Crop Insurance in India and Its Impact on Crop Income: Insights from Pigeon Pea Farmers

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Abstract

PMFBY is a highly subsidized and largest crop insurance scheme in the world. The study has examined the efficacy of insurance policies in India based on the secondary data collected from 2016-17 to 2022-23. Additionally, it uses primary data collected during Kharif 2022 across the Bidar district of Karnataka to assess the impact of PMFBY on input cost and income of pigeon pea farmers. The results revealed that the number of farmers enrollment is increasing whereas the insured area is decreasing every year across India under the insurance schemes. The ANOVA results revealed that the insured farmers significantly benefited under the scheme since they received higher claim amount than the premium paid by them during the reference period. Further, it was found that PMFBY positively impacts seed cost, weeding cost, pesticide cost, and land preparation cost. However, the impact on crop revenue and income is statistically insignificant.

Keywords: Crop insurance, Agricultural risk management, Input cost, Crop income

JEL Classification: Q12, Q14, Q18, Q19

Introduction

Indian agriculture is highly susceptible to the impact of climate change due to its heavy reliance on erratic weather patterns, which introduces significant production risks. Over the past decade, India witnessed a decline of 4.35 percent and 9.75 percent in agricultural productivity, primarily due to substantial variations in temperature and rainfall patterns respectively (GoI, 2018). Moreover, agricultural revenues are projected to experience a 15 percent to 18 percent annual decline due to climate change, it is increasing with unirrigated areas expected to face a steeper decline of 20 percent to 25 percent (GoI, 2018). This volatility in agricultural income disrupts farmers' livelihoods, making their income less predictable (Birthal et al., 2015). The resulting uncertainty often leads to increased indebtedness, reduced consumption, and migration among farmers. Therefore, increasing farmers' income is crucial for reducing rural poverty and ensuring food security in India. Crop insurance serves as a reliable risk transfer mechanism that safeguards farmers' revenue in the event of losses. Against this backdrop, to stabilize the farmers' income Government of India (GoI) introduced highly subsidized crop insurance schemes such as Pradhan Mantri Fasal Bima Yojana (PMFBY) and Restructured Weather Based Crop Insurance Scheme (RWBCIS) in *kharif* 2016 season. PMFBY is an area-based crop insurance; that

estimates yield loss for a designated area based on crop-cutting experiments (CCEs). Whereas under RWBCIS, the claims are being estimated based up on the deviation from the defined weather parameters. The premium paid by farmers remains consistent under both the schemes, regardless of the difference in method of claims calculation. For *Kharif*, the premium is 2 percent of the sum insured, for *Rabi* it is 1.5 percent of the sum insured for insuring all food grain and oilseed crops. For both the seasons, it is 5 percent of the sum insured for annual commercial/ horticultural crops (GoI, 2020). These schemes offer several advantages to farmers, including protection against crop loss, encouragement to undertake risky yet lucrative investments, provision of collateral, and regulation of consumption and income (Cole and Xiong, 2017). However, there is a paucity of literature that empirically assesses the impact of PMFBY on the cost and income of farmers. Therefore, this paper aims to 1) examine the coverage and financial performance of crop insurance in India and 2) analyze the impact of PMFBY on the operating cost and income of pigeon pea farmers in Karnataka.

Data Sources and Methodology

The study utilizes secondary and primary sources of data. The required secondary data has been collected from the Agricultural Statistics at a Glance 2017 to 2022, Ministry of Agriculture & Farmers Welfare, GoI. For primary data, a

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survey consisting of 406 farming households (203 insured & 203 uninsured) has been conducted by the authors in the Bidar district of Karnataka state, India. Pigeon pea is the primary crop of the district and has consistently maintained its top position in Karnataka in terms of average enrollment under PMFBY since its inception. The survey was undertaken between July and October 2022, specifically focusing on the *Kharif* season of 2021-22. To achieve the objectives, Analysis of Variance (ANOVA) and t-test techniques have been used.

Results and Discussion

Performance of *PMFBY* and *RWBCIS*

Table 1 presents year-wise physical and financial progress under PMFBY and RWBCIS from 2016-17 to 2022-23. It presents key metrics such as number of farmer applications (4512.59 lakhs), area insured (3370.81 lakh hectares), sum insured (Rs.13.77 lakh crore), farmers' premium paid (Rs.28132.98 crore), gross premium paid (Rs.1.92 lakh crore), paid claims (Rs.1.32 lakh crore), and outstanding claims (Rs.3858.27 crore). The number of farmers insured under the crop insurance schemes have shown a positive trend over the past seven years except 2017-18 (-8.59 percent) and 2022-23 (-10.22 percent). The overall annual growth rate is positive 31.05 percent. In contrast, the area covered has decreased with time, except for 2018–19. The overall annual growth is negative for the area insured. It indicates that a disproportionate growth between the area insured and farmers' participation. It may be due that farmers are insuring their crops lesser than the area sown. Several states, including Bihar, Telangana, Andhra Pradesh, Jharkhand, West Bengal, and Gujarat, have withdrawn from the PMFBY and RWBCIS schemes after participating for a period of time. This withdrawal has contributed to the decline in enrollment and insured area. The reasons behind these decisions vary, but they often involve concerns about the perceived level of risk and financial limitations (PIB, GoI, 2023).

As shown in Table 1, the sum insured amount is the highest among all other financial parameters. It is evident that the sum insured per lakh hectare has shown an overall upward trend over the years, indicating that the maximum assurance has been provided for each insured acre. A total of Rs. 13.77 lakh crore has been assured for 3370.81 lakh hectares. This upward trend may also be attributed to factors like increasing input costs and higher crop values. Corresponding to the increased sum insured, the gross premium and farmers' share in premium have also increased, indicating a growing financial burden on farmers. However, the farmers' premium is lesser than the gross premium and total claims. This is because of the very low farmers' premium rates under the scheme. As a result, farmers are highly benefited. Whereas gross premium is more than the total claims and claims paid over all the years, it indicates that the insurance companies also benefited under the scheme since the cost-benefit ratio

Table 1. Year-wise physical and financial progress under PMFBY & RWBCIS - Combined from 2016-2017 to 2022-23.

Year	Total Farmer Applications (In lakhs)	AGR (%)	Area Insured (In lakh hectares)	AGR (%)	Sum Insured (In Rs. Crore)	Sum Insured per lakh hectares (In Rs. Crore)	Farmers Share in Premium (In Rs. Crore)	Gross Premium (In Rs. Crore)	Total Claims (In Rs. Crore)	Paid Claims (In Rs. Crore)	Claims Outstanding (In Rs. Crore)
2016-17	581.74		564.00		201799.14	357.80	4085.09	21678.37	16795.46	16795.46	0
2017-18	531.77	-8.59	507.28	-10.06	201966.24	398.14	4171.99	24467.69	22068.44	22065.46	6.66
2018-19	581.93	9.43	532.01	4.88	235740.07	443.11	4694.30	29687.62	29191.12	28666.63	847.39
2019-20	616.16	5.88	508.44	-4.43	221561.20	435.77	4482.20	32329.16	27729.77	27359.73	562.2
2020-21	623.19	1.14	495.44	-2.56	199672.24	403.02	4045.36	31699.68	20835.10	20391.66	525.05
2021-22	831.37	33.41	459.01	-7.35	181096.74	394.54	3695.33	30196.97	16421.62	14906.42	1584.97
2022-23	746.43	-10.22	304.63	-33.63	134797.65	442.50	2958.71	22466.78	2439.19	2264.94	332
Total	**4512.59**	**31.05**	**3370.81**	**-53.15**	**1376633.28**	**408.40**	**28132.98**	**192526.27**	**135480.70**	**132450.30**	**3858.27**

Source: Agricultural Statistics at a Glance 2022.

Table 2. ANOVA results

Particulars	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	198092220368.874	5	39618444073.775	193.803	0.000
Within Groups	7359337212.999	36	204426033.694		
Total	205451557581.873	41			

Table 3. Multiple Least Significant Difference test results.

(I) Financial parameters	(J) Financial parameters	Mean Difference (I-J)	Sig.
Sum insured	Farmer's premium	192642.90	0.000
	Gross premium	169158.14	0.000
	Total claims	177307.51	0.000
	Paid claims	177740.42	0.000
	Claims outstanding	196110.71	0.000
Farmer's premium	Sum insured	-192642.90	0.000
	Gross premium	-23484.75	0.004
	Total claims	-15335.38	0.052
	Paid claims	-14902.47	0.059
	Claims outstanding	3467.81	0.653
Gross premium	Sum insured	-169158.14	0.000
	Farmer's premium	23484.75	0.004
	Total claims	8149.36	0.293
	Paid claims	8582.28	0.269
	Claims outstanding	26952.57	0.001
Total claims	Sum insured	-177307.51	0.000
	Farmer's premium	15335.38	0.052
	Gross premium	-8149.36	0.293
	Paid claims	432.91	0.955
	Claims outstanding	18803.20	0.019
Paid claims	Sum insured	-177740.42	0.000
	Farmer's premium	14902.47	0.059
	Gross premium	-8582.28	0.269
	Total claims	-432.91	0.955
	Claims outstanding	18370.29	0.022
Claims outstanding	Sum insured	-196110.71	0.000
	Farmer's premium	-3467.81	0.653
	Gross premium	-26952.57	0.001
	Total claims	-18803.20	0.019
	Paid claims	-18370.29	0.022

. The mean difference is significant at the 0.05 level.

is 0.70 (135480.70/192526.27) which is lesser than one. It is also found that the insurers have not settled Rs. 3858.27 crore over the past seven years. The outstanding claims indicates challenges in the claims settlement process, which need to be addressed to ensure timely and efficient delivery of benefits to farmers.

Further, to test the statistical difference among the means of financial parameters the ANOVA and Least significant difference (LSD) has been employed. The results of ANOVA

presented in Table 2 revealed a significant difference (F (5,36) = 193.80, p = 0.000) among the amount of insurance coverage (sum insured), the total premiums collected (gross premium), the total claims filed (total claims), the claims that have been paid (paid claims), and the amount of claims still outstanding (claims outstanding). Which financial parameter differs from which is unclear in the ANOVA results. Therefore, a post hoc LSD test was performed to do pairwise comparison for better understanding, the findings are also displayed in Table 3. The average of the sum insured is significantly more than all other financial parameters. Whereas the mean difference among farmers' premium, sum insured and gross premium is negative and significant. It implies that the farmers are paying a very minimal amount as a premium against the total amount of assurance and total gross premium. Over the past seven years, the average farmers' premium is lesser than the total claims and paid claims by Rs. 15335.39 and Rs. 14,902.47 crore respectively. It is indicated that while farmers do gain from the schemes, but the impact is statistically insignificant. The average of total claims refers to the amount of money that the insurers have to pay to farmers, which is significantly lower than the sum insured. This is not a cause for concern, as the amount of claims depends on the actual losses incurred. However, it is found that paid claims amount is insignificantly lesser than the total claims. Though the difference statistically insignificant the unsettled claims amount highlights potential issues with the timely settlement of claims under the insurance schemes.

Impact of PMFBY on Input Cost and Income

Table 4 presents a comparison of the operational costs per acre (in Rs.) between insured and uninsured pigeon pea farmers. The table provides a breakdown of different cost elements and their respective proportions in relation to the overall cost. The determination of statistical significance is accomplished through the use of a t-test.

The results show that the insured farmers significantly spend more on machine labor (tractor), t (404) = 3.070, p = 0.002. Whereas uninsured farmers spend on bullock labor for land preparation but the mean difference is statistically insignificant (t (404) = -0.811, p = 0.418). This indicates that insured farmers are using modern technology compared to uninsured for their cultivation of land. The total land preparation cost is significantly higher for insured farmers (M = 3111.87, 19.82 percent of total cost) compared to uninsured farmers (M = 2886.80, 20.33 percent of total cost), t (404) = 3.056, p = 0.002. Insured farmers have much higher seed expenses (M = 576.67, 3.67 percent of total cost) compared to uninsured farmers (M = 489.56, 3.45 percent of total cost), t (404) = 5.204, *p* < 0.001. This indicates that insured farmers are investing more on seed without having any moral hazard.

There are no notable disparities in the price of machine labor, bullock labor, and human labor for sowing between farmers who have insurance and those who do not. The

overall sowing costs do not show a significant difference between the insured group (M = 1095.57, 6.98 percent of total cost) and the uninsured group (M = 1032.51, 7.27 percent of total cost), t (404) = 1.717, p = 0.087.

The costs for fertilizer, manure, and human labor related to fertilization and manure application do not show any substantial differences between the two groups. The overall cost in this category does not exhibit any substantial variation. This clearly demonstrates that regardless of the risk coverage provided by the PMFBY, insured farmers are likely to use fertilizer and manure at a similar level as uninsured farmers.

Insured farmers spending Rs. 147.79 per acre more than the uninsured for bullock labor for removal of weed whereas the uninsured are spending more (Rs. 142.61/acre) on human labor on weeding activity. The overall weeding activity by bullock and human labor do not have a statistical difference between the groups. The weedicide expenses for insured farmers are much higher (M = 921.09, 5.87 percent of total cost) compared to uninsured farmers (M = 664.63, 4.68 percent of total cost), t (404) = 2.270, p = 0.024. It suggests that insured farmers rely on utilizing bullocks and applying weedicide instead of employing human labor for weed clearance, in contrast to uninsured farmers.

The proportion of pesticide cost to overall operational cost is highest among both the insured (26.32 percent) and uninsured (27.42 percent) groups. This shows that during the reference period, there was a higher incidence of disease and pest infestation on the pigeon pea crop, which can be attributed to the elevated cost of pesticides. While insured farmers spend approximately Rs.240 more than uninsured farmers, the disparity is not statistically significant.

Neither machine labor nor human labor costs for harvesting show significant differences between insured and uninsured farmers. The total harvesting costs are also not significantly different (insured: M = 2473.89, 15.75 percent of total cost; uninsured: M = 2269.68, 15.98 percent of total cost), t (404) = 1.188, p = 0.235.

Insured farmers incur an additional cost of Rs. 323.76 per acre for insurance, which is 2.06 percent of total cost. which is absent for uninsured farmers. It is found that the insured farmers have a much higher total operational cost (M = 15703.66) compared to uninsured farmers (M = 14201.41), with a t-value of 3.186 and a p-value of 0.002. This result is consistent with the study conducted by Cariappa, et al (2020) and Varadan and Kumar (2012).

Further pertaining to the yield, t-test results show that there is no significant difference in yield quantity per acre between insured farmers (M = 319.35) and uninsured farmers (M = 341.49), t (404) = -1.484, *p* = 0.138. This suggests that being insured does not have a significant impact on the crop yield per acre. The negative t-value indicates that uninsured farmers, on average, have a higher yield, but the difference

Table 4. Comparison of Operational Cost and Income of Insured and Uninsured Pigeon pea Farmers

(Rs./acre)

Cost items	Insured	% to Total cost	Uninsured	% to Total cost	t-value	p - value
Land Preparation						
Machine labor	2851.23		2558.23		3.070*	0.000
Bullock labor	260.64		328.57		-0.811	0.418
Total	**3111.87**	**19.82**	**2886.80**	**20.33**	**3.056***	**0.002**
Seed cost	**576.67**	**3.67**	**489.56**	**3.45**	**5.204***	**0.000**
Sowing						
Machine labor	758.87		742.12		0.420	0.675
Bullock labor	188.67		171.67		0.438	0.662
Human labor	148.03		118.72		0.919	0.359
Total	**1095.57**	**6.98**	**1032.51**	**7.27**	**1.717**	**0.087**
Fertilizer and manure						
Fertilizer	1299.40		1208.13		1.377	0.170
Manure	492.29		477.30		0.121	0.904
Human labor	141.43		148.27		-0.191	0.848
Total	**1933.12**	**12.31**	**1833.70**	**12.91**	**0.618**	**0.537**
Weeding						
Bullock labor	329.56		181.77		3.326*	0.000
Human labor	805.42		948.03		-1.659	0.098
Total	**1134.98**	**7.23**	**1129.80**	**7.96**	**0.055**	**0.956**
Weedicide						
weedicide	498.18		324.24		2.581*	0.010
Human labor cost	422.91		340.39		1.509	0.132
Total	**921.09**	**5.87**	**664.63**	**4.68**	**2.270***	**0.024**
Pesticide						
Pesticide	2421.87		2168.52		2.069*	0.039
Human labor cost	1362.07		1322.76		0.342	0.733
PML cost	348.7685		403.4483		-0.755	0.451
Total	**4132.71**	**26.32**	**3894.7291**	**27.42**	**1.140**	**0.255**
Harvesting						
Machine labor	868.03		703.31		1.648	0.100
Human labor	1605.85		1566.37		0.229	0.819
Total	**2473.89**	**15.75**	**2269.68**	**15.98**	**1.188**	**0.235**
Insurance	**323.76**	**2.06**	**0**	**0**		
Total operational cost (B)	**15703.66**	**100**	**14201.41**	**100**	**3.186***	**0.002**
Yield kg/acre	319.35		341.49		-1.484	0.138
Price/kg	55.03		55.36		-0.229	0.819
Claims/acre	2454.73		0		-	-
Crop revenue (A)	**21248.57**		**19861.92**		**1.526**	**0.128**
Crop Income (B-A)	**5544.91**		**5660.51**		**-0.120**	**0.904**

*. The mean difference is significant at the 0.05 level.

is not statistically significant. The price per kg also has not shown significant difference between the groups. It suggests that despite the risk coverage given by the PMFBY, farmers are inclined to sell their crops immediately during the season rather than keeping and selling them when prices increase. It is because of the delay in claim settlement under the scheme.

Insured farmers received significant claims with a mean value of Rs. 2454.73 while uninsured farmers received no claims. This substantial difference highlights the financial protection that insurance provides to farmers in the event of crop failure or adverse conditions.

In contrast to the results of Akber, et all (2023) the crop revenue which includes the total income from crop sales and any insurance claims received, is not shown significant difference between insured farmers (M = 21248.57) and uninsured farmers (M = 19861.92), t (404) = 1.526, p = 0.128. This result suggests that although insured farmers' average crop revenue is higher, the difference is not statistically significant at 5 percent level of significance. This finding suggests that the extra income generated from insurance claims does not result in a substantial difference in the total revenue from the crop between the two groups. However, in overall the average crop income between insured farmers (M = 5544.91) and uninsured farmers (M = 5660.51) is also found to be statistically insignificant. This because the increased operational cost offsets the marginal difference in crop revenue of Rs 1387 per acre among insured farmers.

Conclusion and Policy Implications

It has been found that the area insured under PMFBY and RWBCIS is decreasing every year. This pattern is detrimental to PMFBY's goal, which is to have 50 percent of the farmed land covered by crop insurance (Tiwari et al., 2020). Farmers are benefited from the schemes at the same time, the schemes are also viable for insurance companies since the gross premium collected is more than total claims. Insured farmers are not shown any moral hazard in input usage for crop production. However, the insurance claim has not significantly increased the average crop revenue and income of insured compared to uninsured farmers. It demands for accuracy in the estimation of yield loss.

To increase participation in the crop insurance, it is recommended to conduct more comprehensive awareness programs at the village level and address farmers' grievances directly at their doorsteps. Ensuring that the resources are allocated for these efforts are regularly audited for effectiveness is crucial. Subsidizing entire premium amount for marginal and small farmers in rain-fed areas could significantly enhance their inclusion in the safety net.

For accurate yield loss estimation, the insurance unit has to bring down to village level and increase the sample size in CCEs. Additionally, advanced technologies such as "Satellite Remote Sensing, Drone, Modeling, AWS/ARG, Artificial Intelligence & Machine Learning (AI&ML) real-time transmission of data" should be integrated with CCEs to enhance the precision of yield loss assessments. The study recommends to introduce additional insurance products, such as input cost insurance and revenue-based crop insurance, alongside PMFBY (yield-based crop insurance) to augment the crop income.

References

Akber N, Paltasingh K and Mishra A 2023. Does crop insurance ensure food security for Indian farmers? Evidence from a nationally representative survey. *Agribusiness.* https://doi.org/10.1002/agr.21884.

Bahinipati C S, Kumar V and Viswanathan P K 2021. An evidence-based systematic review on farmers' adaptation strategies in India. *Food Security* **13**:399–418. https://doi.org/10.1007/s12571-020-01139-3

Birthal P S, Negi D S, Khan Md T and Agarwal S 2015. Is Indian agriculture becoming resilient to droughts? Evidence from rice production systems. *Food Policy* **56**: 1–12. https://doi.org/10.1016/j.foodpol.2015.07.005

Cariappa A G A, Mahida D P, Lal P and Chandel B S 2020. Correlates and impact of crop insurance in India: Evidence from a nationally representative survey. *Agricultural Finance Review* **81**: 204–221. https://doi.org/10.1108/AFR-03-2020-0034

Cole S A and Xiong W 2017. Agricultural Insurance and Economic Development. *Annual Review of Economics* **9**: 235–262. https://doi.org/10.1146/annurev-economics-080315-015225

GoI 2018. Economic Survey 2017-18. Government of India Ministry of Finance, Department of Economic Affairs, New Delhi.

GoI 2020. Pradhan Mantri Fasal Bima Yojana (PMFBY) Revamped Operational Guidelines. Government of India Ministry of Agriculture & Farmer Welfare, Department of Agriculture & Farmer Welfare, New Delhi. https://pmfby.gov.in/pdf/Revamped%20Operational%20Guidelines_17th%20August%202020.pdf

PIB, GoI, 2023. *States opting out from Pradhan Mantri Fasal Bima Yojana, Ministry of Agriculture & Farmers Welfare.* Retrieved from https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1906871

Tiwari R, Chand K and Anjum B 2020. Crop Insurance in India: A Review of Pradhan Mantri Fasal Bima Yojana (PMFBY). *FIIB Business Review* **9**:249–255. https://doi.org/10.1177/2319714520966084

Varadan R and Kumar P 2012. Impact of crop insurance on rice farming in Tamil Nadu. *Agricultural Economics Research Review* **25**: 291-298.