Innovations in agricultural insurance solutions

Robert Finger, Tobias Dalhaus, Willemijn Vroege, Janic Bucheli

Agricultural Economics and Policy Group, ETH Zurich
Risk exposure in agriculture

- Production risks relevant for crop and livestock production (e.g. Lehmann et al., 2013, Finger et al. 2018)

- Increase of risk exposure (extreme events) due to climate change (Trnka et al. 2014)

- Risk management of key interest for farmers and other stakeholders

- Policy interest: sustainable strategies to make agricultural sector more resilient


Agricultural risk management options

On Farm Instruments

Risk Prevention/Reduction

Diversification

Holding Reserves

Risk Management Instruments

Risk Pooling (Insurance)

Risk Transfer via Contracting

Agricultural risk management options

On Farm Instruments
- Risk Prevention/Reduction
- Diversification
- Holding Reserves

Risk Management Instruments
- Risk Pooling (Insurance)

Market Based Instruments
- Risk Transfer via Contracting

- Individual portfolio chosen at farm (e.g. de Mey et al. 2016, Meraner & Finger 2018)
- Risk sharing (e.g. insurances) allows to exploit profitable on-farm activities

Agricultural insurance

- Insurance premia globally >>30 billion USD/a
- Increasing trend (policy support, heavy subsidization, increasing risk exposure)
- Indemnity insurance dominant, with highly diverse solutions

Growth of world agricultural insurance premium volume


SHARE OF AGRICULTURAL INSURANCE PREMIUM (2011)

Source: Adapted from Swiss Re, 2013.


Indemnity insurances

- Individual perils (e.g. hail)
- Multiple perils
- Entire yield
- Revenue insurance
- Profit margin insurances
- Whole farm insurance // income insurance*

*e.g. Canadian Agricultural Income Stabilization or Income Stabilization Tool in European CAP:

US insurance market: revenue insurance (yellow) replaces yield insurances (APH) (blue)
Indemnity insurances

- Broad acceptance across farmers, in particular if subsidized
- Insurability of risks (idiosyncratic vs. systemic)
- Insured crops
- Information asymmetry: moral hazard & adverse selection

- Only some risks and farms covered
- Limited coverage especially for systemic risks
- Innovations to complement indemnity insurance
New insurance opportunities

**Indemnity insurance**
- Indemnity insurance with physical inspection

**Weather index insurance**
- Weather index insurance based on weather station data or grid data
New insurance opportunities

- **Indemnity insurance**: Indemnity insurance with physical inspection

- **Weather index insurance**: Weather index insurance based on weather station data or grid data

- **Area-yield insurance**: Area-yield insurances based on (physical) regional yield levels
New insurance opportunities

- **Indemnity insurance**
  - Indemnity insurance with physical inspection

- **Satellite imagery**

- **Weather index insurance**
  - Weather index insurance based on weather station data or grid data

- **Area-yield insurance**
  - Area-yield insurances based on (physical) regional yield levels
Structure

- Index insurance solutions (example weather index insurance)
- Opportunities and limitations
- Improving index insurance solutions
- Exemplary applications in Europe
- Satellite imagery for agricultural insurances
- Discussion & Conclusion
Weather Index Insurance (WII)

Market Revenues (Yield x Price)
Weather Index Insurance (WII)

Revenues

Market Revenues (Yield x Price)

Rainfall
Weather Index Insurance (WII)

Market Revenues (Yield x Price)
Weather Index Insurance (WII)

- WII payout if rainfall (index) falls below threshold
- WII payout increase if level of rainfall decreases
- Objective measurement of index
  - before critical growing season, index, weather station of index measurement and index accumulation period have to be defined
Weather Index Insurance (WII)

Market Revenues (Yield x Price)

Insurance Payout

Rainfall (Index)
Weather Index Insurance (WII)

- **Rainfall (Index)**
- **Revenues**
- **Insurance Payout**
- **Insurance Premium**
- **Total Revenues – Insurance Premium**
- **Market Revenues (Yield x Price)**

---

**Revenues**

- **Total Revenues – Insurance Premium**
- **Market Revenues (Yield x Price)**
- **Insurance Payout**
- **Rainfall (Index)**
Weather Index Insurance (WII)

Advantages
- Low costs, no information asymmetry, abundant data
- Immediate payouts
- Wide spectrum of activities/crops
- Flexibility: covers yield losses and additional costs

Disadvantages
- Complexity/novelty
- Basis risk: insurance payout and realized losses not necessarily coincide

- WII can make worst possible outcome even worse
- Very risk averse farmers do not buy WII (e.g. Clarke 2016)
- Low uptake of WII

Basis Risk

To be defined before growing season:
- Index variables
- Weather station of index measurement
- Index accumulation period
Basis Risk

To be defined before growing season:
- Index variables
- Weather station of index measurement
- Index accumulation period

Index is a poor predictor for losses
Basis Risk

To be defined before growing season:
- Index variables
- Weather station of index measurement
- Index accumulation period

Index is a poor predictor for losses

Too large distance between field and weather station
Basis Risk

To be defined before growing season:
- Index variables
- Weather station of index measurement
- Index accumulation period

Basis Risk

Design
- Index is a poor predictor for losses

Spatial
- Too large distance between field and weather station

Temporal
- Critical growth phase not met by index
Basis Risk

To be defined before growing season:
- Index variables
- Weather station of index measurement
- Index accumulation period

- Index is a poor predictor for losses
- Too large distance between field and weather station
- Critical growth phase not met by index

- Reducing basis risk is key to exploit opportunities of WII
- Contributions to reduce basis risk
Contributions to reduce basis risk

- Better indices (e.g. evapotranspiration, soil moisture, heat stress etc.), wider applications (e.g. Finger et al. 2018), accounting for quality related losses
- Improved statistical analysis and treatment of yield and weather data
- For example: quantile regression to quantify payout structure (yield-weather relationships) results in better coverage of extreme losses (downside risks) (e.g. Conradt et al. 2015)


Contributions to reduce basis risk

Basis Risk

- Officially provided gridded weather data* can improve and facilitate WII contracts
- Grid data not worse than station data, and live and continuously available, avoids allocation problem of weather station

* e.g. RegNie (Regionalisierte Niederschlagshöhen, regionalized amount of precipitation)

Contributions to reduce basis risk

Basis Risk

- Design
- Spatial
- Temporal

- Defining index accumulation period in growth phase (not calendar dates). Objective measurement of crop growth phases required.


Contributions to reduce basis risk

- Defining index accumulation period in growth phase (not calendar dates) Objective measurement of crop growth phases required
- Ex-ante determination of crop growth stages
  - Growing degree days (GDD)
  - Phenology observation network data (DWD, ca. 1200 observer for wheat in Germany)
  - Phenology observations available in many countries, grid datasets
Weather Index Insurances in Europe

- Weather extremes also (increasingly) relevant for European agriculture

- CAP strengthens insurance solutions
  - Premium subsidies in second pillar
  - Lower insurance coverage than in US, mainly multi-peril
  - Ad-hoc disaster aid and direct payments reduce overall insurance demand, lower subsidies

- Availability & penetration of WII in Europe limited

- Yet, various examples emerged recently
Weather Index Insurances in Europe (selection, not complete)
Remote Sensing/Satellite Imagery

- RS becomes better and cheaper, promising for insurance purposes (de Leeuw et al. 2014)
- Insurance for ‘uninsurable’ crops (e.g. pastures)

- Satellite based grassland insurances, e.g. in Spain, USA, Canada, France (e.g. Roumiguié et al. 2017)
- H2020 Research Project SURE-Farm (e.g. crop applications)

- Low- and high-resolution allow use for area-yield and indemnity insurances respectively
- Satellite based assessment of weather, soil moisture etc.
Vroege, W., Dalhaus, T., Finger, R. Index-based Insurances for Grasslands – A Review. Submitted
Discussion (I/III)

- Wide range of insurance options
- No ‘one-fits-it-all’, not dominant solution → various trade-offs
Discussion (II/III)

- Digitalization and smart farming increase amount and integration of data (e.g. Walter et al., 2017, Woodard, 2016)

Potential to be game changer, also for agricultural insurances
## Discussion (III/III)

### Policy Issues

- Legal system and support shall embrace and not discourage diversity of insurance solutions
- High quality, independent and open data as important infrastructure component
- Sustainable insurance solutions needed
  - Insurance solutions allow farmers to take risks, stabilize incomes
  - If subsidized: Efficiency compared to other policy instruments? Sufficiently targeted and tailored?
  - Insurance can lead to more intensive and less diverse production, counteracting other policy goals
  - More focus on solutions for sustainable agricultural practices?
Conclusions

- Innovations in indemnity, index and satellite products will complement existing risk management portfolio
- Potential solutions for un- or underinsured activities and risks and quality risks
- Diversity rather than narrow focus on insurances needed. Policy shall allow this diversity to develop
- Sustainability aspects of insurance (support) need to be addressed
- New technologies /datasets with massive potential
Thank you very much for your attention

www.aecp.ethz.ch

https://agrarpolitik-blog.com/
References

- Vroege, W., Dalhaus, T., Finger, R. Index-based Insurances for Grasslands – A Review. Submitted