P-ISSN: 2618-0723
E-ISSN: 2618-0731

NAAS Rating: 5.04
www.extensionjournal.com

International Journal of Agriculture Extension and Social Development

Volume 7; Issue 8; August 2024; Page No. 510-515

Received: 04-05-2024
Accepted: 11-06-2024

Indexed Journal
Peer Reviewed Journal

Impact of Rythu Bharosa Kendras (RBKS) intervention on cost of cultivation of maize farmers in Guntur district of Andhra Pradesh

[1]E Devi Prasanna, [2]B Aparna, [3]V Sitarambabu and [4]D Ramesh

[1]M.Sc. (Ag.), Department of Agricultural Economics, Agricultural College, Bapatla, ANGRAU, Hyderabad, Telangana, India

[2, 3]Assistant Professor, Department of Agricultural Economics, Agricultural College, Bapatla, ANGRAU, Hyderabad, Telangana, India

[4]Assistant Professor, Department of Statistics and Computer Applications, Agricultural College, Bapatla, ANGRAU, Hyderabad, Telangana, India

DOI: https://doi.org/10.33545/26180723.2024.v7.i8h.973

Corresponding Author: E Devi Prasanna

Abstract

Agriculture is the primary source of livelihood for most of India's rural population for food production and quality to combat malnutrition and food scarcity. Number of schemes had been formulated to help the farmers to increase production and to reduce the cost of cultivation. Still, the farmers face many problems during the procurement of costly inputs, unable to access the market information and marketing of their produce *etc*. Keeping this in the view, YSR Rythu Bharosa programme was launched by the Hon'ble Chief minister of Andhra Pradesh, Sri. Y. S. Jagan Mohan Reddy on 15th October, 2019. Later "Rythu Bharosa Kendras" (RBKs) were established on 30th May, 2020 as a one-stop solution to farmers. This paper assesses the Impact of Rythu Bharosa Kendras (RBKs) intervention on cost of cultivation of maize farmers in Guntur district of Andhra Pradesh using Propensity Score Matching technique with a sample size of 180 maize farmers. The results of ATT revealed that the treated farmers have Rs. 12,228/ha to Rs. 20,405/ha lesser cost of cultivation when compared to the control farmers in the study area. Education (0.287), timely availability of inputs (2.514), access to extension services (1.180), trainings attended by the farmer (0.627), and farm management decisions of farmer (1.681) were found to be statistically significant and had a positive influence on participation in RBKs by the farmers in the study area. The participation in RBKs led to a significant difference in the cost of cultivation of maize farmers. The study recommended to provide inputs to farmers on credit basis, supply of new generation seeds, provision of storage facilities and minimal post-harvest facilities *etc.*, to improve performance of RBKs.

Keywords: Cost of cultivation, maize, propensity score matching, Rythu Bharosa Kendras

1. Introduction

Agriculture is the primary source of livelihood for most of India's rural population. With a growing population, India urgently needs to enhance food production and quality to combat malnutrition and food scarcity. Number of schemes had been formulated to help the farmers to increase production, decrease the cost of cultivation and to protect them from paying high interest rates but they only serve a definite population, because of long reach of farmers from higher level of authority i.e., where the schemes are formulated. Still, the farmers face many problems during the procurement of inputs, high costs of inputs, unable to access the market information and marketing of produce *etc*. Hence, a strong integrated platform is necessary to resolve all these issues and increase the farmer's income. Keeping this in the view, YSR Rythu Bharosa programme was launched by the Hon'ble Chief minister of Andhra Pradesh, Sri. Y.S. Jagan Mohan Reddy on 15th October, 2019. Later "Rythu Bharosa Kendras" (RBKs) were established on 30th May, 2020 as a one-stop solution to supply seeds, fertilizers *etc.*, to agriculture sectors and also to provide services to other allied activities. This initiative has brought about a significant transformation in the agricultural sector by addressing the comprehensive needs of farmers, ranging from seed selection to final sale.

At present, there are 8912 RBKs in the state (apwardsachivalayam.ap.gov.in). RBKs provide single window services to farmers across the state i.e., from making available pre- certified quality inputs to farm advisories and providing remunerative prices for the farmers' produce. These RBKs have digital kiosks and apps to help the farmers in purchasing of agri inputs like seeds, fertilizers, pesticides, livestock feeds, and veterinary medicines *etc*.

Maize crop is selected for the study as it is one of the major crops grown in India, and is globally known as 'Queen of Cereals'. It is the third most important cereal crop in India. India produced 31.51 million tonnes of maize in an area of 9.9 million ha (ANGRAU Maize Outlook, 2021) [1]. In Andhra Pradesh, maize was cultivated in an area of 3.01 lakh ha with a production of 17.84 lakh tonnes and productivity of 5918 kg/ha, contributing 5.66 percent to total country's production (*des.ap.gov.in*, 2020-21).

The present study entitled "Impact of Rythu Bharosa

Kendras (RBKs) Intervention on Cost of Cultivation of Maize farmers in Guntur district of Andhra Pradesh" was undertaken to examine the factors of RBKs influencing the cost of cultivation of maize farmers in Guntur district of Andhra Pradesh.

2. Collection of data

Both primary and secondary data were employed in this study. The requisite primary data was collected from the sample farmers using pre-tested schedule. Required secondary data was collected from Directorate of Economics and Statistics, Andhra Pradesh, 2020-2021, Department of Agriculture -Government of Andhra Pradesh, *des.ap.gov.in*, Directorate of Economics and Statistics, Telangana, Department of Agriculture -Government of Telangana and Telangana State Statistical Abstract, 2020-21

3. Materials and Methods

A multistage purposive sampling technique was employed to select the state, district, mandals, and villages, while farmers were selected randomly. Andhra Pradesh state was selected as it is the only state with RBKs, with maize being a major crop (17.84 lakh tonnes production and 5918 kg/ha productivity, *des.ap.gov.in*, 2020-21). Telangana was also selected for comparison, serving as the control state while Andhra Pradesh is the treated state. In Andhra Pradesh, Guntur district was selected due to its highest maize production (392,116 tonnes) and productivity (9614 kg/ha) (Directorate of Economics and Statistics, Andhra Pradesh, 2020- 2021). In Telangana, Warangal district was selected for its leading maize production (305,544 tonnes) and productivity (6970 kg/ha) (Telangana State Statistical Abstract, 2020-21). In Guntur, Bhattiprolu and Ponnur mandals were selected and in Warangal, Duggondi and Nekkonda mandals were selected for their highest maize production. From Guntur's Bhattiprolu mandal, Pedapulivarru and Oleru villages were selected and from Ponnur mandal, Munipalle and Dandamudi villages were selected for their highest maize production. In Warangal's Duggondi mandal, Mallampalle and Muddunoor villages were selected and from Nekkonda mandal, Chandrugonda and Redlawada villages were selected for their highest maize production. In Andhra Pradesh, 15 farmers were randomly selected from each village, totaling 60 farmers. In Telangana, 30 farmers were randomly selected from each village, totaling 120 farmers. The overall sample size comprised 180 farmers.

3.1 Propensity Score Matching (PSM) technique

The Propensity Score Matching (PSM) technique introduced by Rosenbaum and Rubin (1983) [14] is the primary approach used in this study to control for selection bias based on observable characteristics. The basic idea behind the PSM method is to find control observations (farmers not availing benefits from RBK) having observable characteristics as similar as possible to the treatment farmers (farmers availing benefits from RBK), to serve as valid surrogates for the missing counterfactuals. The Propensity Score Matching (PSM) approach aims to encapsulate the influences of various observed covariates X on participation within a single propensity score or index. Subsequently, outcomes of treated and control groups possessing similar propensity scores are contrasted to derive the program effect. Farmers without a suitable match are excluded from the analysis. PSM constructs a statistical comparison group that is based on a model of the probability of participating in the treatment T conditional on observed characteristics X, or the propensity score: P (X) = Pr (T = 1|X). It follows that the expected treatment effect for the treated population is of primary significance. Where, P (X) is propensity score and Pr is the probability of receiving the treatment.

T=1, for treated farmers and T=0 for control farmers. The PSM can be expressed as,

$$P(z) = Pr\{T = 1/Z\} = E\{1/Z\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where T = {0,1}is the indicator for treated group and Z is the vector of pre-adoption characteristics. The conditional distribution of Z, given p (Z) is similar in both groups of treated and control.

PSM must meet the balancing property, which states that after matching, the covariate means of members and non-members must be equal We calculate the average treatment effect on the treated (ATT) after satisfying these assumptions, which is the influence on participation in RBKs by the farmers.

The ATT is calculated as follows:

$$ATT = E(Y1 - Y0/Ci = 1) = E(Y1/Ci = 1) - E(Y0/Ci = 1) \ldots. (1)$$

Where, Y1 and Y0 are the performance indicators of farmers in the treated and untreated conditions, respectively; and Ci is an indicator variable denoting participation in RBKs.

Probit model was used to estimate the conditional likelihood that a farmer's participation in RBKs based on the observed features. The cost of cultivation of maize farmer converted in terms of 000'Rs/ha is the key outcome variable of PSM technique used in this study. Among the matching variables, experience of farmer in farming, education, farm size, distance to input market (km) and training programmes attended by the farmers were continuous variables. Timely availability of inputs, access to extension services, access to farm machinery and farm management decisions were considered as dummy variables. Matching algorithms are employed in the second stage to match treatment and control groups. The ATT is estimated using standard matching methods such as Kernel Based Matching, Radius Matching Method, Stratified Matching Method. PSM necessitates the balancing property, *i.e.,*

matching the observed covariate distribution to eliminate systematic differences in the distribution of covariates and ensuring common support in the two groups after matching.

Farmers from Guntur district in Andhra Pradesh were taken as treated group (farmers availing benefits from RBK) and farmers from Warangal district in Telangana were taken as controlled group (farmers do not availing benefits from RBK). The variables used for probit model are listed in the Table 1.

Table 1: Description of variables used in PSM and Probit regression model

Variable type	Abbreviation	Variable Expansion	Variable type
Outcome variable (for PSM)	Cost of cultivation of maize 000'Rs/ha	Cost of cultivation of maize converted in terms of 000'Rs/ha	Continuous
Treatment variable (dependent variable for probit)	Treatment	Farmers participation in RBK	Dummy (1= Treated 0= Controlled)
Independent variables	Education	Number of years of education (years)	Continuous
	Experience	Experience in farming (years)	Continuous
	Farm size	Size of the farm (ha)	Continuous
	Distance to input market (km)	Distance from village to nearby input market place	Continuous
	Timely availability of inputs	Whether inputs to farmers were available at proper time	Dummy (1= Yes, 0= No)
	Access to extension services	Whether farmer has access to any extension services	Dummy (1= Yes, 0= No)
	Access to farm machinery	Whether farmer has access to farm machinery	Dummy (1= Yes, 0= No)
	Trainings received	No. of training programmes attended by farmers	Continuous
	Farm management decisions	Whether the farm management decisions were profitable	Dummy (1= Yes, 0= No)

4. Results and Discussion

4.1 Variable description and descriptive analysis of treated farmers, control farmers and pooled sample

The descriptive statistics of the sample respondents is presented in Table 2. The overall average cost of cultivation of the farmer was Rs. 1,00,550/ha. The cost of cultivation of treated farmers was Rs. 86,890/ha which was lower than control farmers (Rs. 1,07,390/ha). The treated farmers had more years of education (3.68 years) than control farmers (2.73 years) whereas, the overall education of farmers was 3.04 years. The results were similar with the findings of Babu *et al.* (2023) [23]. The overall farming experience of farmers was 24.63 years. The treated farmers had three years less experience (22.42 years) in farming compared to control farmers

(25.74 years). The results were similar with the findings of Babu *et al*. (2023) [23]. The overall farm size of farmers was found to be 2.14 ha. The treated farmers had larger farm size (2.51 ha) compared to control farmers (1.96 ha). The results were found similar with the findings of Anuhya *et al*, 2022 [2] and Sathish and Chandargi, 2019 [15]. The average distance to input market is found to be similar for both treated (5.98 km) and control (5.77 km). Treated farmers have more access to timely availability of inputs as they purchase most of their inputs (E.g., Fertilizers) from RBKs compared to control farmers who purchase their inputs from open markets. The results were found to be similar with the findings of Mandi *et al.* (2022) [13] and Emmanuel *et al.* (2016) [9]. The treated farmers have more accessibility to extension services compared to control farmers. However, accessibility for farm machinery is almost similar for both treated and control farmers. The overall number of trainings received by farmers was 2.02 on an average, treated farmers received more trainings (7) conducted by RBKs compared to control farmers (2). The farm management decisions of treated farmers (0.98) were better than control farmers (0.78) because treated farmers had more interactions with Agricultural assistants, extension services and have attended a greater number of training programmes compared to control farmers.

Before calculating the propensity scores for the sample farmers and deriving the average treatment effect on the treated (ATT), Probit model was employed to find out the determinants of farmers participating in RBKs.

Table 2: Variable description and descriptive analysis of treated farmers, control farmers and pooled sample

Variable Type	Variable	Variable Description	Treated farmers (60)		Control farmers (120)		Pooled sample (180)	
			Mean	S. D	Mean	S. D	Mean	S. D
Outcome variables	Cost of cultivation	Cost of cultivation of maize converted in terms of 000'Rs/ha	86.89	6.64	107.39	19.16	100.55	18.78
Matching Variables	Education	Number of years of education (years)	3.68	1.21	2.73	1.24	3.04	1.31
	Experience	Experience in farming (years)	22.42	9.25	25.74	10.38	24.63	10.11
	Farm size	Size of the farm (ha)	2.51	1.31	1.96	1.56	2.14	1.50
	Distance to input market	Distance from village to nearby input market place (km)	5.98	1.81	5.77	1.80	5.84	1.80
	Timely availability of inputs	Whether inputs to farmers were available at proper time. (1=yes, 0=no)	0.93	0.25	0.91	0.29	0.92	0.28
	Access to extension services	Whether farmer has access to any extension services (1=yes, 0=no)	0.88	0.32	0.73	0.45	0.78	0.42
	Access to farm machinery	Whether farmer has access to farm machinery (1=yes, 0=no)	0.72	0.45	0.77	0.42	0.75	0.43
	Trainings received	No. of training programmes attended by farmers	6.7	1.58	1.70	1.23	2.02	1.43
	Farm management decisions	Whether the farm management decisions were profitable (1=yes, 0=no)	0.98	0.13	0.78	0.42	0.84	0.36

4.2 Determinants for farmers participation in RBKs based on Probit regression model

The determinants for farmers participation in RBKs were analysed using Probit regression model and presented in the Table 3. The estimated marginal effects were used to interpret the results as the coefficient of parameters was not suitable for interpreting magnitudes in probability models. The sign of the marginal effect values indicates the direction of the influence of the explanatory variables on the dependent variable *i.e.,* Farmers participation in RBKs, while the magnitude shows the size of the probability of effects.

Table 3: Determinants of farmers participation in RBKs based on Probit regression model

S. No.	Independent Variable	Coefficient	Standard Error	P>|z|	Marginal Effects
1.	Education	0.287	0.039	0.027	0.086**
2.	Experience	-0.014	0.005	0.426	-0.004
3.	Farm size	0.063	0.034	0.578	0.019
4.	Distance to input market	0.124	0.026	0.149	0.038
5.	Timely availability of inputs	2.514	0.051	0.000	0.294***
6.	Access to extension services	1.180	0.066	0.000	0.266***
7.	Access to farm machinery	0.008	0.119	0.983	0.002
8.	Trainings attended by farmer	0.627	0.041	0.000	0.189***
9.	Farm management decision of farmer	1.681	0.052	0.000	0.298***
	Number of observations	180			
	Prob> chi2	0.000			
	Pseudo R2	0.3312			

Note: *** At 1 percent level of significance, ** At 5 percent level of significance, * At 10 percent level of significance

From the Table 3., it was observed that, experience, farm size, distance to input market and access to farm machinery were found to be statistically non-significant. Even though farm machinery costs more, maize crop cultivation is less dependent on farm machinery *viz*., for land preparation tractors are used but for harvesting labourers are used instead of harvesters.

Education shows statistically significant influence on the farmers participation in RBKs. Because educated farmers are more adaptive to new technologies and practices which makes them more efficient. The marginal effect of 0.086 interprets that a unit increase in education, there is a 8.6 percent increase in probability of participation in RBKs.

Timely availability of inputs was found to be statistically significant and had a positive influence. The marginal effect of 0.294 interprets that a unit increase in the timely availability of inputs, there is an increase in the probability of participation in RBKs by 29.4 percent.

Timely availability of inputs plays a major role in decreasing the cost of cultivation of farmer. The results coincided with findings of Mandi *et al.* (2022) [13].

Access to extension services for farmers has shown a statistically significant and positive impact on their likelihood of participating in RBKs. The marginal effect of 0.266 indicates that for each unit increase in access to extension services, there is a 26.6 percent increase in the probability of participating in RBKs. Extension services provide farmers with vital resources such as market information on Minimum Support Prices (MSP), weather information and technical advice from scientists, which help enhance their production and create opportunities to secure better prices for their produce in the market. Farmers with access to these services are more likely to be informed about the benefits of RBKs, positively influencing their decision to participate. These findings similar with the results of Mandi *et al.* (2022) [13] and Emmanuel *et al.* (2016) [9], but contrast with the conclusions of Karen *et al*. (2021) [12].

Trainings received by the farmer showed a statistically significant and positive influence. The marginal effect of 0.189 interprets that a unit increase in the trainings received by the farmer, there is an increase in the probability of participation in RBKs by 18.9 percent. Trainings helps farmer to enhance their knowledge on crop management practices which results in minimizing the costs and maximizing the profits. These findings similar with the results of Sisang and Lee (2023) [16] and Jabbar *et al.* (2022) [11].

Farm management decisions of the farmers showed a statistically significant and positive influence. The marginal effect of 0.298 interprets that a unit increase in the trainings received by the farmer, there is an increase in the probability of participation in RBKs by 29.8 percent. Due to the training programmes arranged by RBKs, the decision-making capacity of the farmers was improved in the study area.

4.3 Propensity scores of treated farmers and control farmers

The Table 4. depicts the details of the propensity scores and the distribution of treated and control farmers among them. The propensity scores ranged from 0.043 to 0.8. The highest number of respondents fell under the propensity range of 0.2, and the lowest number in the range of 0.7. Totally, 60 treated farmers were matched with 88 control farmers.

4.4 Common support and propensity score graph (ps-graph)

The reliability of Propensity Score Matching (PSM) results hinges significantly on the quality of matching. The overlap between the estimated propensity scores of treated and control farmers is a key criterion for assessing this quality.

Table 4: Propensity scores of treated and control farmers in the study area

Inferior of block of p-score	Treatment		Total
	0	1	
0.043	31	3	34
0.2	41	9	50
0.4	7	14	21
0.6	4	25	29
0.7	3	0	3
0.8	2	9	11
Total	88	60	148

Common support refers to the overlap interval between the propensity scores of individuals in the treatment group and those in the control group. Generally, a wider range of common support indicates better matching quality. It is clear from the ps-graph (Fig. 1.), that there is a considerable range of overlap between the propensity score of the treated farmers and the control farmers. The ps-graph was used to observe the number of treated farmers and control farmers who got support and those who do not find their support in the distribution. More specifically, the common support area is [0.043, 0.8] which is associated with a loss of few observations owing to matching. In the graph, most of the treated and control farmers were concentrated from 0.043 to 0.6. The proportion of respondents falling under p-score greater than 0.6 is low. However, the number of observations lost varies depending on the matching method used. It is common practice to employ multiple matching methods in such analyses. In the current study, three matching methods were selected: the Kernel-Based matching method, the Radius matching method, and the Stratified matching method. Regardless of the matching method employed, the common support condition is well satisfied (Fig. 1). A contrast pattern was observed in the study by Karen *et al.* (2021) [12] and Gershon *et al.* (2020) [10] where the number of untreated observations with lower propensity scores was more than those of the treated.

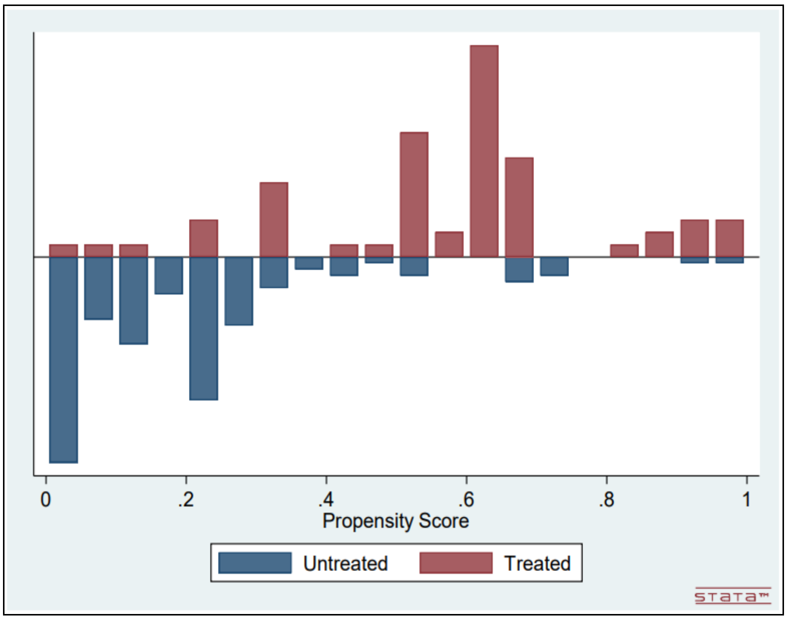

Fig 1: ps-graph of treated and control farmers in the study area

4.5 Impact of RBKs on cost of cultivation of maize farmers

Impact of RBKs on cost of cultivation of maize farmers was measured from both Average treatment effect (ATE) and Average Treatment Effect on the Treated (ATT) of the matching methods.

Table 5: Average Treatment Effect (ATE) of sample farmers

ATE	Coefficient	Standard error	P>Z
Cost of cultivation of maize farmers (000'Rs/ha)	-17.613***	3.213	0.000

Note: *** At 1 percent level of significance, ** At 5 percent level of significance, * At 10 percent level of significance

4.5.1 Average treatment effect (ATE)

The Average Treatment Effect (ATE) measures the impact of a treatment (in this case, participation in RBKs) on both the treated and control farmers. Although the treatment is typically administered only to the treated farmers, the entire population might experience some direct or indirect effects from it. Therefore, the ATE reflects the impact of the treatment on the entire sample. According to the Table 5, the ATE of RBKs on the cost of cultivation for maize farmers is Rs. 17,613/ha. The p-value of 0.000 indicates its significance at 1 percent level of significance. This indicates that by participating in RBKs, farmers reduced their cost of cultivation by Rs.17,613/ ha.

4.5.2 Average Treatment effect on the Treated (ATT)

ATT is the effect of treatment (participation in RBKs) actually applied on the treated farmers. The current study employed ATT to study the impact of RBKs on cost of cultivation of maize farmers. The average effect of the treatment on the treated (ATT) estimates with three different matching methods for cost of cultivation of maize is presented in Table 6. The matching methods namely Kernel Based matching method (attk), Radius matching method (attr) and Stratified matching methods (atts) were employed to analyse the group of 180 observations to find a proper match among the distribution of observations. All the three matching methods *i.e.*, Kernel matching method and Stratified matching method matched 60 treated farmers with 88 control farmers whereas Radius matching method matched 59 treated farmers with 88 control farmers. The results for ATT received by the farmers for various matching methods were presented in Table 6.

The PSM results shows significant difference in cost of cultivation of maize farmers who participate in RBKs. The results are also highly consistent across different matching methods. In terms of the magnitude of effects, participation in RBKs would decrease the cost of cultivation of maize between Rs. 12,228/ha to Rs. 20,405/ha.

Table 6: Average Treatment effect on the Treated (ATT) of cost of cultivation of maize farmers by various matching methods

Outcome variable	Matching Method	No. of treated farmers matched	No. of control farmers matched	ATT	Standard Error	Bias	T
Cost of cultivation of maize farmers (000'Rs/ha)	attk	60	88	-15.802***	2.668	-0.071	-5.924
	attr	59	88	-20.405***	2.957	-0.077	-6.901
	atts	60	88	-12.228***	1.873	-0.062	-6.563

Note: *** At 1 percent level of significance, ** At 5 percent level of significance, * At 10 percent level of significance

From Table 6., it was observed that, the Kernel matching method generated ATT of 15.802 with a bias of -0.071, standard error of 2.668 and T-value of -5.924 at 1 percent LOS. The radius matching method generated ATT of -20.405 with a bias of -0.077, standard error of 2.957 and T-value of -6.901 at 1 percent LOS. The Stratified matching method generated ATT of -12.228 with a bias of -0.062, standard error of 1.873 and T-value of -6.563 at 1 percent LOS, indicating that the treated farmers experienced less cost of cultivation from the participation in RBKs. Thus, the above results clearly indicate that the treated farmers have less cost of cultivation in the range of Rs. 12,228/ha to Rs. 20,405/ha due to the farmers participation in RBK. Similar results were reported by El-Shater (2016) [8] and Becerril and Abdulai (2010) [4].

5. Conclusion and Recommendations

Experience, farm size, distance to input market and access to farm machinery showed a non-significant influence on participation in RBK, while education, timely availability of inputs, access to extension services, trainings attended by the farmer and farm management decisions of the farmers showed a statistically significant and positive influence on participation in RBK. Thus, the results clearly indicate that the treated farmers have lesser cost of cultivation compared to control farmers due to the farmers participation in RBKs. This shows that RBKs have potential impact on cost of cultivation of maize farmers. To enhance the performance of RBKs, it is recommended to provide inputs to farmers on credit basis, supply of new generation seeds, provision of storage facilities and minimal post-harvest facilities by providing tarpaulins *etc.*, can enhance the RBKs performance and reduces the risk factors in agriculture.

6. References

1. ANGRAU. Maize Outlook; c2021. [cited 2024 Aug 20]. Available from: [URL if available].
2. Anuhya P, Khare NK, Bisht K, Nahatkar SB. Extent of adoption of Rythu Bharosa Kendra's technologies and services in Anantapur district of Andhra Pradesh. Asian J Agric Ext Econ Sociol; 2022;40(10):51-55.
3. Babu NN, Venkataramulu M, Prasad HV, Sarma ASR, Usha M. Impact of Rythu Bharosa Kendra's as perceived by the farmers. Asian J Agric Ext Econ Sociol. 2023;41(9):606-616.
4. Becerril J, Abdulai A. The impact of improved maize varieties on poverty in Mexico: A propensity score-matching approach. World Dev. 2010;38(7):1024-1035.
5. Department of Agriculture - Government of Telangana; 2024 Aug. Available from: https://agri.telangana.gov.in/
6. Directorate of Economics and Statistics. Government of Andhra Pradesh. Andhra Pradesh Statistical Abstract; c2020-2021. [cited 2024 Aug 20]. Available from: https://des.ap.gov.in/
7. Directorate of Economics and Statistics. Government of Andhra Pradesh. cited 2024 Aug 20. Available from: https://des.ap.gov.in/
8. El-Shater T, Yigezu YA, Mugera A, Piggin C, Haddad A, Khalil Y, *et al*. Does zero tillage improve the livelihoods of smallholder cropping farmers? J Agric Econ. 2016;67(1):154-172.
9. Emmanuel D, Owusu-Sekyere E, Owusu V, Jordaan H. Impact of agricultural extension service on adoption of chemical fertilizer: Implications for rice productivity and development in Ghana. NJAS Wageningen J Life Sci. 2016;79(1):41-49.
10. Gershon O, Matthew O, Osuagwu E, Osabohien R, Ekhator-Mobayode UE, Osabuohien E. Household access to agricultural credit and agricultural production in Nigeria: A propensity score matching model. S Afr J Econ Manag Sci. 2020;23(1):1-11.
11. Jabbar A, Liu W, Wang Y, Zhang J, Wu Q, Peng J. Exploring the impact of farmer field schools on the adoption of sustainable agricultural practices and farm production: A case of Pakistani citrus growers. Agronomy. 2022;12(9):1-13.
12. Karen A, El Azhari M, Laamari A, Martin J, Hattab S, Bomba Z, *et al*. Impact of mobile-based extension service on wheat yield among rural farmers of Settat Province, Morocco. Int J Finan Account Econ Manag Audit. 2021;3(5):918-935.
13. Mandi K, Chakravarty R, Ponnusamy K, Kadian KS, Dixit AK, Singh M, *et al*. Impact of Jharkhand state cooperative milk producers' federation on socio-economic status of dairy farmers. Indian J Ext Educ. 2022;58(2):47-52.
14. Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. Biometrika. 1983;70(1):41-55.
15. Sathish HS, Chandargi DM. Farmers' perception of effectiveness of public extension organizations. J Pharmacogn Phytochem. 2019;8(4):1181-1186.
16. Sisang BB, Lee JI. Impact of improved variety adoption on rice productivity and farmers' income in Cameroon: Application of propensity score matching and endogenous switching regression. J Agric Life Environ Sci. 2023;35(1):26-46.
17. Telangana State Statistical Abstract. Government of Telangana; c2024 Aug. Available from: https://www.telangana.gov.in/