Economic implications of disease and pest losses – data, modelling and analytical approaches

John M. Antle

Professor of Applied Economics

Oregon State University

AgMIP co-PI and Regional Economics Leader

International Crop Loss Conference, INRA, Paris October 16-18 2017

AgMIP The Agricultural Model Intercomparison and Improvement Project

Oregon State University

Themes

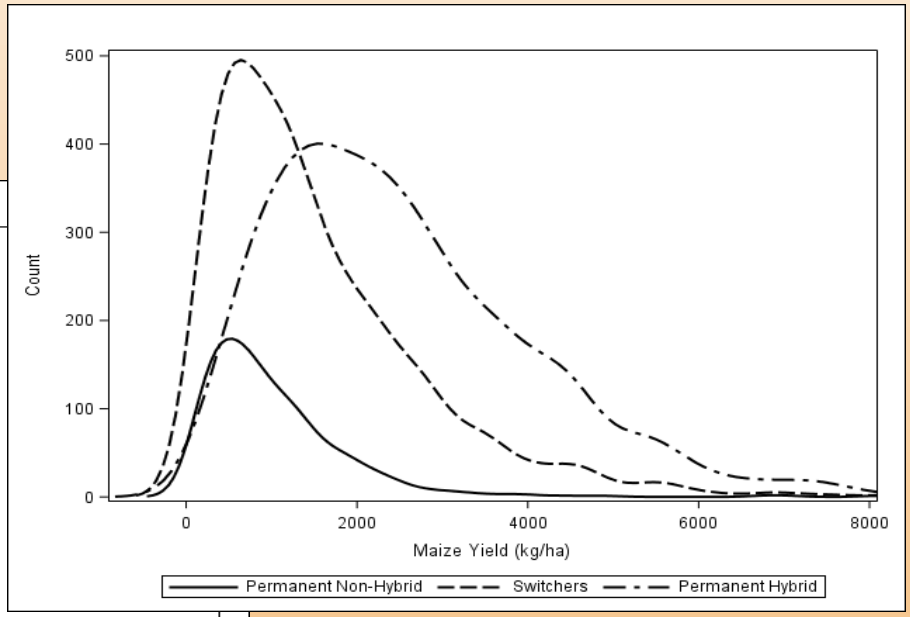
- DPL: An economic and policy perspective
- Some insights from the AgMIP Next Gen project
- Economic perspective on modeling issues
- Towards a new approach to private-public data

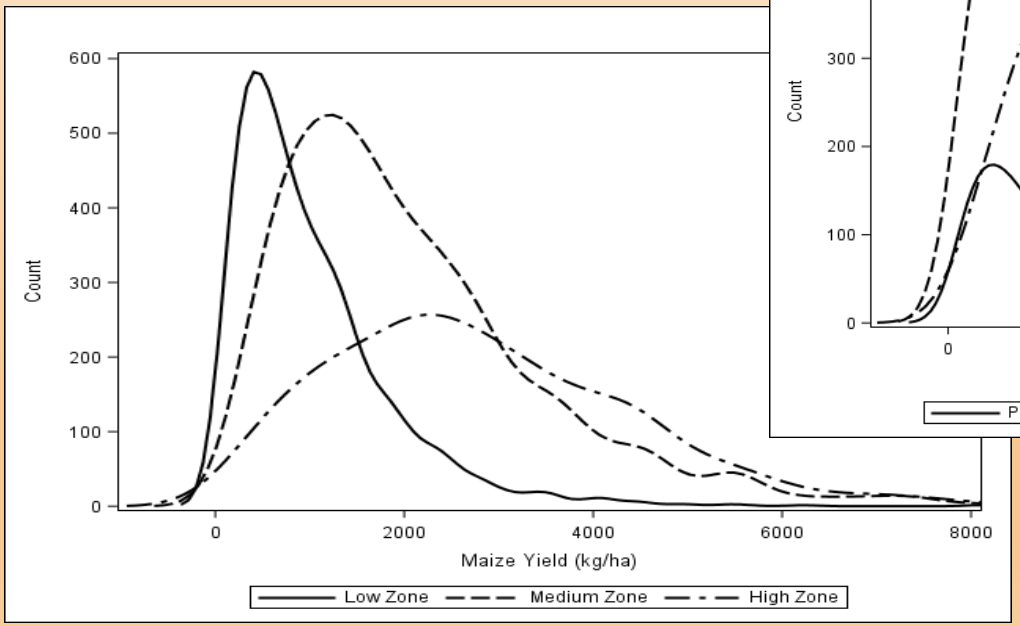
Issues and Challenges

- Crop loss and its management: a complex, challenging and unquestionably important problem
- What are objectives? Scientist vs stakeholder perspectives
  - Industrialized ag: food production & quality; consequences of high intensity of chemical use (disease & pest resistance to chemicals; farm worker health & safety; consumer health risk; environmental risk).
  - Developing ag: food production & quality (consequences of limited pest management); emerging: farm worker and family health and safety; environmental risk
  - Private sector role: ag R&D, chemical production, distribution, management advisory services
  - Public sector: farm worker safety, food safety, environmental regulation (local, regional and global externalities)
- We know there are huge gaps in science, data and models
- How to improve data, modeling capability, and provision of information to decision makers?

The problem (?): with available data, we can't say what role diseases and pests play in explaining the huge variation in Kenyan maize yields across low and high productivity agro-ecozones, or in adoption of technologies such as hybrid seed and fertilizer.

Econometric production models explain 30-50% of variation in data from a statistically representative sample of 1100 households over 5 years using observable covariates. Crop model simulations (DSSAT, APSIM) do worse. Covariates do not include any pest occurrence or pest management information.





Source: Tegmeo Inst Rural Household Surveys, 1997-2010

The problem: with available data, we can't say what role diseases and pests play in explaining the huge variation in Kenyan maize yields across low and high productivity agro-ecozones.

Econometric production models explain 30-50% of variation in data from a statistically representative sample of 1100 households over 5 years using observable covariates. Crop model simulations (DSSAT, APSIM) do worse. Covariates do not include any pest occurrence or pest management information.

Rural Household Survey July-June 2007
CROP INPUTS
Q3k. What **CROP INPUTS** did you purchase/hire on **CREDIT OR IN CASH in 2006/07 cropping year**? **(Exclu**
Filename: input07.sav *Key Variables: hhid inputype mcrop numpur punit inputpr*

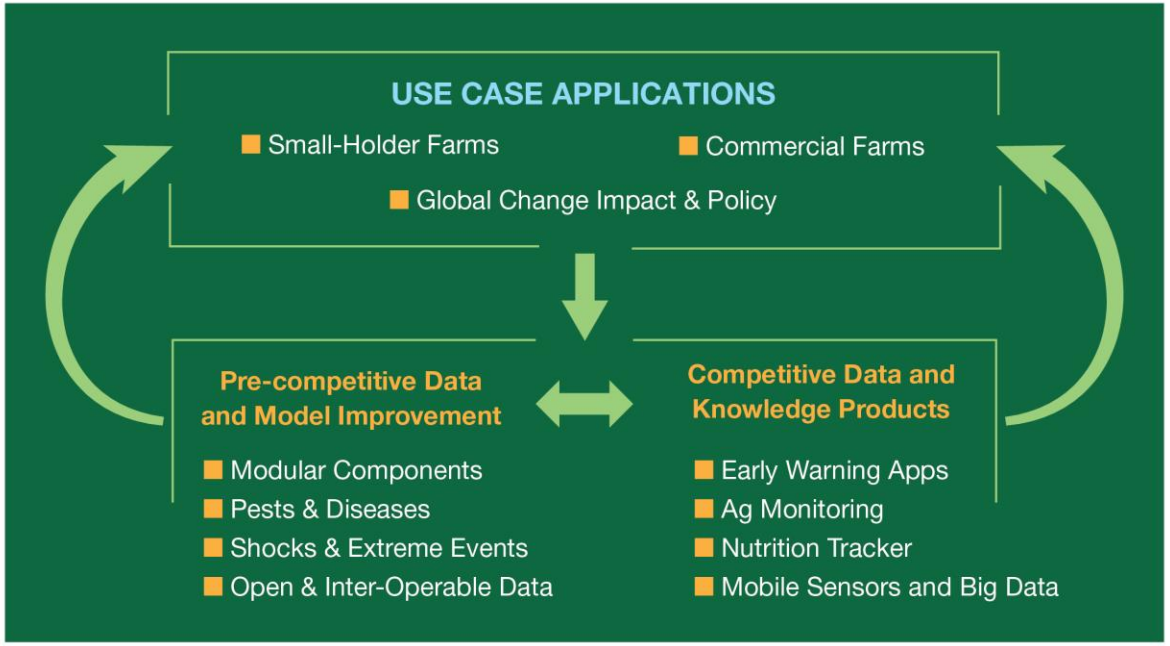
Input codes:
1=DAP
2=MAP
3=TSP
4=SSP
5=NPK (20:20:0)
6=NPK (17:17:0)
7=NPK (25:5:+5S)
8=CAN (26:0:0)
9=ASN (26:0:0)
10=UREA (46:0:0)
11=SA (21:0:0)
13=Manure
14=Foliar feeds
15=NPK (23:23:23)
16=NPK (20:10:10)
17=DAP + CAN
19=Magmax Lime
20=DSP
21=NPK (23:23:0)
22=NPK (17:17:17)
23=NPK (18:14:12)
24=NPK (15:15:15)
58=NPK(25:5:0)
25=Mavuno-basal
26=Kero green
27=Rock-phosphate
28=NPK 14:14:20
29=Mijingu 1100
30=UREA+CAN
31=Mavuno-top dress
43=NPK (22:6:12)
32=pesticide
33=insecticide
34=herbicide
35=plough
36=sprayer
37= AT equip
39=technical support
40=fungicide
41=water
46=planter cost
47=harvester cost
48=transport
49=sheller cost
50=fuel
51=gunny bags
52=ridger cost
53=land rent
54=land preparation cost(on credit only)
55=farm implements
56=farm machinery
57=irrigation equipment
59=NPK:22:6:12+TE
60=NPK:26:5:5
61=NPK:22:11:11
62=Baler

Input type (Select codes from column on the left)	Main Crop for which input was used	Quantity bought /hired	**Unit** 1=90 kg bag 2=kg 3=litre 7=25 kg bag 8=10 kg bag 9=gorogoro 10=tonnes 11=50 kg bag 13=gram 14=w/barrow 15=cart 17=numbers 21=days 20=5 kg bag 30=acres	**Price per unit** specified	**Mode of Purchase** 1=own cash 2=borrowed cash 3=in kind credit 4=own and borrowed cash	**Source of Fertilizer and other inputs** **Source type codes::** 1=small trader/ 2=stockist 3=large company 4=CBO 5=KFA 6=coffee coop 7=farmer / neighbour 8=KTDA 9=Other coop 11=Farmer group 12=Relative or friend 14=Research/learning institution 15=Fuel station
inputype	**mcrop**	**numpur**	**punit**	**inputpr**	**mdpurch**	**inpsorce**

Source: Tegmeo Inst Rural Household Surveys, 1997-2010

Some Insights from AgMIP's Next Gen Project

- Use cases: insights from scientists and stakeholders
  - The need for a stakeholder-driven "computational ag science"
    - To accelerate and generalize traditional experimentation
    - To anticipate emergent challenges, e.g., climate change, pests & diseases
  - But…many needed model improvements
  - Better data may be the greatest challenge



Antle, Jones & Rosenzweig

Ag Systems 2017

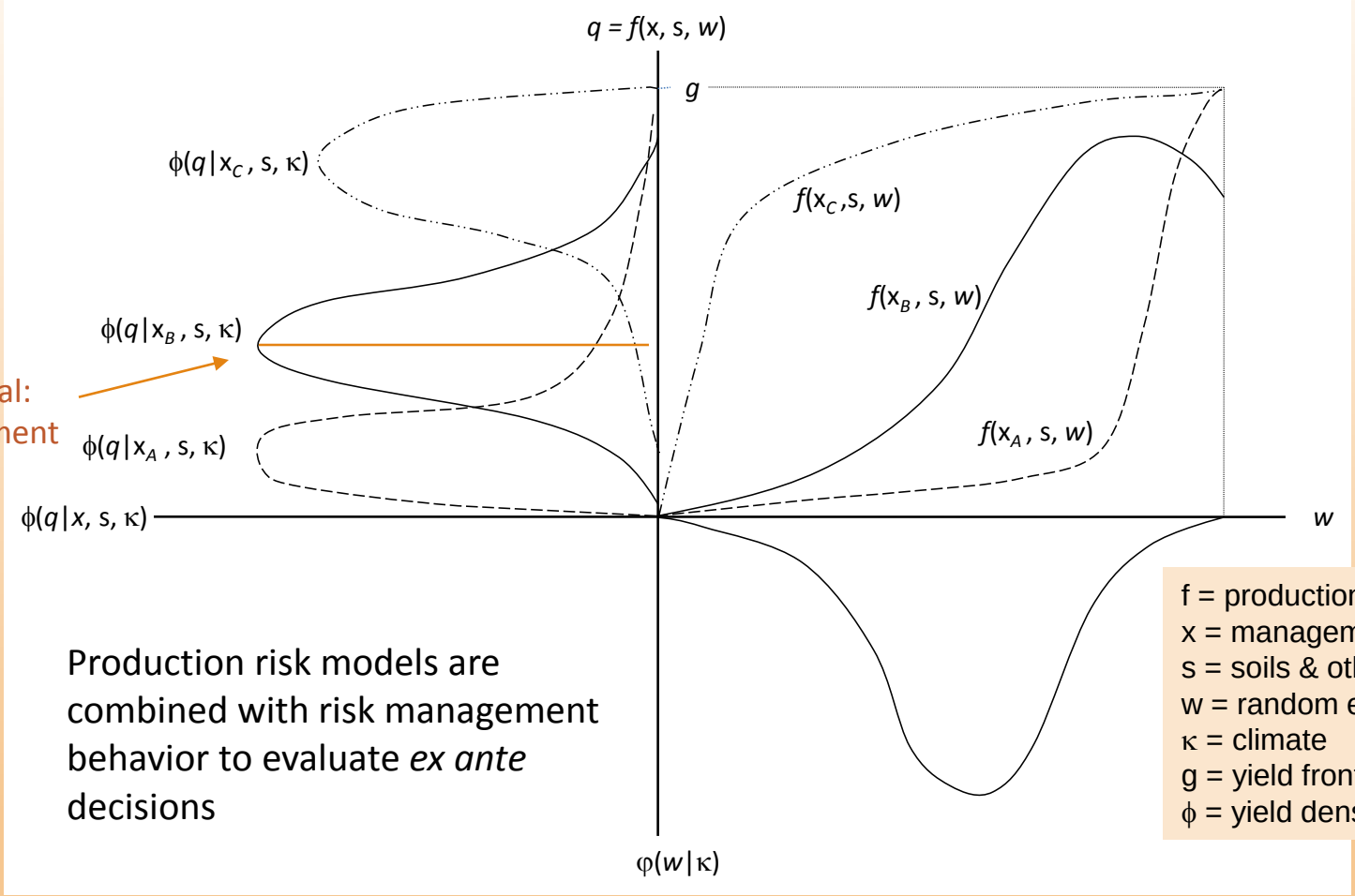
Economic Modeling Challenges

- Challenges within and across scales: in principle can use models for "simulation experiments" to assess DPL:
  - Farm/household/impact assessment/technology adoption
  - Regional land use/market/food system
  - Global market/food system/IAM

- Model improvement hampered by:
  - Diversity of model types, purposes, data requirements (how to inter-compare?)
  - Lack of documentation & transparency
  - Lack of public investment!

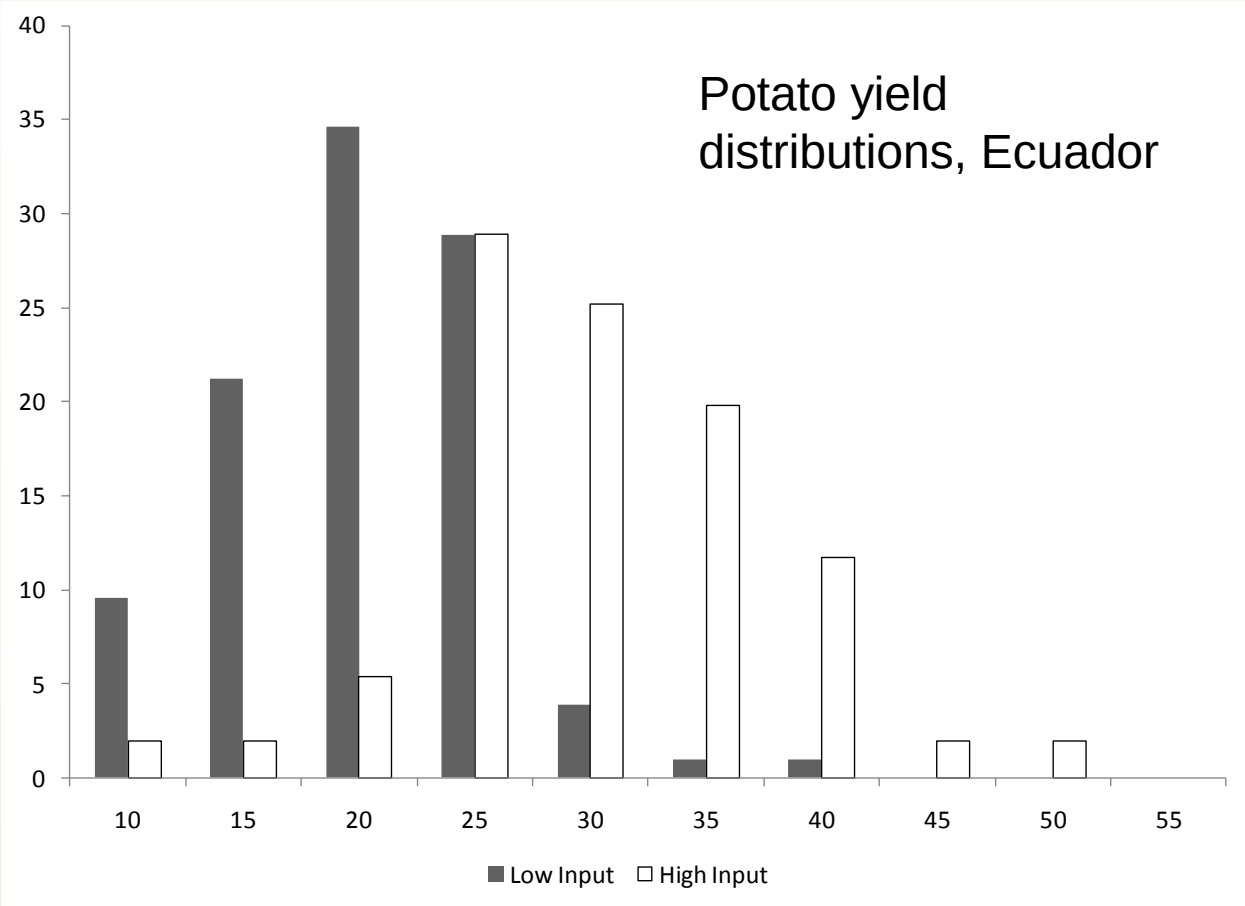
- Critical role of risk management in farm decision making
  - Damage function models
  - Econometric production risk models
  - Behavioral dimensions: managing downside loss, upside gains
  - How to use crop models to characterize production risk, link to economic decision models?

Econometric Approach to Production Risk Modeling & Decisions



Source: Antle, "Asymmetry, Partial Moments and Production Risk." *Am J Ag Econ* 2010.

Farmer use chemicals to manage production risk



Source: Antle, "Asymmetry, Partial Moments and Production Risk." *Am J Ag Econ* 2010.

Economic Modeling Challenges (cont.)

- Spatial heterogeneity and dynamics
  - Bio-physical (soils, climate)
  - Economic (farm size, location, …)
  - Production system dynamics critical to disease & pest management
  - Difficult to model together!

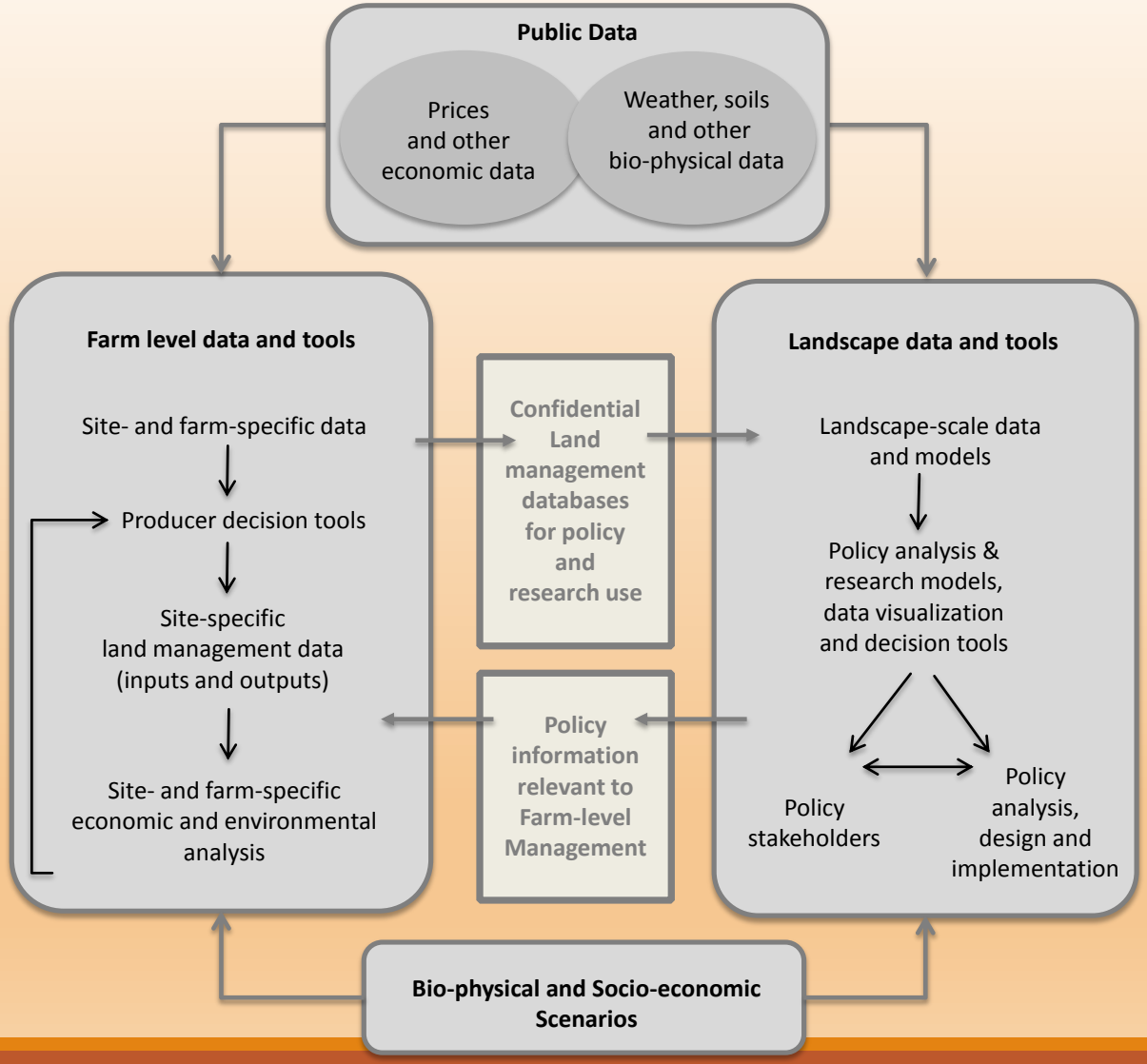
Data Challenges

- Conventional approaches and limitations
  - Experimental
  - Farmer-collected/reported
  - Farm surveys - research
  - Farm surveys – government

- Most data lack key information
  - Disease and pest occurrence
  - Type, quantity and timing of chemical use
  - Prices paid (price is not equal to cost!)
  - Information based on inaccurate records or recall
  - Multiple observations over time, space (panel data)

- Need for an essential/minium data ontology

Towards a private-public data system for farm management, research and policy decision making…



Capalbo, Antle and Seavert, *Ag Systems* 2017