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A study of weather risk in agriculture sector, its impact on farmer's health and use of weather derivative to hedge.

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Abstract

Introduction: India is country of rural background where large part of population (61.5%) depends on agriculture produce for their living. Due to poor irrigation facilities, around 80% of Indian agriculture land relies on monsoon rainfall, so insufficient rainfall can severely impact the production of crops. Region which experienced insufficient rainfall or droughts, crop yield have declined and that area show increase rate of suicide rate by farmers. **Objective:** this research is conducted to study the factors affecting farmer's health due to bad weather and acceptability of weather derivatives as a tool to hedge the weather risk amongst farmers. **Originality:** very few studies have been conducted to find the factors affecting farmer's health and the acceptability of weather derivatives among the farmers to hedge the financial loss due to bad weather. **Material & Method:** Survey amongst the farmers has been conducted and the data has been analysed by using binomial Logit-Probit regression and tabular analysis.

Result & Discussion: Result of logit- probit regression shows that there are 7 factors affect farmers health significantly which are pending loan, feeling mentally stressed, surety of yield, landholding, education, age and source of water supply. The observation also shows that farmers are ready to accept weather derivative and they feel it will reduce their financial stress. The farmers are ready to hedge their risk by using weather derivatives. **Application:** findings of this research can be useful to give recommendation to the government to introduce weather derivatives in India to help hedging risk due to bad weather condition. by hedging weather risk effectively, we can reduce the cases of farmers suicides. **Conclusion:** To reduce the farmers suicide cases in India government should introduce weather derivatives in Indian market and provide subsidy and proper financial education to farmers so that can use these derivative instruments to hedge financial risk.

Keywords- weather derivatives, Weather risk, farmer's health

Introduction

India is country of rural background where large part of population (61.5%) depends on agriculture produce for their living (Census 2011)[4]. The timely arrival of the monsoon and sufficient rains is the key for Indian economic growth. Agriculture, hydro-electric power generation and agriculture industry in India are majorly depends on the performance of the summer monsoon which provides 75-90% of annual rainwater potential over most parts of India. The risk of monsoon is a repetitive phenomenon.

Poor small farmers are vulnerable to change in income due to climate change. Even the rural poor people who are not directly involved in agriculture are also get affected by bad weather as their income associated with the agricultural output [3].

Due to poor irrigation facilities, around 80% of Indian agriculture land relies on monsoon rainfall, so insufficient rainfall can severely impact the production of crops[1][6]. Region which experienced insufficient rainfall or droughts, crop yield have declined and food for farmers and cattle has become scarce [5] and that area show increase rate of suicide rate by farmers.

Table 1 shows the data of farmer's suicides of top 5 states based on the report published on 21 October 2019, by national crime records Bureau (NCRB)[2]. It is an alarming signal for the government and we need to find a solution for this situation.

Table 1: States with most farmer suicides (2016)

State	No of farmers committed suicide
Maharastra	3661
Karnataka	2079
Madhya Pradesh	1321
Andra Pradesh	804
Chattishgarh	682

Source: ADSI (Accidental Death and Suicides India), 2016, NCRB

Government try to mitigate this risk by offering many crop insurance like Comprehensive Crop Insurance Scheme (CCIS), National Agriculture Insurance Scheme (NAIS), Pradhan Mantri Fasal Bima Yojana(PMFBY) etc. However these schemes did not meet with much success. The major reason of failure of insurance schemes is that in case of insurance we need to prove the loss so a farmer taking insurance had to show that he suffered a loss due to effect of weather conditions. It involves a lot of paper work and other formalities which deter people from going for insurance policies. Introduction of weather derivatives in India can help to solve this problem, as in case of weather derivatives no prove of loss occurred is required by the farmer for payoff, only occurrence of weather event is sufficient. In this research project we will study that how weather risk can be managed by using weather derivatives and at what extent farmer will accept these new risk management tools.

Literature Review

Turvey (1999) demonstrated that rise of primary and secondary markets for weather based risk management products will bring about numerous new products going to the market. Precipitation insurance can give a straightforward instinctive way to deal with overseeing creation dangers which can be conveyed in a cost effective and unambiguous way.

Skees, et al, (2001) analyzed the improvement of weather products in light of precipitation to insure against dry spell in four Mexican states viz., "Durango, Jalisco, Tamaulipas and Zacatecas". The plausibility study had two primary segments. To start with, it analyzed the relationship amongst precipitation and yield to decide the misfortune because of absence of rain. Second, it composed a model precipitation contract and inspected how this agreement influences the change of incomes from these yields.

Geyser (2004) watched that when a "weather-event" is a wellspring of "economic-risk" for agriculture, a weather derivative can turn into a hedging tool for agriculturists and for "risk-underwriters". The acquaintance of weather derivatives with oversee yield chances in agrarian markets in South Africa could be of awesome advantage to ranchers.

Veeramani et al, (2005) opines that the crop insurance program was in certainty advantageous to the farmers however it has negative impact on the govt. spending plan. Exchanging overabundance risk to worldwide reinsurers is a practical contrasting option to disaster payments and reinsurance by the legislature. In any case, universal reinsurers are hesitant to reinsure crop insurance risk from developing nations for the most part because of the absence of dependable crop yield information.

Anshul & Surendra (2006), have drawn out that India being agriculture based economy, it can without much of a stretch accept weather derivatives and can be successfully used to oversee farming production risk. They further watched that weather derivatives can be valuable means for tending to the systemic bit of agrarian risk, prompting to potential applications in the stand-alone or layer structures in the re-insurance of agricultural risk exposure.

(Pauline, 2006) expressed that weather risk is likewise more a high recurrence - low seriousness chance. In this way, standard insurance does not appear to be the most proper arrangement. The ideal length of the database relies on upon the normality of climate information (drift, consistent regularity) and somewhere around 10 and 30 years is considered as the standard.

Rao and Bockel, (2008), proposed that weather index insurance has comparable points of interest to those of region yield insurance. This program

gives convenient remuneration made on the premise of weather index, which is normally precise. All people group whose livelihoods are reliant on the weather can purchase this insurance

Seth et al. (2009) evaluated "weather-risk" hedging by farmers, concentrating on the readiness to pay in Rajasthan, India and proposed for further research on drawing out the request, the eagerness to-pay, and the valuation of "weather-derivatives products" for various organizations which would help in deciding the structure of products furthermore recommended for research to know the conceivable connections between weather derivatives contracts and commodity futures prices for portfolio development.

Material and Method

Objectives of study

1. To study the factors affecting the farmer's health
2. To study the acceptability of weather derivatives as a tool to hedge the weather risk amongst farmers.

To achieve the above objectives we have conducted a survey amongst the 500 farmers of Gwalior-Chambal region. Gwalior Chambal region has 7 districts consists of Gwalior, Shivpuri, Guna, Datia, Bhind, Morena, Sheopur.

Statistics used: Binomial Logit-probit regression analysis is used to identify the relationship between the health of farmers and other selected factors. Cross tabulation analysis is used to check the acceptability of weather derivatives as a tool to mitigate the weather risk amongst farmers. SPSS version 20 is used to apply all the statistical tools.

Result and discussion:

To study the factors affecting farmer's health we have designed a questionnaire/schedule and get it filled by 500 farmers of 7 district of Gwalior-Chambal regions. Series of multivariate regression were applied on the selected data by taking farmers health as dependent variable and other 14 variables as independent variable.

Table 2: List of variable considered for analysis

Sr. No.	Variable	Description	Type
1	Health	Is bad financial condition due to low yield affected health condition in family	Dependent
2	Loan	Do you have any pending outstanding loan	Independent
3	FMS	Do you feel mentally stressed due to bad weather condition	Independent
4	SOY	How much sure you are about the yield of the farm	Independent
5	Land	Landholding by farmers	Independent
6	Edu	Education level of farmers	Independent
7	Age	Age of farmers	Independent
8	Savings	Monthly savings	Independent
9	Crop	Number of crop grown in a year	Independent
10.	SW	Source of water supply	Independent
11.	SI	Source of Income	Independent
12	Yield	Total Production in farm	Independent
13	SS	Satisfaction level in previous scheme	Independent
14.	LH	Livestock holding	Independent
15.	PCT	Preference for derivative contract time	Independent

Source: Researcher's database

Variables which have less effect on dependent variable were left out from the final model. In our final model, 7 variables viz., pending loan, feel mentally stress due to bad weather condition (FMS), Surety of yield (SOY), land holding, Education level, age of farmers, source of water supply were taken as independent variables.

The dependent variable in our model was dichotomous as it has only value (Yes or No) so the regression method which was applied here is binomial logit and probit regression.

Table 3a and 3b shows the parameter estimates when logit -probit model are fitted with the model:

$$Pr(Yes) = Pr [\Theta < (\alpha_1 \text{ loan} + \alpha_2 \text{ FMS} + \alpha_3 \text{ SOY} + \alpha_4 \text{ land} + \alpha_5 \text{ edu} + \alpha_6 \text{ age} + \alpha_7 \text{ SW} - \beta t)/\sigma)] \text{.....Eq 1}$$

Table 3a: Parameter Estimates(Probit)

Parameter	Estimate	Std. Error	Z	Sig.
Loan	0.164	0.042	3.874	0
FMS	0.27	0.133	2.028	0.043
SOY	-0.058	0.024	-2.432	0.015
Land	-0.053	0.031	-1.988	0.048
Edu	-0.346	0.039	-8.956	0
Age	-0.04	0.018	-2.182	0.029
SW	-0.136	0.026	-5.22	0
Intercept	-1.3	0.209	-6.214	0

Source: SPSS output

Table 3b: Parameter Estimates(Logit)

Parameter	Estimate	Std. Error	Z	Sig.
Loan	.399	.124	3.208	.001
FMS	.636	.418	1.980	.045
SOY	-.121	.070	-2.250	.044
Land	-.085	.090	-2.134	.034
Edu	-.689	.113	-6.100	.000
Age	-.066	.055	-2.310	.025
SW	-.383	.080	-4.778	.000
Intercept	-2.864	.630	-4.550	.000

Source: SPSS output

The null hypothesis is that the parameter α1, α2,....α7 and β are equal to zero. The Z score value for each parameter is greater than 1.96 and p value is less than 0.05. So the null hypothesis is rejected.

If we interpret the result of above table we can see that probability that farmer's health is affected by bad weather condition increases with pending loan and if they are feeling mentally stress due to bad weather conditions. The probability decreases with surety of yield, landholding, education, age and source of water supply is proper.

To study the acceptability of weather derivatives as a tool to mitigate the weather risk amongst farmers we has asked farmers, if weather derivative relieve financial stress of farmers and if they are interested in hedging risk by using weather derivative instrument. The result of both the questions is available in table 4a and 4b.

Table 4a: Will weather derivative relieve financial stress

District	Would help to a very large extent		Would help to a fair extent		Would help marginally		Might not help		Am sure will not help		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Ashoknagar	31	62%	11	22%	5	10%	1	2%	2	4%	50	100%
Bhind	50	63%	17	21%	8	10%	1	1%	4	5%	80	100%
Datia	25	63%	8	20%	6	15%	1	3%	0	0%	40	100%
Guna	36	51%	21	30%	9	13%	1	1%	3	4%	70	100%
Gwalior	8	20%	22	55%	1	3%	2	5%	7	18%	40	100%
Morena	41	68%	11	18%	7	12%	0	0%	1	2%	60	100%
Sheopur	32	64%	9	18%	7	14%	1	2%	1	2%	50	100%
Shivpuri	35	44%	38	48%	1	1%	4	5%	2	3%	80	100%
Total	258	55%	137	29%	44	9%	11	2%	20	4%	470	100%

Source: SPSS output

Table 4b: Would you be interested in hedging risks by using weather derivative						
District	Would be interested		Would not be interested		Total	
	N	%	N	%	N	%
Ashoknagar	49	98.0%	1	2.0%	50	100.0%
Bhind	76	95.0%	4	5.0%	80	100.0%
Datia	35	87.5%	5	12.5%	40	100.0%
Guna	58	82.9%	12	17.1%	70	100.0%
Gwalior	33	82.5%	7	17.5%	40	100.0%
Morena	57	95.0%	3	5.0%	60	100.0%
Sheopur	50	100.0%	0	0.0%	50	100.0%
Shivpuri	62	77.5%	18	22.5%	80	100.0%
Total	420	89.4%	50	10.6%	470	100.0%

Source: SPSS output

While asking if weather derivative relieve the financial stress, 84% farmers said it would help fair to very large extent. 9% said it would help marginally, 2 % said it might not help and 4% said it will surely not help (table 4a).

While asking would you be interested in hedging risk using weather derivatives 89.4% farmers said they would interested and only 10.6 % said they would not be interested (table 4b).

Conclusion

It is observed that 7 variables (Pending loan, feeling mentally stressed, and surety of yield, land holding, education, age and source of water supply) affect the farmer's health in case of loss due to bad weather condition. The financial loss due to bad weather condition can be avoided if weather derivatives would be used in proper manner and make farmers aware about these kind of derivatives. The observation shows that farmers are ready to accept weather derivative and they feel it will reduce their financial stress. The farmers are ready to hedge their risk by using weather derivatives.

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