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Impact of Jharkhand State Cooperative Milk Producers' Federation on Socio-economic Status of Dairy Farmers

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ABSTRACT

The paper assesses the impact of membership of dairy cooperative i.e. Jharkhand State Cooperative Milk Producers' Federation (JMF) on the performance of dairy production systems using propensity score matching techniques. Dairy cooperative members differed significantly from non-members in terms of outcome variables. The mean difference value explained that the socio-economic condition of members was better than non-members. The findings revealed that membership of JMF contributes towards improving yields of dairy animals, net dairy income, and also, to household milk consumption. The non-members reaped better price for the milk in the wet market as compared to the members. Nonetheless, the member-producers recorded higher proportion of milk sale as compared to the non-members which also indicated their intensity of market participation. These results indicate towards the need to improve dairy farmers' linkages through cooperatives or other such institutions for their socio-economic development.

INTRODUCTION

India is the world's largest producer of milk, with 22 per cent of global production (FAO, 2019). According to NDDB (2019), India produced 187.7 MT of milk with per capita availability of 394 g/day. The dairy industry accounts for 27 per cent of agricultural GDP and 67 per cent of overall livestock output, thus providing employment opportunity for over 70 million people (GoI, 2018). The co-operative framework of dairy development initiatives is credited with much of the success of India's "White Revolution". India with the world's largest Dairy Cooperative structure, at present, constitutes 163 lakh dairy farmer members, 1.77 lakhs village dairy cooperative societies, 218 district milk cooperative union and 27 state milk federations. Previous research indicates that farmers' participation in dairy cooperatives has resulted in a significant increase in milk production and productivity, as well as a reduction in per-unit milk production costs, allowing them to achieve higher output prices, lower transaction costs, and increased profits (Labrecque et al., 2015). Cooperatives have been found to increase farmers' bargaining power, resulting in more competitive prices for both inputs and outputs, as well as to reduce transaction costs, improve information symmetry, and improve agro food safety and quality standards (Holloway et al., 2000; Valentinov, 2007; Hellin et al., 2009; Markelova et al., 2009; Moustier et al., 2010; Jia et al., 2012; Trebbin, 2014; Singh et al., 2014) Farmers can ensure a stable market and fair prices by cooperatively establishing their own collection system and processing facilities (Uotila & Dhanapala, 1994; Birchall, 2004; Das et al., 2015). Dairy farming entails a high level of market dependence as well as socio-economic values (Bor, 2014), wherein DCs help dairy farmers to vertically integrate to countervail power against oligopolistic powers in distribution and retailing (Van der Krogt et al., 2007) by organizing dairy supply chains with better strategic logistics between production, processing and distribution (Berre et al., 2014) in emerging markets (D'Antoni and Mishra, 2012) and reducing financial risk and economic uncertainty faced

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by members in a mature market (Maynard, 2009) due to increasing volatility in milk and feed prices (Wolf & Widmar, 2014) and paying dairy farmers the milk price at levels that far exceeds market prices (Charlebois & Labrecque, 2009).

Even though India is self-sufficient in milk production following the Operation Flood Programme, milk production in India is not uniformly distributed, resulting in a large demand and supply gap for milk and milk products in a few states such as Jharkhand. The state currently ranks 17th in both milk production and milk productivity (GoI, 2019). With a view to give impetus to dairy development in Jharkhand, the State Government formed the Jharkhand State Cooperative Milk Producers' Federation (JMF) in August 2014, with an aim to promote dairying as a source of livelihood in the rural parts of the State and propel Jharkhand towards self-reliance in milk and milk products. Therefore, the study attempts to assess the overall impact of JMF on member-producers.

METHODOLOGY

The study was conducted in Jharkhand State. A total sample of 360 respondents, comprising of JMF members (180) and non-members (180) were purposively selected from three districts of Jharkhand viz. Ranchi, Latehar and Ramgarh for this study. To access the impact of JMF on socio economic status of dairy farmers, Propensity Score Matching (PSM) was espoused for this study since PSM based on conditional independence assumption (CIA) can address the problem of selection bias by conditioning on the observed characteristics by pairing each member household with one or more non-member households with similar observed characteristics, according to Rosenbaum & Rubin (1985), Heckman et al., (1997); Caliendo & Kopeinig (2005). Matching models, in essence, replicate the conditions of a random assignment of members and non-members in an experiment. Finally, PSM must meet the balancing property, which states that after matching, the covariate means of members and non-members must be equal (Chagwiza et al., 2016; Mojo et al., 2017). We calculate the average treatment effect on the treated (ATT) after satisfying these assumptions, which is the influence of dairy cooperative membership on the dairy farm performance metrics of interest. The ATT is calculated as follows:

$$ATT = E(Y_1 - Y_0/C_i = 1) = E(Y_1/C_i = 1) - E(Y_0/C_i = 1) \quad \ldots. (1)$$

Where, Y_1 and Y_0 are the performance indicators of dairy production system in the treated and untreated conditions, respectively; and C_i is an indicator variable denoting cooperative membership status.

Probit model was used to estimate the conditional likelihood that a household will join a dairy cooperative based on the observed features. The age and education of the household head, family size, herd size, ownership of dairy animals, distance to market, access to institutional credit, and experience in dairy farming are all independent variables. The definitions and measurements of these variables are listed in Table 1. Matching algorithms are employed in the second stage to match treatment and control groups. The ATT is estimated using standard matching methods such as nearest neighbour matching (NNM), Epanechnikov kernel based matching (KBM) with bandwidth 0.06, and radius matching (RM) with calliper 0.1. 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.

RESULTS AND DISCUSSION

The impact of dairy cooperatives on a few key farm performance indicators in Jharkhand (both members and non-members) was investigated. Due to the non-experimental character of the data, the selection bias was addressed using the propensity score matching technique. The findings show that there was bias in the distribution of variables across treatment and comparison groups, implying that self-selection bias must be taken into account in order to generate unbiased estimates of outcome indicators. Table 1 shows the descriptive and inferential statistics. An analysis of t-test indicates that there was statistically significant difference

Table 1. Descriptive statistics for outcome and explanatory variables

Variables	Member		Non-member		Mean
	Mean	S.E.	Mean	S.E.	difference
Milk yield	11.59	0.58	8.81	0.26	2.78**
Net Dairy Income	105614.28	5861.41	90606.66	4087.69	15007.61*
Proportion of dairy income	0.62	0.008	0.52	0.005	0.10**
Milk price	33.26	0.49	37.14	0.18	-3.88**
Proportion of milk sold	1.42	0.03	1.19	0.02	0.23**
Per capita milk consumption	195	0.54	165	0.27	30.0**
Age	46.21	1.08	42.26	1.07	3.95
Education	8.61	0.50	4.64	0.38	3.97**
Family size	7.45	0.27	6.42	0.18	1.03
Herd size	13.27	0.39	6.24	0.20	7.03
Milch animals	5.56	0.20	2.94	0.09	2.61**
Market distance	6.64	0.25	3.62	0.12	3.02**
Access to credit	0.96	0.01	0.86	0.02	0.09**
Experience in dairy farming	10.99	0.23	10.15	0.28	0.84
Extension services	0.85	0.07	0.72	0.21	0.13*
Provision of veterinary services	0.92	0.22	0.68	0.17	0.24*
Input supply	0.82	0.05	0.74	0.02	0.08**

** and * denote significance at 1 and 5 per cent level, respectively

between members and non-members in terms of different socio-economic attributes. Dairy cooperative members differ significantly from non-members in terms of outcome variables. The mean difference value explained that the socio-economic condition of members was better than non-members. Members and non-members were similar in age, family size, herd size, and dairy farming experience, but not in education, ownership of dairy animals, market distance, access to credit, extension services, veterinary services, or input supply, according to the results corresponding to the observed covariates. Heads of member families, for example, were better educated than their non-member counterparts and were more likely to use advanced breeding, feeding, and healthcare technology. Furthermore, compared to non-member farmers, most farmer-members had better access to credit through formal sources. Members also have better access to extension services, veterinary services, and input supplies than their non-member competitors. This further indicates that farmers with better access to credit could meet the daily expenses of feed, fodder and mineral mixture for their dairy animal herd. The majority of the members accessed credit facilities through banks and government schemes in the form of short-term loans. Besides this, extension services like training, demonstration and advisory services are provided through different field level extension functionary regarding improved dairy farming practices. This empowered dairy farmers in better decision making and influenced their participation in dairy cooperatives. Provision of regular veterinary services like vaccination, A.I., treatment of chronic diseases etc. by JMF veterinary staff or government veterinary officers created health awareness among dairy farmers to timely diagnose and treat their animals, thus maintaining proper healthcare of their milch cattle and buffalo. In addition to this, the members are largely benefitted from a wide range of extension and input services offered by JMF. The grassroots extension workers and dedicated staffs employed by JMF offers solutions and caters to various aspects of dairy farming viz. breeding, feeding, healthcare, management and extension and advisory needs of the member-producers from time to time. Again, farmers residing farther to market are more inclined to be associated with dairy cooperative (JMF) as most of the member-producers resided near to the vicinity of the milk pooling points (MPPs), wherefrom JMF regularly procured the milk.

Table 2. Probit estimation: Socio-economic variables influencing farmers' participation in Dairy Cooperative (JMF)

Variables	Coefficient	Standard error	Marginal effect
Age	0.03	0.03	0.00
Education	0.28*	0.09	0.04
Family size	0.01	0.05	0.00
Herd size	0.10	0.05	0.01
Milch animals	1.78**	0.25	0.57
Market distance	0.23**	0.08	0.08
Access to credit	0.98**	0.33	0.37
Experience in dairy farming	0.32	0.38	0.02
Extension services	0.25*	0.04	0.50
Provision of veterinary services	0.62**	0.02	0.09
Input supply	0.75**	0.29	0.28
Constant	-1.05	0.67	
LR Chi^2 (11)	116.42**		
Prob> Chi^2	0.000		
Pseudo R^2	0.4368		
Number of observation	360		

** and * denote significance at 1 and 5 per cent level, respectively

Determinants of participation and impact of participation in dairy cooperative

The Probit regression findings described in Table 2 show that a few observable covariates can be used to estimate the conditional Dairy Cooperative (JMF) membership density. The explanatory variables had a combined statistical significance of 116.42 (LR Chi^2 test statistics) (p-0.000). The pseudo R^2 (0.4368) was relatively high, indicating that the model is a good fit. The education level of the household-head had a significant and positive impact on the likelihood of becoming a member of a dairy cooperative (JMF) (p-0.01). Theoretically, knowledge allows a person to better understand the potential benefits of cooperative membership. Other variables that were positively and significantly associated with JMF membership include the number of milch animals, market distance, access to institutional credit, provision of extension services, provision of veterinary services and input supply. Dairy cooperatives are more likely to be joined by farm households that owned at least one crossbred cow or buffalo and have access to formal credit. Herd size had a positive but non-significant effect ($p>0.05$) on the likelihood of joining a dairy cooperative, showing that herd size may not be a determinant in membership decisions. Dairy cooperative participation is also unaffected by a farmer's past dairy farming experience. Cooperative membership, on the other hand, shows a positive and significant correlation with access to extension services, veterinary services, and input supply. The decision to join a cooperative is influenced by the distance from the nearest market. This suggests that farm households located farther from market had a higher rate of cooperative participation, confirming the notion that proximity to the market gives farmers additional possibilities for selling their produce through alternate channels.

The propensity score, as noted by Lee (2008); Becerril & Abdulai (2009), is primarily used to match the distribution of observable covariates between treated and control groups. As a result, the success of the propensity score is dependent on the resultant matching. The Pseudo R^2 has decreased significantly from 44 per cent before matching to 4-6 per cent after matching, as indicated by the covariate balancing test (Table 3). The likelihood-ratio of the joint significance of all regressors before matching was high across the matching estimators, showing that the treatment and comparison groups differed in a systematic manner. After matching, the differences between the two groups were eliminated, and the two groups became comparable (insignificant p-values after matching). Furthermore, after matching, there was a significant reduction in bias (66.98-76.44%). Finally, a visual examination of the propensity score distributions for JMF members and non-members after matching reveals that the groups are highly overlapping (Figure 1). Cooperative members and non-members who are a good match are labelled as 'treated on support' and 'untreated,' respectively. JMF members with bad matches from among the non-members are referred on the graph as 'treated off

Table 3. Indicators of matching quality before and after matching

Matching algorithm	Pseudo R^2 before matching	Pseudo R^2 after matching	LR χ^2 (p-value) before matching	LR χ^2 (p-value) after matching	Mean standardized bias before matching	Mean standardized bias after matching	Total % bias reduction
NNM[a]	0.44	0.06	116.42(p=0.000)**	0.47 (p=0.234)	53.9	17.8	66.98
KBM[b]	0.44	0.04	116.42(p=0.000)**	7.18 (p=0.517)	53.9	15.4	71.43
RM[c]	0.44	0.04	116.42 (p=0.000)**	7.00 (p=0.537)	53.9	12.7	76.44

** indicate significant at 1% level, [a]NNM= five nearest neighbor matching with replacement and common support, [b]KBM= kernel based matching with band width 0.06 and common support, [c]RM= radius matching with caliper 0.1 and common support

Figure 1. Distribution of the propensity scores and common support

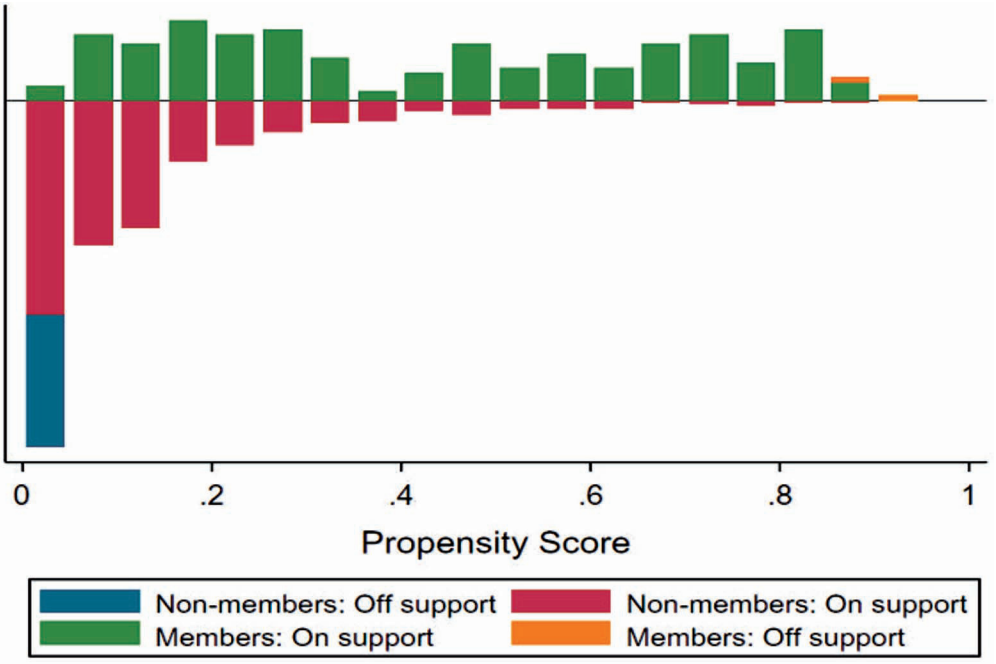

Table 4. Estimation of ATT: Impact of JMF on socio-economic status of the dairy farmers

Outcome variables	NNM (5)[b]	KBM (0.06)[c] ATT[a]	RM (0.1)[d]
Milk yield	1.99 (3.09)**	1.61 (2.05)**	1.80 (2.78)**
Net Dairy Income	70184.69 (2.97)**	67356.44 (2.95)**	68486.11 (2.98)**
Proportion of dairy income	0.09 (1.28)	0.09 (1.73)*	0.09 (1.78)*
Milk price	-4.90 (3.02)**	-4.26 (2.64)**	-4.50 (3.43)**
Proportion of milk sold	0.13 (1.68)*	0.11 (1.62)	0.10 (1.30)
Per capita milk consumption	134.86 (3.10)**	96.39 (1.94)*	110.58 (2.55)**

[a]ATT estimates of all matching algorithms are obtained through implementation of 'psmatch2'command (Leuven and Sianesi, 2003) in STATA 14. Figures in parentheses are bootstrapped z statistics using 50 replications;
* and ** indicate significant at 5% and 1% level, respectively.
[b]NNM (5) = five nearest neighbour matching with replacement and common support.
[c]KBM (0.06) = kernel based mathing with bandwidth 0.06 and common support.
[d]RM (0.1) = radius matching with caliper 0.1 and common support.

support'. Table 4 shows estimates of the influence of dairy cooperatives on selected farm performance indicators as an average treatment effect on the treated (ATT). Although the ATT results for different matching algorithms varied statistically, they are qualitatively identical. The milk yield of cooperative members is shown to be considerably higher than that of non-members. They, on the other hand, receive a lesser price than the open market price. Cooperatives give their members easy access to markets, as well as inputs and services, ensuring a greater yield. As a result, these advantages compensate for the cheaper milk price. Additionally, at the end of the year, cooperative members earn dividends. This is reflected in the higher annual net dairy income, higher consumption and higher milk sales. Furthermore, Kumar et al., (2013) discovered that DCS members possessed much more improved cattle breeds than independent farmers, resulting in significantly increased market participation. It is interesting to note

that members of dairy cooperative societies have significantly higher per capita household milk consumption compared to that by non-member households. This indicates that the commercialization of milk production has no negative impact on milk consumption. These findings are in line with those of previous investigations (Chagwiza et al., 2016; Kumar et al., 2013; Bardhan & Sharma, 2012). These studies, unlike ours, did not account for confounding factors that could impact farmers' self-selection.

The impact of JMF on smallholder dairy farmers across Jharkhand has been quite significant. It serves as the best alternative source for income generation and employment opportunities among dairy farmers. The data presented in Table 4 inferred that member-producers reaped higher milk yield than non-members. This was because members reared large herd sizes of milch animals comprising of high yielding crossbred cattle and buffalo. As a result of this members accrued higher net dairy income, as well as proportions of dairy income since they regularly disposed bulk quality of milk to the dairy cooperative. Besides this, the proportion of milk sold by the member-producer was also higher as compared to the non-members, and a statistically significant difference between them was observed at a 5 per cent level of significance. This also indicated dairy farmers' increased participation in the dairy cooperative. The per capita milk consumption of member-producers was also significantly higher than non-members, indicating that members had enough market surplus of milk to meet their daily household consumption. However, milk price was the only outcome indicator where non-members outperformed non-members. The non-members reaped better prices for their milk in the market, this was due to a lack of price regulation in the market. Unlike dairy cooperatives, the milk price was fixed based on the Fat and SNF percentage. Even though non-members received higher milk prices but their cost-benefit ratio was less. Unlike JMF members who received all the input, extension and veterinary services at the subsidised price, non-members on other hand had to incur additional transaction costs. Similar findings were revealed by Das et al., (2020); Sudhanshu (2019); Karthikeyan et al., (2019). Therefore, the net profit or net dairy income was more in the case of members as compared to the non-members. The ATT estimates of all matching algorithms confirmed that members were socio-economically sound than their non-member counterparts.

CONCLUSION

Farmers' participation in JMF has a positive and statistically significant influence on milk yield, farm income, and marketable surplus while having no negative impact on household milk consumption. Cooperative pricing, on the other hand, are lower than open market prices as non-members reaped better milk price than the members. These findings have significant implications for Jharkhand's dairy growth. JMF can help boost milk output in the state by improving producers' access to markets. As a result, a level playing field for different stakeholders is required to attract cooperative investment in dairying. Aside from that, cooperatives must examine milk price policy while taking open market prices into account. Furthermore, updated technologies must be disseminated to farmers for better efficiency and productivity.

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