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Weather Based Risk Management Tool to Mitigate the Farming Risk in India

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***Abstract:* This paper analyzes the dynamic nature of weather based risk management tool. The Purpose of this paper is to present weather insurance as a non-catastrophic whether risk management tool, empirically demonstrate the process of designing it and assess their effectiveness as a risk management tools. The weather based farm risk market in India is the world's largest, having transitioned from small-scale and scattered pilots to a large-scale weather based crop insurance program covering more than 9 million farmers. This paper provides a critical overview of this market, including a review of indices used for insurance purposes and a description and analysis of common approaches to design. Products should be designed based on sound agronomic principles and further investments are needed both in quantifying the level of basis risk in existing products, and developing enhanced products with lower basis risk. In addition to pure weather based products, hybrid products that combine both area yield and weather indices seem promising, with the potential to combine the strengths of the individual indices. The market structure for weather based crop insurance could better reward long-term development of improved product designs through product standardization, longer term contracts, or separating the roles of product design and delivery. This article is mainly focused on a Whether Based Crop Insurance.**

***Key Words:*-Weather Insurance, Demand for Insurance, Basis Risk**

I. INTRODUCTION

Farming is a financially risky occupation. On a daily basis, farmers are confronted with an ever-changing landscape of possible price, yield, and other outcomes that affect their financial returns and overall welfare. The consequences of decisions or events are often not known with certainty until long after those decisions or events occur, so outcomes may be better or worse than expected. When aggregate crop output or export demand changes sharply, for example, farm prices can fluctuate substantially and farmers may realize returns that differ greatly from their expectations. Risk is uncertainty that affects an individual's welfare, and is often associated with adversity and loss. In dealing with risky situations, risk management involves choosing among alternatives to reduce the effects of the various types of risk. It typically requires the evaluation of tradeoffs between changes in risk, changes in expected returns, entrepreneurial freedom, and other variables.

The weather Insurance industry is relatively young. This insurance sector began to develop in 1997, as a result of the severe weather events of El Niño. The El Niño events of 1996-1998 were the first such major climate forecasts that the meteorological community forecasted correctly. The El Niño winter of 1997-1998 was forecasted to be unseasonably mild. This caused numerous companies that had earnings tied to weather to realize the importance of hedging their seasonal weather risk. During this time, the insurance industry was in a position to make available a sufficient amount of capital to hedge weather risk. There were a large number of options with payouts tied to weather events that were written by insurance companies, which increased liquidity for the development of a monthly and seasonal market for weather insurance. As a result of these events, the weather insurance market grew rapidly into a thriving over-the-counter market (Considine, 2006).

II. OBJECTIVES

The objectives of this research paper is to outlines the Indian experience of scaling up a national weather indexed insurance program and suggests a roadmap for future research on the supply of weather indexed insurance policies and to identify the scope of weather based risk mitigating tools in India with potential transfer towards other developing countries.

III. WEATHER BASED CROP INSURANCE-A REVIEW

During the year 2003-04 the private sector came out with some insurance products in agriculture based on weather parameters. The insurance losses due to vagaries of weather, i.e. excess or deficit rainfall, aberrations in sunshine, temperature and humidity, etc. could be covered on the basis of weather index. If the actual index of a specific weather event is less than the threshold, the claim becomes payable as a percentage of deviation of actual index. One such product, namely Rainfall Insurance was developed by ICICI-Lombard General Insurance Company. This move was followed by

IFFCO-Tokio General Insurance Company and by public sector Agricultural Insurance Company of India (AIC). Under the scheme, coverage for deviation in the rainfall index is extended and compensations for economic losses due to less or more than normal rainfall are paid. ICICI Lombard, World Bank and the Social Initiatives Group (SIG) of ICICI Bank collaborated in the design and pilot testing of India‟s first Index based Weather Insurance product in 2003-04. The pilot test covered 200 groundnut and castor farmers in the rain-fed district of Mahaboobnagar, Andhra Pradesh. The policy was linked to crop loans given to the farmers by BASIX Group, a NGO, and sold through its Krishna Bhima Samruddhi Area Bank. The weather insurance has also been experimented with 50 soya farmers in Madhya Pradesh through Pradan, a NGO, 600 acres of paddy crop in Aligarh through ICICI Bank‟s agribusiness group along with the crop loans, and on oranges in Jhalawar district of Rajasthan. Similarly, IFFCO-Tokio General Insurance (ITGI) also piloted rainfall insurance under the name- „Baarish Bima‟ during 2004-05 in Andhra Pradesh, Karnataka and Gujarat. Agricultural Insurance Company of India (AIC) introduced rainfall insurance (Varsha Bima) during 2004 South-West Monsoon period. Varsha Bima provided for five different options suiting varied requirements of farming community. These are (1) seasonal rainfall insurance based on aggregate rainfall from June to September, (2) sowing failure insurance based on rainfall between 15th June and 15th August, (3) rainfall distribution insurance with the weight assigned to different weeks between June and September, (4) agronomic index constructed based on water requirement of crops at different phases and (5) catastrophic option, covering extremely adverse deviations of 50 per cent and above in rainfall during the season. Varsha Bima was piloted in 20 rain gauge areas spread over Andhra Pradesh, Karnataka, Rajasthan and Uttar Pradesh in 2004-05.

Based on the experience of the pilot project, the scheme was fine-tuned and implemented as "Varsha Bima -2005" in about 130 districts across Andhra Pradesh, Chattisgarh, Gujarat, Karnataka, Mahrashtra, Madhya Pradesh, Orissa, Tamil Nadu, Uttarakhand and Uttar Pradesh during Kharif 2005. On an average, 2 or 3 blocks /mandals / tehsils were covered under each India Meteorological Department (IMD) rain gauge stations. The scheme covered the major crops provided at least two coverage options namely, Seasonal Rainfall Insurance or Rainfall Distribution Index and Sowing Failure Insurance. Varsha Bima-2005 covered 1.25 lakh farmers with a premium income of Rs.3.17 crore against a sum insured of Rs.55.86 crore. Claims amounting to Rs.19.96 lakh were paid for the season. Further, during *kharif* 2006, the scheme was implemented as Varsha Bima-2006 in and around 150 districts/ rain gauge station areas covering 16 states across the country. The Weather Based Crop Insurance Scheme (WBCIS) of AIC was implemented in the selected areas of Karnataka on a pilot basis. WBCIS is a unique weather based insurance product designed to provide insurance protection against losses in crop yield resulting from adverse weather incidences. It provides payout against adverse rainfall incidence (both deficit and excess) during *kharif* and adverse incidence in weather parameters like frost, heat, relative humidity, un-seasonal rainfall etc., during *rabi*. It operates on the concept of area approach i.e., for the purpose of compensation, a reference unit area shall be linked to a reference weather station on the basis of which weather data and claims would be processed. This scheme is available to both loanees (compulsory) and non-loanees (voluntary). The NAIS is not available for the locations and crops selected for WBCIS pilot. It has the advantage to settle the claims with the shortest possible time. The AIC has implemented the pilot WBCIS in Karnataka during *kharif* 2007 season, covering eight rain-fed crops, insuring crops nearly 50,000 ha for a sum insured of Rs.50 crore. WBCIS is being implemented in 2007-08 on a larger scale in selected states of Bihar, Chattisgarh, Haryana, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh for *rabi* 2007-08 season and will be continued even in 2008-09 also as a pilot WBCIS (Union Budget 2008-09, GOI). Together these above mentioned companies have been able to sell weather insurance policies to about 5.39 lakh farmers across India from their inception in 2003-04 to date. Though, weather insurance coverage was limited, it holds lessons for future programmes.

Table 1.1: The Indian weather index insurance market

Agricultural Year	Farmers Insured	Sum Insured (USD Millions)	Commercial Premium Volume (USD Millions)	Claims Paid (USD Millions)	Claim Payments as a multiple of Commercial Premiums
2003-04	1,000	--	<0.1	<0.1	--
2004-05	11,300	--	0.2	0.1	--
2005-06	112,500	--	1.6	0.2	--
2006-07	181,900	--	1.6	1.0	--
2007-08	678,425	398	33.1	23.9	72%

2008-09	375,100	208	18.6	14.2	77%
2009-10	2,278,407	1,093	99.9	62.0	62%
2010-11	9,278,000	3,174	258.9	125.0	48%

Note:-1.Commercial Premium includes both farmer premium and government premium subsidies

2. Kharif Season Only

3. WBCIS Only

The market for weather indexed insurance in India fundamentally changed in 2007 with the launch of the Weather Based Crop Insurance Scheme (WBCIS), the pilot scheme weather indexed insurance scheme of the Indian government. Before 2007, states could either choose to opt in to NAIS, in which case insurance purchase would be compulsory for farmers that borrowed from financial institutions and voluntary for other farmers, or opt out. From the 2007-8 agricultural year states had the additional option of choosing WBCIS as an alternative to NAIS.

Table 1.2 Premium subsidies for commercial crops covered under WBCIS

Commercial Premium	Subsidy for Commercial Crops
<2%	No Subsidy
2%-5%	25% of Commercial Premium, with minimum of 2%
5%-8%	40% of Commercial Premium, with minimum of 3.75%
8%+	50% of Commercial Premium, with minimum of 4.8% and maximum of 6%

WBCIS enjoys substantial government subsidy, with farmer premium rates capped at 1.5% for wheat and 2.0% for other *food* crops (cereals, millets, pulses and oilseeds) and defined subsidy rates for other, *commercial*, crops (Table1.2), although subsidy rates for commercial crops are typically lower than the subsidy rates enjoyed by the NAIS. With WBCIS offering lower, more predictable costs to state government and quicker claim payments to farmers, some large states have experimented with WBCIS as an alternative to NAIS.

IV. FUNCTIONAL FORMS FOR WEATHER INDEXED INSURANCE PRODUCT DESIGN

Many types of products have been tried for weather index insurance in India. A selection of these product forms are described below and in the appendix. However, as discussed at the end of this section it should be noted that there has been a striking absence of rigorous statistical analysis to help insurers choose the best index in a specific environment.

In theory, the more degrees of freedom available to a product designer, the more freedom the designer has to reduce basis risk. However, complex products do not necessarily have low basis risk. While many alternative product forms have been sold in India, very little is understood about the level of basis risk in different products or whether more complex products do actually exhibit lower basis risk. Since minimizing basis risk is a key aim of weather indexed insurance product design, more work in understanding what products exhibit lower basis risk would be helpful, as would research into the degree to which an increase in the density of weather stations can decrease basis risk.

V. MULTIPLE PHASE WEATHER INDEXES

In response to the farmer feedback collected after the first pilot, ICICI Lombard developed a rainfall index with multiple phases for the Kharif 2004 season, described in Giné et al (2010). For such an index the growing season is divided into sequential phases of varying duration, typically chosen to correspond to the crop-growth stages as defined by crop calendars and other reference sources for agronomy. For each phase, the schedule of payments is typically piecewise linear in the total rainfall in the phase, reflecting the water requirements of the crop in that phase, and with payments only if the total rainfall in the phase is sufficiently low.

Table 1.3 Rainfall index with multiple phases (ICICI Lombard, Kharif 2004)

Phase	Dates	Strike(mm)	Exit (mm)	Sum Assured
Establishment and vegetative Growth	June 10-July 14	75	20	3,000
Flowering and Pod Formation	July15-August 28	110	40	2,000
Pod Filing and Maturity	August 28-October 2	75	10	1,000

For example, Table 1.3 provides an example of a product for which payments are triggered if the total rainfall in the phase r_p is below the rainfall trigger $Trigger_p,$ linearly increasing to the maximum payment of $Rate_p \times (Trigger_p - Exit_p)$ for $r_p \geq Exit_p.$ Such a schedule would lead to a claim payment as follows:

$$\text{Deficit rainfall index with phases} = \sum_{p \in \{phases\}} Rate_p \times \max\left[0, Trigger_p - \max\left(r_p, Exit_p\right)\right]$$

This design could be more intuitive to potential policyholders by clearly associating each critical crop-growth phase with a distinct rainfall insurance structure, and provides scope for interim payouts instead of having to wait till the completion of policy period. However, multiple-phase rainfall insurance index may not capture long dry spells, particularly for phases with durations exceeding a fortnight.

Perhaps more importantly multiple-phase rainfall indices do not fully capture the conditional impact on rainfall in different phases on yields, instead implicitly assuming that the crop productivity in a particular phase is independent of the crop health and rainfall in the previous phase(s). For example, if the index defined in equation is used to determine claim payments, a farmer will only ever receive the maximum claim payment of $\sum_p Rate_p \times [Trigger_p - Exit_p]$ if there is sufficiently low rainfall in *all* phases; complete crop loss in one phase is not sufficient to trigger a maximum claim payment even if it is sufficient to destroy an entire crop.

Table 1.4 Rainfall index with multiple phases and carry-forward (AICI, Kharif 2009)

Period	10-Jun to 30-Jun	1-Jul to 31-Jul	1-Aug to 31-Aug	1-Sep to 30-Sep
Trigger I (<)	50mm	90mm	100mm	60mm
Trigger II (<)	25mm	45mm	50mm	30mm
Exit	0	0	0	0
Payout Rate I (□/mm)	10	10	12	15
Payout Rate II (□/mm)	70	68	58.0	52
Max. Payout (□)	2000	3500	3500	2000

Note:-Rainfall of more than 2 times the trigger during a particular phase is considered for 'Carry Forward' to the next phase. In case of Phase-I, 25% of the rainfall in excess of the trigger (provided the rainfall is more than twice the trigger value) would be carried forward to Phase - II. In case of Phase - II, 30% of the rainfall in excess of the trigger (provided the rainfall is twice the trigger value) would be carried forward to Phase III. And in case of Phase III, 30% of the rainfall in excess of the trigger (provided the rainfall is twice the trigger value) would be carried forward to Phase IV.

Designers have experimented with two ways of introducing conditionality between phases. First, products usually include a maximum claim payment for the policy which is smaller than the sum of maximum claim payments for each phase. A maximum claim payment may therefore be triggered by exceptionally poor weather in one or a small number of phases. Second, a product may allow rainfall to be *carried over* between phases, to try to capture the soil moisture at the start of the phase.

VI. CONSECUTIVE DRY DAYS (CDD) INDEX

Another approach to capturing adverse rainfall events is to construct an index equal to the maximum consecutive number of *dry days* within a specified period, where a dry day is defined as a day with total rainfall below a threshold value.

Table 1.5 Consecutive Dry Days (AICI, Kharif 2009)

Cover Period	1-Jul to 31-Aug		
Rainy Day Definition	Daily Rainfall ≥ 2.5 mm		
Trigger Non-Rainy Days (>=)	17	25	30
Payout (□)	750	1500	2000

Consecutive Dry Days index = Maximum Number of Consecutive Days with r actual < r threshold

This cover offers protection for long dry spells and can be sold as a standalone product or in conjunction with other indexed cover, particularly rainfall volume based products. For example, a consecutive dry days product where the index uses a daily threshold of 2.5mm, and with claim payment a step function of the index, with claim payment of ₹750 if the index is between 17 and 24 days, ₹1,500 if the index is between 25 and 29 days and ₹2,000 if the index is greater than or equal to 30 days.

VII. EXCESS/UNTIMELY RAINFALL INDEX

Heavy and continuous rainfall within a short period has the potential to cause severe physiological damage to crops, particularly during the maturity and the harvest phases when excess rainfall makes many crops highly susceptible to attacks by pestilence and disease. The indices that have been designed to capture wet spells are similar in nature to those already described for deficit rainfall, dependent on consecutive rainy days, aggregate rainfall over a period of between two and four consecutive days, or a piecewise linear function of rainfall in each phase. For example Hess et al. (2005) report on a rainy days product for Mahabubnagar, Andhra Pradesh for which was 10mm of daily rainfall and a claim was triggered if the rainy day index was four or more. The most recent products seem to be mainly based on aggregate rainfall over a period of two, three, or four consecutive days.

VIII. LOW TEMPERATURE OR FROST INDICES

Temperature can have a significant impact on yields (Lobell et al. 2011) and Indian insurers have experimented with indices based on weather station temperature readings, particularly for the Rabi (winter) crop.

Northern parts of India are particularly exposed to the risk of low temperatures or frost which can cause severe crop loss in a short space of time for crops like potato, chick-pea and mustard. Indices have been designed to offer some protection against adversely low temperatures, typically defined as a function of the minimum temperature in the cover period.

IX. HIGH TEMPERATURE INDICES

Complex temperature-based indices have been designed to offer some protection to farmers against adversely high temperatures, particularly for wheat crop. For example, AICI and the Indian Agricultural Research Institute (IARI) designed a phase-based high temperature index for wheat crop in Rajasthan for the Rabi 2007 season, where the claim payment to farmers in respect of each phase was a function of the mean temperature for that phase (Table 1.6).

Table 1.6: Temperature index with multiple phases (AICI, Rabi 2007)

Cover Objective	Heat or Rise in Mean Temperature					
Cover Period	1st January to 31st March					
Total Payout	Sum of The Payout of Various Fortnights					
Max. Sum Assured	□ 5400					
Period (Fortnight)	1-15 Jan	16-31 Jan	1-15 Feb	16-29 Feb	1-15 Mar	16-31 Mar
Rise in Fortnightly Mean Temp (*C)	Payout (Percentage of Sum Assured)					
1.0	0.00	0.00	0.00	0.00	0.00	0.00
2.0	0.00	0.00	0.00	3.82	4.31	4.31
3.0	0.00	0.00	0.00	6.76	6.57	6.57
4.0	0.00	3.99	3.53	9.92	8.39	8.39
5.0	4.66	5.70	4.92	12.68	9.52	9.52
6.0	0.00	7.04	9.20	15.17	10.78	10.78

As another example, ICICI Lombard sold a product for wheat crop in 2010 for which claim payments depended on excess daily temperature, rather than excess average fortnightly temperature (Table 1.7). However, while it is known that high temperatures can reduce wheat yields, very little is known about the level of basis risk in high temperature indexed products.

Table 1.7: Cumulative High Degree Deviation (HDDN) Index (ICICI Lombard, 2010)

Crop	Wheat				
Reference Weather Station	NCMSL Dhar				
Index	Total Sum of upward deviation of average of daily maximum temperatures of every sub phase from the corresponding benchmark temperatures of every sub phase, measured in degree Celsius, during the cover phase. i.e.3n *[0,Average (Tmaxn)-BTn], where Tmax is daily maximum temperature, n is sub phase, BT is Benchmark Temperature.*				
Cover Phase, from	1-Jan-10	**Sub Phase**			**Benchmark Temperature (C)**
To	31-Mar-10	S.No	From	To	
Strike 1 (C)	6.50	1	01-Jan-10	15-Jan-10	26
Strike 2 (C)	13.50	2	16-Jan-10	31-Jan-10	27
Exit (C)	17.50	3	01-Feb-10	14-Feb-10	29.5
Notional 1 (□/C/Hectare)	785.70	4	15-Feb-10	28-Feb-10	31
Notional 2(□/C/Hectare)	2562.70	5	01-Mar-10	15-Mar-10	34.5
Phase Limit (□/Hectare)	15750.00	6	16-Mar-10	31-Mar-10	37.5

X. WEATHER INDICES FOR PESTS AND DISEASES

Indices have been developed in India to try to capture exposure to pestilence or disease, such as aphid infestation or potato blight and are typically based on relative humidity (see Table 1.8), or a combination of relative humidity, temperature and rainfall. Such indices are typically complex and, to an even greater degree than other indices, there has been little analysis of the degree to which such indices capture yield shortfalls.

Table 1.8: Relative Humidity Index for Pests and Diseases

Index Objective	To Protect against possible yield loss because of weather conditions conducive to occurrence of aphid and blight disease.
Crop	Cumin
Reference Weather Station	Bikaner
High Relative Humidity (RH) Event	A RH reading of >65 % taken at 08:30 or 17:30 hours in a day
Index	Maximum number of 5 day moving count of high RH Events
Cover Start Date	1-Jan
Cover End Date	28-Feb
Strike (High RH Events)	7.0
Exit (High RH Events)	10.0
Notional (□/High RH Event)	2000
Policy Limit (□)	6000

Table 1.9: Multiple Parameter Weather Index for Pests and Diseases (ICICI Lombard, Kharif 2006)

Crops	Potato
Reference Weather Station	Ranchi
Index	Number of Blight conducive events (BCE) within the policy period where a BCE occurs when within a period of 5 days the following conditions are observed simultaneously: There is some amount of rainfall observed in 2 consecutive days, morning and evening relative humidity is observed to be more than 85 % for 2 continuous days, and

	the maximum and minimum temperature on a day is observed to be between 7.2-26.6 C for 4 consecutive days
Policy Duration	15-Sep to 06-Nov
Strike (No. of BCEs)>	1
Exit (No. of BCEs)>=	2
Payout (in □for Observed index of 1 BCE)	600
Payout (in □ for Observed index of 2 BCE)	1000
Premium (□)	157
Policy Limit (in □)	1000

XI. BASIS RISK

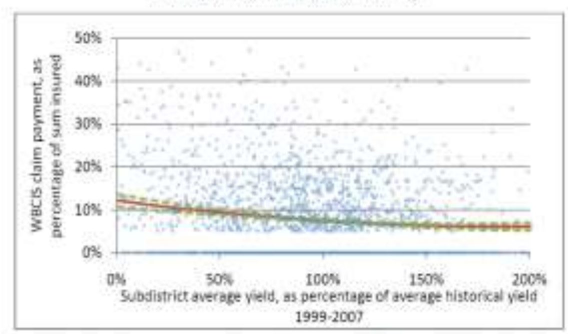
One key requirement of any index-based approach to agricultural insurance product design is that the claim payments from the indexed product are sufficiently correlated with yield losses of individual farmers, particularly in those years with significantly poor yields. In other words, products must have limited basis risk between the index and the actual individual yield loss.

Preliminary statistical analysis has been conducted for the relationship between average sub district yields and weather indexed claim payments for all 270 WBCIS products sold in one state in one year, spanning 13 districts and 12 crops. Applying the product characteristics to available historical weather data we obtain the claim payments that would have been paid in each of the fourteen years from 1999 to 20013. These historical burn costs may then be compared with sub district average yields, where each yield measurement is normalized by the average yield between 1999 and 2007 for the respective crop in the respective sub district.

Figure 1 presents a scatter plot of the empirical joint distribution of claim payments and sub district average yields, and a kernel plot of the average claim payments conditional on the yield. The relationship between WBCIS claim payments and yields appears to be rather weak, with low average claim payments in the event of extreme yield losses; the leftmost point estimate of the kernel regression indicates that in the event of a zero yield, the average WBCIS claim payment is only 12% of the sum insured while in the event of yields being twice the historical average, the average WBCIS claim payment is 6% of the sum insured.

Considering the entire empirical joint distribution, the average Pearson product-moment correlation coefficient is -14% and the average Spearman's rank correlation coefficient is -13%. (In both cases a more negative coefficient indicates lower basis risk.) While these correlations are the correct sign, the magnitudes are quite low. Moreover, for some crops the average correlation is the wrong sign, with lower yields associated with lower claim payments.

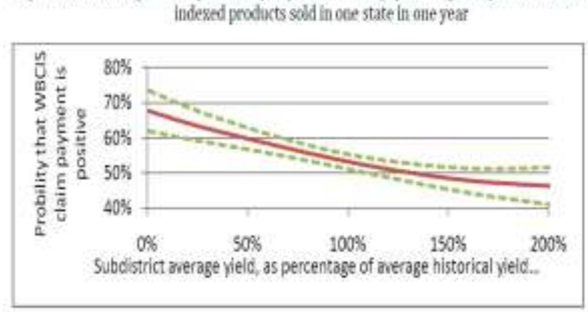
Figure 1: Scatter plot and kernel regression: claim payments against yields, for all weather indexed products sold in one state in one year



Note: The lines show the point estimate and 95% confidence intervals for an Epanechnikov kernel with a bandwidth of 0.8.

On this basis we estimate that conditional on total crop loss, that is an area average crop yield of zero, there is a 1-in-3 chance of receiving no claim payment from the WBCIS (Figure 2). This may arise because of perils not captured by the weather station data, such as localized weather, pestilence or disease, or weather events not adequately captured by the index used in the WBCIS product. Conversely, there is a high risk of farmers receiving a positive WBCIS claim payment, even in years with good yields. For example, again reading off from the kernel regression point estimate in , conditional on the yield being twice the historical average the WBCIS products included in this analysis paid claims with probability of 45% (Figure 2).

Figure 2: Kernel regression: probability of positive claim payment against yields, for all weather indexed products sold in one state in one year



Note: The lines show the point estimate and 95% confidence intervals for an Epanechnikov kernel with a bandwidth of 0.8.

However, the interpretation of this analysis requires care due to three data limitations. First, the yield data are based on crop cutting experiments which may not be wholly reliable. In past years the results from crop cutting experiments determined the claim payment due to farmers under the NAIS, and there are concerns both about measurement error and that some yield figures may have been underreported to trigger claim payments (Mahul et al. 2011).

Second, we do not consider individual farmer yields in this analysis, but rather area average yields. While 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 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, significant investments in weather station infrastructure have been made in the last few years by both the public and private sectors, increasing the number of weather stations per district. Since one source of basis risk is likely to arise from the distance between a farmer's plot of land and the contractual weather station (spatial basis risk), this increase in granularity of weather stations might be expected to reduce basis risk. The degree to which this might happen is an open empirical question.

XII. CONCLUSION

This paper offers an overview of the market and suggestions for future research and innovations. First, states may wish to support long-term development of improved products that aim to minimize basis risk. A comparative statistical analysis of different products would be valuable and should be possible in India given the availability of long-term yield and weather data. This could lead to further standardization of products, based on agronomic and statistical principles, which would in turn support robust actuarial design and pricing.

The WBCIS offers substantial opportunities to understand how to increase demand, particularly from the most vulnerable farmers. A rigorous monitoring and evaluation could be integrated into these programs to ensure that at the end of the pilot period government and states have the information they need to make decisions about the future of agricultural insurance in India.

While this paper has focused on weather indexed insurance contracts, there is merit in further research to better understand how best to combine the information from different indices so that farmers can rely on timely claim payments in bad years.

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