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**WEATHER DERIVATIVES: WITH REFERNCE TO AGRICULTURAL SECTOR IN INDIA.**

**Shivani Tyagi<sup>1</sup>,**  
**Dr. Manjula Shastri<sup>2</sup>**

<sup>1,2</sup>Amity University, Noida

**Abstract:**

*In today's technology based society 1/3 of business activities in the world are directly or indirectly affected by weather changes. It influences our daily lives, choices and has an immense impact on corporate revenue and earnings. In today's environment, climate change is creating new risk but also new opportunities for all sectors of society. In addition, IMF (2011) climate changes have significances for financial market. Innovative instruments for example (weather derivatives, catastrophe bonds) offer a practice to maintain some climate related risk. The weather has become quite unpredictable because of global warming and burning of fossil fuels. In India Agriculture, Hydroelectric power generation & agriculture industry are heavily dependent on monsoon. India is a country where agriculture is the major source of income for majority of the population. Over 58% of the rural households depend on agriculture as their principal means of livelihood. Agriculture is one of the largest contributors to the GDP. According to the Central statistical office (CSO), agriculture and allied sector (including agriculture, livestock and fishers) contributes 16.1% percent to the Gross Value Added (GVA) during 2014-2015. The impact of weather on the Indian economic is very compelling because agriculture is the backbone of the Indian economy and agriculture in India largely depends on Monsoon, weather alone accounting 90% of volatility of crop yields. Until recently there were very few financial tools offering security against weather related risk. However, the inception of the weather derivative by making weather a tradable commodity has changed all this. The weather derivatives and cat-linked securities are new instruments that determine the transfer of weather and natural disasters risk to a country to international capital market. The interest of individual and institutional investors for these securities is high because of low correlation with other financial instruments. The development of weather risk market is important for farmers and companies from both the developed and developing countries to diversification their portfolio. This paper tries to explain the concept; functioning and application of weather derivatives and studies the need for weather derivatives contracts in the context of the Indian market. With this paper the researcher also try to examine the feasibility of weather derivatives as a risk management tool in agriculture sector of India.*

**Keywords:** *Weather, Weather Derivatives, Agriculture, Risk Management, India, And Economic Development.*

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## Introduction

Weather change, associated with a broaden risk universe, has led to a compelling rise in the density amount of claims compensated by insurers and reinsurers over the past three decades. According to the William Daley (1998), "Weather is not just an environmental issue, it is a major economic factor. As far as, insurance has been the prime appliance for protection against unpredictable weather conditions. But insurance gives stability only against catastrophic damage. Insurance does nothing to defend against the shortened demand that business participation as a conclusion of weather that is warmer or colder than expected. Weather risk management is the modern and most productive markets for financial risk transfer and have participants from a immense range of economic sectors such as energy, insurance, banking, agriculture, retailing, construction, transportation, leisure and entertainment. Though Weather Risk Markets are well leading in the energy sector, their functions to agriculture, a demanding sector for most developing countries, are still narrow because this type of markets is very different and has to fight with highly contributed crop insurance schemes. Weather markets design-advanced opportunities for developing countries for trading with disaster risk by course of weather or insurance commodity, for those sectors that are extremely dependent on weather.

Insuring crop against unpredictable weather events is a specific mechanism among farmer in prosperous countries. In developing countries Agriculture and Agri-business are only the subsistence for the most families, business and insurance is either very effusive or is unavailable for small farmers in developing countries. The farmer around the world facing a cautionary period. Earlier 2015 broke history for exceptional, unstable and unseasonal weather. Farmer's aspect disaster from extreme weather conditions. According to the evidence given by World Meteorological organization determine in the global climate. Primary heat waves (e.g. average maximum temperature exceeded 42.C in India (April- May). High rainfall noted to exceptional flooding (e.g. Northern U.K. winter), drought (e.g. dry and warm conditions of the western U.S.A ride to wildfires, counting a history of 400 fires burning 728,000 hectares across Alaska in May) and tropical cyclones (e.g. Strom Patricia, Mexico 24 October, 2015 was the substantial cyclone on history in the Atlantic or eastern north pacific basins, with superlative constant wind spread of 320 km/hour) to name a few. The significance for farmers over the world has been definite. In Alberta, Canada, the government has announced the drought accomplished in the spring & summer, implemented about 80% of the farmer's region and shortened the years yields by 25% down the five year average to a calamity. In Central America, due to dry weather, there is a downward of 60% maize & 80% beans. The government distribute agriculture and packages to upgrade farmers try to improve in consecutive farming and administering direct food aid to cooperate with the families go through with food deficit. In France 2015 winter season get fruits trees to floret further which construct a catastrophic event that dilute the trees to diseases and endemic. India aspects an acute weather conditions throughout the year, dry season with meager temperature advance to storms hail, rain winds defeating specific territory across the country. About 2035 farmers quit the agriculture sector every day, and farmer's pursuit suicide as agriculture is only the prime origin of income for most of the families in different regions of the country. One of the main reason Weather Derivatives are not used generally in agriculture is shortcoming of awareness and understanding about the Weather derivatives contract and its usage.

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## Weather Derivatives

Weather risk markets are the different and utmost aggressive markets for financial risk transfers and have participants from an immense range of economic sectors such as energy, insurance, banking, agriculture, leisure and entertainment. Weather Risk Market is till established in U.S. (United States), new participants from Asia, Latin America and Asia are arriving this market. Weather risk markets already leading in the energy sector, their utilization to agriculture are still narrow. This type of market is very modern and has to contest with immensely subsidized crop insurance schemes in developed countries (Varangis, 2002).

Weather derivatives were established by Enron in the United States in 1997.They get into force during the El Nino winter of 1997-98. Today, it is traded both over- the-counter and on the Chicago Mercantile Exchange (CME). The Chicago Mercantile Exchange (CME), presently deals weather instruments in 18 U.S. cities, 9 European Cities, 6 Canadian cities and 2 Japanese cities .A joint review by the U.S. based Weather Risk Management Association and the consultancy firm Price Water House Coopers has informed that global market of weather derivatives has trebled, between March 2002 and April 2003.At least 11,756 contracts cost \$4.2billion were endorsed worldwide between April 2002 and March 2003.The raise is due to revived interest evinced by new firms in Europe , who want to hedge against weather risk .The number of contracts endorsed in Europe grow by 90% percent to 1,480 year on year according to the survey .

### Sectors Using Weather Derivatives to Hedge risk

Business	Weather Condition	Risks
Energy	Unexpected Warmth and cold	Unexpected reduced and demand
Agriculture	Excess rainfall or drought precipitation	Crop yield, Storing, Pests
Construction	Excess Rainfall	Delays in project completion
Retailers	Unexpected Weather changes	Reduced demand / Footfall
Entertainment	Excess rainfall or unexpected snow	Postponement, reduced attendance.
Tourism	Unpleasant weather in tourist spot / Low snowfall	Less demand for tours/ less or no customers.
Manufacturers	Excess rainfall	Demand Reduction or rising cost of raw material
Government	Unpleasant Weather	Expenditure Overruns
Sales	Excess Rainfall	Reduction of demand for weather sensitive products

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## **The Concept of Weather Derivatives**

A weather derivative is a contract between two parties that determine how payment will be traded between the parties; build upon on sure meteorological prospects during the contract period. It is necessary to figure out the comparison of weather derivatives with weather insurance.

### **Comparison with Weather Insurance**

Insurance are mostly implemented for incident which are high risky having low expectations to occur such as a natural catastrophe like an earthquake. Weather Derivatives are more convenient for companies, which want to hedge against the more apparent risk of unpredictable weather changes, which can brunt, the business revenues on day-to-day or seasonal ground. Losses may not be vast in this case but considerable to hedge /cover by acquiring cost of buying futures or premiums on options.

Insurance companies have been amplified in the weather risk market directly or indirectly for a very sustained era. Insurers of commercial property portfolio or domestic are naturally defined to strict weather incidents. These acknowledgements materialize as an outcome of insurers normal undertakings and are not considered to be an applicable focus or specialty. There are a number of significant differences between Weather Derivatives and Weather insurance:

- ❑ Insurance contracts lid high risk, low prospects events, whereas weather derivatives lid low risk, high prospects scenarios.
- ❑ With weather derivatives, the payout is constructed to be in proportion to the magnitude of the phenomena. Weather insurance reward a once –off lump sum that may or may not be proportional and as such lacks resilience
- ❑ Insurance normally reward if there has been clue of damage or loss. Weather Derivatives have need only a predetermined index value is passed.
- ❑ Traditional weather insurance can be comparably expensive and needs a demonstration of loss. Weather derivatives are less valuable in analogy to insurance, require no demonstration of loss and give protection from the unpredictable of variable weather conditions.

Weather Derivatives vary from traditional derivatives in one major esteem, namely that there is no underlying traded appliance on which weather derivatives are based. Whereas equity, bonds or foreign exchange derivatives, for example, have their correspondent in the spot market, weather is not traded as an underlying appliance in a spot market. This means that unlike other derivatives are not used to hedge the price of the underlying appliance, as the weather itself cannot be priced. They are used, as a proxy to hedge against other risks afflicted by weather surroundings, such as agriculture yield risk. The concept behind a weather hedge is simple: it is a approach to cover businesses from excessive costs or shortened supply due to adverse \weather conditions.

In this sensibility, weather derivatives are an expansion of traditional risk management tools. Although they are a new product to be used to help solve a historical problem, they are established on the same assumptions and instruments as options, futures, swaps and combinations such as strangles, straddles and collars (Zeng and Perry, 2002)

### **Weather Index**

Derivative instruments assume their value from an underlying asset/ variable .In this case the variable is a weather parameter. Typically, weather derivative based all over on an index. These indices are situated on parameters like rainfall, snowfall, temperature, etc. Most weather derivative products are situated on indices like heating degree day (HDD) and cooling degree days (CDD). A degree day is the measure of how much a day's moderate temperature differ from 65' Fahrenheit .The moderate daily temperature is the moderate of the day's maximum and minimum temperature on midnight to midnight basis. The index is fixed 65' Fahrenheit because energy utility companies used to shift on their furnaces at this temperature.

### **The HDD & CDD Indices are shown in Figure**

<b>Index</b>	<b>Definition</b>	<b>Computation</b>
<b>HDD</b>	A heating degree-day measure the coldness of daily temperature compared to the standard of 65'c degree Fahrenheit.	Daily HDD = Max (o, 65' Fahrenheit - daily average temperature)
<b>CDD</b>	A cooling degree -day (CDD) measures the warmth of daily temperature as compared as compared to the standard of 65'c Fahrenheit.	Daily CDD = Max (o, daily average temperature - 65' degree Fahrenheit)

### **Types of Weather Derivatives**

Various brokerage and trading firms personalize the weather derivatives to the client's needs. Only assured parties may be attentive in trading a definite type of weather commodity based on their business structure. Some of the common weather derivative product consist of:

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**Swaps:** They are contracts where two parties settle to exchange their risk. Thus, one party admit to pay the other if the index fix above a certain level, while the other admit to pay if premium, and they administer protection against adverse weather conditions in exchange for a profit that is obtain during benign business conditions. For example, an ice cream company can infiltrate into a swap deal for stability against a summer season that is not hot enough by giving up some revenue that was gaining all along a profitable summer season

**Collars:** Collar is akin to swap in that insurance against adverse weather is provided in return for giving up some of the recovery achieve in favorable conditions. The difference is that the payments to and from the parties takes place outside an upper and lower level. This grant revenue to fluctuate within a normal range of weather conditions but protects either party against extreme weather.

**Puts:** Put options or floors offer insurance to the buyer if the particular weather parameter falls down a certain predetermined level. Like all plain vanilla puts, they involve a premium being paid upfront. For example, a farmer can adopt a put option on the level of rainfall during the monsoon season .The farmer will be insurance if the level of rainfall is not high sufficient for cultivation. However, if the level of rainfall is adequate, his determination to lose only put premium that had been paid directly.

**Calls:** Call options or caps reward the buyer of the contract if the particular weather parameter ascent above a prearranged level. Identical to plain vanilla options, it also requires payment of a call premium upfront. For example, a restaurant can purchase a call option established on the level of rainfall. This will atone the owner of the restaurant for any loss of customers and there by revenue due to heavy rain. The only defect of this hedging strategy is that the restaurant belief to lose the premium that has been paid direct in case of a favorable day

## Literature Review

**Ms.Hemlata Chelawat, Hitesh Chelawat & Dr. Anil Kothari** in their study titled

“Weather Derivatives -‘A tool for Agri –Risk Management’ (2012)” tried to examined the need for hedging the agricultural sector against weather risk .The study highlighted the major issues like how to assess the drawbacks of agriculture insurance in India and the reason for its failure, also to examined the feasibility of rainfall derivatives as a risk management tool for Indian agricultural sector and also construed the use of various type of derivatives contracts in agriculture sector .In the study they found that crop insurance has proved very expensive for the farmer and it has been very heavily subsidized in comparability weather derivative can serve as an effective and low cost option for managing weather risk in management .**Anjali Choksi (2012)** in her study “Emergence Of Weather Derivatives” focused on analyzing the emergence of weather derivatives as an alternative hedging tool. The study determined that weather derivatives assume a good hedge against the vagaries of nature,



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which affect India and lead to huge loss every year and therefore the researcher, suggested that an adequate, sustainable weather risk management system should be recognized in Indian agriculture sector. Further, she found that in agriculture sector the traditional crop insurance has failed due to associated deficiencies. As an alternate weather derivative contracts are free from the deficiencies and these contracts offer prospects of low-cost flexible and sustainable approach to Weather risk management.

**A.Stoppa &U.Hess (June 2003)** in their study titled “Design & Use of weather derivatives in agricultural policies.” inferred that analysis of the rainfall index insurance scheme for Morocco & Weather Derivatives could be effectively used to manage agricultural production risk if weather elements have a prevalent and observable causal relationship with the production variable. They conclude that governments of many countries (U.S Canada, Spain) are expanding the use of subsidized reinsurance agreements and various countries (e.g. Portugal, Italy, Greece) have recently oriented public intervention in that direction. Another study conducted by **Anshul Anand & Surendra Mahadik (2006)** titled “ Weather Derivatives Pricing & Design Issue in India” discussed about rain index and various methods of pricing weather derivatives and the design of the weather contracts. They observed that the weather elements have prevalent and causal relationship with the production variables, so weather derivatives can be effectively used to manage agricultural production risk. They also observed that weather derivatives can be useful means for addressing the systemic portion of agricultural risk in the reinsurance of agricultural risk exposure. **Neha Arora (2013)** in her study titled “ Weather Derivatives - Are you willing to hedge the monsoon with special reference to Agriculture Sector in India.”

She mentions that by using weather derivatives contracts it is simple to protect business for depressed demand due to unfavorable weather conditions. She evaluates the effectiveness of weather derivatives as a risk management tools. Further, She also highlighted the role of weather in agriculture and other industries of the country; Weather can have both direct and indirect impact on agriculture sector economic growth of any country. Direct influence reflects in agriculture gains and losses and indirect influence noticed on the economic growth. **Travis L.jones (2007)** in his study titled, “Agricultural Applications of Weather Derivatives mention that weather future contracts could be easily used to hedge much of the risk in agricultural commodity volume and in turn lead to increased revenues for farmers and other people in agricultural sector .It has been observed that Weather derivatives are currently the fastest growing derivatives market. He also, examined the structure of Heating Degree Day and Cooling Degree Day contracts along with agricultural hedging uses of weather derivatives. **K. Nagarajan & RST.Kiruthika** in their study titled, “Weather Derivatives: A Need for Indian farmers”(2009) briefly explain the concept of weather derivatives in India. They found that Weather derivatives have a wide scope in India. Trading firm in a very huge scale offers weather derivatives products. Further they observe that India is a country with the potential to have a weather derivatives markets. Only the challenge is to educate the farmers about such contracts and their usage. Further more they conclude that government should also take necessary action for improving weather derivatives market in India. Another study conducted by **Dr.E.V.P.A.S. Pallavi titled,** “Challenges to Weather Derivatives Instruments in India” (2015). This study examines the challenges to weather derivatives instruments in India. This study further finds that in 2010 due to uncertain global weather condition many business and industries are affected especially

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commodities. **Anil K. Sharma & Ashutosh Vashisht** conducted a research study titled, "Weather Derivatives: Risk Hedging prospects for agriculture and power

sector in India" in the journal of Risk Finance (March 2007). They examined that the effectiveness of weather derivatives as a risk management tool in Indian agriculture sector and inferred that the appropriate use of weather derivative may be more economical way of managing the volume related weather risk in developing countries like India. Yet another study conducted by **Gurdev Singh** titled, "Crop Insurance In India" (2010). The paper review the dependence of Indian agriculture on ambiguous rain. The study observed that the farmer sense different risk, like production risk which associated to various crop enterprises and marketing risk for distinct agro climatic regions and area. The study further discussed imperative schemes i.e. Weather Based Insurance Scheme & National Agriculture Insurance Scheme to manage production risk.

### **Need**

Weather derivatives are getting popular day by day as they serve as tools to hedge risk of adverse weather conditions for many small to large companies. In spite of technological advancement more than 20% of US economy is impacted due to ups and downs in weather conditions. The effect of weather on the agriculture is substantial, which is further amplified by the fact that the weather forecasting in India is very undependable. The need for hedging the agricultural sectors against weather risk is necessary and hence the need for an appropriate, sustainable system of Weather risk management. The weather risk is an unsystematic risk which means the predictability of amount of rainfall, drought, humidity, coldness and hotness of weather is not really in our control. Hence unexpected weather changes can cause significant financial losses to many companies. For example: A drought or heavy rainfall or both might lead to heavy losses in agriculture, coldness in the air during summers may impact ice cream manufacturers, warmth or humidity during winters may result in no demand for woollen clothes and can have adverse impact on overall fashion industry and so on. Increasingly companies are using weather derivatives to hedge themselves against the financial losses due to unsuitable weather conditions.

### **Research Methodology**

#### **Data Collection Methods:**

The general idea of research is that is concerned with collection of data, making questionnaires and then analyzing and evaluating the collected data. Identification of problem and the approach needed to solve the problem is also important.(Ghuri et al;1995). Data sources are referred to as the carriers of data information. Data sources are divided into two categories: Primary Data and Secondary Data. Primary data is disturbed with the interviews and observation collected while conducting research papers whereas, secondary data is collected by others and academic and non-academic sources are included in secondary type of data. The research method use in my study is secondary data collection method. This includes the gathering of information from sources like Internet, which is one of the major sources of information. These all sources of information will be helpful for the accomplishment of my research.



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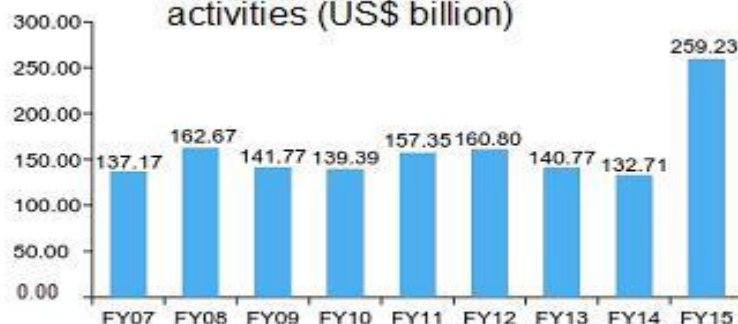
### Data Sources:

Secondary data collection method is used in my research paper. Main sources for my research is FBES (Faculty of Business, Environment and Society), which provides the best online business information services which including the digital management library. Some of the main sources for my research paper are EBSCO Business Source, Emerald, Net Library and a lot of journal articles.

### Agriculture Sector in India:

Agriculture and Agri-business are the main pillar of the India' economy. Agriculture is the fundamental source of livelihood for about 58% of Indian population (IBEF 2015). The contribution of agriculture and its allied sectors to India GDP was recorded at USD259.23 billion during 2015. (Agriculture 2016). The following figure illustrate that agriculture and allied sectors recorded a growth of 8.3 % from the previous year.

**GDP by value added – size of agriculture and allied activities (US\$ billion)**



Source: Ministry of Agriculture, Print Release, RBI, TechSci Research;  
Notes: GDP – Gross Domestic Product, CSO – Central Statistical Organisation

With 20 Agri- climatic regions, all 15 major climates in the world exist in India. The country also possesses 46 of the 60 soil types in the world. India is the largest producer of species, pulses, milk, tea, cashew & jute and the second largest producer of Wheat, Rice, Fruits, Vegetables, Sugarcane, Cotton, oilseeds. The Indian agricultural services and agricultural machinery have cumulatively attracted USD 2,211.17 million from 2000 to September 2015 (Agriculture 2016). Agriculture is the source of supply of raw materials to our industries. Agriculture income drives demand for other domestic goods, which in turn drives others capital consumption and sustains demand for other industrial goods. In spite of its significant contributions to the Indian economy, Indian agriculture suffers from several weaknesses. India's agriculture yield is among the lowest in the world. Timely arrival of monsoon and the quantum and distribution of rainfall are crucial for far output, as almost 55% of the area under cultivation depends on rain. Agriculture in India remains a high – risk prone sector as it largely depends on monsoons, weather alone accounts for 90% of variability of crop yields. The Indian agriculture still doesn't have a strong irrigation system to support its farmers. Most part of India is dependent on the monsoons for a better crop yield. Hence it is most likely that weather derivatives in India should have the monsoon or rainfall as their underlying. It is also based on the way that normal derivatives are traded on the exchange.

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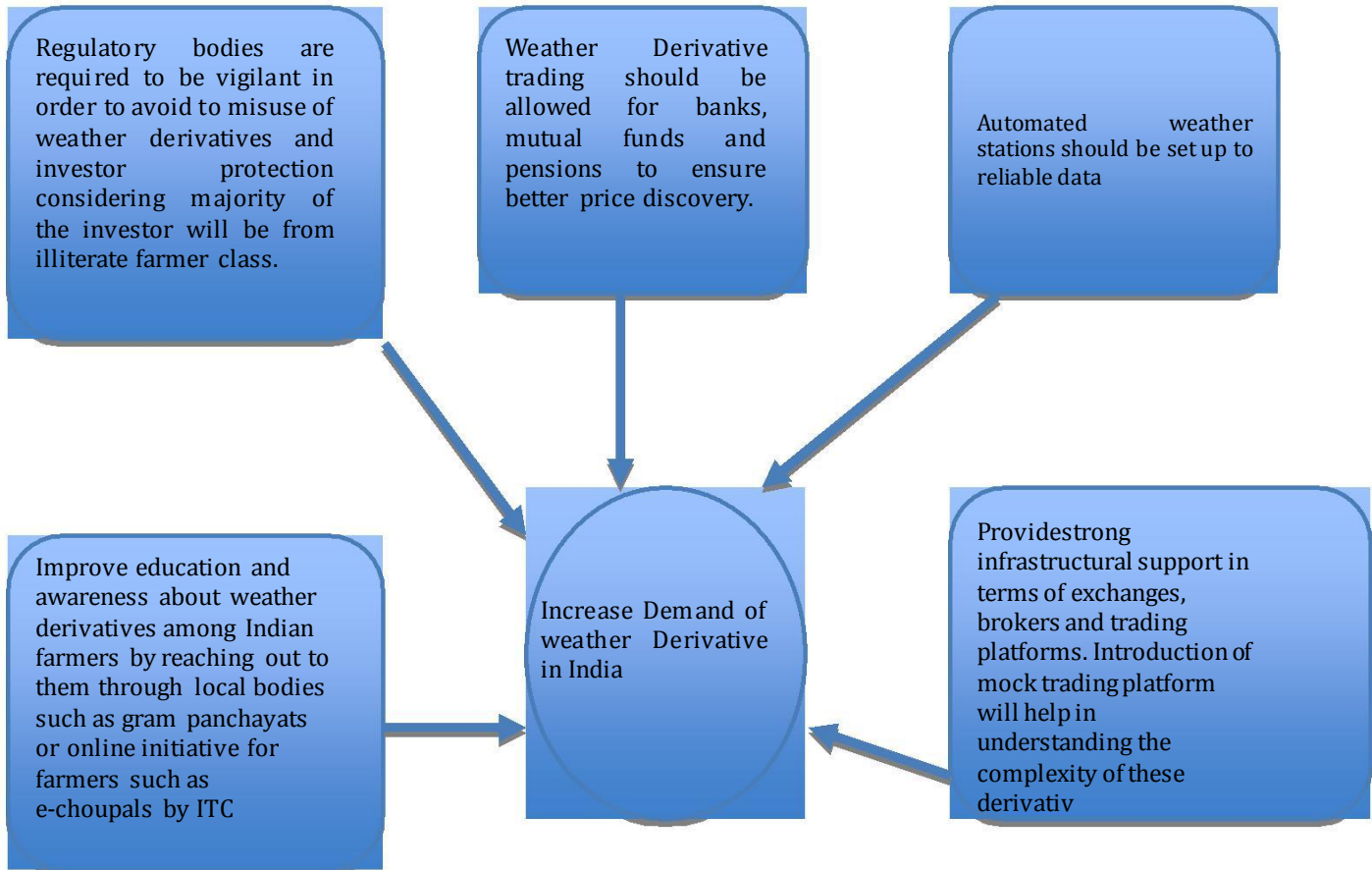
## **Application of weather Derivatives in India**

Nowadays crop insurance is the only approachable option to hedge the agriculture risk, but it is restricted to few crops and failed, owing to their misestimating of probability of risk. For success of crop insurance in India, government subsidy on premium is the only way out, but that will mean increase fiscal cliff due to increase in public expenditure. So weather derivatives with temperature or rain index may come handy to the market. It is very cost effective for farmers, as they have to shell out fewer premiums to invest in derivatives and hedge their risk. The trading floor will grant one to buy and sell the value of temperature or rainfall index at future date, while electricity industries such as Reliance power can deal in CDD and HDD contracts and evaluated how much electricity could be absorbed. Weather Derivatives can be adopting by the farmers to hedge against poor harvest induced by draught. The trading platform will allow one to buy & sell the value of temperature or rainfall index at future date. In Indian Capital market, many studies show that there has been immense growth of derivatives mainly who based on Nifty and Sensex. According to the studies, in March 2011 future and option traded on exchange was 1.6 billion contracts. NSE is ranked world's 7<sup>th</sup> largest derivative exchange by contract volume in 2009. Such instrument can be tailored to the risk bearing capacity of the farmer.

## **Evolution of Weather Derivatives in India**

Weather is not accepted as tradable commodity by Indian regulators and hence weather derivatives are not yet institutionalized on exchanges but it is said that around \$ 1 billion OTC markets already lies in India who are trading, rather speculating on weather conditions. There have been some steps in order to introduce Weather ETFs on Multi commodity (MCX) and National Commodity and Derivatives (NCDEX) but certain permission are still awaited. Legalizing weather derivatives in India can dispose of the demerits correlate with traditional weather risk management tools such as crop insurance or loans and become an alternative, economical and feasible part to hedge the risk of uncertain weather conditions for Indian farmers

Below steps are needed to be taken by Indian Government in order to assure the weather derivatives are not to only urban production such as power companies or large retailers but can also be handled by Indian Farmers in villages and small towns



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## Conclusion

Weather derivatives should not be studied as technique of only earning profits by belief on weather conditions. There can be a very substantial risk management mechanism for assuring revenue losses for the industries depending upon weather.

In the Indian context addition of weather derivatives in financial markets can implement a continual weather risk mitigation system to agricultural or power sector where products are extremely weather sensitive. There are minor limitations or threat in terms of immense complexity of these products appearing in probable lack of demand from illiterate farmers, vast infrastructural costs to grant access of these appliance to farmers in remote areas and availability of accurate weather data to participator but if legalized in correct manner, weather derivatives will exactly be worthy to Indian farmers and other sectors currently left at the humanity of Mother nature to generate profits and live comfortably.

When weather hazards hits, developing countries affected more than developed countries as maximum developing nation's economies depend massively on agriculture and thereby weather. Weather derivatives are still at its corner stage in developing countries like India, South Africa is few name .The accelerated changes in climatic surroundings will make it significant to adapt weather derivatives as a hedging vehicle for businesses. On daily basis, new policies and commodities are being popularized in weather market to hedge weather risk. The weather derivatives are emerging and are conventional to have an alight future all over the universe.

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