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Agricultural Income Gains under Pradhan Mantri Krishi Sinchai Yojana (PMKSY): Evidence from North Eastern Karnataka, India

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***Abstract*:** The Pradhan Mantri Krishi Sinchai Yojana (PMKSY), launched by the Government of India in 2015, aims to support small and marginal farmers through micro-irrigation facilities. The impact of PMKSY's on cropping patterns and income in the North Eastern Karnataka region was valuated. Comparative analysis shows that PMKSY beneficiaries have diversified their crops more significantly than non-beneficiaries, allocating greater area to high-value crops such as maize and groundnut during kharif, and Bengal gram and jowar during rabi, while non-beneficiaries predominantly grew traditional crops. Beneficiaries cultivated a gross cropped area of 132.44hectares and a net cropped area of 86.41hectares with a cropping intensity of 152.56 %, compared to cropping intensity of 135.72 % for non-beneficiaries. Income analysis reveals 23.11% increase in total income for beneficiaries, driven by a 28.87% rise in crop production income and 17.77% increase in income from other occupations. However, wage income for beneficiaries declined by 37.71 per cent reflecting reduced reliance on manual labour. The DID(Difference in difference) analysis reveals that the beneficiary farmers realised higher farm income per hectare compared to control farmers (₹73809/ha). These findings underscore the effectiveness of PMKSY in enhancing cropping efficiency and farmer income, highlighting its potential for future agricultural policy interventions.

Keywords: PMKSY, Cropping pattern, Income, difference in difference (DID)

Agriculture serves as the backbone of India's economy, employing a significant portion of the population and contributing substantially to the nation's GDP (Reddy et al., 2020, Suresh et al., 2019). However, the sector faces persistent challenges, including dependency on erratic rainfall, limited irrigation coverage, and inefficient water use. Recognizing these issues, the Government of India launched the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) in 2015 (Anonymous 2015) aimed at achieving comprehensive irrigation coverage and improving water use efficiency under the themes of "Har Khet Ko Paani" and Per Drop More Crop (PMKSY 2025).

The North Eastern Karnataka region, characterized by semi-arid conditions and uneven rainfall patterns, represents an area where PMKSY has the potential to significantly transform agricultural practices and uplift socio-economic conditions. Small and marginal farmers, constituting the majority of the agricultural community in this region, often grapple with water scarcity, low crop yields, and financial instability. The implementation of PMKSY, particularly its micro-irrigation initiatives, offers a promising pathway to address these challenges by promoting sustainable water management and enhancing agricultural productivity. This study investigates the impact of PMKSY on the cropping pattern and income of respondent farmers in North Eastern Karnataka region by analysing changes in crop yields and water use efficiency. The findings will help gauge the effectiveness of the scheme in promoting sustainable agricultural practices and its role in improving the socio-economic conditions of farmers in water-scarce regions.

MATERIAL AND METHODS

Sampling design: The multistage random sampling procedure was used to select respondents for the study, conducted in two districts of the North Eastern Karnataka region, Koppal and Kalaburagi, based on their large area under micro-irrigation (Fig. 1). Two taluks from each district were selected, and a total of 120 respondents were chosen, including 60 beneficiaries and 60 non-beneficiaries of the Pradhan Mantri Krishi Sinchai Yojana (PMKSY). From each taluk, 3 villages were selected, and within each village, 5 beneficiaries and 5 non-beneficiaries were randomly chosen, resulting in 15 beneficiaries and 15 non-beneficiaries per taluk. Non-beneficiaries are farmers who do not receive PMKSY subsidies but may still use micro-irrigation systems.

Analytical Tools

Tabular presentation: Data on number of beneficiaries involved in the scheme, income and cropping pattern of beneficiary farmers under the PMKSY were analyzed by tabular analysis technique.

Difference in difference technique: Difference-in-Differences (DiD) is a quantitative method often used to estimate and compare change in outcome before and after scheme for beneficiary and non-beneficiary farmers. The advantage of using the double difference method is that it nets out the effects of additive factors that have fixed (time-invariant) impacts on income indicator, or that reflect common trends affecting beneficiary and non-beneficiary

equally such as changes in income (Duflo et al., 2004, Verner et al., 2005, Sarma et al., 2015, Ravallion et al., 2005).

DD = (Y p1 – Y p0) – (Ynp1 – Y np0) -------(1)

Where,

DD=Income difference between the respondents

Y p1 = outcome (e.g., income) of beneficiaries after the PMKSY scheme;

Y p0 = outcome of beneficiaries before the PMKSY scheme;

Y np1 = outcome of non beneficiaries after the PMKSY scheme; and

Y np0 = outcome of non beneficiaries before the PMKSY scheme.

Paired 't' test: Paired 't' test was employed to assess the impact of PMKSY on income of beneficiary farmers in study area. The level of significance of difference was tested using pairedt-test.

$$X_1 = X_i - \bar{X}$$

$$Y_i = (Y_1 - Y_i)$$

Then t is defined as

$$\sqrt{\frac{n(n-1)}{\sum_{i=1}^{n}(\bar{x}_i - \bar{Y}_i)^2}}$$

Where,

X_1 and Y_1= two paired sample of beneficiary farmers and non-beneficiary farmers income respectively

n=sample size

n– 1 degree of freedom

The DID regression technique also provide us the same estimator along with the significance level (Gertler et al., 2010, Sinha and Laha 2019). The empirical specification of the regression can be written as follows:

$Y = \alpha + \beta T + \gamma I + \theta(T.I) + €$

Where *T* is a time dummy variable (*t* = 1 for after PMKSY started, *t* = 0 for before PMKSY started), and I is a treatment variable (*i* = 1 for beneficiary of PMKSY and *i* = 0 for non-beneficiary of PMKSY). The interaction effect (or the composite variable) *T.I* is a dummy variable (*t* = *i* =1 for PMKSY beneficiary's income after PMKSY scheme).

RESULTS AND DISCUSSION

Comparative cropping pattern of beneficiary and non-beneficiary farmers : During the *kharif* season, beneficiaries used 44.23 per cent of their gross cropped area, while non-beneficiaries used 53.46 per cent (Table 1). In the *rabi* season, beneficiaries allocated 32.62 per cent of their gross cropped area, compared to 26.35 per cent by non-beneficiaries. Beneficiaries also cultivated summer crops on 1.83 per cent of their gross cropped area, whereas non-beneficiaries did not grow any summer crops. Annual crops accounted for 21.31 per cent of the gross cropped area for beneficiaries and 20.19 per cent for non-beneficiaries.

Among beneficiaries, the major *kharif* crop was maize, covering 19.71 per cent of the gross cropped area (26.10ha), followed by bajra at 8.40 per cent and cotton at 7.56 per cent. In the *rabi* season, jowar was the leading crop at 13.83 per cent, with Bengal gram at 7.41 per cent and groundnut at 6.42

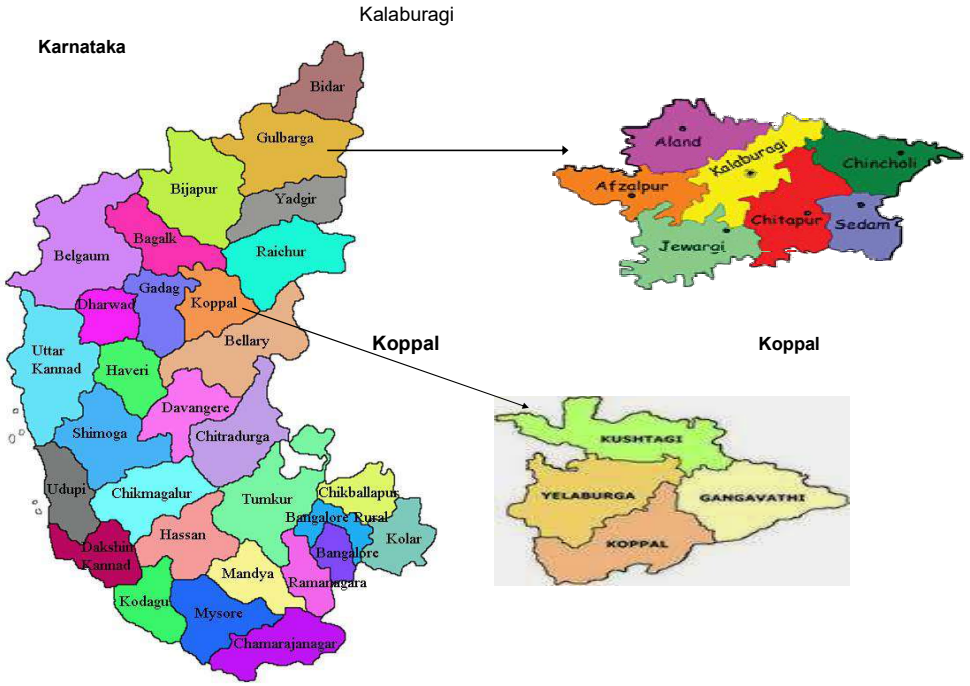

Fig. 1. Map showing the study area

per cent. Beneficiaries also allocated 1.83 per cent of their gross cropped area for summer vegetables, and their annual crops included were banana (11.69 per cent) and pomegranate (9.63 per cent). Non-beneficiaries primarily grew pigeonpea during the *kharif* season, accounting for 17.56 per cent of their gross cropped area (27.72ha), with maize covering 11.41 per cent and bajra at 8.46 per cent. In the *rabi* season, jowar was the primary crop at 7.18 per cent, followed by groundnut at 6.35 per cent and Bengal gram at 5.26 per cent. Non-beneficiaries did not grow summer crops, and their annual crops consisted of banana at 11.73 per cent and pomegranate at 8.46 per cent.

The gross cropped area of non-beneficiaries was 157.83 haand 132.44hectares for beneficiaries of PMKSY. The net cropped area was 86.81hectares for beneficiaries and for non-beneficiaries was116.25hectares. The PMKSY beneficiaries exhibited a higher cropping intensity of 152.56 per cent, compared to 135.77 per cent for non-beneficiaries indicating PMKSY beneficiaries exhibited a higher cropping intensity and adopted a more diverse cropping pattern compared to non-beneficiaries, especially in the *rabi* season. Beneficiaries allocated 32.62 per cent (43.20 ha) of their gross cropped area to *rabi* crops, while non-beneficiaries allocated 26.35 per cent (41.58ha). This indicated that more intensive land use by beneficiaries, supported by PMKSY, particularly in the cultivation of crops like jowar, Bengal gram, and groundnut. The adoption of sprinkler irrigation systems under PMKSY likely contributed to increased land utilization, allowing beneficiaries to manage water resources effectively for better crop productivity. Reddy et al. (2020), o studied the impact of PMKSY-Watersheds project in Srikakulam district of Andhra Pradesh and revealed that a series of farm ponds were constructed in farm fields and the beneficiaries started judicious use of farm pond water from different cultivation operations and more over farmers initiated the growing of horticultural crops like cashew, pomegranate, guava etc., on embankments in order to earn higher sustainable income.

Cropping pattern of beneficiary farmers of PMKSY: The cropping pattern of beneficiaries under PMKSY, revealed significant changes in crop allocation and intensity when compared the period before and after the implementation of the programme (Table 2). Before PMKSY, beneficiaries allocated 58.16 per cent of their gross cropped area to *kharif* crops, which decreased to 44.23 per cent after the program. Conversely, the area dedicated to *rabi* crops increased from 28.57 per cent to 32.62 per cent, indicating a more intensive use of land during

Table 1. Comparative cropping pattern of beneficiary and non-beneficiary farmers

Season	Crops	Beneficiaries		Non-beneficiaries	
		Area (ha)	%	Area (ha)	%
Kharif	Maize	26.10	19.71	18.01	11.41
	Bajra	11.13	8.40	13.35	8.46
	Cotton	10.02	7.56	10.93	6.92
	Groundnut	7.08	5.35	4.45	2.82
	Pigeonpea	4.25	3.21	27.72	17.56
	Paddy	0.00	0.00	9.92	6.28
	Sub total	58.58	44.23	84.38	53.46
Rabi	Jowar	18.31	13.83	11.33	7.18
	Bengalgram	9.81	7.41	8.30	5.26
	Groundnut	8.50	6.42	10.02	6.35
	Safflower	6.58	4.97	6.07	3.85
	Paddy	0.00	0.00	5.87	3.72
	Sub total	43.20	32.62	41.58	26.35
Summer	Vegetables	2.43	1.83	0.00	0.00
Biennial/ perennial	Banana	15.48	11.69	18.51	11.73
	Pomegranate	12.75	9.63	13.35	8.46
Sub total		30.66	23.15	31.87	20.19
Gross cropped area (ha)		132.44		157.83	
Net cropped area (ha)		86.41		116.25	
Cropping Intensity (%)		152.56		135.77	

this season. Beneficiaries also began cultivating summer vegetables, accounting for 1.83 per cent of the gross cropped area post-PMKSY, whereas no summer crops were grown pre-PMKSY. There was also a significant increase in annual crops, with pomegranate and banana expanding from 13.27 per cent to 21.31 per cent of the gross cropped area.

Specifically, maize remained the dominant *kharif* crop post-PMKSY, covering 19.71 per cent of the gross cropped area (58.58 ha), though its area decreased by 10.42 per cent compared to the pre-PMKSY period. Bajra and cotton became significant crops, contributing 8.40 per cent and 7.56 per cent respectively. During the *rabi* season, beneficiaries increased their focus on jowar, which covered 13.83 per cent of the gross cropped area marking to 54.70 per cent increase compared to pre-PMKSY. Bengalgram and groundnut also saw increased cultivation areas. The introduction of summer vegetables and the rise in annual crops like pomegranate (9.63%) and banana (11.69%) demonstrated the program's impact on diversifying cropping patterns.

The total gross cropped area increased slightly from 118.98 hectares pre-PMKSY to 132.44 hectares post-PMKSY, while the net cropped area grew marginally from 84.99 hectares to 86.81hectares. Cropping intensity improved from 140.00 per cent to 152.56 per cent. Although there was a reduction in the area allocated to *kharif* crops, the percentage of land dedicated to *rabi* and annual crops increased, showcasing how PMKSY helped beneficiaries diversify crop selection and utilize land more effectively. The adoption of micro irrigation systems, such as sprinkler and drip irrigation systems through PMKSY also, likely contributed to these improvements, leading to better land management, enhanced productivity, and increased cropping intensity. Suresh et al. (2019) in study on micro-irrigation development in India: an analysis of distributional pattern and potential correlates observed similar trend.

Comparative crop productivity among beneficiary farmers and non-beneficiary farmers The beneficiary farmers achieved a significant increase in crop productivity compared to non-beneficiaries, highlighting the impact of the PMKSY program and the use of micro-irrigation systems. Bajra productivity was 47.39 q/ha among beneficiaries, 33.94 per cent higher than the 35.38 q/ha produced by non-beneficiaries (Table 3). Bengalgram showed the largest difference with beneficiary farmers producing 20.95 q/ha, which was 60.61 per cent more than the 13.05q/ha harvested by non-beneficiaries. Similarly, in cotton, beneficiaries achieved a yield of 27.11 q/ha, 30.13 per cent higher than the 20.83 q/ha of non-beneficiaries. Groundnut yields among beneficiaries reached 23.5 q/ha, 24.48 per cent greater than the 18.88 q/ha from non-beneficiaries. For *rabi* jowar crop,

Table 2. Cropping pattern of beneficiary farmers of PMKSY

Season	Crops	Before PMKSY (2020)		After PMKSY (2023)		% Change
		Area (ha)	%	Area (ha)	%	
Kharif	Bajra	9.71	8.16	11.13	8.40	14.58
	Cotton	11.23	9.44	10.02	7.56	-10.81
	Groundnut	7.89	6.63	7.08	5.35	-10.26
	Maize	29.14	24.49	26.10	19.71	-10.42
	Pigeonpea	11.23	9.44	4.25	3.21	-62.16
	Sub total	69.20	58.16	58.58	44.23	-15.35
Rabi	Bengalgram	9.00	7.57	9.81	7.41	8.99
	Groundnut	8.09	6.80	8.50	6.42	5.00
	Jowar	11.84	9.95	18.31	13.83	54.70
	Safflower	5.06	4.25	6.58	4.97	30.00
	Sub total	33.99	28.57	43.20	32.62	27.08
Summer	Vegetables	0.00	0.00	2.43	1.83	-
Biennial/ perennial	Pomegranate	6.07	5.10	12.75	9.63	110.00
	Banana	9.71	8.16	15.48	11.69	59.38
Sub total		15.78	13.27	28.23	23.15	78.85
Gross cropped area		118.98		132.44		11.31
Net cropped area		84.99		86.81		2.14
Cropping Intensity (%)		140.00		152.56		8.97

beneficiaries produced 30.94 q/ha, 25.96 per cent more than the 24.56q/ha yielded by non-beneficiaries. In maize, beneficiaries saw a 31.07 per cent difference, producing 59.53 q/ha compared to 45.42 q/ha for non-beneficiaries. Pigeonpea productivity for beneficiaries was 18.01 q/ha, 33.03 per cent improvement over the 13.54 q/ha of non-beneficiaries, while safflower yields among beneficiaries stood at 11.19 q/ha, 39.38 per cent higher than the 8.03 q/ha recorded by non-beneficiaries. Among horticultural crops, banana and pomegranate also showed higher productivity. Beneficiaries produced 698.40 q/ha of banana, 14.71 per cent more than the 608.85 q/ha of non-beneficiaries, while pomegranate yields for beneficiaries were 155.28 q/ha, 5.83 per cent above the 146.73 q/ha for non-beneficiaries. These figures underscore the effectiveness of the PMKSY program in boosting crop yields through the use of micro-irrigation systems such as sprinkler and drip irrigation, leading to improved efficiency in water use for beneficiary farmers.

Comparative income level among beneficiary farmers and non-beneficiary farmers: The results in Table 4 demonstrate significant differences in income levels between beneficiary and non-beneficiary farmers. Beneficiary farmers reported higher income from crop production (₹5, 59, 050) compared to non-beneficiaries (₹4, 33, 800), showing a 28.87 per cent increase. Income from other occupations was also higher for beneficiaries (₹57,239) than non-beneficiaries (₹48,603), with a 17.77 per cent difference. Conversely, wage income was lower among beneficiaries (₹22,954) compared to non-beneficiaries (₹36,850), reflecting a 37.71 per cent lower income. Overall, the total income of beneficiary farmers (₹6, 39, 243) was higher than that of non-beneficiaries (₹5, 19, 253), indicating a 23.11 per cent increase. These findings highlight the positive impact of the intervention on beneficiaries' income levels, particularly through enhanced crop production. The results are in line with results reported by Kiran (2023) conducted study on socio-economic performance of Ganga Kalyana Yojana (GKY) in Ballari district of Kalyana Karnataka Region.

Table 3. Comparative crop productivity among beneficiary farmers and non-beneficiary farmers

Crops	Beneficiaries (n=60)	Non-beneficiaries (n=60)	% difference
Cereals			
Bajra	47.39	35.38	33.94
Rabi jowar	30.94	24.56	25.96
Maize	59.53	45.42	31.07
Pulses			
Bengalgram	20.95	13.05	60.61
Pigeonpea	18.01	13.54	33.03
Oil seed			
Groundnut	23.50	18.88	24.48
Safflower	11.19	8.03	39.38
Commercial crop			
Cotton	27.11	20.83	30.13
Horticultural crops			
Banana	698.40	608.85	14.71
Pomegranate	155.28	146.73	5.83

Impact of PMKSY on income of beneficiary farmers: Before the program, beneficiary farmers had a crop production income of ₹3, 27, 782, which increased significantly to ₹5,59,050 after PMKSY with a 70.56 per cent increase and statistically, demonstrating the program's strong positive effect on crop productivity (Table 5). Income from other sources, including livestock and poultry, increased from ₹46,520 to ₹57,239, marking a 23.04 per cent rise. This increase is also statistically significant indicating that PMKSY positively impacted additional income sources. Wage income for beneficiaries decreased by 20.03 per cent, from ₹28,705 to ₹22,954,indicated that reduction in reliance on wage labour, potentially due to higher income from other sources. Overall, beneficiaries' total income increased from ₹4,03,007 to ₹6,39,243, reflecting a 58.62 per cent rise. This increase, statistically significant, underscores the comprehensive positive impact of PMKSY on beneficiaries' financial well-being. Hence PMKSY led to significant improvements in crop production and other income sources for beneficiaries, despite a reduction in wage income. The program has effectively enhanced the overall financial stability and economic prospects of the farmers.

Double difference estimates of impact of PMKSY: The

Table 4. Comparative income level among beneficiary farmers and non-beneficiary farmers

Particulars	Total income (₹ per farm)			
	Non-beneficiary (n=60)	Beneficiary (n=60)	t-statistics	% difference
Crop production/year	4,33,800	5,59,050	5.05*	28.87
Other occupation	48,603	57,239	6.81*	17.77
Wage income	36,850	22,954	-8.43*	-37.71
Total income	5,19,253	6,39,243	4.72*	23.11

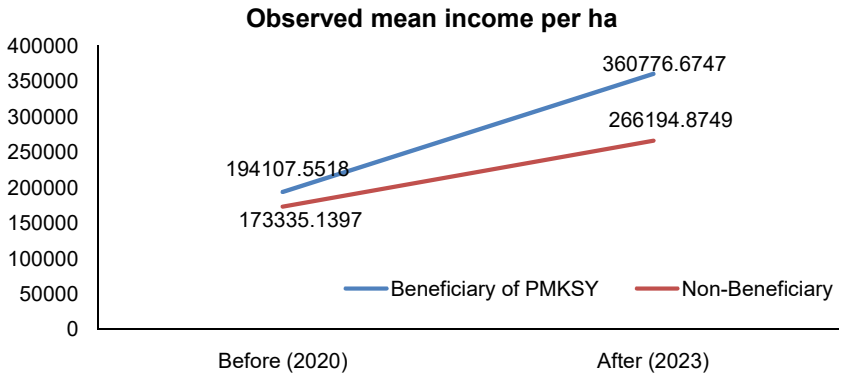

Fig. 2. Parallel trend in income per ha

Table 5. Impact of PMKSY on income of beneficiary farmers of PMKSY

Particulars	Total income (₹ per farm)			
	Before PMKSY	After PMKSY	t-statistics	% Change
Crop production/year	3,27,782	5,59,050	7.94*	70.56
Other occupation	46,520	57,239	19.36*	23.04
Wage income	28,705	22,954	-14.15*	-20.03
Total income	4,03,007	6,39,243	7.28*	58.62

Table 6. Double difference estimates of impact of PMKSY on income per ha

Particulars	Beneficiary of PMKSY	Non-Beneficiary	Difference
Before (2020)	194107.55	173335.14	20772.41
After (2023)	360776.67	266194.87	94581.80
Change	166669.12	92859.74	73809.39

Table 7. Difference-in-difference regression of income per hectare

Variables	Coefficients	Std. Error	t stat	Prob
Intercept	173335	31880	5.437	1.35e-07 ***
Treatment (I)	20772	45085	0.461	0.6454
Time (T)	92860	45085	2.060	0.0405**
DID (T*I)	73809	63760	1.158	0.2482
Adjusted R-squared: 0.0707				
F-statistic: 7.061*** p-value: 0.0001452				
No of observations :240				

mean income per hectare difference of the beneficiary and non-beneficiary farmers before and after the PMKSY was ₹ 20772 and ₹ 94581.80, respectively (Table 6). The positive mean double income difference of about ₹ 73809was realized between the beneficiary and non-beneficiary farmers. The PMKSY significantly benefited the beneficiary farmers (Fig. 2). The impact of PMKSY on farmers profit per hectare per year was ₹ 73809. The interaction between treatments (I) and time (T) variable shows a positive and significant impact of ₹73809/ha/season increase among PMKSY Beneficiary farmers after the participation in the PMKSY scheme (Table 7). Therefore, the DiD regression results are confirming the tabular results, which indicates that the PMKSY scheme has made an impact on beneficiary farmers' income in the study area (Bhavani et al., 2022).

CONCLUSION

The Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) has had a measurable positive impact on farmers' income through increased irrigation coverage, productivity gains, and crop diversification**.** There was an increase in cropping intensity among PMKSY beneficiary farmers compared to non-beneficiaries, beneficiaries achieved higher crop productivity in bajra and Bengal gram. The beneficiary farmers saw a higher income from crop production compared to non-beneficiary farmers. The overall income of beneficiaries rose by 23.11 per cent, with a significant 58.62 per cent increase post-PMKSY. The DID analysis infers that the beneficiary farmers realised higher farm income per hectare compared to control farmers. These findings underscore the effectiveness of PMKSY in enhancing crop yields, diversifying farmers' income sources, and improving their financial stability. However, to achieve its full potential in doubling farmers' income, there is a need to strengthen extension services, ensure timely disbursal of subsidy, and scale up adoption of micro-irrigation in rainfed regions.

AUTHOR'S CONTRIBUTIONS

Shreekantha Reddy: Writing-original draft preparation, conceptualization, methodology, figure preparation and editing. Suresh K: Conceptualization, formal analysis, supervision, reviewing and editing. Amrutha T Joshi: Supervision and editing. Prabhuling Tevari: Visualization and editing. Kapil Patil: supervision and reviewing. All authors have read and agreed to the published version of the manuscript.

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