



Economic Study on Targeting Rice Fallow Area (TRFA) Scheme in Kalyana Karnataka Region

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Abstract— Rice is a major staple crop cultivated extensively in Karnataka; however, a substantial portion of the rice area remains fallow during the rabi season due to moisture stress, inadequate irrigation facilities and limited awareness regarding suitable crop diversification options. These rice fallow areas offer considerable scope for enhancing agricultural production, farm income and employment through the cultivation of short-duration pulses and oilseeds. In this background, the present study analyses the impact of the Targeting Rice Fallow Areas (TRFA) scheme on area utilization, production performance, income and employment of farmers in Karnataka, with special emphasis on the Kalyana Karnataka region. The study was conducted in Raichur and Ballari districts of Kalyana Karnataka using a multistage random sampling technique. Primary data were collected from 120 sample farmers, comprising 60 TRFA beneficiary farmers and 60 non-beneficiary farmers. In addition, data were collected from 10 government officials of the Department of Agriculture to identify the major constraints in the implementation of the TRFA scheme. Secondary data on area, production and productivity of pulses and oilseeds were collected for the period 2008-09 to 2023-24. The analytical tools employed included compound annual growth rate (CAG) and Difference-in-Difference (DiD) technique. The results revealed that in Kalyana Karnataka, the area under pulses increased marginally by 0.46 per cent during the post-TRFA period, while production and productivity declined by 3.95 per cent and 4.39 per cent, respectively. In contrast, oilseeds showed better performance with an increase in area (2.56%), production (8.80%) and productivity (6.44%), indicating a stronger positive impact of the TRFA scheme. At the state level, oilseeds recorded higher growth in production (5.62%) compared to pulses. The extent of utilization of rice fallow areas was significantly higher among TRFA beneficiary farmers, contributing to improved cropping intensity. The Difference-in-Difference analysis indicated that TRFA beneficiary farmers experienced a significant increase in annual farm income ranging from Rs.27419 per farm and generated additional employment of about 38 man-days per annum compared to non-beneficiaries. The study recommends timely fund release, development and promotion of short-duration, drought-tolerant pulse varieties suitable for rice fallow conditions and adoption of crop replacement strategies such as promoting sunflower in place of poorly performing crops like mustard. Further, advance identification and mapping of suitable rice fallow areas, intensive pre-season awareness programmes and strengthening of monitoring and evaluation mechanisms are essential to enhance the effectiveness and sustainability of the TRFA scheme.



Keywords— Employment, Farm income, Kalyana Karnataka, Rice fallow, TRFA scheme.

I. INTRODUCTION

Paddy is the principal crop during kharif season in India. The crop occupies an area of over 40 million ha. This area is not fully utilized for crop production in the subsequent rabi season; about 12 million ha remains fallow (Subbarao et al., 2001). This unutilized area offers enormous opportunities to overcome the problem of food and nutritional insecurity. Accomplishing household food security remains the primary concern though at the national level India has piled up a huge stock (about 60 million tonnes) of food grains, mainly rice and wheat. Food crops such as pulses and oilseeds are critical to food security. Nutritional security is equally important; about 30 per-cent of the population suffer from malnutrition in India (Joshi et al., 2002). A majority of Indian population is vegetarian, deriving its protein requirement from pulses and other vegetarian sources. The per capita availability of pulses has been declining. India is deficit in pulses and edible oils and imports huge quantities of these commodities to meet the domestic demand.

About 30 per-cent (11.7 m ha) of the area under paddy production during kharif season in India remain fallow in the subsequent rabi due to number of biotic, abiotic and socioeconomic constraints. Despite of ample opportunities rice fallow systems have been bypassed in the research and developments for a number of constraints. Major rice fallow area (82%) is concentrated in eastern parts of the country. States with larger area of rice-fallows are Chhattisgarh, Madhya Pradesh, Jharkhand, Bihar, West Bengal and Orissa the remaining 18 per-cent area is in the states like Tamil Nadu, Karnataka and Andhra Pradesh and there exists a large scope for expansion of area under pulse crops. Short duration pulses are ideal crops for their cultivation in such areas (Joshi et al., 2002).

Pulses are required to grow not only for nutritional security but also for sustainability of any system. To cope up with the increasing demand of pulses in the country pulses should be included as an integral part in rice fallow areas with a dual advantage of crop diversification for sustainable production and increasing the area under pulses. To exploit these rice fallow areas with pulses, location specific and economically viable technology for better performances of pulses are required to be standardized through proper understanding of the system ecology and constraints study. This effort should have strong research support to deliver appropriate varieties and matching crop management technology suited to rice fallows cultivation. The existing rice fallow area (11.7 m ha) in India is almost equivalent to the net sown area of Punjab, Haryana and western Uttar Pradesh. If this area is brought under cultivation, it may usher

another green revolution in India benefiting millions of farmers. Promotion of pulses crops in the existing paddy fallow area would also improve sustainability of the rice production system besides enhancing production and augmenting farmers income. It should be considered appropriate to identify abiotic, biotic and socio-economic constraints to rabi cropping that can be addressed through technological and policy intervention.

After the harvest of kharif rice, climatic conditions of rice fallow lands in many areas are suitable for growing cool and warm season pulses profitably. The residual moisture left in the soil at the time of rice harvest is often sufficient to raise short-season crops. Further, by use of short-duration and high-yielding varieties of rice allowing to vacate fields during September-October, the traditional rice fallows can be converted into productive lands. Introduction of cool and warm season pulses such as lentil, mungbean, urdbean, lathyrus, peas etc. Rice fallows can increase the productivity as well as sustainability of rice. The small-seeded varieties of these pulses may find prominence under utera cultivation (relay cropping) in the states of Chhattisgarh, Jharkhand, Bihar, West Bengal and Assam. This practice can be made more effective by using short-duration and high-yielding varieties of rice, as rice crop will vacate the field in September-October. In low land areas with excessive soil moisture, lentil is more suitable and assured than chickpea. Consequently, the rice-lentil system can be made more popular in the low lands of eastern Uttar Pradesh, Bihar, Jharkhand and West Bengal.

Introduction of groundnut in rice fallows can be a profitable proposition in Char area of Bihar and eastern Uttar Pradesh, Mahananda of Odisha, Brahmaputra valley of Tripura, Assam, Meghalaya, Manipur and coastal Andhra Pradesh. Under zero-till, mustard in eastern Uttar Pradesh has good scope besides traditional urdbean and mungbean. Of late, rabi sorghum has also been successfully introduced in the rice fallows of coastal Andhra Pradesh (Mishra et al., 2013). This unutilized area offers enormous opportunities to overcome the problem of food and nutritional insecurity. The rice fallows have a great potential for cultivation of short-duration pulses and oilseeds. However, very little efforts have been made to efficiently utilize these rice fallow with appropriate technical and developmental back-up. It is expected that nearly 3.0-million-hectare area of rice fallows can be brought under cultivation, which can provide about 1.5-2.0 million tonnes of additional food grain production (Anon, 2018) and help in meeting the increasing demands of pulses and oilseeds. Development and popularization of improved varieties of pulses and oilseeds suiting to rice fallows of different agro-ecological regions coupled with improved agro-technology will boost production and thus

improve income and livelihood security as well as nutritional security of farming community. Most pronounced effect of climate change is a drastic change in the rainfall pattern in the form of delayed monsoon, early withdrawal or inadequate precipitation with poor distribution leading to either drought or waterlogged conditions, particularly in rain fed ecosystem. Therefore, timing of rice transplanting plays an important role in getting higher yield of rice and sowing of succeeding dry season crops mainly pulses or oilseeds. Kalyana Karnataka, a region located in the northern part of Karnataka, is an agriculturally significant area, where rice is a major crop during the kharif season. However, a substantial portion of the region's rice fields remain fallow during the rabi (post-monsoon) season due to factors such as water scarcity, inadequate irrigation infrastructure and limited crop diversification. This fallow period not only results in underutilization of valuable agricultural land but also restricts the earning potential of farmers, contributing to economic vulnerabilities in the region.

Targeting Rice Fallow Areas (TRFA) Scheme

Recognizing the potential of rice fallow areas for crop diversification and productivity enhancement, the Department of Agriculture & Farmers Welfare (DA&FW), Ministry of Agriculture and Farmers Welfare, Government of India, launched the Targeting Rice Fallow Areas (TRFA) Scheme during 2016–17 under the umbrella of the National Food Security Mission (NFSM). The scheme was initially implemented in six eastern states Assam, Bihar, Chhattisgarh, Jharkhand, Odisha and West Bengal where the rice fallow problem was most prominent. Following its initial success, the program was expanded in 2018-19 and 2019-20 to include additional states such as Madhya Pradesh, Maharashtra, Gujarat, Tamil Nadu and Karnataka which also have significant rice fallow. The TRFA operates through cluster-based demonstrations, seed and input support, awareness creation and convergence with ICAR institutions, State Agricultural Universities (SAUs) and Krishi Vigyan Kendras (KVKs) to promote sustainable intensification in rice-based systems.

II. MATERIALS AND METHODS

Selection of the districts

The two districts *viz.*, Raichur and Ballari districts of Kalyana Karnataka were purposively selected as beneficiaries under TRFA scheme is relatively higher in two districts of the region. Kalyana Karnataka region contributes about 49.07 per cent to the total pulses production and 53.56 per cent to the total oilseeds production of the state.

Selection of the taluks and villages

Two taluks were selected from each selected district and these taluks chosen based on the highest number of beneficiaries. Further, villages in all 4 taluks were selected in consultation with agriculture officer (AO) of respective taluks.

The list of beneficiary farmers under the TRFA Scheme was obtained from the district agriculture office and the multistage random sampling technique was used for selection of sample farmers. In the first stage Raichur and Ballari districts were chosen based on highest number of TRFA beneficiaries in the Kalyana Karnataka region. In the second stage, two taluks *viz.*, Raichur and Manvi were selected from Raichur districts, Ballari and Siruguppa from Ballari district were chosen for the study. Accordingly, four taluks were selected based on highest number of beneficiaries and area under pulses and oilseeds cultivation in rice fallow area to obtain the required number of sample farmers. In the third stage, two villages from each of the chosen taluks were selected randomly. Finally, 15 beneficiary farmers and 15 non-beneficiary farmers were chosen from eight villages of each taluk. Thus, a total of 120 sample farmers constituting 60 beneficiaries (TRFA) and 60 Non-beneficiaries (non-TRFA) were chosen from 8 villages across 4 taluks in 2 districts (Table 3.4). In addition, 10 government officials from agricultural department were consulted to gather the information on constraints faced by them in implementation of TRFA scheme.

Under the TRFA scheme, beneficiary farmers in Ballari and Raichur districts received various inputs and technical support to promote the cultivation of pulses and oilseeds, particularly Bengal gram and mustard in rice fallow lands. The scheme aimed to enhance input use efficiency, ensure timely availability of quality resources, and improve productivity under residual soil moisture conditions. For evaluating the objectives of the study, the required data was collected through personal interview method with the help of a well-structured and pre-tested schedule. The collected data pertained to the agricultural year 2023-24. The data relating to the size of holding, general information of farmers, labour and input use in pulse and oilseed production, availing benefits under the TRFA scheme and constraints faced in adopting the scheme were collected from the sample farmers.

Secondary data pertaining to area, production and productivity of pulses and oilseeds of the study districts, Kalyana Karnataka region as a whole and Karnataka for the year 2008-09 to 2023-24 from the Directorate of Economics and Statistics, Bangalore. However, for better understanding of growth and development of pulses and

oilseeds, their growth rate in area, production and productivity were compared for period from 2008-09 to 2023-24 which was further divided into two periods: i) the first period ranging from 2008-09 to 2015-16 (before TRFA) and ii) the period ranging from 2016-17 to 2023-24 (After-TRFA). The year 2016 was considered as a cut-off point because of implementation of "Targeting rice fallow area" to promote pulse and oilseeds production in India where in Karnataka state also covered.

Compound Annual Growth Rate (CAGR) analysis

For analysing the growth trend in area, production and productivity of pulses and oilseeds in Karnataka and the study districts of Kalyana Karnataka region, compound growth rates were computed using the following form of relationship. Before calculating the growth rate, the exponential function of area, production and yield has to be estimated i.e.

$$Y_t = ab^t u_t \quad \dots\dots(01)$$

Where,

Y_t : Dependent variable of which growth rate is estimated (area, production and productivity of pulses and oilseeds).

a : Intercept (constant)

b : Regression coefficient

t : Years which take values, 1, 2, 3,.....,n.

u_t : Disturbance term for the year t

The compound growth rate was obtained from the logarithmic form of the equation (1) as below

$$\ln Y = \ln a + t \ln b$$

The per cent compound growth rate was derived using the relationship

$$\text{CAGR} = (\text{Anti log of } \ln b - 1) * 100$$

Difference in Difference (DiD) technique

Difference-in-Differences (DiD) is a quantitative method was used to estimate and compare change in income and employment 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 prices (Ravallion *et al.* 2005). The Double-Difference method, which is also known as Difference-in-Difference method has the following formula:

$$DD = \left[\frac{1}{P} \sum_{i=1}^P (Y_{1ia} - Y_{1ib}) \right] - \left[\frac{1}{C} \sum_{j=1}^C (Y_{0ja} - Y_{0jb}) \right]$$

Where,

DD = Income difference between the respondents

P = Number of beneficiary farmers

C = Number of individuals in the control group (non – beneficiary farmers)

Y_{1ia} = Income variable of beneficiary after the TRFA scheme (2024)

Y_{1ib} = Income variable of participant before the TRFA scheme (2015)

Y_{0ja} = Income variable of non-beneficiaries after TRFA scheme (2024)

Y_{0jb} = Income variable of non-beneficiaries before TRFA scheme (2015)

Difference-in-Differences Regression

The Difference-in-Difference (DiD) approach was used to compare the beneficiaries with non-beneficiaries in terms of income and employment. DiD is a quasi-experimental design that makes use of longitudinal data from treatment (beneficiaries) and control (non-beneficiaries) groups to obtain an appropriate counterfactual to estimate a causal effect of Targeting Rice Fallow Area (TRFA) Scheme. DiD is typically used to estimate the effect of a specific intervention or treatment (implementation of TRFA) by comparing the changes in outcomes (income and employment) over time between beneficiaries of TRFA (the treatment group) and non-beneficiary farmers (the control group). In the DiD approach, the interaction term between time and treatment group dummy variables shows the impact of the treatment after the introduction of the TRFA Scheme. In this β_3 indicates the increase in the income and employment of beneficiary farmers when compared to the non-beneficiary farmers after discounting for initial differences in profitability. We have used data for 2015 (before TRFA Scheme) and 2024 (after TRFA Scheme). The study uses robust standard errors to account for autocorrelation between before and after while running regression

$$Y_t = \alpha + \beta_1 D_{1i} + \beta_2 D_t + \beta_3 (D_{1i} * D_t) + u_i$$

Where,

α = Intercept

$D_{1i} = 1$ for Beneficiary of TRFA

0 for Non-beneficiary of TRFA

$D_t = 1$ for income / employment before TRFA (2015)

0 for income / employment after TRFA
(2024)

$D_{1i} * D_t$ = Interaction term (DiD)

β_1, β_2 and β_3 are coefficients

u_t = error term

III. RESULTS AND DISCUSSION

Cropping pattern and extent utilization of rice fallow area by sample farmers

The data presented in Table 1 Illustrate cropping pattern and extent of utilization of rice fallow areas among TRFA and Non-TRFA farmers in the study region. The analysis depicted how effectively the rice fallow lands were brought under cultivation during the *rabi* season, highlighted differences in the extent of area utilized, crop composition and cropping intensity between the two categories of farmers.

During the *kharif* season, paddy was found to be the major crop cultivated by all the sample farmers, covering 332 acres among TRFA farmers and 280 acres among Non-TRFA farmers, accounting for 100 percent of the cropped area in both cases. This indicated that paddy continued to dominate the agricultural landscape of the study area as the principal *kharif* crop due to its suitability to local agro-climatic conditions and the availability of monsoon rainfall.

In the *rabi* season, the rice fallow lands were partially utilized for growing pulses and oilseeds, reflecting the extent to which farmers were able to convert fallow lands into productive use. Among TRFA farmers, 268 acres (80.72%) of the total 332 acres were utilized, while 64 acres (19.28%) remained unutilized. In contrast, Non-TRFA farmers utilized 207 acres (73.92%) of their 280 acres, with 73 acres (26.08%) remaining fallow. This

showed that TRFA farmers had achieved a higher utilization rate, mainly due to the awareness and guidance provided under the TRFA scheme, which targeted the promotion of secondary crops in rice fallow lands.

Among the crops grown in rice fallow areas, Bengal gram emerged as the dominant crop cultivated by both groups. It occupied 132 acres (39.75%) among TRFA farmers and 126 acres (45.00%) among Non-TRFA farmers. Farmers preferred Bengal gram due to its short duration, ability to thrive under residual soil moisture conditions and higher market price. The crop also helped in enriching soil fertility through biological nitrogen fixation, making it an ideal choice for inclusion in rice-based cropping systems.

Mustard was the next important crop grown in the rice fallow areas, covering 90 acres (27.10%) among TRFA farmers and 41 acres (14.64%) among Non-TRFA farmers. The relatively higher share of mustard cultivation among TRFA farmers indicated that they were more exposed to demonstrations and technical support provided under the TRFA scheme, which encouraged diversification towards oilseeds. Mustard was valued for its adaptability to low-moisture conditions and its potential as a cash crop, thereby generating additional income for farmers during the *rabi* season.

Green gram accounted for 9.03 per cent (32 acres) of the rice fallow area among TRFA farmers and 10.00 per cent (28 acres) among Non-TRFA farmers. Farmers cultivated green gram mainly because of its short growing period and low input requirements. The crop also contributed to improving soil structure and fertility, which benefited the subsequent paddy crop. Similarly, black gram occupied a smaller share of the rice fallow area, covering 14 acres (4.21%) and 12 acres (4.28%) among TRFA and Non-TRFA farmers, respectively.

Table 1. Cropping pattern and extent utilization of rice fallow area by sample farmers

Sl. No	Particulars	TRFA farmers (n=60)		Non-TRFA farmers (n=60)	
		Area (acre)	%	Area (acre)	%
A	Kharif				
1	Paddy	332	100.00	280	100.00
B	Rabi (Rice fallow)				
1	Bengal gram	132	39.75	126	45.00
2	Mustard	90	27.10	41	14.64
3	Green gram	32	9.03	28	10.00
4	Black gram	14	4.21	12	4.28
5	Utilized area (a)	268	80.72	207	73.92

6	Unutilized area (b)	64	19.28	73	26.08
7	Grand Total (a+b)	332	100.00	280	100.00
8	Gross cropped area	600		487	
9	Net sown area	332		280	
10	Cropping Intensity (%)	180.72		173.92	

Note: TRFA-Targeting Rice Fallow Area

Although the area under black gram was limited, it played an important role in providing household nutrition and enhancing soil fertility.

The gross cropped area was recorded as 600 acres for TRFA farmers and 487 acres for non-TRFA farmers, while the net sown area stood at 332 acres and 280 acres, respectively. The cropping intensity was higher among TRFA farmers (180.72%) compared to Non-TRFA farmers (173.92%). This indicated that TRFA beneficiaries were able to achieve better land-use efficiency by adopting pulse and oilseed cultivation in rice fallows, primarily due to the awareness, input support and training they received under the scheme.

It was concluded that during the *kharif* season, paddy continued to be the predominant crop cultivated by all farmers, while during the *rabi* season, a significant proportion of the rice fallow lands was converted into productive use by TRFA farmers through the cultivation of pulses and oilseeds such as Bengal gram and mustard. The TRFA farmers exhibited a higher level of rice fallow utilization and cropping intensity compared to Non-TRFA farmers, reflecting the positive impact of the TRFA scheme on land-use efficiency and diversification.

However, a considerable portion of the rice fallow area among Non-TRFA farmers remained unutilized due to lack of awareness, inadequate information and limited exposure to the TRFA scheme targeting rice fallow areas. Insufficient irrigation facilities, unavailability of short-duration crop varieties, and lack of institutional support further constrained the adoption of *rabi* crops among Non-beneficiary farmers. Therefore, strengthening extension activities, improving awareness about the TRFA programme and promoting water-saving technologies could play a crucial role in enhancing the productive use of rice fallow lands and increasing cropping intensity in the region.

Income and employment of the farmer before and after implementation of TRFA

The average farm household income and employment level of sample farmers before and after implementation of TRFA scheme summarized in Tables 2 and 3. The total annual income of TRFA farmers increased

from Rs.92,900 before the implementation of TRFA scheme to Rs.1,51,183 after implementation, showing a remarkable gain of Rs.58,283 per farmer. Meanwhile, Non-TRFA farmers experienced a smaller increase from Rs.78,508 to Rs.1,09,647, with a gain of Rs.31,139. Improvement among beneficiaries can be attributed to the adoption of improved technologies, access to quality seeds and better input management practices facilitated under TRFA scheme. These interventions helped reduce production costs and increase productivity, thereby enhancing net returns.

A detailed examination of seasonal income revealed that during the *kharif* season, TRFA farmers income raised from Rs.83,666 to Rs.1,16,867, while Non-beneficiaries' income increased from Rs.71,166 to Rs.95,283. In the *rabi* season, where Bengal gram and mustard was the major crop promoted under TRFA scheme, the income of beneficiaries more than tripled from Rs.9,233 to Rs.34,316 compared to a smaller rise among Non-beneficiaries i.e., Rs.7,341 to Rs.14,363. This clearly demonstrates that TRFA played a pivotal role in promoting profitable crop diversification in rice fallows, transforming an otherwise idle period into a productive and income-generating season.

The total employment increased from 202 to 264 man-days per household, a gain of 62 man-days, whereas Non-beneficiaries recorded a smaller increase from 194.57 to 218.74 man-days (24 man-days gain). Seasonal data shows that in the *rabi* season, employment among TRFA farmers nearly doubled from 60 to 116 man-days indicating that the introduction of pulse and oilseeds such as Bengal gram and mustard in rice fallows significantly expanded rural employment opportunities. The increase in labour use during this season reflects the adoption of improved crop management practices and the shift from fallow to productive cultivation, leading to higher on-farm labour demand.

Overall, it can be concluded that the TRFA scheme positively impacted farmers' socio-economic conditions, boosting both income and employment through the promotion of pulse and oilseed-based intensification in rice fallows. The findings align closely with those of

Mankar *et al.* (2013) who found that 74.16 per cent of National Horticultural Mission (NHM) beneficiaries

income increased by 50.69 per cent (from Rs. 1.65 to Rs. 2.49 lakhs), employment days rose by 41.12 per cent

Table 2. Farm household income of the sample farmer before and after implementation of TRFA

Season	Income (₹/year)			
	TRFA farmer (Beneficiary)		Non-TRFA farmer (Non-Beneficiary)	
	Before TRFA (2015)	After TRFA (2024)	Before TRFA (2015)	After TRFA (2024)
Kharif	83666	116867	71166	95283
Rabi	9233	34316	7341	14363
Total	92900	151183	78508	109647

Table 3. Farm household employment of the sample farmer before and after implementation of TRFA

Season	Employment (mandays/year)			
	TRFA farmer (Beneficiary)		Non-TRFA farmer (Non-Beneficiary)	
	Before TRFA (2015)	After TRFA (2024)	Before TRFA (2015)	After TRFA (2024)
Kharif	142	148	137.16	135.58
Rabi	60	116	57.41	83.16
Total	202	264	194.57	218.74

Impact of TRFA on income and employment of respondents

The results presented in Table 4 clearly indicate that the TRFA scheme had a significant positive impact on both income and employment of the beneficiary farmers. The average annual income of beneficiaries increased from Rs.92,900 before participation to Rs.1,51,183 after, registering a mean difference of Rs.58,283, which was statistically significant at the 1% level ($t = 19.76^*$). In comparison, Non-beneficiaries recorded a smaller increase in income from Rs.78,508 to Rs.1,09,647 with a mean difference of Rs.31,439 ($t = 13.82^*$). The double difference estimate of Rs.26,844 signifies that TRFA beneficiaries experienced a substantially higher gain in income due to improved access to inputs, training, and technology provided under the scheme.

In terms of employment generation, a similar trend was observed. The average employment days for TRFA beneficiaries increased from 202.16 before implementation of TRFA scheme to 264.75 man-days per year after implementation of TRFA, reflecting a mean difference of 62.58 man-days ($t = 14^*$). Non-beneficiaries showed a smaller increase from 194.57 before TRFA to

218.74 man-days after TRFA with a mean difference of 24.16 man-days ($t = 3.11^*$). The double difference value of 38.41 man-days demonstrates that TRFA farmers benefited more in terms of labour engagement and farm employment opportunities, likely due to the adoption of improved crop management and resource utilization practices encouraged by the TRFA interventions.

These findings suggest that TRFA has not only enhanced the economic status of farmers but also contributed to labour absorption in rural areas, reducing underemployment during the *rabi* season. The increase in income can be attributed to higher productivity, better input use efficiency and cost-effective technologies promoted under TRFA. Similarly, increased employment reflects the expansion of area under Bengal gram and mustard cultivation in rice fallows and the adoption of labour-intensive but remunerative practices such as integrated nutrient and pest management.

Overall, the TRFA programme proved to be an effective institutional intervention in improving the socio-economic conditions of pulse growers in rice-fallow areas. The double difference estimates confirmed that TRFA beneficiaries experienced greater economic gains and

employment growth than their Non-beneficiary counterparts. The present findings are in close agreement with those of Manjunatha *et al.* (2019), who evaluated the impact of the National Food Security Mission (NFSM) across major rice- and wheat-growing states of India. Their study revealed that NFSM farmers earned on average 40 per cent higher annual income (Rs.2,25,463 per household) compared to Non-NFSM farmers (Rs.1,60,621

per household), primarily due to increased productivity and cost reduction. Similarly, the programme also led to higher employment generation through better access to inputs and mechanization. These findings support the current study's observation that institutional programmes like TRFA play a vital role in raising farm income and employment levels by improving technology adoption, resource efficiency and capacity building among farmers.

Table 4. Double difference estimates on impact of TRFA on income and employment of respondents

Variables	Income (₹/year)			
	Before	After	Mean Difference	t-Statistics
Beneficiary	92900	151183	58283	19.76*
Non-Beneficiary	78508	109647	31439	13.82*
Double Difference	-	-	26844	7.38*
Variables	Employment (mandays/year)			
	Before	After	Mean Difference	t-Statistics
Beneficiary	202.16	264.75	62.58	14*
Non-Beneficiary	194.57	218.74	24.16	3.11*
Double Difference	-	-	38.41	4.11*

Note: * Indicates significant at 5%

Impact of TRFA scheme on income and employment in the study area

The results in Table 5 revealed that the intercept for income was Rs.78,508 with a standard error of 6551 and a t-value of 11.985, which was significant at 1% level. The coefficient for time (β_1) was Rs.31,138 and highly significant, indicating a positive increase in income over time. The coefficient for the intervention (β_2) was Rs.14,392 but was not statistically significant, whereas the interaction term (Time $\times$ Intervention, β_3) had a positive and significant coefficient of Rs.27,419, showing that the programme brought about a significant improvement in farmers' income due to the intervention. The R^2 value of 0.2268 indicated that about 22.68% of the variation in income was explained by the model. In terms of employment, the intercept coefficient was 194.583 mandays, the time coefficient (β_1) was 24.167, and the interaction term (β_3) was highly significant with 38.497 mandays, suggesting that the intervention led to a substantial increase in employment opportunities. The R^2 value for employment was 0.3833, explaining 38.33% of variation. The F-values were 22.97 and 48.68 respectively, confirming the overall significance of both models, and the number of observations used was 240.

Table 5. Difference-in-Differences Regression results for income and employment in the study area

SI. No.	Explanatory variables	Income (₹/year)			Employment (mandays)		
		Coefficient	Std. Error	t-value	Coefficient	Std. Error	t-value
1	Intercept (α)	78508**	6551	11.985	194.583**	4.488	43.356
2	Time (β_1) 1 for Beneficiary of TRFA and 0 for Non-beneficiary of TRFA	31138**	9264	3.361	24.167**	6.347	3.808
3	Intervention (β_2) 1 for income / employment before TRFA (2015) and 0 for income / employment after	14392	9264	1.553	7.583**	6.347	1.195

	TRFA (2024)						
4	Interaction (Time $\times$ intervention) (β_3) (DiD)	27419*	13129	2.088	38.497**	8.995	4.280
5	R ²	0.2268			0.3833		
6	F value	22.97			48.68		
7	Number of observations	240			240		

Note: * and ** indicates significant at 5% and 1%

Dependent variable: Income and employment

The increase in income and employment might have occurred due to the implementation of the Targeted Rice Fallow Area (TRFA) scheme, which enabled farmers to cultivate short duration pulse and oilseeds rice fallow lands and adopt improved management practices. The programme also provided input subsidies and technical guidance, resulting in better productivity and higher labour demand. The positive and significant interaction term indicated that farmers under the scheme experienced greater gains compared to non-beneficiaries due to enhanced access to inputs, extension support, and efficient use of land that was previously uncultivated. The intervention not only increased farm income but also generated additional employment days within the agricultural sector.

Overall, the difference-in-differences regression results clearly showed that the TRFA scheme had a favourable and statistically significant impact on both income and employment of the farmers in the study area. The results are consistent with the findings of Bhavani *et al.* (2022) reported a significant rise in profitability among seed-growing farmers due to the intervention of seed village programme Using Difference-in-Difference Approach in Telangana.

IV. CONCLUSION

The introduction of short-duration and drought-tolerant crops like black gram, green gram, horse gram, and chickpea in rice fallows offers a promising opportunity to enhance cropping intensity, soil fertility and overall farm productivity. The utilization of rice fallows for pulses not only ensures efficient land use but also aligns with sustainable agricultural goals and improves nutritional security for rural communities. Recognizing the importance of these fallow lands, the Government of India launched the Targeting Rice Fallow Areas (TRFA) Scheme in 2016–17 under the National Food Security Mission (NFSM). Apart from enhancing the area and production of

pulses and oilseeds, the broader objectives of the TRFA scheme include improving soil fertility and land productivity at the individual farm level, creating additional employment opportunities and strengthening the economic stability of farming households. The scheme also aims to restore farmers' confidence by promoting sustainable agricultural practices through crop diversification and efficient utilization of rice fallow lands. These efforts contribute to the long-term goals of achieving food and nutritional security, reducing dependency on imports of pulses and oilseeds and ensuring livelihood resilience among small and marginal farmers. To address the decline in pulse area and productivity after TRFA, there is a need to develop short-duration greengram and blackgram varieties which are suitable to the study area. These targeted measures could help revive and enhance pulse cultivation in rice fallow areas. There is a consistent negative growth in the area, production and productivity of mustard after the implementation of the TRFA scheme in the study area, introducing a crop replacement strategy (sunflower in place of mustard) could be considered. Promoting more suitable and climate-resilient crop such as sunflower may be promoted in rice fallow areas.

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