion
Supporting
Persistent attraction
Farm(ing) skills (management, technical)
Farm-level cost; farm income, land tenure, farm size, number of livestock
Farm system, management, facilities
Farm location, distance

Knowledge
- Relative advantage of innovation: effectiveness, capital embodied technologies

Motivation, willingness
- Perceived usefulness/ease of use
- Trust

Behaviour, intention
- Ex ante evaluation
- Cost benefit estimation

Confirmation
- Recalculate resource availability to adopt,
- Risk aversion
- Bargaining process/discussion

Output:
(Early) adoption decision

Some early adopters will enter social system, changing their role and build stronger network/trust with other farmers

Process continued in cycle, more adoptions

Review of the reviews

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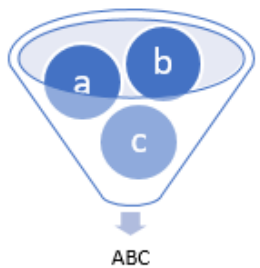

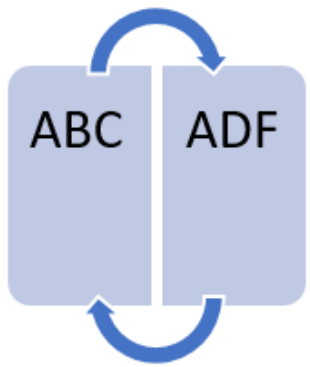

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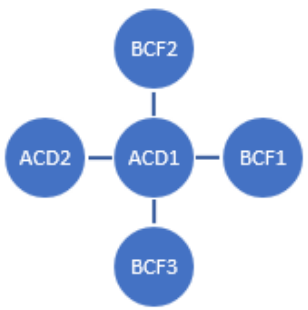

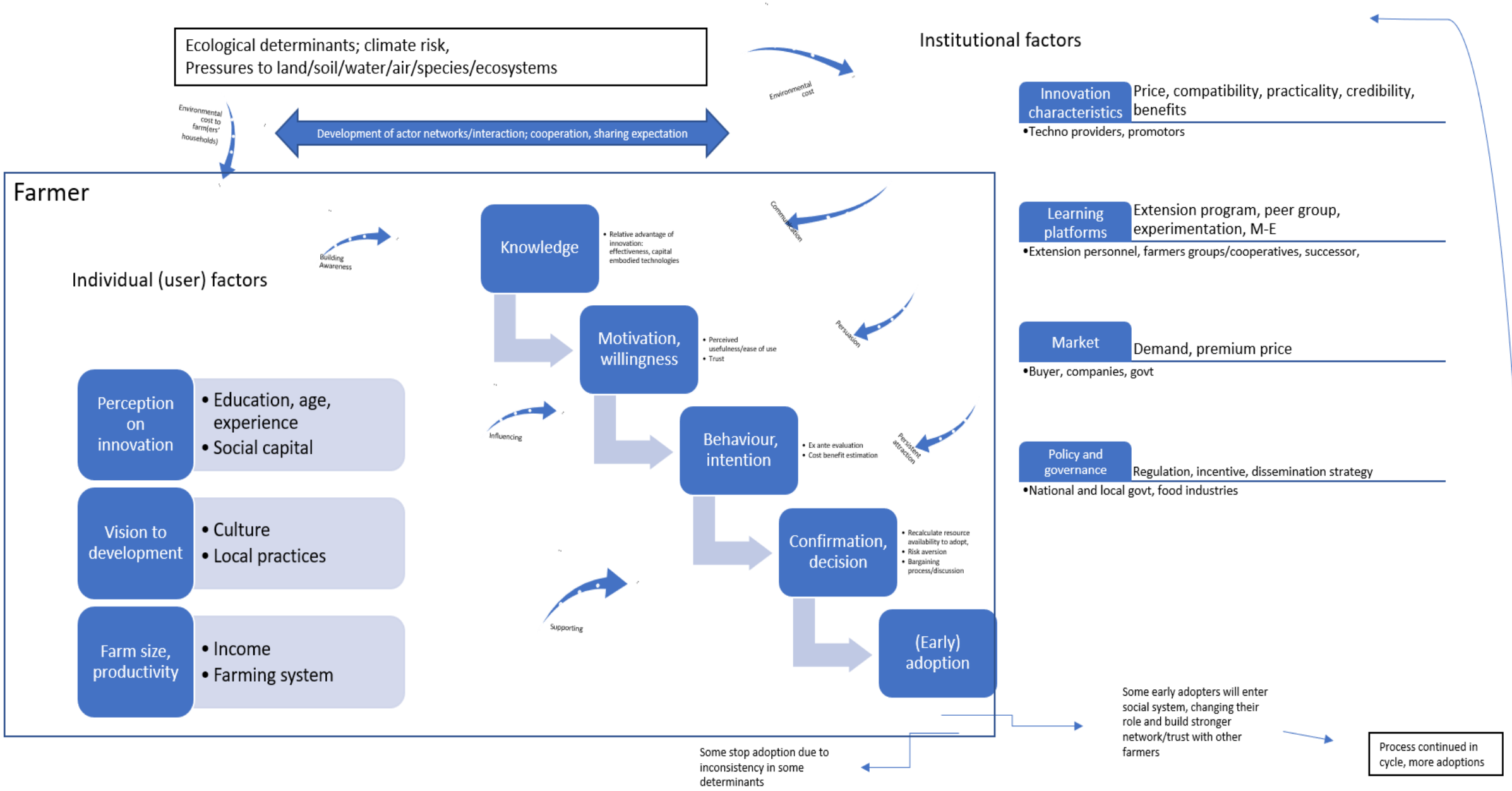
Ecological determinants; climate risk,
Pressures to land/soil/water/air/species/ecosystems
Environmental cost
Environmental cost to farm(ers' households)
Development of actor networks/interaction; cooperation, sharing expectation
Institutional factors
Innovation characteristics
Price, compatibility, practicality, credibility, benefits
•Techno providers, promotors
Learning platforms
Extension program, peer group, experimentation, M-E
•Extension personnel, farmers groups/cooperatives, successor,
Market
Demand, premium price
•Buyer, companies, govt
Policy and governance
Regulation, incentive, dissemination strategy
•National and local govt, food industries
Farmer
Individual (user) factors
Perception on innovation
• Education, age, experience
• Social capital
Vision to development
• Culture
• Local practices
Farm size, productivity
• Income
• Farming system
Building Awareness
Knowledge
• Relative advantage of innovation: effectiveness, capital embodied technologies
Communication
Motivation, willingness
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Persuasion
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Behaviour, intention
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Confirmation, decision
• Recalculate resource availability to adopt,
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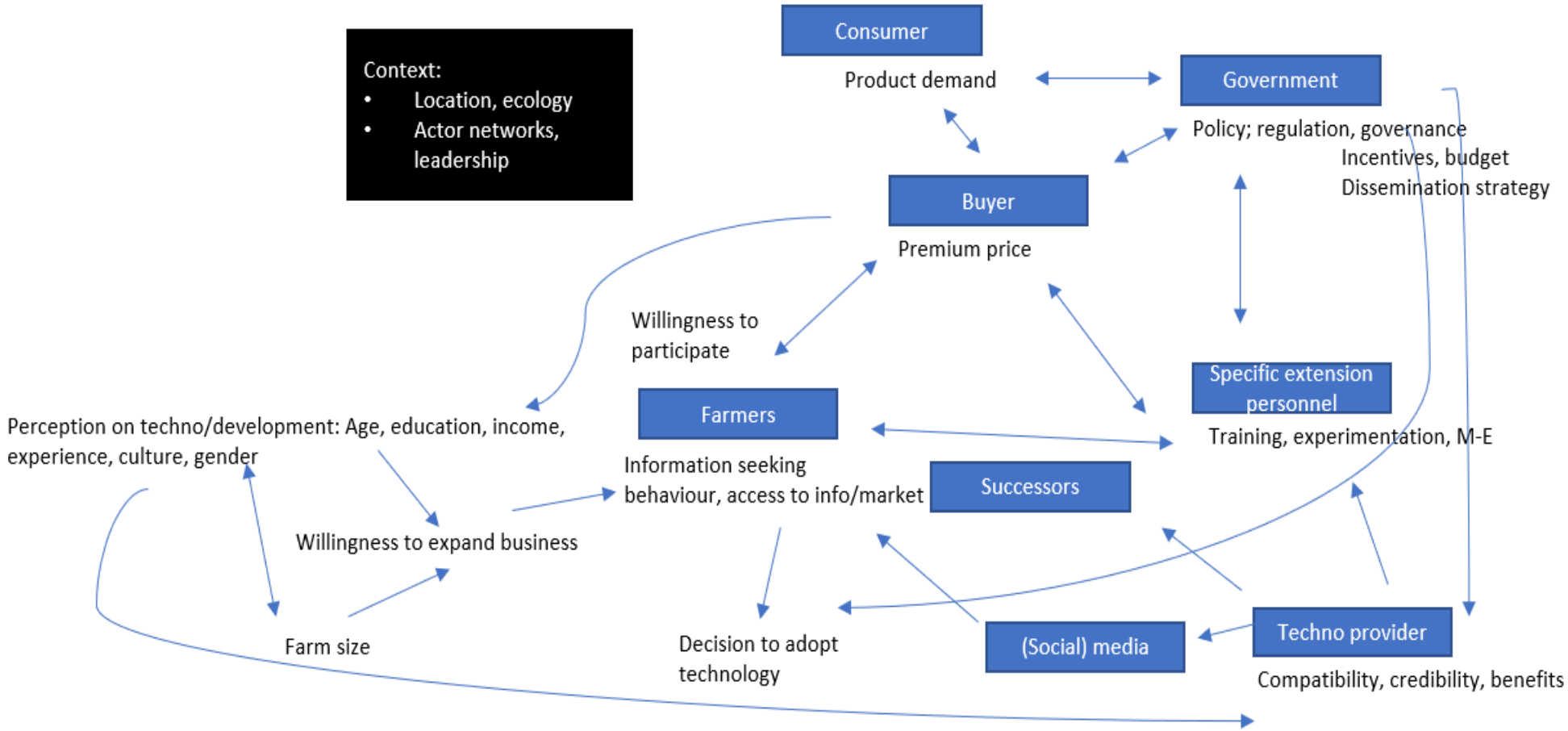
Supporting
(Early) adoption
Some stop adoption due to inconsistency in some determinants
Some early adopters will enter social system, changing their role and build stronger network/trust with other farmers
Process continued in cycle, more adoptions

Interaction between factors



Relevance; the use of the framework

- To select specific locations and strategy for promoting agriculture technologies/innovation
- Further development; To predict adoption rate of innovation

Thank you!

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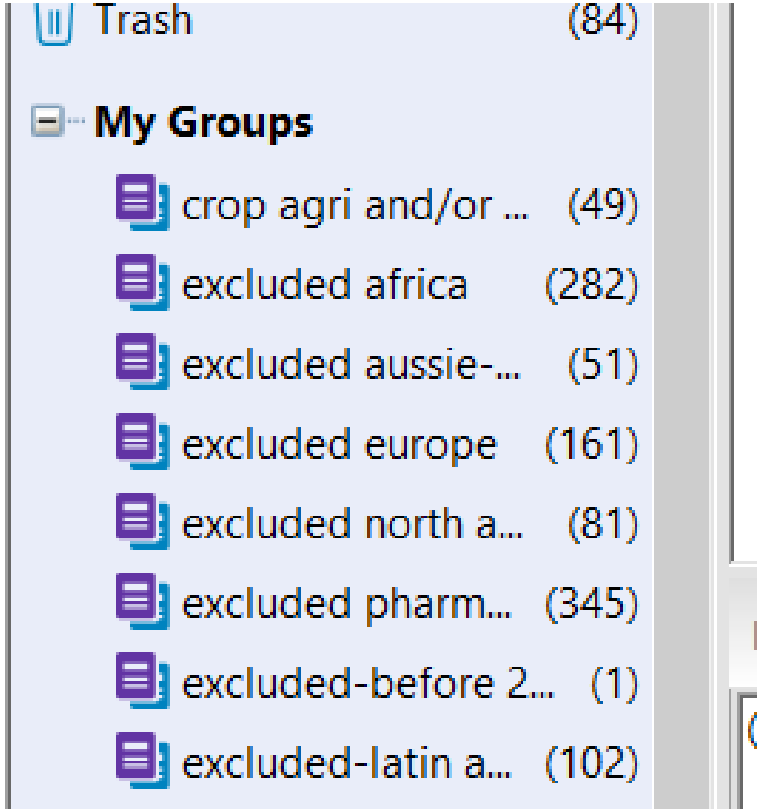
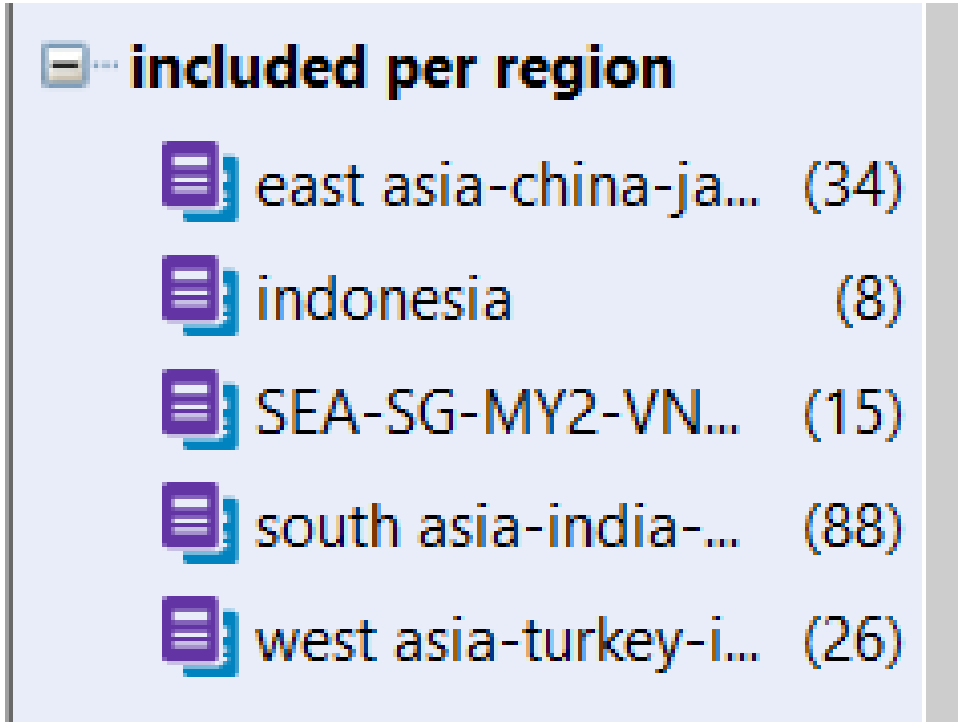
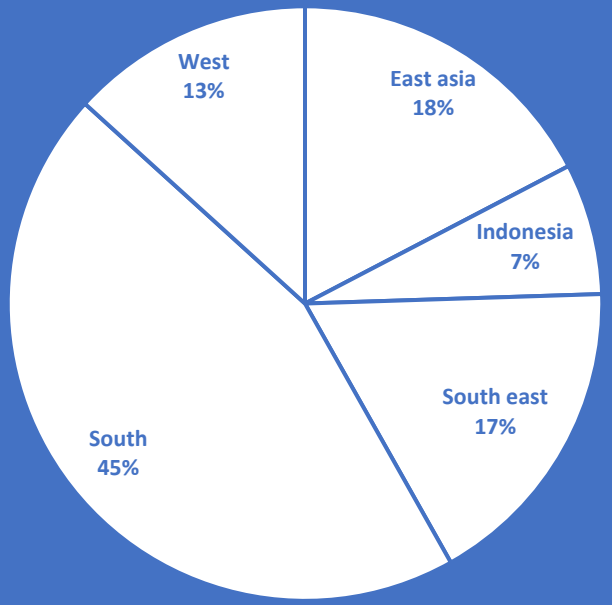
Appendix

SLR, screening, collaboration for other review?





CASE DISTRIBUTION



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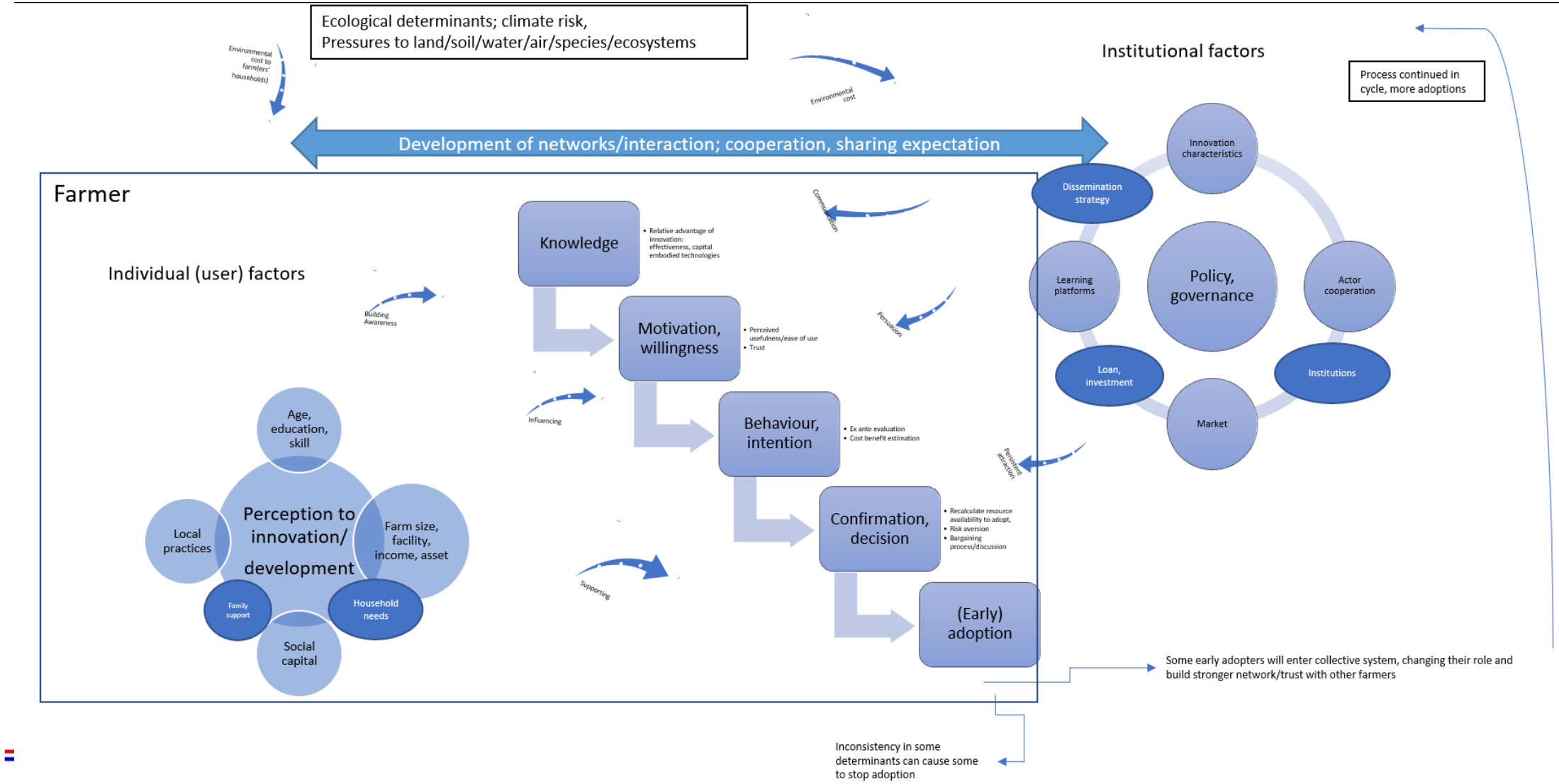
Mapping the important factors

- Scoring the importance of the identified factors:
  - 1 for factors that have a significant correlation to the decision for adoption, and 0.5 for factors that have a lower correlation to the decision
    - Quantitative and mixed-method papers; significant factor = p-value ≤ 0.05
    - Qualitative papers; significant factor = the most emphasized points in the result and analysis
  - In the end, we used range classification for accumulated scores; e.g. 6-10 = important factors and 1-5 = less important factors
- Many technology adoption studies use statistical approach to measure the strength of correlation between multiple factors with farmers technology adoption decision. Different treatment are applied for qualitative papers that did not use that correlation level approach. This depends on the nature of the selected papers.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Farm size, facility, income, asset
Family support
Household needs
Social capital
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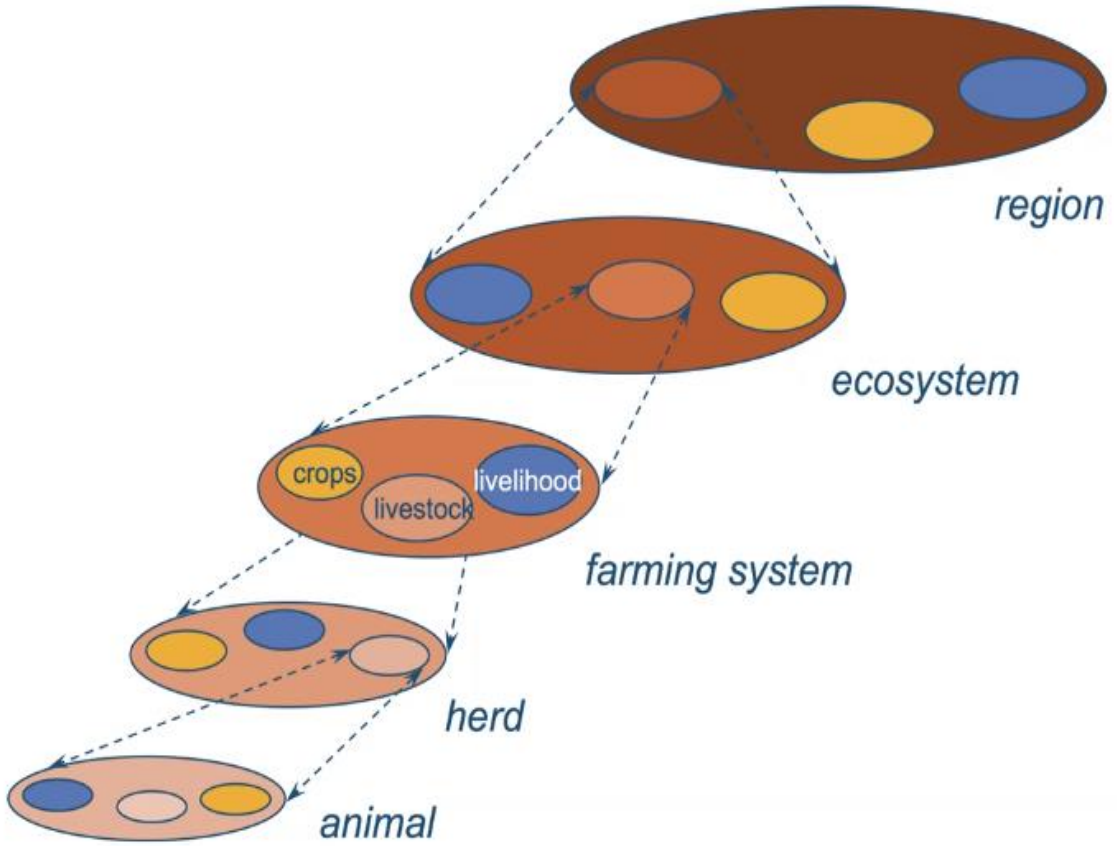
Inconsistency in some determinants can cause some to stop adoption

Aggregation levels



Review of the reviews

	Title	Publication year	Authors	Countries case studies	Agriculture/livestock technologies
1	A systematic literature review of the factors affecting the precision agriculture adoption process	2019	Pathak, Hari Sharan Brown, Philip. Best, Talitha	United States, Germany, Denmark, Turkey, Hungary, Nigeria, Canada, Brazil and Iran.	• Precision Agriculture: Yield monitoring, grid/GPS soil sampling, aerial photos and satellite imagery, geographical information system • Management techno: variable rate, automation irrigation
2	Drivers of Precision Agriculture Technologies Adoption: A Literature Review	2013	Pierpaoli, Emanuele. Carli, Giacomo. Pignatti, Erika. Canavari, Maurizio	United States, Nigeria, Iran, Canada	Precision agriculture technologies
3	Factors influencing the adoption of precision agricultural technologies: a review for policy implications	2012	Tey, Yeong Sheng. Brindal, Mark	Australia, United States	Precision agriculture: (1) GPS, (2) yield monitoring systems, (3) remote sensing systems, (4) soil sampling regimens and (5) variable-rate applicators.
4	Technology Adoption by Agricultural Producers: A Review of the Literature	2018	Ugochukwu, Albert I. Phillips, Peter W. B.	Global review	Livestock health and breeding technologies; animal health (vaccines), disease prevention, and management practices to breeding (artificial insemination, embryo transplants, and sexed semen), genetics, and genomics innovations
5	A review of social science on digital agriculture, smart farming and agriculture 4.0	2019	Klerkx, Laurens. Jakku, Emma. Labarthe, Pierre	General review	Precision farming, digital agriculture

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Inclusion criteria, framework synthesis

- Innovation intended for farmers, smallholders, rural stakeholders,
- Setting/context of papers are on innovation/technology adoption/diffusion/dissemination (including its knowledge exchange) in animal agriculture, mixed crop-livestock/animal system
- Analysing adoption barriers/factors by farmers
- Review papers with case-studies from multiple countries
- Year of publication after 2000

To search for the review, three key concepts were defined; 1. Animal farming, 2. Technology or innovation adoption, and 3. Review studies. These are used as search terms. This query was used in Google Scholar.