Research Article

Alternative Milk Marketing Channels and Dairy Performance of Smallholders in Pakistan: A Case of South Region of Punjab Province

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Abstract | This study attempts to measure the economic benefits of milk marketing cooperatives working in two districts (Vehari and Muzzafargrah), geographically located in the southern region of Punjab province of Pakistan. The study analyzed the significance of milk marketing cooperatives by revealing and evaluating possible returns to smallholders in dairy sector. The hypothesis that milk marketing cooperatives are beneficial for milk producers was tested by surveying the cooperatives' members. Econometric techniques to draw inferences include the application of t-test, binary Logistic model and Propensity Score Matching (PSM) with algorithm of near neighbor (NN) and interval matching. The impact of cooperative membership on small milk producers was evaluated by calculating the values of average treatment effects (ATE) on eight performance indicators. The outcomes of study disclosed that cooperative members have higher farm income, more milk production, reared improved cattle breeds, get better access to veterinarian services and used more nutritious fodder (silage), as compared to non-members. The findings of study also provided the evidence that establishment of milk marketing cooperatives foster more economic opportunities to female dairy smallholders and assist them in rural development. Based on study findings certain policy options has also been suggested to extend the farmer cooperative activities over different aspects of agriculture sector.

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Introduction

Milk has certain distinctive characteristics as compare to other farm products which significantly influence its marketing structure. First and foremost, milk in its fluid form is more perishable than other farm products. Unlike most agricultural products, milk can only be hold for a few hours at appropriate conditions. The second important property is that milk is normally harvested twice a day whereas most agricultural products are being harvested once a year and can be stored for later sales. The third distinctiveness is the supply and demand counter-cycle over the year. These facts put a milk producer on his own at competitive disadvantage when dealing with only a few marketing choices. The demand of milk and dairy products is increasing due to expanding urbanization, high population and consumers' income level. These circumstances prospects small milk producers to attain a higher level of market integration. An efficient milk market structure induces considerable improvements in economic returns to the principal actors *i.e.* milk producer and milk consumer. Recently, an integrated collaboration between several institutional and

NGOs has been initiated for sustainable development of incipient dairy industry in Pakistan.

Milk and milk products constitute an important part of Pakistani diet. Milk is considered as whole diet and especially in children food is inevitable. In Pakistan, consumers prefer to consume loose raw milk due to its freshness and taste. So majority of consumers buy raw milk from traditional milk collectors and boiled it at home. Although modern dairy industry ensure milk quality through processing and pasteurization methods but not preferred due to taste and high price. Owing to consumer preferences and lack of cost efficient dairy technology, almost 95% of milk is marketed through informal milk marketing chains; remaining 5% is processed by dairy industry and marketed through formal marketing chains. In Pakistan, more than 51% of milk animals (cow and buffaloes) are reared by 83% smallholders; whereas, 21% of total animals by 3% large-scale milk producers while 28% are kept by 14% medium-sized milk producers (FAO, 2011).

As far as the milk marketing channels are concerned, we could identify two milk marketing systems i.e. traditional and modern milk marketing. Traditional or informal milk marketing dominates the milk market and the village milk collector, locally known as Dhodi is the most important link between milk producer and consumer. The dhodi collects milk from far flung rural areas at low prices and supply it with high margin to urban milk sale points or directly to consumers. The milk producers are deprived off from better profit and are being adversely exploited by milk collection agents. The modern milk supply system comprised of large dairy processing companies producing ultra-high temperature (UHT) processed milk o powered milk. Variation in seasonal demand of milk, price instability and potential high fixed costs converted dairy enterprise into a risky venture. The uncertainties in milk demand, quality and spoilage is higher in Pakistan and cold chain is still in early stage of development.

Pakistan dairy industry is passing through transitional stage and confronting numerous issues which hinder its development and future growth. More than 80% of livestock farmers hold a herd size of 1-4 cattle (Agriculture Census of Pakistan, 2010). Thus a large population of milk producer is unproductive and incapable to take the advantage of economies of scale. Further the challenges in the area of farm infrastructure, financial constraints, unskilled labour, quality assurance and imperfect price mechanism worse the situation. The scattered nature of small dairy farms leaves a big question mark about farm economies and adoption of modern dairy technology. For a rapid dairy development, it is necessary to organize small-scale milk producers, integrate marketing system with production, upgrade milk collection mechanism, enhance market information and improve farm profitability. To access a wide range of benefits derived from milk value chains and improved dairy practices, a close collaboration of farmers in the form of cooperative can serve as vehicle for sustainable development (Milford, 2014).

Agriculture cooperatives with high quality management played significant role for rural development and food security. Adrian and Green (2001) stated that farmers engaged in cooperatives have more access to information and input resources, lower transaction costs, more power and control over production, less vulnerable to marketing of agricultural products with more bargaining power. There are various types of agriculture cooperatives as; Supply cooperatives (*e.g.* inputs and machinery pool), Marketing cooperatives, Credit cooperatives, Services cooperatives, Purchasing cooperatives and Dairy cooperatives *etc*. Kydd and Dorward (2004) analyzed that small farmers have a variety of structural constraints which hinder them for market integration. These constraints tend to increase marketing transaction costs. Market integration can be facilitated through coordinating product attributes and delivery services. The association of small farmers is an essential tool to avoid various hazards linked with perishable commodities such as milk. Dairy cooperative is source of pooling milk supplies and sales, reduce price risks, enhance dairy farmer bargaining power and provide quality milk to consumers at fair prices (Holloway et al., 2000).

The statistics of Cooperatives department in Punjab disclosed that total 33068 cooperative organizations have been registered in Punjab province of Pakistan with more than 1.68 million memberships. These cooperatives are in the field of supply; construction; housing; small and medium enterprises as well as in agriculture sector. However, a lot of many cooperatives are non-functional or ceased due to management constraints that hamper their performance. These cooperatives were merely developed with an intension of having access to loan and subsidies on seed & fertilizers from public sector rather than undertaking

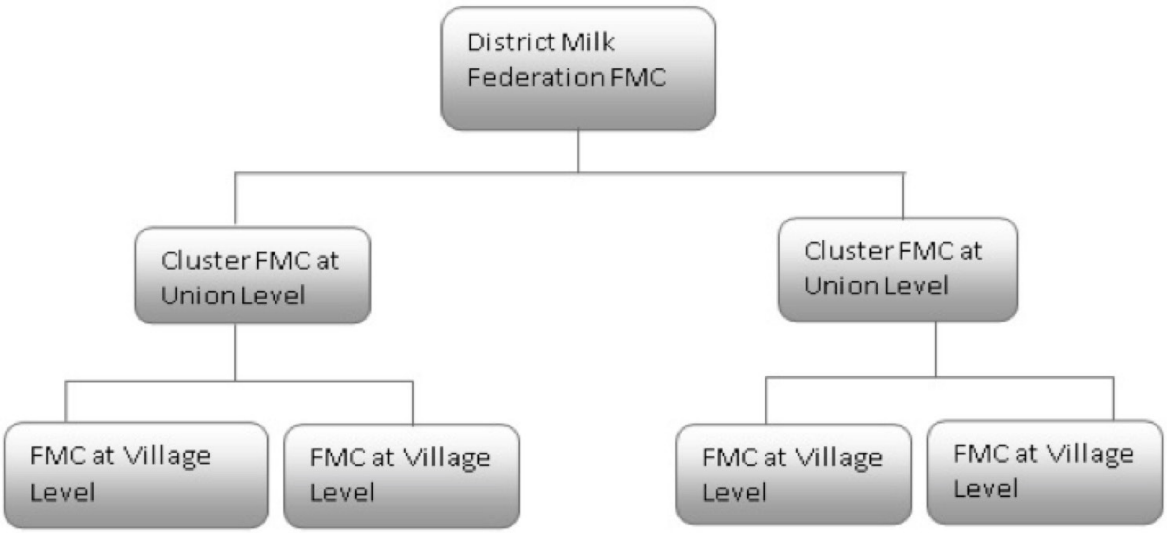

Figure 1: *Milk cooperative three-tier model at district level*

the cooperatives tangible objectives. Since mid-1970, various attempts had been made to establish dairy cooperatives in different parts of Pakistan but these attempts were not materialized as expected. The reasons which hampered the livestock associations in safe-guarding the mutual benefits of small holders were; extraordinary public-sector intervention in cooperative management affairs, poor infrastructure in many dairy farms, lack of efficient extension services, disparity between individual and collective interests etc. These challenges and circumstances created a mistrust of farmers for cooperative organizations and futile the potential of cooperative advantages.

Taking into consideration all above mentioned facts, a non-profit organization "Plan International-Pakistan" has started a pilot project for milk marketing cooperatives in two districts of southern Punjab (*i.e.* Vehari and Muzzfargrah). Plan International-Pakistan (an NGO) has adopted the Amul India dairy cooperative model in Pakistan. In India over 25 years, Gujarat Cooperative Milk Marketing Federation (GCMMF) through Amul India dairy cooperative had revolutionized the structure of milk distribution and production. Today, more than 100,000 village dairy cooperatives federated in 177 milk unions and 15 milk federations. The milk marketing network comprising of 48 sales offices, 5000 wholesale distributors, and 700,000 retail outlets. Amul India has the largest milk handling capacity in Asia and exporting milk products to 48 countries with largest cold chain networks (Sharma et al., 2009). Plan International in Pakistan has also attempted to develop a similar three-tier cooperative structure similar to Amul India. The first tier is village level dairy cooperative named as Farmer Milk Cooperatives (FMC), these village level FMCs are affiliated to a cluster cooperative at union council levels, and finally, the cluster cooperatives are federated into district level milk cooperatives as elucidated in Figure 1.

Recent government interventions for rural development and poverty reduction through farmers' associations have placed an opportunity for revival of cooperative development. The NGOs participations for cooperative development with better services and high quality management is also an added advantage. Although, many studies have been made on rural dairy development (Mustafa and Gill, 1998; Wollini and Zeller, 2007; Bernard and Spielman, 2009; Devaux et al., 2009; Stattman and Mol, 2014). Nevertheless, there is still need to carry out a study in order to improve milk marketing structure with a particular focus on farmers' welfare and consumer protection.

Given this background, the present study examines the milk marketing structure in general and systematically asses the performance of farmer milk cooperatives working in two districts of south-region of Punjab province.

Study Objectives

The specific objectives of this study are:

1. To carry out performance and efficiency analysis of milk marketing cooperatives organized with the support of NGOs at village level.
2. To assess whether milk cooperative can serve as alternative milk marketing channels in study area.
3. To examine milk marketing cooperatives as ef-

ficient institutions to foster rural development and a source of sustainable milk supply for dairy industry.

Hence, this study used a holistic approach to judge the potential of milk marketing chain as a driver of dairy development in Pakistan. For example, if farmer milk cooperative proves to be a potential competitor in milk supply market than its expansion can successfully substitute for traditional milk marketing system (dhodi system) which occupies a dominate share of more than 90% in milk market. In addition to it, an examination of farmers' participation response in milk cooperatives and appraisal of farmers' profitability or benefits would be helpful in formulation of appropriate policies for improvement in milk supply chain. This paper is organized as follows; section 2 explains the methodology for data collection and analytical models; section 3 presents the results; section 4 provides conclusions and draws policy implications.

Materials and Methods

Study Area

The study was carried out in two districts *i.e.* Vehari and Muzzafargrah geographically located in south region of Punjab province. Out of 36 districts of Punjab province, these two districts were purposely selected for this research because milk marketing cooperatives are only working in these districts. About 85% population of study area is associated with agribusiness activities; particularly rural community mainly depends on livestock rearing. The study area has a temperate climate; where, June to August is warmest period and January is coldest one.

Data Source and Research Design

The research design for this article was primary study. To execute field surveys, the proportional random sampling technique was applied according to cost basis approach. After discussion with NGOs representatives; out of 135 farmer milk cooperatives working in study area, eight FMCs (Laraib Milk cooperative; Bismillah FMC; Sandal FMC; Al Khair FMC; Al-Hamad FMC; Frogh-e-Rozgar FMC; FMC 419 EB; and Kot Harru FMC) were selected from district Vehari and three FMCs (Ittifaq FMC; Rehaim Bakhsh FMC; and Ithhad FMC) were selected from district Muzzaffargrah. The data was collected from 320 small dairy farmers (160 cooperative members and 160 non-members). The non-members were also interviewed from the same villages where the 11 selected FMCs were established.

Data Collection Method

Face-to-face interviews with dairy farmers were conducted through a structured questionnaire. The questionnaire was composed of close-ended and open-ended questions relating to; reasons for their membership; number of cattle before and after cooperative participation; milk production and proportion of income received from milk marketing; farmers' future intentions about cooperative membership and to what extent milk marketing cooperatives have facilitated the small dairy farmers to achieve the desired goals. The in-charge of milk cooperatives and managers of small scale milk processing plants were also interviewed to uncover the problems and challenges related to cooperatives. It took on average two months to complete the field survey from February to March 2016.

Analytical Models

t-test: The sample was collected from two groups (cooperative members and non-members), so independent t-test was applied on a number of household characteristics for comparison between them. The independent t-test is a useful tool to compare the characteristics of two groups where participants of one group have no specific relationship to the participants of second group. The null hypothesis that the mean of cooperative members and non-members are equal is tested by t-test.

$$Ho: \mu 1 - \mu 2 = 0$$

$$H1: \mu 1 - \mu 2 \neq 0$$

The general formula for t-test is given below:

$$t = \frac{\overline{X1} - \overline{X2}}{\sqrt{\frac{S_1^2}{n1} + \frac{S_2^2}{n2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;
X1= Mean of cooperative members
X2= Mean of non- members
S1= standard deviation of cooperative members
S2= Standard deviation of non-members
*n*1= Total no. of observation in cooperative group
*n*2= Total number of observation in non-member group

The standard deviation is derived by equation 2:

$$S = \sqrt{\sum \frac{(X - \overline{X})^2}{n-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Logistic Regression Analysis

To estimate the probability of dairy farmers' participation in milk cooperatives, a binary logistic regression model was applied. This model would explain the relationship between cooperative membership (1= member, 0= non-members) and dairy farmers socioeconomic characteristics. The logistic model in this case is a function of selected independent variables and can be written as follows:

$$p = ln\left(\frac{px}{1-px}\right) \quad \text{(3)}$$

$$logit(p) = \beta o + \beta 1X1 + \beta 2X2 + \cdots + \beta nXn \quad \text{(4)}$$

$$Px = \frac{\exp(\beta o + \beta 1X1 + \cdots + \beta pXn)}{1+\exp(\beta o + \beta b1X1 + \cdots + \beta pXn)} \quad \text{(5)}$$

Where;
p= indicate probability of cooperative participation
$X_1, X_2 \ldots\ldots Xn$ = Explanatory variables
X1= Household age
X2= Dependency ratio
X3= Education of household
X4= Dairy herd size
X5= Distance to milk collection centres
X6= Dairy farming experience
X7= Land ownership
X8= Proportion of female dairy farmers in study area

Propensity Score Matching (PSM) Model

The study applied "Propensity Score Matching" econometric technique to identify appropriate performance comparison (based on selected impact indicators) between cooperative members and non-members. This technique is capable enough to control biases that may exist between two groups during observational studies. PSM technique was applied on Ethiopian farmers to assess the impact of cooperative membership on their performance by Francesconi adn Ruben (2012), Hernández-Espallardo et al. (2013) and Bernard and Spielman (2009). During field studies we may encounter the presence of a number of biases, so the choice of independent variables in analysis is very crucial. In our study, the potential biases may be due to sampling methods as our respondents of two groups were selected from the same villages where possible spillover effects might happen. The indirect benefits of milk marketing cooperatives may also be received by non-members in the selected villages. Caliendo and Kopeinig (2008) suggested that in comparison model, variables should either be fixed over time or measured before participations. Several observable characteristics of member and non-member such as age, education, dependency ratio, proportion of improved breed, herd size and dairy income were also included. To calculate each household propensity score of performance indicators, the cooperative membership is modeled as function of various household characteristics.

Dairy farmers were divided into two groups: (1) treated group (that participated into cooperative program); (2) control group (that did not participate in milk cooperative). Treatment "D" is a binary response that determines if the dairy farmers are in treated or control group. D=1 for treated observations and D=0 for control group. The propensity score model is also a shape of logit model with D as dependent variable and X as independent variables. The equation for propensity score model can be written as following:

$$P(x) = prob(D = 1|x = E(D|x) \quad \text{(6)}$$

To assess the impact of milk marketing cooperative membership on performance indicators, the average treatment effects (ATE) on treated were calculated and comparison is made between the outcomes Y of treated and control group after matching.

$$Y = \begin{Bmatrix} Y1 \; if \; D{=}1 \\ Yo \; if \; D{=}0 \end{Bmatrix} \quad \text{(7)}$$

Average Treatment Effect (ATE) is the difference between the outcomes of treated and control groups.

$$\Delta = Y1 - Yo$$

$$ATE = E(\Delta) = E(Y1|x, D = 1) - E(Yo|x, D = 0) \quad \text{(8)}$$

Matching of observation for treated and control groups are based on their propensity scores. Several matching methods are available for PSM approach: kernel matching, nearest neighbor (NN), radius matching and stratification or interval matching. Two algorithms: (1) nearest neighbor (NN) with replacement and (2) interval matching were applied in this study to estimate propensity scores for explaining the membership impacts. We focus to estimate on eight performance impact indicators like; total farm income, proportion of milk income, proportion of using improved feed (silage), proportion of genetically improved cattle breed in herd, milk productivity, average milk price, investment trend on technological innovation and proportion of processed dairy products. The

challenge to ensure maximum comparability between two groups (members and non-members), the sample has been restricted to be drawn from the same area and therefore a condition of common support region was applied. To improve the quality of matches, 5% common support cut-off point has been used.

Results and Discussion

This section presents the descriptive and econometrics results derived from data analysis. During field visit it was found that currently, with the support of Plan International (an NGO) 135 Farmer Milk Cooperatives (FMCs) are working in district Vehari and 24 in district Muzaffargrah. In near future, 105 and 121 more FMCs will be established by that NGO in Vehari and Muzaffargarh respectively. It was also observed that in rural remote areas, most of the dairy management activities were carried out by females whereas the revenue generated from milk sale is grasped by male family head. To hold back the situation, Plan International implement a female govern cooperative organizational structure to provide them maximum benefits. Therefore, the membership of one FMC constituted of 75% females and 25% male participation which is an attempt to lessen the intensity of male dominance.

Table 1: *Major Data in Milk Production of Pakistan*

Year	LGP (2005-06)	LP (Million)	GMP (000 tons)	HMC (000 tons)	AvMP (PKR)
2011	3.39	157.9	46,440	37,475	45
2012	3.99	162.1	47,951	38,690	50
2013	3.45	166.7	49,400	39,855	57
2014	2.48	171	50,990	41,133	68
2015	3.99	175.6	52,632	42,454	76
2016	3.63	180.5	54,328	43,818	78

Source: *Pakistan Bureau of Statistics; Ministry of National Food Security and Research, 2016;* **LGP:** *Livestock growth percentages;* **LP:** *Livestock Population;* **GMP:** *Gross milk Production;* **HMC:** *Human milk consumption;* **AvMP:** *Average Milk Price*

Descriptive Statistics of Members and Non-Members

The descriptive statistics derived from t-test on household characteristics to make a simple comparison between cooperative members and non-members are presented in Table 2. The descriptive statistics showed that FMCs members on average have large family size, less age and small livestock herd as compared to non-members. Education is considered an important factor for better management and it was significantly higher among FMCs members. The variable of education was significant at 1% implying that the educated dairy farmers more readily adapt to better dairy management practices (Table 2). Milk production is associated with number of cattle in dairy farm. Large farmers relatively perform better for cattle rearing, veterinarian facilities and conscious herd management. The dairy cooperative farmers have Rs. 7050/- more average income, 8.2 litter/day more milk production, large herd size. However, the price of milk was not significantly different but almost similar when compared to non-members. The results are summarized in Table 2.

Table 2: *Descriptive Statistics for members and Non-members*

Indicators	N	Coops. Memb.	Non-memb.	t-statistics	Sig.
Age	120	44.37	48.16	2.164	0.045
Household Size	120	6.57	5.23	2.861	0.002
Education	120	5.9	4.5	3.347	0.001
Herd Size	120	3.2	3.9	1.957	0.087
Total dairy income (Rupee)	120	25480	18430	3.14	0
Total Milk production(lit/day)	120	20.56	12.36	3.174	0.001
Dairy Experience (years)	120	18.13	22.47	-1.045	0.124
Average price per liter (Rupee)	120	45	46	0.137	0.521

Source: *Authors field data results, 2016*

Outcomes of t-test in Table 2 disclosed that, the mean values of both groups were statistically different in terms of dairy income and milk production level but the average price per litter of milk was more or less similar. Dairy experience was negative in sign and insignificant; because more experienced dairy farmers were of old age and they prefer to sell milk at their door-step through traditional milk collectors/dhodi.

Distribution of Milk Sale among Major Milk Marketing Channels

The field observation of study area revealed that there were four major milk sale outlets available for dairy farmers as; traditional milk collectors/dodhi; small scale milk processors; milk marketing cooperatives and milk collection centers of dairy companies. Figure 2 explains milk marketing channels and milk flow carried out in study area.

Traditional milk collectors/dodhi usually collects milk from smallholders on daily basis which lack quality

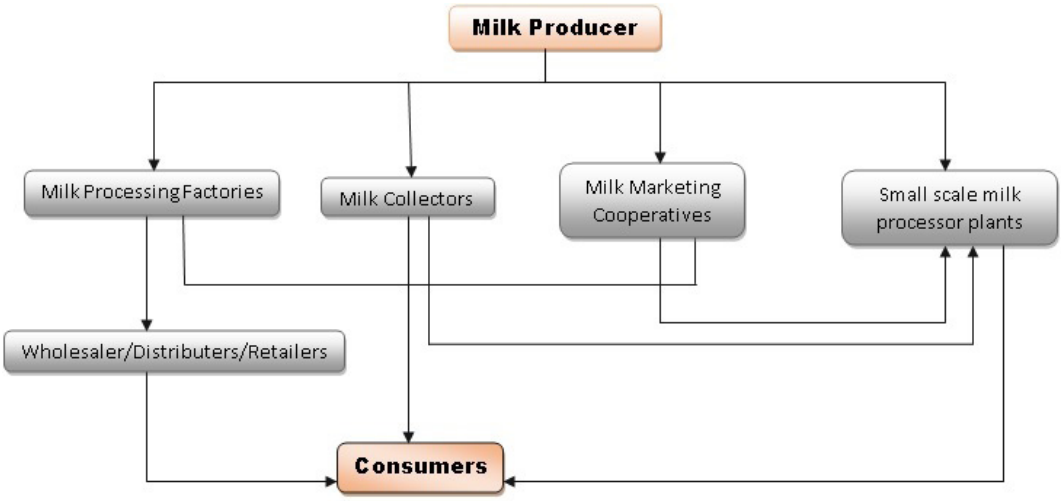

Figure 2: *Milk marketing channels in Punjab*

Table 3: *Average Distribution of milk among major milk marketing channels of respondents on daily basis*

Dairy Farms	To milk collectors		To small scale milk processing enterprises		To milk marketing cooperatives		To milk processing factories		Total	
	Liter/day	%age	Liter/day	%age	Liter/day	%age	Liter/day	%age	Liter/day	%age
small scale farms	1801	75.8	285	12	175	7.4	114	4.8	2375	100
medium scale farms	577	70.8	116	14.3	87	10.7	34	4.2	814	100
commercial scale farms	543	50.3	168	15.6	146	13.5	222	20.6	1079	100
Total	**2921**	**67.4**	**569**	**13.3**	**408**	**9.6**	**370**	**8.7**	**4268**	**100**

Source: *Authors field data results, 2016*

inspection methods. They re-sell it to urban areas without undergoing any processing method. They use motor-cycle and metal or plastic cane for transporting the fresh milk. The second important group is small milk processors who collect milk from dairy farms directly or from milk collectors and processed it as yoghurt, milk beverages/lassi, sweets, khoya, confectionery products etc. The collective market share of these two major milk marketing channels is around 80%. The Plan International is serving as an external facilitator in motivating the interested farmers at grass-root level to undertake FMCs.

Milk cooling tanks (chillers) are being provided to village level cooperatives. The milk marketing cooperatives collect milk from their FMCs members and cool it at 4°C. The milk collection centers (MCCs) of large dairy processing companies like Nestle, Engro Foods Pvt. Ltd, Haleeb Foods Pvt. Ltd are also established in study area. These MCCs have milk chillers facility at their purchase centers. At milk collection centers prior to milk purchase, certain milk quality tests are applied to examine fat contents, adulteration and somatic cell count etc. Hence, the milk collected by milk marketing cooperatives and MCCs is of good quality. These MCCs offer milk prices as per milk quality basis and payment mode is on weekly or fortnightly. It was noted that advance milk payments or credit were offered by milk collectors/dodhi which was not in case of milk marketing cooperatives. The average distributions of milk among these four market-outlets were examined and results are presented in Table 3.

The values presented in Table 3, shows that 75.8% small dairy farmers, 70.8% medium scale farmers and 50.3% commercial dairy farmers sell their milk through informal milk collectors/dhodi. This huge share of milk distribution to informal sector is due to certain reasons like; advance payments of milk, no prior quality inspection, collect milk at door step, provision of ancillary facilities of feed and payment of utility bills, social contacts *etc*. The major disadvantage of informal milk collectors is that most of the time, they do not buy evening milking because usually they collect milk in morning and then immediately re-sell it to urban areas but in evening they do not again travel to cities. It was also observed that share of milk flow towards milk processing factories outlets

was approximately 16% higher as compared to small and medium scale dairy farmers. Hence, it was noted that commercial dairy farmers have more intention for selling milk to formal milk marketing channels (Table 3).

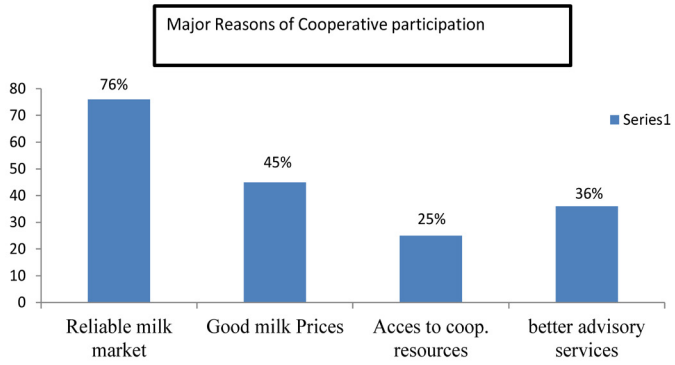

Figure 3: *Reason for cooperative participation*

The respondents were questioned about what are major reasons for joining FMCs and their responses are graphical portrayed in Figure 3. Four major reasons for participating in cooperative organizations are; (i) FMCs offers a reliable and consistent milk market with assured payment plan; (ii) to get high milk prices; (iii) to get access of cooperative resources (fertilizers, equipment, credits, vaccination *etc.*); (iv) to receive dairy management advisory services. Hence, FMCs members have better access to nutritive feed and fodder, high yielding cattle breed and animal vaccines. The dairy farmers who were not members of cooperatives respond that cooperative organizations do not defend the farmers' benefits and there is dearth of democratic management. The lack of education and extension services making the situation more badly.

Logistic Regression and Impact of Dairy Farmers' Participation Probability Factors

The binary logistic regression was applied on eight socioeconomic variables of respondents for assessing the likelihood of milk marketing cooperative membership. The outcomes of logistic regression disclosed that, five variables showed significant tendency towards cooperative membership whereas three variables were non-significant. The age of dairy farmers, dependency ratio (family members dependent on household head), education level, distance to milk collection centres and proportion of female farmers were statistically significant at standard significance level (5%) and positively associated. The data is illustrated in Table 4.

The distance to milk collection centres (MCCs) was positively interlinked implying that dairy farmers who live in far flung areas have more participation probability towards cooperatives as compared to peri-urban farmers. The similar results were also reported by Nugusse et al. (2013) that probability to cooperative membership declines due to close market center. Table 4 shows a negative relationship between herd size and FMCs participation indicating that farmer's probability to participate in cooperative decline with increase in herd size. As large farmers are already

Table 4: *Results of logistic regression for probability factors towards milk cooperatives*

Probability Factors	coefficients	std. error	t-statistics	sig.
Age	0.851	0.382	2.23	0.028**
Dependency ratio	0.786	0.221	3.56	0.003***
Education level	1.040	0.18	5.78	0.001***
Herd size	-0.457	0.215	-2.12	.061*
Distance to collection centers	0.713	0.186	3.82	0.005***
Dairy farming experience	0.045	0.038	1.16	0.187
Land ownership status	-0.092	0.505	-1.82	0.157
Proportion of female farmers	0.835	0.373	2.24	0.035**
constant	-3.138	0.99	-3.17	0.000***
No. of observation	240			
LR Chi^2	82.36			
Prob. > chi2	0.000			
Pseudo R2	0.1578			
Log Likelihood	-198.54			

Source: *Authors' field survey data analysis results, 2016;* ***, **, ***:** *Indicate significance level of 10%, 5% and 1%, respectively*

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working on economies of scale and have other better opportunities. The similar results were also reported for farmers in Kenya and Ethiopia by Fischer and Qaim (2012) and Abebaw and Haile (2013), respectively, that cooperative can indeed play a vital role for improving the livelihood of poorest dairy farmers rather than large farmers. The milk production areas with higher proportion of female farmers also have more probability for FMCs participation (Table 4). FMCs also encouraged female participation because females have more trends for family economic development as compared to males. Dairy farming experience and land ownership found to be statistically insignificant and did not explain much impact on likelihood of cooperative membership (Table 4).

Farmer milk cooperatives (FMCs) under Plan International tried to attain maximum access of remote areas. Each FMC catchment area is of 2-3 kilometer radius which encircled three to four villages. To retain milk quality and to cool it at temperature of 4°C, Plan International (NGO) provides one milk chiller to each FMC. At the initial phase of FMC, all expenses in lieu of milk collection, chilling, transportation, electricity bills etc. are provided by Plan International. A lump sum amount of Rs. 30,000/- per month paid to one FMC for one year as functional cost. The milk collection capacity of each FMC was approximately 500 litters per day. FMC purchase milk at market price and every cooperative member supply at least 10 litters of milk. After one year when FMC is stable enough, the cooperative management applies a minimum saving/profit benchmark of Rs. 2 per litter to carry out the operational cost of milk chiller and staff expenses. The FMCs existed in peri-urban areas re-sell the collected milk to urban milk centres while distant FMCs make agreement with dairy processing companies. The management of one FMC at village level is illustrated in Figure 4.

Propensity score matching (PSM) technique was applied on data to estimate the impact of cooperative membership on selected dairy performance indicators. The major issues in doing econometric analysis was the collection of accurate information about the dairy farmers' performance parameters, as due to lack of record keeping farmers were unable to provide precise information about their farming activities. ATE values were derived from nearest neighbor (NN) and interval matching algorithms. The outcomes of propensity

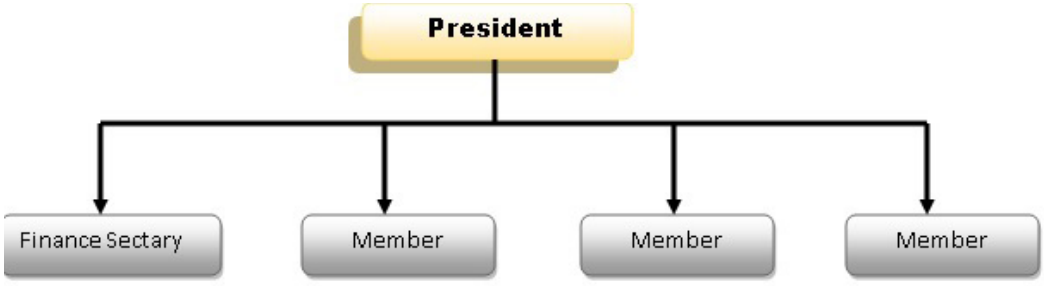

Figure 4: *Farmer milk marketing cooperatives (FMC) at village level*

Table 5: *Impact of cooperative membership on selected dairy performance indicators*

Impact parameters	Coop. farmers	Non. coop. farmers	t-statistic	ATE (NN)	ATE(Interval)
Total farm income	21456	13731	3.14 (0.000)***	6969.41(1004.25)***	6886.79(1053.69)**
Proportion of milk	0.58	0.43	4.657(0.000)***	0.0852(0.078)**	0.0628(0.063)***
Usage of improved feed (silage etc.) kg.	18518	11432.33	6.45 (0.000)***	5258.34(1130.80)***	5814.04(1041.52)***
Proportion of improved cattle breed in herd	0.678	0.357	2.94(0.001)***	0.226(0.064)**	0.264(0.054)**
Milk productivity per cattle (liter/day)	6.25	4.6	3.54(0.002)***	1.264(0.288)*	1.1184(0.334)*
Average milk price per liter	48	46	0.137(0.521)	0.104(0.024) NS	0.083(0.020) NS
Investment trends on technological innovation	0.435	0.194	4.256(0.000)***	0.1718(0.048)**	0.19(0.039)***
Proportion of processed dairy products	0.08	0.48	-6.353(0.023)***	-0.327(0.062)**	-0.225(0.054)**

Source: *Author's field data analysis, 2016;* **i:** *Values in parenthesis indicate standard errors;* **ii:** *Average Treatment Effect (ATE) is equal to =E (Δ) = Yi-Yo through min Πβi- PjΠ. Yo outcomes of non-cooperative farmers subtracted from Yi outcomes of cooperative farmers after propensity score matching through nearest neighbor (NN) and stratification or Interval matching methods;* ***, **, ***:** *indicates the significance level at 10 %, 5 % and 1%*

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score matching techniques are presented in Table 5.

Table 5 presented the values of average treatment effect (ATE) on cooperative members describes the influence of FMC on dairy farmers on selected eight performance indicators. The results illustrates that milk cooperative members have Rs. 6969/- and Rs. 6886 (Rs. Pakistani Rupees) higher total farm income than non-cooperative farmers ($p < 0.01$). The proportional share of milk sale to total dairy income is 8 to 6% higher for cooperative members (Table 5). Further; the two variable of improved cattle breed and more nutritious feed (silage) for the purpose of increasing milk production were higher among FMC members. The significance lies at 1% for the NN matching and 5% for the kernel matching algorithm. We found that FMC members have 10 to 8% higher productivity per cattle than non-members and its significance level lies at 10% (Table 4). The study also found that the trend towards adaption of more improved dairy practices and technology adoption was 0.17 and 0.19 higher among cooperative members at NN matching and kernel matching, respectively. This outcome was also in accordance to the previous study results conducted by Francesconi and Ruben (2012) in Addis Ababa.

Using both algorithm matching methods, we found 0.32 to 0.22 higher proportion of processed milk products among non-cooperatives members. This pattern could be possible due to the fact that non-cooperative dairy farmers still depends on traditional methods. They allocate more proportion of milk to make dairy products such as butter, desi ghee, khoya *etc*. The results presented in Table 5 indicate that FMCs have less impact on price disparity. The milk price variable was insignificant and not much influenced by cooperative membership. The milk prices are market driven and sometimes higher prices are offered to dairy farmers by local milk collectors due to seasonal milk demand fluctuations. Lastly, we also make an attempt to assess the influence of FMC training and advisory services on dairy farmers' attitude toward new investment approaches. These innovative investment approaches include utilization of modern farm practices, purchase of hygiene milking machines, construction of new dairy shed, buying improved and fertile cattle breed at their dairy farms *etc*.

Figure 5 elucidates that FMC members have 50% more tendency to invest on purchase of modern dairy equipment. FMC members buy 39% more high-yield crossbred cows to increase their milk production volume as compare to non-members. The trend to construct new dairy farms or to enlarge existing farm was higher among FMC farmers rather than non-members (Figure 5). Similarly, cooperative members are much influenced by advisory services of FMCs which broaden their vision to make new investments to improve their livelihood and reduce their poverty level. The findings were also supported by (Pascucci et al., 2011).

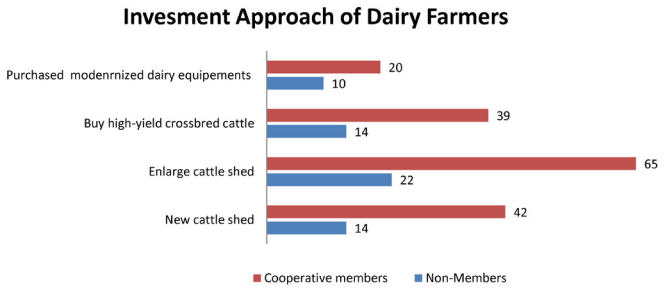

Figure 5: *Impact of FMC on dairy farmers' investment approaches*

Conclusion

The study was carried in two districts of Punjab and it concludes that dairy cooperatives in Punjab are at initial stage of development. Majority of dairy farmers sell milk through traditional milk marketing channels. The study established a positive relationship between likelihood to participate in cooperatives and education level, access to veterinarian services and conscious herd management but a negative relationship exist for dairy farm size. This means that small and poor dairy farmers actually benefiting from cooperative memberships. The distance of milk collection centres increase the probability to participate in milk cooperative. The empirical analysis of FMC working in district Vehari and Muzzfargrah resulted a significant impact on selected dairy performance indicators. Total farm income and proportion of milk income was significantly higher for cooperative members. The study also suggest that FMC facilitate innovation in dairy practices and improve access to technology. Cooperative farmers have higher trends for using nutritious fodder (silage) and raising fertile crossbred cows for increasing milk production. Our results also provide an evidence that milk marketing cooperatives have positive impact on dairy commercialization and offer a reliable and consistent milk market. It was found that cooperative members allocate a large volume of milk to sell in markets as compared to non-member farmers. The study reveals no significant difference of price between two groups. A possible explanation of

this pattern indicates a trade-off between different cooperative services like advisory service, veterinary assistance, family nutrition trainings *etc*. However, the milk cooperative induce a general rise of higher prices both for members and non-members in study area and serve as competitive yardstick in local region. Lastly, the study reported that dairy cooperatives imparts a higher level of investment approach among dairy farmers as compare to non-members.

Overall, our study outcomes suggest that farmer milk cooperatives are substantiality benefiting the small scale dairy farmers. Consumers could also get the benefits of milk cooperatives in form of having quality and hygiene milk which is not supplied to them through informal milk marketing system/dhodi system. Hence, farmer milk cooperatives can be regarded as alternative milk marketing channels to foster smallholders' livelihood, improved quality milk supply, more milk production with higher income and rural development in Punjab. It is recommended that such farmer milk cooperatives should also be organized in other districts of Punjab to provide a consistent supply of quality milk to dairy industry in Pakistan.

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Authors' Contribution

Mazhir Nadeem Ishaq provided basic concept for the manuscript and developed the research design under the supervision of Professor Dr. Li Cui-Xia. Rukhsana Rasheed reviewed the literature; Zeeshan Ahmad and Mazhir Nadeem Ishaq collected data; Muhammad Abdullah and Mazhir Nadeem analysed the data. Data interpretation and overall write-up of the manuscript was done by Mazhir Nadeem and Rukhsana Rasheed whereas; Muhammad Abdullah did technical corrections. Dr. Li Cui Xia overview the manuscript and did final editing. All authors read and approved the final manuscript.

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