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Review Paper

Weather based crop insurance for risk management in agriculture

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ABSTRACT

In recent years, in many parts of the country, indebtedness, crop failures, unpaid prices and poor returns have resulted in agrarian distress. The government has identified and introduced several programs to address these critical issues *viz.* crop insurance, lending waivers etc. among them. Crop insurance as a concept for risk management in agriculture has emerged in India since the turn of the twentieth century and government has launched various insurance schemes in last three decades like Comprehensive Crop Insurance Scheme (CCIS), National Agricultural Insurance Scheme (NAIS) and Modified NAIS (MNAIS) etc. Apart from these schemes, several other pilot projects such as Seed Crop Insurance, Farm Income Insurance Scheme and Weather Based Crop Insurance Scheme (WBCIS) were implemented from time to time. At present, two most important schemes are functional *i.e.* Pradhan Mantri Fasal BimaYojna (PMFBY) and Restructured Weather Based Crop Insurance Scheme (RWBCIS) are in operation. This study focused on the performance of the Restructured Weather based Crop Insurance Scheme (RWBCIS) from historical and analytical perspectives and presents recommendation for future scenarios. RWBCIS scheme having two most important challenges. Firstly, weather data related issues by designing a modern scientific approach to develop high resolution secondary data and secondly, modifying the existing design of RWBCIS Products, based on sound agronomic principles.

Keywords: Crop Insurance, Weather data, CCIS, NAIS, MNAIS and RWBCIS

Agriculture, with its allied sectors, is unquestionably are highly dependent on weather conditions, any weather aberrations cause atmospheric and other forms of stresses and in turn, will increase the vulnerability of these farmers to economic losses (Srinivasarao *et al.,* 2016; Bal and Minhas, 2017). Crop insurance concept was introduced in India for risk management in agriculture sector in the beginning of last century. The seed for index-based insurance was sown in 1912 by J.S. However, despite large public subsidy, a significant majority of India's farmers have remained uninsured largely due to issues in design, particularly the long delays in claims settlement (Hazell, 1992; Mahul *et al.,* 2011) and high basis risk. The first nation-wide crop insurance scheme was the Comprehensive Crop Insurance Scheme (CCIS) introduced in *kharif*, 1985 on all India level. This scheme was based on an area approach and area units were identified for the purpose of assessing indemnity. The CCIS was operational till *rabi* 1999 and was replaced by National Agriculture Insurance Scheme (NAIS) in *rabi* 1999-2000. NAIS was based on an indexed approach known as the area yield-based approach, where the index used is the crop yield of a defined area called an insurance unit (*e.g.* an administrative block). Under this scheme, at the end of the crop season the aggregate claims that exceeded farmers' premium were funded 50-50 by the state and central governments. The NAIS was further modified to include additional features for managing risk in agriculture production in a better way and it is implemented as MNAIS (modified NAIS) on a pilot basis in 50 districts from the *rabi* 2010-11 season onwards. The key features included a reduction of the insurance unit to the panchayat level, calculation of premium based on actuarial rates, raising the minimum level of indemnity to 80 per cent from 60 per cent and a more refined basis for calculation of threshold yield. In addition to these schemes, several other pilot projects have been implemented from time to time, such as Seed Crop Insurance (1999-00), Farm Income Insurance Scheme (*rabi* 2003-04) and Weather Based Crop Insurance Scheme (*kharif*

2007). As agricultural production is an outcome of biological activity which is highly sensitive to changes in weather (Soni and Trivedi, 2013). Weather index-based scheme was first introduced in 2003 by ICICI Lombard for groundnut and castor farmers of Mahboobnagar district in Andhra Pradesh, followed by the pilot rainfall insurance scheme by IFFCO-Tokyo General Insurance (ITGI) in 2004-05 in Andhra Pradesh, Karnataka and Gujarat. Later considering the benefits of weather index insurance, Government of India (GOI) introduced Restructured Weather based Crop Insurance Scheme (RWBCIS) on a pilot basis in the year 2007. The pilot was scaled up as a full-fledged scheme in the year 2013.

Two most relevant systems have been operational in the recent past, *i.e.* Pradhan Mantri Fasal Bima Yojna (PMFBY) and Restructured Weather based Crop Insurance Scheme (RWBCIS) based on restructured weather. These schemes are area-based schemes and were launched on 18th February 2016 for providing a comprehensive insurance cover against crop failure and help stabilize the income of the farmers. The PMFBY provide insurance coverage and financial support to the farmers in the event of failure of any of the notified crop as a result of natural calamities, pests & diseases whereas the RWBCIS aims to mitigate the hardship of the insured farmers against the likelihood of financial loss on account of crop loss resulting from adverse weather conditions using weather parameters as "proxy for crop yields in compensating the cultivators for deemed crop losses.

Highlights of the various crop insurance schemes in India across different timeline are represented in Table1 (ICFA, 2016; Ministry of Agriculture and Farmers Welfare, 2016; 2017; 2018). Despite a numbers of crop insurance schemes, the crop insurance faced severe challenges in withstanding the unique nature of Indian agriculture and inequitable socio-economic status of Indian farmers. Even after repeated revision of the schemes and huge support in the form of premium subsidies for the farmers, crop insurance continues to face hurdles in implementation and in percolation to the farmers. Limitations of the schemes are listed under three major categories i) low penetration of agriculture insurance, ii) premium & sum insured related issues and iii) delay in assessment & settlement of claims.

The penetration of agricultural insurance in India has remained low in terms of the area insured and the number of farmers covered. In the three years period (2013-14 to 2015-16), the average area insured under all the schemes combined was 16.3 million hectares in the *rabi* and 29.7 million hectares in the *kharif* (Gulati *et al.,* 2018). The number of farmers insured was 13 million in the *rabi* and 25 million in the *kharif* for all the schemes. The primary reason for low coverage was unaffordable high premium rates and capping of premium and sum insured under MNAIS and WBCIS resulting less claims. The average premium rate was around 10 per cent for MNAIS and WBCIS. The sum insured was worked by multiplying the Notional Threshold Yield with MSP/average farm gate price. However, in MNAIS and WBCIS, premium rates were calculated on actuarial basis, (which was a departure from the administratively decided premium rate that prevailed during NAIS) and they were capped in order to reduce total expenditure on premium subsidy by both central and state governments. Sum insured per hectare was reduced to an amount commensurate with capped premium rates and this led to low sum insured for most of the crops. As actuarial premium rates under MNAIS were high for most of the insured crops in many districts, sum insured in certain cases was insufficient to even cover the cost of cultivation. The assessment of damage was based on the traditional system of crop cutting experiments that took 6-12 months in proving average yield for calculation of admissible claims of farmers. The settlement of claims took unduly long time; at times it extended beyond the next cropping season. The issue of area discrepancy has been prevalent since early years of crop insurance as in many cases; the area insured was than the net sown area as reported by the government agencies. Problem was acute particularly in some districts of Gujarat growing groundnut as major crop. In *kharif* 1993, the claim for groundnut alone was Rs 192.96 crore out of a total claim Rs 207.42 crore for all crops (Mishra *et al.,* 2014). The problem of area discrepancy continued even after the introduction of NAIS in Gujarat in *kharif* 2000. To solve this problem of fudging of data by state machinery, area correction factor was applied by AIC but the states showed unwillingness to apply such correction factors. Adoption of technology was very poor in erstwhile schemes. In view of challenges in implementation of NAIS, MNAIS &WBCIS, specially delay in settlement of claims, low risk coverage in terms of reduced sum insured due to capping in MNAIS & WBCIS, huge difference of farmer premium in neighboring districts, low transparency in calculation and settlement of claims, fragmented information with different stakeholders, the Government of India reviewed the erstwhile Crop Insurance schemes and Introduced PMFBY to resolve the inherent problems of implementation by adoption of modern technology specially

Table1: Highlights of the various crop insurance schemes in India

Crop insurance Scheme	Highlights of the crop insurance schemes
Individual Approach Scheme was launched in 1971-1978.	The scheme was launched by General Insurance Corporation (GIC) of India on a limited, ad-hoc and scattered scale for cotton and later included groundnut, wheat and potato in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and West Bengal covering 3,110 farmers for a premium of Rs.4.54 lakh against claims of a massive Rs.37.88 lakh.
Pilot Crop Insurance (PCIS) introduced in 1979-1984.	PCIS was 'Area Approach' based scheme for providing insurance cover against a Scheme deficit in crop yield below the threshold level covering cereals, millets, oilseeds, cotton, potato and chickpea. The scheme was implemented in 12 states till 1984-85 and covered 6.23 lakh loanee farmers of institutional sources on a voluntary basis. Total premium collected was Rs.195.01 lakh against claims of Rs.155.68 lakh during the entire period.
Nation-wide Crop Insurance Scheme *i.e* Comprehensive Crop Insurance Scheme (CCIS) introduced in 1985-99.	The scheme was focused on the homogenous area approach' and adopted by 15 States and 2 Union Territories (UTs) covering 763 lakh farmers for a premium of Rs 4.04 crore against claims of Rs. 2,303 crore. However, claim to premium ratio, which was 6.72 for an average of 15 *kharif* seasons (1985-99), and 5.75 for an average of 14 *rabi* seasons (1985-86 to 1998-99), made the scheme financially unviable.
National Agricultural Insurance Scheme (NAIS) launched for the duration *rabi* 1999-2000 to Rabi 2013-14.	The govt launched the scheme aimed to protect the farmers against the crop losses suffered on account of natural calamities, such as drought, flood, hailstorm, cyclone, pests and diseases. It was implemented by the Agriculture Insurance Company of India Ltd. (AIC) in 25 States and 2 Union Territories and covered 2084.78 lakh farmers (both loanee and non-loanee irrespective of their size of holding and covered all crops). Sum insured was Rs. 52,508 crores for *kharif* 2015 and Rs. 27,809.6 for *rabi* 2015-16. Low penetration of agricultural insurance, Area discrepancy, Delay in assessment and settlement of claims *etc.* are the limitations of the scheme.
Modified National Agricultural Insurance Scheme (MNAIS) during *rabi* 2010-11 seasons on pilot basis in 50 districts.	The scheme was thought to be easier and more farmers friendly. It was implemented in 17 States and covered 45.80 lakh farmers. Actuarial premium rates under MNAIS were high for most of the insured crops in many districts; sum insured in certain cases was insufficient to even cover the cost of cultivation. Sum insured was Rs. 8,265 crores for *kharif* 2015 and Rs. 12,022.6 for *rabi* 2015-16. A total (under NAIS and MNAIS) sum insured was Rs. 12,4382 crores for *kharif* 2016 and Rs. 65,860.8 for *rabi* 2016-17.
Weather Based Crop Insurance Scheme (WBCIS) launched across 20 States in 2007-2008.	WBCIS was implemented by Agriculture Insurance Company of India along with some private companies to settle the claims within shortest possible time. WBCIS is based on actuarial rates of premium. Premium actually charged from farmers has been restricted at par with NAIS. Premium of Rs.7,51,920 lakh was collected against the claims of Rs. 52,860 lakh under the Scheme from 2007-08 to 2012-13. Sum insured under WBCIS were Rs. 6,903 crore (*kharif* 2016) and Rs. 3,473.1 crore (*rabi* 2016-17).
A Coconut Palm Insurance Scheme (CPIS) in 2009-10.	The pilot was implemented during the years 2009-2010 in the selected areas of Andhra Pradesh, Goa, Karnataka, Kerala, Maharashtra, Odisha and Tamil Nadu. Later on, it was extended to West Bengal and continues during 2017-18 and 2018-19 to be under implementation. It has been administered by the Coconut Development Board (CDB).Since inception of the scheme 57.25 lakh palms of 1.24 lakh growers for a sum insured of Rs. 506 crore have been covered. Against premium of Rs. 3.26 crore, claims of Rs. 4.40 crore have been paid to about 0.09 lakh farmers during 2017-2018.

Table1: Continue

Crop insurance Scheme	Highlights of the crop insurance schemes
Restructured Weather Based CropInsurance Scheme (RWBCIS) was launched in 20 States	Restructured weather-based crop insurance scheme (RWBCIS) has been introduced with the goal of providing coverage for those crops for which there is no fixed methodology for yield assessment. The scheme was revised based on the PMFBY's premium structure.
Pradhan Mantri Fasal Bima Yojana (PMFBY) was introduced in 2016.	PMFBY was designed to cover the loop holes of all the previous schemes and also uses technological advancement of recent days. 2.0% of sum insured or actuarial premium is payable for *kharif* season for all oilseed crops (Cereals, rate, Millets, Pulses, Oilseeds); 1.5% for *rabi* season for all food grains and oilseed crops (Cereals, rate, Millets, Pulses, Oilseeds) and 5.0% for *kharif* season for annual commercial and horticultural crops rate. ~577 lakh farmers (crop insurance sum of Rs. 2,03,360 crore) during 2016-2017 & ~ 519 lakh farmers (crop insurance sum of Rs. 2,07,435 crore) were enrolled during 2017 18 under PMFBY & RWBCIS.

real time flow of information of insured farmers, result of Crop Cutting experiments (CCEs), for faster claim settlement. Comparison of the various crop insurance schemes based on the parameters is listed in Table 2 (Ministry of Agriculture and Farmers Welfare, 2016; 2017).

Weather based crop insurance in India: Overview

Singh *et al.* (2019) discussed about the policy issues in implementing WBCIS along with the coverage, enrollment issues, claim settlement, infrastructure *etc.* Weather index is a quantitative index which correlates the yield loss of crops with weather variables alone or in combination (Clarke *et al.,* 2012). RWBCIS operates on the concept of "Area Approach" in selected notified RUA for the purposes of acceptance of risk and assessment of compensation. Each RUA is linked to an RWS, on the basis of which the claims would be processed. Adverse weather incidences, if any during the current season would entitle the insured a payout, subject to the weather triggers defined in the 'Payout Structure' and the terms & conditions of the Scheme. Rainfall indexed insurance concept, against drought was introduced by Chakravarti as early as 1920 (Chakravarti, 1920) and Gine *et al*. (2010).

Risk period & seasonality discipline

Risk period (Insurance period) is covered from "Sowing Period" to "Maturity" of the crop which varies with individual crop and RUA depending on the duration of the crop and the weather parameters chosen. The risk period is notified by the SLCCCI (State Level Co-Ordination Committee on Crop Insurance) before the commencement of risk period.

Perils Covered

Deficit rains, un-seasonal/excess rains, heat (temperature), low temperature/frost, relative humidity *etc.* are the weather perils, which are deemed to cause "Adverse Weather Incidence", leading to crop loss would be covered under the Scheme. The specific "Adverse Weather Incidence" with its timing/duration applicable.

Cultivators eligible for coverage

All the cultivators (including sharecroppers and tenant cultivators) growing any notified crop in any reference unit area is being eligible for coverage. The Scheme compulsory for all loanee applicant cultivators *i.e.,* those who have sanctioned credit limit from a Financial Institution [FI] for a notified crop in a reference unit area. It is voluntary for all non-loanee cultivators *i.e.,* those who do not have sanctioned credit limit from any FI for a notified crop in a reference unit area.

Trigger/Term sheets

Payouts are structured against these triggers (based on long term crop and weather relationship) to compensate farmers for their losses. For example, four key crop-stages are identified for groundnut crop in deficit rainfall:

(i) Sowing & germination;

(ii) Vegetative phase;

(iii) Flowering & pegging

(iv) Pod formation & maturity.

The Table 3 shows the crop-stage and corresponding calendar period, weather-trigger (*i.e.* the minimum amount of rainfall below which payout starts), exit (rainfall at which full payout is given), payout for each mm of rainfall below the trigger and the maximum payout for each crop stage. Two key crop-stages for groundnut w.r.t. excess rainfall is:

Table2: Comparison of the various crop insurance schemes is listed in

Parameters	NAIS	MNAIS	PMFBY
States covered	All states and UTs opting for the scheme	Same as NAIS	Same as NAIS
Farmers covered	All farmers including sharecroppers and tenant farmers growing the notified crops in the notified areas were eligible for coverage. Scheme was compulsory for farmers availing crop loans and voluntary for others.	Same as NAIS	Same as NAIS
Risks covered	All risk' insurance	'All risk' with added advantage of sowing failure cover.	All risk' insurance with provision of coverage of risks of prevented sowing, and post-harvest losses, localized risk *etc*.
Crops covered	(a) Food crops (cereals, millets, pulses) and oilseeds (b) Annual Commercial (sugarcane, cotton, potato, onion, ginger, banana, *etc.)* /Horticultural crops	Same as NAIS	Same as NAIS
Insurance unit/ Reference Unit Area	Unit area of insurance may be a gram panchayat, mandal, hobli, circle, phirka, block, taluka, *etc*.	Unit area to be reduced to village / village panchayat or other equivalent unit for all crops.	Insurance unit to be village / village panchayat for major crops and higher than village/village panchayat like block, taluka for other crops.
Threshold Yield/ Data requirement	Average of last three years for wheat and rice and five years for other crops multiply by indemnity level	Average of last seven years excluding maximum two calamities years for all crops multiply by indemnity level	Same as MNAIS.
Sum insured	Loanee farmers – Equivalent to the amount of loan availed. Non-loanee farmers –Upto value of 150 per cent of average yield.	In case of loanee farmers- Equivalent to the 'cost of cultivation' and is pre-declared by SLCCCI and notified. Sum insured will be at least equal to amount of crop loan sanctioned/advanced.Non-loanee farmers equivalent to sum insured up to value of 150 per cent value of average yield.	Equal to the Scale of Finance decided by District Level Technical Committee (DLTC) for both loanee and non-loanee
Premium rate	*Kharif* season 3.5 per cent - Oilseeds and bajra 2.5 per cent - Cereals, millets & pulses. *Rabi* season 1.5 per cent- Wheat 2 per cent - Other food and oilseeds crops Actuarial premium for Annual commercial/ horticultural crops	Actuarial premium as well as net premium rates (premium rates actually payable by farmers after premium subsidy) for each notified crop through standard actuarial methodology in conformity with provisions of IRDA	Maximum premium of 2 per cent of sum insured for *kharif* (food & oilseed) crops. b.1.5 per cent of sum insured for *rabi* (food and oilseed) crops; and c. 5 per cent of sum insured for annual commercial/ horticultural crops.

Table2: Continue

Parameters	NAIS	MNAIS	PMFBY
Premium subsidy	10 per cent to small and marginal farmers only, to be shared equally between centre and states.	Actual premium with subsidy up to 75 per cent to all farmers, to be shared equally between centre and states.	The difference between the Actuarial Premium Rate (APR) and insurance charges payable by farmers shall be provided by Governments as subsidy, and shall be shared equally by the centre and states.
Implementing Agency	GIC till March 2003 and AIC thereafter.	Both AIC and empanelled private insurance companies were eligible for appointment as IAs at district level based on lowest premium quoted by them for specific season.	AIC, Public Sector and private empanelled insurance companies were eligible for appointment as IAs. In smaller states, one IA was to be appointed. In larger states, two or three IAs could be appointed. Selection of IA may be made for upto 3 years.
Claim Liability	In case of food crops and oilseeds, claim liability of upto 100 per cent of premium collected was to be borne by the AIC. Thereafter, the centre and state governments shared the liability equally.	All claims were to be borne by the IAs. To protect IAs, against overall loss exceeding 500 per cent of gross premium, a Catastrophe Fund at national level was to be set up with contribution of centre and state governments.	All claim liabilities on insurer and claim liability beyond 350 per cent of premium collected or 35 per cent of sum insured at national level to be shared equally by the centre and state governments.
Seasonality Discipline	Broad seasonality discipline for Loanee/ Non-Loanee farmers were as under: Loanee farmers: *Kharif* season - November and for *Rabi* season - May Non-loanee farmers: *Kharif* season-31st July and for *Rabi* season- 31st December.	The broad seasonality discipline for Loanee/ Non-Loanee farmers were as under: *Kharif* season-31st July *Rabi* season-31st December	Same as MNAIS
Use of better technologies for yield estimation	Yield estimation through traditional CCEs.	Pilot studies for yield estimation through use of Remote Sensing Technology (RST).	Provision for adoption of RST, drone and other technologies in yield estimation and categorization of number of CCEs after validation by pilot studies. Use of Smartphone apps for accurate and fast transmission of CCE data to facilitate early settlement of claims.

(i) Flowering & pegging and

(ii) Pod formation & maturity.

Triggers (2-day excess rainfall) have been fixed separately for each of the 2 crop stages. These are 200 mm rainfall for flowering, pegging stage and 150 mm for pod formation, maturity stage. The details of Pay-out are given in the Table 4. There is a possibility that a yield loss at the farm level is not reflected in the pre-determined weather triggers in the weather index product. This loss could be due to biotic factors like pests & diseases and can be covered by

Table 3: Details of crop-stage, calendar period, weather-trigger, exit & pay-out for groundnut crop

Sr. No.	Crop stage	Calendar period	Trigger (mm)	Exit (mm)	Pay-out (Rs./mm)	Max. pay out
1	Sowing & germination(21 days)	10th – 30th June	30 mm	10 mm	Rs.100	Rs. 2000
2	Vegetative phase(31 days)	1st – 15th July 16th – 31st July	2525	55	Rs. 125 Rs. 125	Rs. 2500
3	Flowering & pegging(31 days)	1st – 15th Aug 16th – 31st Aug	4040	1015	Rs. 100 Rs. 120	Rs. 3000
4	Pod formation & maturity (45 days)	1st Sept – 15thOct	80	30	Rs.70	Rs. 3500

*The Pay-out under "Vegetative phase" is the average of the 2 fortnights between 1st July and 31st July.

Table 4: Details of crop-stage, calendar period, weather-trigger, exit & pay-out for groundnut crop

Sr. No	Crop stage	Period	Trigger span (Days)	Trigger (mm)	Pay-out (Rs./mm)	Max pay out
1	Flowering & pegging (31 days)	1st – 31st August	2	200	Rs. 7.50	4000
2	Pod formation & maturity(45 days)	1st Sept – 31st October	2	150	Rs. 7.50	

Table 5: Premium Slabs for RWBCIS

Food Crops & Oilseeds		Crops premium payable by insured
Wheat		1.5% or actuarial rate, whichever is less
Other crops (Cereals, Millets, Pulses, & Oilseeds)		2.0% or actuarial rate, whichever is less.
Annual Commercial/ Horticultural Crops		
Sl.	Premium Slab	Subsidy
1.	Up to 2%	No Subsidy
2.	>2 – 5%	25%, subject to minimum net premium of 2.00% payable by farmer
3.	>5 – 8%	40%, subject to minimum net premium of 3.75% payable by farmer
4.	>8%	50%, subject to minimum net premium of 4.80% and maximum net premium of 6% payable by farmer

offering 'double trigger' insurance products by splitting the sum insured between the two triggers (weather and yield) working independent of each other. The proposed 'double trigger' product helps reduce over-reliance on any particular index and can minimize moral hazard. The esoteric terminology and validation of triggers are used in term sheets.

Premium rates, premium sharing & subsidy

The farmers' share of premium rates is capped at 1.5% for *rabi* and 2% for *kharif,* 5% for horticultural crops of sum insured as per the RWBCIS operational guidelines. The detailed structure of premium payable by the insured is given in Table 5.

Need of virtual weather stations as substitute to incomplete weather data information

For locations with no weather data, virtual weather stations (VWS) should be created by constructing interpolated weather surfaces at a finer resolution by using standard spatial interpolation algorithm and by quantifying the uncertainties arising from input data and interpolation technique used for mapping weather station density. VWS are to be represented on regular grids and are derived from interpolation methods/techniques for the country as a whole or for the various subdivisions on a 0.1^{O} lat/long grid (approx. 10 km) covering the specific sub-divisions. This will include combining data from AWSs, traditional weather stations of IMD and state governments as well as satellite-based observations (TRMM Gridded Data-0.25^{0}x0.25^{0}, Aphrodite Gridded Data-0.25^{0}x0.25^{0}, NASA power grid-10x10 km *etc.*), complemented with reanalysed data sets as needed (Rajeevan and Bhate, 2006; 2009).

Present challenges and recommendations of RWBCIS scheme

One of the major constraints for the improvement of weather index insurance in India is the availability of complete meteorological data. Hence, there is an immediate need to develop VWS which can help in minimizing the basis risk associated with the coverage of weather stations.

Government should promote the development of a centralized data centre and products should be well designed integrating with agrometeorological & agronomic informations. In spite of this there are biggest challenges of the present program:

- Designing a weather index with higher predictive capability to proxy crop losses taking into account the inter-farm variability at an acceptable level of disaggregation.
- Reducing the basis risk, where the weather index covers risk arising out of deviations in parametric weather exigencies.

CONCLUSION

Climate is beyond farmers control and as such crop insurance is a catalytic tool for managing crop production risk. There are a number of risks that cannot be covered by a single product or scheme and therefore a wide range and multiple schemes should be operated simultaneously within the nation. Along with the government, the participation of private firms should be encouraged to provide. Despite various schemes launched from time to time in the country agricultural insurance has served very limited purpose. Most of the farmers are not satisfied with these schemes due to large basis risk and scheme operations. High levels of basis risks are often result of the faculty design of both the trigger as well as the term sheet. Determining accurate weather triggers is therefore extremely important when designing agricultural insurance products. Weather data will always be a constraint due to the data gaps, quality and sensor calibration issues. Significant efforts have been made in research to assess its impacts on agriculture risk management and to contribute to improvements in design and implementation. In this context, PMFBY and weather index-based insurance products will be an ideal risk transfer tool for the millions of Indian farmers to help them face the vagaries of nature.

REFERENCES

Bal, S.K. and Minhas, P.S. (2017). Atmospheric Stressors: Challenges and Coping Strategies, In: "Abiotic Stress Management for Resilient Agriculture". (Eds. P.S. Minhas *et al*.) .pp.9-50. Springers Nature Singapore Pte. Ltd.

Chakravarti, J.S. (1920). Agricultural insurance: a practical scheme suited to Indian Conditions, Government Press, Bangalore.

Clarke, D.J., Mahul, O., Rao, K.N. and Verma, N. (2012). Weather based crop insurance in India. The World Bank.

Gine, X., L. Menand, R. Townsend, and J. Vickery. (2010). Micro insurance: a case study of the Indian rainfall index insurance market, Policy Research Working Paper Series 5459, The World Bank.

Gulati, A., Terway, P., Hussain, S. (2018). Crop Insurance in India: Key Issues and Way forward. Working Paper no. 352.

Hazell, P. (1992). The appropriate role of agricultural insurance in developing countries, *J. Int. Develop.*, 4 (6): 567–581.

Indian Council of Food and agriculture (ICFA). (2016). Annual Report on crop insurance in India.

Mahul, O., Verma, N. and Clarke, D.J. (2011). Improving famer's access to agricultural insurance in India, World Bank, mimeo.

Ministry of Agriculture and Farmers Welfare. (2016, 2017 & 2018). Annual Report, Govt. of India.

Mishra, P. K. (2014). Report of the Committee to Review the Implementation of Crop Insurance Schemes in India. Department of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India.

Rajeevan, M. N. and Bhate, J. (2009). A high-resolution daily gridded rainfall dataset (1971–2005) for meso-scale meteorological studies; *Curr. Sci*. 96(4):558–562.

Rajeevan, M., Bhate, J., Kale, J. D. and Lal, B. (2006). High resolution daily gridded rainfall data for the Indian region: Analysis of break and active monsoon spells; *Curr. Sci*. 91(3):296-306.

Singh, R.N., Bal, S.K., Malleswari, S., Kumar, R. and Srinivasa, Rao. (2019). Challenges and Emerging Opportunities in Indian Agriculture, ICAR–National Academy of Agricultural Research Management. pp-321. Hyderabad, India.

Soni, B.K. and Trivedi, J. (2013). Crop Insurance: An Empirical Study on Awareness and Perceptions. *G. J. e-Journal*, 3(2): 81-93.

Srinivasarao, Ch., Gopinath, K.A., Prasad, J.V.N.S., Prasanna, K., Singh, A.K. (2016). Climate Resilient Villages for Sustainable Food Security in Tropical India: Concept, Process, Technologies, institutions, and Impacts. *Adv. Agro.* 140(3): 101- 214.

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