Using system dynamics for *ex-ante* impact assessment of food safety policies in pig value chains

Rich, K.M.; Thu Huyen, N.T.; Nam Ha, D.; Duong Nga, N.T.; Xuan, V.K.; Trung, N.X.; Van Long, T.; Van Hung, P.; Unger, F.; Hamza, K.; Lapar, L.

Karl M. Rich, Ph.D.
Lab 863 Ltd.
University of New England

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What is system dynamics?

- "System dynamics is a **computer-aided approach** to policy analysis and design. It **applies to dynamic problems** arising in complex social, economic, or ecological systems
- Literally any dynamic systems are characterized by **interdependence, mutual interaction, information feedback, and circular causality**"
- It provides a methodology for **studying complex dynamic** systems that include nonlinearities, delays, and feedback loops.
- System dynamics is currently applied in economics, public policy, environmental studies, defense, commodity cycles, management, etc.

Source: System Dynamics Society

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Why system dynamics for value chains?

- A major gap in value chain (VC) analysis: understanding the *impact* of VC investments
  - The general *performance* of a chain
  - The ability to evaluate *ex-ante* between different (intervention) options
- Value chain analysis does a very **nice job of *describing* the chain** and things that influence it. But it is **less good on measurement**, e.g. effects of potential interventions (e.g. reduced pathogen loads versus investment)

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Why system dynamics for value chains?

- An example: suppose tomorrow you were given US$20 million to improve an existing agricultural value chain

- Given the tools you have so far, could you evaluate how best to use that money?
  - Where to invest, which node, scope of investment, how long it may take

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Why system dynamics for *pig* value chains?

- To **assess dynamic impacts of interventions** over time
  - Effects on markets
  - Effects on adoption
  - Effects on sustainability
- To operationalize value chain analysis as a **tool for impact assessment** rather than just for diagnostics.
- It provides the ability to use **interface as communication platform** for dissemination.

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SD concepts

- Stocks (accumulation)
- Flows (change overtime – rate/time unit)
- Feedback loops (circular causality)
- Delays

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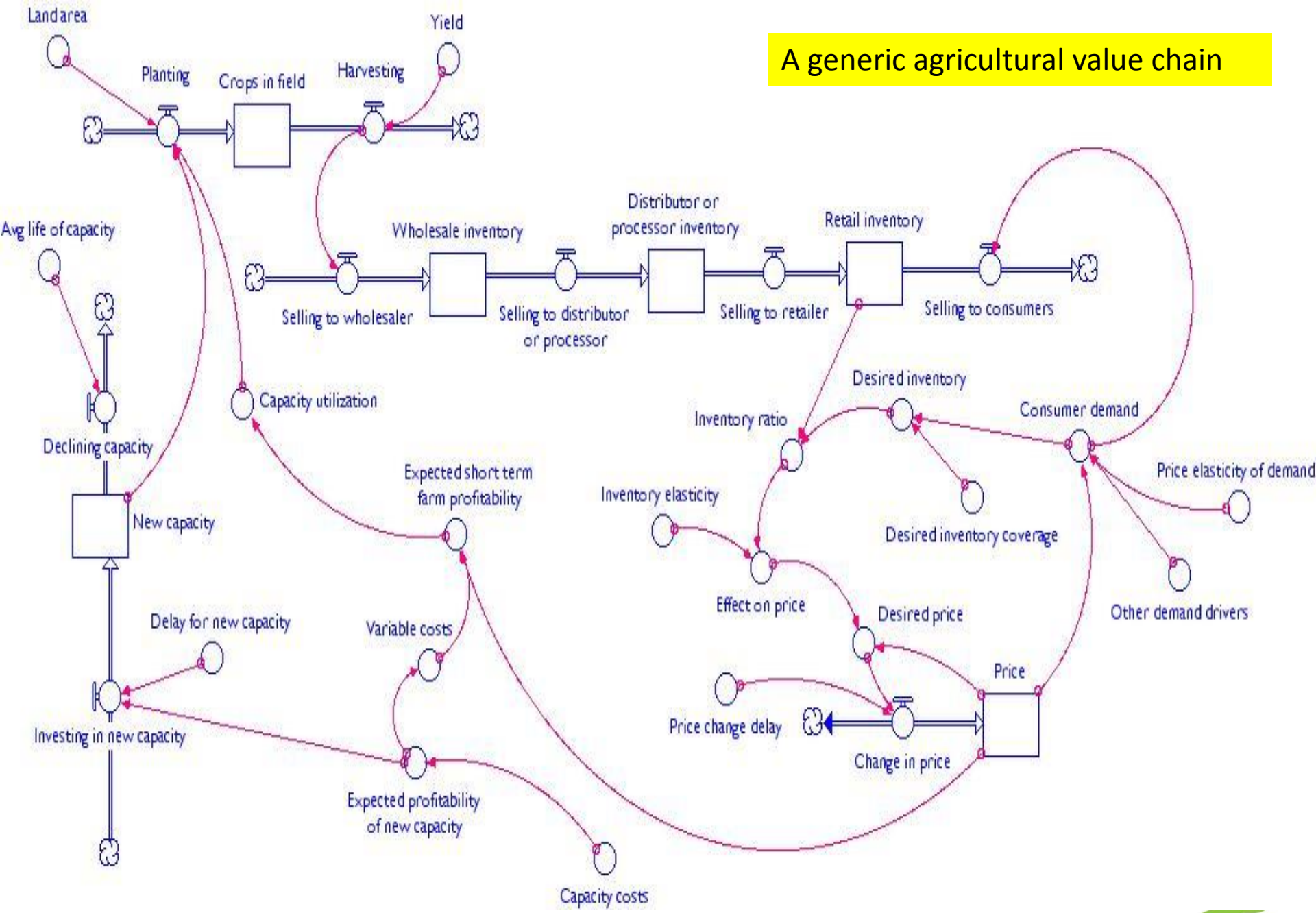
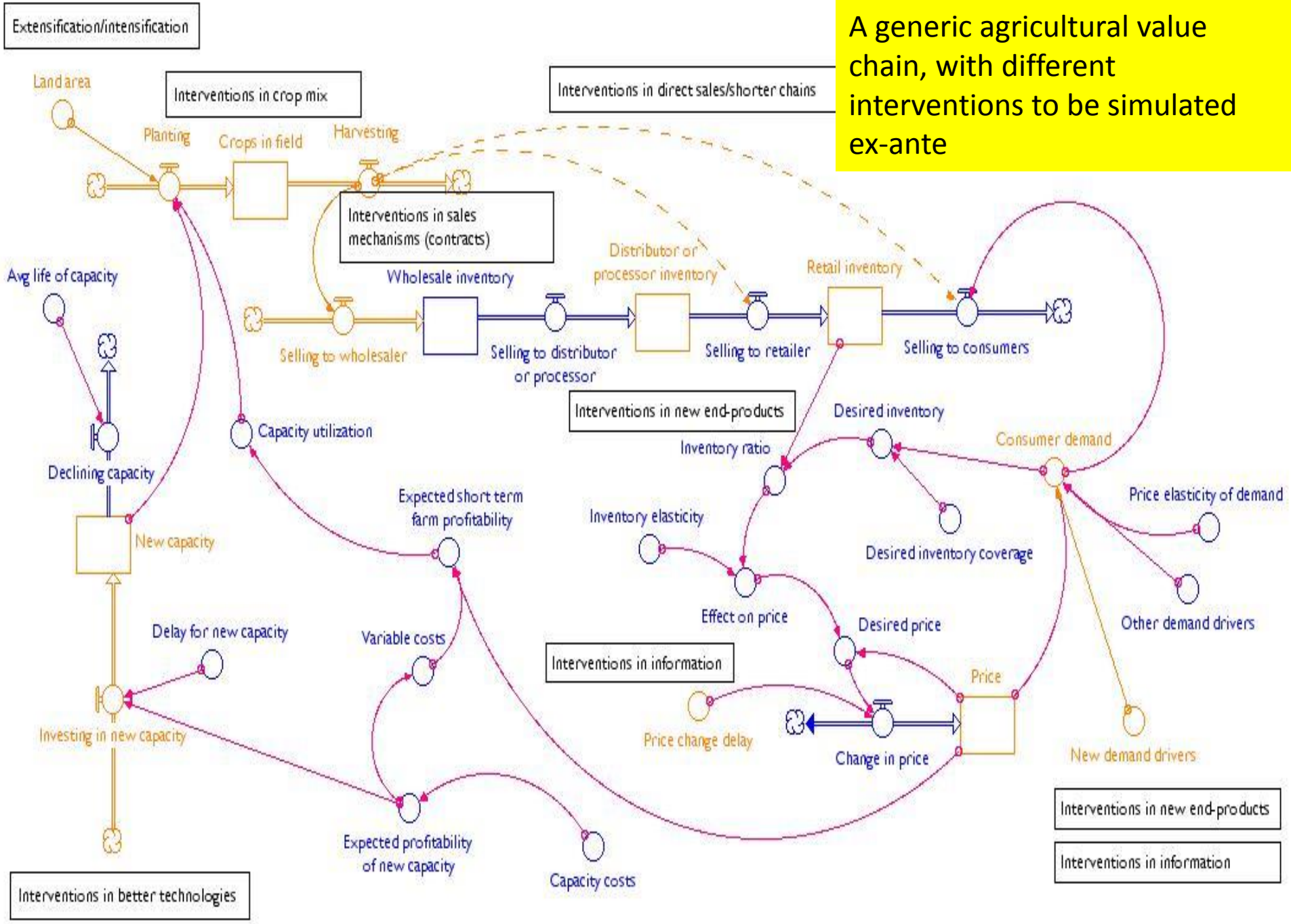
A generic agricultural value chain



Source: Rich, Rich, and Hamza (2015)

A generic agricultural value chain, with different interventions to be simulated ex-ante



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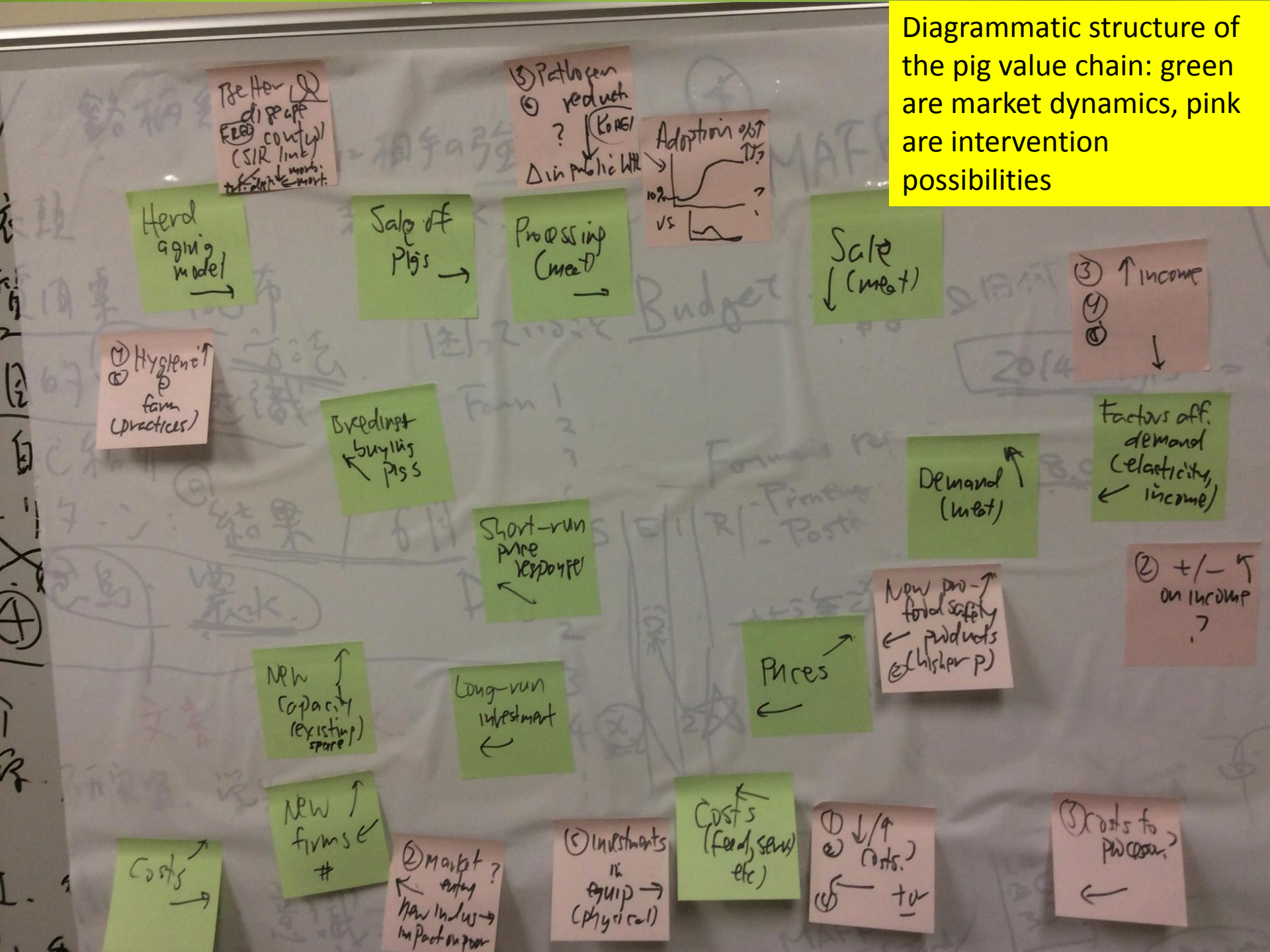
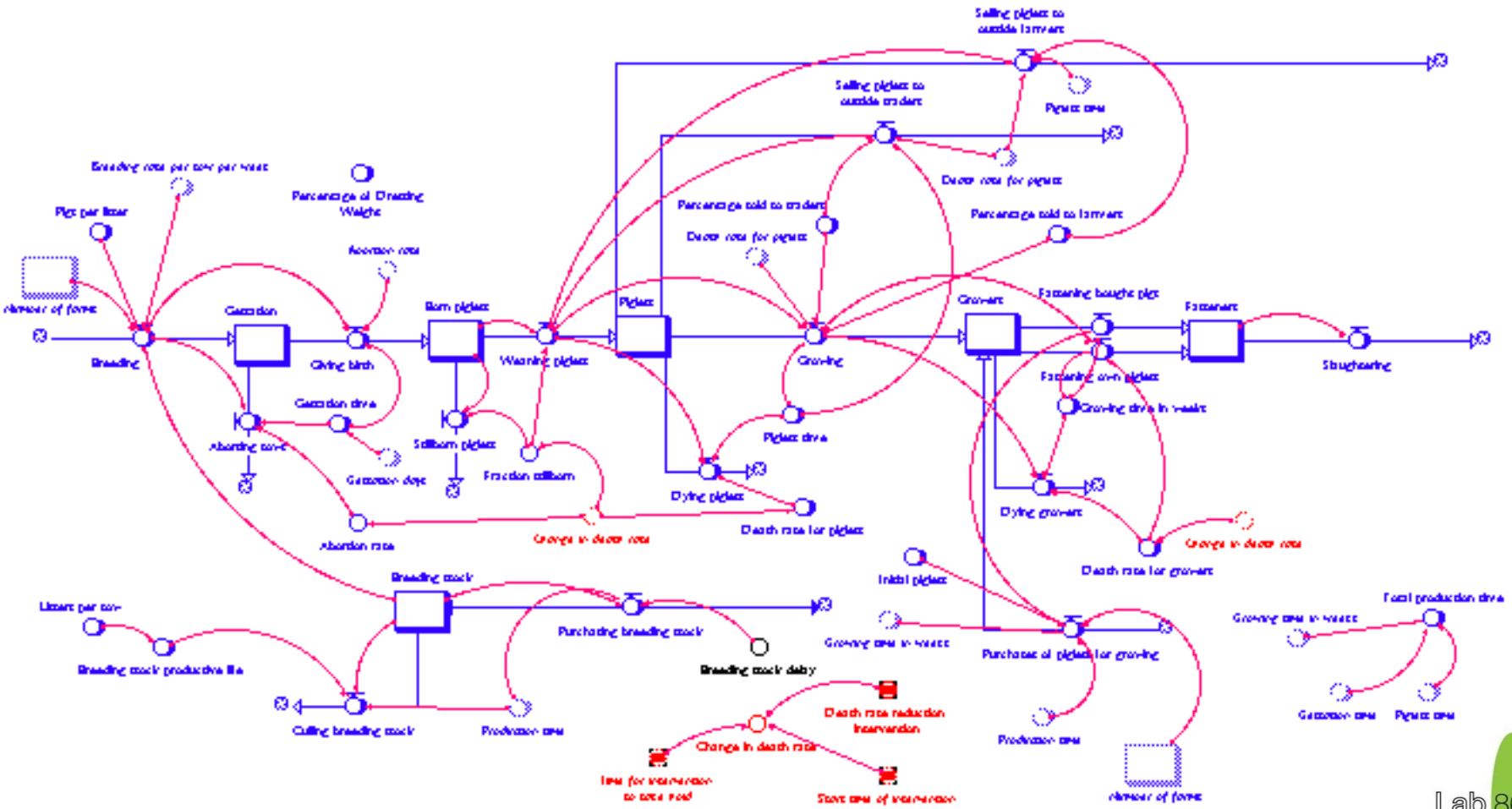

Herd aging model
Sale of Pigs
Processing (meat)
Sale (meat)
Hygiene (farm practices)
Breeding buying pigs
Short-run price response
Demand (meat)
Factors aff. demand (elasticity, income)
Income
Prices
New capacity (existing spare)
Long-run investment
New firms
Costs
Costs (feed, serv etc)
Adoption
Diagrammatic structure of the pig value chain: green are market dynamics, pink are intervention possibilities

Production module



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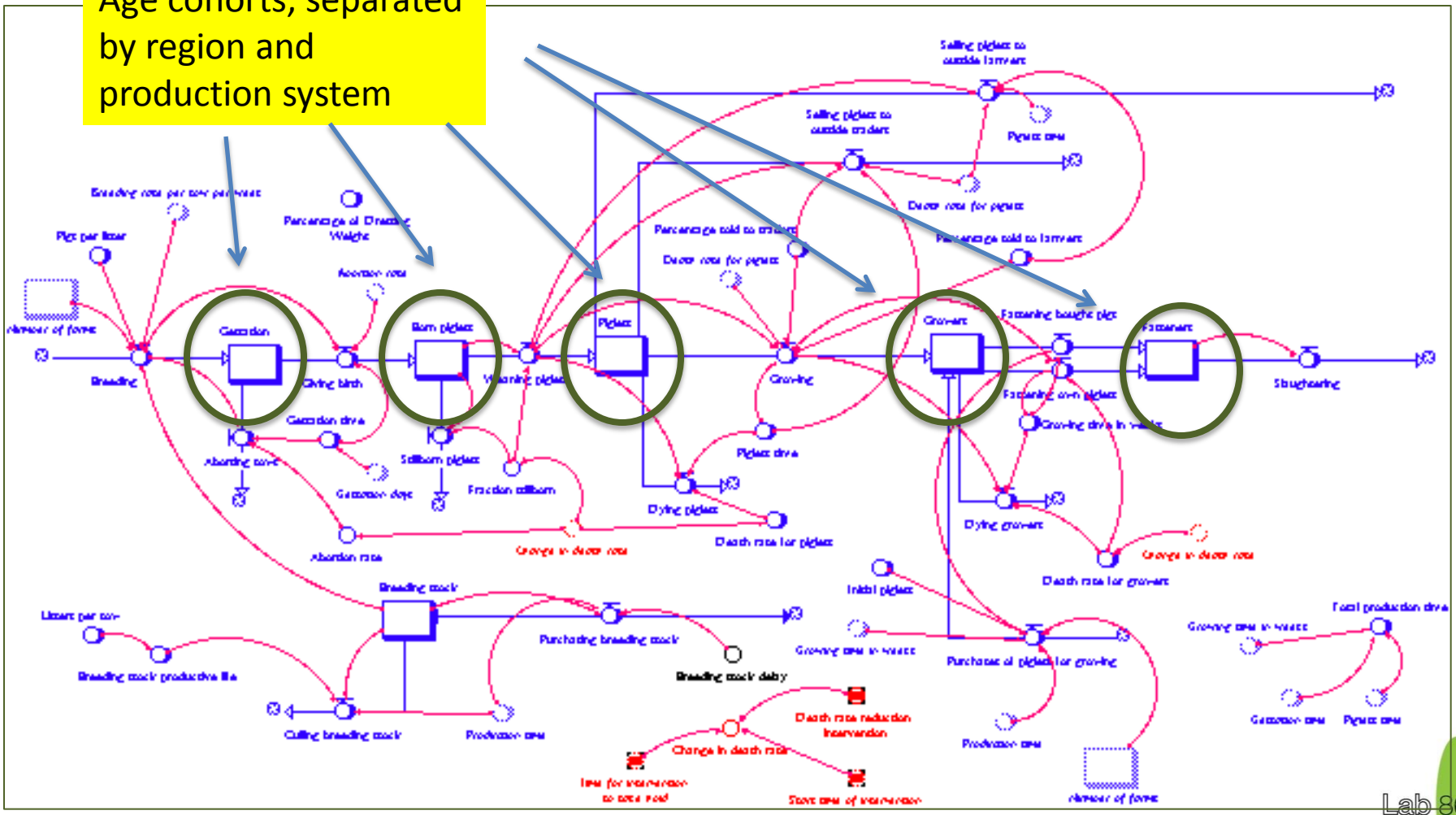
Production module

Age cohorts, separated by region and production system



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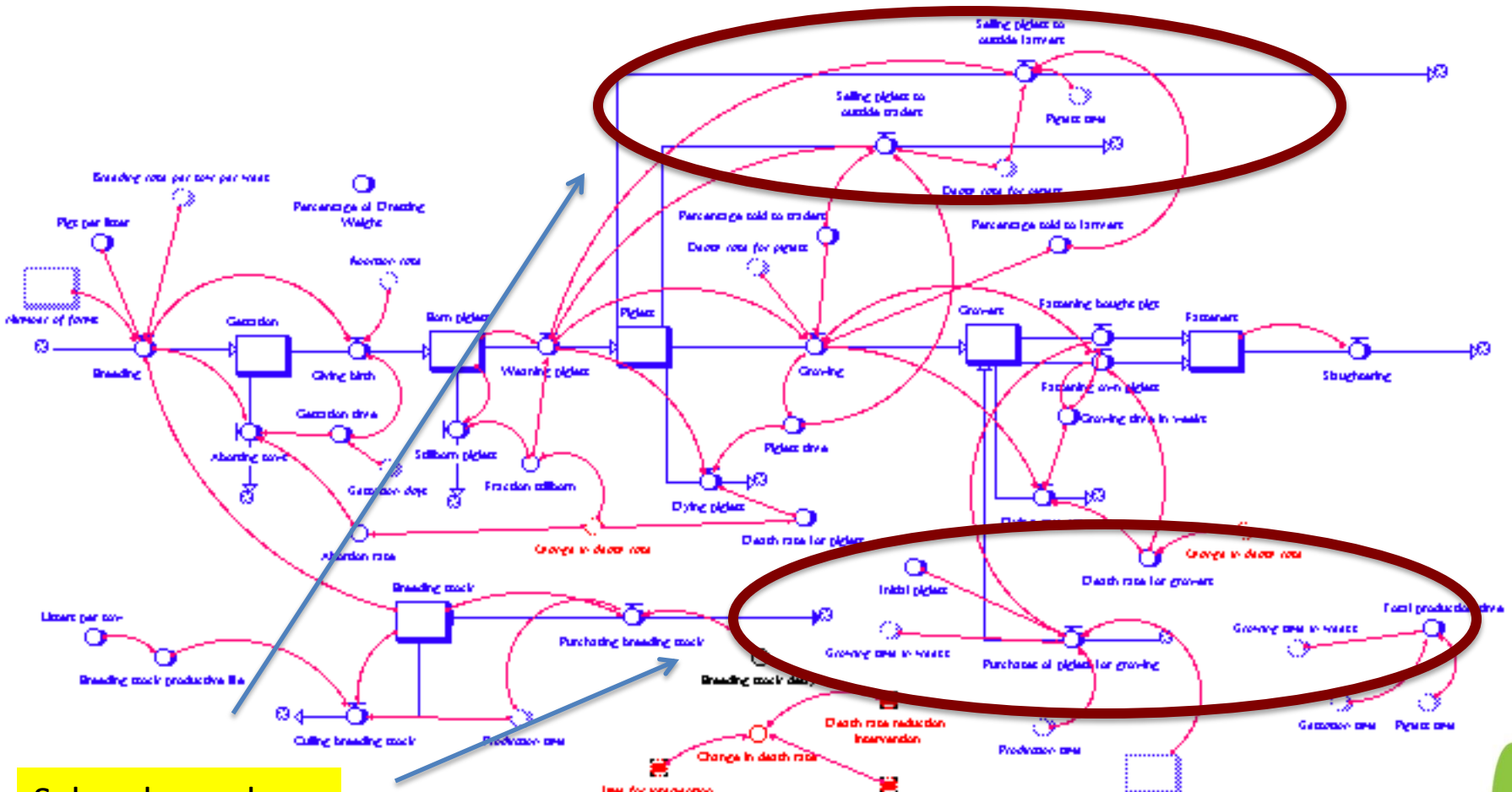
Production module



Sales channels for pigs

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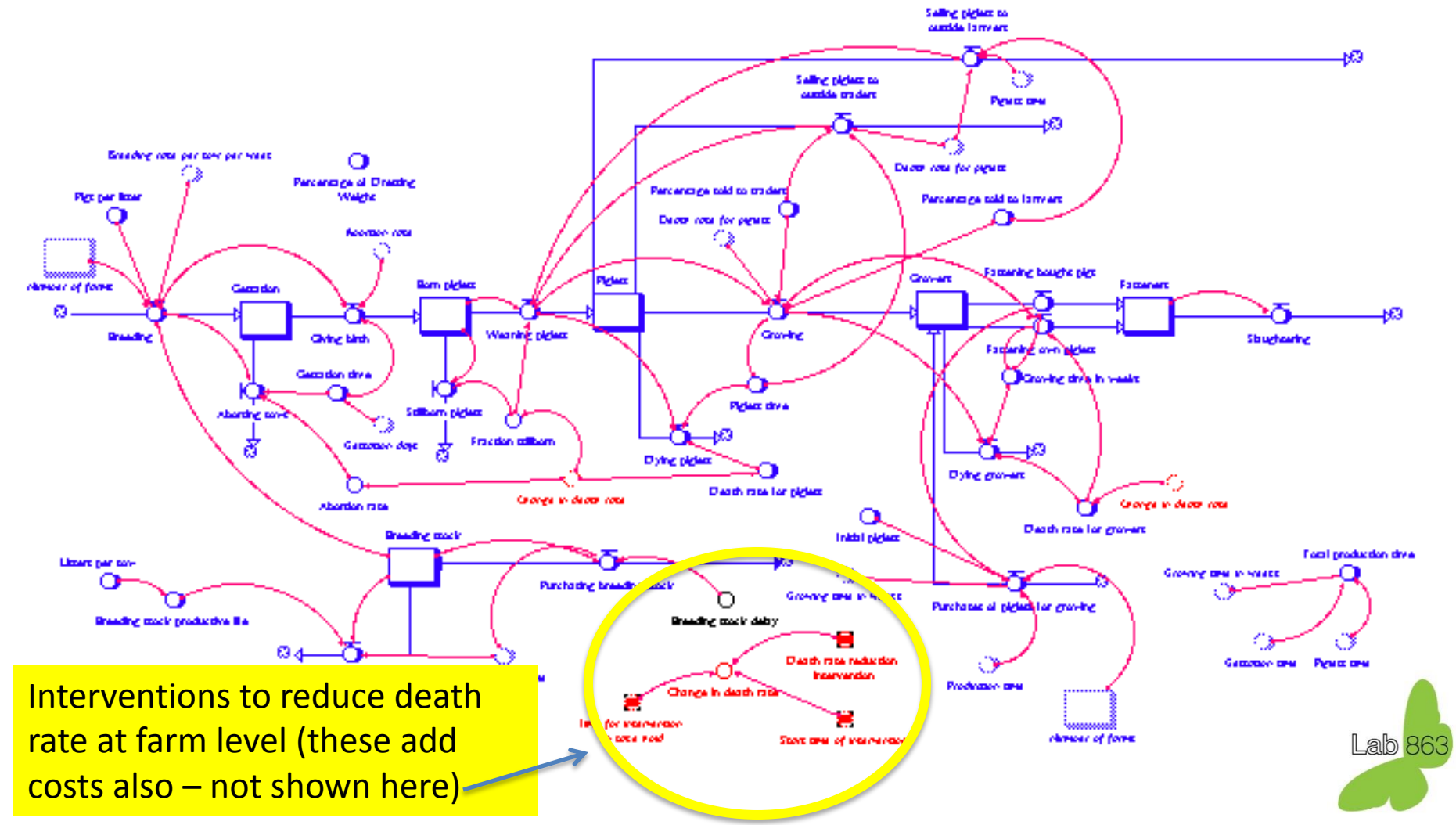
Production module



Interventions to reduce death rate at farm level (these add costs also – not shown here)

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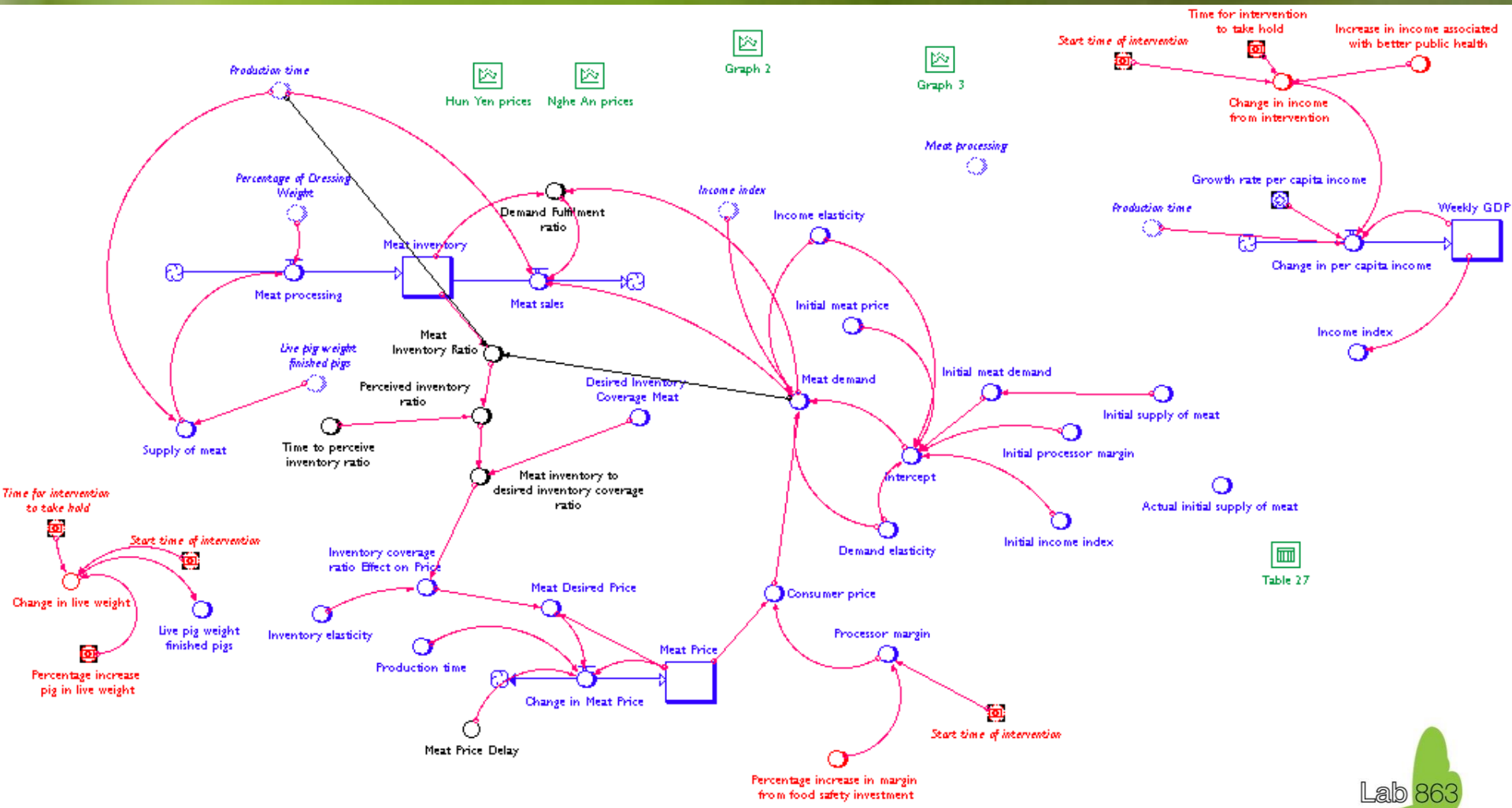
Demand



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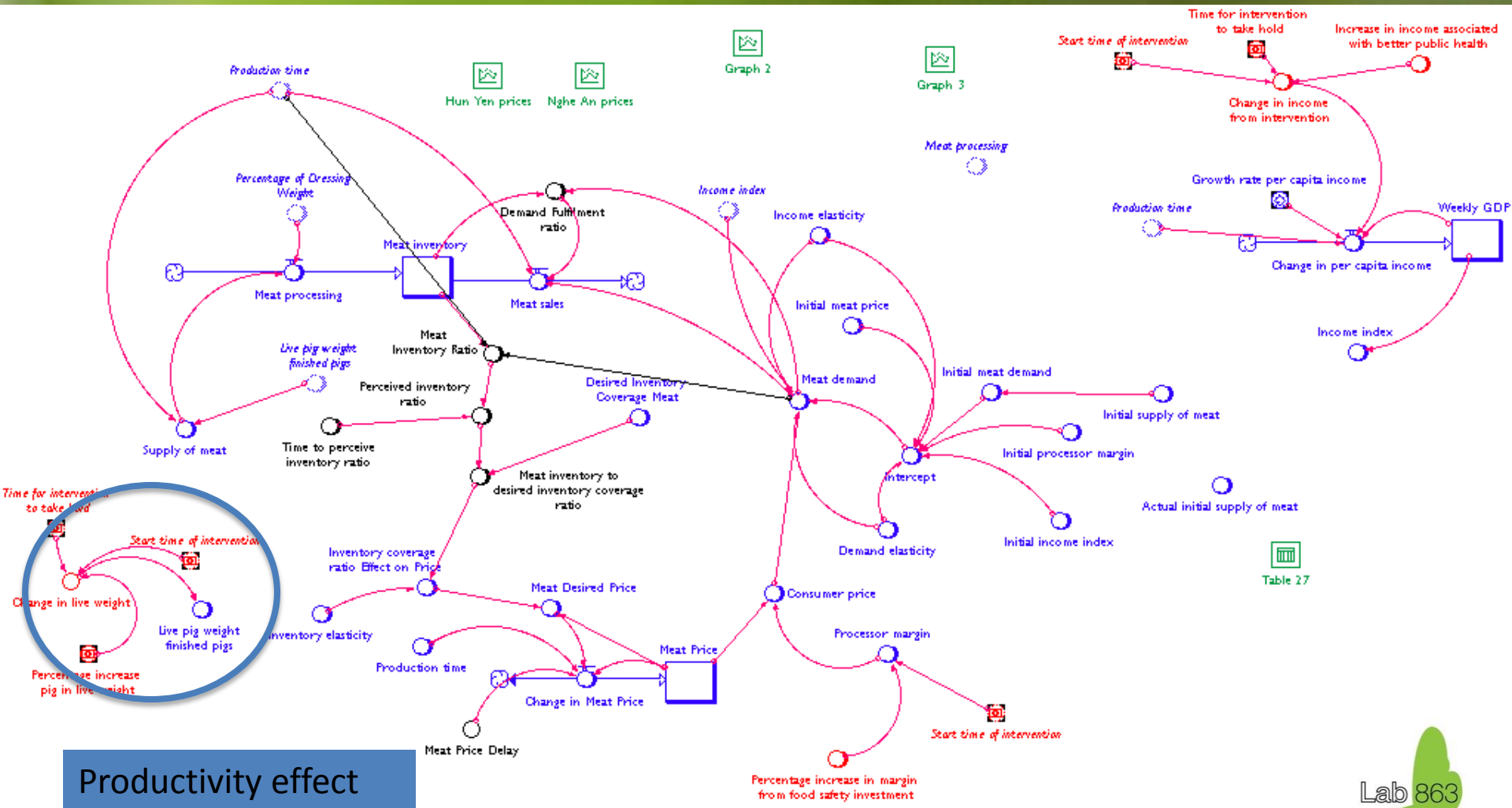

Productivity effect from healthier pigs

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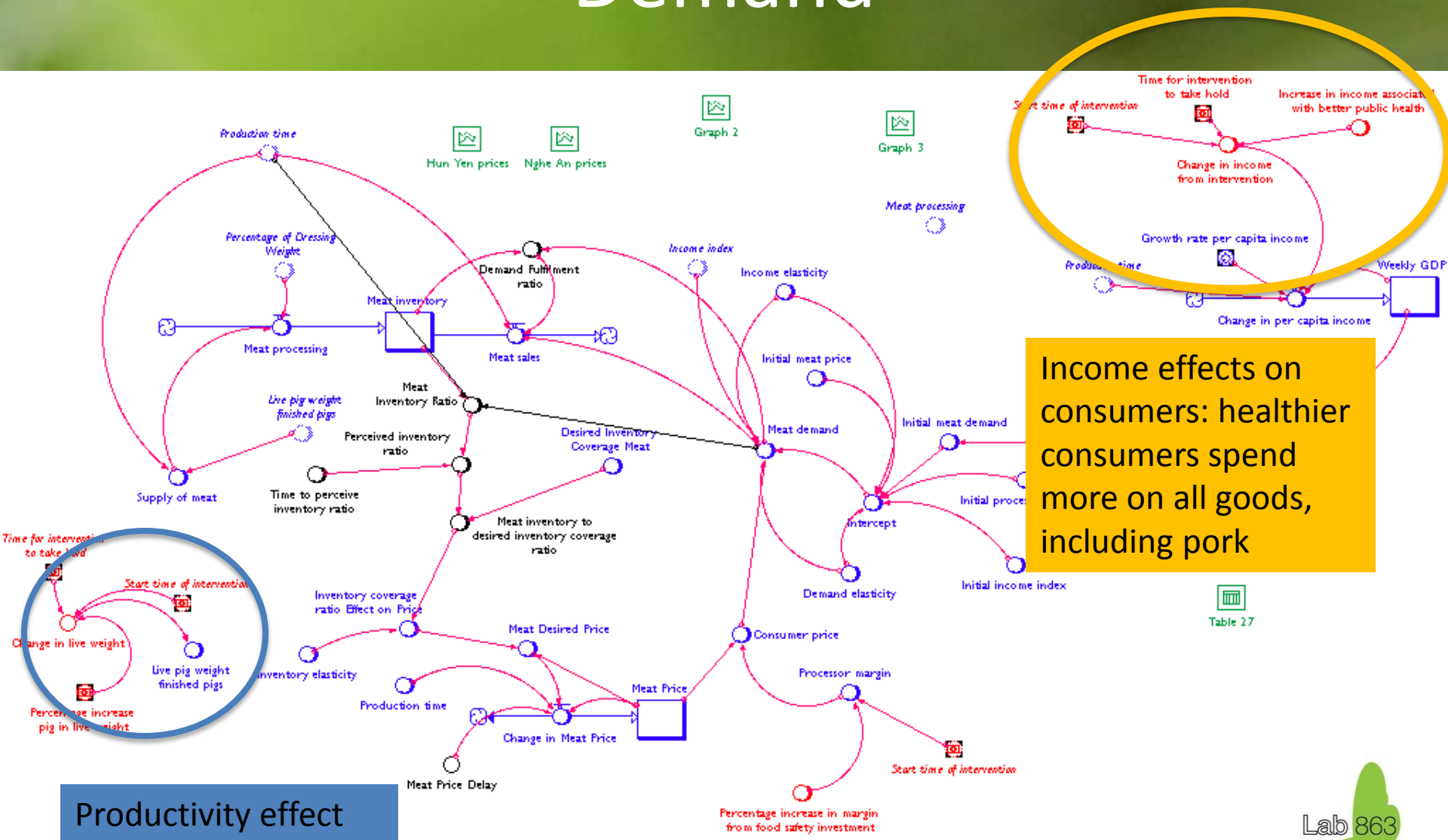
Demand



Income effects on consumers: healthier consumers spend more on all goods, including pork

Productivity effect from healthier pigs

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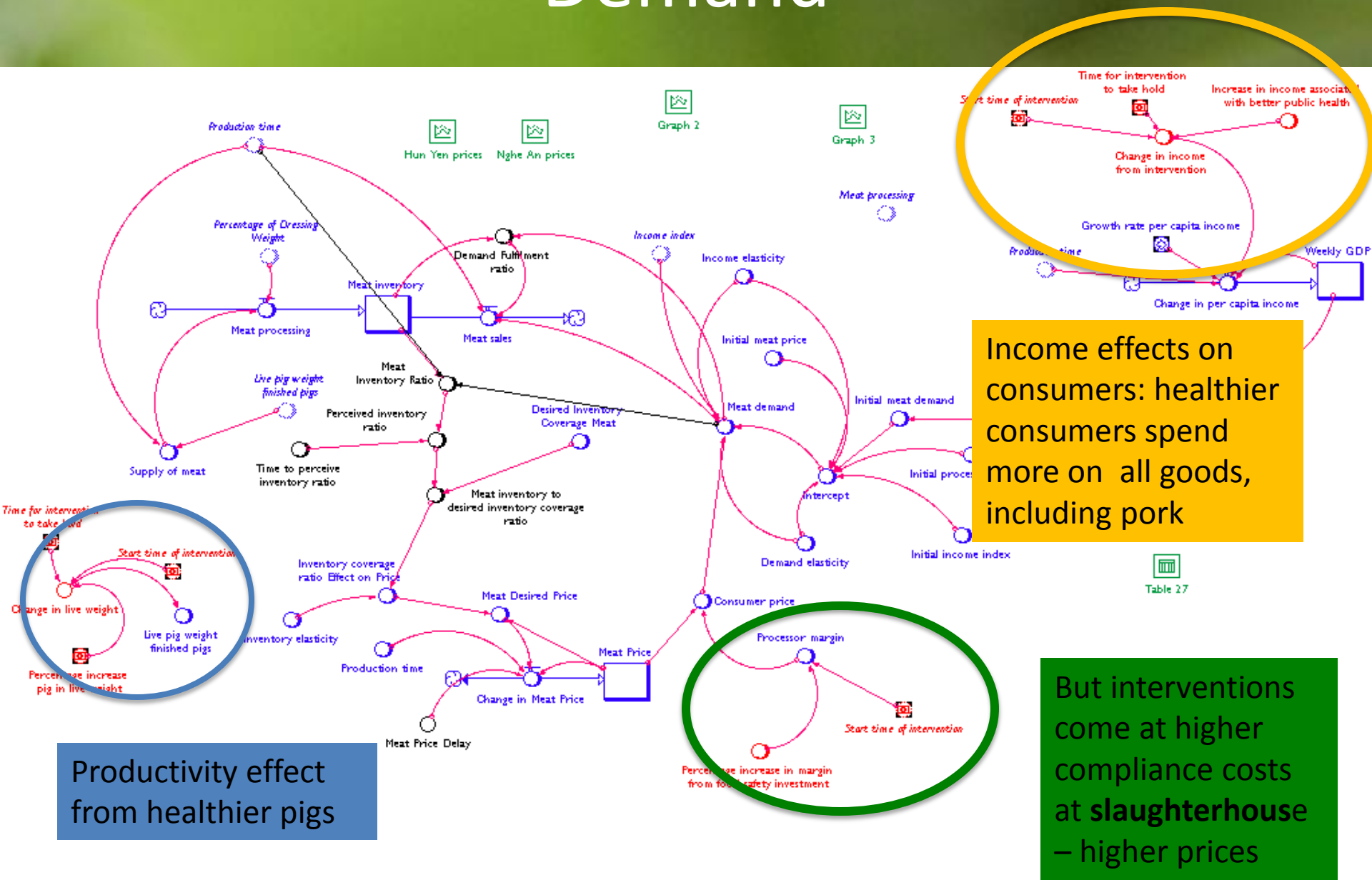
Demand



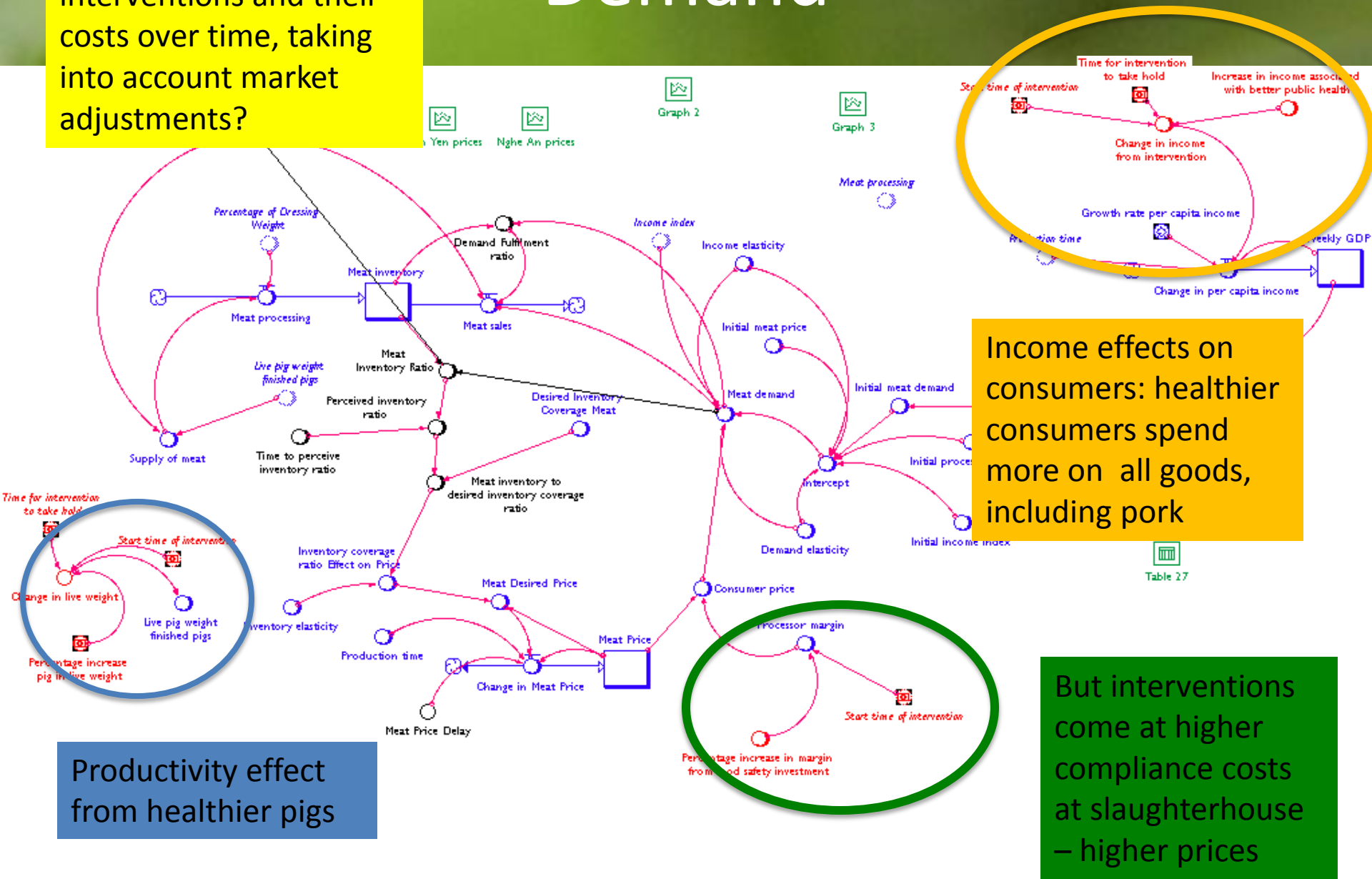
Income effects on consumers: healthier consumers spend more on all goods, including pork

Productivity effect from healthier pigs

But interventions come at higher compliance costs at **slaughterhous**e – higher prices

What are the *tradeoffs* between the benefits of interventions and their costs over time, taking into account market adjustments?

Demand



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Productivity effect from healthier pigs

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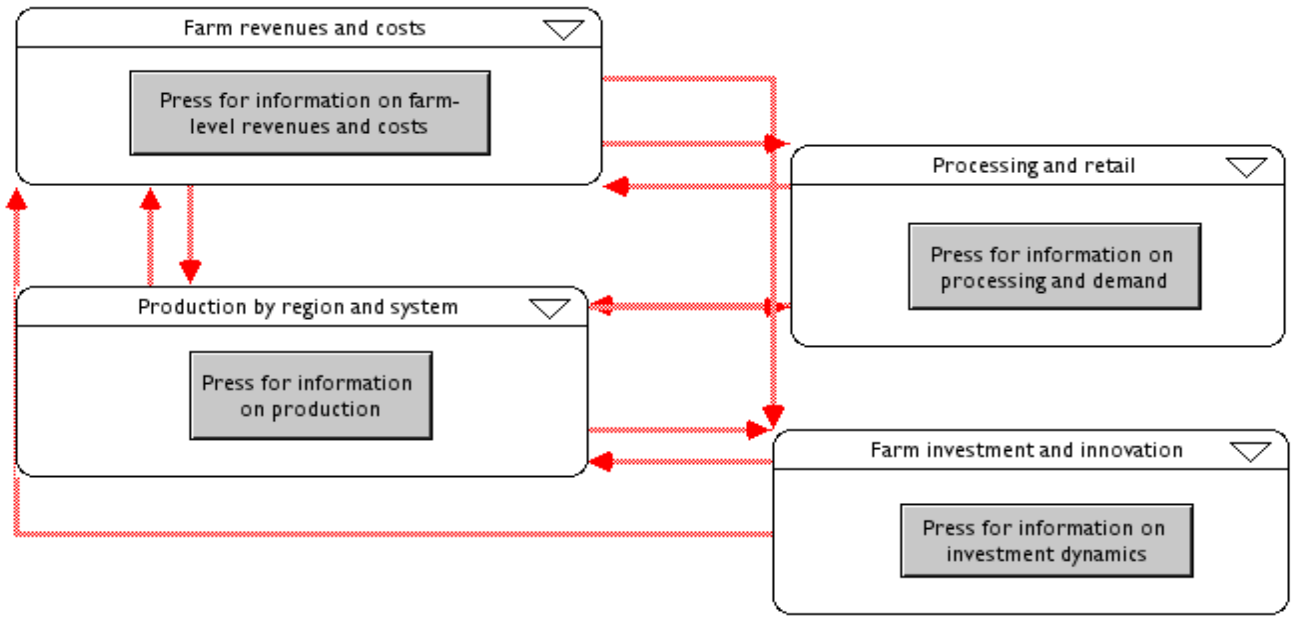
Model interface in iThink

A system dynamics model of pig value chains in Viet Nam - applications to food safety and animal health interventions

Version 2.0
13 August 2015

Overview: this is a model of the different pig value chains systems in Viet Nam (farrow-wean, grow-finish, and mixed). The model has been calibrated to value chain product flows in Hung Yen and Nghe An based on the 2014 survey conducted by the Hanoi University of Agriculture. The model can be applied to the assessment of different food safety and animal health interventions on the dynamics of the value chain. The model runs on a weekly basis for 20 years (1040 weeks).

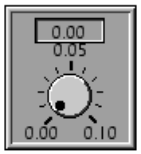
The structure of the value chain



Model interface in iThink: baseline

Policy scenarios

% increase in income



1. Animal health intervention

Death rate reduction

% increase in pig weight

Weeks for intervention

Additional weekly costs at farm level

2. Public health intervention (Hung Yen only)

% increase in slaughterhouse margin

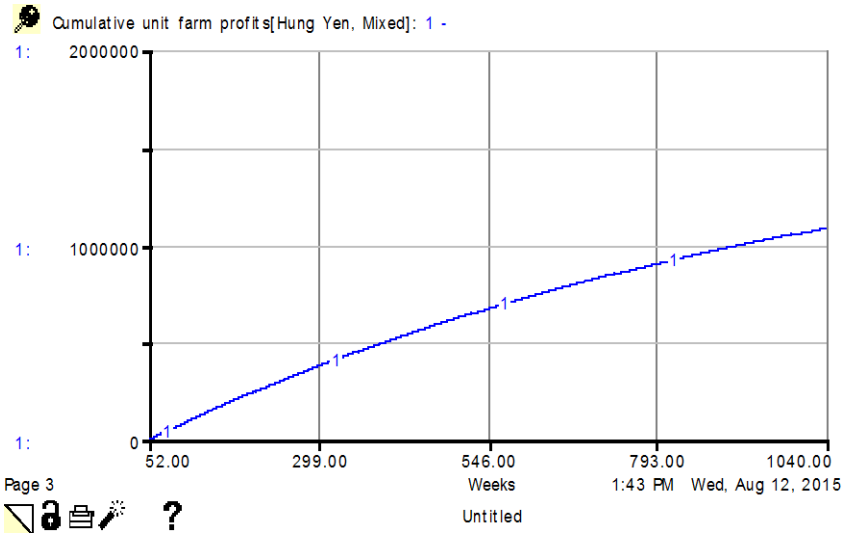
% increase in income from better health

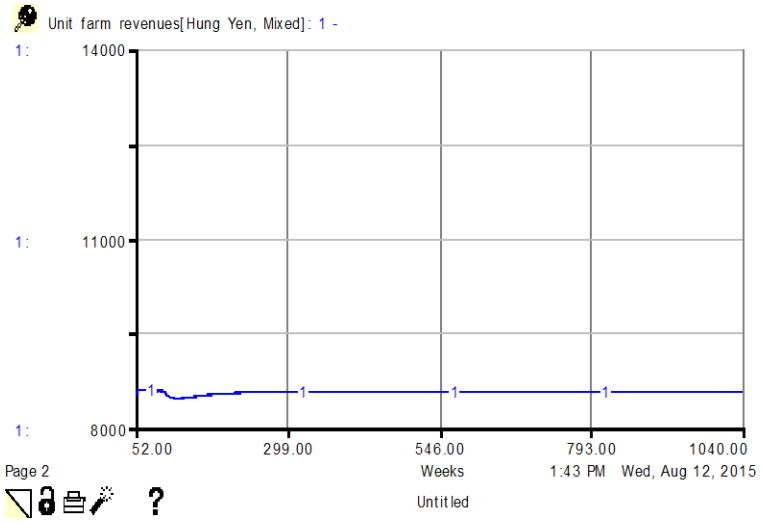
For illustration, we highlight two types of interventions:
(1) interventions in diseae control that both reduce mortality and increase liveweight;
(2) interventions in pathogen reduction that increase food safety and thus increase income

For simplicity, we allow these parameters to be adjusted by different percentages to reflect the expected change in benefits and costs

Simulation results

Zoom for more results

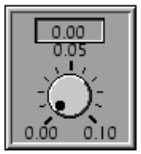




Model interface in iThink: sample scenario

Policy scenarios

% increase in income



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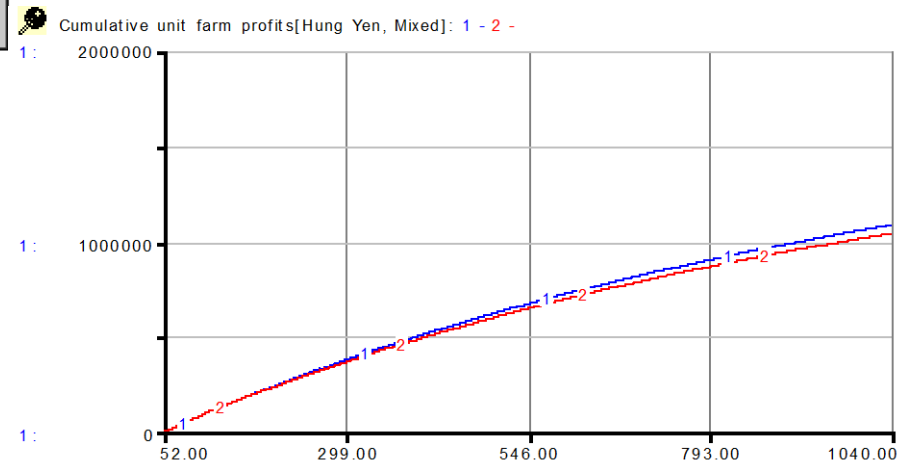

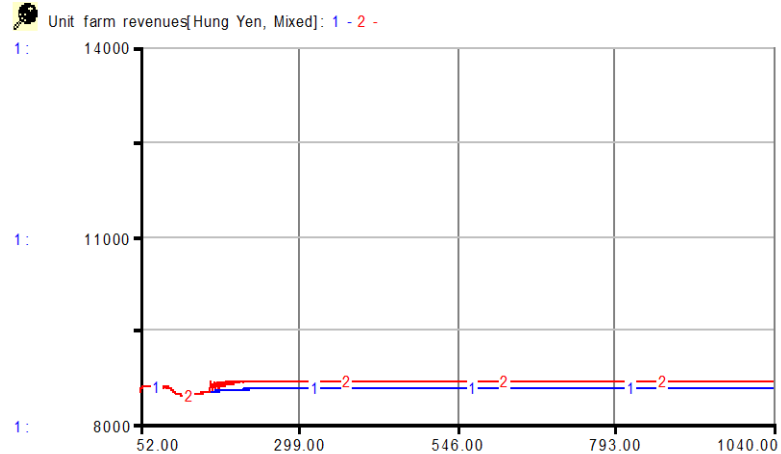

Where are we so far?

- Baseline model parameterized in iThink based on value chain survey
- Validation of data in process – a few data inconsistencies to be resolved

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What do we need?

- Definition of intervention options – critical need
- Costs: relatively straightforward
- Benefits: more difficult translating technical impacts into economic terms
  - Effects of disease reduction into production gains?
  - Effects of pathogen reduction into health gains?

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- HSPH

Thank you!