10.1 Summary and conclusions

The agricultural sector occupies a key position in the Indian economy. About 65% of the working population of the country is employed in this sector. However, incomes are dependant, to a fair extent, on the success of the monsoons. In such a situation, weather risk mitigation measures become imperative.

Weather derivatives are a form of weather-related risk hedging, with all the benefits of crop insurance and with added advantages. In India, there has been a prolonged debate on the introduction of these instruments, not only for farmers, but also for other stakeholders. A few regulatory hurdles remain, but weather derivatives, as financial instruments, are likely to be permitted in the very near future.

This thesis looks at the opportunities and the challenges that will be thrown up as we adopt this newer form of risk management of crop yield, in the country.

A summary of the important findings in the thesis are enumerated below:

1. An empirical estimation of the willingness-to-pay by farmers growing soyabean in the Jhalawar district of Rajasthan, based on a theoretical model, yields a figure of 5.5% of the average MSP for soyabean.

2. Basis risk is an important consideration in weather derivatives. Based on a study of rainfall patterns at two weather stations, located close to each other, it was concluded that for short-term rainfall-index based weather derivative contracts, the location of the weather station assumes significance. For longer term contracts, the use of proxy weather stations could be justified to an extent.

3. 98% of farmers go through mental stress, worrying about the affect of abnormal rainfall on their crops.

4. Awareness levels of existing crop insurance schemes are low.
5. The proposed weather derivatives schemes were received enthusiastically by the farmers; 92% farmers feel that weather derivative schemes would help them in mitigating weather-related risks.

6. A very large proportion of farmers prefer to go in for weather derivative schemes offered by the government.

7. Willingness-to-pay for weather derivatives is determined to be approximately 8.8% of the maximum payout of the weather derivative contract.

8. Especially in the initial stages of introduction of weather derivatives in India, pricing of weather derivatives needs to be done through actuarial techniques, keeping in mind the social welfare aspect of stabilising the farmers' income against the vagaries of weather.

9. Some initiatives required while introducing weather derivatives are listed below:

(i) **Infrastructure.** One of the important requirements for the spread of weather derivatives in India would be the availability and reliability of weather data. In order to minimize basis risk, and to increase investor confidence, there would be a need for real-time availability of village-level weather data. Whilst it might not be so important for temperature based derivatives, rainfall derivative contracts would only be successful if village-level rainfall data is made available real-time and in a reliable form. Even while we have argued for a larger entry of private players in the weather derivatives market, it would be too much of an investment for any one provider. Infrastructure, in the form of computerized mini-weather stations at village level, will need to come up in the form of public goods, providing real-time weather data. The government could play a major role in this and one suggestion is to divert the money going into subsidies for crop insurance schemes to providing weather station infrastructure and letting private players come up with innovative weather derivative products.

(ii) **Payment facilities.** With the spread of ICT kiosks at the village level, farmers could be encouraged to trade in weather derivatives and make payments/receive money through the internet. This would require a fair amount of awareness generation and
training, but it could considerably lower transaction costs of the weather derivatives.

(iii) **Pilots.** The regulatory agency for weather derivatives would need to encourage providers to carry out a large number of pilot projects in weather derivative products in order to understand the needs, to assess the kinds of products structuring required and to address the challenges.

(iv) **Pricing.** There are two issues in pricing. Firstly, the market makers, or the agencies which decide to, as an example, be short in put options on rainfall, would need to be convinced that the pricing of the options is such that their risk is either covered, or can be reinsured in some other market. Secondly, the pricing has to be such that it is within the amount that buyers of the put option, say farmers, are willing to pay.

(v) **Experimentation.** The regulatory and policy environment should be such that experimentation in innovative products is not discouraged.

(vi) **Dissemination.** Results and recommendations from academic studies and learning’s from pilot projects would need to be actively disseminated. This could be done through stakeholder workshops.

(vii) **Government role.** The government would need to move away from an “intervention” role, (for example government intervention takes place through subsidizing crop insurance), to that of a “facilitator” for weather derivatives. Similarly, subsidies provided by the government would need to be re-channeled. Directly subsidizing financial services would discourage innovations by providers, in product designs and pilot testing. As an example, the various crop insurance products subsidized by the Central/State government have dissuaded private players from participating by coming up with their own products.

(viii) **Information sharing.** Credit information sharing between various players could help in reducing risks and costs. This aspect needs to be studied further for implementation.
10.2 Limitations of the Study

Whilst in developed countries, people have realised that they can no longer blame low profits on the weather, this realisation has not come about in developing countries. The large market foreseen for weather derivatives in India is in the agriculture sector. However, a significant number of farmers are either illiterate or unaware of possibilities of weather risk hedging. Issues surrounding the provision of a hedge against weather could be complex in the face of heterogeneity of opinion on the efficacy of a scheme like weather derivatives trading. A lack of awareness of the possible benefits of such instruments, itself, might influence the willingness of a farmer to opt for them. Although a very serious attempt was made to educate the farmers on weather derivatives, prior to their answering the questionnaire, this might not be adequate to give them a comprehensive understanding.

As such, a study of willingness to invest might be affected by factors other than socio-economic factors.

Weather derivative products are significantly linked with meteorological data. The availability of or the need for a very large number of weather stations might affect the growth of the market. Regulatory issues would therefore be guided, to an extent, by infrastructure constraints.

As such, Regulatory and Policy recommendations suggested would have considerably large monetary and fiscal implications, which would have to be borne in mind.

A fairly limited amount of work has been done in pricing of weather derivatives. The selection of a relevant index, itself, would be governed by a plethora of factors. Some of the work done in the area is considered proprietary and so details of these are not available.

The Contingent Valuation study may have the following limitations:

i. The answers to the valuation questions may actually bring out feelings that the farmer may have on the issue at hand, rather than his actual willingness to pay.

ii. There may be a fundamental difference in the manner in which the respondent makes a hypothetical decision as
compared to an actual decision which he may need to take later, when weather derivatives are actually introduced.

iii. Respondents might not have taken the willingness to pay questions seriously, since they do not have to pay the stated amount.

iv. The starting bid may have had an effect on the respondents' answers.

v. Respondents might have given strategic answers i.e., they may have answered in a way which they feel might influence the outcome of the study to their benefit.

10.3 Scope for Further Research

With Weather Derivatives being in their nascent stage, the scope for further research is enormous. An attempt is made to detail out some of the areas in which future research can be done, but this list is by no means exhaustive.

i. The ideal situation, and one in which the scope of cost reduction would be maximum, would be where weather derivatives are in demand not only by farmers, but also by different businesses. As brought out in the introduction to this thesis, a large number of businesses would have their revenues affected by weather, and weather derivatives would be a source of hedging for them. Similar research, bringing out the demand, the willingness-to-pay, and the valuation of weather derivative products for different businesses would help in determining the structure of products which would be in demand across businesses.

ii. One of the findings of this research is that a sizeable number of farmers would be interested in weather derivatives based on a composite index of rainfall and temperature. Future research could focus on building a composite index. Such an index would possibly be most relevant in tropical conditions.

iii. As suggested in this thesis, government subsidies to crop insurance schemes could be diverted to building-up the infrastructure required for up-scaling the access and quality of weather derivatives. One of the first requirements, in order to reduce basis risk in these products, would be to have a large network of reliable weather stations capable
of recording basic weather parameters. Future research could go into the geographical requirements and the costs of setting these up.

iv. Research could be done on the effect of meteorological forecasts on weather derivative prices. Would farmers, for example, be willing to buy weather derivatives, as a hedge against low rainfall, at a higher price if the meteorological forecasts predict a lower than normal rainfall? However, this research would be meaningful only when market data for weather derivative trades are available.

v. From a speculator's point of view, individual weather derivative contracts will be fairly risky propositions. However, research could be done on the amount that his risk can be reduced by holding a portfolio with diversified weather contracts in different locations, or by holding a portfolio consisting of weather contracts along with, say, correlated energy/electricity contracts.

vi. Again, once market data for weather derivative trades is available, research can be done into possible correlations between weather derivative contracts and commodity futures prices. Infact, there could be the possibility of use of weather derivatives to improve the efficiency of forward markets for foodgrain commodities.