ETH zürich

Innovations in agricultural insurance solutions

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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


Ben Fertig, IAN, UMCES


Jane Hawkey, IAN, UMCES

Finger, R., Dalhaus, T., Allendorf, J., Hirsch, S. (2018). Determinants of downside risk exposure of dairy farms. *European Review of Agricultural Economics*. In Press
Lehmann, N., Finger, R., Klein, T., Calanca, P. Walter, A. (2013). Adapting crop management practices to climate change: Modeling optimal solutions at the field scale. *Agricultural Systems* 117: 55-65
Trnka, M., Rötter, R. P., Ruiz-Ramos, M., Kersebaum, K. C., Olesen, J. E., Žalud, Z., & Semenov, M. A. (2014). Adverse weather conditions for European wheat production will become more frequent with climate change. *Nature Climate Change*, 4(7), 637.

Agricultural risk management options

On Farm Instruments

Risk Management Instruments

Risk Prevention/ Reduction

Diversification

Holding Reserves

Modified from: Mußhoff, O., & Hirschauer, N. (2016). *Modernes Agrarmanagement: Betriebswirtschaftliche Analyse-und Planungsverfahren*. Vahlen.

Agricultural risk management options

On Farm Instruments ⟨ **Risk Management Instruments** ⟩ **Market Based Instruments**

- Risk Prevention/ Reduction
- Diversification
- Holding Reserves

- Risk Pooling (Insurance)
- Risk Transfer via Contracting

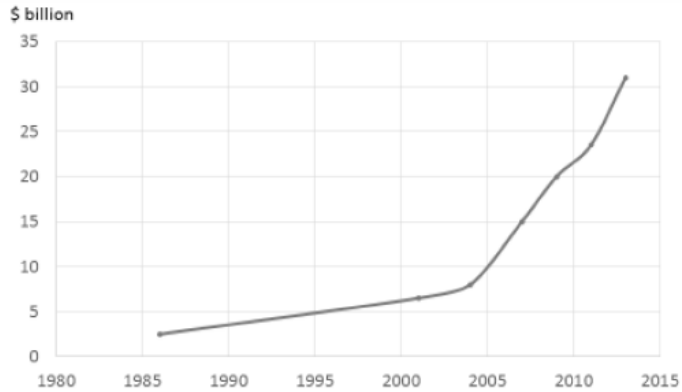
- Individual portfolio chosen at farm (e.g. de Mey et al. 2016, Meraner & Finger 2018)
- Risk sharing (e.g. insurances) allows to exploit profitable on-farm activities

de Mey, Y., Wauters, E, Schmid, D., Lips, M, Vancauteren, M., van Passel, S. (2016). Farm household balancing: emprical evidence from Switzerland. *European Review of Agricultural Economics* 43, 637–662
Meraner, M., Finger, R. (2018). Risk perceptions, preferences and management strategies: Evidence from a case study using German livestock farmers. Journal of Risk Research. In Press

Agricultural insurance

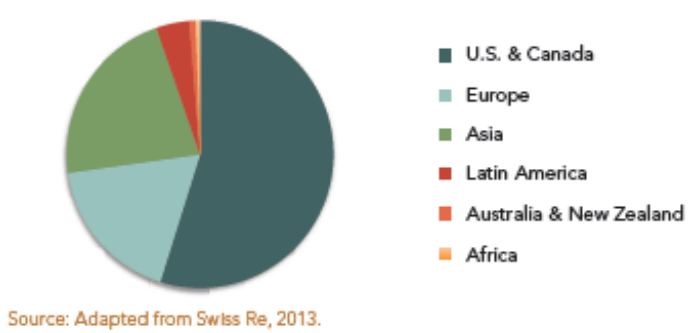
- Insurance premia globally >>30 billion USD/a
- Increasing trend (policy support, heavy subsidization, increasing risk exposure)
- Indemnity insurance dominant, with highly diverse solutions

Growth of world agricultual insurance premium volume



Source: Roberts (2005), Dick and Wang (2010), Mahul and Stutley (2010), Boissonade (2015).

Glauber 2015



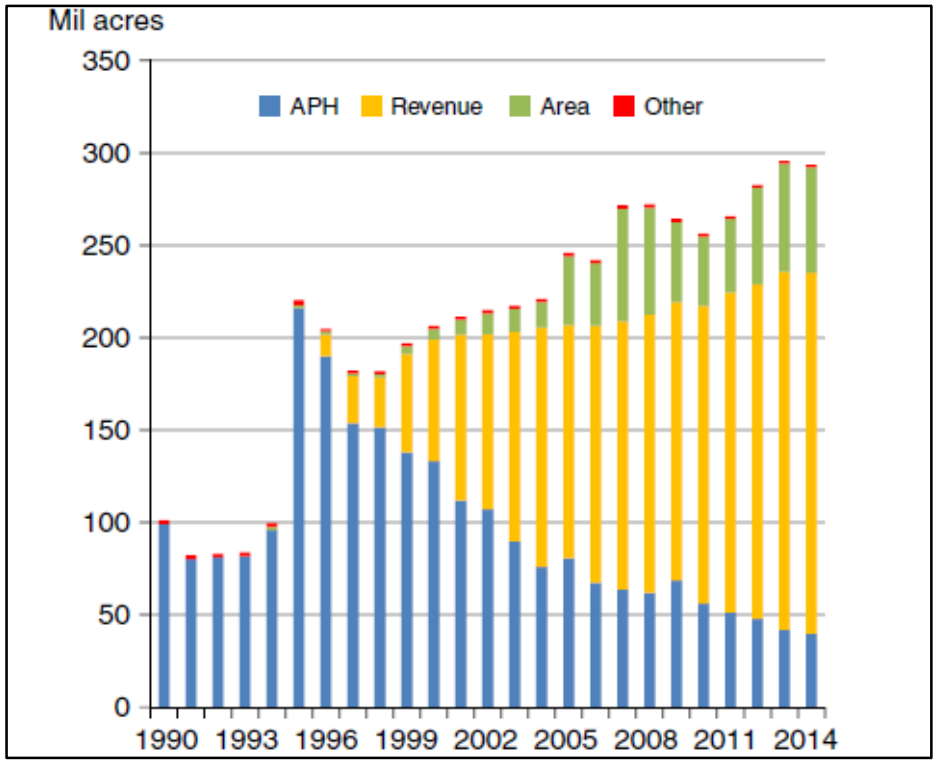
Source: Adapted from Swiss Re, 2013.

Bardají, I., Garrido, A., Blanco, I., Felis, A., Sumpsi, J. M., & García-Azcárate, T. (2016). Research for Agri committee-State of play of risk management tools implemented by member states during the period 2014-2020: national and European frameworks. *Agriculture and Rural Development, European Parliament*.
Glauber, J. W. (2015). Agricultural Insurance and the World Trade Organization.

Indemnity insurances

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

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



*e.g. Canadian Agricultural Income Stabilization or Income Stabilization Tool in European CAP:
El Benni, N., Finger, R., Meuwissen, M. (2016). Potential effects of the Income Stabilization Tool (IST) in Swiss agriculture. *European Review of Agricultural Economics* 43: 475-502
Severini, S., Biagini, L., Finger, R. (2018). Modelling Agricultural Risk Management Policies - The Implementation of the Income Stabilization Tool in Italy. Journal of Policy Modeling. In Press

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 <u>complement</u> 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

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

New insurance opportunities

Indemnity insurance

Indemnity insurance with physical inspection

Weather index insurance

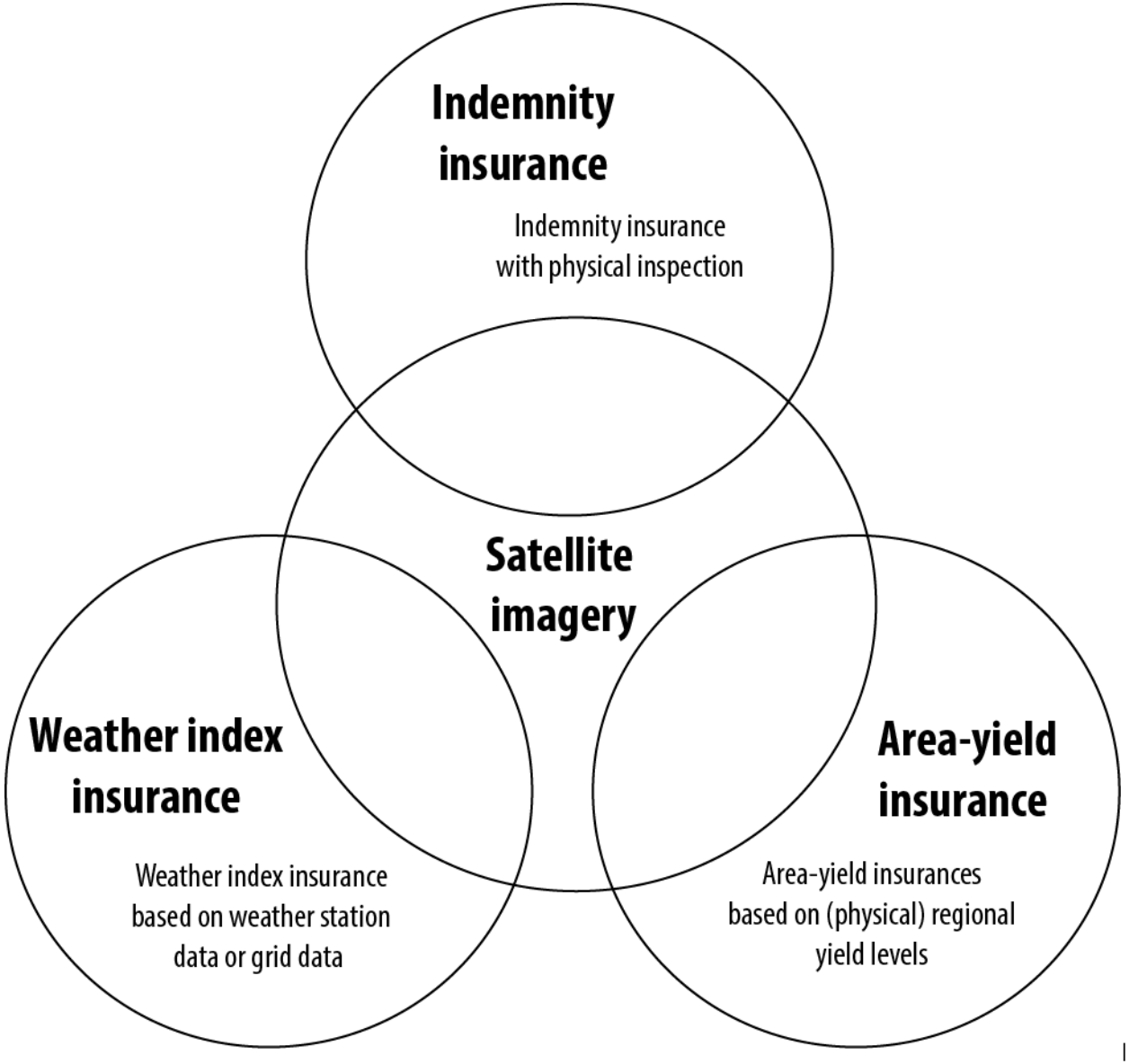
Weather index insurance based on weather station data or grid data

Area-yield insurance

Area-yield insurances based on (physical) regional yield levels

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

New insurance opportunities



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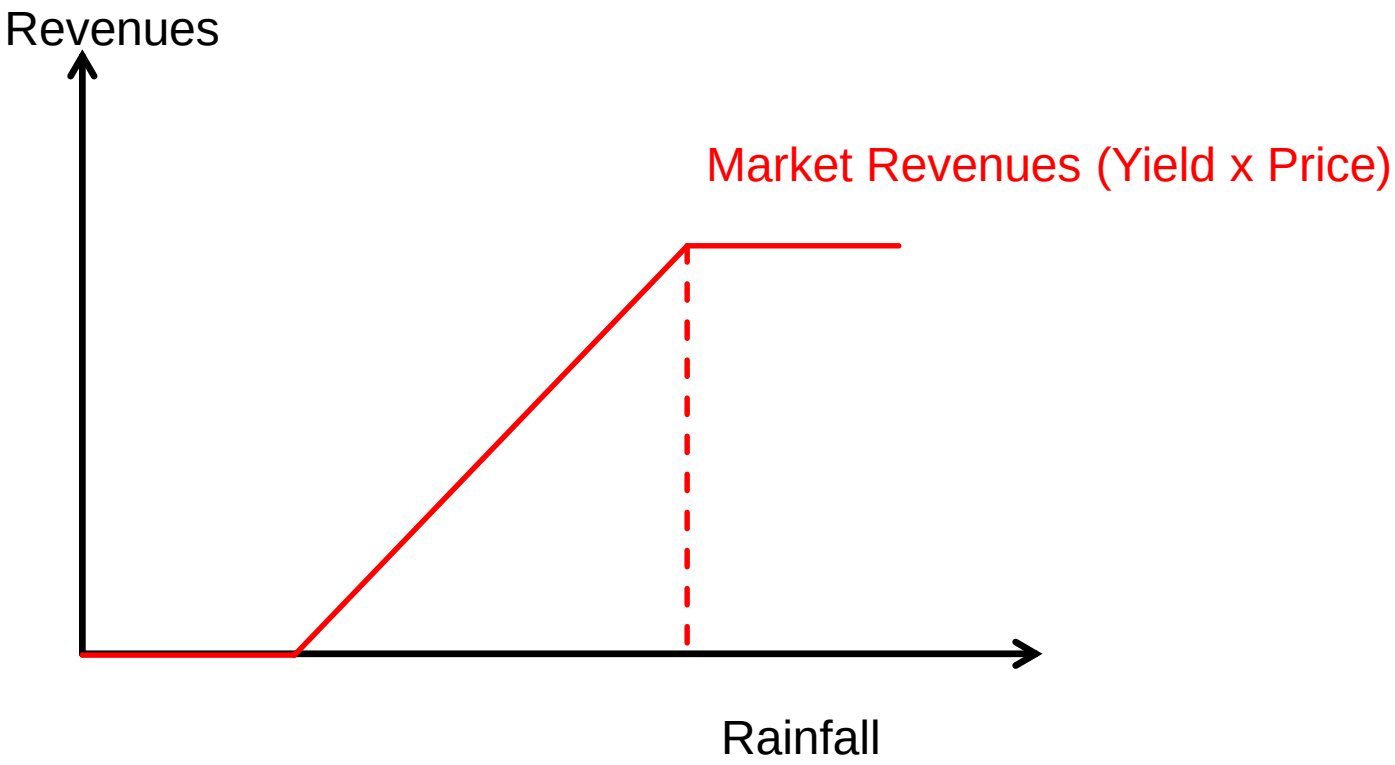
Structure

- 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)



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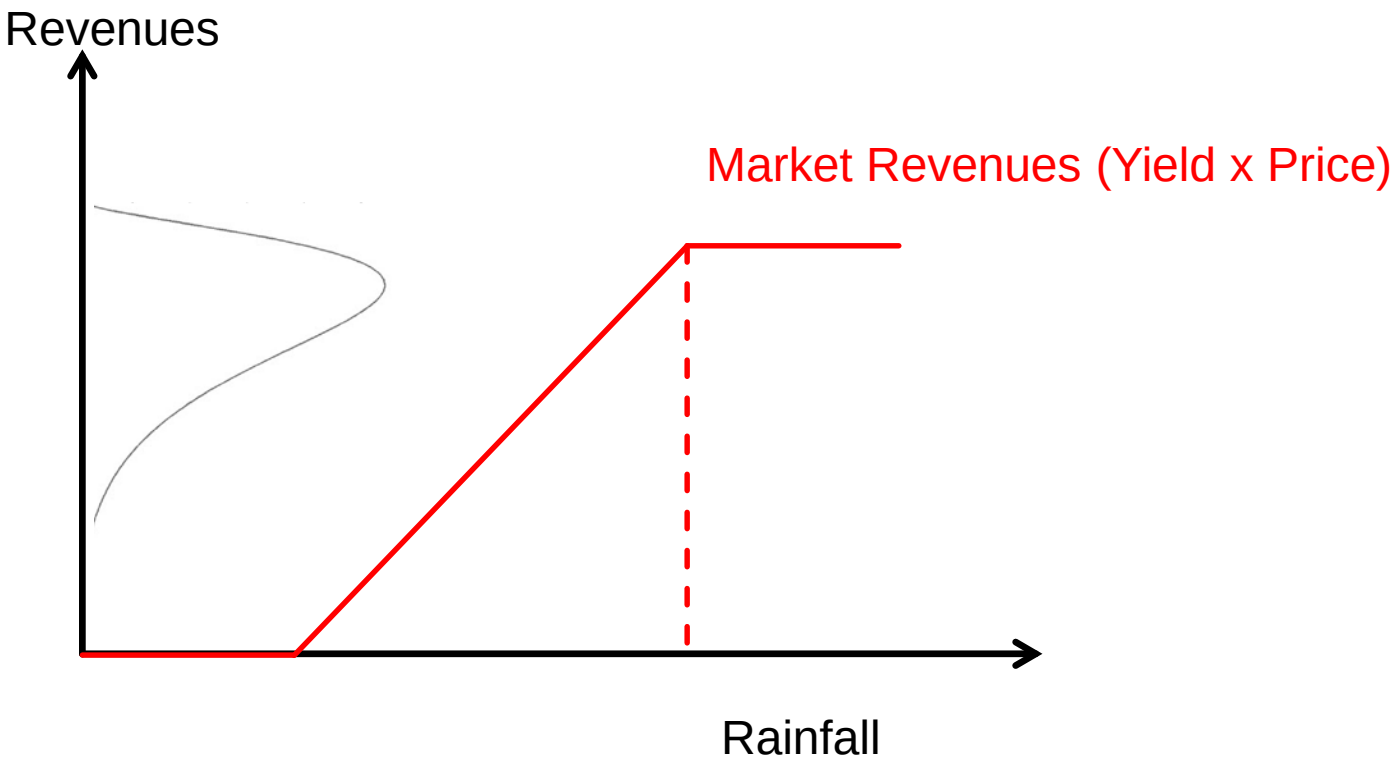

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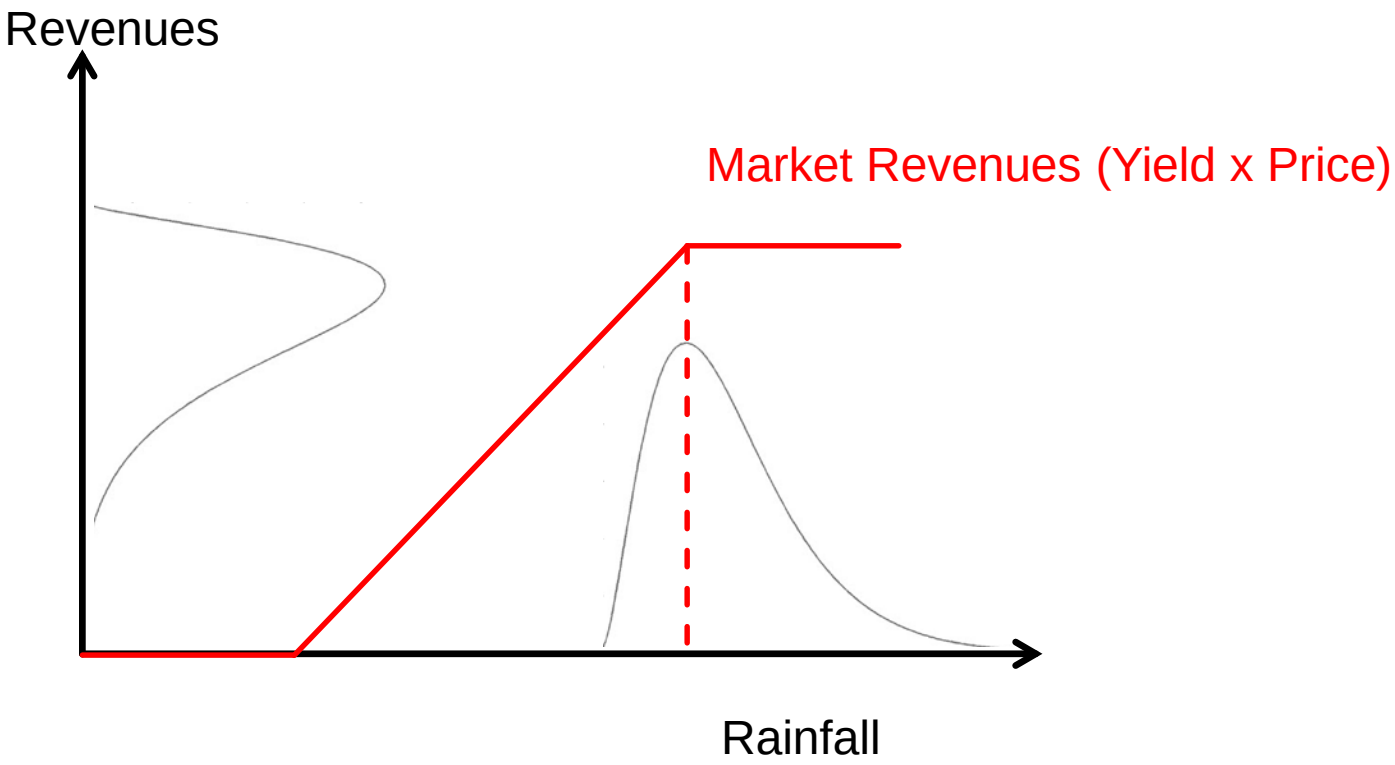

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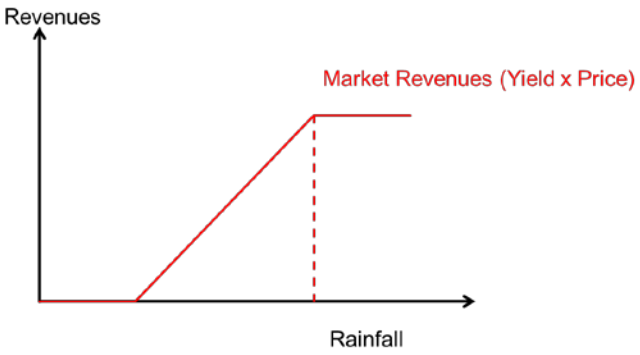
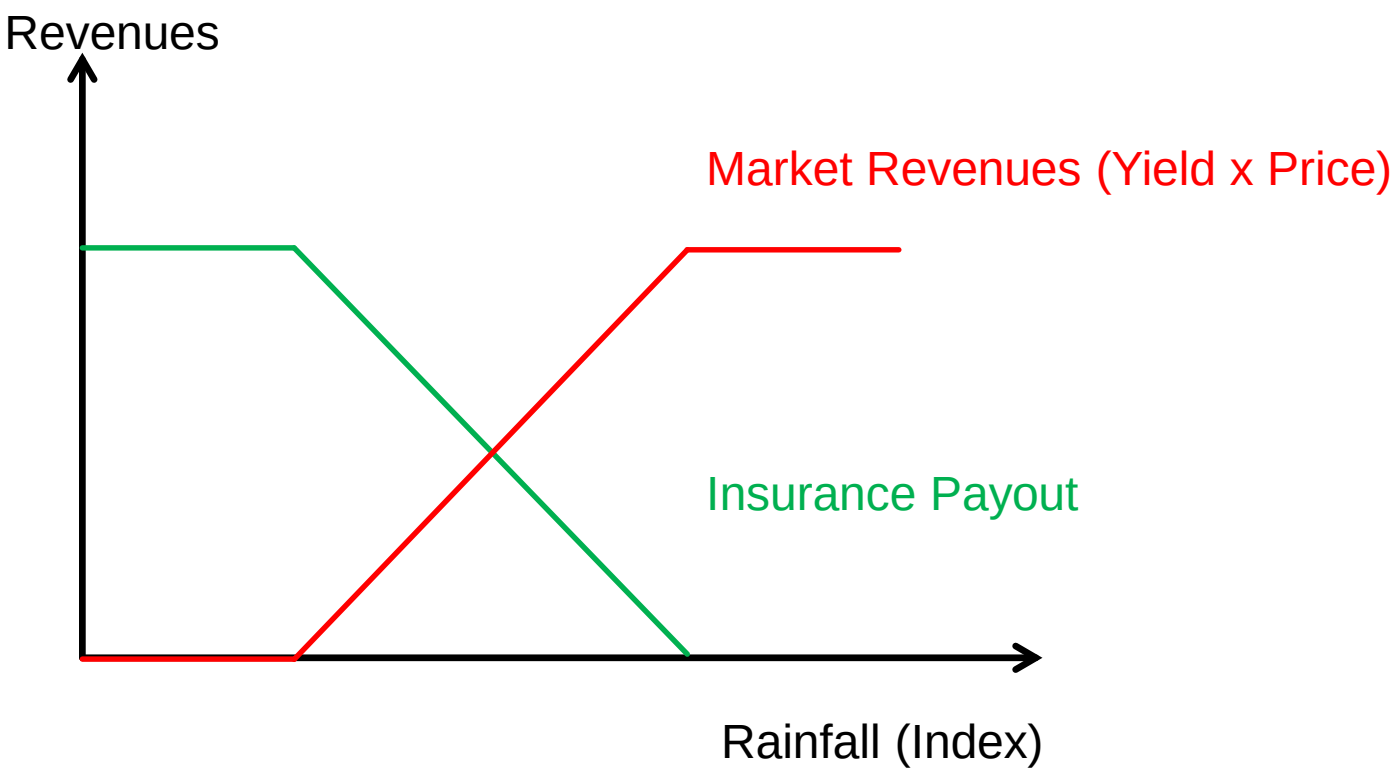


- WII payout if rainfall (index) falls below threshold
- WII payout increase if level of rainfall decreases
- Objective measurement of index

→ before critical growing season, index, weather station of index measurement and index accumulation period have to be defined

Weather Index Insurance (WII)



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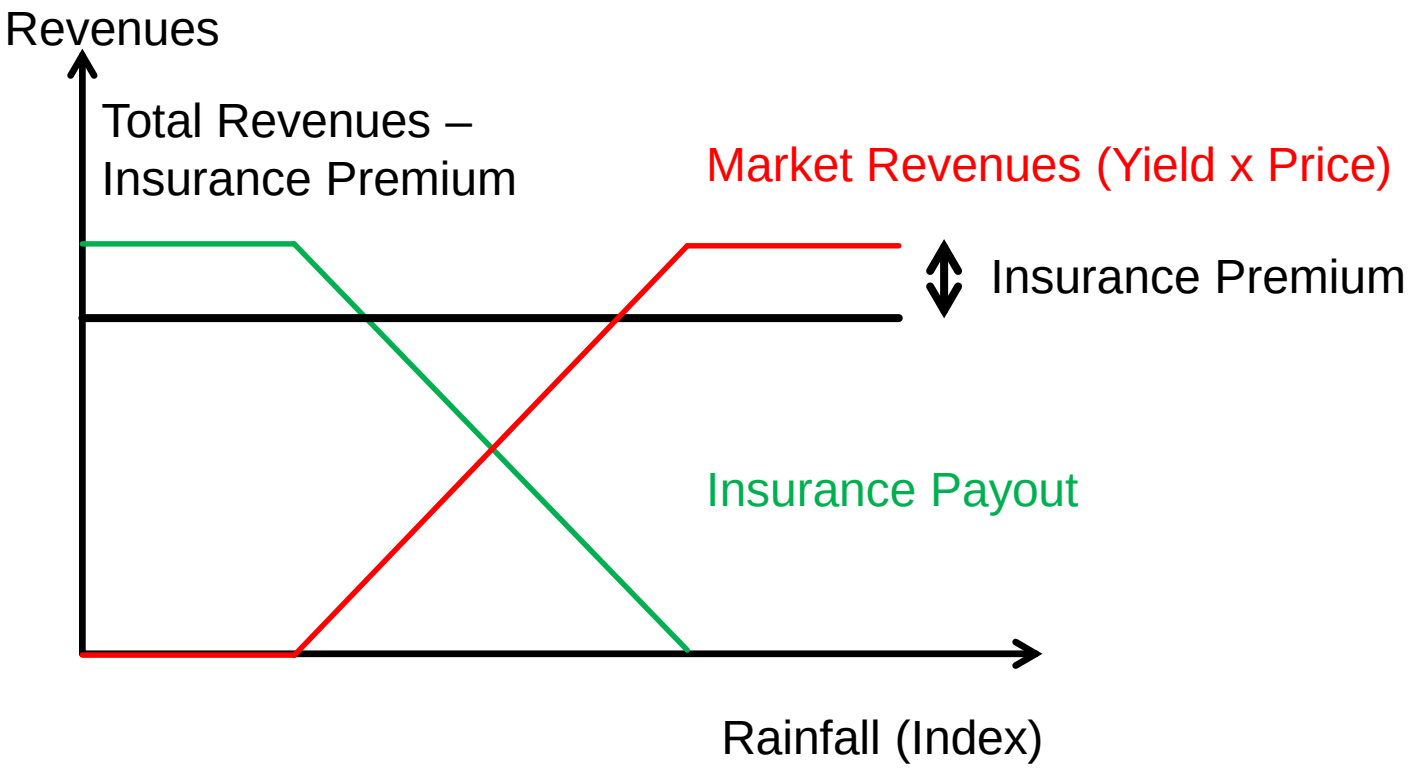

Weather Index Insurance (WII)

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**

Clarke, D. J., 2016: A theory of rational demand for index insurance. *Amer. Econ. J.: Microeconomics*, **8**, 283–306

Basis Risk

To be defined before growing season:

- Index variables
- Weather station of index measurement
- Index accumulation period

Basis Risk

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To be defined before growing season:

- Index variables
- Weather station of index measurement
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Basis Risk

Design

Index is a poor predictor for losses

Basis Risk

To be defined before growing season:

- Index variables
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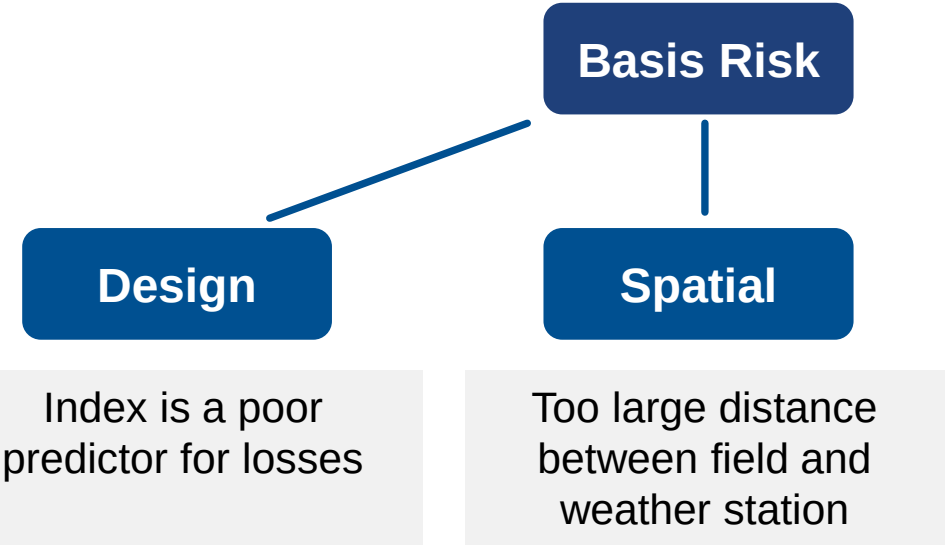


Basis Risk

To be defined before growing season:

- Index variables
- Weather station of index measurement
- Index accumulation period

Basis Risk

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

Basis Risk

To be defined before growing season:

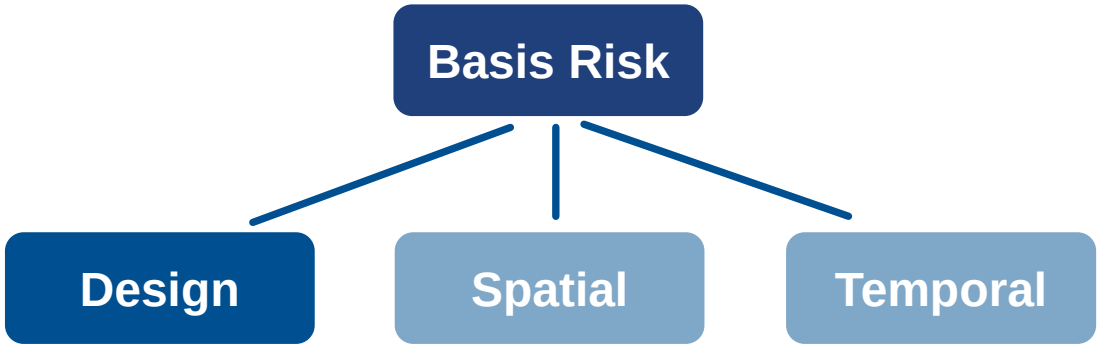
- Index variables
- Weather station of index measurement
- Index accumulation period

Basis Risk

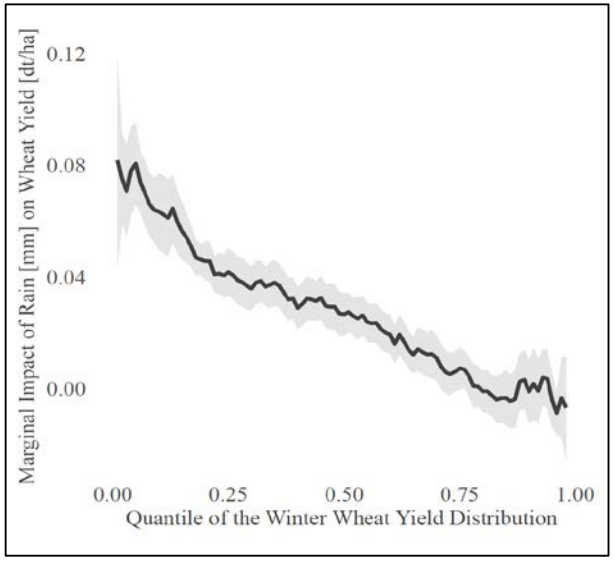
Design	Spatial	Temporal
Index is a poor predictor for losses	Too large distance between field and weather station	Critical growth phase not met by index

- **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)



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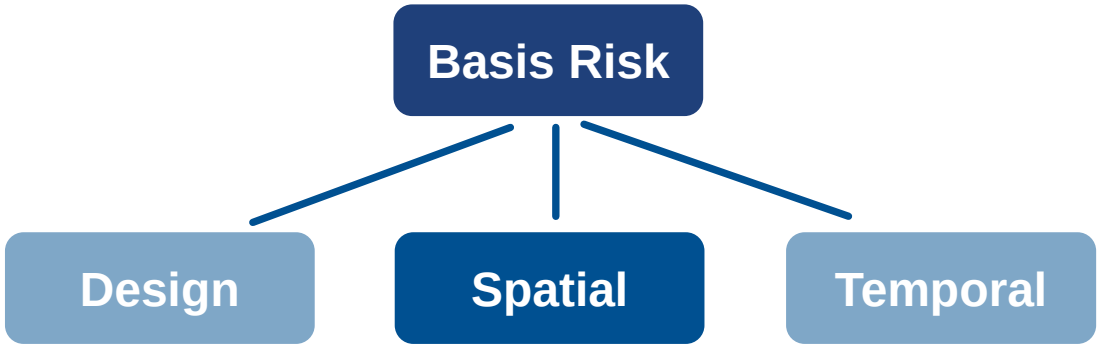
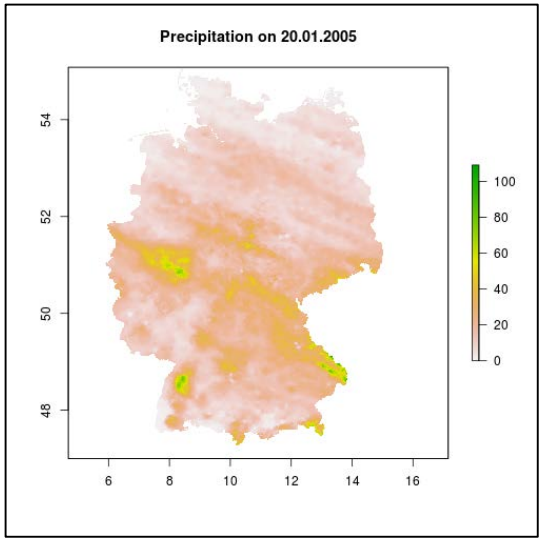
Contributions to reduce basis risk



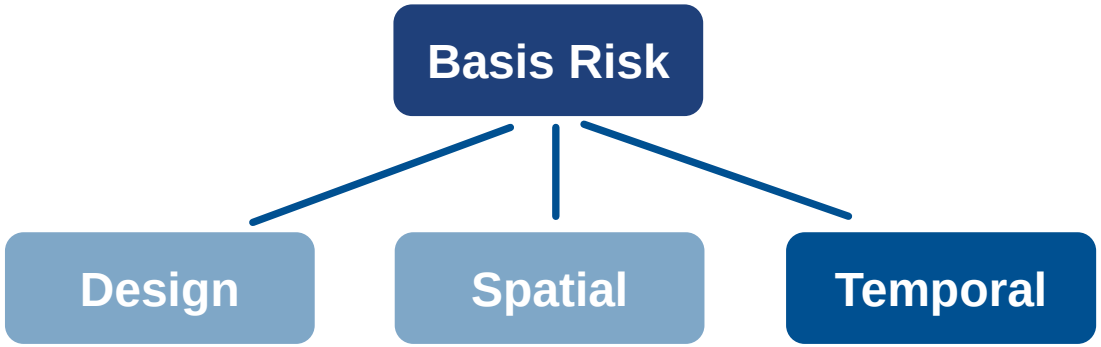


Deutscher Wetterdienst. www.dwd.de

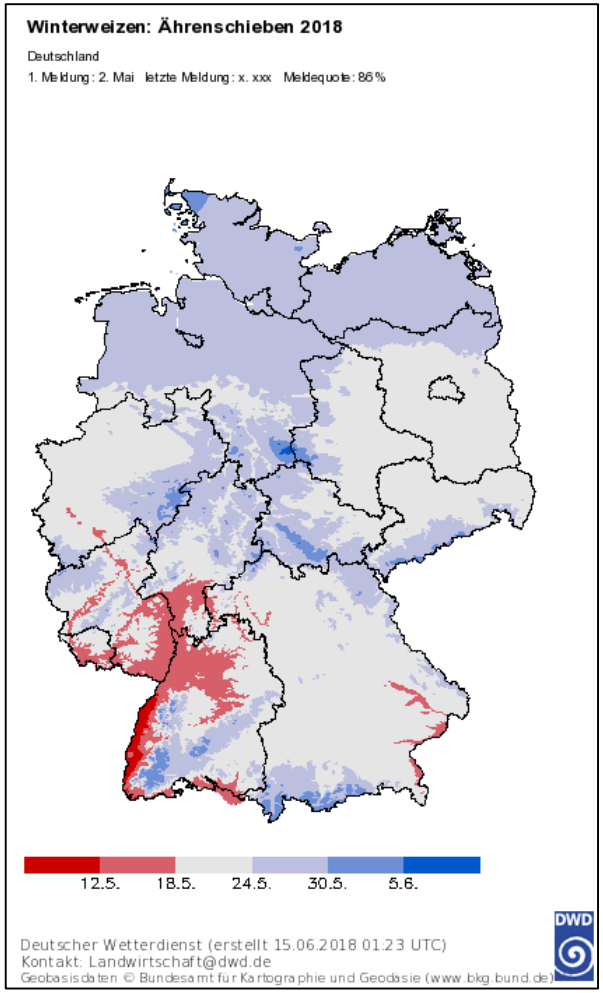
- Officially provided gridded weather data* can improve and facilitate WII contracts
- Grid data not worse than station data, and live and continuously available, avoids allocation problem of weather station

*e.g. RegNie (Regionalisierte Niederschlagshöhen, regionalized amount of precipitation)
Dalhaus, T., Finger, R. (2016). Can Gridded Precipitation Data and Phenological Observations Reduce Basis Risk of Weather Index-based Insurance? *Weather, Climate and Society* 8, 409–419

Contributions to reduce basis risk



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



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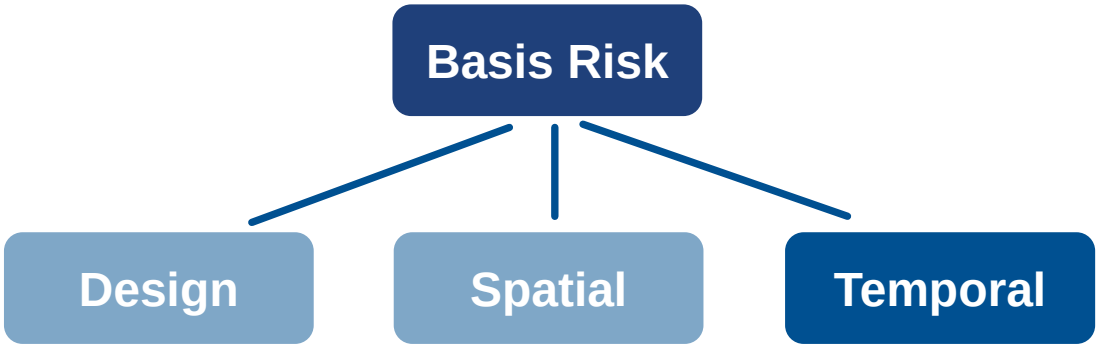
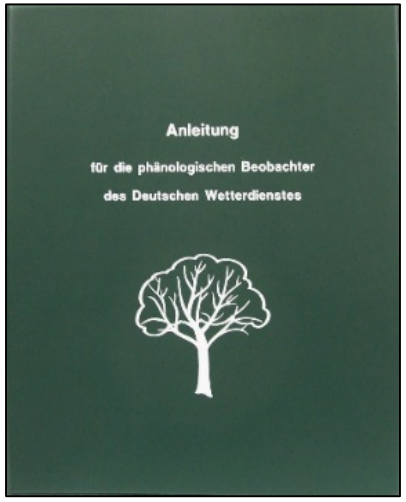
Contributions to reduce basis risk




Deutscher Wetterdienst, www.dwd.de

- 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



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Weather Index Insurances in Europe

- Weather extremes also (increasingly) relevant for European agriculture

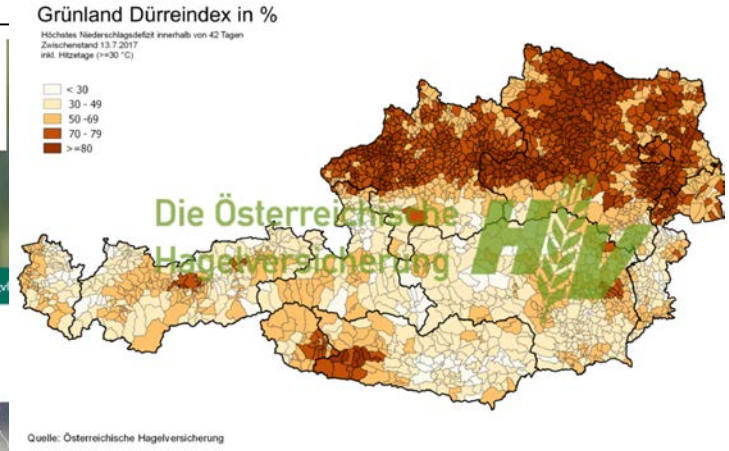
- CAP strengthens insurance solutions
  - Premium subsidies in second pillar
  - Lower insurance coverage than in US, mainly multi-peril
  - Ad-hoc disaster aid and direct payments reduce overall insurance demand, lower subsidies

- Availability & penetration of WII in Europe limited

- Yet, various examples emerged recently

Meuwissen, M. P., de Mey, Y. & van Asseldonk, M. (2018). Prospects for agricultural insurance in Europe. *Agricultural Finance Review*, *78*(2), 174-182.
Vroege, W., Dalhaus, T., Finger, R. Index-based Insurances for Grasslands – A Review. Submitted

Weather Index Insurances in Europe (selection, not complete)



WetterProtect

Wetterstation
Hannover-Langenhagen

Absicherungszeitraum
01.04.2016 – 31.05.2016

Grenzwert für eine Dürreperiode
70 ltr./qm Niederschlag

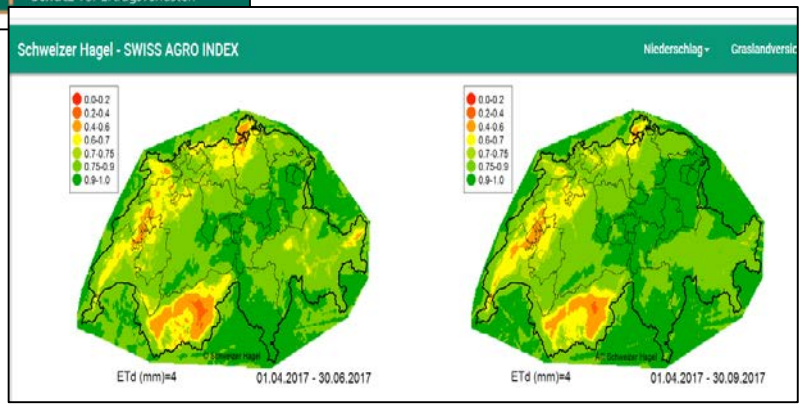
Auszahlungsbedingung
weniger als 70 ltr./qm Niederschlag in April und Mai

Auszahlung pro fehlenden ltr/qm Niederschlag
300 € bzw. 3 € pro ha

Maximale Auszahlung
21.000 € bzw. 210 € pro ha

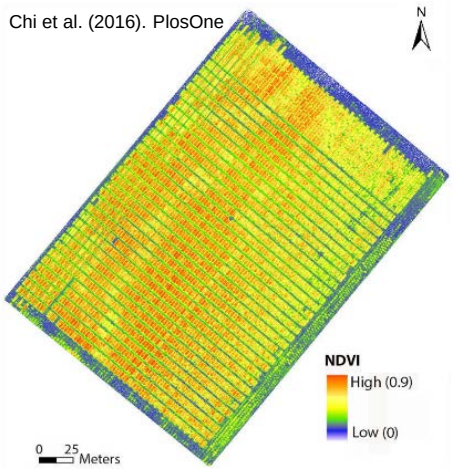
Versicherungsbeitrag
2.000 € bzw. 20 € pro ha (exklusive VSt.)

Auszahlung im Jahr 2009
7.600 € bzw. 76 € pro ha



Remote Sensing/Satellite Imagery

Chi et al. (2016). PlosOne



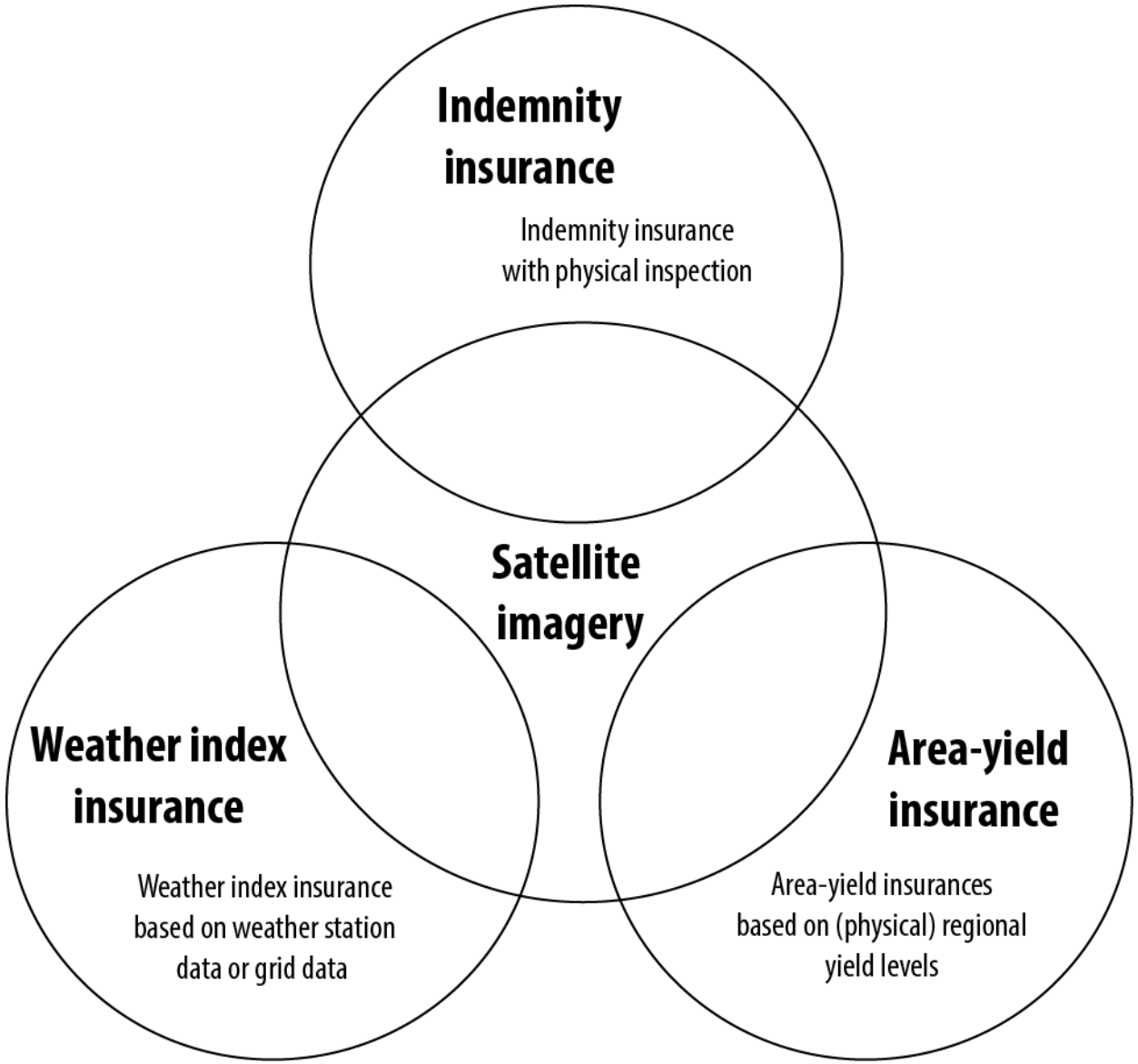
- o RS becomes better and cheaper, promising for insurance purposes (de Leeuw et al. 2014)
- o Insurance for ‘uninsurable’ crops (e.g. pastures)

- ➢ 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)

- o Low- and high-resolution allow use for area-yield and indemnity insurances respectively
- o Satellite based assessment of weather, soil moisture etc.

SURE Farm
SUSTAINABLE RESILIENT EU FARMING SYSTEMS

J. de Leeuw, W. Vrieling, A. She, C. Atzberger, K.M. Hadgu, C.M. Biradar, H. Keah, C. Turvey. The potential and uptake of remote sensing in insurance: a review. Remote Sens., 6 (11) (2014), pp. 10888-10912
Roumiguié, A., Sigel, G., Poilvé, H., Bouchard, B., Vrieling, A., & Jacquin, A. (2017). Insuring forage through satellites: testing alternative indices against grassland production estimates for France. *International Journal of Remote Sensing*, *38*(7), 1912-1939.
Vroege, W., Dalhaus, T., Finger, R. Index-based Insurances for Grasslands – A Review. Submitted



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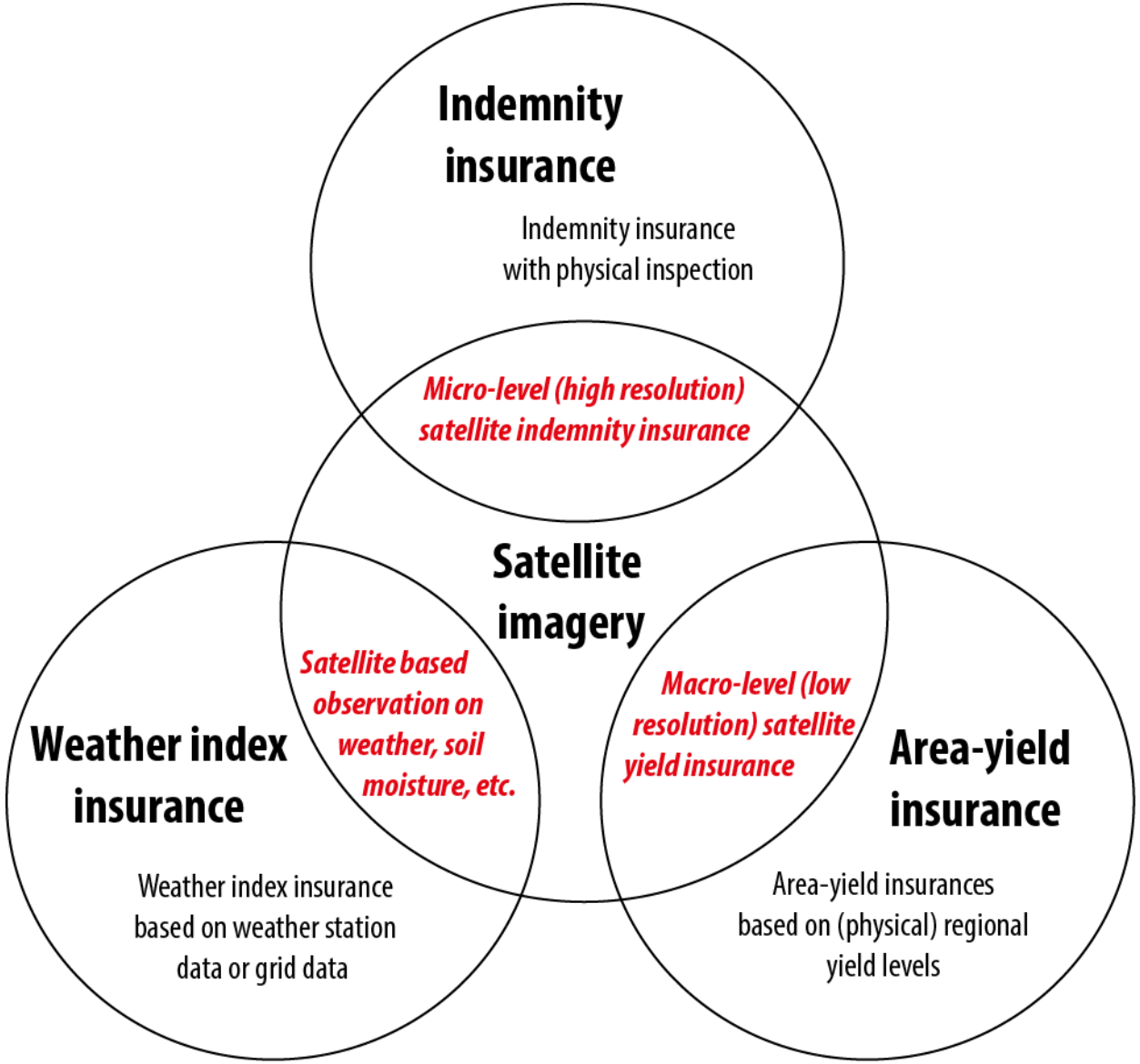

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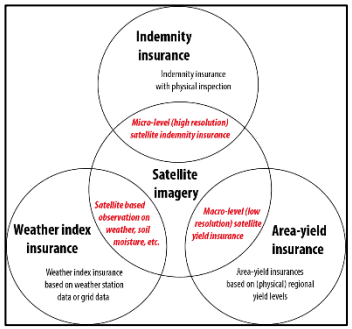
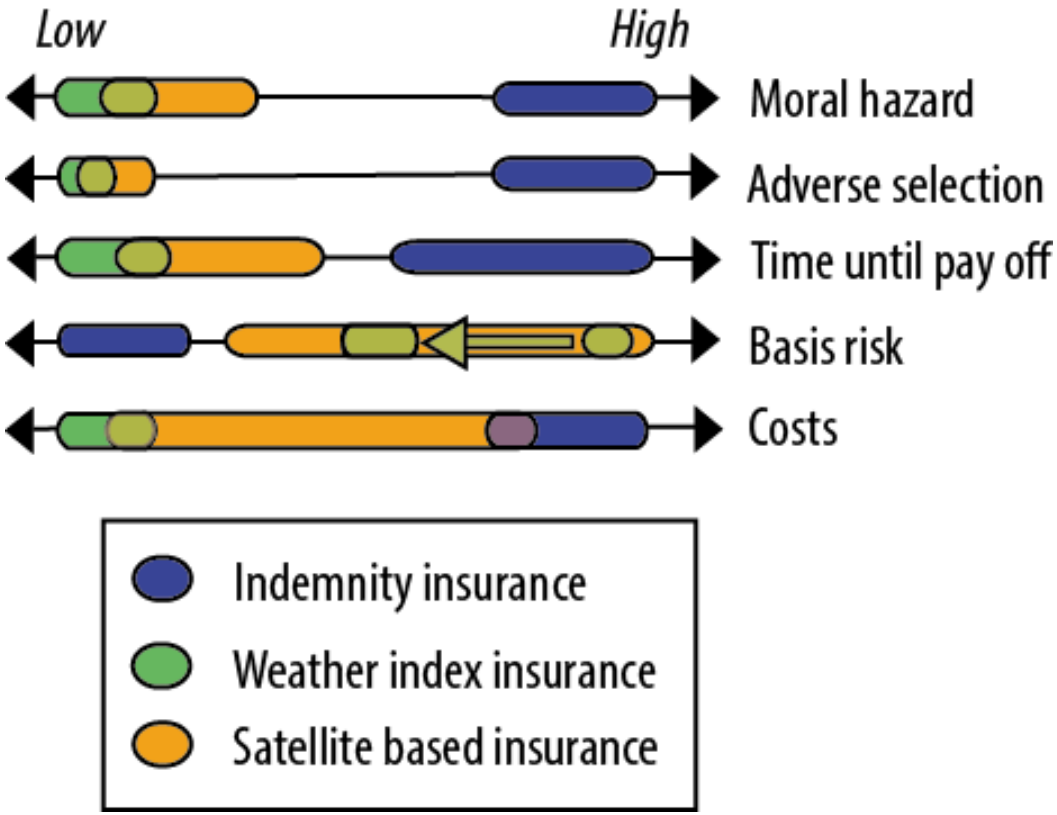
Discussion (I/III)



- 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

Walter, A., Finger, R., Huber, R., Buchmann, N. (2017). Smart farming is key to developing sustainable agriculture. Proceedings of the National Academy of Sciences USA 114 (24) 6148-6150
Woodard, J. D. (2016). Data science and management for large scale empirical applications in agricultural and applied economics research. *Applied Economic Perspectives and Policy*, *38*(3), 373-388.

Discussion (III/III)

opendata.swiss

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/

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