

# Evolution of systems perspectives on agricultural innovation

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# Purpose of the talk

- To give an overview of how systemic thinking on innovation has developed in the agricultural sector (mainly focused at the farm level) and what were the underlying systems conceptualizations
- To give an overview of how the concept of agricultural innovation systems is currently being interpreted, researched and operationalized
- To indicate some critical issues and directions for future research on agricultural innovation systems



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# The study of innovation in the agricultural versus other sectors

- The agricultural sector seems to have its own tradition and publishes in agriculture oriented outlets
- There is however some cross-over from industrial innovation studies, which appears to have increased in recent years
- A question is how homogeneous the agricultural sector is as a sector: large differences between subsectors such as horticulture and dairy



# Innovation in agriculture as a sector – different views

- According to Keith Pavitt (1984): supplier dominated sector
- Sources of technology: public research, large agro-industrial firms (seeds, fertilizer, chemicals), extension services, big users
- This view appears to connect to what is commonly referred to as the 'linear model' or 'diffusion and adoption model' which preceded the systems oriented agricultural innovation models



# Evolution of systems thinking

Broadly, four subsequent perspectives:

- Diffusion and adoption perspective
- Farming systems research perspective
- Agricultural knowledge and innovation systems (AKIS) perspective
- Agricultural innovation systems (AIS) perspective

These perspective have been fed into by other approaches (e.g. Transfer of Technology, Induced Innovation, Farmer First, Participatory Technology Development, etc.)



# Linear adoption and diffusion perspective

Linked to concepts such as National Agricultural Research Systems using Transfer of Technology approaches

- Innovations = component technologies
- Innovations come from outside (from research)
- Innovations are adopted by individuals

*Fundamental science -> applied science -> education & extension -> farmers*

# Linear adoption and diffusion thinking: Key problems

- Introduced technologies are not adapted to the context and logic of those who are supposed to adopt
- Individuals cannot adopt (even if they 'know' and 'want' to)
- No effort made to adapt the context to the technology



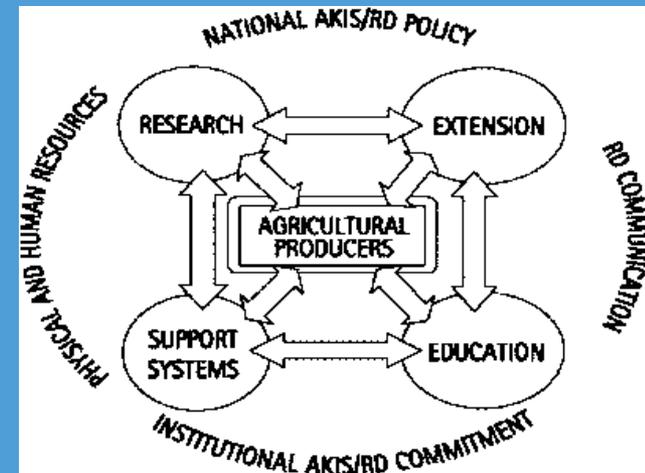
# Farming systems research perspective

- Emerged in response to limitation of linear diffusion and adoption models
- More holistic view on farms in their direct biophysical and socioeconomic context and recognition of different 'farming styles'
- Partnerships between technical and social scientists and farmers.
- Critique is that FSR is mainly science oriented and much focused on the farm and less on the broader socioeconomic context



# Agricultural Knowledge and Information Systems perspective

- Emerged from an extension perspective: more focus on interactive learning, with consciousness of the broader institutional environment
- Recognizes multiple bodies of knowledge and multiple realities and worldviews
- Soft systems thinking – system boundaries are negotiated
- Still quite focused on the farmer-extension-research-education system



# Agricultural Innovation Systems perspective

- Emerged almost parallel to AKIS, but more from a research perspective
- Influenced by National Innovation Systems thinking, eg. Lundvall, 1992
- Emphasizes role of multiple actors and institutions
- 'a network of **organizations**, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the **institutions** and policies that affect the way different agents interact, share, access, exchange and use knowledge'. (World Bank, 2006)



# Comparison

|                           | <b>Diffusion &amp; adoption</b>          | <b>FSR</b>                                  | <b>AKIS</b>                                     | <b>AIS</b>  |
|---------------------------|--|---|---|---|
| Era                       | Central since 1960's                     | From 1970's/1980's                          | From 1990's                                     | From 2000's   |
| Mental model              | Supply technologies through pipeline     | Learn farmers constraints through surveys   | Collaborate in research and extension           | Co-develop innovation in partnerships                           |
| Knowledge and disciplines | Single discipline driven (e.g. breeding) | Multi-disciplinary (agronomy and economics) | Inter-disciplinary (plus sociology and farmers) | Trans-disciplinary, holistic systems perspective                |
| Drivers                   | Supply push from research                | Diagnose farmers' constraints and needs     | Demand-pull from farmers                        | Responsiveness to changing contexts and patterns of interaction |



# Comparison cont'd

|                                  | <b>Diffusion &amp; adoption</b>   | <b>FSR</b>  | <b>AKIS</b>  | <b>AIS</b>   |
|----------------------------------|---|---|--|--|
| Relation with policy environment | Science is independent – institutional factors as external conditioners of adoption | Science is independent – institutional factors as external conditioners of adoption | Science and technology develop in a historically defined context | Science and technology develop in a historically defined context |
| Role science                     | Innovators  | Experts   | Collaborators  | Partners, one of many responding to demands                      |
| Role farmers                     | Adopters/laggards   | Sources of information  | Experimenters  | Partners, entrepreneurs, innovators exerting demands             |



# Comparison cont'd

|                    | <b>Diffusion &amp; adoption</b> | <b>FSR</b>                    | <b>AKIS</b>   | <b>AIS</b>   |
|--------------------|---------------------------------|-------------------------------|---|--|
| Innovators         | Scientists                      | Scientists and extensionists  | Farmers, scientists and extensionists                       | Multiple actors, innovation platforms/networks             |
| Key changes sought | Farmer's behaviour change       | Removing farmers' constraints | Empowering farmers  | Broader institutional change, creating innovation capacity |
| Intended outcomes  | Technology adoption/uptake      | Farming system fit            | Co-evolved technologies better fitted to livelihood systems | Capacities to innovate, learn and change                   |



# The AIS perspective further explored

- While adoption & diffusion thinking is still to be adhered to by many, systems perspectives as AKIS and AIS have gained currency
- AIS has become dominant in the discourse in recent years
- Main problems lie in a lack of clarity about :
  - The way the AIS concept is interpreted
  - The way AIS are delineated
  - The way the AIS concept is applied



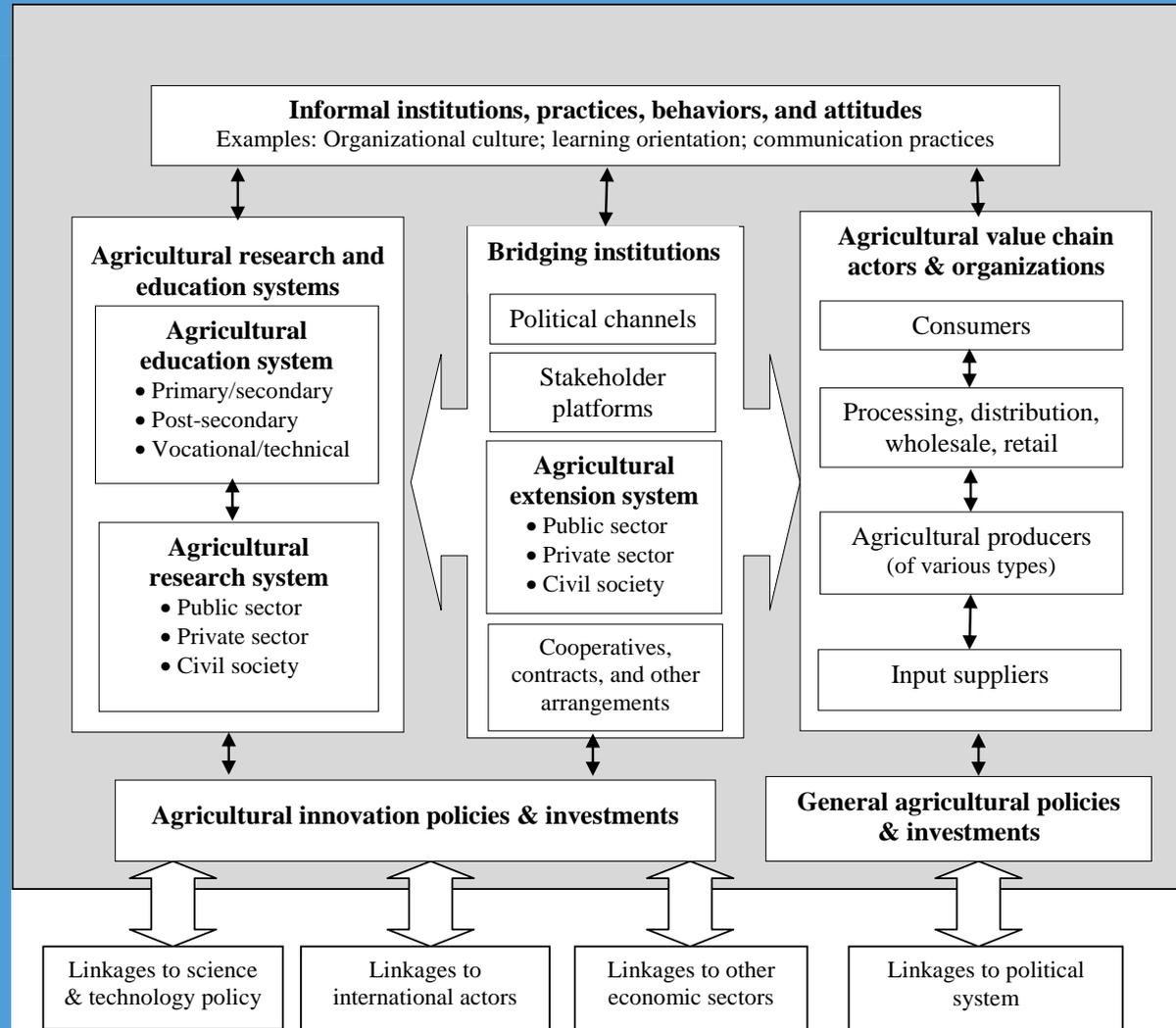
# Main AIS interpretations

- Structural view of AIS: AIS as 'innovation support structures' or 'pre-conditions for innovation'
- Dynamic view: AIS as 'complex adaptive systems'
- Functional view: AIS as a set of functions that need to be fulfilled to make innovation occur



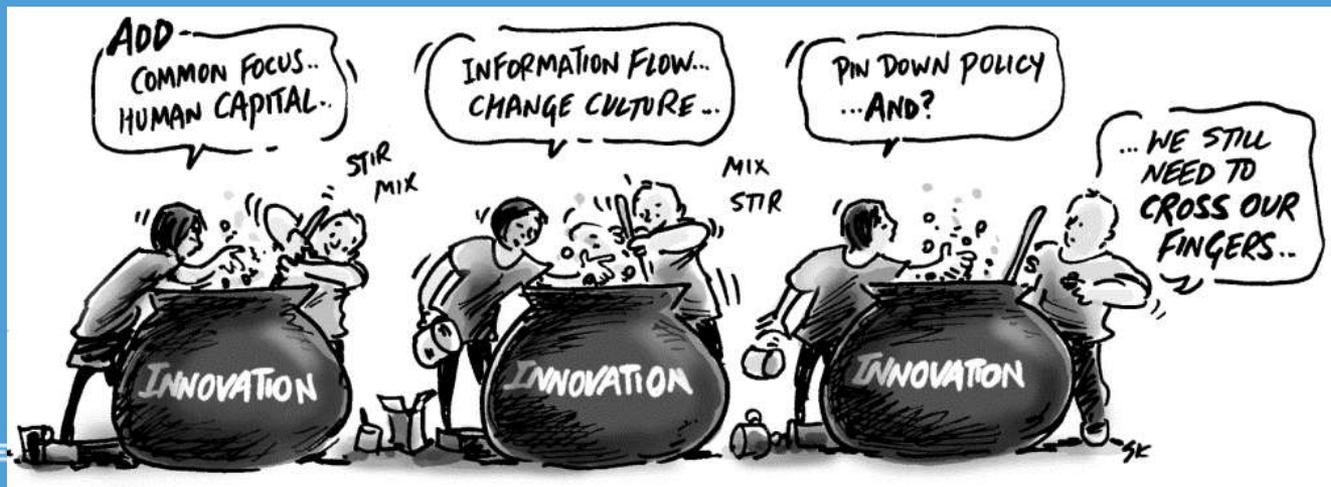
# AIS as national/sectoral innovation system

- Often static analysis (e.g. SNA)
- Main question is: what are system components and how does system enable or constrain innovation
- Boundaries: national, (sub) sectoral



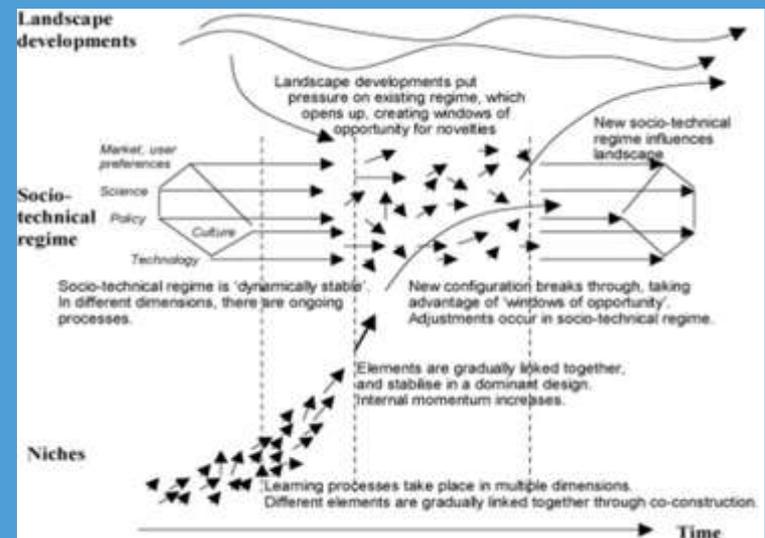
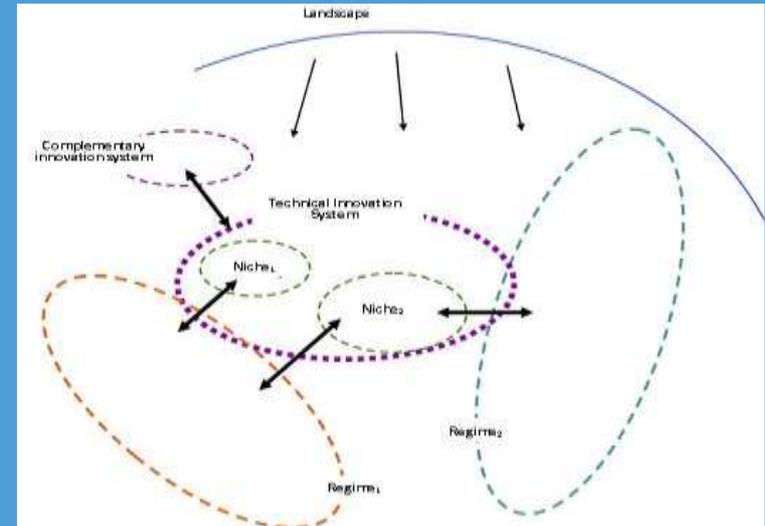
# Conditions for AIS functioning

- Adequate infrastructure: roads, communications, R&D, funding, etc.
- Well-trained human resource base – people can participate in and contribute to innovation
- Well-established and effective linkages between heterogeneous actors – networks/platforms form and function
- Conducive institutional framework (rules, regulations, norms, values)



# AIS as complex adaptive system

- Emphasis on non-linear co-evolutionary processes
- More attention to resistance and political processes
- Often focused on specific crop or technology
- Clear resemblance with ideas from multi-level model of socio-technical transitions
- Only recently integration between AIS and MLP



# A functionalist approach to AIS

- Approach developed in the context of technological innovation systems and transitions
- 7 functions:
  1. Entrepreneurial activities
  2. Guidance of the search
  3. Knowledge development
  4. Knowledge diffusion in networks
  5. Resource mobilization
  6. Creating legitimacy
  7. Market formation
- Functions approach has been sparsely used in the AIS field so far



# Summary: conceptual diversity in AIS

- In terms of system boundaries (country, sub(sector), region, technologies, even projects)
- In terms of how change comes about (provision of functions, taking away structural barriers, through coincidence, self-organisation and competition in a selection-environment)
- Different ways on how the concept of system is used: as a descriptive or normative concept, as a discreet hard system or as a soft system



# Studying AIS

- The study of AIS has often focused on micro-level studies (following the tradition of participatory research studies) based on cases
- However, also some sectoral and national level studies have been done, but to a lesser degree



# Studying AIS

- *Benchmark analysis*, based on indicators such as patents, R&D expenditures, numbers of researchers, and input-output/spill-over analysis on R&D investment, returns on risk capital, etc. - *has been done quite a lot, but rather focused on R&D systems*
- *Institutional analysis*, looking at the influence of institutional enablers and constraints in relation to innovation systems performance or of parts of it, e.g. looking at projects and governance mechanisms such as R&D planning schemes – *also many examples of these types of studies*



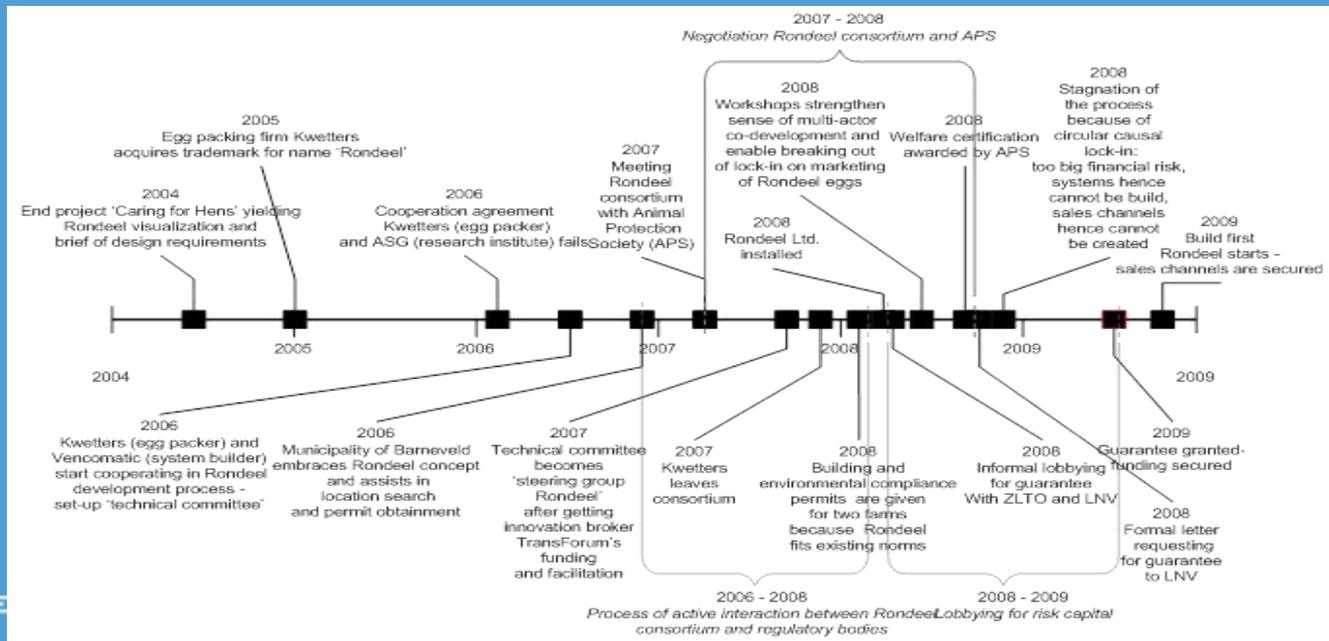
# Studying AIS

- *Social network analysis* to map institutional linkages, visualizing relationships between actors, and assessing the position of actors within the system (in terms of centrality, number of ties, strength of ties). *This literature is growing*



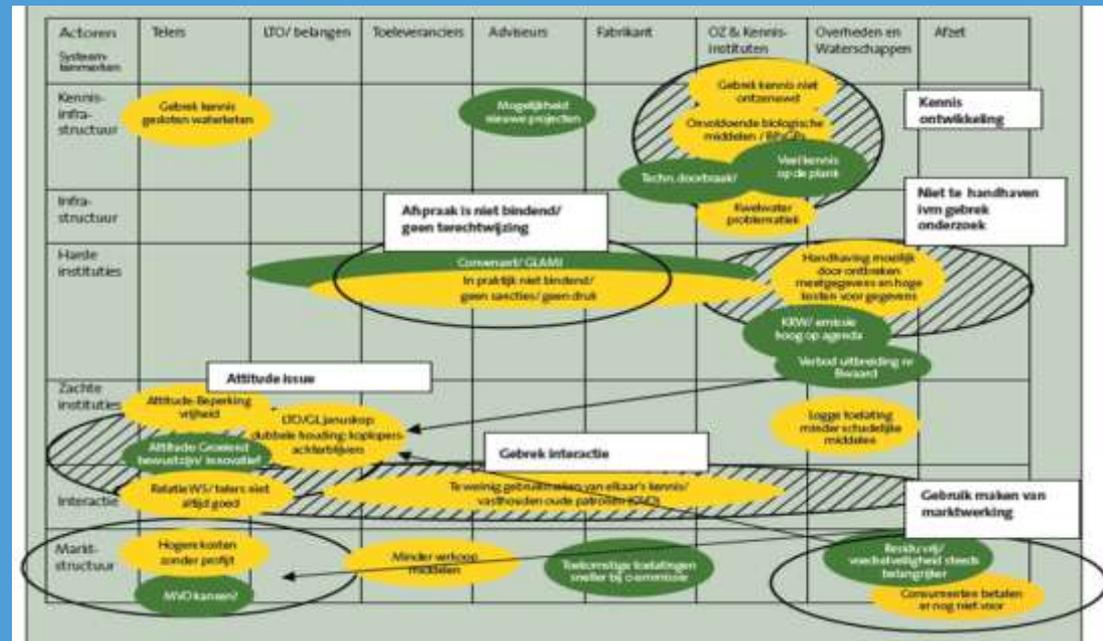
# Studying AIS

- *Innovation histories or innovation journey analysis* This is a way of recording innovation processes by means of timelines, focusing on important events and the relationships and activities which defined those events and influenced the outcome of the innovation process (related: causal process tracing, technography). *This literature is growing*



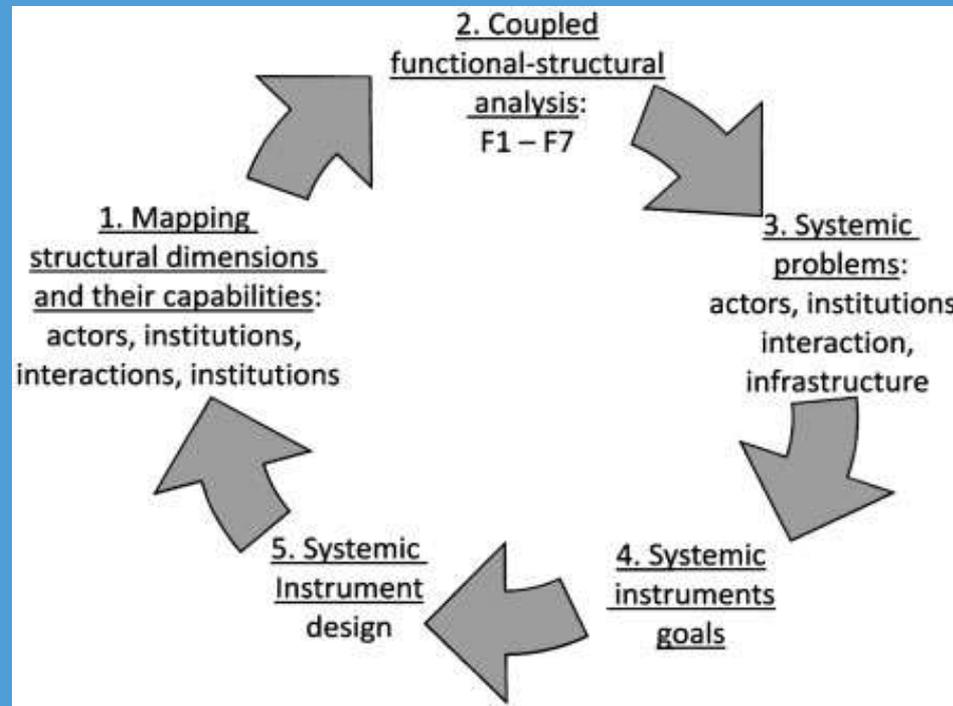
# Studying AIS

- *Innovation system analysis, using the different categories of system failures cross-tabulated against actor groups to identify failures and underlying motives in the innovation system as well as to identify windows of opportunity. has been applied to a limited extent.*



# Studying AIS

- *Functions of an innovation systems approach: are all functions properly performed? Has been applied very sparingly.*



# Studying AIS

- Political analysis of AIS (political ecology/ political agronomy). Looking critically to winners and losers, competing development directions (seeing AIS as TIS)  
*Has been applied frequently, in connection to topics such as GM, SRI*



# Intervening in AIS

- Participatory research and technology development models have been expanded to participatory innovation development models
- There is a developing literature on 'innovation platforms' as coordinating structures in AIS
- There is a developing literature on 'innovation brokers' acting as systemic intermediaries
- There is a developing literature on innovation process monitoring from an innovation systems perspective (RMA, Impact Pathway Analysis, PMCA, etc.)
- However, still under-attention to broad range of policy tools beyond research and extension (move towards 'systemic instruments')



# Critical issues and future research needs

- Getting a clearer description of the boundaries of AIS: what kind of innovation systems do we talk about, and what are the choices made in determining the boundaries?
- Better connect the different systems thinking in innovation strands to each other, e.g. system innovation (niche-regime) to innovation systems thinking and connect to sectoral innovation systems literature
- Better conceptualize the underlying systems models for AIS and the theories of change: hard systems thinking, soft systems thinking, complex systems thinking, critical systems thinking



# Critical issues and future research needs

- Better address scale levels in AIS, i.e. agency of innovators vs. the structures they are embedded in, through concepts such as political agronomy, institutional entrepreneurship and effective reformism
- Develop better indicators for measuring AIS performance beyond classical S&T indicators (R&D investments and returns, patents): systemic indicators



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