Crop insurance design using remote sensing and modelling approaches for yield estimations

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Parallel Session 12

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Phases of the insurance design process

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1. Product concept and application
2. Product parameters
3. Insurance wording
4. Pricing or the art of rate making
5. Organizational implications

1. Phase: Product concept and application

Yield or loss – the two key parameters in crop insurance

Yield: tonnage produced on a specific area (e.g. hectare)

Loss: Crop damage as a percentage of the yield obtained without the insured event

1. Phase: Product concept and application

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1. **Yield concept using crop growth models:**
   a. Insurance related applications:
      - Area yield insurance product using modelled yields: Modelled yield are used as trigger parameter
      - Verify and establish insured yields in a specific region
   b. Applications for state institutions: Yield loss estimations after natural catastrophes

      Context: disaster aid

      → provisioning of financial funds and correct allocation to affected regions

1. Phase: Product concept and application

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2. Loss concept

a. Insurance related applications:

Crop loss assessment based on flooded area and duration:

- Input factor for crop yield model
- Triggers for flood insurance according to duration of the flood in a specific plot/area

b. Applications for state institutions: Crop loss estimations after natural catastrophes

Context: disaster aid

→ provisioning of financial funds and correct allocation to affected areas

2. Phase: Insurance parameters

Area yield insurance product using yield models

Insured interest: specific crop (e.g. rice, corn, soybean, wheat)

Area insured: size of plots [ha] and geographical allocation to:

- administrative units (e.g. county, community)
- grid (e.g. 10 x 10 km)

Coverage level: e.g. 80% (of historic average modelled yield)

Guaranteed yield: Coverage level x historic average modelled yield

Sum Insured (SI):

Area insured [ha] x guaranteed yield [t/ha] x fixed price [Currency/t]

Premium: Rate x SI

Indemnification (if actual yield < guaranteed yield):

(Guaranteed yield – actual model yield) x insured area x fixed price

2. Phase: Insurance parameters

Damage based insurance product using remote sensing flood data

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Insured interest: specific crop (e.g. rice, corn, soybean, wheat)

Insured area: size [ha] and geographical location (e.g. georeferenced or otherwise defined)

Sum Insured (SI): Area insured [ha] x expected/potential yield [t/ha] x fixed price [Currency/t]

Alternative: Area insured [ha] x production costs [Currency/ha]

Premium: Rate x SI

Deductible: e.g. 10% of SI of plot; 10% of Total SI

Indemnification: (% loss x SI) - deductible

2. Phase: Insurance parameters

Insurance product using remote sensing flood data

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From remote sensing flood data to loss percentage

Susceptibility of different crops to standing water and submergence:

- Most crops (except rice) high: after 1 day → severe damage to be expected (even if there is no submergence: lack of oxygen in root zone prevails and subsequent disease infection likely.

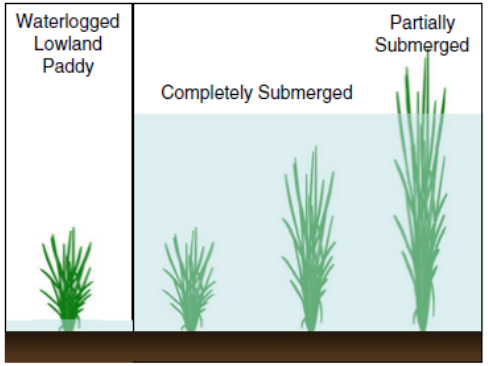
  → 100 % loss after complete submergence of 1 day to be expected.

- Rice: tolerance to submergence depending on varieties.

  → expertise of plant physiologists and plant scientists required in order to establish the matrix.

Rice: Example for loss percentage matrix dependent on flood duration and rice variety

Flood duration	Lowland - submergence intolerant varieties		Submergence tolerant (SUB1) varieties	
	Vegetative stage	Reproductive stage	Vegetative stage	Reproductive stage
[days]	Loss [% of SI]			
1	0%	20%	0%	0%
2	5%	40%	0%	10%
3	30%	50%	0%	30%
4	50%	80%	0%	50%
5	80%	100%	0%	80%
6	100%	100%	10%	100%
7	100%	100%	20%	100%
8	100%	100%	35%	100%
9	100%	100%	50%	100%
10	100%	100%	70%	100%
11	100%	100%	90%	100%
12	100%	100%	100%	100%



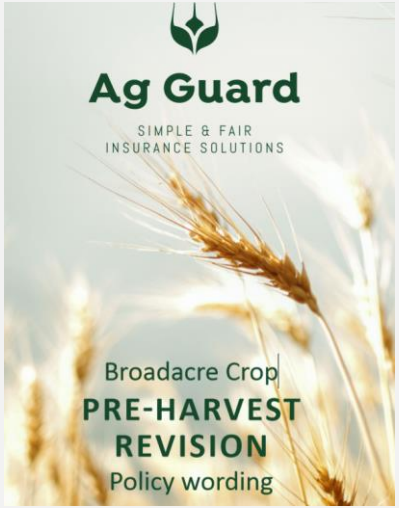
	Submergence tolerant (*Sub1*)	Lowland submergence intolerant	Deepwater rice
Waterlogged paddy depth (cm)	5 to < 50	5 to < 50	> 50 to 400
Subspecies	*aus, indica*	*japonica, indica*	*indica*
Underwater response strategy	quiescence	escape	deepwater escape
Ethylene-triggered GA-mediated elongation	suppressed	enhanced in shoot, leaf	enhanced in internodes
ERF controlling response strategy	*SUB1A*		*SK1, SK2*

Source: Bailey-Serres et al, 2010

3. Phase: Insurance wording

= Contract between client and insurance company with all relevant provisions

→ Approval by insurance regulator



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4. Phase: Pricing of insurance products - art of rate making

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What is risk adequate price for a specific insurance product?

Commercial rate = **risk rate** + loading factor (capital costs + distribution costs + admin costs)

Important steps in the pricing process:

- Pricing differentiated for „Basis Loss“ and „Cat Loss“
- Detrending of data sets

4. Phase: Pricing of insurance products - art of rate making

Pricing approaches

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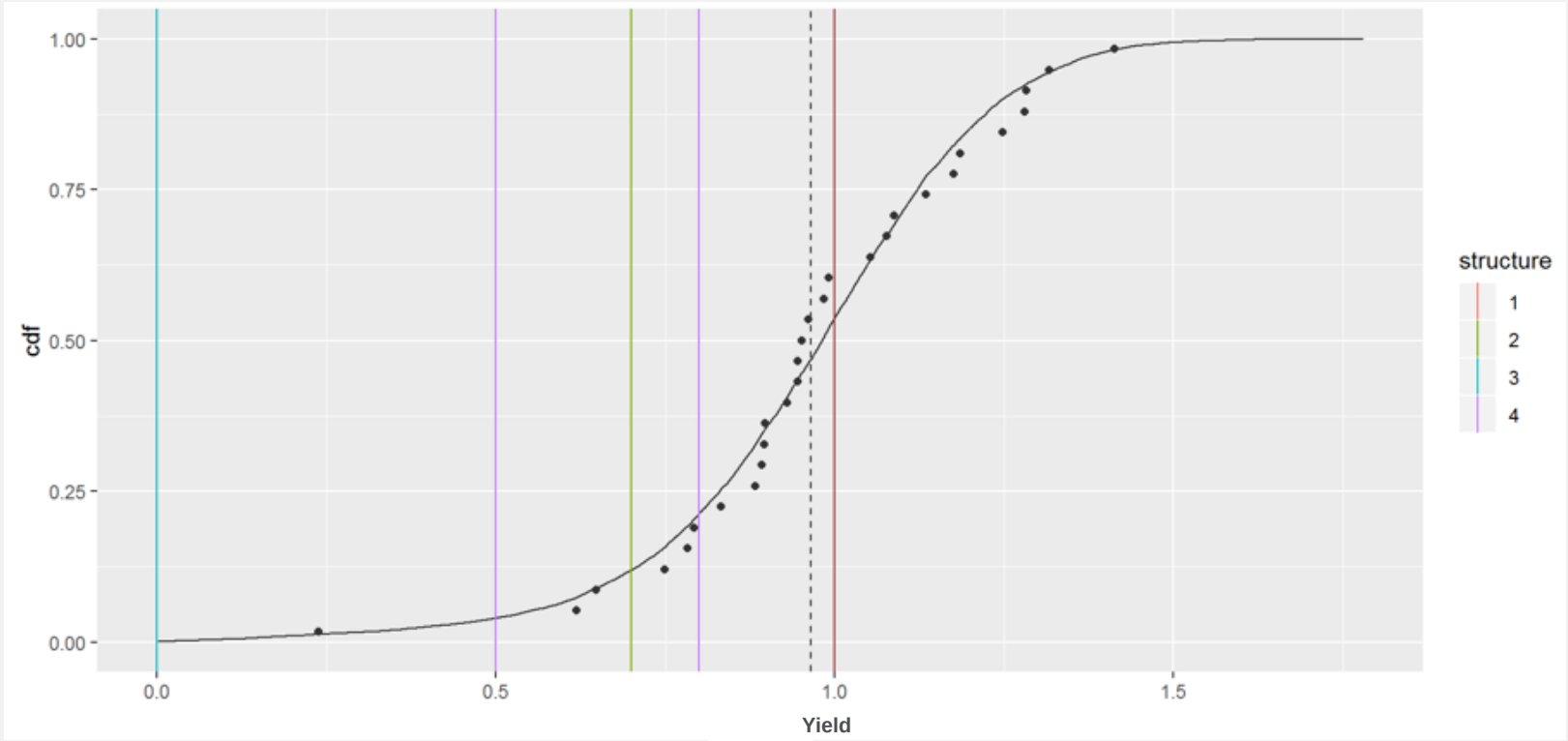
1. **Loss data based pricing**

   Loss cost analysis: Risk rate = Losses/SI

   - Advantage: accurate method
   - Disadvantage: Historic loss data required; only for established products possible → not suitable for new products

2. **Distribution based pricing**

Area yield product: Yield distribution function (example)



4. Phase: Pricing of insurance products - art of rate making

Pricing approaches

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   Loss cost analysis: Risk rate = Losses/SI

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2. **Distribution based pricing**

3. **Experience based pricing**

5. Phase: Operational implications

The stakeholders in technology based crop insurance

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1. Client/Insured (farmers, aggregators or governments)
2. Distribution channel (agents, brokers, banks, input providers)
3. Insurance company: risk taker, policy issuing, underwriting, claims handling, compliance
4. Reinsurance company: ultimate risk taker, expertise provider

Additionally (in contrast to traditional crop insurance)

5. Technology service company:
   - Determining the modelled yields for the insured areas/regions
   - Providing flood monitoring data

   → have to undergo a selection and approval process lead by the insurance company and regulator

Summary and outlook

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1. Crop insurance products based on **crop growth models and remote sensing monitoring** data will complement the presently available insurance solutions in the near future.
2. In developing countries these **new insurance products** will lead the future development in the segment of small and medium size farms.
3. **Indemnity based crop insurance** will remain for larger farms and specialized farms – also in developing countries – the best choice.
4. Prerequisite of crop insurance products based on crop growth models and remote sensing monitoring data are independent and impartial **technology service companies**. They have the task to determine yields and triggers as basis of any indemnification. Furthermore they support the pricing with data and modeling.
5. **Basis risk** remains the main challenge for these technology based insurance products. It will be the big future endeavor of insurance companies and service providers to increase accuracy and thus reducing the basis risk for the insured.

Sources

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Thank you …

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