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Impact of crop insurance schemes (PMFBY and WBCIS) on risk minimization in Anantapur district of Andhra Pradesh, India

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Abstract
Agriculture is varied, diversified and prone to a variety of risks. Agricultural insurance is considered an important mechanism to effectively reduce the risk and increase income resulting from various manmade and natural events. This study investigated the impact of crop insurance schemes *viz.*, Pradhan Mantri Fasal Bima Yojana (PMFBY) and Weather based Crop Insurance Scheme (WBCIS) on risk minimization and determinants of farmers Willingness to Pay (WTP) for crop insurance in Anantapur District of Andhra Pradesh. Anantapur district comes under drought prone area and three stage stratified purposive cum random sampling design was adopted to select the sample of 120 farmers. The results from Simpson Diversification Index (SID) revealed that greater difference of diversification index between insured and non-insured farmers was observed in Kambadur mandal with the value of 0.73 for insured and 0.79 for non-insured. The results of Binary Logistic Regression showed that family size, accessibility to credit, annual income, access to information, awareness about the crop insurance schemes and extent of irrigation were the significant factors influencing the farmers about the insurance. These findings suggested that Crop insurance should cover the individual risk and also large scale awareness building programmes should be conducted with the collaboration of local banks and farmer groups to increase the coverage.

Keywords: Binary logistic regression, crop insurance, risk and Simpson diversification index

1. Introduction
Agriculture is spinal card of Indian economy. It is varied, diversified and prone to a variety of risks. Risk can be understood in terms of impact of uncertain outcome on the quantity or value of some economic variable, here, agricultural income, which can be segregated into production risks, marketing risks or price risks, financial & credit risks, Institutional risk, Technology risk and Personal risk. It is highly risky venture because of both uncertainty in crop production and volatility in prices. The devastation occurred in the agrarian economy due to the appearance of weather-induced natural disasters such as flood, cyclone, drought, hurricane and pest attacks very often inflict huge crop losses. (Raju and Chand, 2008) [12].
Provision of credit to agriculture sector has been one of the main concerns of policy planners in India since independence. The Government of India has taken many measures to reduce risk and impart greater resilience to agriculture. Agricultural insurance is considered an important mechanism to effectively reduce the risk and increase income resulting from various manmade and natural events. In India crop insurance has been subsidized by the central and state governments, managed by General Insurance Corporation (GIC) and delivered through rural financial institutions, usually tied to crop loans. After that the government has established a separate Agriculture Insurance Company with capital participation of GIC, the four public sector general insurance companies and NABARD.
Groundnut is an important oilseed crop grown in India and also an important agricultural export commodity. India is the second largest producer of groundnut in the world after China. In India, A.P is in 4th place in production with 883kg/ha. In Andhra Pradesh it is mainly cultivated in Anantapur. Maize is the third largest food crop in India. It is predominantly grown as rainfed crop in India. According to USDA world agricultural supply and demand estimates report, October 2018 maize production was forecasted 1068.30 million tonnes in 2018-19 in World. With this background, the focus of this study is to assess the impact of crop insurance schemes on risk minimization in Anantapur district of Andhra Pradesh.

2. Materials and Methods

Three stage stratified purposive cum random sampling design was adopted to select the sample. Anantapur district of Andhra Pradesh is purposively selected for the study because the district comes under drought prone area. Farmers experienced failures in crop production during the past years and highest number of farmers are covered under credit linked crop insurance scheme. Out of 63 mandals of Anantapur district, three mandals with maximum insurance coverage *viz*., Kalyandurg, Kambadur, Kanaganapalle and three mandals with low insurance coverage area *viz*., Hindupur, Lepakshi, Peddapappur were purposively selected. 12 villages were selected based on high and low insurance coverage area from each mandal under WBCIS and PMFBY. From each village, five insured and five non-insured farmers were selected randomly making a total sample size of 120 farmers. The number of farmers from each village were selected randomly. Ten farmers were personally interviewed from each village. The farmers who are cultivating Groundnut and Maize over the years were majorly interviewed.

Primary data was collected from farmers about different variables specified in schedule through personal interviews. Secondary data were collected from Agriculture Insurance Company (AIC) of India, different commercial banks in study area, Chief Planning Office (CPO) and Joint Director of Agriculture (JDA) office Anantapur district.

Simpson Index of Diversification (SID)

To assess the extent of crop diversification by sample farmers, SID was employed.

$$SID=1-\sum\left(\frac{a}{A}\right)^2$$

Where, a_j is the area under the j^{th} crop and A is the gross cropped area

It ranges between zero and one. If SDI is near Zero, it indicates that the zone or region is near to the specialization in growing of a particular crop and if it is close to one, in the zone is fully diversified in terms of crops (Basavaraj *et al*., 2016) [4].

Logit Analysis

A Binary Logit Regression Model was used to determine the factors that influence farmers' willingness to participate in crop insurance scheme. The use of Binary Logit Regression Model, which gives the maximum likelihood estimates, overcomes most of the problems associated with linear probability models and provides estimators that are asymptotically consistent, efficient and Gaussian. The Binary Logit Model based on the cumulative logistic probability function is computationally easier to use than the probit models and was used in this study (Pindyck and Rubinfeld, 1981) [11]. The theoretical model is given as follows. The cumulative logistic probability model is specified as:

$$\text{Ln}\,(P_i/(1-P_i) = \beta_0 + \beta_1 X_1 + \ldots\ldots\ldots + \beta_{10} X_{10} + e_i.$$

Where,

P_i = probability of farmer's adoption of agricultural insurance

$1 - P_i$ = probability of not adopting agricultural insurance

β_0 = intercept

β_i (1,2,3,…..10) = Regression coefficients,

X_i (1,2,3,…..10) = Independent variables

Ln(Pi/(1-Pi) = in log-odds ratio

e_i = error term.

The Binary Logit Model is used to determine the effect of the explanatory variables on farmers' willingness to participate in crop insurance schemes in Anantapur. The dependent variable is a binary variable representing the willingness to participate (1) and otherwise (0). Independent variables included are farmer socio-economic characteristics such as age, educational level, family size, household income, years of farming (experience), farm size, access to information, access to credit, use of alternate risk mitigation mechanisms, awareness regarding crop insurance schemes, contact with extension agents, subsidiary occupation and extent of irrigation. For this study, above equation is expressed implicitly as

$$WTI = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b10X10 + b11\ X11 + ui.$$

Where,

WTI = Willingness of the respondents to take insurance (1 if yes, 0 if no)

X_1 = Age of the farmer (years)

X_2 = Education level of farmer

X_3 = Farm size (hectares)

X_4 = Household size

X_5 = Farm income (Rs.)

X_6 = Farming experience of farmer (years)

X_7 = Accessibility to credit (if, yes=1 or no=0)

X_8 = Contact with the extension agents (if, yes=1 or no=0)

X_9 = Awareness about insurance policy (if, yes=1 or no=0)

X_{10} = Access to information (if, yes=1 or no=0)

X_{11} = Use of alternate risk mitigation mechanisms (if, yes=1 or no=0)

X_{12} = Extent of irrigation (if, yes=1 or no=0)

X_{13}= Subsidiary occupation (, yes=1 or no=0)

b_1, b_2 . . . b_{11} are parameters corresponding to estimated variables' coefficients. u_i is the error term and consists of unobservable random variables.

3. Results and Discussion

Agricultural risk is associated with the variables like outbreak of pest and diseases, climatic factors like drought, flood and storms and price risks which altogether are not within the control of farmers. Crop credit insurance also reduces the risk of becoming a defaulter of institutional credit.

3.1 Sources of information about risk mitigation measures to the non-insured farmers

From the Table.1, most of the farmers from both high insurance coverage area (30 percent) and low insurance coverage area (33.33 percent) were getting information about risk mitigation from implementing agency followed by agricultural department, 23.33 percent for both low insurance and high insurance coverage area (Kumar *et al*., 2011) [8].

Table 1: Source of information about risk mitigation measures to the non-insured farmers

S. No	Sources	High insurance coverage area		Low insurance coverage area	
		No. of respondents	Percent	No. of respondents	Percent
1	Dooradharshan	2	6.67	2	6.67
2	NGO	3	10.00	2	6.67
3	Newspapers	2	6.67	1	3.33
4	Money lenders	-	0.00	1	3.33
5	PACS	2	6.67	2	6.67
6	Advertisement Hoardings	-	0.00	-	0.00
7	Bank	3	10.00	2	6.67
8	Implementing Agency	9	30.00	10	33.33
9	Village Saba	2	6.67	3	10.00
10	Agriculture Department	7	23.33	7	23.33
	Total	30		30	

Source: Field survey data

3.2 Non-insured farmers perception on strategy to face losses

From the Table.2, when the non-insured farmers were asked about other source they would go when they suffer due to crop failure or other reason, majority of the high coverage non-insured farmers were taking credit from co-operative societies (30 percent) followed by friends and relatives (16.67 percent) and hypothecation of house or jewellery with 15 percent. For low coverage non-insured farmers, majority of the amount taken from both co-operatives societies with 26.67 and money lenders each with 23.33 percent followed by bank loan with 15 percent.

Table 2: Non - insured farmers' perception on strategy to face losses

S. No	Channel	High insurance coverage area		Low insurance coverage area	
		Frequency	Percent	Frequency	Percent
1	Sale of Fixed assets	2	6.67	2	6.67
2	Sale of Livestock	0	0.00	0	0.00
3	Friends/ Relatives	5	16.67	3	10.00
4	Bank loan	4	13.33	4	13.33
5	Money Lender	2	6.67	7	23.33
6	Government Relief	2	6.67	2	6.67
7	Co-operative Society	9	30.00	8	26.67
8	Offering land on Lease	1	3.33	-	0.00
9	Hypothecation of house/Jewellery	5	16.67	4	13.33
	Total	30		30	

Source: Field survey data

3.3 Extent of crop diversification by sample farmers

From the Table.3, it was observed that non-insured farmers practiced slightly more diversified crop combination than that by the insured farmers in all the mandals. Farmers following crop diversification as one of the risk coping mechanisms against the vagaries of monsoon. Incidentally, crop insurance effectively absorbed the production risk and played a significant role in encouraging the farmers to concentrate on a few profitable crops instead of spreading their limited resources across a number of crops. Simpson index of crop diversification were calculated for all the six mandals, pedhapappur mandal non-insured farmers has highest SDI of 0.86 as the farmers are growing more crops in the land. Greater difference of diversification index between insured and non-insured farmers was observed in Kambadur mandal with the value of 0.73 for insured and 0.79 for non-insured.

Table 3: Simpson index of crop diversification for selected mandals

S. No	Name of the Mandal		SDI
1	Hindupur	Insured	0.73
		Non-insured	0.74
2	Lepakshi	Insured	0.72
		Non-insured	0.79
3	Pedhapappur	Insured	0.81
		Non-insured	0.86
4	Kalyanadurgam	Insured	0.69
		Non-insured	0.71
5	Kambadur	Insured	0.73
		Non-insured	0.79
6	Knaganapalle	Insured	0.72
		Non-insured	0.74

Source: Field survey data

3.4 Factors Affecting the Farmers' Participation In Crop Insurance

The parameters of the binary logistic regression model were estimated using SPSS statistical package. In this model, the dependent variable is the farmers' willingness to pay (WTP) for crop insurance. The farmers who are willing to pay crop insurance are assigned a value of 1, and those who are not willing to pay are assigned a value of 0. In this model, thirteen independent variables are selected to identify the main factors affecting the farmers' WTP. The definition and expected sign of the coefficient are given in Table 4. The logistic regression model is as follows:

$$\text{Ln}\ (P_i/(1-P_i)) = \beta_0 + \beta_1 x_1 + \ldots + \beta_p x_p + e_i$$

Where, the dependent variable, Ln $(P_i/(1-P_i)$ log, in Equation is the log-odds ratio in favour of decision to participate in crop insurance and x_1, x_2,… x_p are the independent variables and e_i is the error term. The explanatory factors included; age, educational status, household size, farm size, farming experience, accessibility to credit, contact with extension agents, subsidiary occupation, annual income, access to information, awareness about crop insurance schemes, use of alternate risk mechanisms and extent of irrigation. The results show that family size, accessibility to credit, annual income, access to information, awareness about the crop insurance schemes and extent of irrigation are the significant factors influencing the farmers about the insurance.

Chi-square value (111.389) was significant at one percent level which indicates that well fit for the model. Cox and Snell-R^2 (0.605) is pseudo R^2 indicated moderately strong relationship for the model. Nagelkerke"s R^2 of 0.808 indicates a moderately strong relationship between prediction and grouping.

Family size was significant at one percent with a positive coefficient reveal that an increase in family size by one member will increase the probability of the farmer's willingness to participation. The result is consistent with the findings of Mohammed and Ortmann, (2005) [9] and large family size provides more labour for farm operation and an increased incentive to produce more output on farm. The farmer with large family size are willing to participate in crop insurance.

Access to credit by the farmers is significant at one percent and positive, indicates that the higher access to credit by the farmers, the higher their participation in agricultural insurance which was evident in response of most farmers that access to loans from banks is better facilitated when they have insurance cover and therefore, they subscribe to insurance scheme so as to increase their accessibility to loans. The result is consistent with similar study by Abdulmalik *et al.* (2013) [1].

Annual income was significant at five percent at and positively affects farmers' willingness to take insurance. Farmers with high farm income were to take insurance more readily than their low income counterparts. This could result from the fact that those who earn high income from their farm operations are likely to adopt other methods of risk management even at high cost, which their low income counterparts may not be able to afford.

Awareness about crop insurance schemes was found significant at five percent level of significance. As the level of the farmers about insurance increase, the probability of adoption also increases. This is in line with a priori expectations and consistency with previous studies (Akinola, 2014) [2].

Coefficient of extent of irrigation also showed significant results at five percent. Most of the farmers with irrigated lands had maximum area under cultivation. As risk mitigation mechanism farmers were taking crop insurance and share of irrigated area enhanced the probability of adoption (Kumar *et al*., 2011) [8].

Findings in Table.4, also indicate that age of the farmer, farm size and use of alternate risk mitigation mechanisms showed negative coefficient but they were not significant. This result is also consistent with the findings of who evaluated the use of alternate risk management strategies on crop insurance participation and found high farming experience contributed to their proficiency in utilizing technologies and alternative risk management approaches (Akinola, 2014) [2].

Table 4: Logit regression analysis to know the determinants of farmer's adoption in crop insurance schemes

S. No	Variable	Co-efficient	Standard error	Exp (B)
	Constant	-16.62	6.25	0.00
1	Age of the farmer	-0.04	0.18	0.96
2	Educational level of household head	0.11	0.48	1.11
3	Household size	1.16**	0.41	3.19
4	Farm size	-0.05	0.16	0.95
5	Experience in farming	0.002	0.16	1.00
6	Accessibility to credit	3.51**	1.42	33.38
7	Contact with the extension agents	1.01	1.31	2.99
8	Subsidiary occupation	0.56	0.93	1.75
9	Annual income	0.87*	0.42	2.38
10	Access to information	2.82#	1.56	16.72
11	Awareness about crop insurance schemes	4.04*	1.89	57.24
12	Use of alternative risk mechanisms	-0.82	1.23	0.44
13	Extent of irrigation	2.76*	1.24	15.79
	Chi-square		111.389**	
	Cox and Snell R square		0.605	
	Nagelkerke's R square		0.808	

Source: Field survey data

The log odds ratio (EXP (B)) is 33.38 for the access to credit indicated that farmers who have access to credit are 33.38 more ready to participate in crop insurance than those who do not have access to the credit. This is as predicted given the

existence of evidence to the effect that micro-credit plays an important role in promoting income generation activities among beneficiaries (Khadaker, 2005) [7]. Log odds ratio was 3.19 times as large for respondents who had large family than those who did not had. Therefore farmers who has large family size are participating more in crop insurance than who do not have. Log odds ratio of farmers‟ access to the credit increases their disposal income making them more likely to go for insurance cover. The effect of income on willingness to participate in the crop insurance market did not meet the a priori expectation that the higher the household income the more willing a farmer will be to participate in the crop insurance. The odd ratio of 2.38 indicated that farmers who have more annual income are 2.38 times more ready to participate in crop insurance. The odd ratio for experience in farming of 1.00 means that a unit increases in experience will have no effect on willingness to participate.

4. Conclusion

In Anantapur district, Farmers who do not have access to institutional credit could not participate in crop insurance. Farmers do not have full awareness about crop insurance schemes which is not sufficient to make them as beneficiaries. There observed much need to create full awareness among sample farmers. Farmers do not have full awareness about crop insurance schemes which is not sufficient to make them as beneficiaries. There observed much need to create full awareness among sample farmers. Amount of sum insured was not sufficient as it is not covering the losses completely mainly in case of groundnut than maize. Major constraints observed were delay in getting the compensation amount, lack of full knowledge about schemes and high premium rate. Crop insurance should cover the individual risk and all crops grown and large scale awareness building programmes should be conducted with the collaboration of local banks and farmer groups to increase the coverage.

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