Chapter 2
REVIEW OF LITERATURE

2.1. Introduction
In this Chapter, earlier studies on insurance, weather risk, Alternative Risk Transfer (ART) instruments and research papers which address the problems in crop insurance program, weather risk hedging and effectiveness of using weather derivatives have been reviewed.

2.2. Research on Weather Risk and Insurance

Ashan et al., (1982) pointed out that the major role played by insurance programmes is the indemnification of risk to risk-averse individuals, who might be adversely affected by natural probabilistic phenomenon. Insurance, by offering the possibility of shifting risks, enables individuals to engage in risky activities which they would not undertake otherwise.

Insurance business works on the concept of risk pooling where risk is spread among larger numbers (law of large numbers). Also it thrives where loss occurs to a single holder at a single point of time so that loss is distributed among large number. So pooling risks on a scale that is feasible for most private insurers is difficult since many of the natural disaster risks associated with crop production affects all the crops at one time. Also it becomes unattractive for farmers when offered at market prices. Many researchers have argued that moral hazard and adverse selection are problems that significantly affect the viability of multi-peril crop insurance (Ashan et al, 1982, Chambers, 1989). Thus without massive government support in the form of subsidy on insurance premium it is extremely difficult to sustain the traditional approach.

Turvey (1999) indicated that emergence of primary and secondary markets for weather based risk management products will result in many new products coming to the market. For forage crop insurance, this is timely since the largest problem with forage insurance is measuring actual yields. Rainfall insurance can provide a
simple intuitive approach to managing production risks which can be delivered in a cost effective and unambiguous manner.

4Skees, et al, (2001) examined the development of weather contracts based on rainfall to insure against drought in four Mexican states viz., Durango, Jalisco, Tamaulipas and Zacatecas. The feasibility study had two main components. First, it examined the correlation between rainfall and yields to determine the loss due to lack of rain. Second, it designed a prototype rainfall contract and examined how this contract affects the variance of revenues from these crops. The study finds that weather contracts are feasible in about 40% of the planted area in these four states where the correlation between rainfall and yields is around 60-80%. Also, rainfall contracts could reduce the relatively risk by up to 30%. These findings suggest that rainfall contracts have potential in Mexico.

4Skees et al, (2001) argue that payout is not based on actual yield. Rather, it is linked with a pre-defined specific weather parameter. This makes it impossible to indulge in moral hazard practices. Also, the possibility of adverse selection is minimized.

4Skees, et al, (2001) added that innovations could be combined with well-crafted weather based index risk management products. Not only could such indices be developed to offer insurance to the rural people, but the same indices can be crafted to allow improvised governments opportunities to hedge budgetary exposure when they provide free disaster aid.

While the crop insurance is notionally available, very few individuals purchase it (Sinha, 2004). The reasons are many; first, it is primarily sold through government banks, which require agricultural borrowers to purchase the insurance. However, few farmers, and in particular very few poor farmers, are able to borrow from government banks. Many are not aware of the product. Even when the policy should pay out, the insurance companies may legally decline to pay, as their liability is limited by the amount of premiums they collected.
Sinha (2004) compares area-based crop insurance with rainfall insurance on several important dimensions. Like systemic risk: Both rainfall and crop insurance are likely to be subject to similar systemic risk component. This will be especially true if the rainfall index is created separately for each crop-area using weights which maximize the correlation between the rainfall index and crop yield. Moral hazard: Unlike individual crop yield insurance, area-based crop yield insurance is subject to significantly reduced moral hazard problems. Of course, the moral hazard problem is completely eliminated in the case of rainfall insurance. Basis risk: Area based crop yield insurance will be subject to basis risk for the farmers depending upon size and heterogeneity of the unit of area chosen. Rainfall insurance will also be subject to a similar kind of basis risk since the rainfall data can only be collected from a limited number of locations within a geographical area. An additional source of basis risk for rainfall insurance is the less than perfect correlation between rainfall and yields. This basis risk is reduced by choosing weights, which are appropriate for the crop and region in constructing the rainfall index. Adverse selection: This is a result of asymmetric information the farmer usually has better information about his risk than the insurance company when setting the premium rate. This problem is addressed through the underwriting process. This involves developing risk assessment instruments and using these instruments to assign a risk classification to potential policyholders. In both area based crop yield insurance and rainfall insurance the classification is done on the basis of geographical area. The larger the area the less likely is it to be homogeneous and the greater the potential for adverse selection.

Weather risk is also more a high frequency - low severity risk. Therefore, standard insurance does not seem to be the most appropriate solution. The optimal length of the database depends on the regularity of weather data (trend, regular seasonality) and between 10 and 30 years is considered as the norm (Pauline, 2006).

Barnett and Mahul, (2007), in his article states that over one-half depend on agriculture or agricultural labor as their primary source of livelihood. Thus, poor rural households are particularly susceptible to the financial consequences of
weather-related natural disasters. In principle, traditional insurance instruments, including crop insurance, can be used to transfer the risk of extreme weather events. However, insurance markets are underdeveloped and often nonexistent in rural areas of lower income countries due to poor contract enforcement; asymmetric information, high transaction costs, and high exposure to spatially covariate risks ([8] Skees and Barnett 2006). These problems are particularly acute for crop insurance.

[9] Raju and Chand (2009) opined that agriculture production and farm incomes in India are affected by one or the other natural disasters such as droughts, floods, cyclones, storms, landslides and earthquakes. Susceptibility of agriculture to these disasters is compounded by the outbreak of epidemics and anthropogenic disasters such as fire, sale of spurious seeds, fertilizers and pesticides, price crashes etc. All these events severely affect farmers through loss in production and farm income, and they are beyond the control of the farmers. The question is how to protect farmers by minimizing such losses. For a section of farming community, the minimum support prices (MSP) for certain crops provide a measure of income stability. But most of the crops and in most of the state’s MSP is not implemented. In recent times, mechanisms like contract farming and futures trading have been established which are expected to provide some insurance against price fluctuations directly or indirectly. But, agricultural insurance is considered an important mechanism to effectively address the risk to output and income resulting from various natural and manmade events. Agricultural Insurance is a means of protecting the agriculturist against financial losses due to uncertainties that may cause agricultural losses arising from named or all unforeseen perils beyond their control. Unfortunately, agricultural insurance in the country has not made much headway even though the need to protect Indian farmers from agriculture variability has been a continuing concern of agriculture policy.

2.3. Research on ART instruments

[10] Moreno (2002) States in his research paper that despite the high exposure of business to rainfall risk, most weather derivatives that have been traded have been based on a temperature index. This has been mainly due to the demand for weather
protection by Energy companies as the demand for power is heavily correlated to the temperature. Nevertheless many end users such as farmers or hydroelectric generators are very sensitive to rainfall magnitude and frequency. A significant number of businesses are also well aware of the sensitivity of their revenues to rainfall. As an extreme example, when it rains, road accidents are more frequent. According to Peugeot S.A., the French car manufacturer, road accident frequency is doubled when it rains and can be increased by up to 7 times depending on the nature of the rainfall. So, a very rainy year produces more accidents than normal, which could consequently affect insurance companies' results. A huge area of concern is water resource. Water storage is clearly extremely dependent on rainfall. Water companies are expected and required to manage water resources so that there is a constant supply to consumers. However, in extreme cases, hosepipe bans are imposed and water has to be purchased from other water companies. In such situations, the water company is facing three problems. The first problem is the Regulator that may pursue the company for failure to comply with regulations, the second problem is the affect on revenues in metered areas and finally the damage that is done to the consumers’ perception of the company. To provide for all eventualities, a rainfall contract can be taken out to compensate having to purchase water from elsewhere and hence to cover itself from droughts. For water companies the annual amount of rainfall is an important measure.

He observes that a typical difficulty with risk analysis based on rainfall is that the magnitude and the frequency of rainfall strongly depend on the site where it is measured whereas the temperature is a more ambient measure. By way of example, if in Heathrow the temperature is 20 C then you can assume that the temperature in Central London is near 20 C (average differences taken off). However, even if it rains heavily in Heathrow you cannot assume that it will rain simultaneously in Central London. There is a positive probability, but it is not 100%.

Moreno, (2002) observes that for daily rainfall protection, the reference site upon which a contract is based should be extremely close to the location to be insured. For longer periods, proxy sites can be considered with caution. If the required
protection on a site is daily, the use of only one proxy site may be insufficient to cover the risk. Instead several reference sites surrounding the location should be considered. His observations can be suitably applied to basis risk.

Stoppa and Hess, (2003) preferred that the structure of the rainfall insurance programme was developed in analogy to a European put option where the option price is the cost of the coverage and the strike is the rainfall threshold below which an indemnity is triggered. The idea underlying such types of contracts is that, once the existence of a sufficient degree of correlation between rainfall and yield is established, an agricultural producer can hedge his production risk by entering into a contract under which payments would be made if rainfall levels fall below the selected strike. In order to structure the contract, the issues are to determine the strike and at what level to set it. In the case of cereal and sunflower production in Morocco, the adopted procedure for developing rainfall insurance contracts was: (i) production and rainfall data were collected and organised; (ii) the most appropriate rainfall period was selected estimating correlations between yields and different rainfall periods; (iii) specific rainfall indexes were constructed assigning “weights” to different rainfall periods in order to maximise correlation between yields and rainfall; and (iv) different payment schemes were analysed and evaluated. The ultimate condition for the success of the programme is the price at which the coverage can be provided.

Geyser (2004) observed that when a weather event is a source of economic risk for agriculture, a weather derivative can become a hedging tool for farmers and for risk underwriters. The introduction of weather derivatives to manage yield risks in agricultural markets in South Africa could be of great benefit to farmers. Combining, for example, a rainfall option strategy with existing insurance contracts and agricultural futures contracts could allow farmers to focus more of their attention on the actual farming process since the major risk categories — yield, event and price risks — would have all been hedged. He also states that in order to develop weather derivatives for agriculture, just as for any other weather derivative, the weather variable must be measurable, historical records must be adequate and
available and all parties involved in the transaction must consider such measures objective and reliable. In addition, more so than with other weather derivatives, the existence of a complex relationship between the product and the weather factor must be carefully explored. For many weather derivatives traded in the energy sector, for example, derivatives on heating degree days (HDD), the relationship between temperature and demand for heating is simple and direct: the lower the HDD the higher the demand for energy.

For agricultural production the relationship is not always as straightforward since differences in products, crop growth phases and soil textures have different responses to the same weather factor. Also, the more skilled and advanced the cultivating techniques, the greater the entrepreneurial influence on yields, the smaller the portion of variability generated by the specific weather elements. Agricultural insurance is relatively easy to market. It could be sold through banks, farm cooperatives, input suppliers and micro-finance institutions, and perhaps even sold directly to farmers.

Weather derivatives are not only for farmers and rural people. Banks and rural finance institutions could also purchase weather derivatives to protect their portfolios against defaults caused by severe weather events. Once financial institutions can offset the risk with this type of contracts, they may be in better positions to expand credit at perhaps improved terms. This is a critical issue as credit availability to agriculture is constrained, partly because of weather risks. Finding solutions to protect borrowers against adverse weather events could contribute to improving credit markets in developing countries. He further opines that weather derivatives will only be successful if a substantial education process accompanies their introduction. Not only do producers of agricultural products have to be made aware of the use and benefits of these derivatives, but also other potential end-users such as theme parks and event organizers, who can act as counter-parties to such contracts.
Seethapathi (2004) states that the Black-Scholes model is probably inadequate for weather derivatives market and it badly requires a standard pricing model so that all the players of the market talk a common language further adds that a lot of research has to take place in identifying a standardized pricing model.

Weather risk can be defined as an uncertainty in the occurrence of normal weather conditions affecting, each and every business enterprise either favorably or adversely (Bhaskaran, 2004). He further opines that in a country like India, where deregulation process is still nascent the introduction of weather derivatives may have to wait. It would be ideal, if weather derivatives are introduced in a more mature market.

The aim of ART is to affect optimized risk transfer at optimal price, through a combination of insurance and other capital market instruments (Godbole, 2004).

Vedenov and Barnett (2004), add to the existing literature on agricultural applications of weather derivatives by moving beyond pricing issues to consider the efficiency of weather derivatives as risk management instruments for crop production. More specifically, weather derivatives are designed for three different crops (corn, cotton, and soya) grown in six crop reporting districts or CRDs (two districts per crop). The efficiency of each instrument is then evaluated for typical crop producers in each district using various risk-reduction measures.

Vedenov and Barnett (2004), opines that major disadvantage of weather derivatives is the basis risk, reflecting the fact that the underlying weather variables are measured at specific locations and may differ from realizations of the same variables at different locations. Since weather phenomena such as rainfall tend to be fairly localized, even a relatively small distance between the measuring station and the crop field may result in drastic discrepancies between realized losses and weather derivative payoffs. Ideally, a weather derivative should be written on an index measured at the same location where the derivative is used as a risk management instrument, thereby completely eliminating basis risk. From a practical
standpoint, however, this is obviously an unrealistic proposition that would negate the major advantages of the index contracts such as lower transaction cost (relative to traditional crop insurance) and the possibility of risk transfer to capital markets. A contract written on weather measured at a specific farm would hardly attract investor on Wall Street or otherwise generate adequate volume trade. For practical purpose, a weather derivative contract should be designed for a relatively large geographical area.

Veeramani et al, (2005) opines that the crop insurance programme was in fact beneficial to the farmers but it had a negative influence on the government budget. The current trend towards disinvestment of the public sector means that, increasingly, the government wants to shy away from ad hoc disaster payments. Transferring excess risk to international reinsurers is a viable alternative to disaster payments and reinsurance by the government. But international reinsurers are reluctant to reinsure crop insurance risk from developing countries mainly due to the lack of reliable crop yield data. If the current area yield index insurance numbers are an indication, encouraging private participation in insurance programmes will not be a reality.

Veeramani et al, (2005) opines that crop insurance is an alternative risk management technique available to farmers for stabilizing their revenue risk and schemes based on area yield have been in operation for quite some time. They suggested rainfall based insurance indices and options as a replacement for the expensive area yield programs. Instead of direct premium subsidy, which is distorting premium subsidy was taken as a function of adverse deviation of rainfall from the mean. A sensitivity analysis at different revenue elasticity levels with respect to rainfall was performed by them. Potential for private insurer’s and reinsurer’s participation exists with rainfall based index and options.

Veeramani et al, (2005), observed in their study that the widespread availability of reliable data for long periods makes it attractive to private insurers and reinsurers and helps developing countries explore both domestic and international markets for
risk sharing. Rainfall based indices reduce moral hazard and adverse selection and also avoid the problem of an extensive margin. The rainfall insurance also faces basis risk. A high correlation between the index and the individuals risk is important for reducing basis risk. He further opined that financial institutions and investment bankers can hedge their funds on these rainfall options. Since agriculture occupies a significant part of the economy adverse deviation in rainfall can affect the stock markets and traders can protect themselves by hedging their stock with rainfall options. Hence, an effective secondary market can be developed based on the portfolio principle.

Kotreshwar (2006), concludes that the index based insurance is demonstrably an improvement over the traditional crop insurance and is likely to elicit greater participation of private insurers. What is imperative is the need for developing monsoon derivatives market that would facilitate onward transfer of risk by private insurers.

Kotreshwar and Kanakasabai (2006), suggest that the precipitation derivatives aptly suits Indian economy. Monsoon derivatives could serve as special purpose vehicles facilitating transfer of systemic monsoon risk to capital markets. A well developed monsoon derivative market is critical for the development of insurance markets as it provides opportunity to insurers to hedge their monsoon exposure.

Skees et al, (2006), discuss the linkage between weather risk and poverty provides background information on weather index insurance products, describes requirements for the implementation of weather index insurance and possible roles for governments, donors, and international financial institutions in facilitating implementation, and briefly reviews recent efforts to provide weather index insurance products in rural areas of some middle and lower income countries. Their other studies in this regard build on this background material by providing detailed examples from India, Peru, Vietnam, and Kenya.

Anshul & Surendra (2006), have brought out that India being agriculture based economy, it can easily adopt weather derivatives and can be effectively used to
manage agricultural production risk. They further observed that weather derivatives can be useful means for addressing the systemic portion of agricultural risk, leading to potential applications in the stand-alone or layer structures in the re-insurance of agricultural risk exposure. Weather derivatives giving hedge against the agricultural risk happen to be cheaper and more effective than insurance schemes for agriculture. They commented that to support such new developments in weather markets, at production or re-insurance levels, the regulators may focus on providing infrastructure— in particular weather stations and free availability of weather data—and support for transaction costs for ‘Weather Derivatives’ development.

Oliver et al (2006), defines basis risk as the uninsurable risk resulting from the difference of the weather index at the derivative’s reference point and the location of agricultural production. They state that this aspect is less important concerning temperature related derivatives but cannot be neglected when the effectiveness of precipitation derivatives is analyzed because of the high spatial variability of precipitation.

Barnett and Mahul (2007), suggest that effective mechanisms for transferring risk can catalyze investment and economic growth, thus contributing to poverty reduction in rural areas of lower income countries. Weather index insurance is a relatively simple concept that, under certain circumstances, can effectively transfer spatially covariate weather risks. Because the policyholder has no better information than the insurer about the underlying index, weather index insurance is not highly susceptible to the asymmetric information problems of adverse selection and moral hazard. Further, operating costs are generally lower for weather index insurance than for traditional insurance products. While experience to date is too limited to draw general conclusions about the long-run sustainability of weather index insurance, the experience in Mexico and India suggests that at least in some areas, these products may prove to be a valuable risk transfer mechanism for the rural poor (Barnett and Mahul, 2007).
Gine, et al (2007), argues that index insurance is transparent, inexpensive to administer, enables quick payouts, and minimizes moral hazard and adverse selection problems associated with other risk coping mechanisms and insurance programs.

Ravikumar (2007), brings out that farmers face price risk (crash in prices due to bumper crop) and volumetric risk (weather leading to crop failure) and suggest that hedging can be through commodity exchange for price risk, for volumetric risk through weather insurance and weather derivatives. He further observes that, farm insurance though seen in some pockets of the country (India) is still not pervasive.

Roth et al, (2007), recent growth in the weather risk transfer market is mainly related to speculative trading in the energy sector. Stakeholders in the agriculture sector around the world are increasingly interested in weather risk transfer products. However, the lack of exchange based instruments in this field, the relative high basis risk between weather indexes and agriculture yield, the fact that agriculture markets are still highly regulated and inadequate information and training are all impeding the growth of this business.

Sharma et al, (2007), examined the state of risk management in agriculture and power sector of India and evaluated the effectiveness of weather derivatives as alternative risk management tool and basic framework required to implement. Risks originating from natural events sometimes lead to unexpected negative impacts on a project's cash flows or value. In order to face these risks and to attract financing, it is necessary to mitigate the risks in a way that diminishes the probability of appearance of such events. One way to manage weather risks is to use weather derivatives. It is important that the various market participants (farmers, consumers, financial intermediaries, etc.) understand the benefits and risks associated with weather derivatives.

Sharma et al (2007), finds the significance of agriculture and power sectors in the Indian economy and their vulnerability to weather factors, the need for evolving an adequate, sustainable weather risk management system. In agriculture sector the
traditional crop insurance system has failed due to associated deficiencies. As an alternative, weather derivative contracts are free from these deficiencies. These contracts offer prospects of a low-cost, flexible and sustainable approach to weather risk management. Weather derivatives, like any other risk-hedging instrument, operate strictly on the basic insurance principles of law of large numbers, estimatability of probability and diversity in individual expectations. As such, the relevance of the concept is not country-specific. Its success elsewhere as revealed by various empirical studies only makes a case for its adoption in any country, more particularly a country whose performance is severely constrained by highly unpredictable, erratic weather conditions. The conditions necessary for the success of weather derivative market may not be equally present in all countries. But as far as the Indian economy is concerned, it appears to be, by and large, a substantially fit case for the adoption of weather derivatives. It has an immensely weather-based and predominant agricultural sector. The huge energy sector is mostly hydro-based and occupies a pivotal position in the economic infrastructure. The extreme climatic conditions during winter and summer in most parts of the country increase the dependence of people on electricity substantially. Besides the present trend of integrating the Indian financial sector with the global market may be expected to contribute to the growth and success of the derivatives market in terms of participation of foreign players and raising the level of competition. Above all, the country's fiscal health does not warrant continuation of subsidizing the traditional crop-insurance system, any longer. The policy-makers need to make a choice between yielding to populist approach and disciplining the fiscal system.

They also observe that there are some limitations of weather derivative contracts. They suffer from "basis risk". Also, the non-availability of accurate weather data to the parties concerned seriously hampers the smooth functioning of these contracts. But these limitations are not insurmountable. Despite these limitations, weather derivatives continue to capture increasing attention of risk managers, all over the world. Weather derivatives are undoubtedly a low-cost, flexible and sustainable option. It deserves to be tried.
Farm sector is differently influenced by weather risks in comparison with other sectors, a single crop being affected by more factors in a different manner (humidity, temperature or rainfalls) the most appropriate solution would be that of outlining weather derivatives having as support asset a complex of the involved factors (Gheorghe et al. 2008). Weather risk can be transferred within the market to speculators, one can also consider the case of targeting the risk towards those companies in sectors with divergent risks as regards the same meteorological event. An important perspective with could refer to the possibility of simultaneously covering the risks in the hydro energetic sector and the agricultural one. As the companies in the hydro-energetic industry depend from point of view of gains both on the temperature, and on rainfalls, there can be outlined contracts to encompass the two types of meteorological phenomena.

27Travis, (2007), dealt in his article the background of the weather derivatives market and its benefits for agricultural risk management and further examined the structure of Heating Degree Day and Cooling Degree Day contracts along with agricultural hedging using of weather derivatives, notably, hedging of volumetric risk.

28Rao and Bockel, (2008), suggested that weather index insurance has similar advantages to those of area yield insurance. This programme provides timely compensation made on the basis of weather index, which is usually accurate. All communities whose incomes are dependent on the weather can buy this insurance. Weather insurance helps ill-equipped economies deal with adverse weather conditions (65% of Indian agriculture is dependent on natural factors, especially rainfall. Drought is another major problem that farmers face). It is a solution to financial problems brought on by adverse weather conditions. This insurance covers a wide section of people and a variety of crops; its operational costs are low; transparent and objective calculation of weather index; and quick settlement of claims.
29 Osgood et al, (2008), recommended that the contract design, and in particular, the selection of an appropriate index, is crucially important in minimizing basis risk. Other factors that have implications for basis risk are proximity of the insured crop to a weather station, and availability of climate data.

30 Hellmuth et al, (2009), opined that risk transfer approaches such as insurance have played a role in mitigating climate risk in many parts of the world. However, they have generally not been available in developing countries, where insurance markets are limited; if they exist they are not oriented towards the poor. A new type of insurance – index insurance – offers new opportunities for managing climate risk in developing countries. If designed and introduced carefully, it has the potential to contribute significantly to sustainable development, by addressing a gap in the existing climate risk management portfolio. However, this potential has yet to be proven; and there are some significant challenges that must first be addressed.

31 Manfredo and Richards (2009), when using weather derivatives to hedge volumetric risks, risk managers often face unique basis risks arising from both the choice of weather station where a derivatives contract is written, as well as the relationship between the hedged volume and the underlying weather index. Using the encompassing principle, their research shows that the nonlinear relationship often found between crop yields and weather creates a specific hedging role for options. The results suggest that weather derivative instruments with nonlinear payoffs, such as options, be used solely or in combination with linear payoff instruments, such as swaps or futures, to minimize basis risk associated with the nonlinear relationship between yields and weather. Their research also suggests that the choice of weather station may be less critical in managing basis risk than properly accounting for the relationship between yields and weather.

32 Seth et al, (2009), controlling weather is not something we can do very much about however, controlling the risks to a business due to the effect of weather is possible through the use of weather derivative products. While the scope of weather
derivatives is enormous, there are the accompanying challenges of valuing and pricing the derivatives, not only be financially viable instruments, but also be instruments with appeal to the financially weaker sections of society, viz, the farmers, especially in a developing country like India. Their study indicates the feasibility of introducing weather derivatives as an investment option for small farmers to hedge weather related yield risks.

They defined a rainfall index future as an agreement to buy or sell the value of the index at a pre-defined date in the future. A rainfall call option would be a contract where the owner has the right (but not the obligation) to buy a futures contract at a price which is correlated to a pre-specified “strike” on the index. Similarly, a put option would be a contract where the owner has the right (but not the obligation) to sell a futures contract at a price which is correlated to a pre-specified “strike” on the index. The buyer of a put option pays the seller a premium upfront. In the situation that the actual rainfall at the end of contract is less than the strike value of the index, the option would be in-the-money and buyer will exercise the option.

32Seth et al. (2009) assessed weather-risk hedging by farmers, focusing on the willingness to pay in Rajasthan, India and suggested for further research on bringing out the demand, the willingness-to-pay, and the valuation of weather derivative products for different businesses which would help in determining the structure of products and also suggested for research to know the possible correlations between weather derivative contracts and commodity futures prices for portfolio creation.

33Yang et al., (2009), opines that weather derivatives represent today's fastest growing derivative market. Trading of standardized weather contracts have grown substantially since their introduction. In hedging using standardized weather derivatives, hedgers must bear basis risk and the risk due to a weather contract being written in a different location than the area the hedger wishes to cover. Basis risk is an important concern in hedging with standardized contracts.
Traditional reinsurance operates efficiently in managing relatively small, uncorrelated risks and in facilitating efficient information sharing between cedants and reinsurers. However, when the magnitude of potential losses and the correlation of risk increases, the efficiency of the reinsurance model breaks down, and the cost of capital may become uneconomical. At this juncture, securitization has a role to play by passing the risks along to broader capital markets. Securitization also serves as a complement for reinsurance in other ways such as facilitating regulatory arbitrage and collateralizing low-frequency risks (Cummins et al 2009).

Weather is more than an element of the environment; it is a major economic factor. Weather affects economies worldwide, having a serious impact on revenues and earnings. For the successful development of weather derivatives market, a law and economic framework is needed, as is the development of new weather products, training qualified specialists for working with these instruments, attracting companies interested in hedging their profits, etc. all these factors will help growth and will accelerate the process of weather derivatives market development in Portugal (Alieva et al, 2010).

Although exchange traded contracts are used extensively in the energy and power industries, they are of lesser value for other applications. The idiosyncratic nature of weather, specialized and local weather variables of interest, and the limited number of locations upon which exchange traded contracts are based preclude their use, even for cross-hedging purposes (Don Cyr et al, 2010). The over-the-counter (OTC) market for weather contracts, however, has also been growing steadily as various financial intermediaries begin to realize the potential widespread application of weather derivatives. An increasing number of firms such as Weatherbill Inc., Evolution Markets and MSI Guaranteed Weather, as well as many insurance firms, now stand ready to structure and sell specialized weather contracts based on very specific weather variables and locations.

Chung,(2011), finds that the hedging effectiveness of using weather options increases as the level of spatial aggregation increases from farm level to county
level to multi-county aggregate level. This implies that the government as a reinsurer can reduce idiosyncratic yield risk by aggregating the individual risk exposures at the county or higher level, and hedge the remaining systemic weather risk by purchasing weather options in the financial market. As a result, weather derivatives could be used by the government as a hedging tool to reduce the social cost of the federal crop insurance program, since the government currently does not hedge their risk exposures in the program.

38 Anjali, (2012), observe that despite limitations, weather derivatives continue to capture increasing attention of risk managers, all over the world. Weather derivatives are undoubtedly a low-cost, flexible and sustainable option. It deserves to be tried for success or failure. The potential is there in India for weather derivatives. One has to wait and see how the weather derivative saga unfolds once the Government passes the bill. Studies done in the US on weather trading, indicates the sensitivity of weather to the various economic sectors and found that approximately 30 % of the US economy is affected by the vagaries of weather. Similar study was done in Amsterdam, Netherlands on effect of weather on tourists. The effects of weather and climate are regionally distributed for different regions of the World and the effect is more on underdeveloped and impoverished countries than developed countries.

In Indian context, weather derivatives would prove to be a blessing especially in the agricultural sector. Like any other derivative instrument traded on exchange weather derivatives will also serve its purpose with more volume and demand. With the success of these contracts in developed countries available from empirical evidences, India being an agrarian economy seems to have the potential to have a weather derivative contract supported with unprecedented growth in Equity derivative market. The currency derivatives, interest rate derivatives, derivatives on global Indices are the tip of the ice berg and now it is the time that government speeds up the process of launching weather derivatives in India.
Prabhu et al. (2012), the performance of index based weather insurance depends upon the various factors. The important factor among them is basis risk. The rainfall insurance scheme for coffee operated on mountain sides involves high levels of basis risk, adversely affecting the performance and is likely to lose the confidence of the growers. Their study reveals the need for initiating steps to minimize the basis risk. The problem of basis risk can be resolved with the help of localization of automatic reference rainfall stations. It implies that the automatic reference rainfall stations should be installed at the Grama panchayath level, which is nearest to the growers’ individual plot. It is negating one of the advantages of index based rainfall insurance i.e. minimization of cost. But it substantially reduces the basis risk and leads to adequate protection against rainfall risk. This is likely to improve transparency and performance of the rainfall insurance scheme.

Prabhu (2013), has studied the rainfall variability for three Coffee growing adjacent districts of Karnataka state, found interesting results on volatility of rainfall. He found that during monsoon and post monsoon period the volatility of rainfall varies across these districts. However the results were contrary for pre-monsoon period.

Shivkumar et al. (2013), focused on rainfall–indexation and suggested a unique ticker symbol Monsoon Outcome Index (MOX) for each of the sample meteorological subdivisions of India. Further, an estimating function based on time-series simple regression is attempted to enable determination of expected MOX value at the end of the monsoon season. Essential statistical properties of MOX series are captured to indicate the vast scope for creating a new class of financial instrument for hedging and portfolio management purposes. Widespread availability of reliable data for long periods make it attractive to private insurers and international reinsurers and should help developing countries explore international markets for risk sharing.
Rainfall index based RTPs are critical for the development of insurance and risk markets to create hedging opportunities to insurers and other players in the market whose financial prospects closely interconnected to monsoon outcome. The analysis of coefficient of variation indicates existence of variations in the MOX values for rainfall amongst the subdivisions and reverting of MOX back to the long time average rainfall at the end of monsoon period. A very few subdivisions have significant correlation and for majority of subdivisions the correlation is very weak and insignificant. Geographically nearer sub-divisions have moderate correlation where as distant sub-divisions have weak to very weak (negative) correlation. MOX as an asset class complements other tradable indices as correlation of MOX values with other assets is insignificant and varying between negative to positive. MOX can be an excellent instrument in the quest for portfolio diversification.

2.4 Summary

Climate contributes to poverty both directly, through actual losses from climate shocks, and indirectly, through responses to the threat of crisis. These impacts can last for years in the form of diminished productive capacity and weakened livelihoods. The increasing popularity of temperature based weather derivatives in US has brightened the prospects of innovating with rainfall based weather derivatives. Countries like South Africa, India, Morocco and others have started experimenting with weather derivatives.

Researchers have explored the possibility of using rainfall in developing insurance products and have indicated rainfall based insurance indices and options as a replacement for the expensive area yield programs, as index insurance is transparent, inexpensive to administer, enables quick payouts, and minimizes moral hazard and adverse selection problems associated with other risk-coping mechanisms. It is important therefore to establish upfront the relationship between yield and rainfall. Rainfall index insurance involves using a meteorological measurement as the trigger for indemnity payments due to deficit/excess rainfall.
The performance of Rainfall index insurance programme in India depends upon resolving issues of product servicing and timely payout.

Basis risk is defined as mismatch between coverage and the actual results. This risk is always there with rainfall index based insurance programmes since rainfall received at farm field may not always match with that received at weather station. Too much basis risk will deter interest. The poor density of weather stations has been a major handicap in the spread of this product. The hedging effectiveness of using weather options increases as the level of spatial aggregation increases from farm level to county level to multi-county aggregate level.

The price of insurance reflects the probabilities of payouts, which are in turn driven by the probabilities of adverse weather events reflected in the index. These probabilities must be accurately assessed so that prices are fair to both buyers and sellers and properly reflect the costs of transferring the risk.

Crop insurance programme is beneficial to the farmers but it had a negative influence on the government budget and the government wants to shy away from ad hoc disaster payments. So, transferring excess risk to international reinsurers is a viable alternative to disaster payments and reinsurance by the government. The widespread of availability of reliable data for long periods for India makes it attractive to private insurers and reinsurers. The success of weather derivative contracts in developed countries is evidence, India being an agrarian economy seems to have the potential to have a weather derivative contract supported with unprecedented growth in Equity derivative market. However, success of a weather insurance programme in India would depend on the product design; the adoption of reliable and sustainable pricing mechanisms
2.5 References


3. Turvey, Calum.,(1999),” The essentials of rainfall derivatives and insurance”, working paper WP 99/06, *Department of Agricultural Economics and Business, University of Guelph*, Ontario


