ETH zürich

# Determinants of pesticide use in Swiss crop production

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# Overview

1) Introduction
2) Methods & Data
3) Results & Conclusion

# Introduction

# Background

- On the top of European agricultural policy agenda: NAP‘s

- Non welfare maximizing pesticide use:
  - due to external effects (on human health and the environment)

- Non profit maximizing pesticide use:
  - maximize physical output instead of yield (Pedersen et al. (2012))
  - Economic risk (Horrowitz and Lichtenberg,1994)
  - Individual farm effect explains big share of observed variability (Bürger et al. (2012))

→Which are the determinants of this variability between farms?

# Motivation: literature review determinants of pesticide use

- **Socio-economic determinants:** age, education, farm size, wealth

  (Dasgupta et al. (2001), Rahman (2003), Galt (2008))
- **Agronomic determinants:** crop management, climate, soil

  (Bürger et al. (2012), Andert et al., 2015)
- **Limitations:** cross-sections, single pesticide indicator, no crop differentiation

Improve understanding by:

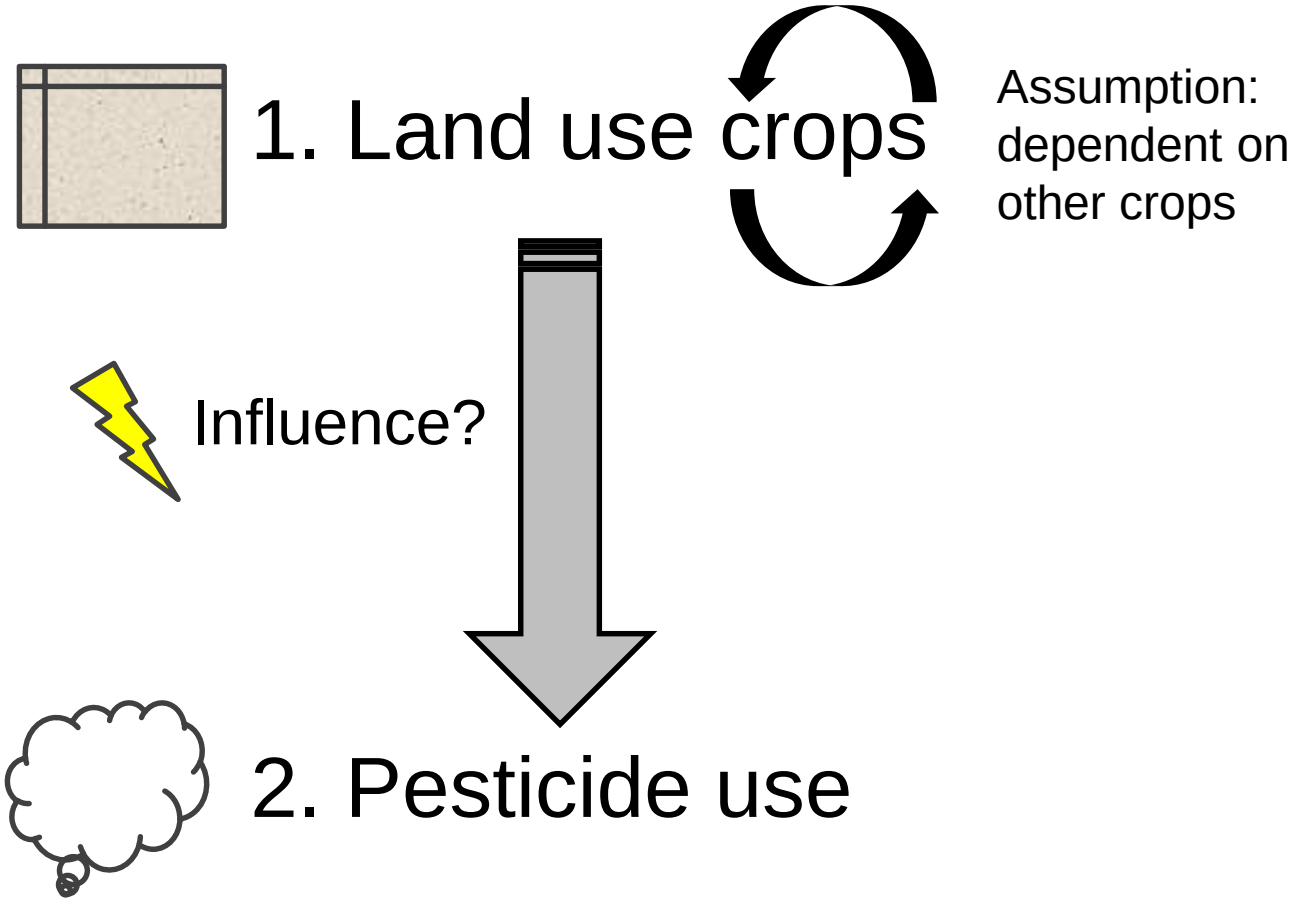
- Integrating agronomic and socio-economic perspective
- Crop choice: different determinants per crop
- Indicator choice: amounts, concentration, toxicity, type of product
- Use of highly detailed and high frequency panel data

# Research Questions

- Which are socio-economic/agronomic determinants of Swiss pesticide use?
- Do determinants differ with respect to crops and/or indicators of pesticide use?

# Methods & Data

# Proposed decision making process



# Overview data / Choice of variables I

ZA-AUI/BH Data 2009-2013

- Detailed field journal (real observations!) + Bookkeeping data
- Considered crops here: Winter wheat (Extenso), Maize, Potatoes
- Aggregation level: crop per farm
- Balanced panel: 108 farmers, representative for Swiss crop farmi

**Load Index**:

$$\sum_{Anwendungen\ Schlag} \frac{Load * SprA\ kg}{Standard\ Dosis}$$

*(Median Landwirt und Kultur)*

**Zusammensetzung Load**:
Load = Health Load + Fate Load + Tox Load

| Dependent variables | Indication | Cal |
|---|---|---|
| Active ingredient /ha | Amount (in kg/l) used | |
| Load Index /ha | Potential environmental and health risk and intensity used | |
| Average dosage used | Intensity of pesticide use | $Mean\ (\frac{AI\ per\ ha}{Standard\ dosage})$ |

SprA: «Sprayed Amount» denotes the amount of one product used in a single operation.

# Overview data / Choice of variables II

Explanatory variables (determinants)
and their expected relation to pesticide indicators

| | | |
|---|---|---|
| Farm characteristics | • Zone* (valley to mountaneous) | [+ -] |
| | • Altitude* | [+] |
| | • Work force | [+ -] |
| | • Farm type: share animals | [+] |
| | • Farm type: share off-farm work | [+] |
| Farmers characteristics | • Age | [+] |
| | • Education | [-] |
| Others | • Pesticide Price Indicator | [-] |

+/- denote expected pos./neg. relation
*cannot be determined simultaneosuly

# Methodology

1. Test: influence of land use on pesticide use decision
   - two simple indicators for selection bias (Verbeek and Nijman, 1992) as well as adjusted Hausman test
   - reject influence land use → pesticide use (example age…)
   - except for intensive winterwheat (ambiguous result: requires different methodology)

2. Regress $Pesticide\ use_{crop,i,t} \sim Determinants_{i,t}$
   - Aggregation level: farm and crop
   - Random effects panel estimator: exploit heterogeneity over time and between individuals
   - FGLS estimator: account for heteroscedasticity and clustering in data

# Results & Conclusion

# Results Winter wheat (extensive)

| | AI/ha | Load Index | Dosage |
|---|---|---|---|
| Zone | | ++ | |
| Altitude | ++ | ++ | |
| Work force | | | |
| Share animals | | | |
| Share off-farm work | ++ | | |
| Age | | | |
| Education | - | - | |
| PP Indicator | | | - - |

+/- indicate pos./neg. relations
+/++/+++ indicate significance at levels of 10% / 5% / 1%

- Clear influence of geographical location (weather?)
- Share off-farm work has a strong influence on AI used
- Eucation and Pesticide Price seem to influence intensity of use

# Results Potatoes

| | AI/ha | Load Index | Dosage |
|---|---|---|---|
| Zone | - - | | |
| Altitude | | | |
| Work force | | | |
| Share animals | | | +++ |
| Share off-farm work | | | |
| Age | | | |
| Education | | | |
| PP Indicator | | | |

+/- indicate pos./neg. relations
+/++/+++ indicate significance at levels of 10% / 5% / 1%

- Few determinants: small sample or standardized treatment?
- Farmers specialized on crop farming seem to dose lower

# Results Maize

| | AI/ha | Load Index | Dosage |
|---|---|---|---|
| Zone | +++ | | |
| Altitude | | - | |
| Work force | | | |
| Share animals | | + | |
| Share off-farm work | ++ | | +++ |
| Age | | | |
| Education | | - - - | - - - |
| PP Indicator | | | |

- Ambigious influence of location: difference weather and farming methods?
- Clear effect of specialization on crop farming
- Clear effect of education

**Different crops → different determinants**

+/- indicate pos./neg. relations
+/++/+++ indicate significance at levels of 10% / 5% / 1%

# Summary results by indicator

| | AI/ha | Load Index | Dosage |
|---|---|---|---|
| Zone | + - | | |
| Altitude | + | + | |
| Work force | | | |
| Share animals | | + | + |
| Share off-farm work | + | + | + |
| Age | | | |
| Education | - | - | - |
| PP Indicator | | | - |

+/- indicate pos./neg. relations

**Different Indicators → different determinants**

- Direction of relations are as expected
- Education key determinant of pesticide use
- Dosage and potential risk influenced by specialization on crops and diversification (off-farm)

# Conclusion/Outlook

- Determinants differ for crops / Indicators of pesticide use
- Pesticide policies should account for this heterogeneity: crop specific education programs, tailored taxes, geographically explicit subsidies
- Identified determinants for pesticide use in Swiss crops: Zone, Altitude, Education, Diversification (off-farm), Farm type, (Pesticide prices)

- A further detailed analysis (on plot level) is needed
  - Integration of agronomic variables, economic risk, weather and selection bias in further research
  - Extending considered cultures to fruits: highly relevant

# Thank you for your attention!

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http://agrarpolitik-blog.com

# Literature


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