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PROPOSITION OF WEATHER DERIVATIVE AS A HEDGING INSTRUMENT IN AGRICULTURE SECTOR

Aby George
Farmertree Producer Co. Ltd.

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Human-beings have attained a position to control everything nowadays. But there are few elements of nature which is not under the control of human beings. Weather is one such element. Many of the man-made activities are dependent on weather like agriculture, tourism, entertainment, energy, construction and others. (Saraswat, 2012) Weather is no longer just a part of the environment, it has emerged as a key factor for business also. Weather derivative is a trading instrument, which can be used to hedge against the uncertain risk. Weather derivatives are financial tools to minimize risk associated with unexpected weather event (snow, temperature, rainfall etc.). It may affect the profitability of a company depending on different crops and farmers growing it. (Chen, 2019)

Weather and climate

The words weather and climate can be used interchangeably. The definition of Weather is defined by NASA as "the way the atmosphere is behaving, mainly with respect to its effects upon life and human activities." On the other hand, climate is defined by NASA as "the average of weather over time and space". Also weather may include rain, temperature, snowfall, storm, wind and many more. Therefore weather and climate are identified based on time. If a particular weather persists for a long time then it can be called as climate. (NCEI, 2018)

For the sake of convenience in terms of collection of data, this paper considers rainfall as an indicator of weather.

A glance at the minutes of the meeting of the Ministry of Agriculture and Farmers Welfare, Government of India is as follows: In the post monsoon season, at all-India level, the rainfall during the week i.e. 25th October, 2018 to 31st October, 2018 has been 89% lower than Long Period Average (LPA). Rainfall in the four broad geographical divisions of the country during the above period have

Region	Week Ending (31.10.2018)				Cumulative (01.10.18 to 31.10.18)			
	(in mm)		Deviation (%)	Category	(in mm)		Deviation (%)	Category
	Actual	Normal			Actual	Normal		
North-West India	0.1	2.3	-98	LD	6.9	30.6	-77	LD
Central India	0.3	5.7	-94	LD	22.1	58.4	-62	LD
South Peninsular India	2.2	29.8	-93	LD	92.3	156.0	-41	D
East & North-East India	4.2	13.4	-69	LD	49.2	131.3	-63	LD
Country as a whole	1.2	10.7	-89	LD	35.6	80.9	-56	D

LE: Large Excess, E: Excess, N: Normal, D: Deficient, LD: Large Deficient, NR: No Rain.
Source: India Meteorological Department, New Delhi

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been lower than LPA by 98% in North West India. It is 93% in South Peninsula, 94% in Central India and 69% in East and North East India. (Department Of Agriculture, Cooperation and Farmers Welfare)

Weather Risk

A business involves several risks. Most of which can be avoided or managed today. But weather is one element which businesses have not been able to mitigate effectively. Weather risk management is a type of risk management done by organizations to address potential financial losses caused by unusual weather. Energy, agriculture, transportation, construction, municipalities, travel, food processors, retail sales and real estate are all examples of industries whose operations and profits can be significantly affected by the weather. Unexpected weather events can cause significant financial losses. Although weather and its impact can be measured and gauged. The weather risk market makes it possible to manage the financial impact of weather through risk transfer instruments. It is based on a defined weather element such as temperature, rain, snow, wind, etc. Weather risk management is a way for organizations to limit their financial exposure to disruptive weather events. The unpredictability of the weather is called as weather risk (Cao, Li, & Wei, 2003)

Weather related insurance and schemes in India

Weather insurance is a type of protection against a financial loss caused by weather. It may be incurred because of rain, snow, storms, wind, fog, undesirable temperatures or other weather conditions. Pradhan Mantri Fasal Bima Yojana (PMFBY) that was recently launched is an insurance cover, which protects the farmers against crop failure. This Yojana is beneficial to the farmers since it stabilizes their income. It acts like a protection to the farmer when he faces crop failure due to natural calamities. Similarly Weather Based Crop Insurance Scheme (WBCIS), which is a part of the National Crop Insurance Programme, protects the risk faced by the farmers due to bad weather conditions.

Weather derivatives

Weather derivatives are financial instruments that can be used by organizations or individuals. It is a part of risk management strategy to reduce risk associated with adverse or unexpected weather conditions. Weather derivatives are index-based instruments that usually use observed weather data at a weather station. It is to create an index on which a payout can be based. This index could be total rainfall over a relevant period which may be of relevance for a hydro- generation business. It can be also the number where the minimum temperature falls below zero which might be relevant for a farmer protecting against frost damage.

Across the globe several countries have developed instruments and techniques to tackle risk. One such instrument, which has gained popularity among traders are weather derivatives. Weather derivatives are financial tools to minimize risk associated with unexpected weather events (snow, temperature, rainfall etc.). It may affect the profitability of a company depending on different crops and farmers growing it. Farmers use weather derivatives to manage the risk caused due to heavy rainfall. Also low rainfall, high wind, and temperature fluctuations lead to poor harvests. The crop insurance indemnifies a farmer only in the case of a loss incurred. While for a weather derivative there is no compulsion that the investor/trader should incur a loss and then he can be indemnified for his loss. Weather derivative is a trading instrument, which can be used to hedge against the uncertain risk. (Wikipedia)

1.2 STATEMENT OF PROBLEM

The derivative market is thriving with several innovative instruments. However the weather derivative is in a nascent stage which imposes challenges to farmers, agri-business alike. Agriculture is still the backbone and is a prominent occupation in India. India also holds the 6th position in food and grocery market and 5th in retail market globally. The food processing industry like oil-press, packaged juice, dal and pulses are dependent on agriculture. Since agriculture is highly dependent on weather, weather derivatives along with weather insurance can be enabled by hedging of weather risk.

1.3 OBJECTIVE OF THE STUDY

1. To understand the relationship between rainfall and agricultural yield.
2. To explore the possibility of introducing weather derivatives in the agriculture sector.
3. To know the real beneficiaries of weather derivatives.

1.4 SCOPE OF THE STUDY

Weather is one element that businesses have not been able to mitigate effectively. India being an agrarian economy, livelihood of several people is dependent on agriculture which is dependent on weather. Several literatures focus on the concept, trading and pricing of weather derivatives but fail to throw light on the real beneficiaries of weather

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derivatives. Since the agrarian economy is a feeder to several other businesses. Weather determines the yield of agriculture therefore weather derivatives can be a hedging tool in agriculture.

1.5 NEED FOR THE STUDY

The core purpose of the analysis is to find out whether the introduction of weather derivatives to the Indian agricultural sector would help agriculturists (farmers). It also includes those investors whose company's profits are mainly affected due to the weather conditions. The research is also done to know the actual users and beneficiaries who will be benefited with implementation of weather derivatives in the agriculture sector.

1.6 RESEARCH METHODOLOGY

This research paper considers only rainfall's impact on agriculture. Although other elements like temperature, heating days and cooling days are also a part of weather. For convenience only rainfall has been considered. The paper uses secondary data obtained from various sources for analysis. Several literature and websites have been reviewed to understand the concepts related to weather derivatives. The paper uses data of agricultural production of crops like Rice, Wheat, Maize and Ragi, which are considered as 'Food crops'. These crops are chosen because these are the crops that are widely grown across most of the states in India. Also these crops are the principally grown crops in India. Cotton, Sugarcane, Mesta and Jute are selected as 'Cash crops'. The data has been collected across different States of the Indian subcontinent. Data is collected from the Directorate of Economics and Statistics, Ministry of Agriculture and for data on rainfall was collected from India Meteorological Department (Ministry Of Earth Sciences). The research paper is conceptual and qualitative in nature. The production of food crops is measured on thousand tones and rainfall is measured in millimeters. Statistics from Make in India food processing sector has been analyzed to understand the contribution of agriculture towards other allied businesses. This study has been conducted in time period starting from August 1 to August 15, 2020.

CHAPTER 2
THEORITICAL FRAMEWORK

2.1 INTRODUCTION

Derivatives with weather-based parameters (such as variability in rainfall or temperature) are financial instruments that can be used by organizations or individuals to reduce risks associated with adverse or unexpected weather conditions. These instruments can be traded over exchanges or in over-the-counter (OTC) platforms. Farmers can use rainfall derivatives to hedge against poor harvests caused by drought or excess rainfall. Globally, variations in temperature are one of the biggest weather risks that are hedged against using weather derivatives. Although risks from other weather phenomena such as rainfall variability or snowfall days could also be similarly protected. In India, the protection is generally sought against the impact caused due to the uncertainty and unreliability of rainfall. Hence there is a perceptible demand for rainfall derivatives. (FE, 2018)

According to media reports, the overall area insured has decreased over the last two years—from57.2 million hectares in 2016-17 to 47.5 million hectares in 2017-18. This amounts to less than 24% of the gross cropped area (against a target of 40%)—and this is much lesser than 89% in the US and 69% in China. In this context, weather derivatives can complement the existing crop insurance programmes and, unlike crop insurance, cover low risk, high possibility events—as they essentially cover against any variation from normal weather.

2.2 Weather Hedging Strategies

The five examples that follow will give you a better idea of structures that producers, consumers, marketers, distributors and transporters of weather-based energy can use to modify their cash streams.

i) Degree-Day Swaps

Swaps can be used to stabilize cash streams associated with cooling and heating energy. For example, an energy producer sells a swap and gets compensated pro rata per degree-day whenever degree-days settle below an agreed strike level. When degree-days settle above the strike, the producer pays the buyer of the swap. The combination of the swap and the producer's revenue from operations is a more stable revenue stream. The buyer of the swap sees a mirror effect. This might be a consumer looking to stabilize his total cost of consumption.

ii) Cooling and Heating - Degree-Day Options

In their simplest form, options provide a one-sided hedge towards the downside, while preserving upside potential. This sounds better than a swap on the surface, but it comes at the expense of a premium the buyer must pay up front for the hedge. For example, a producer buys a put option and gets paid pro rata per degree-day whenever degree-days settle below an agreed strike level. This offsets lower revenue from operations, and sets a minimum floor on total revenues. If degree-days exceed the strike level, the

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producer pays nothing more than the option premium, and enjoys full upside operating revenues.

iii) Collars

Collars put boundaries on natural outcomes, limiting them to a desired range. Collars are constructed using a combination of put and call options. For example, a producer buys a rainfall put option with a low strike level and sells a call option with a high strike level. If rainfall settles between the two strike levels (the strike range), there is no payout to either the buyer or the seller of the hedge. If rainfall settles below the low strike, the producer receives pro rata payment per inch of rainfall from the seller of the put option. If rainfall settles above the high strike, the producer pays the buyer of the call. When combined with the producer's natural revenues from operations, the total revenue pattern is stabilized by the hedge outside of the strike range. Within the strike range, total revenue follows the unhedged trend.

iv) Digital Structures

Digital structures are used to cause lump sum cash transfers between contract parties whenever specified conditions are met. These structures are useful in situations where risk and associated costs come in discrete amounts instead of a variable scale. An example would be a power producer who incurs a fixed cost of bringing a peaking facility on line whenever temperatures exceed a threshold level.

v) Embedded Weather Agreements

These types of agreements can be used to combine weather hedges and physical energy delivery in a single transaction. The payout of the weather hedge is embedded in the energy supply cost. This can be useful as a matter of convenience, or when policy restricts the use of naked hedge agreements. Embedded agreements sometimes make it easier to see the result of combining weather hedges with operating results. Weather hedges can also be combined with price hedges and physical energy supply.

2.3 Weather Derivatives Compared to Insurance

Weather derivatives are similar to but different from insurance. Insurance covers low probability, catastrophic weather events such as hurricanes, earthquakes, and tornados. In contrast, derivatives cover higher-probability events such as a dryer-than-expected summer. Insurance does not protect against the reduction of demand resulting from a slightly wetter summer than average, but weather derivatives can do just that. Since weather derivatives and insurance cover two different possibilities, a company might have an interest in purchasing both. Also, since the contract is index-based, buyers of weather derivatives do not need to demonstrate a loss. In order to collect insurance, on the other hand, damage must be shown.

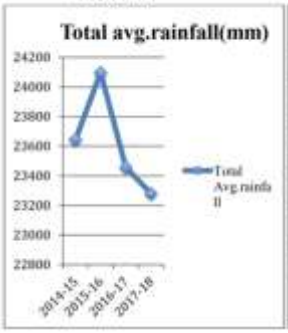
CHAPTER 3
DATA ANALYSIS AND INTREPRETATION

3.1 FOOD CROPS

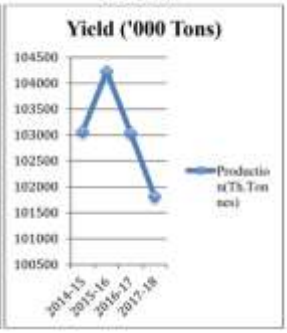
i) RICE

GRAPH 3.1 & GRAPH 3.2 - Total Average rainfall for the year 2014-18 and Total production for the year 2014-18

GRAPH 3.1



GRAPH 3.2

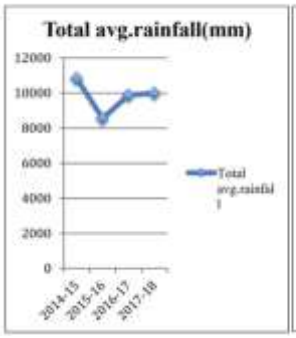


The above two graphs indicate that there is exists a co-movement of production of rice and rainfall. It can be observed that rise or fall in the rainfall is combined with a similar rise and fall in production of rice. It can be said that both the variables move in the same direction.

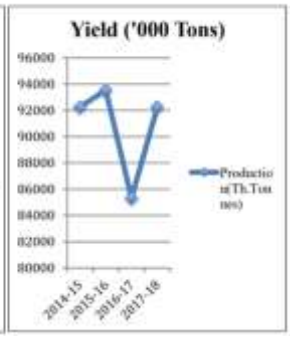
ii) WHEAT

GRAPH 3.3 & GRAPH 3.4 - Total Average rainfall for the year 2014-18 and Total production for the year 2014-18

GRAPH 3.3



GRAPH 3.4



From the above graphs it can be seen that unlike Rice production, rainfall and wheat do not move in the same direction. This suggests that wheat production depletes as rainfall increases suggesting that unfavorable rainfall may lead to low production of wheat. So it can be clearly identified that wheat

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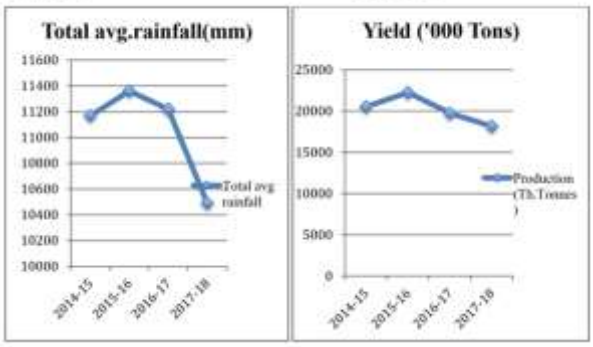
is not solely and predominately dependent on rainfall for its growth.

iii) MAIZE

GRAPH 3.5 GRAPH 3.6



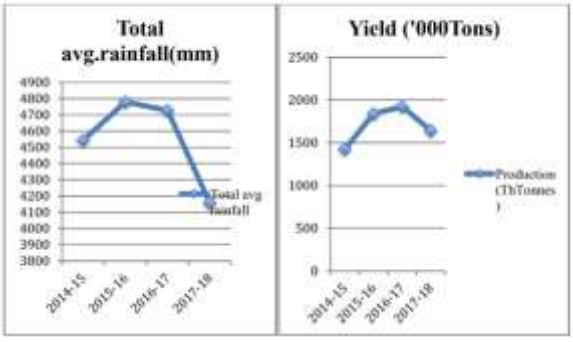
GRAPH 3.5 & GRAPH 3.6 - Total Average rainfall for the year 2014-18 and Total production for the year 2014-18

The above two graphs indicate that there exists a co-movement between rainfall and production of maize similar to rice. It can be observed that rise or fall in the rainfall is combined with a similar rise and fall in production of maize but the changes are not in the same proportion. It can be said that both the variables move in the same direction.

iv) RAGI

GRAPH 3.7 & GRAPH 3.8 -Total average rainfalls for the year 2014-18 and Total production for the year 2014-18

GRAPH 3.7 GRAPH 3.8



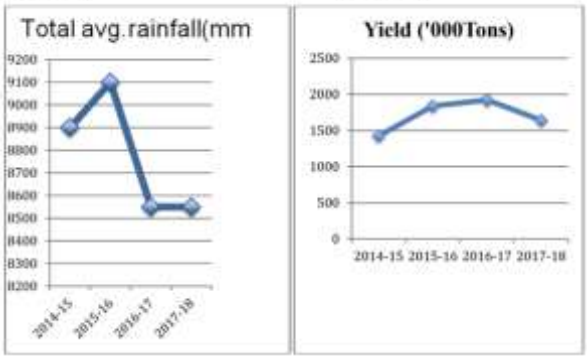
The trend analysis of rainfall and Ragi production indicate that there exists a movement of production of rice and rainfall. It can be observed that rise or fall in the rainfall is combined with a similar rise and fall in production of rice. It can be said that both the variables move in the same direction. However their correlation is established in the later part of the research.

3.2 CASH CROPS

i) COTTON

Graph 3.9 & Graph 3.10 -Total productions for the year 2014-18 and Total Average rainfall for the year 2014-18

GRAPH 3.9 GRAPH 3.10

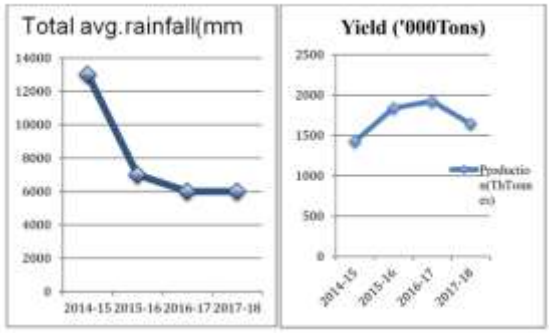


Based on the trend analysis of the above two graphs, it can be observed that although quantum of rainfall and production of cotton move in the same direction, the rate at which they move is not same. But year 2014-15 and 2015-16 are not in tandem. This phenomenon can be further inspected which is not covered in this paper.

ii) JUTE

Graph 3.11 & Graph 3.12 -Total production for

GRAPH 3.11 GRAPH 3.12



the year 2014-18 and Total Average rainfall for the year 2014-18

The above two graphs indicate that there doesn't exists a co-movement between rainfall and production of jute. It can be observed that rise or fall in the rainfall is not combined with a similar rise and fall in production of jute but the changes are not in the same proportion. It can be said that both the variables don't move in the same direction.

iii) SUGARCANE

Graph 3.13 & Graph 3.14 -Total production for the year 2014-18 and Total Average rainfall for the year 2014

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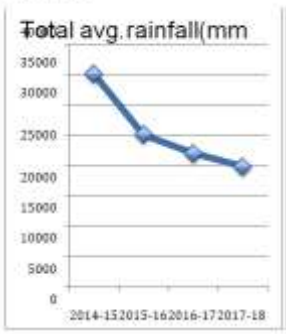
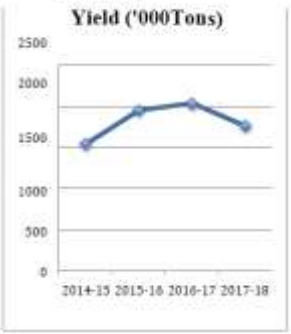
GRAPH 3.14



GRAPH 3.14

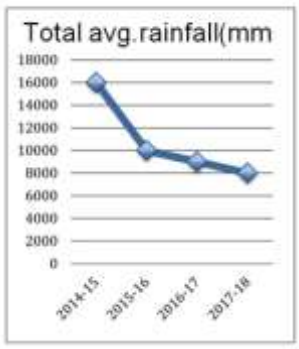


The above two graphs indicate that there doesn't exists a co-movement between rainfall and production of sugarcane. It can be observed that rise or fall in the rainfall is not combined with a similar rise and fall in production of sugarcane but the changes are not in the same proportion. It can be said that both the variables don't move in the same direction.

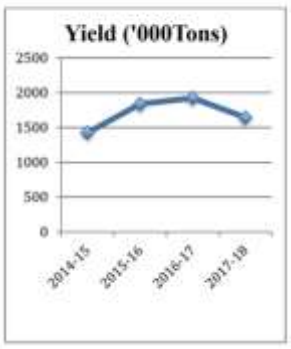
iv) MESTA

Graph 3.15 & Graph 3.16-Total production for

GRAPH 3.15



GRAPH 3.16



the year 2014-18 and Total Average rainfall for the year 2014-18

The above two graphs indicate that there doesn't exists a co-movement between rainfall and production of Mesta. It can be observed that rise or fall in the rainfall is not combined with a similar rise and fall in production of Mesta but the changes are not in the same proportion. It can be said that both the variables don't move in the same direction.

CHAPTER 4
FINDINGS, SUGGESTIONS AND CONCLUSION

4.1 FINDINGS

This research paper aims to understand the relationship between rainfall and agricultural production. It is evident from several literatures that agriculture is highly dependent on weather and weather conditions. Weather as a phenomenon it comprises of rain, temperature, snowfall, storm, wind and many more. For the sake of convenience in terms of collection of data and analysis, this paper has used rainfall in order to quantify weather. Agricultural production is measured in thousand tonnes and rainfall is measured in millimeters. The paper distinguishes the agriculture production based on crops. For convenience, crops have been divided as food crops and cash crops. The crops considered under food crops are rice, wheat, maize and ragi. The crops considered under cash crops are cotton, sugarcane, mesta and jute. India's topography contributes to the growth of these crops across many states. Therefore only the states which are dominant producers of these crops have been considered for selection of data. The data for rainfall is also collected from the respective states and average rainfall has been assumed since total rainfall may obscure the result of the findings.

4.2 SUGGESTIONS

Agriculture plays a vital role in India's economy. 54.6% of the population is engaged in agriculture and allied activities and it contributes 17% to the country's Gross Value Added. (Annual report-2016-17, Department of Agriculture, Cooperation and Farmer's Welfare) India holds the second position in the availability of arable land with 127 diverse agro-climatic zones, with a share of 11.2% of the total arable land in the world. Also, India has the 6th largest food and grocery market and 5th largest retail market globally. The Food Processing Industry is also showing high potential for growth and provides 12.77 % of employment generated in all manufacturing factories. Also the food processing industry contributes 9 % and 11% of GDP in Manufacturing and Agriculture sector respectively.

With Government placing much importance on agriculture and agriculture related business, this sector has one of the largest potential for growth. But agriculture is always threatened by the vagaries of nature. Although several initiatives have been undertaken by Government of India in order to protect the crop of producers. There is a pressing need to support those who are also dependent on agriculture other than farmers namely.

•Government of India's 'Pradhan Mantri Fasal Bhima Yojana' only provides crop insurance especially to producers. However those business entities which rely on agriculture may be left in the lurch. Businesses which are into purchase and sale of

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agricultural products/commodities whose revenues too are affected due to bad weather conditions cannot make use of these schemes.

•Ensure that even Agro Companies get a constant revenue when there is a need for a weather derivative market.

•Also ensure, if India has to hold onto its share in world exports and also improve the exports. Then India must take care of those who are direct stakeholders in agriculture. If the farmers and those in the business of agriculture are not permitted to hedge their exposure towards weather then the vagaries of weather impact may also affect the export position of India globally. Although weather insurance contracts are in place already they are structured only to cover loss whose probability of occurrence is low. Agricultural exports as a percentage of agricultural GDP has come down from 13.56% in 2012-13 to 9.90 % in 2015-16, which should be considered as an alarm.

4.3 CONCLUSION

Although weather insurance and crop insurance schemes are in India these schemes protect the monetary interest of the producers (farmers). However there are several business entities that directly depend on the raw material requirement from agriculture are also an important stakeholder. So weather derivatives can prove to be a useful proposition to such agri-business owners and agriculture sector. It is sure to get a flip with the introduction of such schemes.

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