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Full Length Article

Effect of Milk or Milk Replacer Offered at Varying Levels on Growth Performance of Nili-Ravi Buffalo Veal Calves

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Abstract

The purpose of current experiment was to evaluate the effect of feeding either milk or milk replacer (MR) offered at the rate of (@) 10% *vs*. 15% of body weight (BW) on growth performance, post-weaning nutrient apparent digestibility and economics of rearing Nili-Ravi buffalo veal calves. Thirty-two calves were equally allocated to four treatments in 2 × 2 factorial arrangements. Calves were fed either milk or MR and subdivided into two groups offering liquid diet @ 10 or 15% of BW, but not exceeding 5 and 6 L/d, respectively until week 8 and weaned at 10 weeks of age. Calves were also offered a calf starter (CS) ration from 2nd week to final live BW of 120 kg. Calves fed milk showed higher ($P < 0.05$), overall average daily gain (ADG) and took less time ($P < 0.05$) to reach target weight (120 kg) than MR one's. Calves fed liquid diet @ 10% during the pre-weaning phase also presented higher ($P < 0.05$) overall ADG and took less time ($P < 0.05$) to reach target weight than those fed at 15% of BW. Cost per kg live weight gain (LWG) was higher in calves raised on milk and those fed @ 15% of BW. Feeding MR @ 10% of BW was cost effective; however, MR feeding delayed the days to reach the target weight. Hence the decision of rearing buffalo calves on milk or MR may depend on priorities of the farmers and depending on the price of inputs.

Keywords: Milk; Milk replacer; Buffalo calves; Performance; Economics

Introduction

Buffalo milk is preferred over cow milk by many local consumers of Pakistan due to higher fat content and fetches higher prices (Sarwar *et al.* 2002). High price of milk results in a higher feeding cost compared to the sale price of calves at weaning (Bhatti *et al.* 2012). Thus, many farmers are tempted to sell milk instead of feeding to the calves. As a consequence, many male buffalo calves die due to underfeeding (Ahmad *et al.* 2009). In many western countries, surplus male dairy (cow) calves are raised as veal and sold at premium prices (Mollenhorst *et al*. 2016). Male buffalo calves could also be raised for veal production (Banjade *et al*. 2017), if international quality standards are met economically (Bhatti *et al.* 2013). Previous research suggests that buffalo calves have a better milk conversion ratio than Friesian calves (Bhatti *et al.* 2009). This advantage makes them a suitable candidate to explore for their veal production potential, especially in Pakistan. However, the veal production potential of this buffalo breed under local environmental conditions is not well documented. For successful veal production, high growth rates at an early age can be achieved by feeding *ad lib* quantities of milk (Khan *et al.* 2011; Iqbal *et al.* 2014); however, it also increases the pre-weaning feeding cost (Bhatti *et al.* 2013). To reduce the pre-weaning feeding cost milk replacer (MR) can be an alternative liquid diet as it is cheaper than milk (Heinrich *et al*. 1995; Abdullah *et al.* 2013). The traditional recommendation for feeding milk (or MR) to calves is @ 10% of the body weight (BW) (Ahmad and Rehman 1989). However, higher average daily gain (ADG) was reported for buffalo calves offered milk @ 15% of BW compared to conventional (10% of BW) quantities (Abbas *et al.* 2017). Increasing milk further to 20% of BW; however, has been found to be uneconomical (Bhatti *et al.* 2013). Provision of a calf starter (CS) ration in the pre-weaning period is an economical means of increasing growth rates (Bhatti *et al.* 2012). The use of MR with the provision of a CS ration may be a profitable means of producing high quality Nili-Ravi buffalo calves for veal production.

The study was conducted to assess the effect of feeding either milk or MR offered at either conventional (10% of BW) or enhanced (15% of BW) levels on the growth performance, nutrient apparent digestibility at weaning and economics of rearing of Nili-Ravi buffalo veal calves.

Materials and Methods

Animal's management and dietary treatments

The trial was conducted from August, 2017 to July, 2018 at the Livestock Experimental Station Bahadurnagar, Okara.

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Calves born at Bahadurnagar farm during August to December, 2017 were used in this study. Newly born calves were artificially fed colostrum @ 10% of BW within 6 h of their birth. The calves were kept in individual pens under a single shed open from one side. Thirty-two calves were randomly assigned to one of the four treatments, to give a total of eight calves per dietary treatment. The dietary treatments were as follows: M10: whole milk fed @ 10% of BW but not exceeding 5 L/d and weaned at the age of 10 weeks; M15: whole milk fed @ 15% of BW but not exceeding 6 L/d and weaned at 10 weeks age; MR10: MR fed @ 10% of BW but not exceeding 5 L/d and weaned at 10 weeks age; and MR15: MR fed @ 15% of BW but not exceeding 6 L/d and weaned at 10 weeks age. The quantity of milk or MR given to the calves was adjusted weekly (on calf BW basis) until week 8, and then steadily reduced to zero with the calves weaned by the end of the 10^{th} week. Calves were fed milk or MR, in half equally divided proportions, twice a day in the morning and evening.

Fresh buffalo milk (3.7% CP and 6.4% fat) was obtained from Nili-Ravi buffaloes at Bahadurnagar dairy farms at the time of each feeding. Milk replacer Eurolac Green 20/18 (Schills Holland), containing 22% CP and 18% fat on DM basis, was prepared by thoroughly mixing 1 kg of the powder in 7 L of warm water to attain temperature at the time of feeding ≥ 40°C, similar to freshly drawn milk. Reconstituted MR contained 2.7% CP and 2.2% fat on as fed basis. The calves were fed milk or MR from nipple fitted buckets to mimic natural suckling. The utensils used for milk feeding were washed daily with detergent and then sun dried. In addition to their liquid diet (fed for a total of 10 weeks), all the calves were offered a CS ration (19% CP and 2.9 Mcal ME) from the second week until they reached the target weight of 120 kg. The daily intake of the CS ration was determined by offering a weighed quantity once every day and weighing the refusal the next morning. Calves had free access to clean, fresh water 24 h/d which was provided in a separate bowl located in their pens.

Growth performance

The calves were weighed on an electronic scale at the start of each week before their morning liquid feeding. This also enabled calculation of the volume of liquid, given to each calf each week. All the calves were observed every day, for any incidence of scour, based on ranking of 1–4 as defined by Kertz and Chester-Jones (2004). Calves were observed for other ailments and treated if required.

Digestibility trial

Post weaning (week 10) apparent digestibly of dry matter (DM), ether extract (EE), crude protein (CP) and crude fiber (CF) was performed by the total collection method. Four, randomly selected animals from each treatment were used. The apparent digestibility of nutrients was calculated on DM basis using equation.

Apparent digestibility (%) = [Feed content (g) – fecal content (g)]/feed content (g) x 100

Laboratory analyses

Chemical analysis to determine milk DM and CP contents was undertaken using automatic milk analyser (Milkotester Ltd., Bulgaria). Feed and fecal samples were analysed for DM, CP, EE and CF contents as described by AOAC (2006).

Production cost

Record of expenditure on purchase of calves, feeding, medication, and labour was maintained to calculate feeding and production costs of the buffalo calves. However, expenditure on permanent equipment such as calf pens, feeding buckets and managerial costs were not considered for production cost calculations.

Statistical analysis

The data were analyzed using MIXED Procedures of SAS (SAS 2011); for repeated measures, data were analyzed using an Auto Regressive (1) covariance structure (Littell *et al*. 1998) taking calf effect as random and for non repeated measures, calf's birth weight was taken as covariate. All results were presented as least square means. Values were considered to differ significantly with $P < 0.05$.

Results

Milk or milk replacer intakes

Average daily liquid (milk or MR) consumption of the Nili-Ravi buffalo calves is presented in Fig. 1. Intakes ranged from 2.8– 4.9 L/d and 3.4–5.3 L/d in the calves offered M10 and MR15, respectively. Total liquid intake was higher ($P < 0.05$) in calves fed @ 15% of BW compared to those at the rate of 10% of BW; however, it was not different ($P > 0.05$) in calves offered either milk or MR (Table 1). Nutrient intake (CP and EE) was greater ($P < 0 .05$) among calves given milk in comparison to those fed MR. Crude protein intake was higher ($P < 0 .05$) among calves fed liquid @ 15% of BW compared to 10% of BW. The volume level of fed liquid had no effect ($P > 0.05$) on EE intake (Table 1).

Intake of the calf starter ration

The intake of the CS ration during the first 6 weeks was negligible (< 100 g/d); however, onward CS intake increased among MR-fed calves (Fig. 2). By the time of weaning (10 weeks), the animals in all treatments were consuming ~1 kg/d and did not differ ($P > 0.05$) for total CS intake during the pre-weaning period (Table 1). Intake of CS during the post-weaning phase was increased among calves fed MR and by the 25^{th} week, the daily CS ration consumption reached up to 2.4 kg/d among MR10 calves

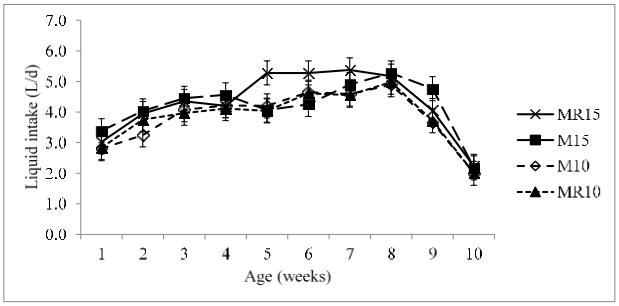

Fig. 1: Average daily liquid intake of Nili-Ravi buffalo calves fed either milk (M) or milk replacer (MR) at the rate of either 10% (M10, MR10) or 15% (M15, MR15) of body weight. The vertical bars are the standard error of the means

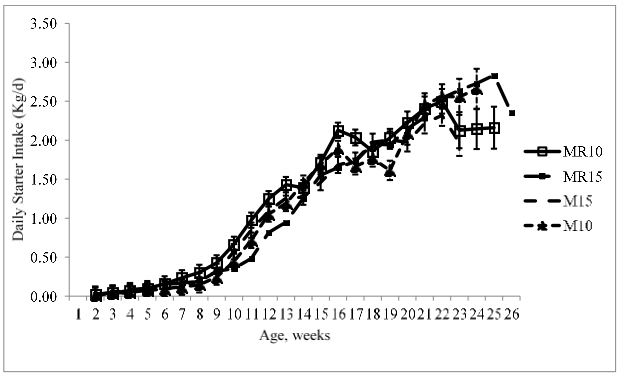

Fig. 2: Intake of calf starter ration by Nili-Ravi buffalo calves fed either milk (M) or milk replacer (MR) at the rate of either 10% (M10, MR10) or 15% (M15, MR15) of body weight during the pre-weaning phase. The vertical bars show the standard error of the means

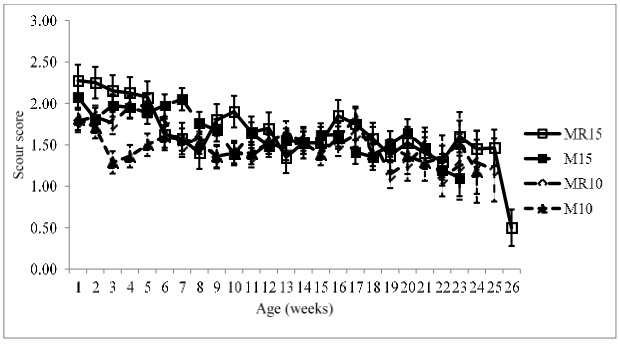

Fig. 3: Calf scour score of Nili-Ravi buffalo calves raised on either milk (M) or milk replacer (MR) fed at the rate of either 10% (M10, MR10) or 15% (M15, MR15) of body weight

(Fig. 2). Total CS intake over the entire feeding trial was greater ($P < 0.05$) among calves raised on MR (Table 1); however, was not different ($P > 0.05$) due to feeding level.

Scour score

During the pre-weaning phase, average weekly scour score was higher ($P < 0.05$) among calves fed @ 15% than those fed10% of BW. The average weekly score was higher during the pre-weaning period and was almost normal during the post-weaning period (Fig. 3).

Growth rates and live weights

Pre-weaning ADG was not different ($P > 0.05$) across the dietary treatments, thus resulted in similar ($P > 0.05$) weaning weights among treatments (Table 1). However, overall ADG (from birth to target weight) was better ($P < 0.05$) for those raised on milk compared with MR and was also better ($P < 0.05$) for calves fed liquid @ 10% of BW during the milk feeding phase. Calves raised on milk reached the target weight (120 kg) earlier ($P < 0.05$) than those given MR. Calves fed liquid @ 10% of BW during the pre-weaning phase also reached target weight earlier ($P < 0.05$) than those offered liquid at 15% of BW (Table 1). Furthermore, highest ($P < 0.05$) ADG was recorded in M10 calves and the lowest ($P < 0.05$) in MR15 calves. Calves fed milk took lesser time ($P < 0.05$) to reach the target weight than those fed MR.

Apparent digestibility of nutrients

The post-weaning, apparent digestibility of the nutrients is presented in Table 2. All dietary treatment showed no effect ($P > 0.05$) on the apparent digestibilities of DM, CP, EE and CF.

Economics of production

The prices of milk, MR and starter ration were 80 PKR/L, 38 PKR/L and 32 PKR/kg, respectively. The total cost of liquid feed during the milk feeding phase was higher ($P < 0.001$) among calves fed milk; however, was not different ($P > 0.05$) due to feeding level (Table 3). During the pre-weaning period, the intake and thus cost of feeding CS did not vary ($P > 0.05$) across the dietary treatments. Total cost of CS was higher ($P < 0.01$) among calves given MR and was also higher ($P < 0.001$) in calves were fed liquid diet at the rate of 15% of BW (Table 3). Medication costs through the pre- and post-weaning phases were not affected ($P > 0.05$) by either the liquid diet sources or level of liquid feeding. Total feeding cost during the milk feeding phase was higher ($P < 0.001$) in calves fed milk; however, was not different ($P > 0.05$) due to liquid feeding levels. The purchase cost of the buffalo calves was PKR 3500/hd and the labour cost associated with the rearing of these calves was PKR 8500/hd. Total overall feeding and production costs were higher ($P < 0.001$) in calves given milk and was also higher with increased level of liquid feeding (Table 3). Ultimately total cost per kg LWG over the entire feeding period was higher ($P < 0.001$) among calves given milk and was also higher in those fed liquid feed @ 15% of BW during the liquid feeding period.

Table 1: Least square means of growth performance of Nili-Ravi buffalo calves given either milk (M) or milk replacer (MR) fed at the rate of either 10% or 15% of body weight

Parameters	Feeding source		Feeding level		SE	*P*- values		
	M	MR	10%	15%		F1	F2	F1*F2
Total milk intake (L)	280.5	280.0	268.8	295.5	8.3	NS	*	NS
Crude protein intake (kg)	10.4	7.7	8.7	10.0	0.3	***	*	NS
Ether extract intake (kg)	17.9	6.3	11.6	14.8	0.4	***	NS	NS
Calf starter ration intake (kg)								
Pre-weaning	11.9	14.3	13.8	11.8	1.0	NS	NS	NS
Post-weaning	122.8	147.2	126.4	142.4	9.2	*	NS	NS
Total	134.8	161.6	140.2	154.4	9.1	*	NS	NS
Birth weight (kg)	38.7	37.9	37.9	38.7	1.4	NS	NS	NS
Weaning weight (kg)	76.8	72.2	75.2	74.2	3.1	NS	NS	NS
Weeks to reach target weight	19.8	21.5	19.7	21.7	0.8	*	*	*
Weight gain (kg)								
Pre-weaning	38.1	34.4	37.4	35.3	2.3	NS	NS	NS
Post-weaning	45.2	49.4	46.5	47.6	3.1	NS	NS	NS
Total	83.3	83.8	83.9	82.9	1.3	NS	NS	NS
Average daily gain (g/d)								
Pre- weaning	543	491	534	504	33	NS	NS	NS
Post-weaning	676	648	70	611	33	NS	*	*
Overall	612	568	615	563	19	*	*	*

F1 = Feeding source: M or MR; F2 = Feeding level: 10% or 15% of body weight; F1*F2 = Interaction of F1 and F2; NS: non-significant $P > 0.05$; *: $P < 0.05$; ***: $P < 0.001$

Table 2: Least square means of post-weaning nutrient digestibility of Nili-Ravi buffalo calves reared on either milk (M) or milk replacer (MR) fed at the rate of either 10% or 15% of body weight

Apparent digestibility (%)	Feeding source		Feeding level		SE	*P*- values		
	M	MR	10%	15%		F1	F2	F1*F2
Dry matter	72.9	73.2	74.0	72.2	0.8	NS	NS	NS
Crude protein	73.4	73.1	73.1	73.4	1.0	NS	NS	NS
Ether extract	88.0	89.8	90.0	87.8	0.8	NS	NS	NS
Crude fiber	44.4	41.4	44.5	41.3	2.1	NS	NS	NS

F1 = Feeding source: Milk or MR; F2 = Feeding level: 10 or 15% of body weight; F1*F2 = Interaction of F1 and F2; NS: non-significant $P > 0.05$; *: $P < 0.05$

Table 3: Least square means of costs of production of Nili-Ravi buffalo calves fed either milk (M) or milk replacer (MR) fed at the rate of either 10% or 15% of body weight

Cost (PKR)	Feeding source		Feeding level		SE	*P*- values		
	M	MR	10%	15%		F1	F2	F1*F2
Liquid feed	22442	10641	15844	19439	571	***	NS	NS
Starter ration								
Pre-weaning	382	458	440	380	33	NS	NS	NS
Post-weaning	3932	4712	4046	4559	294	*	NS	NS
Total	4314	5170	4486	4939	285	**	*	NS
Medication								
Pre-weaning	586	409	455	584	63	NS	NS	NS
Post-weaning	198	190	183	209	32	NS	NS	NS
Total	784	599	638	793	78	NS	NS	NS
Feeding and medication								
Pre-weaning	23411	11507	16739	20403	564	***	NS	NS
Post-weaning	4130	4902	4230	4768	315	*	NS	NS
Total	27541	16409	20969	25171	425	***	***	NS
Feeding and medication cost per kg live weight gain								
Pre-weaning	642	340	454	592	25	***	*	NS
Post-weaning								
Total	331	197	251	304	6.5	***	**	NS
Total production cost[1]	39540	28409	32968	37171	425	***	***	NS
Per kg live weight gain	324	234	271	305	3.7	***	***	NS

F1 = Feeding source: M or MR; F2 = Feeding level: 10% or 15% of body weight; F1*F2 = Interaction of F1 and F2; NS (non-significant) $P > 0.05$; *: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$

[1]includes calf purchase price (PKR 3500/head) and labour cost (PKR 8500 per head) but not infrastructure cost

Discussion

The study was planned to compare the effects of milk or MR on growth of buffalo calves. Calves at early age are just like monogastrics and are solely dependent on milk diets for nutrient requirements. Therefore, increasing the volume of liquid offered to the buffalo calves resulted in higher intakes. Abbas *et al.* (2017) also found that Nili-Ravi calves

fed a high volume (15% BW) of fresh milk had higher total milk intake than those fed low volumes (10% BW). In present study liquid intake was adjusted weekly depending on the BW of calves, thus due to similar ADG, calves fed milk or MR also did not differ for their liquid intake. All calves were provided access to the CS ration from 2 weeks of age and intake of the CS ration during the first 6 weeks was negligible (< 100 g/d). Calves fed MR showed higher daily intake of the CS after week 6 (Fig. 2); however, total intake of CS at the time of weaning was similar across all the treatments (Table 1). Similar outcomes were reported by Abdullah *et al.* (2013) where Nili-Ravi heifer calves offered whole milk had similar DMI (which included CS and green fodder) to those fed MR at 10% of BW. Early and enhanced dry feed ingesting improves timely rumen microbial growth, and results in greater metabolic activity of rumen (Anderson *et al.* 1987). Thus, intakes of the CS ration during overall trial were higher in calves raised on MR. The volume of liquid feeding had no effect on post-weaning and overall intake of the CS ration starter. Calves offered higher volumes did not consume the whole allowance, thus resulting, similar hunger for solid feed. Results were consistent with Abbas *et al.* (2017) who found that buffalo calves fed milk @ 15% of BW had similar post-weaning CS intake as that fed milk @ 10% of BW.

Increase in weight in buffalo calves during growth phase is usually credited to levels or balance of nutrition. Provision of feed to these calves according to their nutritional (protein and energy) requirement offers a practical dietetic tool to improve efficacy (Tauqir *et al.* 2011). The ADG of the buffalo calves up until weaning ranged between 446 g/d (MR15) to 554 g/d (M10). However, weaning weights (at week 10) of calves were not affected by liquid dietary treatment, ranging between 69.2 kg (MR15) and 76.8 kg (M10). Bhatti *et al.* (2009) reported that buffalo calves given milk @ 10% of BW attained 77.2 kg live weight in 12 weeks period. The lack of difference in the intake of the CS ration during the pre-weaning period also contributed to no difference in weaning weights. Over the entire feeding period, ADG varied, ranging from 478 g/d (MR15) to 618 g/d (M10). As a consequence of these differences in overall ADG, the time to reach target weight also varied, ranging from 19.6 weeks (M10) to 25 weeks (MR15). Despite there being no difference in intake of the CS ration between dietary levels, numerically, CS intake during the liquid feeding period was greater in calves fed liquid at 10% of BW (13.8 kg) than at 15% of BW (11.8 kg). If the calves fed @ 10% of BW started eating the CS earlier would have promoted earlier rumen development, and resulted in better gain in later life.

The most common and frequently occurring disease in buffalo calves is diarrhea. Major risk aspects related with increased occurrence of diarrhea in newborn calves are inappropriate liquid feeding (Ollivett *et al.* 2012). During the liquid feeding phase, the average weekly scour score was higher in calves fed @ 15% than those fed 10% of BW. Similar results were reported by Abbas *et al.* (2017) when buffalo calves fed higher volumes (15% of BW) of milk had a greater number of days in scour compared to those fed lower volumes (10% of BW). Despite the effect of feeding level on fecal score, it had no effect on ADG during the pre-weaning period. Higher intake of liquid diets results in increased digesta flow rate; thus, less retention time negatively affected efficiency. During the post-weaning period the weekly scour score was almost normal. Apparent digestibility measured post-weaning was similar for all dietary treatments. However, numerically higher DM and CF digestibility can be attributed to higher intake of CS among milk-fed and those fed @ 10% of BW and therefore in microbial protein synthesis. Sultan *et al.* (2009) found increasing dietary (rumen degradable) protein resulted in higher DM and NDF digestibilities in Nili-Ravi calves.

Higher pre-weaning cost to feed calves on milk, despite similar level of intake, was a consequence of the higher price of milk compared to MR. Further pre-weaning cost of the CS ration did not vary due to similar intake of the CS ration across dietary sources. Pre-weaning cost associated with liquid feeding level was not different between feeding at 10 and 15% of BW. Numerically higher pre-weaning CS cost in low fed calves neutralized the liquid diet cost differences during pre-weaning period. In contrast, Abbas *et al.* (2017) found that the cost of Nili-Ravi calves during milk feeding period increased as the volume of milk fed increased (from 10 to 15% of BW). However, as consequence of overall increased intake, the cost of the CS ration was higher in the calves raised on MR (5170 PKR) than those on milk. Though not different, numerically cost of the CS ration (post-) was higher in calves fed their liquid diet @ 15% of BW, and resulted in higher overall CS ration cost. Medication costs during the pre- and overall did not vary between dietary treatments. Combining all feeding and medication costs resulted in increased production cost of for calves reared on milk and similarly those offered liquid 15% of BW. The most effective costing to determine the most economically efficient rearing method is the cost per kg LWG. When fed at 15% of BW, MR-fed calves consumed an additional 56.3 kg of CS and reached target weight 5 weeks later than those fed milk. When fed at 10% of BW, there was no significant difference in terms of weeks to reach target weight (19.6 versus 19.8 weeks), although the MR fed calves consumed an additional 12.4 kg of CS. The differences in ADG and CS intake resulted in differences in the cost per kg LWG. On the basis of these results, feeding MR at the rate of 10% of BW is the most appropriate (PKR 321per kg LWG) for the economical raising of buffalo calves for veal production.

Conclusion

Feeding MR at the rate of 10% of BW was cost effective for the rearing of buffalo calves for veal production because of the lower cost/kg LWG; though MR feeding delayed the

days to reach the target weight. Hence the decision of rearing buffalo calves on milk or MR may depend on priorities of the farmers and depending on the prices of inputs.

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Author Contributions

MK Qadeer conducted the study; SA Bhatti planned the study and analyzed the data; H Nawaz and MS Khan helped in writing the manuscript.

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