Research Article

Role of Extension Services in Enhancing Efficiency of Market Oriented Dairy Farmers: An Evidence from Punjab, Pakistan

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Abstract | Agricultural extension programmes are the main source of disseminating technical information to farmers which enhance their skills and in turn farm productivity. Livestock sector in the main sub sector of agriculture in Pakistan that contributes nearly 60% to agricultural value addition. In this study, we investigated the effects of extension services on market oriented dairy farms' technical efficiency in Pakistan. The data was collected from 345 dairy farmers of Punjab through field survey. By employing the stochastic frontier approach, it was found that on an average 85% dairy farms are technically efficient, indicating that output can be increased by 15% by enhancing the efficiency of the dairy farms. The study reveals that extension services enhance the technical efficiency of dairy farmers by imparting better management and disease control skills. Extended extension services are recommended, alongside quality training programmes and the provision of improved crossbred cattle and buffalos to ensure good quality breeds.

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Introduction

Livestock is an important sub-sector of agriculture which plays a major role in both subsistence and the economic development of Pakistan. It contributes 11.22% to the national GDP and accounts for 60.54 % of agricultural value added. Nearly 30-35 million people are affiliated with the livestock sector and earn 30-40% of their income from it (GoP, 2019). The gross value addition of the livestock sector at current factor costs has increased by 4% - from Rs (Pakistani Rupee(s))1384 billion (US$ 8.947 billion) in 2017-18 to Rs 1440 (US$ 9.306 billion) in 2018-19 (GOP, 2019). Milk production is the most important component of livestock. Its average growth is about 3.12% per annum since 2006 while annual demand has increased by 26% (Tahir *et al*., 2019). Loose milk penetration in food baskets is as high as 93% and almost 30% of household expenditure is on milk and milk products (Wynn *et al*., 2006). However, Pakistan's population has increased from 65 million to 180 million over the past three decades with an estimated growth rate of over 2% and is expected to grow to 234 million by 2025. This has raised the gap between milk demand and supply to 3.5 million tons per year (FAO, 2003) and it will increase in future. Despite being the world's fifth largest producer of milk with an annual production of 59.759 million tonnes (GoP, 2019). Pakistan spent about US$ 130.83 million out of its scarce resources on importing milk and milk products in 2017-18 (Sattar, 2020).

The dairy population in Pakistan increased from 189.5 million in 2017-18 to 194.8 million in 2018-19 with a growth rate of 2.72%. Meanwhile, milk production increased from 58 million tons to 60 million tons, with 3.33% growth rate annually in the same period. The cattle population increased at 3.55% per annum and buffalo at 3.0%, while the milk growth of cattle was 3.63% and buffalo was 2.88% over the same period (GoP, 2019). Rural dairy farms contribute 80% of the total milk marketed, while the remaining amount is produced by urban and peri-urban farms. More than 90% of milk is sold via informal ways (such as the milkman or direct supply to consumer), while less than 10% is delivered to the formal processing industry (Aslam and Kamal, 2012). Due to lack of proper storage cooling and transport in the marketing system, about 15% milk wasted out of total sale. (Fakhar and Walker, 2006). Nevertheless, the dairy industry in Pakistan is based on conventional farming which faces problems due to the poor genetic potential of animals for milk production, low quality feed, improper and traditional marketing channels, conventional management practices, and poor extension services (Sarwar *et al*., 2002).

The Pakistani government has implemented policies to increase farm competitiveness and milk production. In its second five-year plan (1955-60), the government planned to purchase milk from specialised dairy farmers and vendors and sell it to consumers after pasteurisation. It also suggested making cooperatives of vendors to transport milk to cities. In the 1970s and early 1980s, the government offered incentives to private milk supply channels and encouraged investment with the initiation of antiseptic packaging material for ultra-high temperature (UHT) treated milk by Tetra Pakistan Limited. The milk processing industry received massive investment in Pakistan, and the private sector launched 23 milk processing plants. However, the supply of fresh milk to the processing industry did not improve (Anjum *et al*., 1989). In 1985, the government imported purebred Holstein Freisian and Jersey cattle from the USA and conducted research until 2001 to evaluate the environmental factors affecting productivity of animals and to improve the genetics of local cattle (Lateef *et al*., 2008).

However, in all the previous efforts government did not focus on extension and veterinary services in dairy sector of Pakistan. In 2006, the government developed a project called *doodh darya* (White Revolution) to increase milk production and to fill the gap between domestic demand and supply with the possibility of being an exporter in the long run. This aimed to invest in both dairy infrastructure and human capital by establishing model dairy farms to introduce modern farm management techniques, mobile milk collection units to enhance the capacity of the milk supply chain, improved and imported semen to improve herd genetics, free vaccination campaigns, vocational and training facilities for dairy technicians and extension workers, and training programs for farmers. The government provided soft loans to farmers and introduced a zero-rated tax regime for value added dairy products to increase investment in the milk processing industry (Fakhar and Walker, 2006).

After shift in focus the number of veterinary hospitals increased from 527 in 2006 to 566 in 2013 in Punjab and number of veterinary dispensaries increased from 775 in 2006 to 1654 in 2013 (BSP, 2015). The government ensured to provide extension and veterinary services to remote dairy farmers through trained staff.

Several studies have assessed the efficiency of production in agriculture using the frontier production technique, most notably (Battese and Coelli, 1995; Battese *et al*., 1996; Brümmer, 2001). Several researches have also been performed to explore the technical productivity of dairy farms in many countries: (Heshmati and Kumbhakar, 1994; Cuesta, 2000; Alvarez and Arias, 2004; Bravo-Ureta *et al*., 2008; Nganga *et al*., 2010; Cabrera *et al*., 2010; Mor and Sharma, 2012; Uddin *et al*., 2014). Mor and Sharma (2012) and Nakanwagi and Hyuha (2015) found that the possession of crossbred livestock affects the efficiency of dairy farmers positively and significantly. O'Neill *et al*. (1999), Ahmed *et al*. (2012), Saldias and Cramon-taubadel (2012) found that the extension and advisory services increased the technical efficiency of dairy farms.

Despite the importance of the dairy sector to Pakistan's economy, we are aware of only two studies on the technical efficiency of dairy farmers in Pakistan: (Burki and Khan, 2011; Sadaf and Riaz, 2012). Both of these studies have focused on the effect of modern milk supply chains on technical efficiency of farmers. (Burki and Khan, 2011) used stochastic frontier analysis to assess the impact of modern milk supply chains in the milk districts of Punjab, and found that technical efficiency has positive effect with a mean of 0.79. (Sadaf and Riaz, 2012) assess the allocative and technical efficiencies of dairy farmers in the Sargodha district by using Data Envelopment Analysis (DEA) techniques. They found that technical efficiency is positively influenced by the herd size, and adversely affected by the size of the functional land area. They observed that the mean technical efficiency of the dairy farmers under varying return to scale was 0.89 while the size efficiency was 0.94.

Access to extension and veterinary services, on-farm training, and improvement in herd breed are critical determinants of competitiveness in the dairy sector. However, little is known about the impact of access to extension and veterinary services and herd breed structure on farmers in Pakistan. The purpose of this study is to cast a light on the impact of extension and veterinary services and herd breed structure on the technical efficiency of market oriented dairy farmers in Pakistan. Using the cross-sectional data from 2013, we address the following questions:

1. Is there evidence that extension and veterinary services cause an increase in technical efficiency?
2. Does the herd breed structure influence the technical efficiency?

This paper gives estimates of technical efficiency of market oriented dairy farmers based on a province-wide sample of Punjab. It identifies the factors influencing the technical efficiency of dairy farmers and is a useful practice to provide further policy guidelines/ recommendations.

Materials and Methods

Theoretical framework

Parametric or non-parametric function based measurement techniques of technical efficiency are tracked back to the work of Farrell (1957). Later, (Aigner *et al*., 1977) and (Meeusen and Van Den Broeck, 1977) developed stochastic production frontiers based on the econometric estimation of parametric functions. Comprehensive work on the stochastic frontier model is explained in (Bauer, 1990; Coelli, 1995; Kumbhakar and Lovell, 2000; Coelli *et al*., 2005). Stochastic frontier production function (SFPF) identifies output variation using a combined error term ε_i, in which additional random error, v_i (noise effect), is add up to the non-negative random variable, u_i (inefficiency effect). The following equation expresses the SFA model for a cross sectional data.

$$Y_i = f\,(X_i;\beta)\exp(\varepsilon_i)$$

$$\exp(\varepsilon_i) = \exp(v_i)\exp\,(-u_i) \quad \ldots\ldots\textbf{(1)}$$

The level of output for observation (farm, i) denotes Y_i. f(Xi; β) is a relevant function (Cobb-Douglas or translog) of the row vector of inputs X_i, and β is a vector of unknown parameters. The error term ε_i, comprised of two independent parts, v_i and u_i, such that $\varepsilon_i = (v_i - u_i)$. v_i is a pure random factor that represents external shocks and factors which are beyond the control of farmers. v_i is supposed to be an *i.i.d.* (independently and identically distributed), normal random variable with zero mean and continuous variance σ^2_v, $[v_i \sim N(0,\sigma^2_v)]$. $u_i \geq 0$ is a systematic, positive random variable which accounts for inefficiency and is associated with farm-specific factors. Estimation of equation (1) hinges upon distributional assumptions regarding the two error terms. Various distributional assumptions are available in the literature for the u_i. However, we use the model of (Battese and Coelli, 1995) which assumes that u_i follows a truncated normal distribution with mean μ_i, and variance σ^2_u,$[u_i \sim N^+(\mu_i, \sigma^2_u)]$

$$u_i = \delta_0 + \delta Z_i \quad \ldots(2)$$

Zi is a Q×1 vector of explanatory variables that could affect the efficiency performance of farmers; this may include socioeconomic and farm management attributes. δ is an associated vector of unknown factor to be investigated.

The frontier of the production function is defined by the "best practice" farms which exhibit the highest potential output for a given set of inputs. Thus, the technical efficiency TE_i of the $_i$th farm is expressed as a ratio of the observed output to the corresponding potential output. This is written as:

$$TE_i = \frac{Y_i}{Y_i^*} = \frac{f(X_i\,;\beta).\exp(v_i - \mu_i)}{f(X_i\,;\beta).\exp(v_i)} = \exp\,(-\,\mu_i) \quad \ldots(3)$$

Where;

Y_i is always ≤ Y_i^* and TEi = $\exp(-u_i) \in [0,1]$ indicates the corresponding output-oriented technical efficiency measure, which shows that if $u_i = 0$, the production remains on the frontier and therefore is technically efficient. However, if $u_i > 0$, the farm remains below the frontier line and is technically inefficient.

Battese and Corra (1977) proposed that the single-step estimation of the parameters of models (1) and (2), and the model of technical efficiency (3), can be estimated in terms of the parameterisation:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \text{ and } \gamma = \sigma_u^2/\ \sigma^2 = \sigma_u^2/\ (\sigma_v^2 + \sigma_u^2)$$

by considering a distributional assumption of the random errors. The value of the γ parameter lies between zero and one. A value of γ = 1 shows that the deviations from the frontier are completely due to technical inefficiency, whereas a value of γ = 0 indicates that the deviations from the frontier are completely due to noise effects.

Table 1: *Summary of the variables in the frontier and inefficiency models.*

Variable	Unit	Mean	Std. Dev.	Min	Max
Frontier Production function model					
Milk (output)	Liters	13734	10164.22	1686	76010
Capital	Rupees	8063	4584.44	1079	28273
Green fodder	Kg	167662	107345.9	25530	774840
Dry fodder and Concentrates	Kg	63307	58861.41	5517	617200
Veterinary services	Rupees	7346	7565.18	600	85000
Family labour	Hour	1681	1492.27	0	7787
Hired labour	Hour	1768	1873.20	0	8760
Peak milk cattle	Numbers	5.91	4.20	1	38
Total herd	Numbers	18.16	12.19	2	62
Technical inefficiency model					
Education	Levels	2.03	1.42	0	5
Age	Years	45.14	11.00	21	75
Experience	Years	16	8.78	2	45
Extension visits	Numbers	12	8.14	1	60
Neighbours' extension visits	Numbers	38.28	15.63	8	120
Crossbred and imported cattle	Percentage	27	28.92	0	100
Processor	Dummy	0.24	0.44	0	1

Data description

We collected data from two regions of Punjab province: South Punjab and North Punjab. These regions are based on political and cultural divisions in the province. Data were collected through the random selection of farmers from twelve districts of two regions (six districts from each region); from each district, one union council randomly selected. In the southern region, we collected data from 171 farmers, while 174 farmers were interviewed in the northern region. The respondents were selected based on selling milk for more than one year on several variables which are described below and summarised in Table 1.

The dependent variable Y_i is defined as the gross milk production in litres at a farm during the year. The vector X_i comprises six inputs: green fodder, dry fodder and concentrates, veterinary services, capital (cost of machinery, vehicles and expenditures on other fixed costs adjusted for depreciation and interest rates), labour, milking cattle. We specify a vector Z that includes several additional variables which represent the determinants of technical efficiency. These variables account for socio-economic characteristics, farm management decisions, and milk market infrastructure based on the characteristics of the production system. Age, experience and education represent the state of human capital. Number of Exotic and crossbred cattle and choice of milk marketing channels (processor=1, and 0 otherwise) represent farm and market conditions.

Extension services create awareness among farmers about new technology and modern farm practices. Generally, extension services are considered to have positive impact on the technical efficiency of farmers. However, quality and focus of extension services defines the outcome of such programmes. Lopez (1996) argued that extension programmes in Chilian agriculture increased the production through greater use of inputs rather than better use of inputs to enhance productivity. Access to veterinary and extension services (vetvisit) represents the visits of veterinary and extension officers as well as farmers' visits to the veterinary station. To capture the effect of extension visits paid to neighbouring farmers on the technical efficiency of farmers, we construct a variable (neighbourvisits) by adding the extension visits paid to three neighbouring farmers. We trace the three neighbouring farmers using GPS locations of the nearest farms.

Empirical model

Based on the theoretical discussion in the section above, we lay out the following econometric description of the stochastic production frontier (SPF) and efficiency model. (Equation 4)

The technical inefficiency model in equation (2) is specified by Equation 5.

$$ln\left(\frac{milk}{gfodder}\right) = \beta_0 + \beta_1 ln\left(\frac{pmcattle}{gfodder}\right) + \beta_2 ln\left(\frac{dfconc}{gfodder}\right) + \beta_3 ln\left(\frac{vetservices}{gfodder}\right) + \beta_4 ln\left(\frac{hflabor}{gfodder}\right) + \beta_5 dfl + \beta_6 ln\left(\frac{capital}{gfodder}\right) + v_i + \mu_i \quad (4)$$

$$\mu_i = \delta_0 + \delta_1 age + \delta_2 \text{ age} + \delta_3 edu + \delta_4 vetvisit + \delta_5 shcic + \delta_6 processor + \delta_7 neighbourvisits \quad (5)$$

Before heading towards final estimation, we have tested the following hypotheses by using the generalised likelihood ratio test (Table 2).

H_0: β_{ij} = 0, specifies that the Cobb-Douglas function described the statistically significant data.
H_0: β_p = 0, states that there are no technological differences between the northern and southern regions of Punjab.
H_0: $\gamma = \delta_0 = \delta_1 = \cdots = \delta_7 = 0$, identifies that inefficiency effects are not present from the model at every level.
H_0: $\delta_1 = \delta_2 = \cdots = \delta_7 = 0$, states that farm-specific factors do not influence the inefficiencies.

Table 2: *Hypothesis tests for the adopted model and statistical assumptions.*

Null hypothesis	L(H_0)	λ	d.f.	$\lambda^2_{0.05}$	Decision
1. $H_0 : \beta_{ij} = 0$	-47.61	22.37	21	24.99	Not rejected
Testing the specification of the technical inefficiency model					
2. $H_0 : \beta_p = 0$	-7.53	5.94	16	26.29	Not rejected
3. $H_0 : \gamma = \delta_0 = \delta_1 = \cdots = \delta_n = 0$	-47.6	2.21	1	1.64*	Rejected
4. $H_0 : \delta_1 = \delta_2 = \cdots = \delta_7 = 0$	-47.61	80.17	7	14.06**	Rejected

**Critical values are taken from Kodde and Palm (1986). For this value, the statistic λ has a mixed χ^2 distribution.*

Results and Discussion

As per the results of generalised likelihood ratio test, the hired labour and its dummy are not statistically significant and have the wrong sign; as a result, we drop these from the final estimation. The second null hypothesis cannot be rejected which is about the specification of the functional form. This concludes that the Cobb-Douglas function is a sufficient interpretation of the data than the translog frontier. The null hypothesis on technological uniformity between the two regions cannot be rejected. This implies that both regions share the same technology, so we pooled the data for further estimation. The test for the lack of inefficiency effects from the model is rejected. This implies that the technical efficiency effects exist in this model. In the end, null hypothesis "firms' particular parameters do not affect the technical inefficiency" is also rejected. Consequently, the variables specified in the technical inefficiency model are crucial to explain the disparity in the production function of dairy farmers in Pakistan, though some of the factors have no statistically significant influence.

Stochastic Production Frontier model estimates

Maximum-likelihood estimations (MLE) of the production frontier are shown in Table 3. All inputs are measured in logarithmic form, so the estimated coefficients represent the partial production elasticities. The expected elasticities of the input variables are significantly positive, except for the coefficient of the dummy for family labour, which is statistically insignificant. This means that capital, dry fodder and concentrates, veterinary expenses, family labour, and milk cattle (buffalo and cow) all have an influence on the dairy production system in Pakistan.

Table 3: *Cobb-Douglas stochastic frontier model estimates.*

Variables	Parameters	Coefficients	Standard Error
Constant	β_0	3.60**	0.50
Peak milk cattle/gfodder	β_1	0.533**	0.05
Dry fodder and concentrates/gfodder	β_2	0.139**	0.03
Veterinary services/gfodder	β_3	0.062**	0.02
Family labour/gfodder	β_4	0.010*	0.00
Dummy family labour	β_5	-0.007	0.03
Capital/gfodder	β_6	0.032	0.03
Log-likelihood		-7.53	
Gamma		0.28	

*† p<0.10, * p<0.05, ** p<0.01*

Cattle have the highest impact on production levels, as the estimated elasticity value is 0.53, which shows that one percent rise in the number of milk cattle gives a rise of 0.53% approximately in milk production. Green fodder produces the next highest elasticity (0.22), followed by concentrates and dry fodder (0.13), capital (0.03), veterinary expenses (0.06), and finally family labour (0.01).

Technical inefficiency model estimates

The findings of the technical inefficiency model are shown in the Table 4. The age coefficient is significantly positive, showing that older dairy farmers are more technically inefficient than younger ones who are progressive and interested in the implementation of modern techniques and technologies. The dairy sector is Pakistan is labour intensive, leaving older farmers at a disadvantage as many lack the physical ability to manage dairy operations. Coelli and Battese (1996) also argue that older farmers are risk averse and reluctant to adopt modern practices and technologies. This finding is consistent with the results of Singh and Sharma (2011) which show that older farmers are less efficient in Indian dairy farming; Likewise, Nganga *et al.* (2010) find that age has a positive relationship with technical inefficiency for milk producers in Kenya.

Table 4: *Technical inefficiency model estimates.*

Variables	Parameters	Coefficients	Standard Error
Constant	δ_0	-1.547**	0.84
Age	δ_1	0.053**	0.01
Experience	δ_2	-0.114**	0.03
Education	δ_3	0.075	0.11
Extension visits	δ_4	-0.126**	0.03
Share of cross bred and exotic cows	δ_5	-0.010†	0.00
Processor	δ_6	-0.459	0.42
Neighbours' extension visits	δ_7	-0.018†	0.01

*† p<0.10, * p<0.05, ** p<0.01*

The coefficient of experience is significantly negative, indicating that farmers who possess more dairy experience are expected to be more efficient as they could better manage their enterprises and are anticipated to cope better with crisis management. During the field survey we noticed that farmers with high dairy experience have better social linkages with other progressive dairy farmers and are up to date with modern practices. Similar results are also revealed in studies of (Nganga *et al.*, 2010; Mor and Sharma, 2012; Uddin *et al.*, 2014).

Exotic and cross-bred cattle are considered to increase the potential output of dairy farmers and ensure the continuous supply of milk in summer season when buffalo milk production drastically drops. The coefficient value of share of the imported and cross breeds cows in the flock is estimated to be statistically negative. This implies that owners of cross and imported breed cows are technically more efficient. Exotic and cross-bred cattle also require more care and are sensitive to local conditions which require better management practices to handle these cattle and press farmers to better manage their farms. These findings are consistent with the studies of (Mor and Sharma, 2012) and (Nakanwagi and Hyuha, 2015) who find a negative association between the possession of exotic and cross-bred cattle and technical inefficiency, indicating that farmers who possess more cross-bred livestock tend to have a lower technical inefficiency. However, low impact of exotic and cross breeds may suggest that farmers are not aware about modern breeding practices and they may not be able to select suitable breeds for producing improved breeds.

The coefficient of extension and veterinary services is statistically negative which shows it reduces the technical inefficiencies of farmers. This implies that extension services improve the technical efficiency of dairy farmers through imparting knowledge on modern farming practices and disease control measures, as well as enhancing the management skills of the farmers. These findings are coherent with the outcomes of (Iqbal and Ahmad, 1999) and (O'Neill *et al.*, 1999). However, extension and veterinary services in Pakistan are mainly focused on awareness about disease control measures and enhancing farmers' knowledge regarding breeding techniques. Extension services put little focus on efficient use of inputs, and we have found no evidence of increase in productivity due to extension services.

The coefficient of neighbour's' extension visits is estimated to be statistically negative. This suggests that extension visits paid to neighbouring farmers play a crucial part in improving the technical efficiency of farmers as they share their experiences. This might also suggest that farmers with more social contacts are more efficient as they learn from the experiences of neighbouring farmers.

The coefficient of milk sale pattern for the farmers is negative, implying that farmers who sell milk to formal milk processing units are technically more efficient than farmers who sell to traditional channels.

However, this association is not statistically significant. One possible rationale could be that the formal milk supply chains have set higher standards for milk purchasing and farmers respond to these standards, which increasing their efficiency. However, modern milk supply chains usually focus on large farmers which do not help to increase the efficiency of farmers across the board.

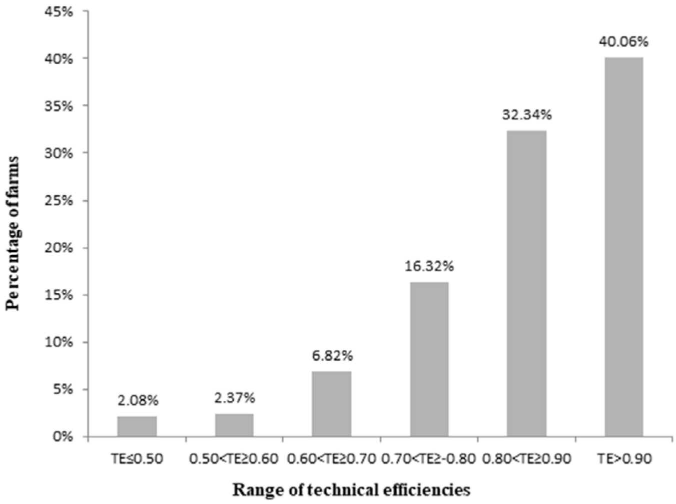

Figure 1: *Technical efficiency of dairy farms in Pakistan.*

Technical efficiency

The mean technical efficiency of dairy farms in Pakistan is 0.85, with minimum and maximum values of 0.47 and 0.99 respectively; the standard deviation is 0.11 (Figure 1). About 40.06% of the dairy farmers have technical efficiency indices above 0.90, while 50.66% of the farmers range between greater than 0.70 and less than or equal to 0.90. Thus, 88.72% of the farmers have 0.71 or above technical efficiency scores. Only 11.2% of the farmers have less than 0.71 technical efficiency score. The 0.85 mean technical efficiency indicates that, on average, dairy farmers in Pakistan produce 85% of their potential yield, given the current state of the technology in the dairy sector. Therefore, milk production can be increased by 15% by adopting the best practices of dairy farming.

Conclusions and Recomandations

This study shows that dairy farmers in Pakistan exhibit constant returns to scale and the number of milking cows has contributing higher among all the input variables, followed by green fodder, and dry fodder and concentrates. The mean technical efficiency is 0.85, indicating that the productivity can be enhanced by means of 15% with no extra inputs. The joint impacts of all the determinants of the technical inefficiency model are statistically significant in justifying the intensity and disparities in the efficiency of dairy farming in Pakistan, though some of the specific variables have no significant effect. We have found a significant role of extension and veterinary services in decreasing the technical inefficiencies of the dairy farmers. Studies also show that extension visits paid to neighbouring farmers also reduce the technical inefficiency of farmers. However, extension and veterinary services in Pakistan are mainly focused on awareness about disease control measures and enhancing farmers' knowledge regarding breeding techniques. It is quite necessary that extension services should also focus on educating farmers about efficient and balanced used of feed to enhance their productivity and reduce cost and create awareness among farmers about modern farm technologies. We find that share of exotic and cross-bred cattle reduces the technical inefficiency of farmers. Exotic and cross-bred cattle are considered to increase the potential output of dairy farmers and ensure the continuous supply of milk in summer season when buffalo milk production drastically drops. It is quite necessary that farmers should be provided with quality semen and also given better training to select suitable breeds for crossing.

We have found that variable related to human capital like experience increases the technical efficiency while age and education reduces the technical efficiency of the dairy farmers. We have found no significant effect of modern milk supply channels on the technical efficiency of dairy farmers. This may suggest that although modern milk supply channels have strict quality standards and demand continuous supply of milk, but they do not train farmers for requite technical skills or farmers do not have easy access to milk selling points. Therefore, it is necessary to invest in rural infrastructure to develop farm to market linkages.

Based on these observations, this study advocates for the provision of extended extension services and quality training programmes for dairy farmers to ensure proper farm management. We would also suggest that farmers should be provided with improved cross-bred cattle and buffalo breeds. It is quite necessary to void indiscriminate crossbreeding by educating farmers about modern breeding practices. To enhance the efficiency and profitability of the farmers, it is necessary to expand milk supply networks to remote areas.

Novelty Statement

Little is known regarding the influence of access to extension and veterinary services and herd breed structure on farmers in Pakistan. Therefore, this study highlights the impact of extension and veterinary services and herd breed structure on the technical efficiency of market oriented dairy farms in Pakistan.

Author's Contribution

Sami Ullah: Idea conception, method development, data and analysis and initial draft writing.
Bernhard Brümmer: Overall supervision, reviewing the final draft.
Umar Ijaz Ahmed: Data collection and entry, reviewing and editing.
All authors read and approved the final manuscript.

Conflict of interest
The author(s) declare(s) that there is no conflict of interests regarding the publication of this article.

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