Hedging Rainfall Risk by Farmers Growing Soyabean in Jhalawar District: A Theoretical Analysis of Willingness to Pay

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Rainfall risk to the yield of a crop can be hedged, to an extent, by the use of weather derivatives. The paper considers a theoretical model which maximises the expected utility of a farmer growing a crop, with respect to planned production. An option to hedge the weather risk to yield, through purchase of weather derivatives, is introduced. The case of farmers growing soyabean in Jhalawar district of Rajasthan in central India is taken as an example in order to determine the theoretical willingness to pay to hedge volumetric risk to yield.

Keywords: Crop Yield Risk, Weather Derivatives, Willingness to Pay
JEL Classification: Q14

1. INTRODUCTION

In India, about 78 per cent of farmers are small and marginal, and are mostly poor (Agrawal 2000). Apart from not being in a position to use the right inputs for the crops they grow, they are largely dependent on rainfall. Most crops are highly dependent on the vagaries of the monsoons. If rainfall is less than normal in a particular year, yield is very low because of the lack of water; if rainfall is
very high, particularly during blossoming, there is poor grain setting and the matured grains germinate on the panicles.

In this context, the development of financial instruments in the form of weather derivatives could help farmers hedge part of the volumetric risk in yield. Weather derivatives are a fairly new concept in India, but they offer a means to manage exposure to unpredictabilities in rainfall.

Oilseed crops occupy about 10 per cent of the total cultivated area and contribute approximately 10 per cent to the production of food crops in India (Deosthali et al. 2005). Noticeable efforts have been made to increase the yield of soyabean over the years, with the result that it has increased by 490 per cent between 1983 and 2004. The real increase in area under soyabean cultivation came about in 1989–90 with the use of short-duration, high-yield varieties. Despite this, the average yield of Indian soyabean, at 1.074 tonnes/ha, is still far lower than the world average of 1.8 tonnes/ha and the Asian average of 1.3 tonnes/ha (Deosthali et al. 2005).

Soyabean is a legume crop, yet it is used widely as an oilseed and, in fact, is now the second largest oilseed in India after groundnut. It grows well in warm temperatures and requires fair-to-heavy rainfall during its growth cycle. It is a highly nutritive crop and can supply much needed protein to the human diet, as it contains approximately 43 per cent protein and 20 per cent oil. In addition, it contains essential amino acids particularly glycine, tryptophan and lysine, similar to cow’s milk.

The soyabean crop requires water, especially during its germination, flowering and pod-formation stages. Lack of water during vegetative growth and seed development can reduce yield considerably.

The minimum support price (MSP) for soyabean, which is the government announced price aimed at ensuring remunerative prices to farmers for their produce, has varied from Rs 1,002 per tonne in 1981–82 to Rs 933 in 1991–92 and to Rs 930 in 2003–04 (at prices inflated to 2003–04) (Central Statistical Organisation [CSO] 2006). More importantly, the yield per hectare of soyabean in Jhalawar district (in southern part of Rajasthan) has varied from 0.538 tonnes/ha in 1981–82 to 1.387 tonnes/ha in 2003–04. Whilst a large portion of the variability in yield could be attributed to technological developments, a substantial variability arises from weather-related effects.

In the central, northern and western parts of India, where rainfall is high and winters are fairly cold, only one crop of soyabean (the kharif crop) is grown during May–November. Typically, soyabean is sown in June and harvested in mid- or end-October.
In Rajasthan, the total production of soyeban in the 2006 kharif season was 4.930 lakh tonnes with 5.803 lakh hectares being sown with the crop.

The theoretical framework in the soybean yield scenario is based on the model used by Simmons and Rambaldi (1997). It builds in simplifying assumptions and includes the cost of and the gain from a possible hedge on the portion of yield variability, which could be attributed to rainfall dependence. An empirical analysis, based on the gross production of soyabean in Jhalawar, is carried out to give a rough estimate of the aggregate willingness to pay to cover yield risk.

Probably the only way to assess the inclination of soybean-growing farmers to hedging volumetric risk attributable to the vagaries of weather is to physically carry out a survey. However, prior to this, a theoretical framework is attempted to give an estimate of the 'willingness to pay' for hedging weather risks.

2. THEORETICAL MODEL

The expected utility of a farmer who cultivates a crop can be expressed as:

\[ E(U) = E(S) - C - R \]  
\[ \text{Where } E(U) \text{ is expected utility, } E(S) \text{ is expected sale price, } C \text{ is the cost of inputs and } R \text{ is a risk premium. The risk premium can be defined using the Pratt Coefficient (Pratt 1964) of absolute risk premium, } k \text{ as:} \]

\[ R = \frac{k}{2} E\left[(S - E(S))^2\right] \]  
\[ \text{So,} \]

\[ E(U) = E(S) - C - \frac{k}{2} E\left[(S - E(S))^2\right] \]  

In actuality, the risk premium, R, would be dependent on the wealth of the farmer, but we assume it to be constant as has been done in other studies (Edwards and Simmons 2004).

We consider yield in a one-year cycle, so that utility in period t is maximised with respect to the information in period, t−1. Yield is expected to follow a
naive model, which includes a trend component, attributed to technological advancements \((T)\) and a multiplicative error term \((1+e)\) which is attributable to variation in weather.

So,

\[
Y_t = (\bar{Y} + aT)(1 + e)
\]

(where \(\bar{Y}\) is the mean yield across the sample)

and production

\[
q_i = AY_i
\]

(where \(A\) is the area under cultivation).

The selling price is taken as the MSP announced by the government—which is generally the price at which the farmer is able to sell his produce. It is assumed that selling price follows a naive model:

\[
S_i = S_o(1+f)
\]

Where \((1+f)\) is a multiplicative error term and \(S_o\) is the price at the start of the season.

So, income from sales = \(S_i q_i\)

\[
= S_o (1+f) A (\bar{Y}+aT)(1+e)
\]

Input costs can be taken as a total quantity decided upfront, based on planned production, \(q^\), and can be written as the sum of fixed costs and variable costs which are dependent on the amount of planned production, \(q^\). Variable costs would mainly include the cost of seeds, fertilisers and pesticides. Fixed costs would be dependent on the area under cultivation and would include all other input costs.

So,

\[
C = C_f A + C_v q_i
\]

Expected utility can be written as:

\[
E_s(U_s) = S_o q_i - C_f A - C_v q_i - \frac{k}{2} E_s \left[ \left( S_o (1+f) A (\bar{Y} + aT)(1+e) - S_o A (\bar{Y} + aT) \right)^2 \right]
\]

\[
= S_o q_i - C_f A - C_v q_i - \frac{k}{2} S_o^2 (\bar{Y} + aT)^3 A^3 E_s \left[ (1+f)(1+e)-1 \right]^2
\]

\[
= S_o q_i - C_f A - C_v q_i - \frac{k}{2} S_o^2 q_i^2 E_s \left[ (e + f + ef)^3 \right]
\]

\[\text{(9)}\]
For maximisation of utility with respect to planned production,

\[
\frac{\partial E_t(U_t)}{\partial q_t} = S_t - C_r - kS^2_t q_t E_s [(e + f + ef)^2] = 0
\]

\[
q_t = \frac{S_t - C_r}{kS^2_t E_s [(e + f + ef)^2]}
\]

We now consider the case where the farmer has an option to hedge the weather risk through purchase of weather derivatives.

We note that \(e\) and \(f\) are aberrations which can be hedged by the farmer. Whilst the farmer can hedge \(f\) by going in for forward contracts, weather insurance or weather derivatives would be the only ways to hedge \(e\). We will, in this analysis, assume that the farmer is not as concerned with price risk as he is with volumetric risks. Thus, he will opt for hedging \(e\) to an extent within his means and his risk appetite.

We take \(h\) as the proportion of \(e\) which the farmer wants to hedge, and the cost of hedging as \(r\), so that the amount paid by the farmer is \(rh\). This amount will be included in the cost of inputs so that:

\[
C = C_t A + C_r q_t + rh
\] (11)

and income from sales

\[
S_t (1+f) A(\bar{Y} + aT) (1 + (1-h)e)
\] (12)

Utility at time \(t\) can be written as

\[
E_t(U_t) = E_t(S_t) - C_t - \frac{k}{2} E_s [(S_t - E_s(S_t))^2]
\]

or \(E_t(U_t) = S_t q_t - C_f A - C_r q_t - rh - \frac{k}{2} E_s \left[(S_t(1+f)A(\bar{Y} + aT)(1 + (1-h)e) - S_t q_t)^2\right]
\]

\[
= S_t q_t - C_f A - C_r q_t - rh - \frac{k}{2} S_t q_t E_s \left[(1+f)(1 + (1-h)e) - 1\right]^2
\]

\[
= S_t q_t - C_f A - C_r q_t - rh - \frac{k}{2} S_t q_t E_s \left[\Delta + h^2\gamma - 2h\gamma\right]
\]

where \(\Delta = e^2 + f^2 + e^2f^2\) and \(\gamma = e^2 + e^2f^2\).
First-order conditions are derived by differentiating $E(U_j)$ with respect to planned production $q_j$ and the amount of hedging $h$:

$$\frac{\partial E(U_j)}{\partial q_j} = S_j - C_j - kS_jq_jE_s[\Delta + h^2\gamma - 2h\gamma] = 0 \quad (14)$$

and

$$\frac{\partial E(U_j)}{\partial h} = -r - kS_jq_jE_s[h\gamma - \gamma] = 0. \quad (15)$$

3. **Empirical Results**

We obtain the model parameters from a dataset of soyabean production, inputs, etc., for the 23-year period between 1982 and 2004 in Jhalawar. Data on the yield of soyabean was obtained from the Directorate of Economics and Statistics, Government of Rajasthan, Jaipur. Rainfall data for Jhalawar for the same period was purchased from the India Meteorological Department.

In the first place, the yield of soyabean was regressed against time in order to obtain a value for \(a\) from the trend which we attribute to technology advancements and for the value of \(\bar{Y}\). We get,

$$\bar{Y} = 0.725 \text{ tonnes/ha}$$
$$a = 0.017$$

Using equation (4) and values of the error term for each of the 23 years of the dataset, we obtain the mean value for \(e\),

$$e = -0.00087$$
with a variance \(\sigma_e^2 = 0.0681\)

Similarly, using equation (6) and values of the error term in the MSP for the 23 years, we obtain the mean value for \(f\),

$$f = -0.00291$$
with a variance \(\sigma_f^2 = 0.00104\)

The MSP for soyabean for each year in the 23-year period 1981–82 to 2003–04 was inflated (using the Wholesale Price Index [WPI]) to 2003–04 levels and a mean obtained:

$$S_o = \text{Rs 9,720 per tonne}$$
The mean yield per year from 1981–82 to 2003–04:

\[ Y_i = 0.933 \text{ tonnes/ha}. \]

(See the Appendix.)

### 3.1 Correlation of Yield with Rainfall

Figures for the yield of soyabean in Jhalawar district were correlated with rainfall data in the 23 years, for the period 16 June–15 October. A positive correlation of 30 per cent was noticed, indicating a fair degree of dependence on rainfall. Similarly, residuals of \( Y_i \) indicated a positive correlation of 33.3 per cent with rainfall in the same months.

In order to calculate the variable cost of inputs, \( C_i \), the cost of seeds, fertilisers and pesticides used per tonne of soyabean produced was calculated. Data was available for 1996–97 for the costs of fertilisers and seeds required per hectare of soyabean crop. Using the yield of soyabean in the same year, the cost per tonne of the produce was arrived at and inflated to the 2003–04 levels. Also, the total amount of N-P-K fertiliser consumed in 1996–97 was applied to arrive at an approximation for fertiliser used for soyabean production through a ratio of area sown vis-à-vis gross sown area. A similar calculation was carried out for pesticides, using the cost for monocrotophos pesticides. Both these input costs were inflated to 2003–04 prices.

We obtained

\[ C_i = 3,243 \text{ rupees per tonne}. \]

The Pratt coefficient of absolute risk premium, \( k \), was arrived at using the method defined by Rambaldi and Simmons (2000). Risk premium in this study has been calculated as the difference between the expected selling price and actual selling price.

The coefficient of relative risk is arrived at from a study by Antle (1987) who carried out an econometric estimation of risk attitudes of farmers in Aurepalle village in Andhra Pradesh. The data is based on an experimental measurement of risk attitudes of farmers in the same village (Binswanger 1980). The relative risk premium arrived at was 0.144.

The coefficient of relative risk aversion is a 'unit free' measure of risk aversion that allows comparisons between groups and results from different studies.
is measured in our study as $P \times k$, where $P$ is the variable profit $(S - C)$ and $k$ is the coefficient of absolute risk premium. This gives us:

$$k = 2.9826 \times 10^{-5}$$

These coefficient and variable values are used to solve for planned production, $q^*$, and the amount of hedge, $h$. From equations (14) and (15), we get:

$$6477 - 0.019377 q^* - 0.00159 q^* h^* + 0.00318 q^* h = 0$$

and

$$r - 0.00159 q^* h + 0.00159 q^* = 0$$

On solving these two equations, we can see that as $r$ approaches 0, $h$ approaches 1; that is, farmers would be willing to hedge completely if the cost of hedging is zero. We also see that the amount they would be willing to hedge, $h$, approaches zero as the cost of hedging, $r$, tends to Rs 531.40 per tonne.

This translates to a theoretical willingness to pay of approximately 5.47 per cent of the MSP.

As such, we could infer that there exists a demand for weather derivatives as a shield against volumetric risk in soyabean production in Jhalawar district; it would be around 5.47 per cent of the sale price that a farmer would get from his produce.

4. CONCLUSION

Based on the fact that there is an element of rainfall dependency in the yield of soyabean, we see that there exists a demand for weather derivative products. This study is done for soyabean production in a selected district in Rajasthan and only indicates a theoretical demand for weather derivative products.

Farmers in other areas could possibly be willing to pay differently for weather derivatives. An ideal situation would be to carry out a survey to ascertain actual willingness to pay.

Thus, these products may need to be introduced selectively in certain areas for certain crops after area-based surveys.
References


QUESTIONNAIRE FOR SURVEY AMONG FARMERS TO ASSESS THEIR WILLINGNESS TO PAY FOR WEATHER DERIVATIVES

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Questionnaire Type: Quantitative

FIELD CONTROL INFORMATION

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Interviewer to fill in

DISTRICT NAME:........................................

VILLAGE NAME:........................................

TYPE OF RESPONDENT

Subscriber.............1 Non Subscriber.............2

Interviewer Name:........................................

Interview Start time AM/PM Interview end time AM/PM Total interview time (in min)

PLACE OF INTERVIEW

Home...............1 Agricultural field......... 2 Street intercept....3 Others.................4

QUALITY CHECK DETAILS

Accompanied......................1 Back Check done......................2 Scrutiny done......................3

Personal.............1 Telephone.............2 Personal.............1 Telephone.............2

Date Date

Supervisor/ Executive Name (Acc by) Supervisor/ Executive Name (BC by) Supervisor/ Executive Name (Scrt by)

Signature (Interviewer)

IDENTIFICATION PARTICULARS:

Introduction: Namaskar. “My name is............... “We are carrying out a study to understand the awareness levels of villagers/farmers on agricultural insurance schemes. This study will further evaluate the nature of insurance demands and willingness of the respondents to pay for weather derivatives. Hence, we have come to your place to request you to participate in the interview based on the questionnaire for the purpose of this study. Your views are important to us, as they will help in designing interventions for people like you. Your participation is voluntary and you may end the interview at any time. The survey will take roughly 30 minutes to complete. Please be assured that the information given by you will be treated in strict confidentiality and will be used for research purposes only.

नमस्कार ! मेरा नाम ............. है ! हम लोग बीमा स्कीम को हाल में लोगों के बीच जानकारी का लर्न समझने के लिए एक तरीक़ा कर रहे हैं। इस स्टडी से हम बीमा की जारीताओं और लोग इसके लिए या किमान आता अर रहते है आदि को समझने का मौका मिलेगा। इसलिए हम आपकी इंटरव्यू के लिए आपकी जानकारी की मदद में बनाने वाले जुड़वांक को योगदान कर सकते हैं। इस इंटरव्यू में हम लोग आपकी जानकारी पर निर्भर करेंगे और आप अप जब यहाँ इंटरव्यू को समय बरत रहेंगे। इस तरह नेव
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<td>Address:</td>
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<td>Sex of the respondent</td>
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<td>Female</td>
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<td>What is your age? (Mention in complete years)</td>
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<td>Respondent is the head of the household?</td>
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<td>What is your educational Qualification?</td>
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<td>b. Primary</td>
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<td>f. Post Graduate</td>
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<td>What is the primary occupation of your family?</td>
<td>a) Cultivation</td>
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<td>b) Agri-labour</td>
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<td>c) Non-agri-labour</td>
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<td>d) Others</td>
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<td>How many persons are presently residing in your household?</td>
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<td>No. of minors (&lt; 16 yrs.)</td>
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<td>Can you please tell us about the sources of income for your household?</td>
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<td>b) Agri-labour</td>
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<td>d) Petty business</td>
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<td>c) Sale of animal products</td>
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<td>e) Remittances from migrated</td>
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<td>Can you please assess your average monthly income (in Rs.) today?</td>
<td>f) Others (specify)</td>
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<td>खेतियों के लिए जेब से बनाया</td>
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<td></td>
<td>own farming:</td>
<td>है तथा बारे पर आवारित १२५</td>
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<td>कितनी जमीन है</td>
<td>आइरिजिडिड शेयर=</td>
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<td>बारे पर है तथा</td>
<td>शेयर=१२५</td>
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<td>13</td>
<td>Whether any part of this</td>
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<td>land is uncultivated?</td>
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<td>IF YES Give reason for</td>
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<td>not cultivating:</td>
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<td>क्या इस खेत का कोई भाग</td>
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<td>नियत नहीं है जिस पर खेती नहीं की</td>
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<td>कीहित है ? अगर है , तो खेती</td>
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<td>न करने के कारण बताईं</td>
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<td></td>
<td>(a) Repeated droughts</td>
<td>बारे में आपके पास आपके पास</td>
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<td>बारे में आपके पास खेत</td>
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<td></td>
<td>(b) Bad returns</td>
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<td>(c) Lack of money to</td>
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<td>invest in farming</td>
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<td>खेती के लिए बिना ही</td>
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<td>अमूर्त के कारण है तथा</td>
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<td></td>
<td>(d) Lack of interest</td>
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<td>इत्यादि है तथा है से</td>
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<td></td>
<td>(e) Others (specify)</td>
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<td>(a) No livestock owned</td>
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<td>कोई खेत के पास नहीं है।</td>
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<td>(b) Cows/ Buffaloes</td>
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<td>(c) Sheep/ Goats</td>
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<td>(d) Poultry</td>
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<td>4 Nos. कितने=</td>
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<td>(e) Camels</td>
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<td></td>
<td>(f) Others (specify)</td>
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<td>क्या आपके पास स्वामी</td>
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<td>क्या खेतियों के सिरे</td>
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<td>कोई भाग नहीं है</td>
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<td>कीहित है ? अगर है , तो बताईं</td>
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<td></td>
<td>a) One…………1</td>
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<td>दो………2</td>
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<td>© More than two……..3</td>
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<td>15</td>
<td>How many crops do you</td>
<td></td>
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<td>harvest in a year?</td>
<td></td>
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<td>आपके हाथ में जितने</td>
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<td>खेत लेने का कारण है</td>
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<td>कीहित है ? अगर है , तो बताईं</td>
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<td></td>
<td>(a) One…………1</td>
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<td>(b) Two………2</td>
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<td>© More than two……..3</td>
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<td>16</td>
<td>Is irrigation water</td>
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<td></td>
<td>supply available to your</td>
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<td>land? क्या आपके खेत के</td>
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<td>सिरे से बारे पर आवारित</td>
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<td>कीहित है ? अगर है , तो बताईं</td>
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<td>Yes है से जाएगा</td>
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<td></td>
<td>No नहीं………………2</td>
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<td>17</td>
<td>IF No THEN, please</td>
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<td>state the source of water</td>
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<td>supply: क्या आपके खेत के</td>
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<td>सिरे से आपकी आवारित</td>
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<td>का खेत बताइं।</td>
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<td>(a) Dependence only on</td>
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<td>rainfall कितने बारे पर बनाया</td>
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<td>है तथा बारे पर करते हैं २</td>
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<td>(b) Personal groundwater</td>
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<td>bore well कितनी खेतियों बारे</td>
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<td>बेल=२</td>
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<td></td>
<td>(c) Common bore wells</td>
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<td>सामूहिक बेल=१२५</td>
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<td>बेल=२</td>
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<td>(d) Other (Please specify)</td>
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<td>बारे पर है से बताईं</td>
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<td></td>
<td>(a) No livestock owned</td>
<td>एक</td>
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<td>कोई खेत के पास नहीं है।</td>
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<td>(b) Cows/ Buffaloes</td>
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<td>(c) Sheep/ Goats</td>
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<td>(d) Poultry</td>
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<td>(e) Camels</td>
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<td>Questions and filters</td>
<td>Coding categories and codes</td>
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<tr>
<td>18</td>
<td>If yes, do you feel the quantity of water supplied is adequate for your needs? (READ OUT)</td>
<td>Yes हाँ</td>
<td>1</td>
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<td></td>
<td>No नहीं</td>
<td>2</td>
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<tr>
<td>19</td>
<td>On an average, what is your produce in a year: आपकी खेती में एक साल में उत्पादन कितना पैदावार होता है?</td>
<td>(a) Crop (specify)</td>
<td>quintals कितने कीमत</td>
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<td></td>
<td></td>
<td>(b) Crop (specify)</td>
<td>quintals कितने कीमत</td>
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<td></td>
<td></td>
<td>(c) Crop (specify)</td>
<td>quintals कितने कीमत</td>
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<td>20</td>
<td>How sure are you of what the quantity of your produce will be? (READ OUT)</td>
<td>(a) Very sure</td>
<td>1</td>
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<td></td>
<td></td>
<td>(b) Sure</td>
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<td></td>
<td></td>
<td>(c) Somewhat sure</td>
<td>3</td>
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<td></td>
<td></td>
<td>(d) Somewhat unsure</td>
<td>4</td>
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<tr>
<td></td>
<td></td>
<td>(e) Unsure</td>
<td>5</td>
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<tr>
<td></td>
<td></td>
<td>(f) Very Unsure</td>
<td>6</td>
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<tr>
<td>21</td>
<td>How do you sell your produce? (READ OUT)</td>
<td>(a) Self in Local Mandi स्वामी नाम की मंडी में खुद से</td>
<td>1</td>
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<td></td>
<td></td>
<td>(b) Through an intermediary वित्तीय मार्ग से द्वारा</td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td>(c) Other buyers अन्य खरीदार</td>
<td>3</td>
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<tr>
<td></td>
<td></td>
<td>(d) Don't sell my produce बेचते नहीं हैं</td>
<td>4</td>
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<tr>
<td>22</td>
<td>At an average what price do you get for your produce? (READ OUT)</td>
<td>(a) Govt. announced Minimum Support price सरकार द्वारा क्षेत्रीय मिथिला कीमत</td>
<td>1</td>
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<td>(b) Less than Minimum Support price न्यूतनत सब्जी कीमत से कम</td>
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<td></td>
<td>(c) More than Minimum Support price न्यूतनत सब्जी कीमत से ज्यादा</td>
<td>3</td>
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<tr>
<td>23</td>
<td>Do you feel mentally stressed in case of abnormal rainfall? (EXCESS OR LESS)</td>
<td>Yes हाँ</td>
<td>1</td>
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<td></td>
<td></td>
<td>No नहीं</td>
<td>2</td>
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<tr>
<td>24</td>
<td>IF YES THEN How much it bothers you? (READ OUT)</td>
<td>(a) Stresses me out to a very large extent बहुत ज्यादा निश्चित का विश्वास करता हूँ</td>
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<td></td>
<td></td>
<td>(b) Stresses me somewhat कुछ हद तक निश्चित का विश्वास होता है</td>
<td>2</td>
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<td></td>
<td></td>
<td>(c) Haven't given a thought to this इस बारे में नहीं सोचा है</td>
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<td>Q No.</td>
<td>Questions and filters</td>
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</table>
| 25    | Do you feel mentally stressed in case of abnormal temperature?                        | Yes ha ........................................................................1  
No Nhi.................................2                                                              | IF Coded 2 Then go to Q 27 |
| 26    | IF YES THEN How much it bothers you?  
अगर हो , तो आपको लिये किस हद तक निझरा का किस्मत होता है ?  
(READ OUT) | (a) Stresses me out to a very large extent  
यूल क्षिति निझरा का किस्मत  
(b) Stresses me somewhat कुछ हद तक निझरा का किस्मत  
(c) Haven't given a thought to this ऐसा बारे में नहीं सोचा है | 1  
2  
3 |
| 27    | What worries you more, variability in yield or variability in sale price?  
कौन सी बात आपको ज्यादा चिंता करती है : विक्रय का कम - ज्यादा होना या विक्रय मूल्य का कम - ज्यादा होना ? | (a) Variability in yield वेल्डार ने कम - ज्यादा होना  
(b) Variability in price कीमत में कम - ज्यादा होना  
(c) Both equally दोनों समान कम से | 1  
2  
3 |
| 28    | What is the amount of weather risk which you would want to hedge by paying for it?  
आप में ज्यादा चिंता निझरा का किस्मत का कितना हद तक चिंता करती है ? | (a) The entire weather risk हॉलिस संभवत यूल जिन्दिम  
(b) 75% of it  
(c) 50 % of it  
(d) 25 % of it  
(e) 10 % or less of it  
10 प्रतिशत या उससे कम | 1  
2  
3  
4  
5 |
| 29    | Are you aware of the earlier schemes like the Comprehensive Crop Insurance Scheme or the National Agricultural Insurance Schemes?  
क्या आप पूरी तरह से सम्बन्धित ज्ञान प्राप्त जिन्दिम कितना हद तक चिंता करते है से पैसे देकर कम करना चाहते हैं ? | Yes ha ............................................1  
No Nhi........................................2  
| 30    | If you have taken this scheme then what was your experience with the earlier schemes?  
अगर आप फासल कीमत भी योजना चिंता तो खराब योजना के साथ आपका अनुभव कैसा रहा है?  | (a) Not taken  
(b) Highly satisfied  
अत्यधिक संतुष्ट  
(c) Somewhat satisfied  
मध्यम संतुष्ट  
(d) Unsatisfied  
असंतुष्ट  
(e) Highly unsatisfied  
अत्यधिक असंतुष्ट | 1  
2  
3  
4  
5 |
<table>
<thead>
<tr>
<th>Q No.</th>
<th>Questions and filters</th>
<th>Coding categories and codes</th>
<th>Skip to</th>
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</thead>
<tbody>
<tr>
<td>31</td>
<td>Why were you not satisfied? क्योंकि कारण असुन्दृष्ट थे?</td>
<td>(a) Because of time taken in claim settlement क्योंकि लेने में लगा समय रहे</td>
<td>1</td>
</tr>
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<td></td>
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<td>(b) Because I felt that the ‘Area Approach’ was disadvantageous to me. मेरे लिए क्षमता है कि एक्षमता हमारे स्तर में नुसार है।</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Other reasons (please specify)</td>
<td>3</td>
</tr>
<tr>
<td>32</td>
<td>Are you aware of the Varsha Bima / Sookha Suraksha Kavach / Rabi Wheat Insurance Scheme introduced by the Agricultural Insurance Company in 2005? क्या आप वर्षा बिमा / सूखा सुरक्षा कवाच / राती जेल्हा बिमा स्वीकार के साथ आपका 2005 का अनुभव है?</td>
<td>Yes हां…………………………1 No नहीं………………………2</td>
<td>IF coded 2 then go to Q 41</td>
</tr>
<tr>
<td>33</td>
<td>Where did you learn about this scheme from? (MULTIPLE RESPONSE POSSIBLE) आपको इस योजना के बारे में कैसे सही रिपोर्ट किया है?</td>
<td>(a) TV टीवी</td>
<td>1</td>
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<td></td>
<td></td>
<td>(b) Newspaper न्यूपापर</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) From other farmers अन्य किसानों से</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Internet kiosks इंटरनेट किशोर</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) Other (please specify)</td>
<td>5</td>
</tr>
<tr>
<td>34</td>
<td>Did you ever subscribe to the scheme? क्या आपने कहीं इस योजना में निश्चित किया है?</td>
<td>Yes हां…………………………1 No नहीं………………………2</td>
<td>IF coded 2 then go to Q 41</td>
</tr>
<tr>
<td>35</td>
<td>What was your experience with Varsha Bima / Sookha Suraksha Kavach scheme? क्या वर्षा बिमा / सूखा सुरक्षा कवाच योजना के साथ आपका अनुभव कैसा रहा?</td>
<td>(a) Highly satisfied अत्यधिक सन्दृष्ट</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Somewhat satisfied गौरव सन्दृष्ट</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Unsatisfied असन्दृष्ट</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Highly unsatisfied अत्यधिक असन्दृष्ट</td>
<td>4</td>
</tr>
<tr>
<td>36</td>
<td>Why were you not satisfied? क्योंकि कारण असहित थे?</td>
<td>(a) Because of time taken in claim settlement क्योंकि लेने में लगा समय रहे</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Because I could not understand the procedures. मेरे लिए सम्बंधित प्रक्रियाओं को समझ न सका</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Other reasons (please specify)</td>
<td>3</td>
</tr>
<tr>
<td>37</td>
<td>What is your opinion of the modalities adopted for claim entitlement? क्या आपनी विश्वासित बताना चाहते हैं?</td>
<td>(a) Very clear and transparent सुस्त साफ और पारदर्शी</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Somewhat clear गौरव साफ</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Not clear सक्ता नहीं</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Feel that the process is grossly unfair हैं लंगता है कि पूरी प्रक्रिया नासक सक्ता नहीं</td>
<td>4</td>
</tr>
</tbody>
</table>
### Q No. Questions and filters

<table>
<thead>
<tr>
<th>Q No.</th>
<th>Questions and filters</th>
<th>Coding categories and codes</th>
<th>Skip to</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>If you are entitled to a claim then which of the following is correct? <em>(READ OUT)</em></td>
<td>(a) I was able to get the claim amount easily</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) The process took too long</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(c) I had to pursue the matter myself</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(d) Claim still not paid for over two months</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>39</td>
<td>For rainfall insurance, are you in agreement with the figure of rainfall on the basis of which claims were paid?</td>
<td>(a) In agreement</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) Felt it was slightly less</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(c) Felt it was much less</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(d) Felt it was more</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(e) Have not even given a thought to this</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>40</td>
<td>For rainfall insurance, what is your opinion of the amount of premium?</td>
<td>(a) Feel that it is too high</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) Feel that it is alright</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(c) Feel that it can be raised</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>41</td>
<td>If not insuring your crop, what is the reason for not doing so?</td>
<td>(a) Unaware of schemes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) Hassles of insuring</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(c) Lack of faith in such schemes</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(d) Lack of money for premium</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(e) Consider the premium too high</td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>42</td>
<td>Have you taken any type of loan in the last 3 years?</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>43</td>
<td>If you have outstanding loans, what is the reason for not returning the loan on time?</td>
<td>(a) No outstanding loan</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(b) Less yield of farm produce due to lack of rainfall</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(c) Less yield of farm produce due to excess rainfall</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(d) Other reasons (specify)</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Q No.</td>
<td>Questions and filters</td>
<td>Coding categories and codes</td>
<td>Skip to</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>----------------------------</td>
<td>---------</td>
</tr>
</tbody>
</table>
| 44    | Have any members of your family discontinued school / college education due to a tight monetary situation resulting from low farm yield? | Yes: ......................................1  
No: ......................................2 |         |
| 45    | Has a low farm yield resulted in tight monetary situations which affected health conditions in your family? | Yes: ......................................1  
No: ......................................2 |         |

I will now tell you about weather derivatives and how they could be structured to act as a hedging tool for farmers.

मैं अब आपको एक नयी योजना के बारे में बताकरं जो कि मौसम संबंधित जोखिम को कम करने में कामयाब होगी।

जैसा कि आपको माना है कृषि हवाई उपलब्ध कराने जलवायु पर निर्भर करता है। कम बारिश तथा ज्यादा तापमान उपलब्ध को प्रभावित करता है। कृषि उद्योग के बारे में आपको जानकारी होगी। इसलिए इसका इस्तेमाल पहले किया जा सकता है, उनके उपर स्टर उपयोगिता की जानकारी की अवधि होगी।

जलवायु कारक एक ऐसी योजना है जिसका द्वारा किसी का कम या ज्यादा वर्षा तथा तापमान से होने वाले दुष्प्रभावी परिस्थितियों से सही प्रतिक्रिया हो सकती है। उदाहरण के लिए यदि एक क्षेत्र के 3000 फीट उपयोग को लिए हैं और उस्तर 10% प्रति वर्ष में दर पर 30,000 की आमदनी होती है तो उस स्थिति में किसी क्षेत्र का कमर्च रणनीति एवं उच्चतम के तीन में 5000% प्रभाव का लागत अनुमानित है। किसी परिस्थितियों ने यदि अवसर 20 का प्रति सूचना के दर पर 4000% प्रभाव होगे। अत: उस क्षेत्र का दृश्य 3500% का लागू होगा। वर्षा और भी कम होने की स्थिति में फायदा और भी ज्यादा हो सकता है।

इस योजना के अन्य लाभ इस प्रकार हैं –
1) लेनदेन की सुविधा व सुलमान – दर का निर्धारण प्रतिदिन चौथाई पर उपलब्ध, इंटरनेट की सुविधा से किया जा सकता है।
2) खरीद एवं बिक्री आर्थिक है, एवं खेती करे, या न करे आप इस योजना का अभिध्युःवर्त हो सकते हैं।
3) शासकीय अंतरिक्ष प्रभाव युक्ततम है – इससे प्रभाव कम होगा।
4) प्रतिशत बचत ज्यादा यानी कि वेगर रिस्केंटिंग लगायें जायें।
5) जलवायू कारक एवं राजस्व में घुटनों या बेचने का समक्ष हो सकते हैं एवं किसी भी सूचना के अलावा दूसरे व्यापारी या कमनियाँ में इसे खरीदना या बेचना चाहिए। उदाहरण के लिए शीतल पेय कम्पनी जलवायु कारण बीच का इस्तेमाल कम वर्षा होने के लिए कम करने पर देंगे जबकि किसी ज्यादा वर्षा के लिए खरीदेंगे। अत: मौसम रिस्केंटिंग का प्रभाव कम होने की सम्भावना है।

viii
46. Do you think weather derivatives as explained could help in relieving financial stress? (READ OUT)

(a) Would help to a very large extent
(b) Would help to a fair extent
(c) Would help marginally
(d) Might not help
(e) Am sure will not help

47. Why you feel so?

48. Which weather factor worries you the most as being detrimental to your crop yield? (READ OUT/SINGLE CODE)

(a) Higher than normal Rainfall
(b) Lower than normal Rainfall
(c) Higher than normal Temperature
(d) Lower than normal Temperature

49. If you were to go in for weather derivatives, you would opt for a hedge against?

(a) Temperature variations
(b) Rainfall variations
(c) A mix of temperature and rainfall
(d) Other pls. Specify

50. You would want to hedge against low rainfall only if it is?

(a) 10% below normal
(b) 20% below normal
(c) 30% below normal
(d) Only when it is 50% or less below normal

51. You would want to hedge against high temperature only if it is?

(a) 2% above normal
(b) 5% above normal
(c) 10% above normal
(d) Only when it is 15% or more above normal

The farmers are explained that for the purpose of this study, we have identified five stages where weather effects could play a role in the yield of the crop: (i) Sowing, (ii) germination stage (iii) vegetative growth stage, (iv) grain formation stage, (v) harvesting.

The farmers are asked to indicate impacts that they have experienced in the past few years to the crop yield, which they can attribute to weather factors.

The purpose of this study is to identify the impact of weather on crop yield at different stages of growth.
<table>
<thead>
<tr>
<th>Q No.</th>
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</thead>
<tbody>
<tr>
<td><strong>Q 52</strong></td>
<td>In the sowing stage (READ OUT) कुआई के समय</td>
<td><strong>Factor</strong></td>
<td><strong>Extent to which yield was affected negatively</strong> फ़िल्म हट तक खेती पर खराब असर हुआ।</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>किस हद तक खेती पर खराब असर हुआ।</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) Excess Rainfall उच्च धावियाँ</td>
<td>Very high बहुत ज्यादा</td>
</tr>
<tr>
<td></td>
<td></td>
<td>काम बाधियाँ</td>
<td>high ज्यादा</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Deficient Rainfall कम धावियाँ</td>
<td>to some extent कुछ हद तक</td>
</tr>
<tr>
<td></td>
<td></td>
<td>कम बाधियाँ</td>
<td>Negligible न के बाहर</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) High temperatures उच्च तापमान</td>
<td>1 2 3 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ज्यादा तापमान</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Low temperatures कम तापमान</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>कम तापमान</td>
<td></td>
</tr>
</tbody>
</table>

| **Q 53** | In the germination stage: (READ OUT) पीछे निकलने के समय | **Factor** | **Extent to which yield was affected negatively** फ़िल्म हट तक खेती पर खराब असर हुआ। |
|       |                        | (a) Excess Rainfall उच्च धावियाँ | Very high बहुत ज्यादा |
|       |                        | काम बाधियाँ | high ज्यादा |
|       |                        | (b) Deficient Rainfall कम धावियाँ | to some extent कुछ हद तक |
|       |                        | कम बाधियाँ | Negligible न के बाहर |
|       |                        | (c) High temperatures उच्च तापमान | 1 2 3 4 |
|       |                        | ज्यादा तापमान | |
|       |                        | (d) Low temperatures कम तापमान | |
|       |                        | कम तापमान | |

| **Q 54** | In the vegetative growth stage: (READ OUT) पीछे से बढ़ने के समय | **Factor** | **Extent to which yield was affected negatively** फ़िल्म हट तक खेती पर खराब असर हुआ। |
|       |                        | (e) Excess Rainfall उच्च धावियाँ | Very high बहुत ज्यादा |
|       |                        | काम बाधियाँ | high ज्यादा |
|       |                        | (f) Deficient Rainfall कम धावियाँ | to some extent कुछ हद तक |
|       |                        | कम बाधियाँ | Negligible न के बाहर |
|       |                        | (g) High temperatures उच्च तापमान | 1 2 3 4 |
|       |                        | ज्यादा तापमान | |
|       |                        | (h) Low temperatures कम तापमान | |
|       |                        | कम तापमान | |

| **Q 55** | In the grain formation stage: (READ OUT) चामन बनाने के समय | **Factor** | **Extent to which yield was affected negatively** फ़िल्म हट तक खेती पर खराब असर हुआ। |
|       |                        | (i) Excess Rainfall उच्च धावियाँ | Very high बहुत ज्यादा |
|       |                        | काम बाधियाँ | high ज्यादा |
|       |                        | (j) Deficient Rainfall कम धावियाँ | to some extent कुछ हद तक |
|       |                        | कम बाधियाँ | Negligible न के बाहर |
|       |                        | (k) High temperatures उच्च तापमान | 1 2 3 4 |
|       |                        | ज्यादा तापमान | |
|       |                        | (l) Low temperatures कम तापमान | |
|       |                        | कम तापमान | |
## Questions and filters

**In the harvesting stage:**

(READ OUT)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Extent to which yield was affected negatively</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very high</td>
</tr>
<tr>
<td>(m) Excess Rainfall</td>
<td>1</td>
</tr>
<tr>
<td>(n) Deficient Rainfall</td>
<td>1</td>
</tr>
<tr>
<td>(o) High temperatures</td>
<td>1</td>
</tr>
<tr>
<td>(p) Low temperatures</td>
<td>1</td>
</tr>
</tbody>
</table>

### The farmers are now explained the fact that if they can identify critical periods, and buy weather derivatives only for those periods, it would be a cheaper proposition

The farmers are now explained the fact that if they can identify critical periods, and buy weather derivatives only for those periods, it would be a cheaper proposition.

### Would you prefer to buy weather derivative cover for specific periods, or would that be too much of a hassle to keep track of?

- (a) Would very much prefer specific period derivatives
- (b) Would prefer specific period derivatives
- (c) Would prefer season based derivatives
- (d) Would very much prefer season based derivatives
- (e) Would be indifferent

### More specifically, what choice of periods of weather derivatives (start to time of expiry) would you prefer:

- (a) 1 week
- (b) 15 days
- (c) 30 days
- (d) 45 days
- (e) 60 days
- (f) 90 days

### Skip to

<table>
<thead>
<tr>
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</thead>
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<tr>
<td>56</td>
<td>In the harvesting stage: (READ OUT)</td>
<td>Factor</td>
<td>Extent to which yield was affected negatively</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(m) Excess Rainfall</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(n) Deficient Rainfall</td>
<td>1</td>
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<td>(o) High temperatures</td>
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<td></td>
<td></td>
<td>(p) Low temperatures</td>
<td>1</td>
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<tr>
<td>Questions and Alternatives</td>
<td>Coding categories and codes</td>
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</tr>
<tr>
<td>Would you be interested in hedging risks related to the date of arrival of the monsoon? This would be in the form of a weather derivative with NO payment if the monsoon arrives on or before a pre-specified date and with proportional payout (with a limit) depending on how many days late the monsoon arrives.</td>
<td>(a) Would be interested triggered by a pre-fixed level of the index with a Yes/No type of payment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What kind of a payout would you prefer?</td>
<td>(b) Would not be interested</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) Less than 2 km.</td>
<td>(c) Less than 2 km.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) 2-5 km.</td>
<td>(d) 2-5 km.</td>
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<tr>
<td>(c) 5-10 km.</td>
<td>(e) Does not make a difference</td>
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<tr>
<td>(d) 10-25 km.</td>
<td>(f) Does not make a difference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e) Does not make a difference</td>
<td>(g) Does not make a difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Weather recording stations:
- Government weather recording stations
- Private weather recording stations
- Would not make a difference*
<table>
<thead>
<tr>
<th>Q No.</th>
<th>Questions and filters</th>
<th>Coding categories and codes</th>
<th>Skip to</th>
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</thead>
<tbody>
<tr>
<td>63</td>
<td>You could, theoretically, buy Weather Derivatives either as an individual or in groups. Which would you prefer: आप चिंतात्मक रूप से मौसम संबंधित उद्देश्य अभियान को अकेले खरीद सकते हैं या सामूहिक रूप से मिल कर खरीद सकते हैं। आप कौन सा पसर करेंगे? (READ OUT)</td>
<td>(a) buying weather derivatives as an individual मौसम संबंधित उद्देश्य अभियान को खरीद करना</td>
<td>1</td>
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<td></td>
<td>(b) buying weather derivatives in small, self-formed groups मौसम संबंधित उद्देश्य अभियान की खरीदारी छोटे समूह में करना</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(c) buying weather derivatives as cooperatives at the village level मौसम संबंधित उद्देश्य अभियान की खरीदारी सहकारी या ग्रामीण स्तर पर करना</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) buying weather derivatives as cooperatives at the block level मौसम संबंधित उद्देश्य अभियान की खरीदारी ब्लॉक / मंडल स्तर पर करना</td>
<td>4</td>
</tr>
<tr>
<td>64</td>
<td>Crop insurance and weather derivatives could be provided both by private agencies and by the government. Which options in your village, according to you, would be best for providing hedging against weather related risks कृषि बीमा और मौसम संबंधित उद्देश्य अभियान द्वारा आपको सरकार द्वारा दी जाने वाला मौसम संबंधित उद्देश्य अभियान द्वारा दी जाने वाला मौसम संबंधित उद्देश्य अभियान</td>
<td>(READ OUT/SINGLE CODE)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(a) Only government insurance schemes / weather derivatives offered by the government सरकार द्वारा दी जाने वाला मौसम संबंधित उद्देश्य</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) Both government and private agencies’ offered insurance schemes / weather derivatives सरकार द्वारा और व्यापारिक उद्देश्य अभियान द्वारा</td>
<td>2</td>
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<tr>
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<td></td>
<td>(c) Only private agencies’ offered insurance schemes / weather derivatives व्यापारिक उद्देश्य अभियान द्वारा</td>
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<tr>
<td></td>
<td></td>
<td>1 Go to Scenario 1</td>
<td>Go to Scenario 2</td>
</tr>
</tbody>
</table>
## VALUATION SECTION

### Scenario 1: (Only government schemes)

1. **You have chosen a scenario with only government schemes because:**
   - (a) You have more faith in government schemes
   - (b) Private players may look for too much gains for themselves
   - (c) Private agencies may not be able to survive in the market
   - (d) Other reasons (Please specify)

2. **If you were to insure your crop or purchase weather derivatives for an amount of Rs 1000, a premium or charge would have to be paid for this. We will now read out some premiums to you. Please tell us if you will be willing to pay this amount.**
   
   (Note: You can insure/purchase weather derivatives for more than Rs 1000 – the premium would be for each Rs 1000 insured)

   - (a) You would be willing to pay Rs 100 for Rs 1000 covered
   - (b) You would be willing to pay Rs 80 for Rs 1000 covered
   - (c) You would be willing to pay Rs 50 for Rs 1000 covered
   - (d) You would be willing to pay Rs 30 for Rs 1000 covered
   - (e) You would be willing to pay Rs 20 for Rs 1000 covered

<table>
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<tr>
<th>Premium</th>
<th>Yes/No</th>
<th>Proceed to</th>
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<tr>
<td>Rs 100</td>
<td></td>
<td>(b)</td>
</tr>
<tr>
<td>Rs 80</td>
<td></td>
<td>(c)</td>
</tr>
<tr>
<td>Rs 50</td>
<td></td>
<td>(d)</td>
</tr>
<tr>
<td>Rs 30</td>
<td></td>
<td>(e)</td>
</tr>
<tr>
<td>Rs 20</td>
<td></td>
<td>(e)</td>
</tr>
</tbody>
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**Note:**
- Yes = 1
- No = 2
- IF YES, go to Q 3.
- IF NO, then proceed to next premium.

---

**xv**
| 3 | What is the maximum number of Rupees per month (in total) that you would be willing to pay for insuring your crop or purchasing weather derivatives? | Rs. ___________ |
### Scenario 2: (Both government as well as private schemes)

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<td>(a) Both government and private agencies should be allowed to compete equally</td>
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<td>(b) Entry of private agencies would bring down premiums</td>
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<tr>
<td></td>
<td>(c) You have equal faith in private players and the government</td>
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<td></td>
<td>(d) Other reasons (Please specify)</td>
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<tr>
<td>2</td>
<td>(a) You would be willing to pay only equal premiums for both types of schemes</td>
</tr>
<tr>
<td></td>
<td>(b) You would be willing to pay more for government schemes</td>
</tr>
<tr>
<td></td>
<td>(c) You would be willing to pay more for private agencies' schemes</td>
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</table>
If you were to insure your crop or purchase weather derivatives for an amount of Rs 1000, a premium or charge would have to be paid for this. We will now read out some premiums to you. Please tell us if you will be willing to pay this amount. (Note: You can insure/purchase weather derivatives for more than Rs 1000 – the premium would be for each Rs 1000 insured)

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<thead>
<tr>
<th>Premium</th>
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<tr>
<td>Rs 100 for Rs 1000 covered</td>
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<td>No</td>
</tr>
<tr>
<td>Rs 80 for Rs 1000 covered</td>
<td>Yes</td>
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</tr>
<tr>
<td>Rs 50 for Rs 1000 covered</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rs 30 for Rs 1000 covered</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rs 20 for Rs 1000 covered</td>
<td>Yes</td>
<td>No</td>
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</tbody>
</table>

What is the maximum number of Rupees per month (in total) that you would be willing to pay for insuring your crop or purchasing weather derivatives?

<table>
<thead>
<tr>
<th>Maximum Number of Rupees</th>
<th>Rs</th>
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</thead>
</table>

xvii
Scenario 3: (Only private agencies)

1. You have chosen a scenario with only private agencies' schemes because:

   (a) You have more faith in private agencies' schemes
   (b) Private agencies would be able to offer more innovative schemes
   (c) Private agencies would be able to offer schemes at lower premiums
   (d) Other reasons (Please specify)

(READ OUT)

2. If you were to insure your crop or purchase weather derivatives for an amount of Rs 1000, a premium or charge would have to be paid for this. We will now read out some premiums to you. Please tell us if you will be willing to pay this amount. (Note: You can insure/purchase weather derivatives for more than Rs 1000 - the premium would be for each Rs 1000 insured)

   (a) You would be willing to pay Rs 100 for Rs 1000 covered
   (b) You would be willing to pay Rs 80 for Rs 1000 covered
   (c) You would be willing to pay Rs 50 for Rs 1000 covered
   (d) You would be willing to pay Rs 30 for Rs 1000 covered
   (e) You would be willing to pay Rs 20 for Rs 1000 covered

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (b)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (c)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (d)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (e)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (f)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (g)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (h)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (i)

   Yes ha............ 1
   No nahi.......... 2
   IF NO, then proceed to (j)

   Yes ha............ 1
   No nahi.......... 2

   IF YES, go to Q 3.
| 3 | What is the maximum number of Rupees per month (in total) that you would be willing to pay for insuring your crop or purchasing weather derivatives? | Rs ___________________ |
## Appendix I

**Data for rainfall and soyabean production: Jhalawar**

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<tr>
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<th>YIELD (t/ha)</th>
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<tr>
<td>3</td>
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<td>4</td>
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<td>1987</td>
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<td>1988</td>
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<td>8</td>
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<td>1990</td>
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<td>10</td>
<td>1991</td>
<td>0.549</td>
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<td>11</td>
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<td>1993</td>
<td>1.390</td>
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<td>13</td>
<td>1994</td>
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<tr>
<td>14</td>
<td>1995</td>
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<td>15</td>
<td>1996</td>
<td>0.836</td>
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<td>1997</td>
<td>1.230</td>
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## REGRESSION: YIELD vs TIME

### Regression Statistics

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### ANOVA

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### Coefficients

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### RESIDUAL OUTPUT

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**Summary**

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**MSP DATA**

<table>
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<th>WPI</th>
<th>MSP soya</th>
<th>MSP inflated to 2004</th>
<th>$f=St/So-1$</th>
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<td>YEAR</td>
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<td>MSP soya</td>
<td>MSP inflated to 2004f=St/So-1</td>
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<td>---</td>
<td>------</td>
<td>----------</td>
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<td>1124.36004</td>
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<td>965.105392</td>
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<td>885</td>
<td>933.282372</td>
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<td>23</td>
<td>2004</td>
<td>1226.131</td>
<td>930</td>
<td>929.999998</td>
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**Summary**

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<th>Value</th>
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<td>Mean</td>
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<tr>
<td>Standard Error</td>
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<tr>
<td>Median</td>
<td>-0.00673678</td>
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<td>Standard Deviation</td>
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<tr>
<td>Count</td>
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</table>
Appendix II

THE STUDY AREA

Rajasthan agriculture

A significant portion of the economy of Rajasthan is agrarian. The agricultural sector of the state accounts for 22.5 per cent of the GDP. The arid state thrives on agriculture that is done with irrigation systems and painstaking efforts of the poor farmers of Rajasthan. As a major portion of the state is parched and infertile, agriculture becomes very difficult.

The total cultivated area of the state encompasses about 20 million hectares and out of this only 20% of the land is irrigated. Ground water is available only at a depth of 30 to 61m. Rajasthan farmers have to depend on different sources of irrigation that include tube wells, wells and tanks. The Punjab Rivers in the north, the Narmada River in the south and the canals from Haryana and Uttar Pradesh provide water to the dry land of Rajasthan. Northwestern Rajasthan is irrigated by the Indira Gandhi Canal.

Rajasthan has two principal crop seasons-
- Rabi
- Kharif

The rabi crops are winter crops and are sown in the months of October and November and are harvested in the months of March and April. The principal rabi crops are wheat, gram, and pulses.

The kharif crops are the crops that are grown in the summer season and are seeded in the months of June and July. These crops are harvested in the months of September and October and include soyabean, bajra, pulses, jowar, maize and ground nuts.

The regions that are highly irrigated or receive abundant water supply are utilized for the cultivation of improved high-yielding varieties of rice.

Some places in Rajasthan see the growth of major cash crops like cotton. In some regions tobacco is also grown.

Apart from these crops, an assortment of fruits and vegetables are also grown in Rajasthan in the local gardens and some fertile regions. These fruits include oranges, guavas, lemon, pomegranates and mangoes.

Rajasthan soil is also suited for the growth of some spice plants, especially red chilies. Other spices grown are cumin seeds and methi. (See Figure 1)
Districts selected for the study

Jhalawar

Area
- 6,219 sq. km. (1.82 per cent of the state).

Location
Jhalawar district is situated in the south-east corner of Rajasthan at the edge of Malwa plateau. On the south-west and east it touches the border of Madhya Pradesh State. In the north, the Mukandra range, running from north-west to east forms a rough boundary between the two districts viz. Jhalawar and Kota.

Distance from major cities
- Jaipur-330 kms.
- Kota-85 kms.
- Delhi-584 kms.

Climate and rainfall
- The minimum temperature in the district varies from 1 to 5 degrees.
- Maximum temperature in the district varies from 43 to 47 degrees.
- The normal annual rainfall in the district is 104.47 cm.
Administrative setup

There are three sub-divisions, Jhalawar, Aklera, Bhawani Mandi. There are six panchayat samities Jhalrapatan, Khanpur, Pirwa, Manohar Thana, Dag and Bakani, six towns and 1,589 villages in the district.

Human resources

Table 1 Indicators of human resources

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
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<tbody>
<tr>
<td>Population</td>
<td>11,80,342</td>
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<tr>
<td>Density of population</td>
<td>190</td>
</tr>
<tr>
<td>Literacy</td>
<td>57.98</td>
</tr>
<tr>
<td>Working Population</td>
<td>38.00</td>
</tr>
<tr>
<td>Percentage distribution of work force</td>
<td></td>
</tr>
<tr>
<td>Cultivators</td>
<td>63.02</td>
</tr>
<tr>
<td>Agricultural labourers</td>
<td>19.19</td>
</tr>
<tr>
<td>Servicing and repairs</td>
<td>1.39</td>
</tr>
<tr>
<td>Other works</td>
<td>16.40</td>
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</table>

Major crops and their production

Table 2 Production: 2004-05 (Tonnes)

<table>
<thead>
<tr>
<th>Crop</th>
<th>Production (Tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>1,61,160</td>
</tr>
<tr>
<td>Maize</td>
<td>67,290</td>
</tr>
<tr>
<td>Gram</td>
<td>15,010</td>
</tr>
<tr>
<td>Jowar</td>
<td>15,010</td>
</tr>
<tr>
<td>Paddy</td>
<td>660</td>
</tr>
<tr>
<td>Bajra</td>
<td>90</td>
</tr>
</tbody>
</table>

Infrastructure

Water

As the ground water is available at a depth of 15 to 20 metres, drinking water does not pose any problem. The medium size irrigation projects in the district are Bhim Sagar Project, Champi Dam and Harish Chandra Sagar Project.

Road transport

Almost all the towns and most of the important places are well connected with the district headquarters. The Jaipur-Bhopal National Highway also passes through Jhalawar. The total length of different category of roads in the district was 1,360 km as of March 2000. (Source: www.rajasthan.gov.in )

Tonk

Area

- 7,194 sq.km. (2.1 per cent of the state).
Location
It is bound in the north by Jaipur, in the east by Sawai Madhopur, in the south by Bundi and Bhilwara districts and in the west by Ajmer district.

Distance from major cities
- Jaipur-82 kms
- Delhi-359 kms
- Ahmedabad-707 kms
- Mumbai-1,258 kms

Climate and rainfall
- The climate of the district is generally dry except in the short south-west monsoon season.
- Maximum temperature in winter is 22 degrees Celsius
- Minimum temperature in winter is 8 degrees Celsius
- Maximum temperature in summer is 45 degrees Celsius
- Minimum temperature in summer is 26 degrees Celsius
- The average annual rainfall in the district: 61.36 cms.

Administrative set up
The Tonk district at present has two sub-divisions viz. Tonk and Malpura, comprising six tehsils and six panchayat samities.

Resources human
Table 3 Indicators of human resources

<table>
<thead>
<tr>
<th>Total population</th>
<th>persons</th>
<th>12,11,343</th>
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</thead>
<tbody>
<tr>
<td>Density of population</td>
<td>persons per sq.km.</td>
<td>168</td>
</tr>
<tr>
<td>Literacy</td>
<td>per cent</td>
<td>52.39</td>
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<tr>
<td>Total working population</td>
<td>per cent</td>
<td>35.97</td>
</tr>
<tr>
<td>Percentage distribution of work force</td>
<td>per cent</td>
<td></td>
</tr>
<tr>
<td>Cultivators</td>
<td>per cent</td>
<td>59.93</td>
</tr>
<tr>
<td>Agricultural labourers</td>
<td>per cent</td>
<td>12.06</td>
</tr>
<tr>
<td>Household industry manufacturing, processing servicing and repairs</td>
<td>per cent</td>
<td>2.55</td>
</tr>
<tr>
<td>Other workers</td>
<td>per cent</td>
<td>25.46</td>
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</table>

Major crops and their production
Table 4 Production: 2004-05 (Tonnes)

<table>
<thead>
<tr>
<th>Crops</th>
<th>Production</th>
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</thead>
<tbody>
<tr>
<td>Jowar</td>
<td>17,880</td>
</tr>
<tr>
<td>Bajra</td>
<td>53,710</td>
</tr>
<tr>
<td>Maize</td>
<td>14,660</td>
</tr>
<tr>
<td>Groundnut</td>
<td>5,570</td>
</tr>
<tr>
<td>Guar seed</td>
<td>3,320</td>
</tr>
<tr>
<td>Wheat</td>
<td>1,69,040</td>
</tr>
<tr>
<td>Barley</td>
<td>9,770</td>
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</table>
Infrastructure

Water
Wells and tanks are the main source of irrigation, seasonal rivers in district are Banas, Mahi, Daian, Sohadra and Bandi. These help the cultivators irrigate their lands either by using the stored water in tanks or by lifting water. The depth of underground water in the district is reported between 2 mtrs. in Niwai to 16.25 mtrs. in Tonk.

Road Transport
The total road length of Tonk district is 1,105 kms. National Highway No.12 (Jaipur-Jabalpur) passes through Niwai, Tonk and Deoli panchayat samitis for a distance of 111 kms. Road length in the district was 1,770 km. as on 31 March 2000.

Figure 2 District map of Rajasthan
(Source: www.rajasthan.gov.in)

Villages selected for the study

i) Salawad. This village, with a population of 1429 (Census, 2001), is located in Tehsil Jhalrapatan in District Jhalawar, 15 Km South of Jhalawar town. Of this, 720 are males and the number of children below 6 years of age is 260. The literacy level is close to 50% (Census, 2001).

ii) Donda. Village Donda also lies in the same Tehsil in Jhalawar district, 12 Km south of Jhalawar town. Its population is 1537, of which, the male population is 793 and the number of children is 258. The literacy level is 44% (Census, 2001).

iii) Khanpuriya. Khanpuriya village in the Jhalrapatan tehsil of Jhalawar district has a population of 1070 of which 562 are male and 166 are children below the age of 6
years. It is located 10 Km SW of Jhalawar town. The literacy level in the village is close to 65%.(Census, 2001).

iv) **Deopura.** This village is in the Tonk tehsil of district Tonk. Located 10 Km from Tonk town, near Soran village, it has a population of 1040, with a male population of 543. The number of children, below 6 years, is 205. The literacy level is 35%. (Census, 2001).

v) **Chandlai.** Village Chandlai is in the same tehsil in Tonk district, 8 Km south of Tonk town. With a population of 1528, it has 814 males and 300 children. The level of literacy is less than 38%. (Census, 2001).

vi) **Soothra.** Village Soothra is located in tehsil Uniara of district Tonk on the SawaiMadhopur Road near Dhikoliya Mor, 30 Km SE of Tonk. Its population is 2608, of which 1375 are males. The number of children below the age of 6 years is 500 and the literacy level is slightly less than 30% (Census, 2001).

**Figure 3. Map of Jhalawar district indicating villages surveyed**
Figure 4 Map of Tonk district indicating villages surveyed
Appendix III

RESULTS OF MONTE-CARLO SIMULATIONS ON INCOME FROM PUT OPTION

TAking strike as mean of rainfall values

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<tr>
<td>Median</td>
<td>0</td>
</tr>
<tr>
<td>Mode</td>
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<tr>
<td>Standard Deviation</td>
<td>242.1291</td>
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<td>Sample Variance</td>
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</tr>
<tr>
<td>Kurtosis</td>
<td>4.784049</td>
</tr>
<tr>
<td>Skewness</td>
<td>1.987161</td>
</tr>
<tr>
<td>Range</td>
<td>1473.687</td>
</tr>
<tr>
<td>Minimum</td>
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<td>Maximum</td>
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<tr>
<td>Sum</td>
<td>80697.44</td>
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<td>Count</td>
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Risk Simulation Histogram

Number of Iterations = 500  Random Number Seed = 0.2235
**Risk Simulation Cumulative Distribution**

Number of Iterations = 500  Random Number Seed = 0.2235

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<table>
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<td>0</td>
</tr>
<tr>
<td>200</td>
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<td>400</td>
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<td>600</td>
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<td>800</td>
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<td>1200</td>
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<tr>
<td>1400</td>
<td>0</td>
</tr>
<tr>
<td>1600</td>
<td>0</td>
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</table>

25, x

TAKING STRIKE AS 95% OF MEAN OF RAINFALL VALUES

<p>| | |</p>
<table>
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<tr>
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<tbody>
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<td><strong>Standard Error</strong></td>
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<td><strong>Mode</strong></td>
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<td><strong>Sample Variance</strong></td>
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<td><strong>Sum</strong></td>
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**Risk Simulation Histogram**

Number of Iterations = 500  Random Number Seed = 0.2709

![Histogram](image)

**Risk Simulation Cumulative Distribution**

Number of Iterations = 500  Random Number Seed = 0.2709

![Cumulative Distribution](image)