

CHAPTER 4: RESULTS AND DISCUSSION

4.1 INTRODUCTION

In this chapter, various aspects of the weather index insurance have been analyzed to understand how well it is able to mitigate climatic risks in agriculture. The chapter begins with the analysis of the existing WI products provided by different insurance providers. This analysis takes into account different methods adopted by the implementing authorities to differentiate between the weather index products of different insurance providers. Then one turns to the analysis of the different WI product designs to understand how well a particular product design identifies crop losses. Another aspect associated with the product designing is the basis risk, i.e., how well an insurance product pays when a real loss occurs. Attempts have been made to quantify the two types of basis risk: product and spatial, to have an optimal product design. Further, the analysis of various weather parameters was done to understand their impact on crop production. This analysis helps one to determine an optimal weather index product design taking into account the various factors that affect crop production. Finally, the analysis is done on the perspectives of the stakeholders in the crop insurance: farmers, state and insurance providers. The results of this analysis could be incorporated in the product design to make a more efficient and a marketable crop insurance product.

4.2. WEATHER INSURANCE PRODUCTS EVALUATION

This section of the chapter covers the evaluation of various WI products. The first part focuses on the products of different insurance providers and how well they perform as risk mitigation tools for the climatic risks, and the second part analyzes effectiveness of different WI product designs.

4.2.1. Comparison and evaluation of different Insurance Products

The key features of weather based insurance products are described below:

- (i) ***Start Day of Product:*** Sowing dates have a proven and significant impact on how weather influences the subsequent crop stages and their durations. For the *Kharif* season, the sowing date is largely a function of quantum of rainfall needed for sowing. There are two ways in which the

dynamic sowing date (varying from location to location and year to year) can be built into the WI product. One way is to incorporate the specific triggers which reflect the ideal conditions for sowing, into a weather insurance product. Suppose for groundnut in Gujarat, the ideal condition for sowing is more than 60 mm rainfall in 2-3 consecutive days. The date of sowing event can be identified from the rainfall data which may then be validated from local officials of the agriculture department. The dates of subsequent crop stages can be made conditional on the sowing cover, included in the WI product. Another way is to offer WI products in a location after the completion of the sowing event or on receipt of adequate rainfall (to complete the sowing) in a location. A basket of WI products can be offered to farmer-customers, in which the dates of constituent covers have start dates and durations, corresponding to the specific sowing date of the farmer-customers. Implementation of the latter approach would require the development of software platform for automation of WI product design/structuring.

(ii) *Commencement Dates & Durations of Key Stages:* Based on the sowing dates and specific agronomic information, the commencement dates and durations of key stages have to be identified. The concept of dynamic dates and durations of different covers, based on the difference in sowing dates, is rarely incorporated in the WI products currently sold under WBCIS.

(iii) *Weather Perils and Parameters of Significance for Key Stages:* After finalization of commencement dates and durations of key crop stages, it is necessary to enlist the set of perils of significance which can adversely affect the productivity at a given crop stage. The perils can be segregated into endogenous (internal/controllable) or exogenous (external/uncontrollable) for inclusion in WI products. For exogenous risks, the causative weather conditions have to be specified in terms of the key weather parameters. It is beneficial to include only those perils whose dependence on weather parameters (with long time series of historical data) is well-established and practically validated. It is imperative the strength of relationship of a particular weather parameter with a given peril has to pass stringent tests of scientific rigor.

(iv) *Period of Time for Consideration of each Relevant Weather Parameter:* Once specific weather perils are identified for inclusion in WI product, period of time for consideration of the

relevant parameters has to be meticulously chosen. In case of deficit rainfall, the period of consideration may be upwards of seven (7) days. In most WI products, the period of consideration of rainfall under deficit rainfall volume cover is one month or more. With improvement in product design and customer understanding, this level may be brought down fortnightly level. In case of excess rainfall, the maximum allowable period of consideration may be three or four days with daily, two-day or three-day cumulative rainfall set as triggers/strikes for pay-out. The period of consideration for temperature parameter, more pertinent for *Rabi* crops, has greater uncertainty and possibility of error. This is borne out of multiple weather parameters, like frost, heat, humidity, rainfall etc. driving the weather-related losses in *Rabi* crops. Therefore, greater attention has to be accorded to this aspect when standardization of weather product for *Rabi* crops is done.

(v) **Relative Significance/Weight for Each Period of Consideration or Peril:** The occurrence of weather peril may cause different economic impact (loss) in different periods of consideration for a peril. For example, deficient rainfall in the 1st week of September causes different degree of loss compared to deficient rainfall in 3rd week of September. In order to differentiate between or provide relative significance to various periods under a given cover, weights or multiplying factors are given to such periods.

(vi) **Design of Weather Index:** A weather index is essentially a function which expresses the economic variables (revenue/income/yield) in terms of weather parameters. Values of a weather index for crop insurance represent different levels of crop productivity and thus indicate the economic manifestation of weather parameters (in terms of yields). One such example is Heating Degree Days (HDD) index which is one of the first indices developed. The idea of structuring a HDD index came about in order to correlate revenue fluctuations and temperature. Analysis of the relationships between temperature and demand for heating in the North America showed that the threshold of 65 degree F was the turning point for increase in energy demand for heating. Based on such a threshold, number of heating degrees per day is given by:

$$HDD = \max[0^\circ, 65^\circ - T]$$

where, T is the average of the high and low temperatures of the day

(vii) Caps/Floors/Triggers/Strikes/Threshold Values for Specific Weather Parameter: These values can be deemed to be the most critical parameters for a weather insurance product. The interplay of these values with the indemnity payment rates (or notional) control a trade-off between the protection level inherent in a WI product and the corresponding price (premium) for the given protection level. It is during the process of setting the caps/floors/triggers/strikes and the indemnity payment rates (or notional) that the greatest dilution takes place in a WI product, in terms of the protection offered by it.

(viii) Pay-out Rates/ Pay-out Structure: Pay-out rates determine the quantum of compensation payable at different values of index under a WI product. Pay-out rate structure for WI product can be (i) Binary pay-outs, (ii) Layered pay-outs (iii) Proportional pay-out, etc.

The graph of the indemnity pay-out structure is a vital tool for understanding how the sum assured for a WI product is distributed across the entire spectrum of the weather index. The curvature or flatness of a pay-out structure gives a quick indication of the lumped or well-distributed nature of indemnity for a WI product.

(ix) Historical Pay-out Distribution: It is the year-wise distribution of claims as simulated for all historical years, considered for the structuring of a WI and computation of pure risk premium through burn cost method. The graph of historical pay-out distribution when viewed in conjunction with the term sheet of a WI product provides an instant snapshot of the pay-out frequency, level of loading and protection level. It is one of the most useful tools for evaluation of a WI product. A sample historical pay-out distribution graph for maximum temperature peril for wheat crop in Bharatpur (Rajasthan) is given below for illustration. The term-sheet for the same WI product precedes the graph.

TABLE 4: TERM SHEET FOR TMAX WI PRODUCT FOR WHEAT IN BHARATPUR

Cover (Phase)	1-Jan-09
To	31-Mar-09
Strike (HDD)	0
Exit (HDD)	10
Standard Loss Rate between strike and exit	600
Policy Limit (INR)	6000

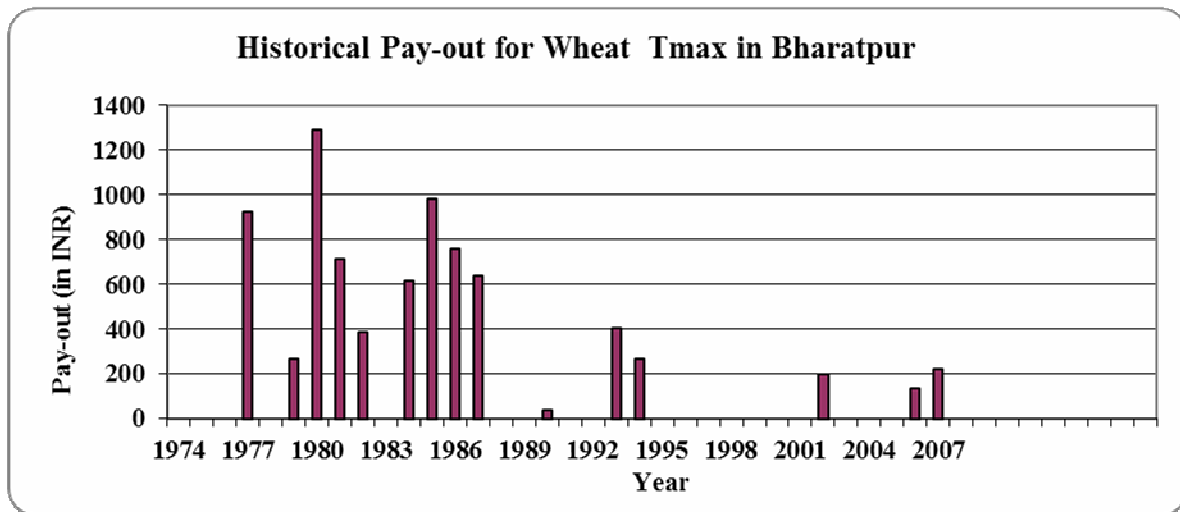


FIGURE 3: HISTORICAL PAY-OUT DISTRIBUTION GRAPH FOR PRECEDING TERM SHEET

The involvement of designated agencies of the State government in the administration of WI has led to the standardization of the fundamental design of WBCIS products. Benchmarking can help in assessing the relative strengths and weaknesses of seemingly identical products. A workable framework for benchmarking of WI products may not be a substitute for the specialized technical manpower for evaluating the multitude of products offered under WBCIS, but can at least be helpful in the in-term. A simple benchmarking can be done in the following ways:

- a) **Pay-out Frequencies for Rainfall Insurance Products:** The pay-out frequency of a rainfall insurance product is more easily understood in terms of the pay-out cycle or the return period for pay-out. The pay-out cycle or return period indicates the average number of years in which an insurance product has yielded a pay-out historically. For a more comprehensive assessment, the pay-out cycles or return periods corresponding to various levels of pay-out can be calculated and compared for different insurance products. Such an exercise was done for the products of three different insurance providers in the Indian market.
- b) **Economic Value and Pricing Indicators for Rainfall Insurance Products:** Pricing of weather insurance is almost entirely done in India using the burn cost method. This is the simplest method of WI product pricing. It involves taking historical values of the weather index, and applying the weather product to these values for computing the historical pay-outs. The average of these historical pay-outs is deemed as the burning cost. The total premium

charged by an insurer for its WI product is constituted of two main components, viz., expected loss (burn cost) and risk margin. The burn cost derived from the simulation of pay-outs of a WI product is taken as the expected loss. This component is expected to be paid out (on an average basis) for every season of coverage under a given WI product. The other component – risk margin, is determined by the risk preferences of the (re)insurance company providing the risk protection: that is, by how they measure the cost of risk with respect to return for the purposes of risk management, capital allocation and business expenses.

Pay-out Frequencies for Rainfall Insurance Products

WI products originally offered for *Kharif* 2011 by three different insurance providers in Bijapur (Karnataka) under WBCIS were analyzed for groundnut, sunflower and pigeon pea (Table-5).

TABLE 5: COMPARISON OF PAY-OUT CYCLE FOR TEST PRODUCTS IN BIJAPUR (KARNATAKA)

Crops	Groundnut			Sunflower			Pigeon pea		
Insurance Provider	'X'	'Y'	'Z'	'X'	'Y'	'Z'	'X'	'Y'	'Z'
No. of Years	35			35			35		
Policy Limit (INR)	15000			15000			15000		
No. of Pay-out Years	20	13	32	21	14	32	24	14	31
'A' (%)	Pay-out Cycle (in Years) for Pay-out > 'A' % of Policy Limit								
1	20	13	27	21	26	14	24	29	14
2.50	20	13	24	21	21	14	24	25	14
5	16	9	17	18	16	12	18	17	11
10	9	4	10	7	6	7	9	11	6
15	6	1	6	6	3	5	7	6	2
20	3	1	3	5	3	2	3	5	2
25	2	0	2	4	3	2	3	3	2
30	2	0	2	4	2	1	2	2	0
40	1	0	0	0	1	0	1	0	0
>50	0	0	0	0	0	0	0	0	0

Considering the groundnut product, the pay-out cycle for a pay-out (irrespective of its quantum) is 1.8 (=20/35) years for insurer 'X' and 2.7 years and 1.1 years for insurer 'Y' and 'Z', respectively. This

indicates that a pay-out under the groundnut product, on an average, takes place every 1.8 years in case of insurer 'X' and every 2.7 years and 1.1 years in case of insurer 'Y' and 'Z', respectively. For pay-out (as proportion of policy limit) levels exceeding 1 percent, 2.5 percent and 5 percent of the corresponding policy limits, the pay-out cycle increases to 1.3, 1.5 years and 2.1 years for insurer 'Z' whereas it is significantly higher at 2.7 years, 2.7 years and 3.9 years for insurer 'Y'. In respect of sunflower product for the same location, the pay-out cycle (irrespective of its quantum) is 1.1, 1.7 and 2.5 years for insurer 'Z', 'X' and 'Y', respectively. At the pay-out level of 30 percent of the policy limit, the pay-out cycles under the pigeon pea product from insurer 'Y' become infinite, indicating the absence of any pay-out exceeding 25 percent of policy limit, as per the historical pay-out distribution. For the same product insurer 'X' has pay-out cycle, though long (35 years) for more than 40 percent of the policy limit.

The groundnut and pigeon pea product of insurer 'X' and sunflower product of insurer Z shows a return period of 35 years for a pay-out equivalent to 40 percent of the policy limit. For pay-out levels exceeding 15 percent of the policy limit, all the products except the sunflower product of insurer 'X' and pigeon pea product of insurer Z have a pay-out cycle of above 10 years. The pay-out cycles of all three crops products from insurer Z are much shorter than those of the product from insurer 'Y' at all levels of pay-out (1 percent to 40 percent of the policy limit) except at 10 and 15 percent of policy limit in sunflower product. Next to insurer Z, insurer 'X' has the shorter pay-out cycles. A shorter pay-out cycle would manifest into higher frequency of pay-out. No product has a finite pay-out cycle for pay-out levels exceeding 40 percent of the policy limit highlighting the fact that there are no historical incidences of pay-out greater than 40 percent of the policy limit for any of the three products of any insurer.

Inference

Pay-out cycle (pay-out frequency) of 1.1 to 2.7 years hardly make WBCIS an insurance product. This appears more like a money swapping deal. Insurance provider 'Y' fares better compared to others, but the fact that his 'maximum payout' over 35 years is at about 20 percent of the policy limit for groundnut, 40 percent for sunflower and 30 percent for pigeon pea, may not make it a sound insurance product (in the light of over five of the 35 years recording major yield losses in excess of 75 percent). 'Z' insurance provider has the highest pay-out frequency pay-out, with maximum pay-outs almost

similar to ‘Y’, making it the least effective product. Of the three, ‘X’ insurance provider has done relatively better in terms of the ‘maximum pay-out’ with 40 percent for groundnut, 30 percent for sunflower and 40 percent for pigeon pea. In all, none of the three look like insurance products, though ‘X’ fares better than others.

Comparison of Pricing Indicators for Chosen Products

Table 6 compares groundnut, maize and guar (cluster bean) products offered for *Kharif* 2009 by two different insurance providers in three locations of Rajasthan on key pricing indicators which can enable a better understanding of the economic value imparted to the customer and the value for the subsidies extended by the government.

TABLE 6: COMPARISON OF PRICING INDICATORS FOR GROUNDNUT, MAIZE AND GUAR PRODUCTS (IN INR)

Crop	Ground nut		Maize (corn)		Guar (cluster bean)			
	‘X’	‘Y’	‘X’	‘Y’	‘X’	‘Y’	‘X’	‘Y’
Insurance Provider								
Location	Chittorgarh		Chittorgarh		Jodhpur		Jaisalmer	
Policy Limit	13,000	15,000	15,000	13,500	10,000	15,000	10,000	15,000
Premium	1,300	1,655	1,500	1,100	1,000	1,655	1,000	1,655
Burn Cost	402	108	563	286	641	214	585	311
Risk Margin (% of Premium)	898 (69)	1,547 (93)	937 (62)	814 (74)	359 (36)	1,441 (87)	415 (42)	1,344 (81)
Highest Historical (% of Policy Limit)	2484 (19)	1435 (9.6)	3086 (21)	1316 (9.8)	2712 (27)	2075 (14)	3500 (35)	5884 (39)

The expected loss components (burn costs) for groundnut and maize products of ‘X’ for Chittorgarh are 31 percent and 38 percent, respectively. This means that these products are expected to pay-out 31 percent and 38 percent of the premium on an average. On the other hand, the expected pay-out in terms of premium for the same products of ‘Y’ is 7 percent and 26 percent, respectively. The highest historical pay-outs for groundnut and maize products of ‘X’ for Chittorgarh are 19 percent and 21 percent, respectively of the respective policy limits. On the other hand, the highest historical pay-outs for the same products of ‘Y’ are 9.6 percent and 9.8 percent, respectively.

The burn costs for guar products of ‘X’ for Jodhpur and Jaisalmer are 64 percent and 58 percent respectively. On the other hand, it is 13 percent and 19 percent respectively for the same products of ‘Y’. The highest historical pay-outs for guar products of ‘X’ for Jodhpur and Jaisalmer are 27 percent and 35 percent, respectively of the respective policy limits. On the other hand, the highest historical pay-outs for the same products of ‘Y’ are 14 percent and 39 percent, respectively.

Inferences

‘X’ insurance provider for all the four products compared to ‘Y’ has better pay-out returns (as can be seen from higher burn cost and lower risk margin). ‘X’ also has the highest historical pay-outs for three of the four products, making it relatively a better product compared to ‘Y’. Another point that comes out of the analysis is, each insurance provider has his own way of pricing the product, or perhaps are using totally different weather data sets for the same location, or both.

The policy limit or sum assured of a WI product is a misnomer as it is perceived as the maximum pay-out that can be expected for that product in the worst case scenario. However, in actual practice, the highest historical pay-out denotes the greatest cumulative pay-out (sum of pay-outs of all constituent covers) among all the cumulative pay-outs simulated historically from a WI product. The quantitative difference between policy limit and the highest historical pay-out for a WI product represents the ‘financial gap’ between the maximum pay-out committed by the product and the actual pay-out that could be expected from that product even in adverse years. In order to improve the economic value imparted to farmer-subscribers, it should be ensured that the highest historical pay-out for WI products should be at least 50 percent of the policy limit.

The analysis of the WI products of the three major insurance providers in the market points to the urgent need for product ‘benchmarking’, as well as creating a technical body to guide and have oversight of the insurance providers.

4.2.2. Comparison and Evaluation of Different Product Designs

Here, the four product designs, viz., Key factor index product, Aggregate rainfall product with dry spell, Market product with crop stage-wise volume and dry spell and INFOCROP based crop growth simulation model –Rainfall volume have been analyzed for the *Kharif* season; and the three

products designs, viz., CRIDA Model, INFOCROP (IARI) based crop growth simulation model- Temperature deviation and Market product for temperature have been analyzed for the *Rabi* season.

4.2.2.1. Historical Maximum Payouts Comparison among the Designs

For comparison of the various product designs, the historical payouts were adjusted such that Pure Premium Rate¹⁴ (PPR) or Burn Cost for each of the product was 10 percent without any change in the frequency of payouts. The adjusted ‘Maximum Payout’ for each product design and location is shown in Figure 4.

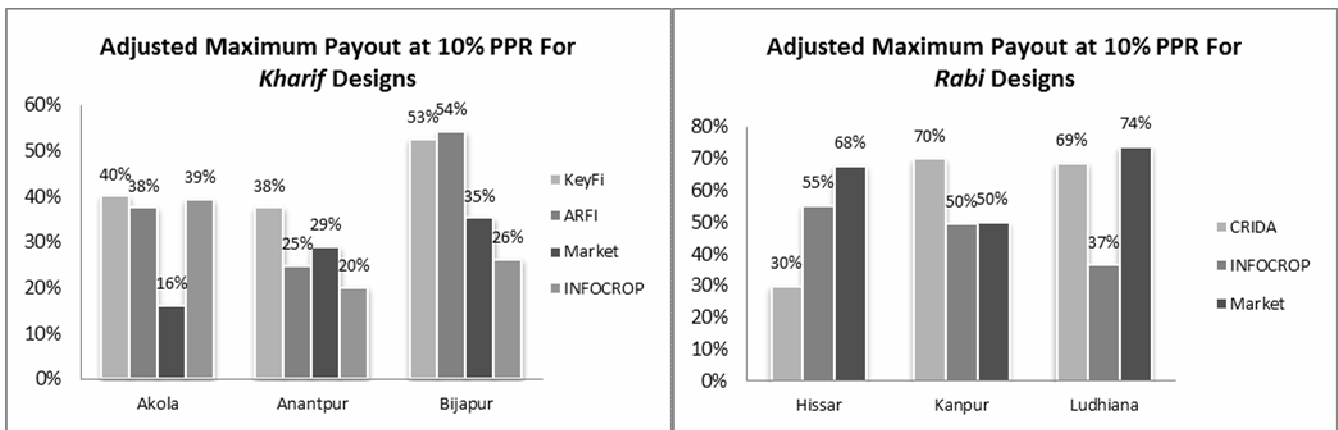


FIGURE 4: BAR CHART SHOWING ADJUSTED MAXIMUM PAYOUTS AT 10 PERCENT PPR FOR ALL WEATHER INDEXED PRODUCT DESIGNS (A) KHARIF AND (B) RABI

It is evident from Figure 4 (*Kharif*) that the Key Factor Index (KeyFi) product has been consistently performing well in the sense of historical maximum payout as compared to other products for *Kharif* designs. The INFOCROP based crop product turned out to be the least effective product. From Figure 4 (*Rabi*), it is evident that ‘Market’ product has been consistently performing well in the sense of historical maximum payout as compared to other products for *Rabi* designs.

4.2.2.2. A Comparison of Product Design against Yield Loss

Yield Loss-

$$\text{Yield Loss} = \frac{\text{Max}(0, \text{Actual Yield} - \text{Guaranteed Yield})}{\text{Guaranteed Yield}}$$

¹⁴ Pure Premium Rate or Burn Cost is the average claim size based on the historical payouts, and is expressed as percentage of the sum insured

Here Guaranteed Yield has been assumed as 100 percent of mean yield of 15 years.

4.2.2.2.1. Assessment of Scatter Plots

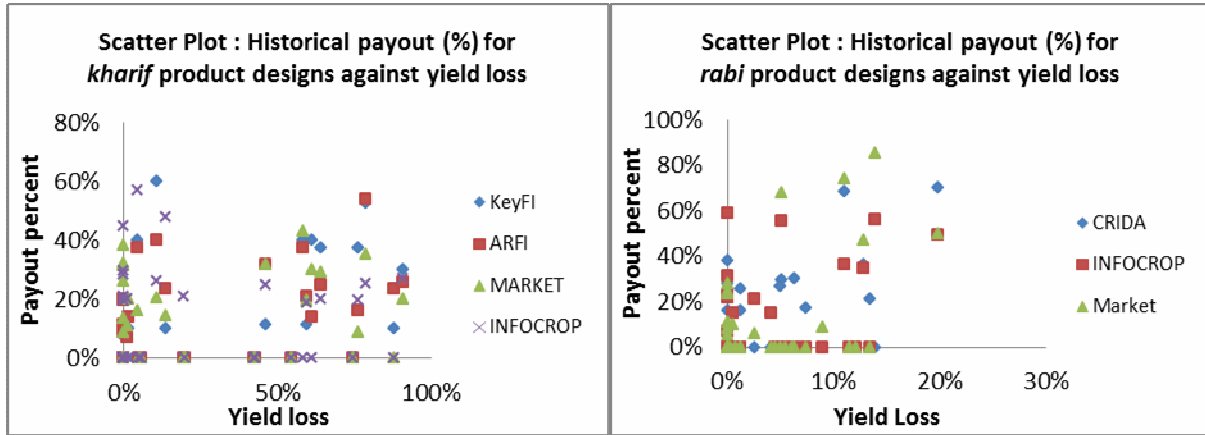


FIGURE 5: SCATTER PLOTS FOR HISTORICAL PAYOUT (PERCENT) FOR PRODUCT DESIGNS AGAINST YIELD LOSS

To have a clearer view, a trend line was drawn for the scatter plot due to each product design along with Ideal line. Particulars of the trend line are shown below in Table 7.

TABLE 7: PARTICULARS OF TREND LINE OF HISTORICAL PAYOUTS DUE TO PRODUCT DESIGNS AGAINST YIELD LOSS (PERCENT)

Season	<i>Kharif</i>				<i>Rabi</i>		
Particulars	KeyFI	ARFI	MARKET	INFOCROP	CRIDA	INFOCROP	Market
Slope	27.3	22.8	13.8	7.7	155	110	196
Intercept	4.4	5.4	7.2	8.4	4	6	2
R Square	25.4	23.3	9.3	3.6	20	10	23

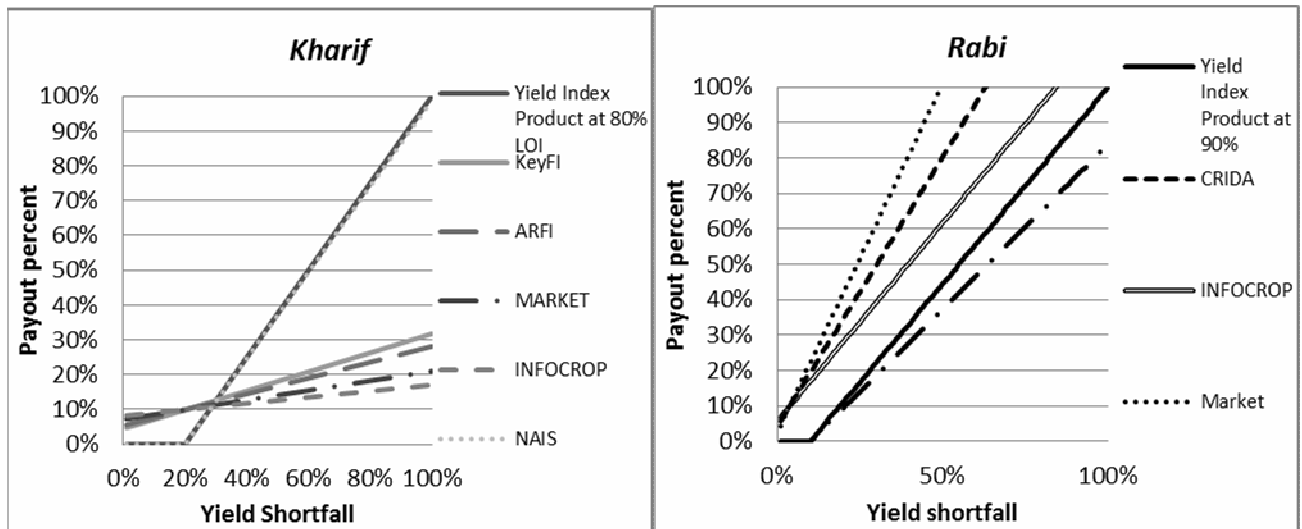


FIGURE 6: TREND LINE (PERCENT) FOR HISTORICAL PAYOUT FOR PRODUCT DESIGNS: YIELD INDEX VS WEATHER INDEX PRODUCTS

After examining scatter plot and trend line for different product designs for both *Rabi* and *Kharif* seasons following observations were made:

- 1) In the scatter plot, for the *Kharif* season, higher yield loss incidences, i.e. yield loss >50 percent, were observed while for the *Rabi* season, no incidences of higher yield loss.
- 2) In Figure 6, the trend lines for *Kharif* products are below the ideal line while trend lines for *Rabi* products are above the ideal line. This means that, on an average, *Rabi* products are making over-payments while *Kharif* products are making under-payments at 10 percent PPR.
- 3) Among *Kharif* products, trend line for KeyFi product has the highest slope and lowest intercept, and also the line closest to the ideal line. Also, the trend line for aggregate rainfall index products has the second highest slope, slightly less than aggregate rainfall index products.
- 4) Among *Rabi* products INFOCROP-*Rabi* Product looks closest to ideal line but because there are no incidences of higher yield loss for *Rabi*, we cannot have much belief on the trend line. Among *Rabi* products, second closest trend line belong to CRIDA model product.

The study also looked at performance of WI products for *Kharif* and *Rabi* seasons taking the case of a year with the highest yield loss. The worst case scenarios (highest yield loss) for the products, which happen to be 2006 for groundnut crop in Anantapur, and 2006 for wheat in Kanpur, are presented below:

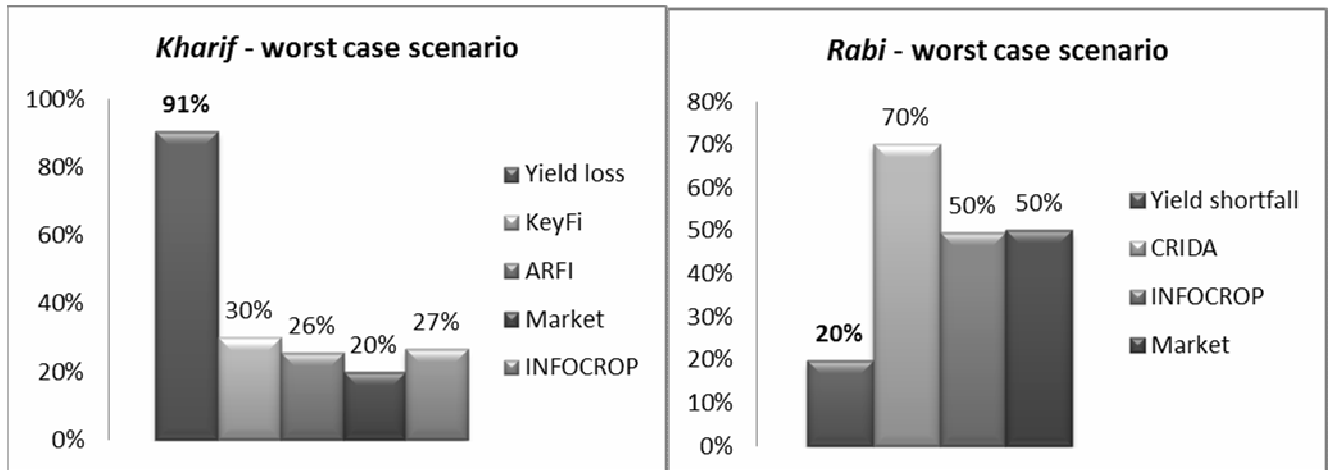


FIGURE 7: HISTORICAL WORST CASE SCENARIO IN TERMS OF YIELD LOSS FOR BOTH KHARIS AND RABI SEASONS

- 1) From Figure 7 (*Kharif*), it can be understood that the yield loss is as high as 91 percent, while the payouts from the weather products is low. It is 30 percent for the Key factor index product, 26, 20 and 27 percent for INFOCROP product, aggregate rainfall product, and Market products, respectively. Thus, it can be inferred that the existing WI products (irrespective of the design) are poor proxies for area yield insurance. Nevertheless, within WI products, the Key factor index product gives marginally a higher payout compared to other WI products.

- 2) From Figure 7 (*Rabi*), the highest yield loss was 20 percent, while WI (temperature) based products gave 50 percent, 50 percent and 70 percent payout for INFOCROP product, Market product and CRIDA products, respectively. As mentioned before, since the worst case scenario (yield loss) is as low as 20 percent it is not possible to examine whether any of the products is paying well or not.

Since payouts of WI products have not shown good correlation with area yield loss (as clear from Figure 7), an attempt has been made to see if large payouts under WI products corresponded to a large area yield losses, as follows:

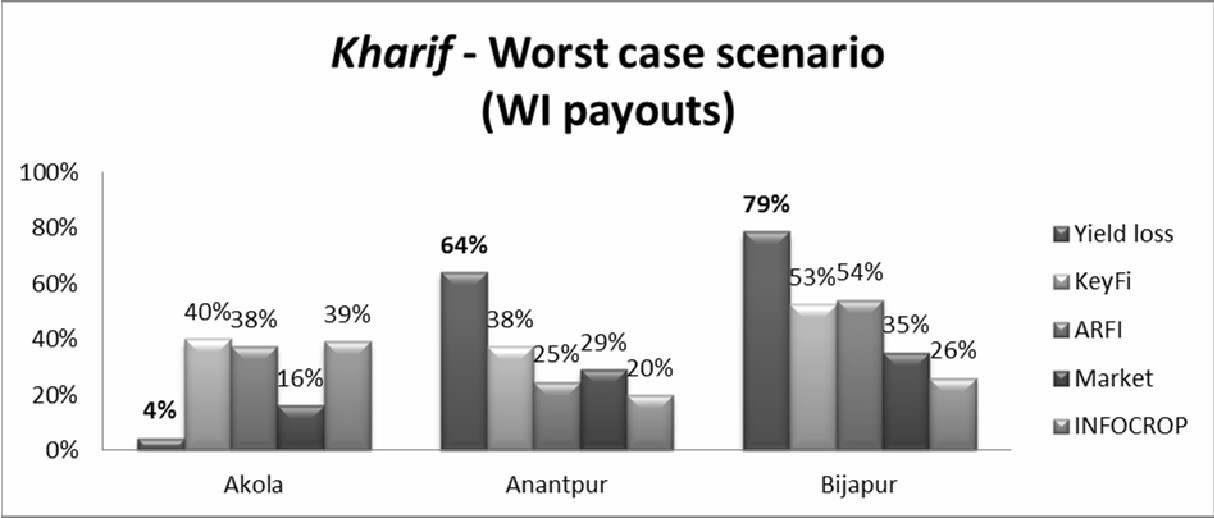


FIGURE 8: HISTORICAL WORST CASE SCENARIOS IN TERMS OF PRODUCT PAYOUTS FOR *KHARIF*

From the earlier analysis (4.2.2.2.) it could be inferred that Key Factor Index (KeyFi) performed well for *Kharif* season, hence, the primary comparison attempted is between KeyFi payout and yield loss. Akola (soyabean-2003) happened to show 40 percent payout for KeyFi, which is highest of all WI product payouts. However, the corresponding yield loss was mere 4 percent. In case of Anantapur (groundnut – 2002) there appears to be better correlation with KeyFi at 38 percent (highest of all the WI products) and yield loss at 64 percent. Bijapur (jowar – 2003) too, had shown even better correlation with KeyFi at 53 percent and yield loss at 79 percent. Akola is showing a 40 percent WI payout though yield loss was only 4 percent is stand-out divergence compared to other two locations. However, overall WI worst case scenario payouts (Figure 8) vis-à-vis yield loss appears to be better correlated compared to Yield loss worst case scenario vis-à-vis WI payouts (Figure 7).

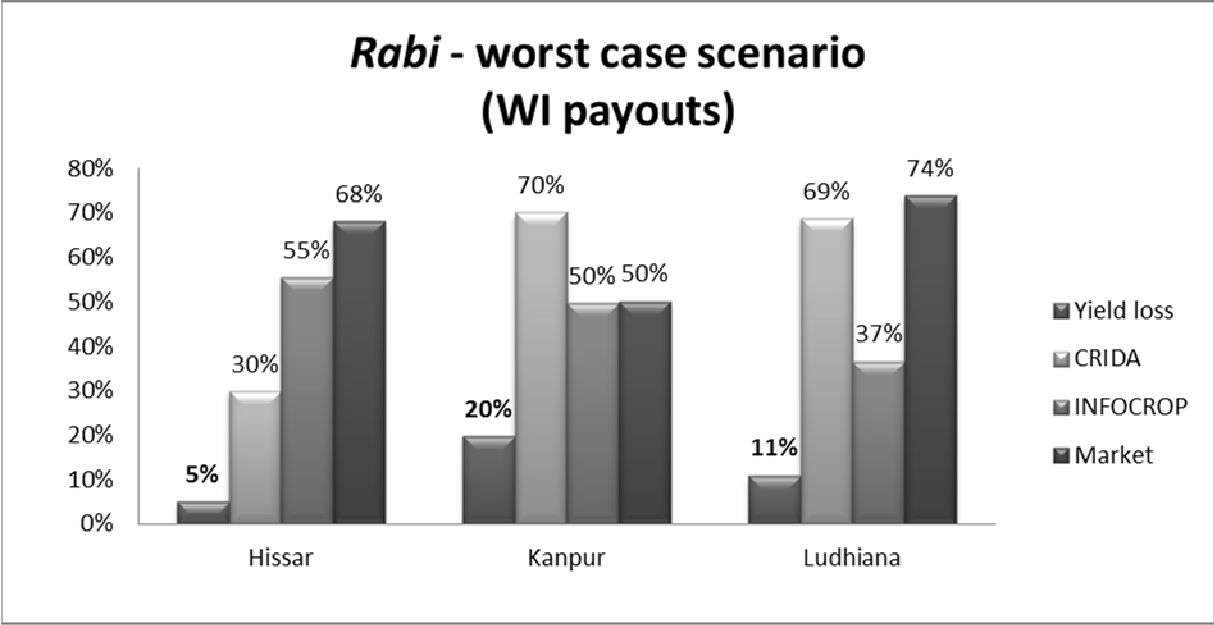


FIGURE 9: HISTORICAL WORST CASE SCENARIOS IN TERMS OF PRODUCT PAYOUTS FOR *RABI*

From the earlier analysis (4.2.2.2.), INFOCROP (IARI) performed well for *Rabi* season, hence, the primary comparison attempted is between INFOCROP payout and yield loss. INFOCROP based WI product in Hissar (wheat – 2010) happened to show 2nd best payouts at 55 percent with the corresponding yield loss at merely 5 percent. Kanpur (wheat – 2006) also happens to give 2nd best WI payout with a corresponding yield loss at 20 percent, improving the correlation. Ludhiana (wheat – 2006) maintained the correlation with 37 percent under WI payout and yield loss at 11 percent. Overall WI payouts have not corresponded (Figure 9) vis-à-vis the yield losses. Also yet again, it proves that *Rabi* WI product (temperature) is overpaying compared to the yield loss.

4.2.2.2.2. Calculation of Pearson product-moment correlation coefficient and Spearman rank correlation coefficient

Pearson’s product moment and Spearman’s rank correlation coefficient between historical yield losses and historical payouts were calculated from the weather-based product designs, and their significance tested.

TABLE 8: PEARSON'S CORRELATION COEFFICIENT BETWEEN YIELD LOSS AND WEATHER PAYOUTS AND CORRESPONDING T-VALUE AND P-VALUE

Product Designs	Correlation (%)	t-value	P-value (%)
KeyFI-Kharif	49.68	3.754	0.56
ARFI-Kharif	47.38	3.528	0.78
MARKET-Kharif	30.31	2.086	7.05
INFOCROP-Kharif	16.91	1.125	29.31
CRIDA-Rabi	45.23	3.326	1.05
INFOCROP-Rabi	32.11	2.223	5.69
MARKET-Rabi	47.58	3.547	0.75

TABLE 9: SPEARMAN RANK CORRELATION COEFFICIENT BETWEEN YIELD LOSS AND WEATHER PAYOUTS AND CORRESPONDING T-VALUE AND P-VALUE

Product Designs	Correlation (%)	t-value	P-value (%)
KeyFI-Kharif	33.21	2.30913	4.98
ARFI-Kharif	33.09	2.29962	5.05
MARKET-Kharif	22.51	1.51518	16.82
INFOCROP-Kharif	10.41	0.68625	51.19
CRIDA-Rabi	23.33	1.57350	15.42
INFOCROP-Rabi	11.20	0.73901	48.10
MARKET-Rabi	15.86	1.05354	32.29

The study revealed that:

- 1) Pearson's correlation coefficient and Spearman rank correlation coefficient for Key Factor Index were highest and significant at 5 percent level of significance. Among *Kharif* products, the aggregate rainfall index product was second in the sense of significant Sample Correlation coefficient and Spearman rank correlation coefficient.
- 2) Among *Rabi* products, only CRIDA and Market- *Rabi* Product had significant correlation coefficient and CRIDA product had the highest Spearman rank correlation coefficient, but it was not significant.

4.2.2.2.3. Plotting of linear best fit lines for probability of positive claim from indexed based product designs against yield loss

Historical payouts were first constructed from weather index product designs to Bernoulli data i.e. '1' for positive payout and '0' for no-payout. Then, a linear regression was fitted with yield loss.

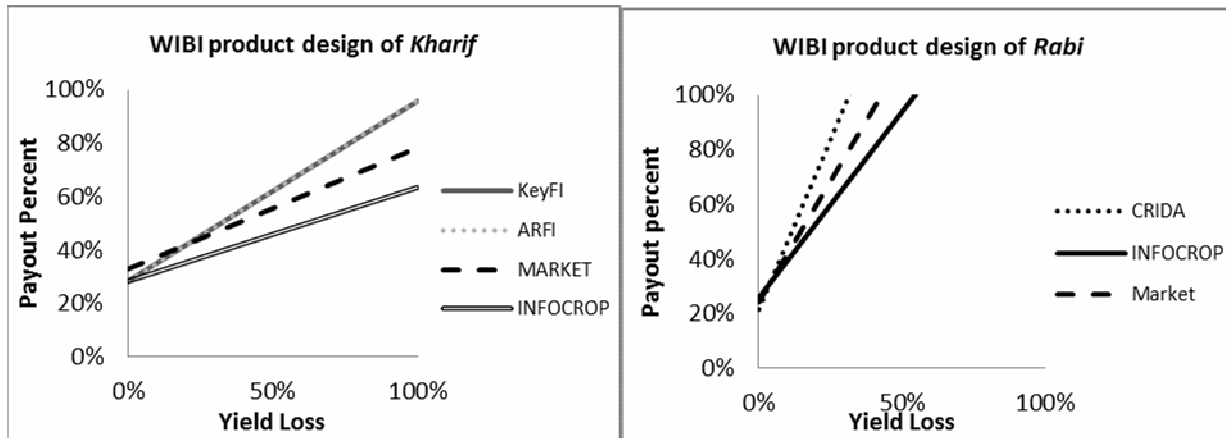


FIGURE 10: KERNEL REGRESSION: PROBABILITY OF POSITIVE CLAIM AGAINST YIELD LOSS FOR ALL WEATHER INDEX PRODUCT DESIGN

The study revealed that:

- 1) For *Kharif* products, the line of regression for probability of positive claim due to Key Factor Index product and aggregate rainfall index product were almost coinciding and had the highest slope among *Kharif* products. This means that these products presented a better probability of paying claims in the event of yield loss.
- 2) For *Rabi* products, the line of regression for probability of positive claim due to CRIDA model product had the highest slope. Again for this product, the probability that it gives a payout in the event of yield loss is highest.

Another important observation is that both *Kharif* and *Rabi* WI products, as mentioned before, are likely to give payouts despite no loss in yield, though it's marginally higher for *Kharif*.

4.2.3. DISCUSSIONS

The analysis was done to identify the optimal product from the group of products being offered currently.

For the *Kharif* season, four products were considered viz., Key Factor Index Product, Aggregate Rainfall Index Product, Market-*Kharif* Product and INFOCROP (IARI)-*Kharif* Product. Among these the best product turned out to be the 'Key Factor Index' Product. It had the highest 'maximum payout' for all considered combinations of crop and locations of *Kharif* season. The trend line for the historical payout against the yield loss for this product was closest to the ideal condition among all the *Kharif* products. Both Pearson's product moment and Spearman's rank correlation coefficients between

historical yield losses and historical payouts were the highest as well as significant for this product. Also, the line of the probability of positive claim with respect to yield loss had the highest slope and the lowest intercept, another ideal situation for the Key Factor Index product.

The Aggregate Rainfall Index Product was the second best product in terms of all the parameters, except for the line of the probability of positive claim with respect to yield loss coinciding with the Key Factor Index line. The poorest product among all the four *Kharif* products was the INFOCROP (IARI)-*Kharif* Product. It had the lowest ‘maximum payout’ for all the considered combinations of crop and locations of *Kharif* season. The trend line for the historical payout against the yield loss for this product was most distant from the ideal condition among all the *Kharif* products. Both Pearson’s product moment and Spearman’s rank correlation coefficients between historical yield losses and historical payouts were insignificant for this product. Also, the line of the probability of positive claim with respect to yield loss had the lowest slope and the highest intercept for the INFOCROP (IARI)-*Kharif* Product.

The Market-*Kharif* Product was slightly better than INFOCROP (IARI)-*Kharif* Product in terms of all the parameters taken into account, except for the Pearson’s product moment and Spearman’s rank correlation coefficients. However, the Key Factor Index Product and Aggregate Rainfall Index Product were still better than the Market *Kharif* Product.

For the *Rabi* season, the three products considered were: CRIDA model Product, INFOCROP (IARI)-*Rabi* Model Product and Market-*Rabi* Model Product. It was observed that Market-*Rabi* Model Product is the best model when ‘maximum payout’ and correlation coefficients were considered. However, when considering the trend line for the historical payout against the yield loss INFOCROP-*Rabi* Model Product turned out to be better. The CRIDA model was the best on considering the line of the probability of positive claim with respect to yield loss. Thus, one could not obtain clear results as to which of the models could be considered the most optimal. The reasons for this problem were then explored. In the case of *Rabi* season, the yield losses were very low, and the maximum yield loss that was observed was just above 20 percent. In fact, there was not a single event of a catastrophic loss at any of the locations considered. Consequently, none of the products could accurately depict the conditions at the locations. In other words, WBCIS product was over-paying when it came to

temperature (heat) cover. Moreover, all the products were taken to be at 8 percent PPR (as allowed under WBCIS) that led to an overestimation in the historical payouts.

Given the parameters under consideration, the CRIDA model on an average proved to be better than the other two models. It had the second highest ‘maximum payout’ for Ludhiana and Kanpur and lowest for Hissar. The trend line for the historical payout against the yield loss for this product was second closest to the ideal condition. The Pearson’s product moment correlation coefficient between historical yield losses and historical payouts was second highest and significant for this product. Also the line of the probability of positive claim with respect to yield loss had the highest slope and the lowest intercept for the CRIDA model.

Certain additional points should be kept in mind while interpreting the analysis. First, weather data is a point data (belongs to a point where weather station is installed) and yield data is the mean of sampled data of an area (sub-district). Thus, the comparisons of point and area estimates are not always feasible. Second, *Kharif* product considered here had only deficit rainfall volume cover while there may be risks other than this. Similarly, *Rabi* product considered here had temperature cover while the other risk factors were not considered.

4.3. BASIS RISK

This section considers the basis risk calculations. The results of the analysis for the Rajasthan dataset are presented below. The results have been divided into two sub-sections, viz., product basis risk and spatial basis risk.

4.3.1. PRODUCT BASIS RISK

For analysis in this sub-section, the yields have been expressed as a percentage of the average yield for a crop in the respective tehsils, and the WI payouts as a percentage of the average WI payouts for the products. The analysis is based on 256 insurance products involving four crops for *Kharif* 2011 season and 372 insurance products involving four crops for *Kharif* 2012 season.

The Pearson product-moment correlation coefficient for tehsil average yields and tehsil-level claim payments are given in Table 10. With the exception of dry-spell cover, it appears from this table alone that the products offered in 2012 had a lower basis risk than those in 2011, as the correlations are more

negative. However, such a conclusion would be premature, as what is of most concern for a farmer is that he / she receives a claim payment in very bad years; and he / she is less concerned with the correlation between claim payments and yields in good years.

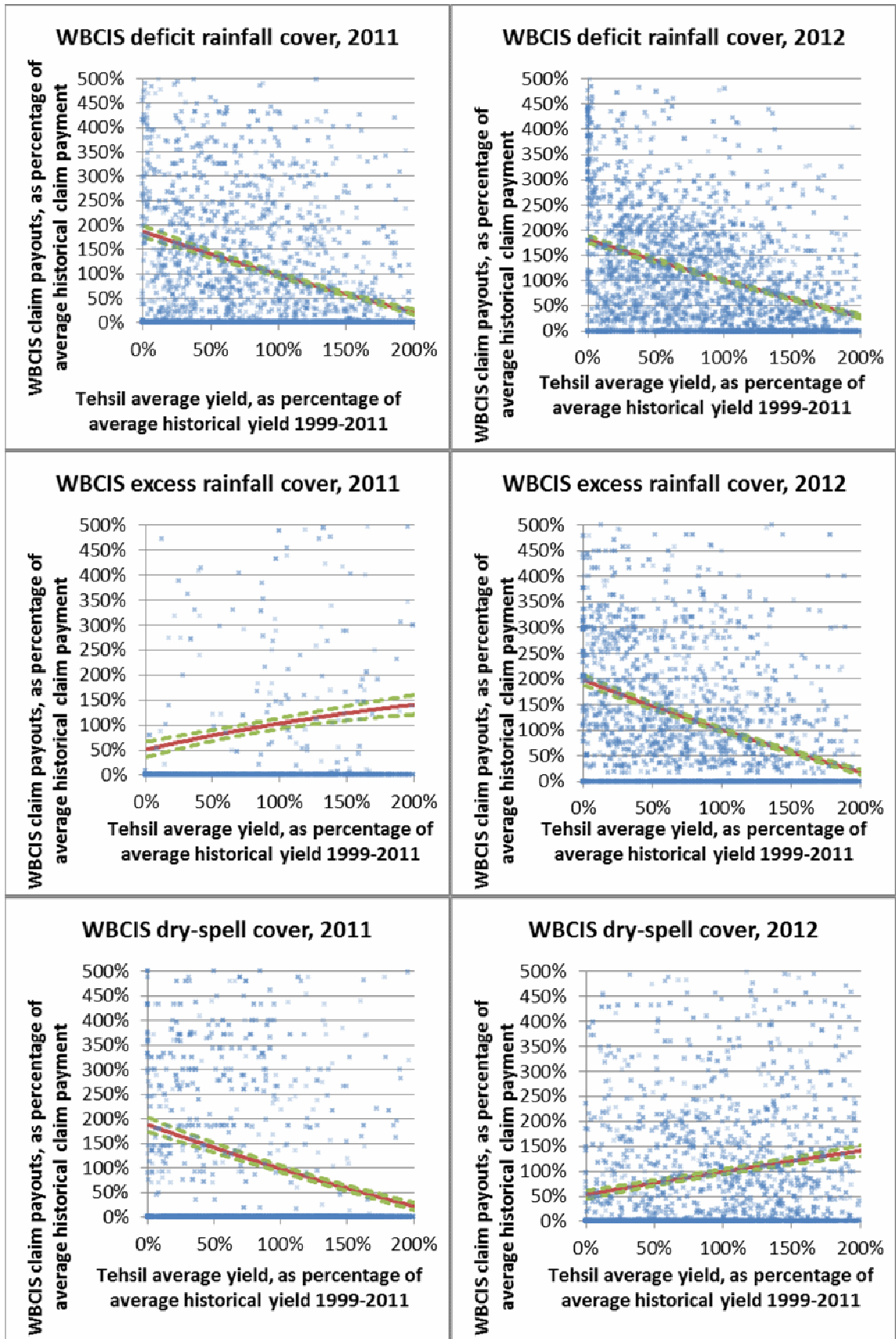
TABLE 10: CORRELATION BETWEEN YIELDS AND CLAIM PAYMENTS FOR DIFFERENT TYPES OF PRODUCTS

Element of WBCIS cover	Pearson product-moment correlation coefficient	
	Products sold in 2011 (percent)	Products sold in 2012 (percent)
Volume deficit rainfall cover	-27	-39
Volume excess rainfall cover	8	-35
Dry-spell rainfall cover	-22	14
Volume-deficit and dry-spell rainfall cover	-33	-33
All WBCIS cover	-28	-40

Note: A lower, more negative correlation corresponds to a lower basis risk since low yields should correspond to high claim payments

To understand this, a full joint probability distribution between yields and claim payments for the set of the products has been considered. Figure 10 presents scatter plots and nonparametric best fit lines for each of the ten products considered. The best fit lines may be interpreted as the expected claim payment rate conditional for a given yield rate. The lines show the point estimate and 95 percent confidence intervals for an Epanechnikov kernel¹⁵ with a bandwidth of 0.8. One may read off these smoothed best fit lines estimates for the expected claim payment for that product type for a given yield loss.

¹⁵The kernel regression is a non-parametric technique in statistics to estimate the conditional expectation of a random variable. The objective is to find a non-linear relation between a pair of random variables X and Y .



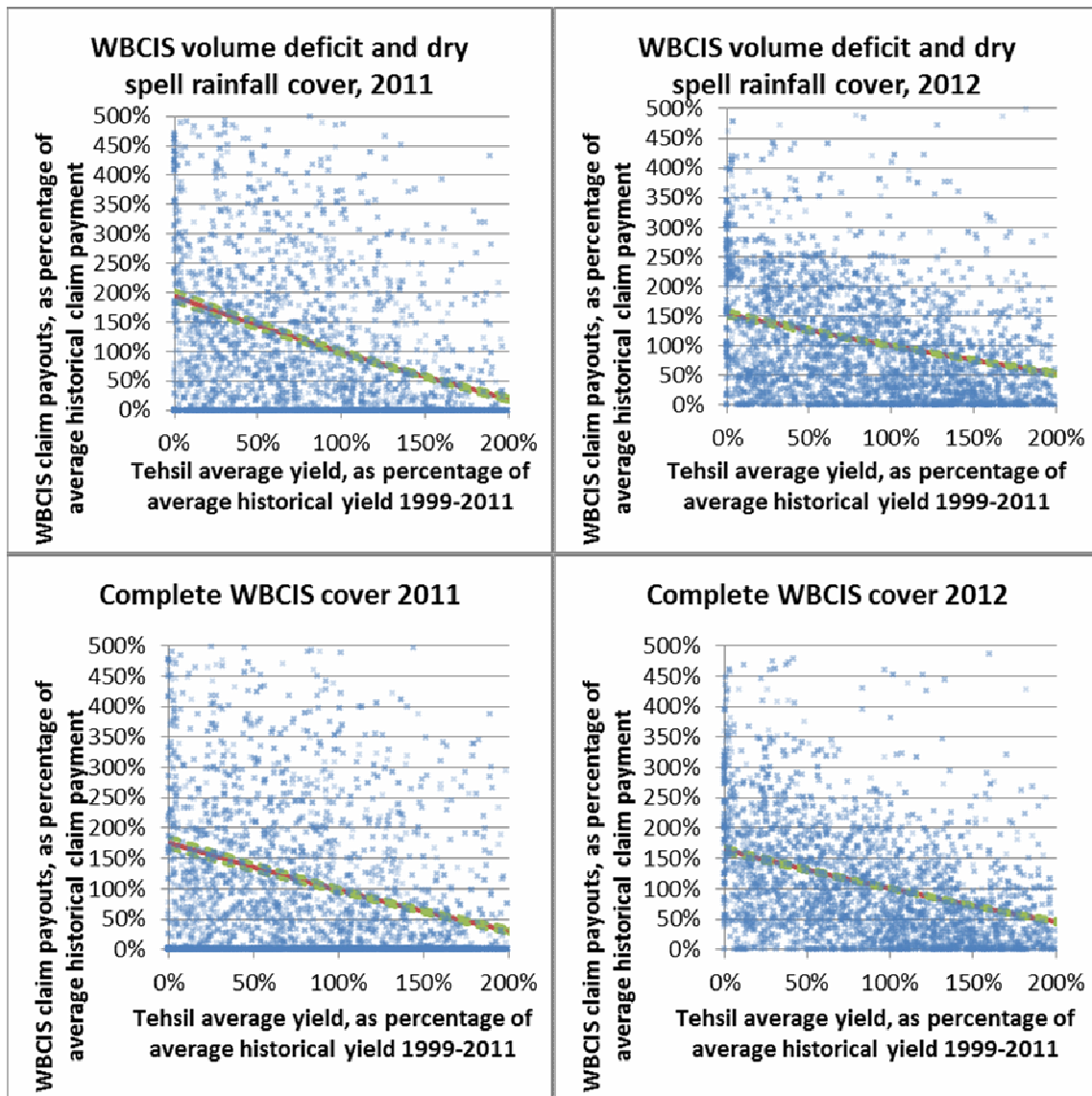


FIGURE 11: SCATTER PLOTS AND KERNEL REGRESSIONS FOR DIFFERENT SETS OF WIBI PRODUCTS

It is possible to compare different products by asking what the average claim payment rate would be conditional on total crop loss, i.e. an area average crop yield of zero, or different levels of partial crop loss. The tables in Annexure-8 present the average claim payment rate conditional on area average crop yield at 0 percent, 50 percent, 70 percent and 90 percent of the average for each of the ten different product types considered.

As is clear from the tables in Annexure-8, the 2011 products appear to be significantly better than the 2012 products in terms of providing a higher average claim payment in the worst years; the average claim payments conditional on total crop loss as a percentage of the historical average claim payment

is 175 percent for the 2011 products as compared to 164 percent for the 2012 products. Moreover, this difference is statistically significant. The lower confidence interval for the average claim payments conditional on total crop loss as a percentage of the historical average claim payment is 166 percent for the 2011 products, 164 percent point estimate for the 2012 products.

Indeed, with the exception of 2011 excess rainfall cover policy element, which by itself seems to have substantially higher basis risk than the 2012 excess rainfall cover policy element, each individual element of 2011 cover has lower basis risk than the corresponding 2012 element of cover.

These results are the reverse of the earlier results that the Pearson product-moment correlation coefficient was more negative for the 2012 products than the 2011 products. However, as already mentioned, this earlier result based on correlations is less interesting than the results from the nonparametric kernel density smoother exercise. The earlier result placed equal weight on the strength of the relationship between claim payments and yields in the good years as in the bad years, although this is clearly not appropriate for WIBI products.

The products offered across Rajasthan in 2011 have been found better than the products offered in 2012 as they offered higher average claim payments in the worst years, and that this difference was statistically significant at 5 percent level of significance.

Evidence has also been found in this study to suggest that WIBI product designers should focus on the relative strengths of WIBI products, viz. capturing rainfall deficiencies. For both the 2011 and 2012 collections of products, basis risk would have been lower if products had only the volume deficit rainfall element of cover, with all other covers removed. This suggests that the other elements of cover were together increasing basis risk relative to a pure deficit rainfall product.

Next step was to check whether the WIBI product pays when the farmers need it most. With the farm yields taken as a benchmark, one may test how efficient the weather products offered are. This was done by the calculation of the probability of payments with respect to the level of yield losses experienced. In this analysis, the 2011 product has been considered.

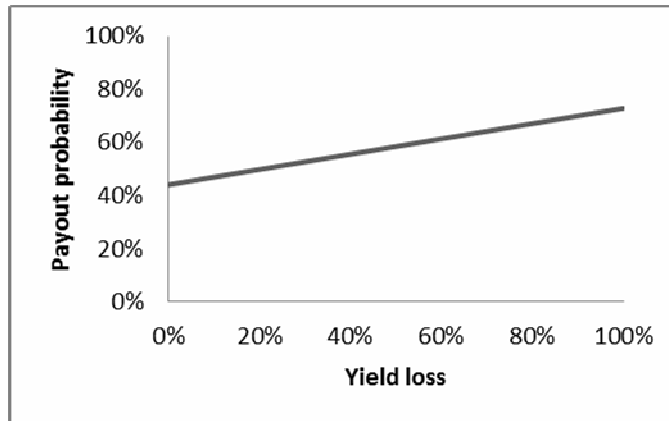


FIGURE 12: LINEAR PAYOUT OF PAYOUT PROBABILITIES AND YIELDS LOSS

A perusal of Figure 12 reveals that even when there is no shortfall in yield, there is about 40 percent chance that the WIBI product would give the payout. On the other hand, if there is 100 percent shortfall in yield, the probability that a payout would be given under WIBI is only 73 percent. This strongly suggests that the foremost objective of insurance, which is to indemnify the loss when it occurs, is not met in the design of this WIBI product. It, therefore, can be concluded that the present set of WIBI products offered in the market are poor proxies to actual yield losses.

4.3.2. SPATIAL BASIS RISK

In this section, the dataset corresponding to Jaipur district has been used. The distances between the weather stations and the tables of the conditional probabilities, correlations and standard deviations are given in Annexure-9.

The available time-series data on rainfall for Jaipur district was categorized into ‘good’, ‘normal’ and ‘bad’ years in terms of the quantum of rainfall received during the south-west monsoon. Within this categorization, three specific years’ corresponding to ‘good’, ‘normal’ and ‘bad’ years were selected for the analysis. A year where the June-September rainfall is more than 120 percent of the long period average rainfall is considered as ‘good’ rainfall year. The year where the June-September rainfall is within 80 to 120 percent of long period average rainfall, is considered as ‘normal’ rainfall year, and the year where the rainfall is below 80 percent of long period average rainfall, is considered as ‘bad’ rainfall year. Accordingly, year 2010 categorized as ‘good’, year 2004 as ‘normal’ and year 2002 as ‘bad’ rainfall years.

First the conditional probabilities of the rainy days, events of ‘rather heavy rainfall’ and dry-spells were analyzed.

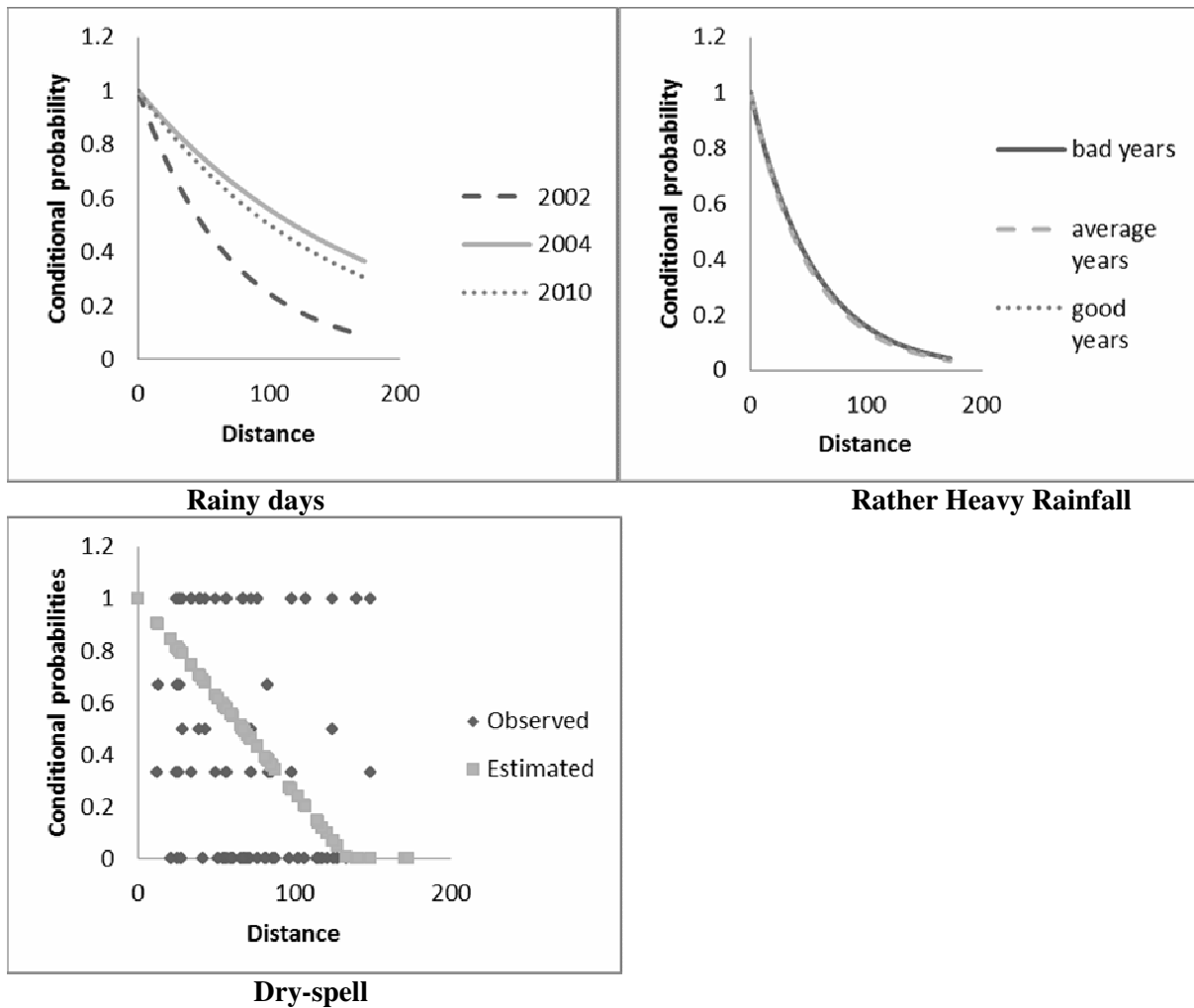
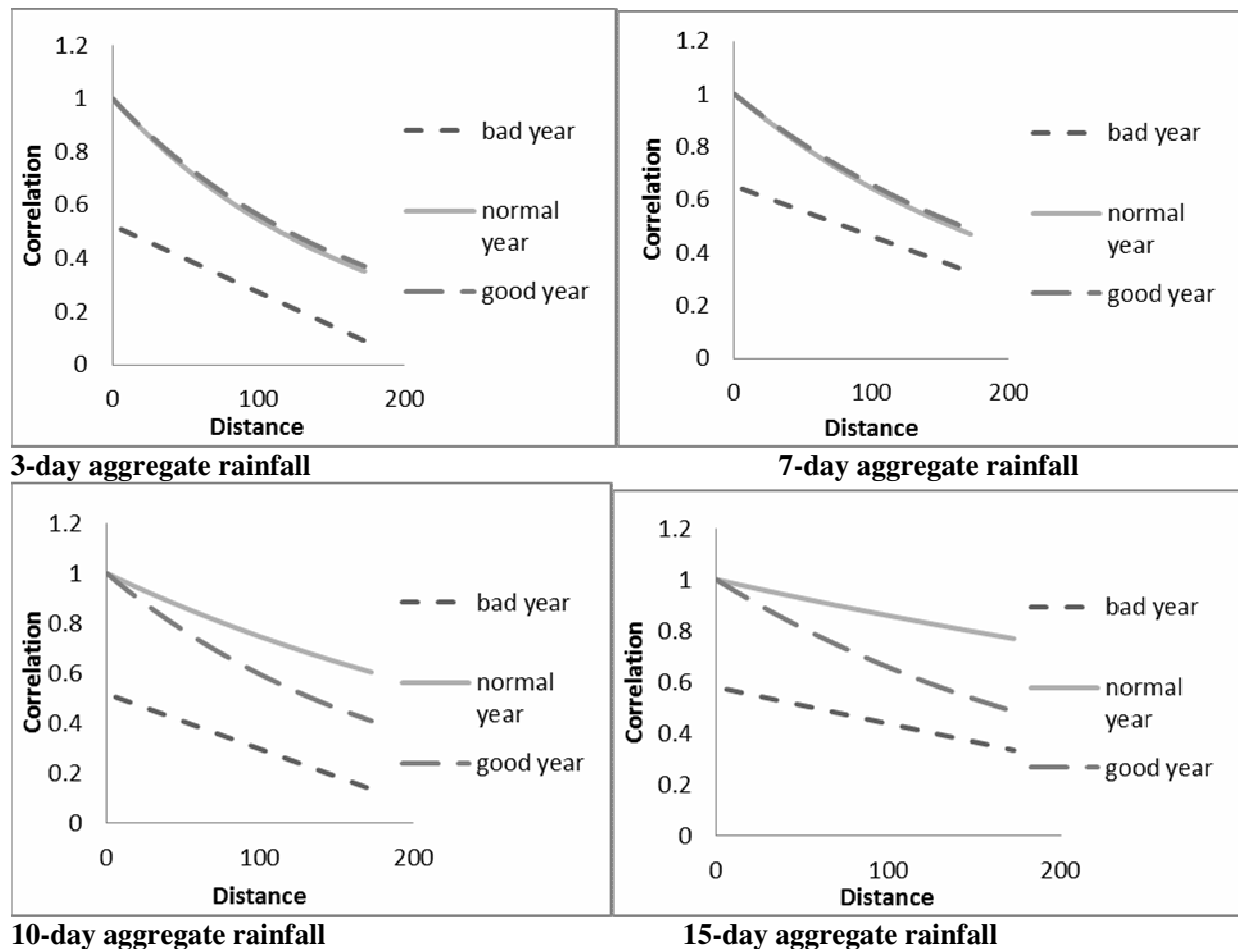


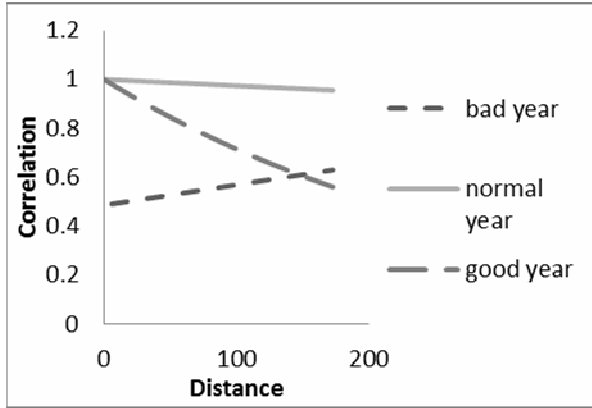
FIGURE 13: SCATTER PLOTS FOR CONDITIONAL PROBABILITIES AND DISTANCES (SPATIAL BASIS RISK)

It was observed that for first two scenarios, probabilities and distances exhibited exponential relationships. In general, as one moves away from the base weather station, the conditional probabilities decrease in an exponential manner. The event of rainy days exhibited that for the bad year 2002 there was a greater exponential decrease in the probabilities with the distances as compared to that in the average year 2004 or a good year 2010. However, the event of rather heavy rainfall was not affected by the amount of rainfall experienced over the years. The relationship was almost similar for all the good, bad and normal years.

The event of dry-spell, on the other hand, exhibited a rather odd behavior. The occurrences of dry-spell in the weather stations exhibited some relation with the distances. Though the fitted linear model was statistically significant, the coefficient of regression for the model was very low. Consequently, it can be concluded that the event of dry-spell has a statistically significant relation with the distances between the weather stations; however, this regression may not exhibit a true nature of the relationship between the occurrences of dry-spell and the distances from the reference weather station. Thus to accurately monitor the risk of dry-spell, one has to establish weather stations at close proximity that need to be insured. Moreover, there were some stations where the dry-spells were not observed, which further contributed to the null probabilities which made the analysis difficult.

Next was the analysis of the aggregate rainfall over a different period of days, viz., 3, 7, 10, 15 and 30 days. Figure 14 shows the relationship between of the aggregate rainfalls of the weather stations for good, bad and normal years as the distances from the reference weather station is increased (A measure of aggregate rainfall was used to classify a year as good, bad or normal).





30-day aggregate rainfall

FIGURE 14: CORRELATIONS OF AGGREGATE RAINFALLS BETWEEN THE WEATHER STATIONS AND DISTANCES

It was observed that as one moved away from a weather station, the correlation between the two corresponding stations decreased in general. Also, as the span of aggregation increased, the correlation between the weather stations improved. In fact, increasing the span of aggregation had a negative impact on the relation between the correlation coefficient and the distances between the weather stations.

TABLE 11: EXPONENTIAL MODEL FOR 7 CONSECUTIVE DAYS FOR THE YEAR 2004

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.721	0.520	0.515	0.357

TABLE 12: EXPONENTIAL MODEL FOR 15 CONSECUTIVE DAYS FOR THE YEAR 2004

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
0.637	0.405	0.399	0.156

From Table 11 and 12 it can be inferred that as the span of aggregation increases the value of the coefficient of determination (R^2) of the models fitted decreases. Thus, it is concluded that as the number of consecutive days over which the rainfall is aggregated increases, the distances between the weather stations exhibit lower correlations with the rainfall patterns. However, the correlations improved as the period of aggregation was increased.

These results were same for the years that experienced normal rainfall (2004) and good rainfall (2010). Although for the calamity year, the results were different from the ideal situation (Figure 14). Firstly, it was observed that there were various instances where the correlation between the stations was negative, making the analysis further difficult. One had to resort to the linear regression to understand the relationship between the correlation coefficients and the distances.

Further, as the span of aggregation increased, the linear regression model (and, as a matter of fact any other model, as for example exponential, quadratic etc.) could not depict accurately the variations between the correlations and the distances between the weather stations. Thus, it can be concluded that as the number of days over which the rainfall is aggregated increases, the relation between the correlations and the distances between the weather stations diminishes.

An attempt was made to analyze the correlations as the number of consecutive days' increases, but it was not possible to fit a statistically significant regression model. The causes of this behavior were then determined. Firstly, since 2002, was a calamity year, there was very high variability in the data that resulted in high deviations in the correlation coefficients. Also, there was scarcity of rainfall quantities that further made analysis difficult.

After analyzing the rainfall events, it was the turn of the WIBI product and how well it pays when one moves away from the reference weather station.

The equation of the fitted model was:

$$\sigma(|P_b - P_k|) = 5.0925 * D_{bk} + e$$

where,

$\sigma(\cdot)$ is the standard deviation;

P_b is the payout at the base weather station;

P_k is the payout at the k th weather station;

D_{bk} is the distance between the base weather station and the k th weather station, and

e is the error -component.

The value of the coefficient of determination is 0.793. Thus, one can infer that 79.3 percent of the variations in the absolute difference in the payouts were explained by the distance between the weather stations. The remaining 20.7 percent of the variations in the data were due to the randomness in the data or other factors.

To find whether or not the given model fits well to the data, the following hypotheses were developed, i.e.

H_0 : There is no statistically significant relationship between the response variable and the predictor variable.

H_1 : There is statistically significant relationship between the response variable and the predictor variable. The ANOVA table under the null hypothesis is given in Table 13:

TABLE 13: ANOVA TABLE FOR THE SPATIAL BASIS RISK

	Sum of Squares	Df	Mean Square	F	Sig.
Regression	1.704E+07	1	1.704E+07	348.838	6.870E-33
Residual	4.444E+06	91	48839.565		
Total	2.148E+07	92			

From Table 13, one can see that the p-value of the given test was 6.870E-33 which is less than 0.05. Hence, the null hypothesis is rejected at 5 percent level of significance, and one may conclude that there is statistically significant relationship between the response variable and the predictor variable.

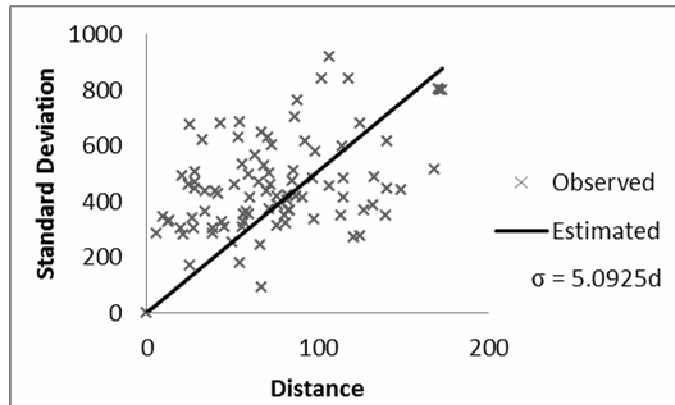


FIGURE 15: SCATTER PLOTS OF STANDARD DEVIATIONS WITH DISTANCES

In Figure 14, a comparison of the observed standard deviations of the absolute differences in the payoffs with the estimated standard deviations has been presented. It can be seen that the given model is a good fit. The standard deviation of the absolute differences is ‘0’ with a distance of ‘0’ km, which is in accordance with the assumptions. Also, as one moves away from the base station, the variations in the payoffs increase linearly.

4.3.3. INTERPRETATION AND IMPLICATIONS FOR POLICY

The interpretation of the analysis requires care due to data limitations. First, if the quality of yield data is poor, then the statistical analysis could suggest a low correlation despite the WIBI product having low basis risk. The yield data is based on crop cutting experiments¹⁶ which may not be wholly reliable. However, there is limited evidence of over-reporting of yields by the state government machinery, and so whilst the extreme left hand sides of Figure 10 may be underestimated, the right hand sides, which suggest that much of the WIBI premium pays for claim payments in good years, are likely to be more reliable.

Second, weather data is a point estimate, whereas yield estimate is based on a certain number of samples taken from the area based on multi-stage stratified random sampling. A comparison between the two becomes highly difficult due to this reason. Any discrepancy in determining the basis risk is sometimes attributed to the differences in the point and area phenomena.

¹⁶The CCEs consist of identification and marking of experimental plots of a specified size and shape in a selected field on the principles of random sampling, threshing the produce and recording of the harvested produce for determining the percentage recovery of dry grains or the marketable form of the produce (<http://agricoop.nic.in/statistics/methodol.htm>).

Another finding in the analysis of the product basis risk suggests that the main principle of the insurance product to pay the farmers when they most need was not being followed. As depicted aptly in the Figure 11 there is a 40 percent chance that a farmer will receive a claim payment whether or not there is any crop loss. In other words, a claim payment will be made at least once in every 3 years, irrespective of the actual risk faced by the farmer. On the other hand, in the case of a real catastrophic event, the insurance product would make claim payments in about 70 percent of the cases. This is in total violation of the insurance principle of indemnity. The main reason for this is the lack of understanding of the insurance character of the products on behalf of the government. This may be due to the shortage of technical experts of insurance in the government. Therefore, sometimes the design of a product is made to meet the needs of the government that contributes to the basis risk.

The product basis risk analysis uses area average yields and so may not be accurate for all the farmers. One does not consider individual farmer's yields in this analysis, but rather area average yields. Whilst farmers with farms very near to the weather station may experience lower basis risk than the average farmer in the sub-district, WBCIS claim payments are expected to correlate more closely with area average yields than individual farmer's yields. This would bias the above figures in the direction of underestimating the extent of basis risk between most farmers and the WBCIS claim payments.

Finally, lack of historical weather station infrastructure may contribute to the present-day basis risk. Significant investments have been made in the past few years by both the public and private sectors, on increasing the number of weather stations. Since one source of basis risk is likely to arise from the distance between a farmers' plot of land and the contractual weather station (spatial basis risk), this increase in granularity of weather stations could be expected to minimize basis risk. This has been established in the analysis of the spatial basis risk. As one moves away from the weather station, the various rainfall events covered under the WIBI product could rightly depict the actual rainfall scenario at an individual insurance unit. However, dry-spells showed no correlation with the distances. The burn costs of the product also varied widely as the distance between the insurance unit and the weather station is increased. One can design a WIBI product in such a way that it takes into account these inverse relationships between conditional probabilities or correlations with the distances.

It was noted that the period of the WIBI contract also affected the basis risk. The shorter period contracts had a higher basis risk than the longer ones. The main reason behind this is that, as the time

period increases the risk gets distributed over the time. It is easier for a product to accurately depict the weather conditions if the span of time under consideration is considerably long. This has also been established in the basis risk calculations.

WIBI products can be evaluated using agronomic theory, a formal crop model, or statistical analysis of historical claim payments and historical yields. Given the possible inaccuracies in the historical yield and weather data, statistical analysis of basis risk should complement, not replace, expert agronomic and actuarial advice. Product design choices and regulatory and policy decisions should not be made solely based on statistical analysis of basis risk.

Finally, despite clear conceptual and statistical links between weather and farmer incomes, one finds that it is of considerable challenge to design a WIBI product with low basis risk; for all collections of WIBI products considered the average claim payment in a year with total crop failure across the tehsil was less than twice the long-run average claim payment. One reason for this could be that some perils, such as some pestilence or disease, may be difficult to capture with weather parameters. Another reason is that it is difficult to define an index which accurately captures the behavior of the farmer, such as planting (or replanting) times. Since most crops are particularly sensitive to rainfall during specific periods in the growth cycle, an index which inaccurately predicts planting times will not necessarily be appropriately sensitive to rainfall during the key periods. This finding suggests that offering double trigger policies, with one weather index trigger, but also a catastrophic area yield index trigger, could significantly reduce basis risk for farmers in the years of extreme weather events.

4.4. WEATHER DATA ANALYSIS AND CLIMATE TRENDS

It has been noted that the WI products being used currently have some deficiencies, as mentioned by the preceding sections. It is possible that one can improve the product design by taking into consideration the behavior of various weather parameters that affect crop production. This section of the chapter, thus, looks at climate trends and the analysis of the weather data that can further contribute to the improvement of the product design.

Table 14 depicts the results for various weather parameters pertaining to rainfall, temperature and relative humidity for the 25-year period (1986-2010) which were analyzed for 21 well-distributed representative locations across the country.

TABLE 14: RAINFALL, TEMPERATURE AND RELATIVE HUMIDITY TRENDS OVER INDIA DURING 1986 - 2010

S. No.	Zone	Observatory Location	1	2	3	4	5	6	7	8	9	10	11	12
1	West Coast	Thrissur	-	+	-	+	-	+	+	+	-	+	-	-
2		Dapoli	+	-	+	-	+	-	+	+	-	+	+	-
3	West	Udaipur	-	+	+	+	-	+	+	+	+	+	+	+
4		Anand	+	+	+	+	-	+	+	+	+	+	+	-
5		Parbhani	-	-	-	+	-	-	-	+	+	+	-	-
6	South	Bijapur	+	+	+	-	-	-	+	-	-	-	-	+
7		Anantapur	+	+	-	-	-	+	-	-	-	-	+	+
8		Benguluru	-	-	-	-	+	-	+	-	-	-	+	-
9		Kovilpatti	-	-	-	-	+	-	+	+	+	+	+	-
10	Central	Jabalpur	+	-	+	+	+	-	+	-	-	+	-	+
11		Raipur	+	+	+	+	-	-	-	-	-	+	+	-
12	East	Bhubaneswar	+	+	+	+	-	+	+	-	+	-	+	+
13		Ranchi	-	-	+	+	+	+	+	+	-	-	-	+
14		Mohanpur	+	-	+	+	+	-	+	+	+	-	+	+
15		Jorhat	-	+	-	-	-	+	-	+	+	+	+	-
16	North	Rakhdiarsar	-	+	-	-	-	+	+	-	-	+	-	-
17		Ludhiana	+	+	-	-	-	-	+	+	+	-	+	-
18		Kanpur	+	+	+	+	-	+	-	+	+	-	-	+
19		Faizabad	-	+	-	-	-	+	+	+	+	-	-	-
20	Hill Station (N)	Palampur	+	+	+	+	-	+	+	+	+	+	+	+
21		Ranichuri	+	-	+	+	-	-	+	+	+	-	+	+

Note:

+	Positive	1	Rainfall during southwest monsoon
-	Negative	2	Number of rainy days
		3	Single day maximum rainfallContd
		4	Two days maximum rainfall
		5	Length of dry spell
		6	Length of wet spell
		7	Relative humidity between 70and 80percent
		8	Relative humidity between 80 and 90percent
		9	Relative humidity more than 90percent
		10	Minimum of daily minimum temperature
		11	Maximum of daily maximum temperature
		12	Average of daily temperature range

4.4.1. RAINFALL DURING SOUTHWEST MONSOON

Across the West Coast of India, the monsoon rainfall was increasing at Dapoli and declining at Thrissur. In the western zone, it was decreasing with the exception of Anand, where it was increasing. In the South, Kovilpatti, Bijapur and Bengaluru showed a declining trend in monsoon rainfall while there was a marginal increase at Anantapur. Both the stations, in the Central Zone (Jabalpur and Raipur), showed the increasing trend in monsoon rainfall. In the East also, Bhubaneswar and Mohanpur showed an increasing trend while Jorhat and Ranchi showed a declining trend. Kanpur and Ludhiana showed an increasing trend across the North while Faizabad and Rakhdiarsar showed a declining trend in monsoon rainfall. In the Hill Zone (N), both the stations (Palampur and Ranichuri) showed an increasing trend in monsoon rainfall from June to September, which is the main crop season across the Country.

Out of the 21 selected stations spread across the Country, 11 stations (Anand, Dapoli, Jabalpur, Raipur, Bhubaneswar, Mohanpur, Kanpur, Ludhiana, Palampur, Ranichuri and Anantapur) showed an increasing trend in the south-west monsoon rainfall, while the rest of the stations (Parbhani, Udaipur, Jorhat, Ranchi, Rakhdiarsar, Faizabad, Thrissur, Kovilpatti, Bijapur and Bengaluru) exhibited a declining trend. It was revealed that the decline in monsoon rainfall was predominant in the South while the Central, West, North and Hill stations (N) showed an increasing trend. In the East, half of the stations showed an increasing trend while the other half of the stations showed a declining trend.

4.4.2. NUMBER OF RAINY DAYS

It is revealed from Table 14 that across the West Coast of India, the number of rainy days was increasing significantly at Thrissur while declining at Dapoli in contrast to the rainfall trends during the monsoon season. In the western zone, the number of rainy days was increasing at Udaipur and Anand, while it was decreasing at Parbhani. In the South, Bijapur and Anantapur showed an increasing trend in the number of rainy days, while a decreasing trend was observed at Bengaluru and Kovilpatti. At Kovilpatti, the trend turned out to be significant at the 5 percent level of significance. In the Central Zone consisting of Jabalpur and Raipur, Raipur showed an increasing trend and was significant at 5 percent level of significance while Jabalpur exhibited a declining trend in the number of rainy days. In the Eastern region, Ranchi and Mohanpur showed a declining trend, and it was significant at

Mohanpur while Bhubaneswar and Jorhat exhibited an increasing trend in the number of rainy days. All the locations in the Northern region (viz., Rakhdiarsar, Ludhiana, Kanpur and Faizabad) showed an increasing trend in the number of rainy days, and it was insignificant. In the Hill Zone (N), Palampur showed an increasing trend while Ranichuri showed an insignificant declining trend in number of rainy days during the south-west monsoon.

Thus, from the analysis it was found that out of the 21 selected stations spread across the Country, eight stations (Dapoli, Parbhani, Bengaluru, Kovilpatti, Jabalpur, Ranchi, Mohanpur and Ranichuri) showed a decreasing trend in the number of rainy days, and it was significant at few stations, while the rest of the 13 stations (Thrissur, Udaipur, Anand, Bijapur, Anantapur, Raipur, Bhubaneswar, Jorhat, Rakhdiarsar, Ludhiana, Kanpur, Faizabad and Palampur) exhibited an increasing trend.

It was revealed that an increase or stability in the number of rainy days during the monsoon season was predominant at the majority of the zones, except for a few stations (viz., Dapoli, Parbhani and Jabalpur).

For a good crop production, amount of rain should be distributed over the crop growth period. But for most of the places, the number of rainy days has decreased over the years, which clearly shows the impact of climatic change. The decreasing number of rainy days may appear insignificant now, but the economic significance of this effect has to be carefully analyzed for the future concern of agriculture.

4.4.3. SINGLE DAY MAXIMUM RAINFALL

Across the West Coast of India, the single-day maximum rainfall has shown a declining trend in Thrissur and a marginal increasing trend in Dapoli (Table 14). It was increasing across the western zone at Udaipur and Anand and a significant decrease at Parbhani. In the South, three stations (Anantapur, Bengaluru and Kovilpatti) have shown a decreasing trend while Bijapur has depicted an increasing trend in the single-day maximum rainfall. In the Central Zone consisting of Jabalpur and Raipur, both the locations showed an increasing trend, which was highly significant at Raipur. In the Eastern region, all the stations (Bhubaneswar, Ranchi and Mohanpur) showed an increasing trend in one day maximum rainfall event, except for Jorhat. In contrast, Rakhdiarsar, Ludhiana and Faizabad in the North showed a declining trend while Kanpur exhibited an increasing trend in the single-day

maximum rainfall. In the Hill Zone (N), both the stations (Palampur and Ranichuri) showed an insignificant increasing trend in the single day maximum rainfall during the south-west monsoon.

Thus, out of the 21 selected stations spread across the Country, nine stations (Thrissur, Parbhani, Anantapur, Bengaluru, Kovilpatti, Jorhat, Rakhdiarsar, Ludhiana and Faizabad) have shown a decreasing trend, while the remaining 12 stations (Dapoli, Udaipur, Anand, Bijapur, Raipur, Jabalpur, Bhubaneswar, Ranchi, Mohanpur, Kanpur, Palampur and Ranichuri) exhibited an increasing trend in the single-day maximum rainfall. It was revealed that the decline in one-day maximum rainfall events was predominant in the South as well as the North, while the East, Central and Hill stations (N) had a predominantly increasing trend.

4.4.4. TWO-DAY MAXIMUM RAINFALL

A perusal of Table 14 reveals that across the West Coast of India, the two-day maximum rainfall showed a declining trend at Dapoli while Thrissur showed an increasing trend. The trend for the two-day maximum rainfall was increasing across the western zone for all the three stations (Udaipur, Anand and Parbhani) while in the South, for all the four stations (Bijapur, Anantapur, Bengaluru and Kovilpatti) it was decreasing. In the Central Zone consisting of Jabalpur and Raipur, both the locations have depicted an increasing trend. In the Eastern region, three stations (Bhubaneswar, Ranchi and Mohanpur) have shown an increasing trend while Jorhat exhibited a decreasing trend in the two-day maximum rainfall. Rakhdiarsar, Ludhiana and Faizabad in the north showed a declining trend while Kanpur exhibited an increasing trend in the event. In the Hill Zone (N), both the stations (Palampur and Ranichuri) showed an increasing trend in two-day maximum rainfall during the south-west monsoon.

Out of the 21 selected stations spread across the Country, nine stations (Dapoli, Bijapur, Anantapur, Bengaluru, Kovilpatti, Jorhat, Rakhdiarsar, Ludhiana and Faizabad) showed a decreasing trend while the rest of the 12 stations (Thrissur, Anand, Parbhani, Udaipur, Raipur, Jabalpur, Bhubaneswar, Ranchi, Mohanpur, Kanpur, Palampur and Ranichuri) showed an increasing trend in the two-day maximum rainfall. It was revealed that the decline in two-day maximum rainfall events was predominant in the South and the North while in the East, West, Central and Hill stations (N) the increase was predominant.

4.4.5. DURATION OF DRY-SPELL

A perusal of Table 14 revealed that across the West Coast of India, the duration of dry-spell was increasing at Dapoli and declining at Thrissur along with all the three stations in the West (Udaipur, Anand and Parbhani). In the South, two stations (Benguluru and Kovilpatti) have shown an increasing trend while Bijapur and Anantapur exhibited a decreasing trend in the duration of dry-spell. In the Central Zone consisting of Jabalpur and Raipur, Jabalpur portrayed an increasing trend while Raipur exhibited a decreasing trend in the duration of dry-spell. In the Eastern region, Ranchi and Mohanpur depicted an increasing trend while Bhubaneswar and Jorhat showed a decreasing trend in the event. All the four stations (Rakhdiarsar, Ludhiana, Faizabad and Kanpur) in the north and both the location in the Hill Zone (N) depicted a declining trend in the duration of dry-spell during the south-west monsoon.

Out of the 21 selected stations spread across the Country, 15 stations (Thrissur, Udaipur, Anand, Parbhani, Bijapur, Anantapur, Raipur, Bhubaneswar, Jorhat, Rakhdiarsar, Ludhiana, Faizabad, Kanpur, Palampur and Ranichuri) portrayed a decreasing trend in the duration of dry-spell, while the remaining six stations (Dapoli, Benguluru, Kovilpatti, Jabalpur, Ranchi and Mohanpur) exhibited an increasing trend. It was revealed that the decline in duration of dry-spell was predominant in the North, West and Hill station (N) while in the South and East it was otherwise.

4.4.6. DURATION OF WET-SPELL

It is observed from Table 14 that across the West Coast of India, the duration of wet-spell was increasing at Thrissur and declining at Dapoli. Udaipur and Anand in the West showed an increasing trend while Parbhani exhibited a declining trend in the event. In contrast, three stations in the South (Bijapur, Benguluru and Kovilpatti) depicted a decreasing trend, while Anantapur exhibited an increasing trend in the duration of wet spell. In the Central Zone consisting of Jabalpur and Raipur, both showed a declining trend in the duration of wet-spell. In the Eastern region, Bhubaneswar, Ranchi and Jorhat exhibited an increasing trend while Mohanpur showed a decreasing trend in the event. Three stations in the North (Rakhdiarsar, Faizabad and Kanpur) depicted an increasing trend, while Ludhiana exhibited a declining trend in the duration of wet-spell. In the Hill Zone (N) Palampur

showed an increasing trend in the duration of wet-spell, while Ranichuri portrayed a decreasing trend during the south-west monsoon.

Out of the 21 selected stations spread across the Country, 10 stations (Dapoli, Parbhani, Bijapur, Bengaluru, Kovilpatti, Raipur, Jabalpur, Mohanpur, Ludhiana and Ranichuri) have shown a decreasing trend and the remaining 11 stations (Thrissur, Udaipur, Anand, Anantapur, Bhubaneswar, Ranchi, Jorhat, Rakhdiarsar, Faizabad, Kanpur and Palampur) exhibited an increasing trend in the duration of wet-spell. It was revealed that the decline in duration of wet-spell was predominant in the South and Central, while in the North, East and West it was otherwise.

4.4.7. RELATIVE HUMIDITY

Across the West Coast of India, the relative humidity was increasing at both the stations in 70-80 percent and 80-90percent range and decreasing in >90 percent range. A similar increasing trend was noticed in the West also, at all the three locations (Udaipur, Anand and Parbhani). However, in the range of 70-80 percent relative humidity, Parbhani depicted a declining trend. In the South, Kovilpatti depicted an increasing trend in all the three ranges of relative humidity while Anantapur exhibited a declining trend. Bijapur and Bengaluru showed an increasing trend in the range of 70-80 percent while in the ranges of 80-90 and >90 percent, a declining trend was observed. Raipur and Jabalpur depicted a declining trend in all the ranges in the Central Region. However, in the range of 70-80 percent, Jabalpur showed an increasing trend. In the East, Mohanpur portrayed an increasing trend in all ranges of relative humidity. There is an increasing trend in Bhubaneswar, except at 80-90 percent range of relative humidity and at Ranchi, except at > 90 percent range of relative humidity. In the case of Jorhat, the relative humidity in the range of 70-80 percent was declining while it was increasing in the ranges of 80-90 percent and >90 percent. In the North, the relative humidity was increasing in all the ranges at Ludhiana and Faizabad. At Kanpur, the results were similar to that of Jorhat (East zone). In the case of Rakhdiarsar, the relative humidity in the range of 70-80 percent was increasing while it was declining in the ranges of 80-90 and >90 percent. Both the Hill stations (N) showed an increasing trend in all the ranges of relative humidity. Overall, the relative humidity in all the ranges was increasing at all the stations except in Raipur, where it was declining. It needs a detailed examination.

4.4.8. EXTREME TEMPERATURES

Air temperature is an important basis for geographical crop distribution and affects crop yields qualitatively and quantitatively. It regulates the rate of metabolic processes and evapotranspiration. Extreme high and low temperatures affect the physiological and enzymatic activities in crop plants, cause desiccation, affect fertilization and thereby yield. Low temperature leads to reduced physiological activity and a very low temperature or frost injury in certain cases may lead to total crop failures. In the projected climate change scenario, extreme events of temperature are likely to occur and reoccur in the ensuing decades. Therefore, there is a need to understand the variations and trends in extreme temperatures such as highest maximum, lowest minimum and temperature range at location / region / national level.

4.4.8.1. MINIMUM OF DAILY MINIMUM TEMPERATURE

Five groups of weather stations were made based on the altitude of the weather station. Each Five stations each fall under less than 100 meter and 100 to less than 250 meter altitudes, four stations each fall under above 250 to 400 meter and above 400 to less than 650 meter altitudes and the remaining three stations located in the high altitude regions grouped together.

It is observed from Table 14 that in the low altitude areas, Bhubaneswar experienced a negative trend while Jorhat showed a positive trend in the minimum of daily minimum temperature of a year i.e., January to December. Thrissur and Kovilpatti have experienced a significant increasing trend. Flowering in fruit crops like Mango and Cashew is likely to be effected if the night temperature is more, as noticed in the years 2010-11 and 2011-2012 across the West Coast of India.

In the less than 250 meter altitude region, all stations (Kanpur, Faizabad, Mohanpur and Ludhiana), except Dapoli showed a decreasing trend. In the ranges of 250 – 400 m altitudinal region, Jabalpur, Raipur and Rakhdiarsar have depicted a significant increasing trend while Anantapur has exhibited a declining trend in the event. An increasing trend was noticed at Parbhani and Udaipur while a decreasing trend was observed at Bijapur and Ranchi in the group of 400 to 650 m latitudes. At Benguluru (930 m AMSL), the minimum of daily minimum temperature was declining. In the range of more than 1200 m AMSL (Hill Stations in the North), Palampur showed an increasing trend while Ranichuri exhibited a declining trend in the event.

Out of 21 stations, 10 stations (Bijapur, Anantapur, Bengaluru, Bhubaneswar, Ranchi, Mohanpur, Ludhiana, Kanpur, Faizabad and Ranichuri) have shown a decreasing trend and the remaining 11 locations (Thrissur, Dapoli, Udaipur, Anand, Parbhani, Kovilpatti, Jabalpur, Raipur, Jorhat, Rakhdiarsar and Palampur) depicted an increasing trend in the extreme minimum temperature. It revealed that the selected locations more or less equally differed in terms of increasing or decreasing trends. A decrease in minimum temperature may lead to weather hazards like cold waves and frost, which is detrimental to field as well as fruit crops.

4.4.8.2 MAXIMUM OF DAILY MAXIMUM TEMPERATURE

In the low altitude region (<100 m AMSL), Jorhat, Kovilpatti, Anand and Bhubaneswar experienced an increasing trend while Thrissur experienced a decreasing trend in the annual maximum of daily maximum temperature during the year (Table 14). In 100-250 m altitude region, Mohanpur, Ludhiana and Dapoli showed an increasing trend while Kanpur and Faizabad exhibited a declining trend in the event. In the range of 250- 400 m AMSL, Rakhdiarsar and Jabalpur showed a declining trend while Anantapur and Raipur showed an increasing trend in the event. A declining trend was noticed at Parbhani, Bijapur and Ranchi while an increasing trend was observed at Udaipur in the group of 400 - 650 m latitude. At Bengaluru (930 m AMSL), the maximum of daily maximum temperature was increasing. In the range of more than 1200 m AMSL (Hill Stations in the North) both Palampur and Ranichuri showed an increasing trend.

Out of 21 stations, eight stations (Thrissur, Parbhani, Anantapur, Jabalpur, Ranchi, Rakhdiarsar, Kanpur and Faizabad) showed a decreasing trend and the remaining 13 locations (Dapoli, Udaipur, Anand, Bijapur, Bengaluru, Kovilpatti, Raipur, Bhubaneswar, Mohanpur, Jorhat, Ludhiana, Palampur and Ranichuri) depicted an increasing trend in extreme maximum temperature. It was revealed that the selected locations more or less equally differed in terms of increasing or decreasing trends. However, it was towards an increasing trend. Therefore, heat waves are likely to occur and it would be detrimental to agricultural production. In the hill regions, crop boundaries are likely to shift to higher altitudes in search of optimum temperature and to escape extremes of maximum and minimum temperatures.

4.4.8.3 AVERAGE OF DAILY TEMPERATURE RANGE

In the low altitude region (<100 m AMSL), Bhubaneswar experienced an increasing trend while Thrissur, Jorhat, Kovilpatti and Anand experienced a declining trend in the extreme temperature range

(lowest daily maximum minus minimum during the year) as observed from Table 14. In 100 - 250 m altitude region, Kanpur and Mohanpur showed an increasing trend while Ludhiana, Dapoli and Faizabad exhibited a declining trend in the average of daily temperature range. In the ranges of 250 - 400 m AMSL, Raipur and Rakhdiarsar showed a declining trend, while Anantapur and Jabalpur showed an increasing trend in the event. A declining trend was noticed at Parbhani alone while an increasing trend was noticed at Udaipur, Bijapur and Ranchi in the group of 400 - 650 m latitude. At Bengaluru (930 m AMSL), the average of daily temperature range was declining. In the range of more than 1200 m AMSL (Hill Stations in the North) both Palampur and Ranichuri showed an increasing trend.

Out of 21 stations, 11 stations (Thrissur, Dapoli, Anand, Parbhani, Bengaluru, Kovilpatti, Raipur, Jorhat, Rakhdiarsar, Ludhiana and Faizabad) depicted a decreasing trend and the remaining 10 locations (Udaipur, Bijapur, Anantapur, Jabalpur, Bhubaneswar, Ranchi, Mohanpur, Kanpur, Palampur and Ranichuri) experienced an increasing trend in extreme temperature range. It revealed that the selected locations differed more or less equally in terms of increasing or decreasing trends. Therefore, it is the temperature range, which is detrimental to crops, in the extremes of minimum and maximum temperatures in terms of cold and heat waves, respectively. They are not uncommon across the country in the northern states where extremes winters and summers are noticed.

The daily temperature range is high when minimum temperature decreases and maximum temperature increases. These patterns are likely to increase under the projected climate change scenario. As a part of climate change adaptation and mitigation efforts, there is a need for appropriate corrective measures to be taken at the local / regional / national and global levels.

4.4.9. WEATHER DYNAMICS

An understanding of rainfall variability in the country is necessary to appreciate the impacts of climate change on crop production and is also important for water management. Comprehensive results on trends of various important weather parameters over the past few decades are depicted in Table 14. The variability in rainfall, number of rainy days, two days maximum rainfall, length of dry-spell / wet-spell and relative humidity more than 90 percent during monsoon seasons is high. Regarding weather patterns, the total amount of rainfall during the monsoon period is increasing at the majority of the selected locations, barring Thrissur, Udaipur, Bengaluru, Kovilpatti, Ranchi, Jorhat and Rakhdiarsar. The temporal variation in the number of rainy days is either increasing or stable at the majority of the

selected locations except Thrissur, Parbhani and Jabalpur. Maximum or intensive rainfall is more important when one is dealing with flood-related studies. One-day or two-day maximum rainfall is also important during critical pheno-phases of crop growth. Over the past few decades, it is observed that at majority of the locations in the Country that two-day maximum rainfall is decreasing, while the number of rainy days is increasing. This indicates that the amount of soil moisture is well distributed, which is good for optimum crop growth.

Another important parameter that is critical for dry-land agriculture is the length of dry and wet-spells. Though the length of wet-spell has exhibited no particular trend over a long period of time, particularly at the all-India level, pockets of significant long-term rainfall changes have been identified. If the number of dry-spells increase and the duration of a spell is lengthy, then it may not be good for optimum crop growth. During prolonged dry-spells, majority of the crops fail due to lack of sufficient moisture in the soil and such a situation may lead to a drought. A moderate drought during the vegetative phase may lead to more number of tillers in monocotyledonous plants¹⁷ and lengthy tap root system in dicotyledonous plants¹⁸. However, any drought-like situation during critical pheno-phases may lead to losses in dry matter and hence final economical yield. It is because less photosynthesis takes place in the absence of sufficient moisture in the soil. Due to less soil moisture that is available for the plants, leaves lose their turgor pressure and stomata closes to avoid water loss due to transpiration. Under such a situation, the leaf temperature rises above optimum level and disturbs the internal physiological activities.

The length of wet-spells has also not depicted any particular trend for the country as a whole. Almost 50 percent of the locations under this study have shown an increase in wet-spells. Though the increase in wet-spells may seem to be useful in enriching the soil moisture; prolonged wet-spells may lead to crop failure due to lack of sufficient oxygen to the root system (i.e., anaerobic situation due to which toxic gases and acids accumulate in the root system) and increase in pest and diseases incidences.

¹⁷ A monocot has only one seed leaf (monocot is short for 'monocotyledon'. A cotyledon is a seed leaf, and 'mono' means one). This seed leaf is usually of the same shape as the adult leaf, long and thin, and the leaf veins nearly always run parallel to the central midrib. Many food plants are grasses. Example: wheat, rice, sorghum, pearl millet, corn, etc.

¹⁸ A dicot has two cotyledons (dicot is short for 'dicotyledon', and 'di' means two). The seed leaves are usually rounded and fat, because they are the two halves of the seed. The first true leaves can be of different shapes, from long and thin to rounded or palmate. Most trees and shrubs and many garden annuals and perennials are dicots. Example: cotton, soybean, groundnut, pulses, etc.

Relative humidity is an important weather parameter, is useful to understand the relative moisture content in the atmosphere. Information on atmospheric moisture content helps in understanding the atmospheric water demand. It is observed that relative humidity above 70 percent is increasing in most of the selected locations except at a few in south and central zones. This trend of increase in relative humidity can be attributed to increase in atmospheric water content and hence increase in number of rainy days and decrease in length of dry-spells.

Finally, while interpreting the results of trend analysis, the observations of Cohn and Lins (2005) are worth repeating: ‘that reported trends are real yet insignificant indicates a worrisome possibility: natural climatic excursions may be much larger than we imagine. So large, perhaps, that they render insignificant the changes, human-induced or otherwise, observed during the past century’.

4.5. PERSPECTIVES FROM STAKEHOLDERS AND THEIR RESPONSE

The weather based insurance product has to take into account the viewpoints of the major stakeholders: states, farmers and insurance providers. This enhances the marketability of the product and the inputs from the stakeholders help in the improvement of the product design.

4.5.1. STATES

4.5.1.1. Overall View on Crop Insurance Schemes

The weighted ranking analysis has revealed that from the perspective of state governments (as perceived by their representatives), the most preferred scheme is NAIS, followed by WBCIS and MNAIS. There is no significant difference in the rank sum between WBCIS and MNAIS (Figure 15). The representatives of Haryana, Kerala, Rajasthan and Tamil Nadu states ranked WBCIS on the top, followed by NAIS and MNAIS, while Andhra Pradesh, Gujarat, West Bengal, Maharashtra and four other states ranked NAIS on the top. It can be said that Rajasthan and Tamil Nadu are among the key states that have embraced WBCIS and it is not surprising that the scheme is ranked high by these states. Similarly, Andhra Pradesh, Gujarat and Maharashtra have benefitted largely by NAIS during adverse seasons, particularly droughts, and ranked NAIS high. As in regards to MNAIS, the scheme is only two seasons old, and not all the states opted to pilot it. Consequently, it has not been ranked adequately high.

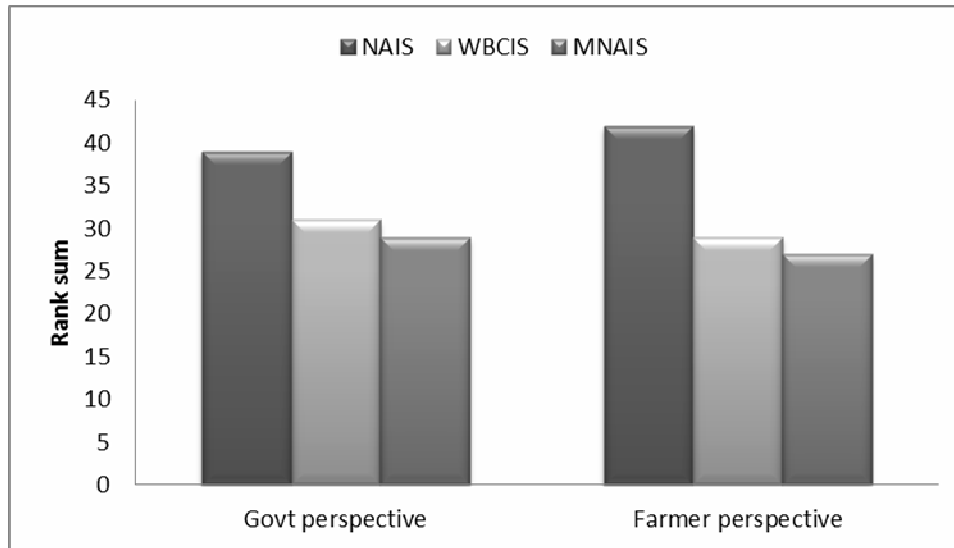


FIGURE 16: PREFERENCES FOR SELECTED CROP INSURANCE SCHEMES

4.5.1.2. Strong and Weak Aspects of Selected Crop Insurance Schemes

Strong Aspects-Ease in implementation (~32%) and ease for farmers to understand (~29%) are the strong aspects of NAIS, as perceived by the states' representatives (Figure 15). In WBCIS, ease in implementation, followed by the choice of insurance companies are the strong aspects stated by 25 percent and 17 percent of respondents, respectively. In the case of MNAIS, adequacy of payments relative to losses, followed by correlation of claim amount with yield loss are the strong aspects represented by about 35 percent and 19 percent of respondents. Overall, the ease in implementation (~22%) and adequacy of payments relative to losses (~21%) are the major strong aspects of all the three schemes, as perceived by the states (Table 15).

Weak Aspects-Time taken in making claim payments was the major weak aspect in NAIS and MNAIS. However, compared to NAIS (59%), only about 29 percent of the respondents felt this as a weak aspect in MNAIS. The MNAIS is regarded better in expediting claim settlements through its various features by the participants despite limited experience with it. In WBCIS, the reliability of data to assess payouts (~30%) is considered as the main weak aspect by the states. Overall, the time taken in making claim payments and correlation of claim amount with yield loss are the main weak elements of all the three schemes (Table 15).

TABLE 15: SUMMARY OF STRONG AND WEAK ASPECTS OF DIFFERENT CROP INSURANCE SCHEMES

S. No.	Aspects	Strong Aspects (in percent)				Weak Aspects (in percent)			
		NAIS	WBCIS	MNAIS	Total	NAIS	WBCIS	MNAIS	Total
1	Adequacy of payments relative to losses	21.4	4.2	34.6	20.5	14.8	13	4.8	11.3
2	Time taken to make claim payments	-	8.3	-	2.6	59.3	8.7	28.6	33.8
3	Ease in implementation	32.1	25.0	7.7	21.8	3.7	-	9.5	4.2
4	Ease in understanding	28.6	12.5	11.5	17.9	-	-	4.8	1.4
5	Liked by farmers	10.7	-	11.5	7.8	3.7	4.3	4.8	4.2
6	Ease of data gathering (crop yields, weather, etc.)	3.6	12.5	-	5.1	3.7	8.7	23.8	11.3
7	Reliability of data to assess payouts	-	12.5	7.7	6.4	7.4	30.4	-	12.7
8	Correlation of claim amount with yield loss	-	-	19.2	6.4	7.4	17.4	19	14.1
9	Transparency of process	3.6	8.3	3.9	5.1	-	13	-	4.2
10	Choice of insurance companies	-	16.7	3.9	6.4	-	4.3	4.8	2.8
	Total (Number)	100	100	100	100	100	100	100	100

While ‘adequacy of payment’ and ‘correlation of payment with yield loss’ have placed MNAIS on a strong pedestal, the ‘time taken to make claim payment’ has been the weakest link for both NAIS and MNAIS. This aspect was probed in terms of the actual time taken for making payment for 2011-12 (*Kharif* 2011 and *Rabi* 2011-12) for three major States where all the schemes were under implementation, and the details are presented in table 16.

TABLE 16: ADDITIONAL TIME TAKEN TO MAKE PAYMENT UNDER MNAIS AND NAIS

	<i>Kharif</i> 2011			<i>Rabi</i> 2011-12		
	(Claim payment effected for MNAIS and NAIS in days since WBCIS claim payment)			(Claim payment effected for MNAIS and NAIS in days since WBCIS claim payment)		
	WBCIS	MNAIS	NAIS	WBCIS	MNAIS	NAIS
State1	T	112	84	T	102	132
State2	T	103	88	T	(payment not due)	164
State3	T	143	143	T	98	149

It can be seen from the table 16, the claim payment in case of MNAIS and NAIS have taken 3 to 5 five months more, confirming the States' perceptions. While MNAIS provides for on-account payment, as well as quick payment in case of prevented sowing, apparently these exigencies were not encountered for the said States during 2011-12, and consequently States could not quite appreciate the MNAIS. Given the comprehensive nature of MNAIS, this clearly demonstrates the need for appropriate communication targeting the stakeholders.

4.5.1.3. Priority Areas for Further Improvements

For both MNAIS and WBCIS, 'timely payouts' and 'faster processing of claims' have emerged as the key focus areas for further improvements (Figure 16). In the case of MNAIS, 'product development in terms of effective insurance products that pay when farmers need it' has surfaced as the second priority area, followed by 'manpower/infrastructure to conduct Crop Cutting Experiments' (CCEs) and 'product design and correlation with farmers' losses'. In WBCIS, 'product design and correlation with farmers' losses' has come out as the second priority area followed by 'weather data quality issues and better tools' to help the state government in making informed decisions among different schemes and insurance companies. A few state representatives have suggested some additional areas, other than listed in Figure 16, of improvement, such as 'further reduction in premium rates', 'increase in premium subsidy', 'making weather index straight and simple', etc. in Table 17. The priority areas have been depicted in Figure17.

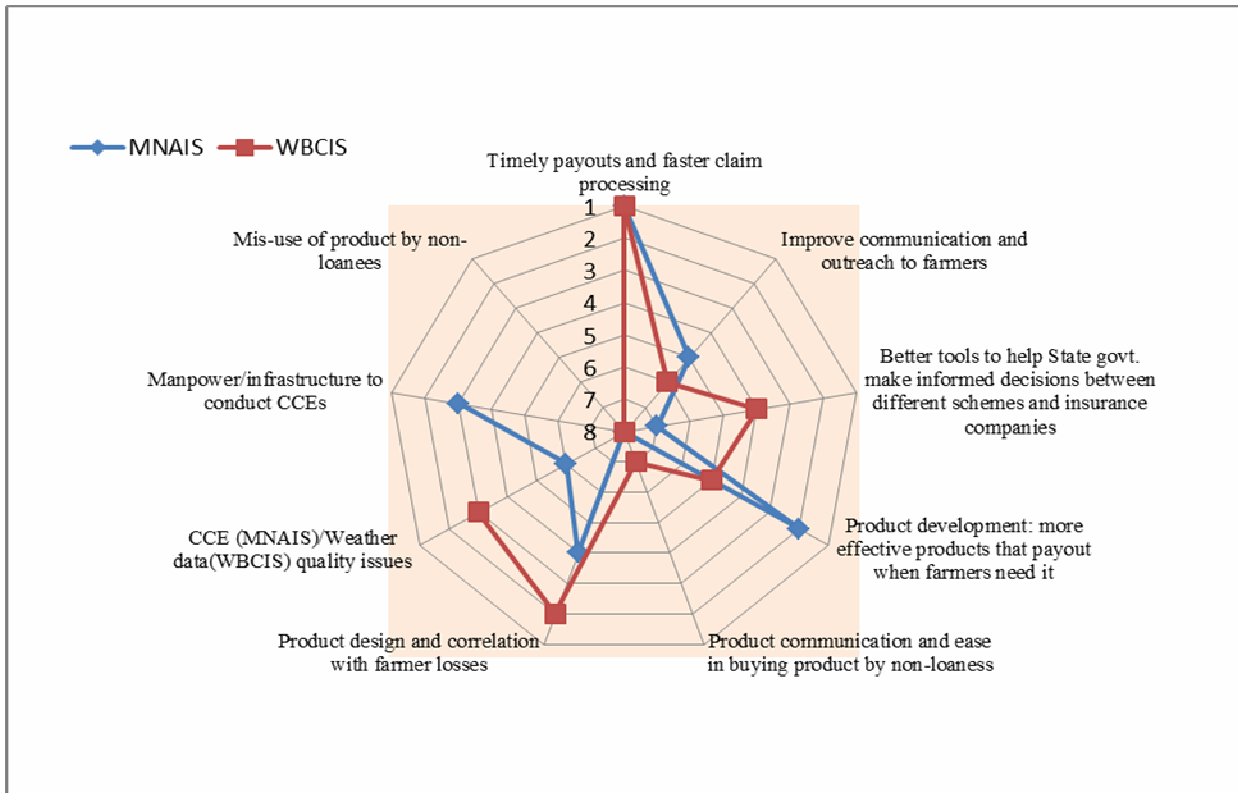


FIGURE 17: PRIORITY AREAS FOR FURTHER IMPROVEMENTS IN MNAIS AND WBCIS

TABLE 17: ADDITIONAL AREAS FOR FURTHER IMPROVEMENTS IN MNAIS AND WBCIS

Additional Areas for Improvement	
MNAIS	
1	Further lowering of premium rate
2	Inclusion of crop loss due to pest & diseases, salt water intrusion, breach & bund losses
3	Coverage of post-harvest losses due to unseasonal rains in non-coastal areas
4	Coverage of loss due to fire for standing crops and harvested crops with assessment on individual basis
5	Damage due to wild life
WBCIS	
6	Weather index (parameters) to be straight and simple
7	Payment of the full sum insured in case of total loss to crops due to weather
8	Increase in premium subsidy and longer cutoff date for participation
9	Need of scientific crop research in designing the product

10	Need of regular monitoring of schemes
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4.5.1.4. Suggested Essential Features of Weather Insurance Products

The most essential features of weather insurance products as perceived from the weighted ranking analysis are: (i) the product payout to correspond to actual losses (product basis risk), (ii) insurance product to be based on practical and research inputs, and (iii) distribution of the sum insured on one or two key weather parameters instead of multiple weather parameters (Table 18). The existing product includes more than three weather parameters / sub-phases with the total sum insured distributed across parameters / phases.

TABLE 18: SUGGESTED ESSENTIAL FEATURES OF WEATHER INSURANCE PRODUCTS

S.No.	Essential features	Rank sum	Rank
1	Product payout to correspond to actual losses	105	1
2	Insurance product to be based on practical and research inputs	91	2
3	Distribute sum insured on 1 or 2 key weather parameters rather than multiple weather parameters	88	3
4	Payout calculations of insurance companies to be certified by an independent entity	73	4
5	Prevent misuse of subsidy by enrolling genuine farmers	72	5
6	Prefer reasonably large payouts once in 4 to 5 years to regular small payouts	58	6
7	No claim discount for payout-free years	54	7

4.5.1.5. Involvement of Multiple Insurance Companies -A Way Forward

Most of the respondents (~77%) opined that involvement of multiple insurance providers is a good way to move forward in the competitive environment. To provide benefit of competition to farmers on involvement of multiple insurance companies, the suggested pre-requisites (Figure 18) by state representatives were: (i) designing of more farmer-friendly products by experts (22%), (ii) competitive rates of premium and transparency in claim processing (15%), (iii) timely/better claim settlement/faster service (15 percent), (iv) good communication facilities and publicity (12 percent), and availability of infrastructure and experience of insurance companies in the state.

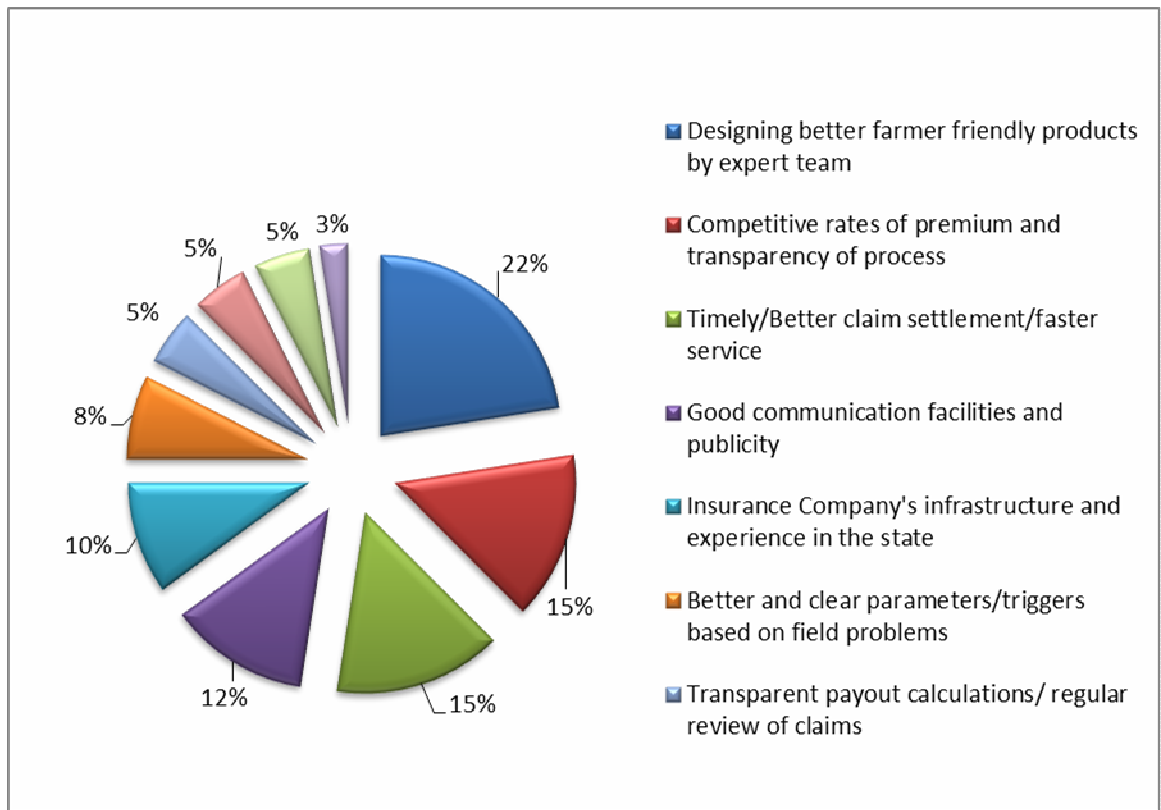


FIGURE 18: PRE-REQUISITES SUGGESTED FOR BENEFITING FARMERS FROM COMPETITION

4.5.1.6. Combination of Weather and Yield Index Insurance Products

Yield index insurance is an all-risk insurance cover but claim assessment and further settlement take more than a reasonable time. Weather index insurance provides risk cover for the major, but not all the perils of agriculture and total yield loss. Therefore, the views are emerging in favour of combining weather index and yield index into a common insurance product, which is expected to be far more efficient to either index based products. Most of the state representatives (88%) have opined that combined (hybrid) product with weather as primary trigger and yield as secondary trigger would be far superior to stand-alone weather or yield index-based products.

4.5.1.7. Comfort Level with Use of Private Weather Data Providers

The existing network of India Meteorological Department (IMD) weather stations is woefully inadequate. The gap in setting up weather stations is being largely exploited by the private weather data providers whose services are being used by the insurance companies to service the WBCIS scheme. Of nearly 2500 weather stations currently used for servicing WBCIS, over 80 percent are

managed by the private sector. But, the comfort level in using the services of private data providers has been rated by the state representatives as “low” – only 2.5 on the rating scale of 1 – 5 by 82 percent respondents. In order to improve the overall acceptance of the services of private data providers, there is a need to create installation, maintenance and data quality standards and protocols for all the data providers. Incidentally, Government of India has now asked IMD to create such a framework (IMD organized one day brainstorming session on the subject on 3rd September 2012).

4.5.1.8. Benchmarking of Product from Multiple Insurance Providers

Most (82%) of the respondents have expressed that, in view of involvement of multiple insurance providers, product benchmarking was essential. About 88 percent of the respondents have opined that states require expertise to benchmark the product so that all the competing insurance companies become more competitive and provide transparent products which can be easily evaluated by the State. The need for creating a ‘Technical Support Unit’ within the Ministry of Agriculture (Government of India) to guide the States and to monitor the performance of insurance companies has been expressed by all the respondents.

4.5.2. FARMERS

4.5.2.1. General Characteristics of Farmers

Age-wise distribution of farmers—The average age of the farmers responded to the survey was 44 years, 41 years and 46 years in Karnataka, Madhya Pradesh and Tamil Nadu, respectively. More than half of the respondent farmers belonged to the age category of 31 - 50 years in all the three states.

TABLE 19: AGE-WISE DISTRIBUTION OF FARMERS (IN PERCENT)

Age categorization (Years)	No. of respondents		
	Karnataka	Madhya Pradesh	Tamil Nadu
≤ 30	20	23.9	5
31-50	50	58.9	61
≥ 50	30	17.1	34
Average age	44	40.7	46.4

Education level of farmers- In Karnataka, most of the respondent farmers were illiterate (45%) or had only primary level education (~43%). The situation was reversal in Tamil Nadu; most of the farmers responded were having high school and intermediate level education (~50%) and about one-fourth were graduates and above. In Madhya Pradesh, more than half of the respondents were illiterates (~25%) and or had primary level education (~38%).

TABLE 20: EDUCATION-WISE DISTRIBUTION OF FARMERS (IN PERCENT)

Education category	No. of farmers (%)		
	Karnataka	Madhya Pradesh	Tamil Nadu
Illiterate	45.0	25.4	7.0
Primary	42.5	37.5	19.0
High School & Intermediate	10.8	29.3	49.5
Graduation & above	1.7	7.9	24.5

Size of landholding -The average landholding size of respondent farmers to this survey was about seven acres in Karnataka, ten acres in Madhya Pradesh and six acres in Tamil Nadu. About two-third of farmers surveyed in all the three states had small and medium landholding sizes.

TABLE 21: SIZE OF LAND HOLDING OF FARMERS

Land categorization\	Farmers (%)		
	Karnataka	Madhya Pradesh	Tamil Nadu
Marginal	16.7	15.4	34.5
Small	39.2	30.4	28.5
Medium	30.8	32.9	26.0
Large	13.3	21.4	11.0
Average size of landholding(Acre)	7.0	10.2	5.8

Major crops cultivated in irrigated and areas - In Karnataka, paddy (42%), cotton (19%) and groundnut (14%) were the principal crops grown in the irrigated areas by the surveyed farmers and bajra (36%), jowar (23%) and sesame (16%) were the principal crops. In Madhya Pradesh, wheat

(56%), gram and soybean were the major irrigated crops and soybean (50%), mustard and sesame were the principal crops. Paddy (55%) and sugarcane were the major irrigated crops and bajra (30%) and maize (corn) were the main crops cultivated by respondent farmers from Tamil Nadu.

Key Weather Perils for Crop Production - There are several elemental perils that impact crop production. A profile of these weather perils in terms of their frequency, severity, and overall importance would be useful for prioritizing risk management actions. Under this primary research, respondent farmers were asked to rank nine key weather perils in crop on each of the three attribute viz., frequency, severity and overall importance. The results of this ranking exercise have been depicted through the following radar charts, in Karnataka, Madhya Pradesh and Tamil Nadu (Figure 18A, 18B & 18C).

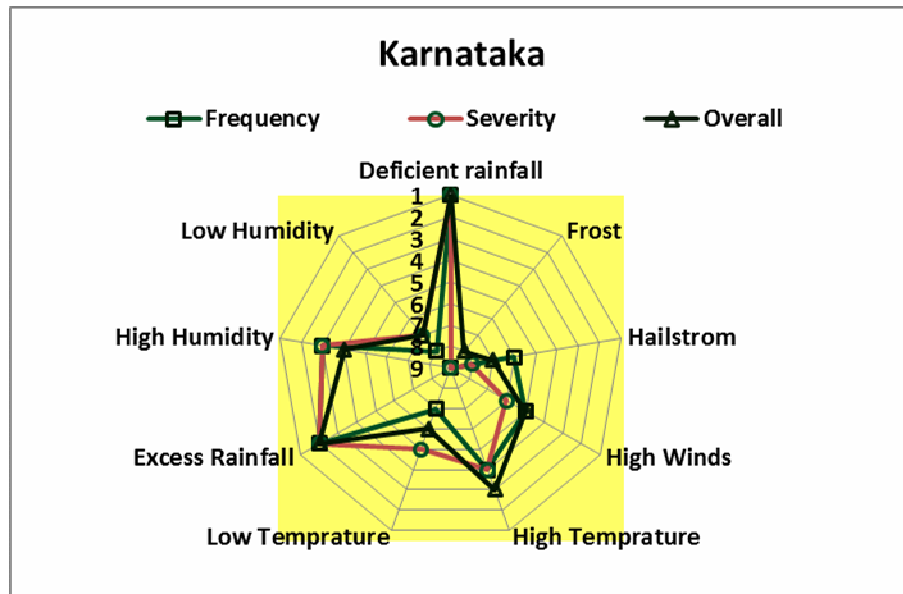


FIGURE 19A: RANKING OF KEY WEATHER PERILS IN KARNATAKA

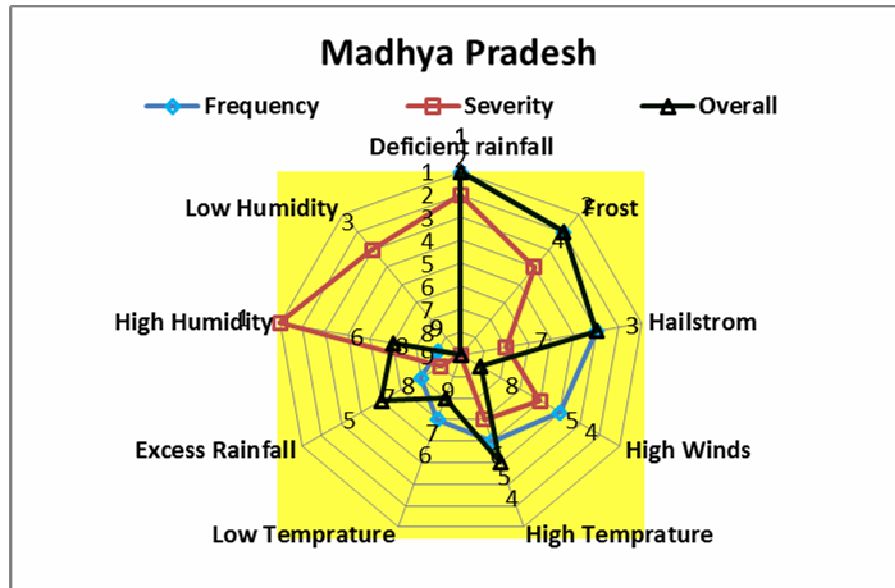


FIGURE 20B: RANKING OF KEY WEATHER PERILS IN MADHYA PRADESH

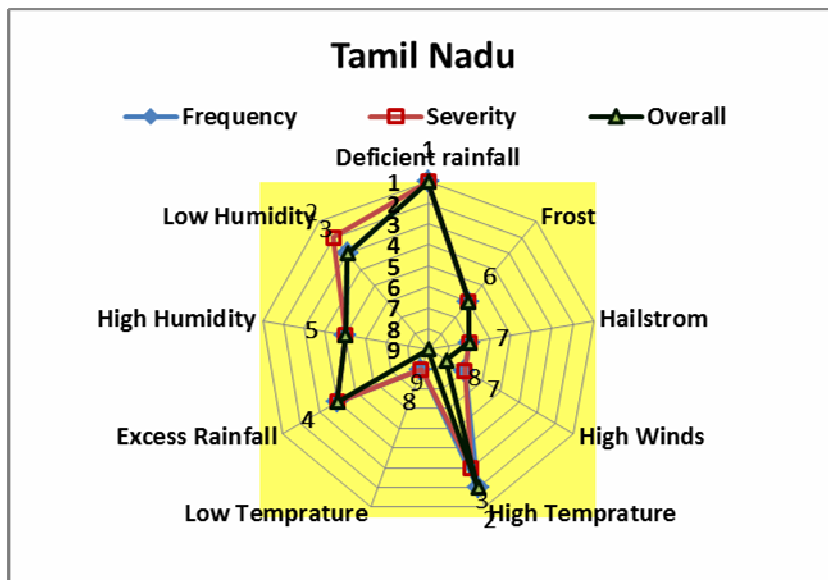


FIGURE 21C: RANKING OF KEY WEATHER PERILS IN TAMIL NADU

4.5.2.2. Influence of Weather on Farming Decisions

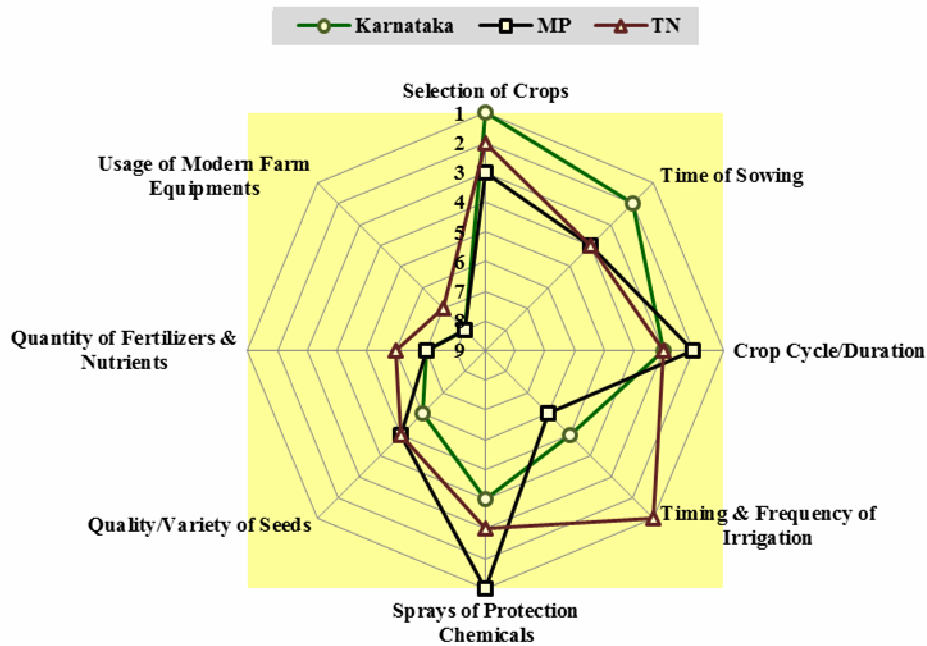


FIGURE 22: RANKING OF FARMING DECISIONS INFLUENCED BY WEATHER

The respondent farmers were asked to rank the key farming decisions based on the extent to which these decisions are influenced by the weather. Selection of crops takes the top rank in Karnataka, second rank in Tamil Nadu (TN) and third rank in Madhya Pradesh (MP). This indicates that weather plays a vital role in the selection of crops that are to be cultivated by farmers during a particular season.

An associated farming decision that is substantially influenced by weather pertains to the duration or cycle of the crops to be cultivated by farmers. If weather is expected to be ideal with timely onset of sowing, farmers would prefer crops with longer-crop cycle. This decision is placed at the second rank in Madhya Pradesh at the third rank in both Karnataka and Tamil Nadu. Another closely related farming decision that is fairly affected by weather is about the time of sowing which takes the second rank in Karnataka and the fourth rank in both Madhya Pradesh and Tamil Nadu.

Weather has an underlying or implicit influence on the extent of sprays of protection chemicals. Respondent farmer respondents from Madhya Pradesh have accorded it the highest rank, whereas those from Tamil Nadu and Karnataka have placed it at third and fourth ranks, respectively.

Timing and frequency of irrigation notches up the highest rank in Tamil Nadu, but has not been able to garner sufficient support from respondent farmers from Madhya Pradesh and Karnataka who have consigned it to the fifth and sixth ranks, respectively.

4.5.2.3. Perceived Need for Crop Insurance

After profiling the key weather perils and assessing the influence of weather on the relevant farming decisions, respondent farmers were enquired about the need for crop insurance. The responses of respondent farmers practicing crop production under rain-fed conditions and under irrigated conditions have been shown separately in Figure 21.

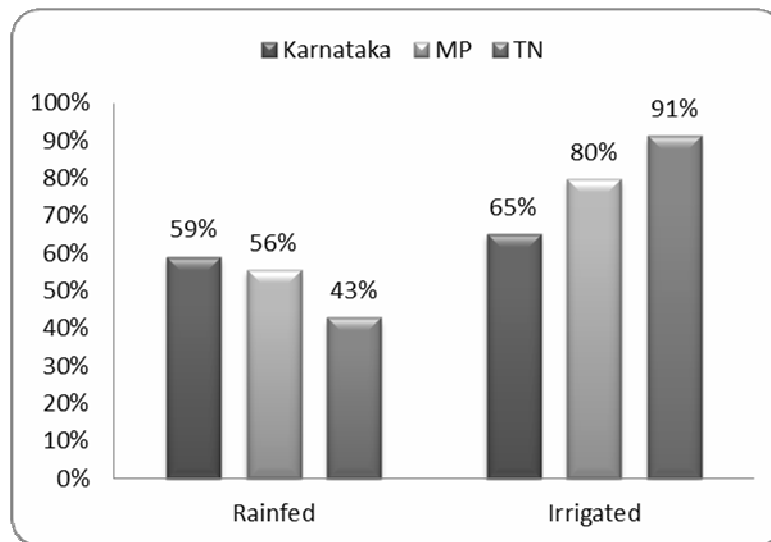


FIGURE 23: PERCEIVED NEED FOR CROP INSURANCE

It is apparently counter-intuitive that farmers practicing crop production in irrigated conditions have indicated the need for crop insurance in significantly higher proportions compared to those carrying out crop production in the rain-fed conditions. The difference in proportion of irrigated as and rain-fed farmers can be deemed high for Tamil Nadu (~48 %), medium for Madhya Pradesh (~24 %) and small for Karnataka (~6 %).

A staggering 91 percent of the farmers practicing irrigated cultivation in Tamil Nadu have affirmed the need for crop insurance. The proportion of such farmers was respectable in Madhya Pradesh with 80 percent and fairly reasonable in Karnataka with 65 percent.

In the case of the farmers engaged in rain-fed farming, the need for crop insurance was indicated by 59 percent respondents from Karnataka, 56 percent respondents from Madhya Pradesh and 43 percent respondents from Tamil Nadu. Thus it can be inferred that the need for crop insurance perceived was higher in irrigated conditions compared to conditions in all the three states. The reason can be higher returns and higher loss (in case of occurrence of risk) in irrigated conditions.

4.5.2.4. Coverage of Weather Variables Required under Crop Insurance

Once the extent of perceived need for the crop insurance was ascertained among farmers engaged in irrigated and rain-fed farming, it was considered useful to examine the weather variables deemed critical for coverage under the crop insurance. The proportions of rain-fed and irrigated respondent-farmers who preferred coverage of enlisted weather variables under crop insurance are shown in figure 22 A & B

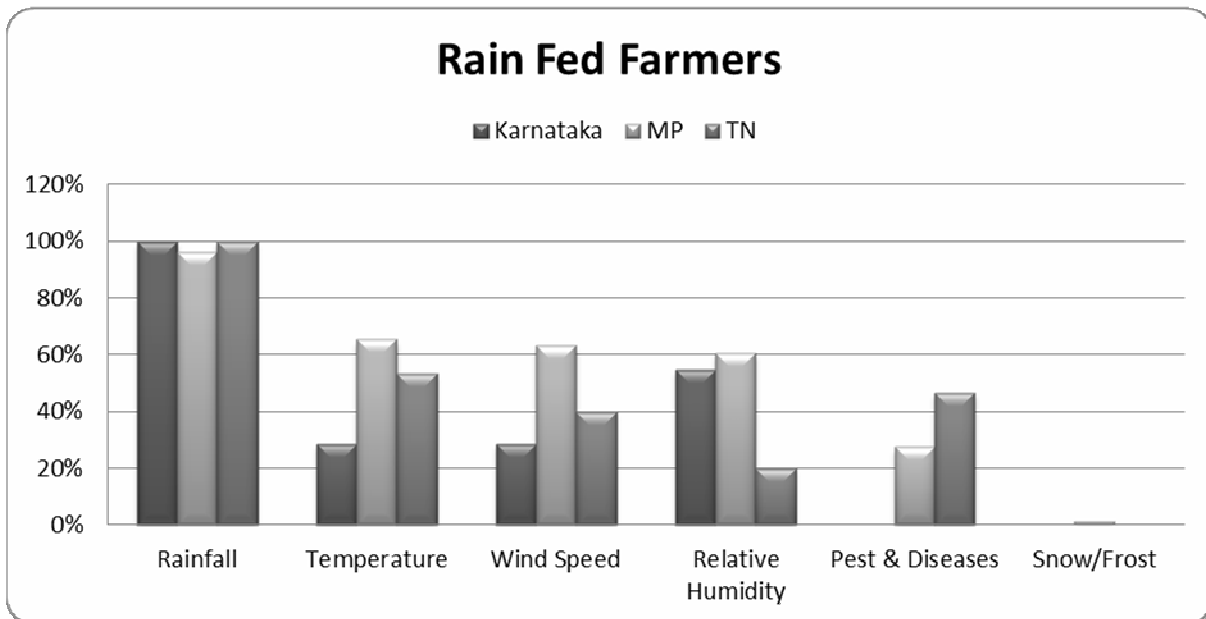


FIGURE 24: RANKING OF KEY WEATHER PERILS IN KARNATAKA

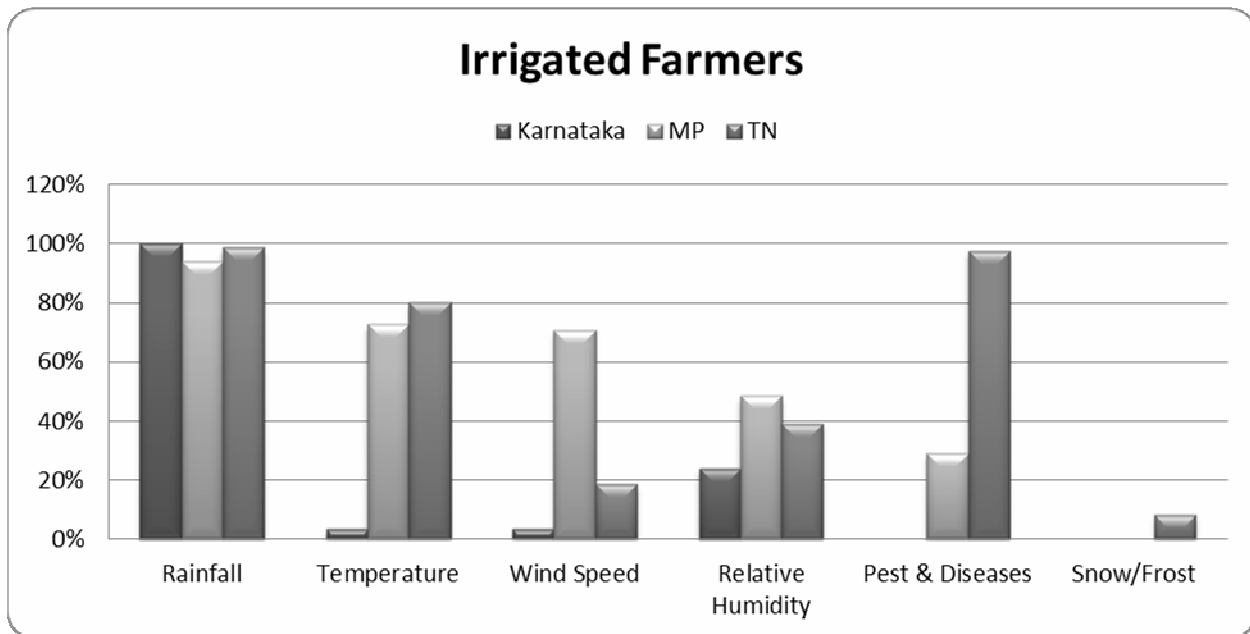


FIGURE 25: COVERAGE OF WEATHER VARIABLES UNDER CROP INSURANCE

Rain-fed Farming- All the respondent farmers from Karnataka and Tamil Nadu practicing rain-fed cultivation have evinced the need for covering rainfall under crop insurance. For Madhya Pradesh, the proportion of such respondents was marginally lower at 96.4 percent. Temperature came a distant second to rainfall with 28.6 percent respondents from Karnataka, 65.5 percent respondents from Madhya Pradesh and 53.3 percent from Tamil Nadu indicating the need for its inclusion under crop insurance. Among the other weather variables, relative humidity and wind speed were tied closely (at an overall level) with relative humidity enjoying a slight edge. 54.8 percent respondent-farmers from Karnataka and 60.7 percent from Madhya Pradesh have lent support to coverage of relative humidity under crop insurance. Wind speed has garnered favour in Madhya Pradesh and Tamil Nadu with 63.1 percent respondents and 40 percent respondents respectively. Though pests and diseases cannot be considered weather variables in the literal sense, the fact that they are influenced substantially by the interplay of weather variables vindicates their inclusion among weather variables. The respondent-farmers from Tamil Nadu and Madhya Pradesh, engaged in rain-fed cultivation, have affirmed their preference for including pests and diseases within the ambit of crop insurance. Over and above the 20 percent respondents from Tamil Nadu and 68.7 percent respondents from Madhya Pradesh who have favoured relative humidity, an additional base of 46.7 percent respondents from Tamil Nadu and 26.4 percent respondents from Madhya Pradesh supported the coverage of pests and diseases under crop insurance.

Irrigated Farming- All the respondent farmers from Karnataka, 98.8 percent from Tamil Nadu, and 94.3 percent from Madhya Pradesh, endowed with facilities for irrigated farming have evinced the need for covering rainfall under crop insurance. As in the case of rain-fed farming rainfall outstrips temperature by a considerable margin. Tamil Nadu and Madhya Pradesh with 80.1 percent respondents and 72.9 percent respondents, respectively constituted the bulk of support for including temperature under coverage of crop insurance. In contrast to the case of rain-fed farming, pests and diseases have staked a formidable claim for coverage under crop insurance. With 97.7 percent respondents from Tamil Nadu and 29 percent from Madhya Pradesh, pests and diseases have been able to garner the backing of irrigated farmers in relatively higher proportion than that mobilized by relative humidity and wind speed. Among the other weather variables, relative humidity pulled in a wider support from irrigated farmers across the three states. Karnataka with 24.1 percent respondents, Madhya Pradesh with 48.6 percent respondents and Tamil Nadu with 39.2 percent respondents tilted the balance in favour of relative humidity vis-à-vis wind speed. Despite the endorsement of 71 percent irrigated respondent-farmers from Madhya Pradesh, wind speed exhibits a more lop-sided pattern of support for coverage under crop insurance.

4.5.2.5. Awareness and Purchase of Crop Insurance

Awareness about the crop insurance program was found high in Madhya Pradesh (72 %) and low in Karnataka (45 %). The purchasing of insurance was also high in Madhya Pradesh with 62 percent. Though awareness was 48 percent in Tamil Nadu, only one percent of the surveyed farmers purchased the crop insurance policy. Crop insurance was compulsory for loanee farmers, but in Tamil Nadu, farmers could take taking crop loan against jewel loan and so compulsory purchase was less which is the major source of crop insurance in India. This has led to less than the national average or lowest crop insurance purchase in Tamil Nadu.

4.5.2.6 Barriers for Crop Insurance Purchase

The considerable demand for crop insurance as indicated by the farmer respondents from all the three states does not correspond well with the observed enrollment rates. In order to gain clarity on the barriers for purchase of crop insurance, respondent-farmers were asked to choose the main factor that deters or can potentially impede the purchase of this financial instrument for risk management. Key factors pointed out by respondents from each of the three states are presented in Figure 23A, B & C.

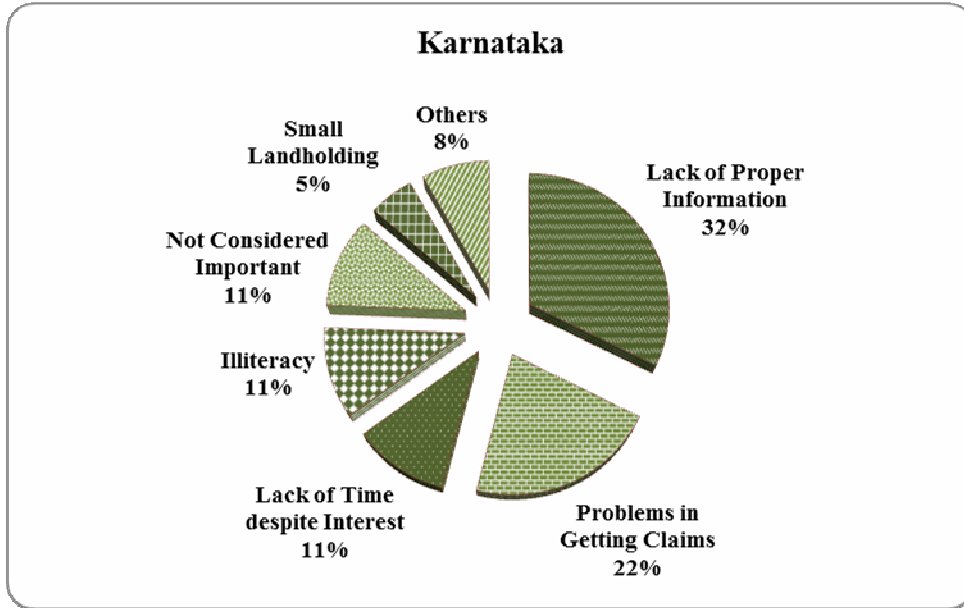


FIGURE 26: BARRIERS FOR CROP INSURANCE PURCHASE

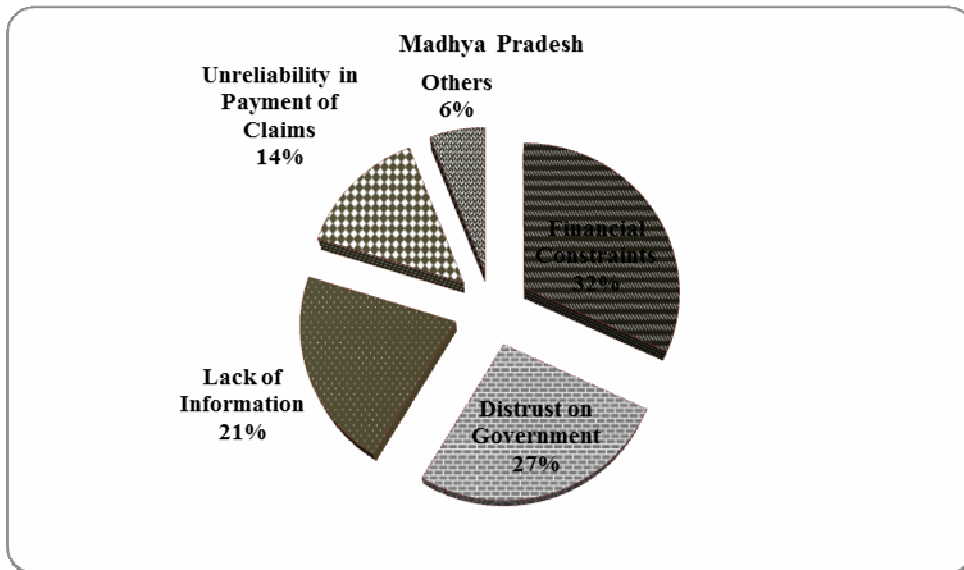


FIGURE 27: BARRIERS FOR CROP INSURANCE PURCHASE

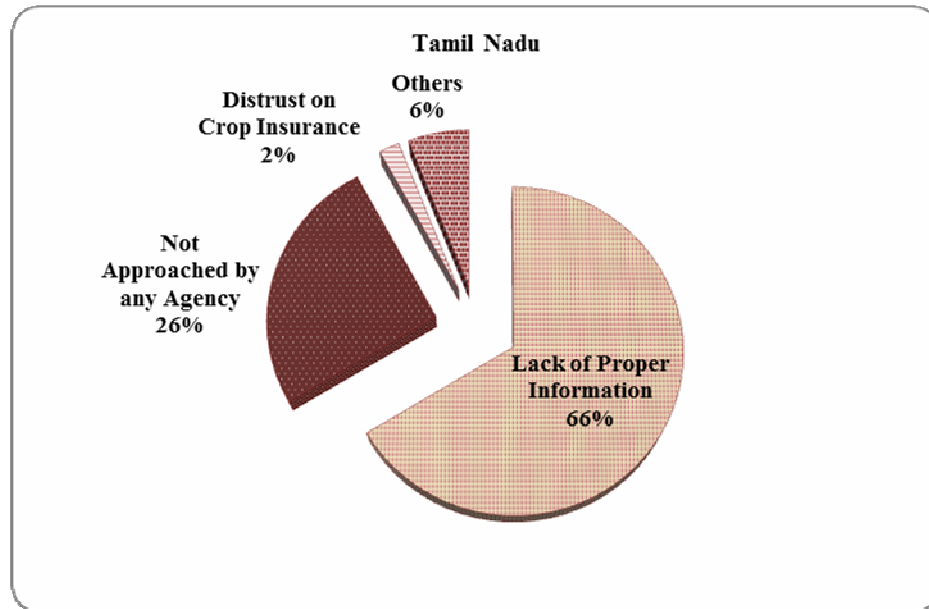


FIGURE 28C: BARRIERS IN CROP INSURANCE PURCHASE

The lack of information (proper information) was the most widely reported barrier in purchasing of crop insurance. The largest proportion of respondents from Karnataka attributed their reluctance for crop insurance to issues related to availability of proper information. Backed by an overwhelming 66 percent (or two-thirds approx.), respondents in Tamil Nadu and a significant 32 percent and 21 percent respondents in Karnataka and Madhya Pradesh, respectively, this factor highlighted the challenges in building awareness and understanding of a seemingly complex financial instrument such as crop insurance. Illiteracy, a factor contributing to lack of information, was put forward by 11 percent of respondents from Karnataka. The issues of reliability and unfriendliness of claim assessment and settlement process under crop insurance were voiced prominently by respondents of Karnataka and Madhya Pradesh. Nearly 22 percent respondents from Karnataka and 14 percent from Madhya Pradesh aired grievances about the claim assessment and settlement process. A number of factors that were specific to one of the three states, also emerged. One of such factors relates to trust on government, widely believed to be the instrumental agency for crop insurance, constituted a major barrier in purchasing of crop insurance in Madhya Pradesh. Almost 27 percent respondents from Madhya Pradesh attributed their reluctance for crop insurance to distrust on the government. Another such factor was the financial constraint to purchase of crop insurance, registered by almost one-third (32 %) respondents from Madhya Pradesh. Though farmers borrowing from banks are mandatorily enrolled under crop insurance, it is startling to note that 26 percent respondents from Tamil Nadu have

indicated 'Not Approached by any Agency' as a barrier for purchase of crop insurance. Likewise, 11 percent respondents from Karnataka have reported their inability for purchase of crop insurance to 'Lack of Time Despite Interest'. It is important to notice here that some of the reasons pointed out by respondents may not be pertinent since crop insurance is mandatory for farmers availing crop loans from formal financial institutions (banks). Among the various factors unique to a state, 'Not Considered Important' asserted by 11 percent respondents of Karnataka could be deemed as the one that raises questions on the fundamental value proposition or utility of crop insurance.

4.5.2.7. Crop Insurance Policy Aspects

Farmers who purchased crop insurance policy were asked to indicate their satisfaction level on different aspects of the policy. The responses were analyzed for the states of Karnataka and Madhya Pradesh, and since crop insurance purchase was low in Tamil Nadu, this study was not done. Farmers responded on four aspects of crop insurance and were satisfied with premium rates (72%) and not satisfied with communication and awareness programs (67%) in Karnataka. The farmers in Madhya Pradesh responded to all the aspects of crop insurance and were satisfied with respect to its availability (92%). They expressed more dissatisfaction with respect to settlement process (97%) and basis of settlement (88%).

4.5.2.8. Results of Logit Analysis

A logistic regression analysis was conducted to predict knowledge about agriculture insurance program for farmers of Tamil Nadu, Karnataka and Madhya Pradesh using age, education, size of landholding and type of farming (irrigated versus) as predictors. The state-wise results of the analysis are presented below:

Tamil Nadu- A test of the full model against a constant model was statistically significant, indicating that the predictors as a set reliably distinguished between awareness and unawareness (Chi square = 94.232, $p < .000$ with $df = 8$). Nagelkerke's R^2 of 0.501 indicated a moderately strong relationship between prediction and grouping. Prediction success overall was 76 percent (76 % for both awareness and unawareness) which was only 52 percent in constant only model. As expected for a good model, Hosmer and Lemeshow Test of Chi square was insignificant.

The Wald criterion demonstrated that the level of education, size of landholding and type of farming made a significant contribution to prediction of awareness about agricultural insurance in Tamil Nadu. Age was not a significant predictor, and in type of farming, only farming (omitted category) was significant. Exp (B) value indicates that when size of landholding is raised by one unit (one acre), the odds ratio is 1.22 times as large and, therefore, farmers are 1.22 times more likely to be aware of agricultural insurance. When education level was primary from illiteracy, farmers are about five-times more aware, and when education level was raised to intermediate level, farmers were about 28-times more aware. But when education level rose to graduation and above, increase in awareness was significant but not too much increase. It indicates that target group of awareness program towards agriculture insurance has to be farmers with high schooling and intermediate level of education where the reach will be comparatively good.

TABLE 22: THE IMPACT OF SOCIO DEMOGRAPHIC AND LAND CHARACTERISTICS ON AWARENESS ABOUT AGRICULTURE INSURANCE INTAMIL NADU

Independent variable	Coefficient (B)	S.E	Wald	Exp(B)
Age	0.015	0.020	0.604	1.015
Education level				
Primary level	1.606*	0.842	3.641	4.983
High school	2.204***	0.763	8.349	9.057
Intermediate	3.338***	0.956	12.202	28.169
Graduation & above	1.927***	0.811	5.653	6.870
Type of farming				
Both irrigated and farming	19.570	8018.1.04	0.000	3.157E8
Irrigated farming	21.052	8018.1.04	0.000	1.389E9
Size of landholding (acres)	0.199***	0.053	14.278	1.220
Constant	-24.401	8018.104	0.000	0.000
Percent correctly predicted				
Constant only model	52			
Models including independent variables (Total, Unawareness & Awareness)	76, 76, 76			
Test Statistic				

Chi square (df=8)	94.232***			
Nagelkerke R Square	0.501			
Hosmer and Lemeshow Test –	8.710			
N	200			

***-Significant at 1 percent level

*- Significant at 10 percent level

Omitted category: Illiteracy and Farming

Karnataka- A test of the full model including the predictors viz. age, education, landholding size and type of farming was statistically significant, indicating that the included predictors reliably distinguished between awareness and unawareness levels (chi square = 61.354, $p < 0.000$ with $df = 8$). Nagelkerke's R^2 value of 0.535 indicated a moderately strong relationship between prediction and grouping. Prediction success overall was ~81 percent (~86 % for unawareness and ~74 % for awareness levels) which was only 55 percent in constant only model. As expected from a good model, Hosmer and Lemeshow Test of Chi square was insignificant.

It was found from the Wald criterion that the level of education, size of landholding and type of farming made a significant contribution to the prediction of awareness about agricultural insurance in Karnataka. Age was not a significant predictor, and in type of farming, both irrigated and farming was significant, but size of landholding was significant. Exp (B) value indicated that when size of landholding is raised by one unit (one acre), the odds ratio becomes 1.33, indicating that farmers are 1.33-times more likely to be aware of agricultural insurance. When education level was raised from illiteracy to primary level, farmers were about six-times more knowledgeable. Other education levels did not significantly contribute to awareness level. It could be due to not having enough samples at higher education levels (two samples each under intermediate and graduation levels). Most of the farmers were found in the lower literacy level bracket. Both categories in type of farming variable viz. irrigated farming and farming (omitted category) significantly contributed to awareness. Exp (B) value indicates that when farmers moved from to irrigated farming, the odds ratio was 7.42-times as large and, therefore, farmers are 7.42 times more likely to be aware of agricultural insurance.

TABLE 23: THE IMPACT OF SOCIO DEMOGRAPHIC AND LAND CHARACTERISTICS ON AWARENESS ABOUT AGRICULTURAL INSURANCE IN KARNATAKA

Independent variable	Coefficient (B)	Standard Error	Wald	Exp(B)
Age	0.021	0.023	0.804	1.021
Education level				
Primary level	1.805***	0.554	10.604	6.078
High schooling	1.401	0.868	2.604	4.058
Intermediate	-0.490	2.684	0.033	0.613
Graduation & above	18.514	23901.082	0.000	1.098E8
Type of farming				
Both irrigated and farming	0.528	0.681	0.601	1.696
Irrigated farming	2.004***	0.627	10.220	7.420
Size of landholding (acres)	0.285***	0.079	12.860	1.330
Constant	-4.900***	1.369	12.811	0.007
Correct prediction (%)				
Constant only model	55			
Model including independent variables (Total, Unawareness & Awareness)	80.8, 86.4, 74.1			
Test Statistic				
Chi square (df=8)	61.354***			
Nagelkerke R Square	0.535			
Hosmer and Lemeshow Test –	9.791			
N	120			

*** Significant at 1 percent level

* Significant at 10 percent level

Omitted category – Illiteracy and Farming

Madhya Pradesh- A test of the full model against the constant only model was statistically significant, indicating that the predictors as a set could reliably distinguish between awareness and unawareness

levels (Chi square = 132.418, $p < 0.000$ with $df = 8$). Nagelkerke's R^2 value of 0.540 indicated a moderately strong relationship between prediction and grouping. Prediction success overall was 84.3 percent (60 % for unawareness and 94% for awareness levels). As expected from a good model, Hosmer and Lemeshow Test of Chi square was insignificant.

The Wald criterion demonstrated that the level of education, size of landholding and type of farming made a significant contribution to the prediction of awareness about agricultural insurance in Madhya Pradesh. Only age was not a significant predictor. Exp (B) value indicated that if size of landholding is raised by one unit (one acre) the odds ratio becomes 1.2-times as large and, therefore, farmers are likely to be 1.2 times more aware about agricultural insurance. If education level rises to primary and high school level, farmers will be about four-times more aware, and if education level rises to intermediate and graduation levels respectively, farmers will be about 14-times and 27-times more aware, respectively about agricultural insurance. Exp (B) value also indicated that when type of farming changes to irrigated from , farmers are about 51-times more likely to be aware of agricultural insurance.

TABLE 24: THE IMPACT OF SOCIO DEMOGRAPHIC AND LAND CHARACTERISTICS ON AWARENESS ABOUT AGRICULTURAL INSURANCE IN MADHYA PRADESH

Independent variable	Coefficient (B)	Standard error	Wald	Exp(B)
Age	0.006	0.014	0.200	1.006
Educational level				
Primary	1.475***	0.434	11.529	4.369
High school	1.279***	0.555	5.323	3.594
Intermediate	2.606***	0.792	10.818	13.542
Graduation & above	3.304***	1.382	5.719	27.225
Irrigated vs. farming				
Both irrigated and farming	3.315***	0.699	20.122	22.984
Irrigated farming	3.927***	0.715	30.126	50.763
Size of landholding (acres)				
Constant	-4.741***	1.052	20.303	0.009
Correct prediction (%)				

Constant only model	71.4			
Model including independent variables (Total, Unawareness & Awareness)	84.3,60.0,94.0			
Test statistic				
Chi square (df=8)	132.418***			
Nagelkerke R Square	0.540			
Hosmer and Lemeshow Test –	3.110			
N	280			

***Significant at 1 percent level

*Significant at 10 percent level

Omitted category – Illiteracy and Farming

4.5.2.9. Practical Measures for Managing Weather Risks

Besides crop insurance, there are a number of other measures that are employed farmers to manage weather risks. Some of the practical measures highlighted by respondent farmers of each of the three states are presented in Figure 24A, B & C charts and discussed below.

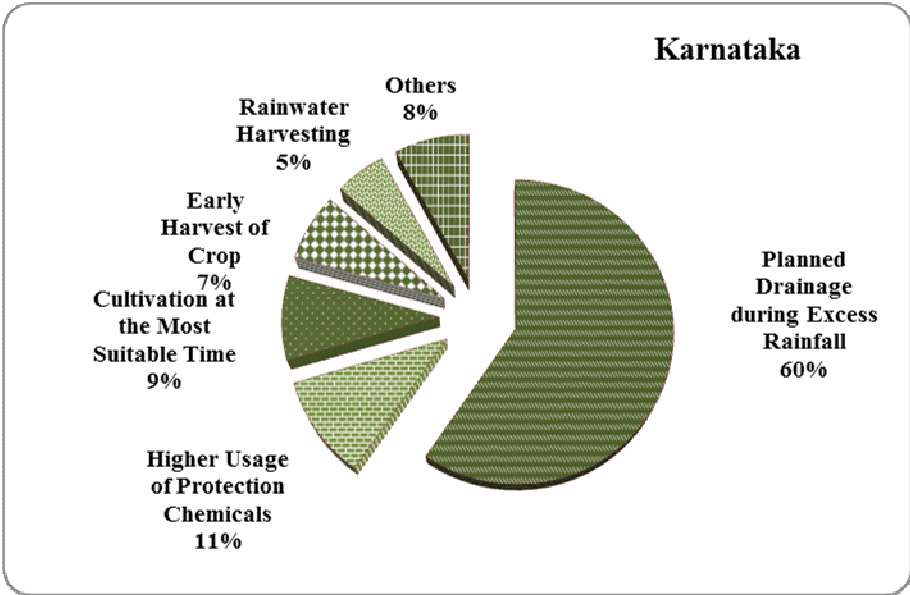


FIGURE 29: PRACTICAL MEASURES BY FARMERS TO MANAGE WEATHER RISKS

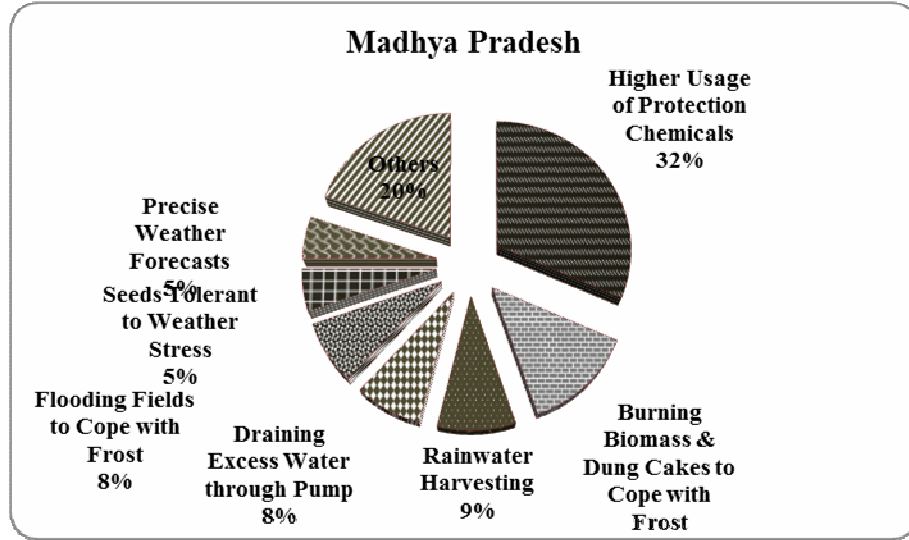


FIGURE 30B: PRACTICAL MEASURES BY FARMERS TO MANAGE WEATHER RISKS

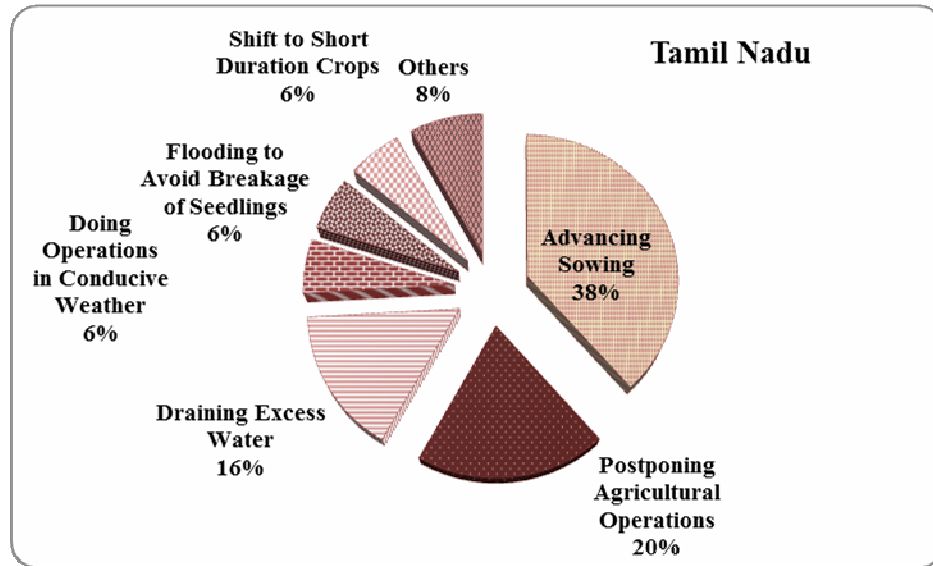


FIGURE 31C: PRACTICAL MEASURES ADOPTED BY FARMERS TO MANAGE WEATHER RISKS

A look at Figure 24C that the practical measures resorted by respondents vary considerably from one state to another. The relative proportion of respondent-farmers suggesting a specific measure appears to be representative of its efficacy in managing the weather peril (s) with high threat perception. For instance, 60 percent of respondents from Karnataka take recourse to planned drainage for managing excess rainfall – the weather peril with the second highest incidence, severity and overall importance,

as indicated by respondents-farmer from Karnataka. The planned drainage of excess water was also being suggested by 16 percent respondents from Tamil Nadu.

In Madhya Pradesh, higher usage of protection chemicals was suggested by 32 percent of respondents. This measure can be helpful in mitigating the severity of pests and diseases borne out of high humidity – the weather peril with the highest severity and third-highest frequency, as indicated by the respondents from Madhya Pradesh. A significant (11%) percentage of respondents from Karnataka supported the idea of using higher level of protection chemicals to tackle the menace of pests and diseases.

In Tamil Nadu, around 38 percent respondents suggested advancing of sowing while 20 percent indicated postponing of agricultural operations to counter deficient rainfall – the weather peril with the highest frequency, severity and overall importance, as indicated by respondent farmers. Similar or related measures such as ‘Doing Operations in Conducive Weather’ and ‘Shifting to Short Duration Crops’ were reported by 6 percent of respondents from Tamil Nadu. Risk management measures that involve adjustment of timing of key agricultural operations, duration of crop cycle and variety of seeds were also have been echoed by the farmers of other two states, viz., Karnataka and Madhya Pradesh.

Some farmers from Madhya Pradesh (9% of respondents) and Karnataka (5% of respondents) acknowledged the adoption of eco-friendly measures such as rainwater harvesting to safeguard their crops from deficit rainfall. For frost – a weather peril relevant only to Madhya Pradesh among out of the three state, protection measures included ‘Burning Biomass and Dung Cakes’ and ‘Flooding Fields’.

4.5.2.10. Awareness about Weather Advisories and Perceptions of their Utility

Weather advisories can enable the farmers to prepare themselves for facing unfavorable weather events. With the help of timely weather advisories that include possible weather scenarios and suggested management actions, farmers can become proactive participants in the weather risk management system instead of being passive entities. The level of awareness about weather advisories and perceptions of respondent farmers-respondent about their utility in all the three studied states are depicted in Figure 25.

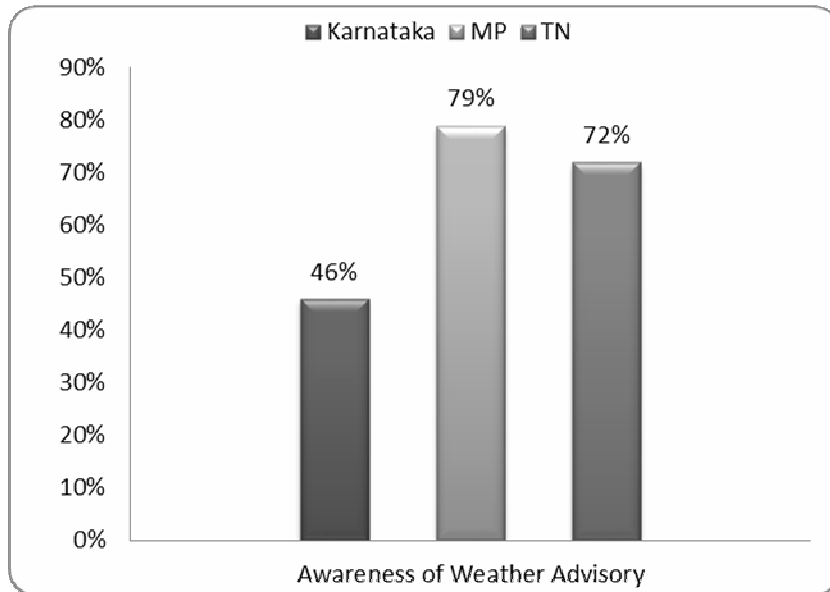


FIGURE 32: AWARENESS OF WEATHER ADVISORY AMONG FARMERS (IN THE SELECTED STATES)

The respondents from Madhya Pradesh and Tamil Nadu displayed a reasonably widespread level of awareness about weather advisories as nearly 79 percent respondents from Madhya Pradesh and 72 percent respondents from Tamil Nadu were aware of weather advisories. However, farmers in Karnataka (with only 46% being aware of weather advisories) lagged considerably behind their counterparts in Madhya Pradesh and Tamil Nadu.

Though respondents from Madhya Pradesh indicated the highest awareness level about weather advisories, their conviction in the utility of timely weather advisories was not conclusive. Against the 45 percent respondents endorsing the utility of timely weather advisories in preventing/minimizing crop losses, there were 53 percent respondents lacking belief in the utility of timely weather advisories. This could be due to a bad past experiences or high payment for the services.

In contrast to the observations from Madhya Pradesh, almost two-thirds (66%) farmers-respondent from TN have showed conviction in the utility of timely weather advisories. However, the remaining 34 percent were not convinced whether timely weather advisories could be helpful to them in preventing/minimizing crop losses.

The respondents from Karnataka were also divided in their assessment of the utility of timely weather advisories. While 54 percent respondents backed the role of timely weather advisories in preventing/minimizing crop losses, 46 percent were either unsure or unconvinced about their benefits.

4.5.2.11. Types of Weather Advisories Preferred

Respondents were asked to indicate their preference for three main types of weather advisories. These advisories were based (a) on historical weather data, (b) on satellite forecast and (c) based on both.

There existed a clear consensus among the respondents across the three states as more than 62 percent farmers from these states indicated preference for weather advisories based on historical weather data. The proportion of such respondents was higher in both Madhya Pradesh (71%) and Karnataka (70%) and reasonably high in Tamil Nadu (62% respondents).

It is surprising, that weather advisories based on both historical weather data and satellite forecast have found negligible (3% or less respondents) takers in all the three states.

4.5.2.12. Choice of Medium for Weather Advisories

Respondents were questioned on their preferred medium for a weather advisory delivery. The alternatives provided were: DD/TV, Radio, Village Head/Opinion Leader, Extension Worker and Newsletter/SMS. From the study Electronic mass media, viz., DD/TV and Radio, emerged as the most preferred media for weather advisory by figuring among the top-two choices in each of the three states.

While DD/TV was the most preferred medium of weather advisory delivery for respondents in Madhya Pradesh and Karnataka, Radio narrowly overtook DD/TV in Tamil Nadu as 61 percent respondents from Madhya Pradesh, 45 percent from Karnataka and 33 percent from Tamil Nadu indicated preference for it. Likewise Radio garnered the support of 35 percent respondents in TN, 28 percent in Karnataka and 22 percent in Madhya Pradesh.

The choice of Village Head/Opinion Leader as the preferred medium for weather advisory delivery turned out to be significant only in Karnataka where it was favored by 24 percent of the respondents. Similarly, Newsletter/SMS as the preferred medium of weather advisory delivery had a significant support in Tamil Nadu where it was favored by 28 percent of the respondents.

Overall, it seems that electronic mass media was the preferred medium for important crop information delivery. The reasons may perhaps lie in their widespread access and ease of communication.

4.5.2.13. Perceived Changes in Weather Variables

Beginning from the academic and scientific community, concerns about climate change have already made inroads into the policy circles at the global and national levels. The society at large is getting sensitized about this phenomenon at a fair pace. In such a scenario, it was considered worthwhile to get an insight into the perspectives of farmers on this complex but tangible issue. The changes in key weather variables as perceived by farmers-respondent of the three states are depicted in charts given in Figure 26 A, B & C.

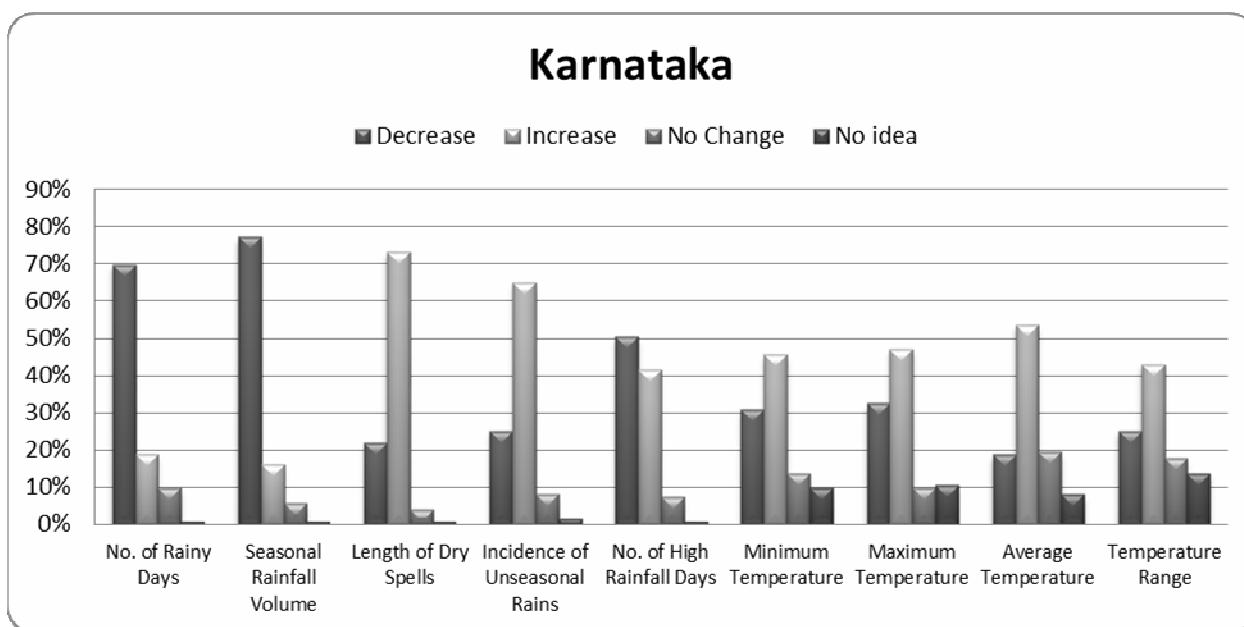


FIGURE 33A: CHANGES IN WEATHER VARIABLES AS PERCEIVED BY FARMERS IN KARNATAKA

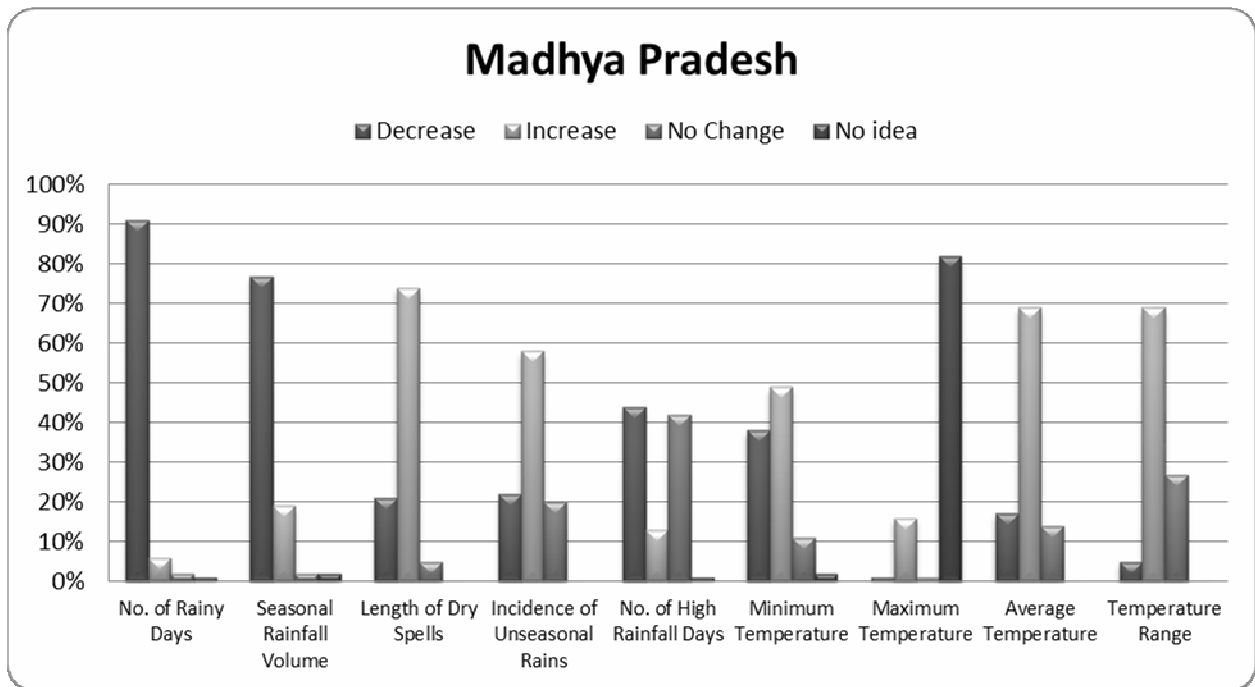


FIGURE 34B: CHANGES IN WEATHER VARIABLES AS PERCEIVED BY FARMERS IN MADHYA PRADESH

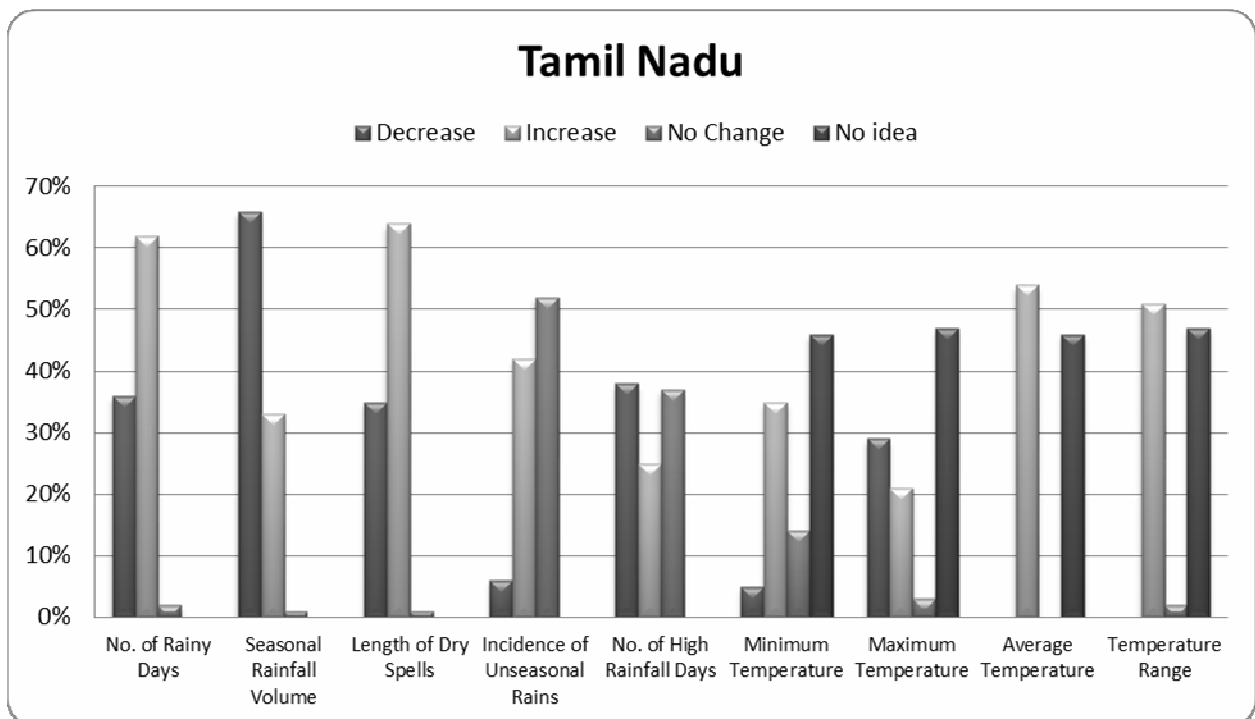


FIGURE 35C: CHANGES IN WEATHER VARIABLES AS PERCEIVED BY FARMERS IN TAMIL NADU

Number of Rainy Days- An overwhelming percentage (91%) of respondents from Madhya Pradesh believed that there was a decline in the number of rainy days. Their belief was supported by the 70 percent respondents from Karnataka. However, the perceptions of respondents from Tamil Nadu diverged considerably with only 62 percent sensing an increase in the number of rainy days.

Seasonal Rainfall Volume- There was an apparent consensus among the respondent farmers of the three states regarding decrease in the volume of seasonal rainfall. An equal percentage (77%) of respondents from Karnataka and Madhya Pradesh were able to strike resonance with 66 percent of respondents from Tamil Nadu. It is important to note that the percentage of respondent from Tamil Nadu sensing an increase in the seasonal rainfall volume was a significant 33 percent as compared to 16 percent from Karnataka and 19 percent from Madhya Pradesh.

Length of Dry- Spells- There seems to be unanimity among the farmers in the three states regarding an increase in the length of dry- spells as 73 percent respondents from Karnataka, 74 percent from Madhya Pradesh and 64 percent from Tamil Nadu believed that dry- spells during the rainy season had become longer. Similar to the volume of rainfall, the percentage of respondents from Tamil Nadu holding an opposing view (decrease in length of dry- spells) was reasonable at 35 percent compared to a more modest 22 percent and 21 percent from Karnataka and Madhya Pradesh, respectively.

Incidence of Unseasonal Rains- Though the majority of respondents from Karnataka and Madhya Pradesh sensed an increase in the incidence of unseasonal rains, the proportion of such respondents (65% and 58% respectively) was less conclusive than in the case of the preceding weather variables. In Tamil Nadu, the opinions of respondents depicted a split between 'increase' and 'no change' with the latter enjoying a slight edge (~10 percent difference in percentage of respondents) over the former.

Number of High Rainfall Days- There was a substantial inconclusiveness across all the three states regarding perceived changes in the number of high rainfall days. In Karnataka, respondents were divided between 'decrease' (50% respondents) and 'increase' (41% respondents). The division between respondent farmers was tighter in Madhya Pradesh and Tamil Nadu where the difference between respondent farmers sensing 'decrease' and those perceiving 'no change' was 2 percent and 1 percent, respectively.

Minimum Temperature- Both in Karnataka and Madhya Pradesh, the respondents perceiving an increase in minimum temperature (46% and 49%, respectively) had a modest edge over those perceiving a decrease in minimum temperature (31% and 38%, respectively). However, in Tamil Nadu, respondents lacking clarity about the occurrence of change and its direction (46% respondents stating ‘no idea’) constituted the largest proportion that had a slender edge over the proportion of farmers sensing an increase (35% respondents).

Maximum Temperature- In this case, Karnataka exhibited a pattern similar to in the minimum temperature. The respondents perceiving an increase in maximum temperature (47%) had a modest edge over those perceiving a decrease in minimum temperature (33%). The vast majority of respondents from Madhya Pradesh (82%) and the largest proportion (47%) from Tamil Nadu admitted having ‘no idea’ about the occurrence and direction of the change in maximum temperature.

Average Temperature- The majority of respondents (>50%) in all the three states have indicated an increase in the average temperature. The perception of increase in the average temperature was substantially conclusive in Madhya Pradesh with 65 percent of respondents backing it. In both Karnataka and Tamil Nadu, 54 percent respondents perceived an increase in the average temperature. Considering the percentage of respondents under the second-most preferred response, the perception in Karnataka seems to be fairly conclusive compared to a mixed one in Tamil Nadu where the second-most preferred response (‘no idea’) had the backing of 46 percent respondents.

Temperature Range- The respondent farmers sensing an increase in temperature range constituted the majority (>50%) both in Madhya Pradesh and Tamil Nadu. The stark difference in Madhya Pradesh and Tamil Nadu was that the perceptions of this majority were substantially conclusive in one state, viz. Madhya Pradesh, whereas they were insufficiently conclusive in the other, viz. Tamil Nadu. Though the proportion of respondents in Karnataka perceiving an increase in the temperature range was less than 50 percent, the edge over the second-most potent respondent group (perceiving decrease in the temperature range) was fairly reasonable (~18%).

General Comment:

National Sample Survey Organisation (NSSO) in the Ministry of Statistics & Programme Implementation conducts surveys at regular intervals to capture the key statistical and economic indicators of the economy, including the agriculture sector. The last published survey (Report No.

496(59/33/3 published in July 2005) was conducted in 2003, called Situation Assessment Survey of Farmers (SAS). The survey was restricted to farmer households in rural India and, like all normal National Sample Surveys (NSS), covered practically the entire geographical area of the country with a sample of 51770 households spread over 6638 villages. NSSO surveys are the most significant and statistically sound longitudinal surveys conducted in a large country like India. The SAS survey had one basic questions about the crop insurance (did you have crop insurance any time; if no, the reasons). Given the importance and the scale of NSSO surveys it would be very useful if some more relevant questions on crop insurance are incorporated into the survey.

4.5.3. INSURANCE PROVIDERS

Starting from 2008 the Indian government allowed (besides AIC) four private sector insurance providers to deliver WBCIS, and subsequently MNAIS since 2010. Thanks to generous amounts of premium subsidies, there has been a lot of interest from the private sector; hence the government has now added five more private sector providers for 2013-14 crop season.

The researcher comes from the industry and has been interacting with other insurance providers offering these products, could use his knowledge to document the views of the market briefly, as follows:

i) Need more of public weather stations

At present over 80 percent of weather stations servicing WI products are from the private sector. In the absence of third party accreditation of the weather stations, installation standards, maintenance norms etc. often question marks on the reliability of the data, especially when there is a lawsuit. Also, the cost of weather data from private weather data providers is high compared to the public weather data provider, i.e. IMD. Given this situation, insurance providers have been impressing upon the government to improve the public weather station density.

ii) Transparency in the selection of insurance providers and insurance products

The existing guidelines issued by the Central government are too broad, leaving the states to adopt the selection system of its choice, often non-transparent and too theoretical. As a result, some insurance providers feel aggrieved. Also, usually states push for a product which requires payouts even for the smallest loss, gradually leading to dilution of insurance principles. Refer to

4.3.1 (product basis risk) to appreciate as to how WI products losing correlation vis-à-vis NAIS. Insurance providers are seeking establishment of a centralized Technical Support Unit (TSU) to assist the states in moving towards insurance principles, based regime.

iii) Need to release premium subsidies upfront

The total government funding comes in as up-front subsidies in premium. While Central government is prompt in releasing premium subsidies in time, there has been a considerable delay in receiving subsidies from the States. Having entered into the reinsurance contract, insurance providers often face cash-flow problems due to delay in receiving premium subsidies.

iv) Facilitation in insuring non-loanee farmers

Most of the crops insured are of three to four months duration, and hence establishing the ‘insurable interest’ becomes difficult in the absence prompt updating of land and crop records by the states. While in case of loanee farmers, the lending banks take responsibility for ensuring the insurable interest, for non-loanee farmers its cumbersome process, and often have to deal with speculative behavior of the insured.

4.5.4. INTERPRETATION

The majority of the States have opined NAIS to be a better product than WBCIS and MNAIS, and it holds good from the farmers’ perspective as well. It is contrary to the popular belief that WBCIS is superior to NAIS, and MNAIS is far better than NAIS. The opinion of States has actually revealed though a narrow, but an important mindset. The preference of States towards NAIS could be due to following reasons: (i) States have a larger say in the programme in terms of benefits (yield estimation), larger window for participation (loanee farmers can participate virtually throughout the crop period, while non-loanees can actually participate till a month after planting), etc., (ii) Entire government funding comes at the back-end (claims subsidy), and States have ample time to provide the money (as compared to up-front subsidies); (iii) States are required to pay only during bad-crop years, and the money directly goes to the farmers (as compared to the premium subsidies which are actually shared with reinsurers and goes out of country); (iv) there is less pressure on the States to lower the insurance unit (as compared to the mandatory lower unit in the case of MNAIS for major crops), etc. Needless to say, that, these opinions are unnecessarily rational, and therefore, may not be reflected in the farmers’ views.

Ease in implementation and simple to understand by the farmers are the two strong aspects of NAIS, while long duration in claim settlement is a significant weak aspect. In WBCIS, ease in implementation, followed by choice of insurance providers are its strengths, while inability of the index to capture losses and the basis risk are its weaknesses. In the case of MNAIS, scope of insurance and better correlation of claims with yield loss (as it provides for contingencies like prevented sowing benefits, on-account payment, individual assessment of losses for localized calamities & post-harvest losses, etc.) are its strong aspects while delay in processing and settlement of claims are weak aspects. Overall, ease in implementation and adequacy of payments relative to losses are the major positive aspects of all the three schemes, while time taken in processing and making claim payments and correlation of claim amount with yield loss are the major negative features of all the three schemes.

In terms of focus areas for improvements in WBCIS and MNAIS, both programmes need improvement in claims processing time and payment. In the case of MNAIS, 'product design that gives payout when farmers have suffered a loss' is the second priority area, followed by manpower/infrastructure to conduct CCEs. For WBCIS, product design and correlation with farmers' losses is the second priority area, followed by weather data quality issues and better tools to help State governments in making informed decisions among different schemes and insurance companies.

The essential features of a weather insurance product from States perspectives should be: (i) payout to correspond to actual losses (basis risk), and (ii) distribution of the sum insured on one or two key parameters rather than multiple parameters. While weather index products (due to compulsions) are designed to provide regular small payouts for weather parameters (to sustain the interest) rather than providing for large losses. However, States have not ranked this sufficiently high in their priority list, indicating the importance of regular payouts.

The states seem to be fully aware about the strong and weak aspects of yield index and weather index insurance products, and are in favour of something like a 'double trigger' product, wherein weather trigger can provide quick and early payout, and subsequently, yield trigger can pay for the residual risks not captured by weather index.

Most of the States have favoured involvement of multiple insurance providers. To provide the benefit of competition to the farmers, some pre-requisites have been suggested; these include: designing of more farmer-friendly products with the help of an expert team (technical support); competitive rates of

premium and transparency in processing and timely claim settlement/faster service and good communication facilities.

The states do not seem to be fully convinced about services delivered by the private weather data providers, and some States have actually skipped the question in view of lack of complete confidence. This in a way points to the need for 'standardization / accreditation of weather equipment, installation procedures and data accuracy standards, etc. to bring more confidence in the private weather data providers.

Bench-marking / standardization of products is essential, particularly for weather index insurance, and more so in view of involvement of multiple insurers. Most importantly States do not have the needed technical expertise to bench-mark / standardize the insurance products, so hand-holding from the Centre in the form of Technical Support Unit could be very useful.

From the farmers' perspective, it was revealed that there is certainly a demand for crop insurance among the farmers. Farmers practicing crop production under irrigated conditions have shown more interest in crop insurance than the farmers dependent on rainfall for crop production. Both irrigated as well as farmers have demanded the inclusion of rainfall cover in the insurance policy. Other weather parameters were more influenced by the location of the respondent farmers. About 50 percent of the farmers were aware about crop insurance and barring Madhya Pradesh, only a low percentage of farmers in other states opted for crop insurance. The lack of information turned out to be the major barrier in the purchase of crop insurance. Also, the issues of reliability and unfriendliness of claim assessment and settlement process under crop insurance have been found prevalent.

The issue of awareness of the crop insurance was dealt in detail by the Logistic regression analysis. It has been revealed that the level of education, size of landholding and type of farming affected the awareness about crop insurance significantly. Although, age was also a significant factor affecting the awareness level, its contribution, however, was much less than of other factors. Thus, it was observed that higher the level of education and the size of the landholding, the more the farmer would be aware about the crop insurance. The type of farming affecting awareness turned out to be area-specific. Therefore, its contribution to awareness generation about the crop insurance depended on the location of the respondent farmer.

Apart from crop insurance, there are other measures that are undertaken by the farmers to manage crop risk. Some of these measures, viz. planned drainage for managing excess rainfall, higher usage of protection chemicals, and advancing of sowing, were area specific. Most of the farmers were aware about the weather advisories; however, the number of farmers considering them useful was low. A high percentage of farmers considered historical weather data to be the best weather advisory. As for the medium of the weather advisory, electronic mass media, viz., DD/TV and Radio, have emerged as the most preferred media for weather advisory delivery.

Finally, the farmers' views on the changes in weather variables seemed to be uniform throughout the survey area. They have reported a decrease in the number of the rainy days and the volume of the seasonal rainfall over the years. Further, the length of dry-spells and incidence of unseasonal rainfall have increased considerably from the farmers' point of view. However, in the case of number of high rainfall days and temperature variables, the respondents had different views. These differ not just among the respondents of different states; even within a state the respondents had varied perceptions on the changes in the number of high rainfall days and various temperature variables, viz. minimum temperature, maximum temperature, average temperature and temperature range.

From the perspective of the insurance providers it has been suggested that there is a need for more of public weather stations as compared to the existing larger share of private weather stations. Transparency in the selection of insurance providers and insurance products is also a major concern for the insurance provider. The need for the timely release of premium subsidies is also a major issue concerning the insurance providers. Finally, the facilitation in insuring non-loanee farmers is an area that needs to be worked upon.