1st Capacity Building Seminar in Crop Insurance
26th September 2019

Crop Insurance

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Appointed Actuary

Apoorva Tatia
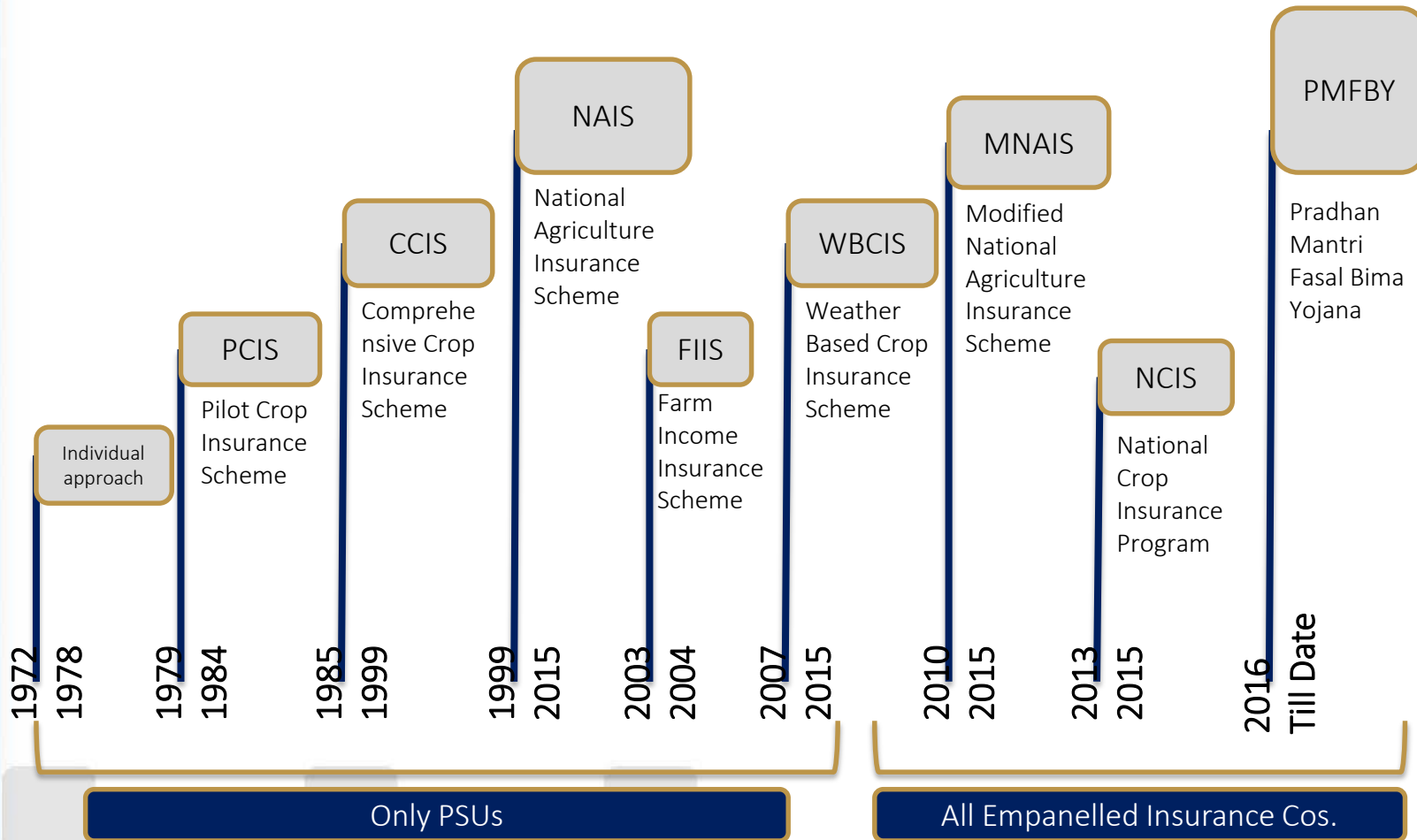
Business Head - Rural And Crop Underwriting

Institute of Actuaries of India

Agenda

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Evolution of Crop Insurance Industry in India

NAIS

National Agriculture Insurance Scheme

MNAIS

Modified National Agriculture Insurance Scheme

PMFBY

Pradhan Mantri Fasal Bima Yojana

CCIS

Comprehensive Crop Insurance Scheme

WBCIS

Weather Based Crop Insurance Scheme

PCIS

Pilot Crop Insurance Scheme

FIIS

Farm Income Insurance Scheme

NCIS

National Crop Insurance Program

Individual approach

1972 1978 1979 1984 1985 1999 1999 2015 2003 2004 2007 2015 2010 2015 2013 2015 2016 Till Date

Only PSUs

All Empanelled Insurance Cos.

- **25 states implement PMFBY/ RWBCIS**
- **15 insurance companies across India**
- **3rd largest market in world for gross written premiums**

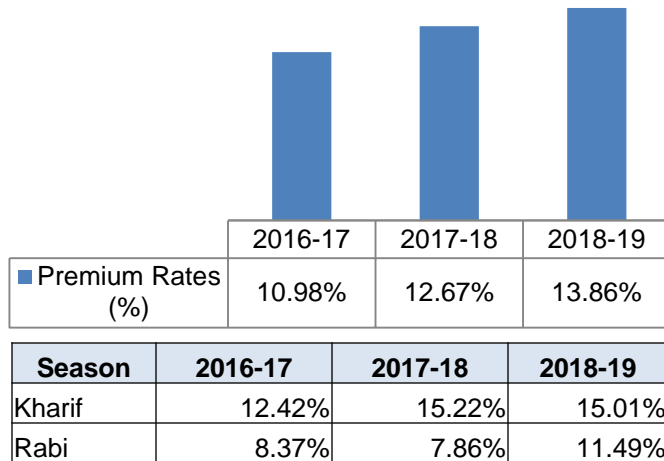# Evolution of Crop Insurance Industry over the years
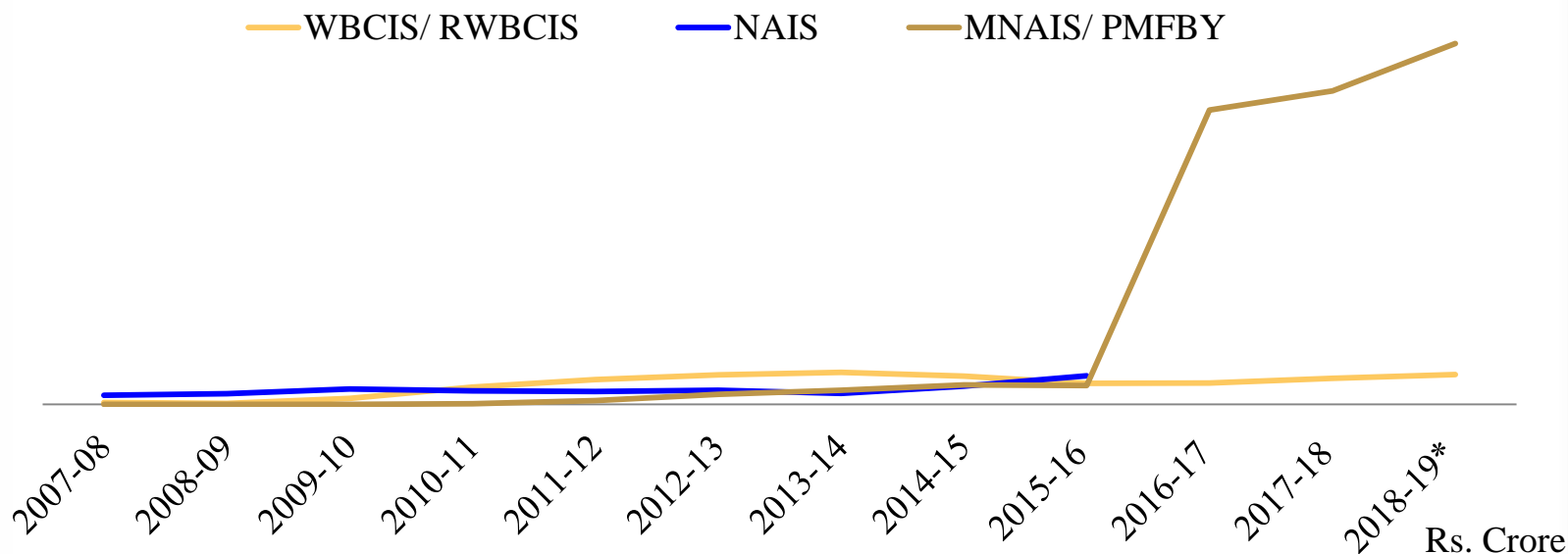
Rs. Crore

Year	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18	18-19*
WBCIS/ RWBCIS	149	82	448	1290	1857	2224	2395	2125	1589	1610	1946	2241
NAIS	683	808	1150	1010	972	1069	822	1381	2142	NA	NA	NA
MNAIS/ PMFBY	0	0	0	47	287	754	1075	1458	1407	22022	23436	26994
Total	832	889	1598	2347	3116	4047	4292	4965	5138	23632	25382	29236

Please note * indicates Estimated Premium

Source – Department of Agriculture and cooperation

www.actuariesindia.org

Crop Insurance (Pan India basis)

Premium Rates (%)

	2016-17	2017-18	2018-19
■ Premium Rates (%)	10.98%	12.67%	13.86%

Season	2016-17	2017-18	2018-19
Kharif	12.42%	15.22%	15.01%
Rabi	8.37%	7.86%	11.49%

Loss Ratio (%)

	2016-17	2017-18	2018-19
■ Loss Ratio (%)	73.53%	86.22%	94.76%

Season	2016-17	2017-18	2018-19
Kharif	64.32%	87.06%	93.35%
Rabi	98.44% *	83.14%	98.21%
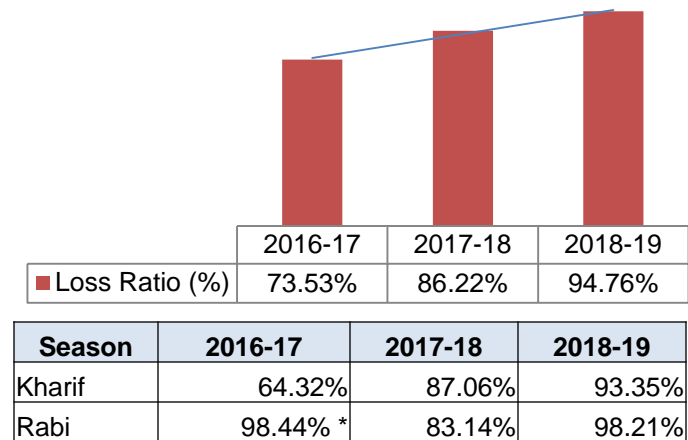
* Major contributor is Tamil Nadu

Rainfall (Departure %)

	2016-17	2017-18	2018-19
■ Rainfall (Departure %)	97%	95%	91%
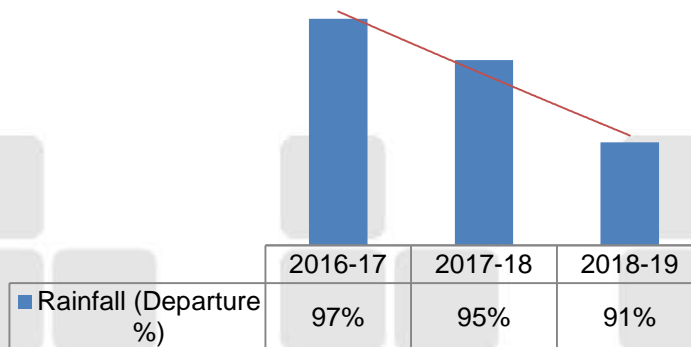
- Rainfall has direct impact on the Loss ratios year on year basis
- In 2016-17, the rainfall departure was 97% and loss ratio was at ~ 74% and subsequently the rainfall decreased and loss ratios increased.
- This results in increase in the premium rates year on year basis.

Agenda

1	Crop Insurance Industry
2	**Current Crop Insurance Products in Market**
3	Technical Premium Pricing
4	Underwriters view and commercial pricing

Current Crop Insurance Products in Market

1. Pradhan Mantri Fasal Bima Yojana (PMFBY)

- Yield based crop insurance scheme
- Claims settlement based on CCE yield data.

2. Restructured Weather Based Crop Insurance Scheme (RWBCIS)

- Weather index based cover.
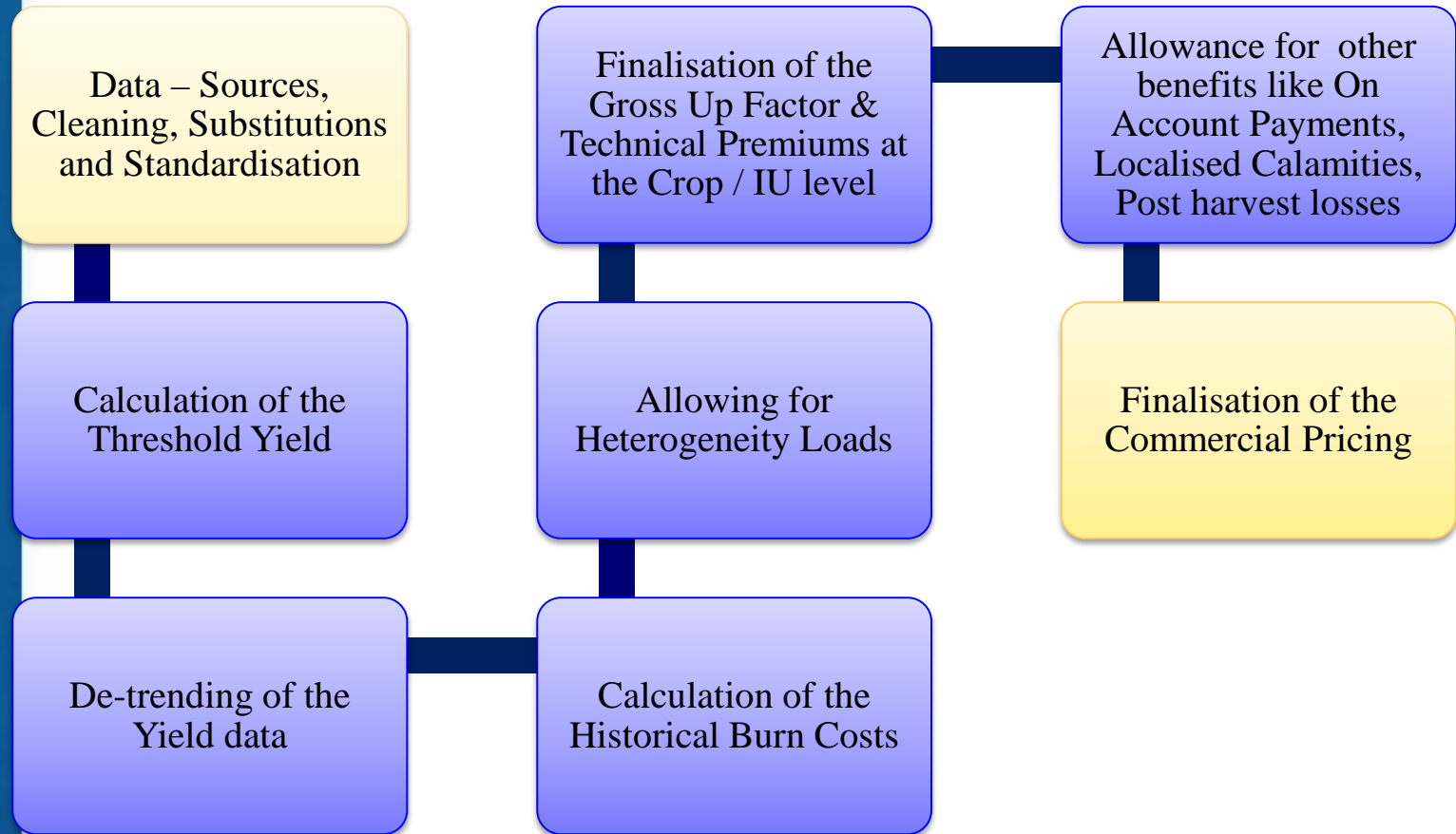- Claims settlement based on pre defined term sheet consisting of weather parameters.

3. Coconut Palm Insurance Scheme (CPIS)

- Risks covered against weather adversities like hailstorm, heavy rains, cyclones, flood, earth quakes, severe drought, etc. and pest/ diseases/ accidental fire, etc.
- Claims settlement will be done post loss assessment survey done with all stakeholders viz. Coconut Development Board (CDB) / Agriculture / Horticulture Department / State Agriculture University (SAU), as authorized by IA

Agenda

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Data – Sources, Cleaning, Substitutions and Standardisation

Finalisation of the Gross Up Factor & Technical Premiums at the Crop / IU level

Allowance for other benefits like On Account Payments, Localised Calamities, Post harvest losses

Calculation of the Threshold Yield

Allowing for Heterogeneity Loads

Finalisation of the Commercial Pricing

De-trending of the Yield data

Calculation of the Historical Burn Costs

Data Requirements – Essentials:

• Past Yield Data for every crop at the IU level (at the level at which claims will be settled)
• Past Sown Areas for every crop at IU level in hectares
• Proposed Sown Area for the coming year
• Past Insured Areas for every crop at the IU level in hectares
• Sum Insured – past & present
• Past Loss Ratios and performance

Data Requirements – Other Considerations:

• Past penetration levels especially in the loan farmers vs non loan farmers
• Seasonal Forecasts
• Internal factors like servicing mechanisms, costs for CCE and crop monitoring etc

Generally available for 10 years. However, more years of data is preferable (with every year, the data has got enriched by a year more – if the Companies has made effort to maintain them)

Other Challenges:
• Missing Data Points – how to substitute?
• Aggregation of data at different levels – IU level data not being available,
• Data Formats – although slowly improving, Last minute changes

Required at two levels – 1. at IU level to roll up the IU level premiums to districts. 2. at district level to roll up district level premiums to cluster level

Sum Insured changes to be tracked to understand level of coverage (State Governments determines the scale of finance)

Awareness, Publicity, Past practices of the State Government etc.. Has a lot of role to play here

Calculated as:
TY = (Average of last 7 years yields ignoring 2 worst years) * Indemnity level

Data – Sources, Cleaning, Substitutions and Standardisation

Finalisation of the Gross Up Factor & Technical Premiums at the Gross /IU level

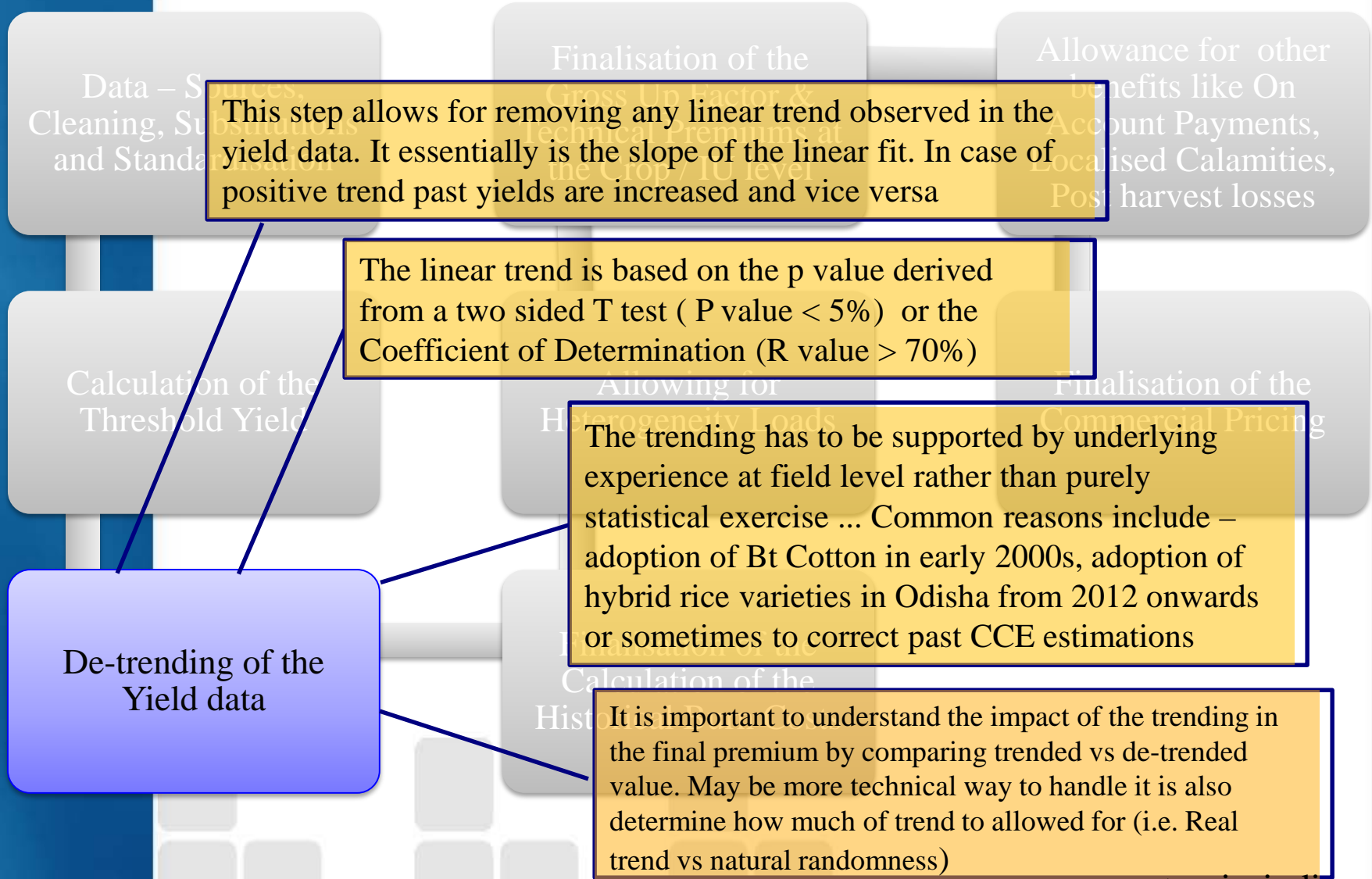**Allowance for other benefits like On Account Payments, Localised Calamities, Post harvest losses**
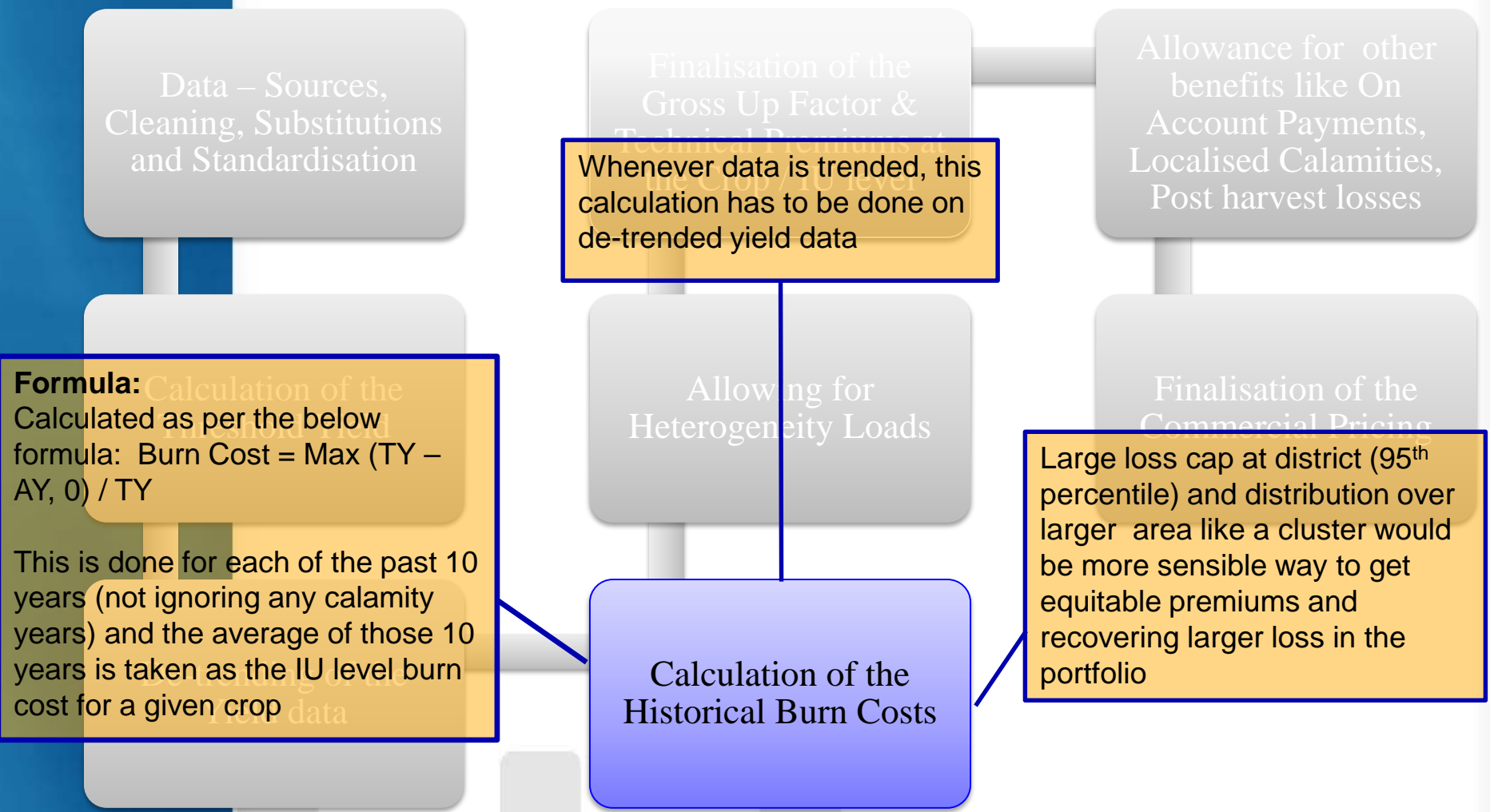
Actuarial / Business Logic:
Ignoring the two calamity year would act to increase the Threshold Yields and hence the commercial premiums. This can be viewed from an angle as an effective mechanism to direct the government subsidy to those IUs that are heavily affected by calamities

Calculation of the Threshold Yield

Allowing for Heterogeneity Loads

Finalisation of the Commercial Pricing

Indemnity Level:
It can be either 90%, 80% or 70%. The districts with high historical losses are generally given 70% indemnity level and vice versa. Generally it can be understood as a reflection of level of variability observed within an IU. District with very high Coefficient of Variation (> 31) under the NIAS scheme used to be assigned an Indemnity level of 60% and those with very low CV (<16) was assigned an Indemnity level of 90%. This seems to be continued here too.

De-trending of the Yield data

Data – Sources, Cleaning, Substitutions and Standardisation

Finalisation of the Gross Up Factor & Technical Premiums at the Crop / IU level

Allowance for other benefits like On Account Payments, Localised Calamities, Post harvest losses

This step allows for removing any linear trend observed in the yield data. It essentially is the slope of the linear fit. In case of positive trend past yields are increased and vice versa

The linear trend is based on the p value derived from a two sided T test (P value < 5%) or the Coefficient of Determination (R value > 70%)

Calculation of the Threshold Yield

Allowing for Heterogeneity Loads

Finalisation of the Commercial Pricing

The trending has to be supported by underlying experience at field level rather than purely statistical exercise ... Common reasons include – adoption of Bt Cotton in early 2000s, adoption of hybrid rice varieties in Odisha from 2012 onwards or sometimes to correct past CCE estimations

De-trending of the Yield data

Finalisation of the Calculation of the Historical Burn Cost

It is important to understand the impact of the trending in the final premium by comparing trended vs de-trended value. May be more technical way to handle it is also determine how much of trend to allowed for (i.e. Real trend vs natural randomness)

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Data – Sources, Cleaning, Substitutions and Standardisation

Finalisation of the Gross Up Factor & Technical Premiums at the Crop/IU level

Allowance for other benefits like On Account Payments, Localised Calamities, Post harvest losses

Whenever data is trended, this calculation has to be done on de-trended yield data

Formula:
Calculated as per the below formula: Burn Cost = Max (TY – AY, 0) / TY

This is done for each of the past 10 years (not ignoring any calamity years) and the average of those 10 years is taken as the IU level burn cost for a given crop

Calculation of the Threshold Yield

Allowing for Heterogeneity Loads

Finalisation of the Commercial Pricing

Calculation of the Historical Burn Costs

Large loss cap at district (95th percentile) and distribution over larger area like a cluster would be more sensible way to get equitable premiums and recovering larger loss in the portfolio

Data – Sources, Cleaning, Substitutions and Standardisation

Finalisation of the Gross Up Factor & Technical Premium at the Crop / IU level

Allowance for other benefits like On Account Payments, Localised Calamities, Post-harvest losses

Calculation of the Threshold Yield

Allowing for Heterogeneity Loads

Finalisation of the Commercial Pricing

Calculation of the Historical Burn Costs

Technically, the loading is increased as the 'level' differences increase and the number of years on which this allowed for. A further consideration has to be statistical credibility of the IU level data

Particulars	Implementations			
	Level 1	Level 2	Level 3	Level 4
Level 1	0%	15%	20%	30%
Level 2	0%	0%	15%	20%
Level 3	0%	0%	0%	15%
Level 4	0%	0%	0%	0%

Reason:
1. Aggregation of data at different level would inherently make trends and credibility of the data less dependable
2. The number CCEs would change if the aggregation is changed
3. The premium calculation and claim settlement are then on different basis
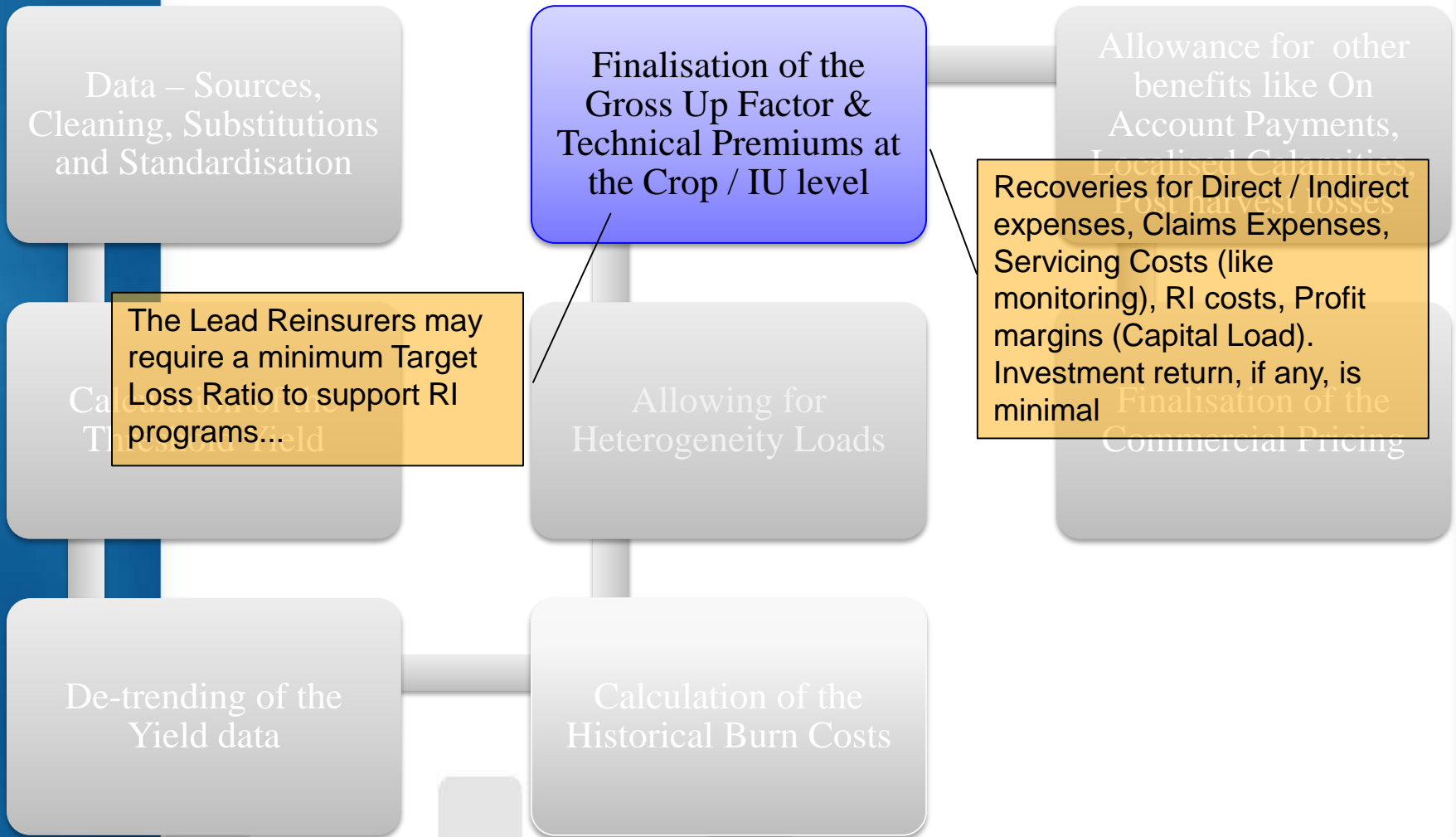
On Account Payment is for midterm losses / prevention of sowing (upto 25% of likely claims / SI respectively).

As dealt under large losses, distributing the expected value over the full portfolio would be better way of handling this (provided that Seasonal Projections, district infrastructure are fully understood before quoting). Another means of looking at this loading, is the impact these claims would have in the RI premiums / net lines of the Company. Checking past Rainfall data vs area sown can give some starting point for arriving at such loadings

Long Term contracts are more trickier, there are various tenders some provide long term for only certain season, other provide for both. Sometimes, states also option to quote different premiums for different years under a long term tender. Some other may require a single premium.

The reinsurer's may insist on certain minimum loadings. Apart from this, the CV of the yield in the past can be the starting point to consider the magnitude of this loading.

Allowance for other benefits like On Account Payments, Localised Calamities, Post harvest losses

Localised Losses are covered for Forest Fire, Landslide, Inundation, Hailstorm and Cloud burst.

For risk of some these perils like Forest Fire, Landslide and Hailstorm are to some extent understandable based on geography and historical experiences. Like hilly terrain and areas near forest fire zone has to be loaded for such perils. However, judgements do play a big role in arriving at these allowances.

Data – Source Cleaning and Standardisation

Calculation of the Threshold Yield

De-trending of the Yield

Calculation of the Premiums at the Crop / IU level

Allowing for Heterogeneity Loads

Calculation of the Historical Burn Costs

Finalisation of the

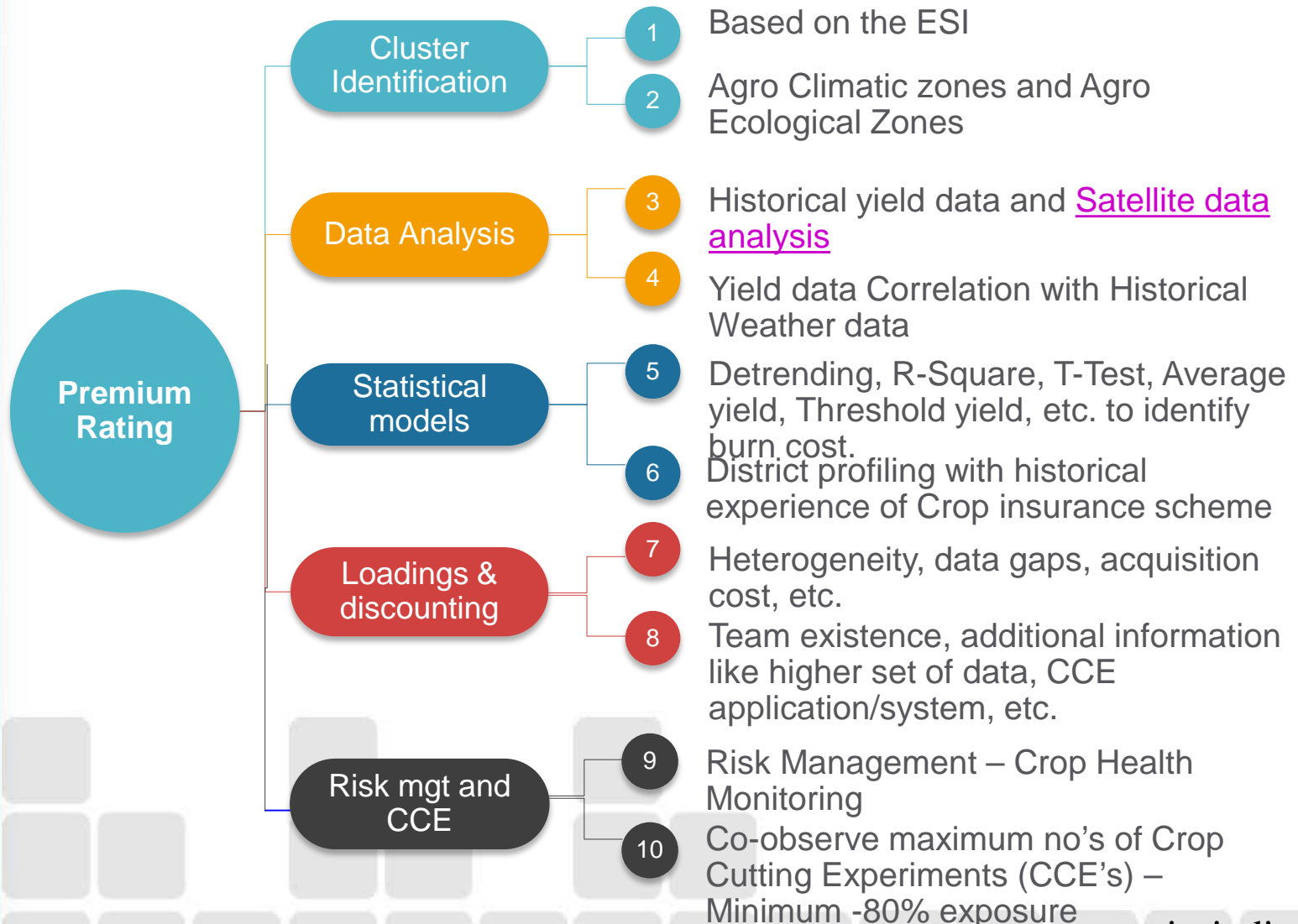| Illustration of arriving at single Cluster Rate from IU rates						
District	Insurance Unit	Crop1	Crop2	Area Sown in ha	Area Sown in ha	Formula Used
D1	IU1	5%	11%	1	0.5	
D1	IU2	6%	8%	2	0.6	
D1	IU3	7%	9%	3	0.7	
D2	IU1	9%	10%	10	3	
D2	IU2	10%	12%	11	4	
D2	IU3	11%	8%	12	6	
D1	All IU	6%	9%	6	1.8	Weighted rate based on the Area Sown at the IU level
D2	All IU	10%	10%	33	13	Weighted rate based on the Area Sown at the IU level
Cluster	All District	9.5%				Weighted rate based on the Area Sown at the District Level

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Pricing Methodology as per Underwriting Philosophy

Premium Rating

Cluster Identification
1. Based on the ESI
2. Agro Climatic zones and Agro Ecological Zones

Data Analysis
3. Historical yield data and <u>Satellite data analysis</u>
4. Yield data Correlation with Historical Weather data

Statistical models
5. Detrending, R-Square, T-Test, Average yield, Threshold yield, etc. to identify burn cost.
6. District profiling with historical experience of Crop insurance scheme

Loadings & discounting
7. Heterogeneity, data gaps, acquisition cost, etc.
8. Team existence, additional information like higher set of data, CCE application/system, etc.

Risk mgt and CCE
9. Risk Management – Crop Health Monitoring
10. Co-observe maximum no's of Crop Cutting Experiments (CCE's) – Minimum -80% exposure

Risk Implementation strategy - Strength

Distribution - Dedicated & Experienced team

Direct ownership by RGICL

Bank level Relationship

Risk area focused favorable non-loanee sourcing

Risk Management - On-field resources – 24x7

Independent Risk management team from day one of season

In-house call centre facility

Integrated in-house claim monitoring mobile APP

CCE Participation Man power allocation

Thank You

Analysis of Satellite data in Maharashtra

- The study area of Maharashtra state has been selected which will be analysed based on October and November data from year 2008 to 2018.

- Based on available satellite imagery data, we calculate the indices which are suitable for understanding the crop situation. We have used Modis data for the period of 2008-2012 to calculate NDVI and landsat-8 imagery data to calculate NDVI, NDMI for the period of 2013 to 2018.

- We have generated the maps of indices viz. NDVI, NDMI for the period of 2013 to 2018.