Chapter 10

Breeding, Management and Environmental Issues at Peri-Urban Dairy Farms

M. Subhan Qureshi

Additional information is available at the end of the chapter

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1. Introduction

Dairy animals have been companions of human beings since the time immemorial. Cattle, buffaloes, sheep and goats are being reared to meet demands for human food, clothing and industrial needs. The river banks have been the seats of civilization and provided an opportunity for dairy farming, especially buffaloes in the South East Asia. However, this farming has just occurred haphazardly, without any scientific, development or business support, in most of the cases.

In the maritimes these farms are facing huge economic losses, due to under managed health, fertility and productivity and a very hostile marketing system. Still the livestock holders survive due to lack of any alternate source of livelihood and a huge investment by the forefathers of these poor people (opportunity cost). Opportunity cost remains the main support for such farmers and new investment is usually avoided. As a resultant such farms can neither provide an appropriate return to the farmers, nor a cheaper food of acceptable quality to the consumers.

The huge investment made by the ancestors of the farming family and the rising levels of unemployment compel them to stick to the business, willingly or unwillingly. The farming family tries to continue the business without considering the financial inputs and products, and the products have been reported to recover only 75% of the cost of productivity. Under such type of income levels the dairy farmers possess no capital to invest in strengthening their dairy production operations.

The peri-urban dairy farming systems in the South East Asia have been reviewed, with a special focus on Pakistan as described earlier (Qureshi, 2008). As a part of the agricultural production system, dairy farming is a prerequisite to alleviation of poverty. It supplements other income generating activities to eradicate poverty and creates adequate opportunities for enhanced rural and peri-urban employment, income generation and economical access to food. The horizontal expansion in dairy farming is still in progress. The increasing human population of the urban areas, the rising income levels and the awareness about need of animal proteins in human diet, has resulted in increasing demand for milk and meat. This demand for food items and the rising levels of prices, calls for expansion of dairy and livestock industry.

Dairy farms provide a unique environment for development of special social norms. The dairy farms are located in the peri-urban areas of the major cities to meet the demand for milk of the urban populations. The farms are established without scientific planning for construction of buildings, roads, water supply and drainage and other requirements of the people and the dairy operations. The farmers are taking care of 57 million dairy animals (cattle and buffaloes) in Pakistan, the approximate value being Pak Rs.1.5 trillion and contributing to the national economy to the tune of Pak Rs.1.2 trillion per annum (US$ 1 = Pak Rs.85). But they do not get the desired contribution from the society.

The living standards of the farmers are low due to low profitability of the farms. The high and non-regulated cost of inputs and state-controlled lower price of the products make the profit margin low. Lack of state-subsidy and hostile marketing system damage these enterprises. Under such circumstances the living standard of the dairy farmers is definitely deteriorated. The farmers have little chance to send their children to better educational institutions, which usually are expensive. The children discontinue their education after passing the primary schools. A so-called self employment is provided to the children by their parents at the dairy farms and their potential for better contribution to the society is wasted.

The prospects for local dairy production have recently become more favorable in the developing countries (FAO, 1995), following the reduction of milk production subsidies in western developed countries and the introduction of more realistic exchange rates under structural adjustment programs. These recent changes have provided many developing countries with the opportunity to develop their own milk industries, primarily through small-scale production, which will have a major impact on different levels of cash income. The document recommended greater attention for the provision of facilities and credit that benefit the small-scale producer, rather than major investments in institutions and facilities, such as big slaughterhouses, dairy plants and feed-mills, which are usually oversized, overstaffed and over-equipped.

Within the industry there are differing views on the way government policy should be used to assist the industry (Wynn, 2006). There is a conflict between the need to generate higher returns for milk producers and a desire to maintain low retail prices for milk that relates to alleviation of poverty for the urban poor. These pressures are evident in other industries (e.g. sugar, wheat) and have led to the implementation of support policies. Pakistan lacks appropriate resources and hence there is no domestic support polices that raise returns for domestic milk producers. However, in time political pressures may emerge to introduce price regulations in order to stimulate increased milk production. Policy makers do not appear to be aware of the implications of these sorts of policy developments for future industry development. The author (Wynn, 2006) emphasized that there would be some value in making key policy makers of Pakistan aware of the mistakes with previous Australian dairy policies.

2. The issues

The peri-urban dairy farms face several challenges impeding its productivity, profitability and sustainability. Resultantly, these farms are at risk of elimination as they can not compete with similar business activities in the peri-urban areas. Poor reproductive efficiency has been reported in buffaloes, associated with their inherent lower fertility, a smaller population of recruitable follicles and problematic estrus detection. Breeding efficiency of the animals is low and the physiological and management factors are responsible for lowered reproductive efficiency.

The dairy buffaloes maintained at the peri-urban dairy farms in the region are primarily kept for milk yield and the rebreeding finds a lower priority in management decisions. Rather the rebreeding and conception are considered undesirable in most of the cases. One of the factors behind the low priority for rebreeding practices has been the higher cost of milk, labor and land cost in the peri-urban regions. It leads to lack of availability of calves in appropriate age groups for replacement of lactating females and breeding sires. Therefore, breeding efficiency has been reviewed in the following paragraphs.

The feeding practice at the peri-urban dairy farms is haphazard, ignoring the nutrient requirements of the various animals' groups. Same scale feeding is practiced which is associated with overfeeding of the low-yielding animals and under-feeding of the higher-yielders. It may lead to malnutrition, affecting the body functions like milk synthesis and growth and may not support the good health conditions of the animals. The quality of feed ingredients is also low. Improper storage of feed items expose them to contamination with aflatoxins which may lead to poor productivity, fertility and health status. In most of the cases the feed stocks are adulterated with undesirable items. Reproductive cyclicity and a successful gestation requires an optimum status of nutrients availability. Any deviation from the optimum range will result in partial or complete cessation of reproductive cyclicity. Therefore, the reproduction-nutrition interaction has been reviewed in this chapter.

Nutritional status of the animal is assessed through the intake of nutrients and its utilization for various body functions. Intake and utilization of nutrients may be assessed through body condition score (BCS). BCS has been used extensively in research studies, since long. It may be recorded a bi-weekly intervals and the changes may be used for predicting a normal parturition, postpartum lactation and post-insemination conception of a dairy cow and buffalo. The author has investigated this parameter extensively for its association with reproductive cyclicity, milk yield and fatty acid profiles and the quality of drinking water.

Milk yield in the dairy buffaloes decline after getting pregnant; which has been a matter of concern for the peri-urban dairy farmers. This may be because of the already stated reason that the animals are provided same-scale feeding. Under such conditions the pregnant animals may get escaped from getting pregnancy supplement rations. After pregnancy the conception gets higher priority over lactation in buffalo and a feed deficiency may lead to decline in milk yield. In addition, the hormonal changes during pregnancy in dairy buffaloes may lead to intervention in the lactation process. The receptors for lactation hormones may intercept with the reproductive hormones, causing a decline in milk yield. These phenomenons were investigated by our group and the findings are reviewed in this chapter.

The labor cost at the peri-urban dairy farms is higher as compared to rural areas. Milkmen are hired for milking the lactating buffaloes, instead of using the milking machines. The milkmen are conscious about their time spent at the farm. They try to get rid of the milking duty as soon as possible. As a routine practice, the young calf is used for milk let down through suckling stimulus. However, as the calf keeping is considered expensive, such calves are disposed off at an earlier age. Under such conditions the milkmen use oxytocin for the purpose of milk let down. It poses a public health problem as well an undesirable offence over the reproductive endocrinology of the dairy buffaloes. This phenomenon has been reviewed in this chapter.

The milk composition, especially the fatty acids vary with the changing nutritional and physiological states of an animal. The human consumers expect healthy milk fatty acids from the dairy animals. Unsaturated fatty acids are considered cardio-protective in nature and such fatty acids may arise as a result of a specific set of management and physiological conditions. This phenomenon has been discussed in this chapter.

The quality of drinking water used at the peri-urban dairy farms may affect the productivity, fertility and milk quality of animals. The heavy metals and toxic materials present in the water supply network need appropriate monitoring to assess its fitness for dairy animals' use. The farms are supplied form the tube-well in these areas, where the water table is usually higher and is exposed to the pollutants from the waste depots. Heavy metal contents of the drinking water pass on to the human diet which may affect the health status of the consumers adversely.

3. Breeding efficiency and associated factors

The major causes associated with the under-developed buffalo farms have been identified as: i) calf losses, irregular breeding, imbalanced feeding; ii) unfavorable loans and; iii) a hostile marketing system. For commercial buffalo herds of Pakistan, those three causes lead to annual losses of US$ 18 billions (Qureshi, 2000). The normal breeding season in the Indo-Pakistan sub-continent begins in August and coincides with the feeding of non-leguminous fodders, such as sorghum and maize. Poor reproductive efficiency has been reported in buffaloes, associated with their inherent lower fertility, a smaller population of recruitable follicles at any given time than the ovary of the cow (89% fewer at birth), and a problematic estrus detection (Drost, 2007).

Breeding efficiency is the percentage performance based on the number of parturitions within the period from first to last lactation in relation to the standard and actual age at first calving. Breeding efficiency (BE) of dairy buffaloes and potential contributing factors were studied by our group (Sohail et al., 2009). A total of 5033 reproductive and productive records from the year 1985 through 2004 were utilized for this purpose. We reported BE (72.24%) which seemed to be sufficient under the management conditions of large sized state farms. However, this trait showed a persistent downward trend over the year (78.20 to 71.38%) during the period from 1991-92 to 2003-04. This may have occurred due to the effects of inbreeding or deteriorating or a deteriorating management conditions at these farms. A higher birth weight of a dairy buffalo was found to be the most significant contributing factor to BE and it also supported an earlier age at puberty (AAP), age at first calving (AFC) and a better lactation yield (LY).

Increase in BE was associated with an increase in lactation yield, confirming the earlier findings of Qureshi et al. (2007) who reported that high yielding buffaloes were also efficient in fertility. However, after a certain level BE was reduced with further increase in production, indicating high priority of nutrients partitioning towards production than reproduction.

An average breeding efficiency of 64.0 % was reported in Nili-Ravi buffaloes (Bashir et al. (2007). Herd and year were found as important source of variation for breeding efficiency while season of calving or age at first calving had no effect in the reported study. This indicated that all the herds used by Sohail et al. (2009) were better managed in terms of reproduction and the animals were fed properly. They also concluded that optimum age at first calving favored breeding efficiency because the reproductive organs and neuro-endocrine system developed sufficiently to support optimum reproductive cycle and conception. Further increase in age at first calving may be the effect of aging leading to a lower reproductive performance.

In a previous study Khan et al. (2008) reported that the decline in milk yield with the onset of pregnancy was prevented by an increase in maturity of dairy buffaloes. It was suggested that the increasing maturity up to some extent results in maintenance of better reproductive performance.

4. Reproduction-nutrition relationship

Under the conventional farming system in the region, diet is not formulated according to the requirements of individual animals, resulting in decreased production and poor health and reproduction (Qureshi, 1995; Qureshi et al., 1999, 2002). The lactating buffaloes are fed green fodders plus concentrate feeds but dry and pregnant buffaloes are considered uneconomical and are mostly fed only low quality green fodders Consequently, animals getting adequate nutrients have higher body condition scores, which enable them to produce higher quantities of milk and they also are bred earlier.

In the absence of any ration formulation practice under this production system, excessive or deficient intake of some nutrients may decrease reproductive performance. Few investigations have studied the association of intake of protein and energy and the resulting serum urea levels and body condition score with reproductive performance in Nili-Ravi buffaloes, under field conditions in the northern Pakistan.

The buffaloes calving during the normal breeding season (NBS, August to January) ($p<0.01$) had a significantly shorter postpartum estrus interval (55.9 vs 91.2 days) than those calving during the low breeding season (LBS, February to July, Qureshi et al., 1999). Milk progesterone levels (MPL) in the LBS remained lower than the NBS ($p<0.01$). Shortest postpartum ovulation interval was noted during autumn (August to October), followed by winter (November to January), summer (May to July) and spring (February to April). The incidence of silent ovulations was higher during LBS than NBS (70.6% versus 29.4%). In autumn there was minimum intake of crude protein (CPI) and maximum intake of metabolizable energy (MEI, $p<0.01$). Calcium intake was higher in NBS than LBS calving buffaloes ($p<0.01$). Phosphorus, copper and magnesium intake was lower ($p<0.05$) and zinc intake was higher ($p<0.01$) in autumn (August to October). It was concluded that onset of breeding season was associated with increasing MEI and decreasing CPI and minerals intake.

Qureshi et al. (2002) reported that crude protein intake (CPI) averaged 1.8 ± 0.5 kg/day, ranged from 0.95 to 2.6 kg/day, varied significantly between seasons, and was positively correlated with serum urea levels ($r=0.22$, $p<0.01$). Degradable protein intake (DPI) was 1.32±0.01 kg/day and was significantly affected by season ($p<0.01$) with summer > spring > autumn / winter. There was a positive correlation between CPI and duration of placenta expulsion ($r=0.21$, $p<0.01$), postpartum estrus interval (PEI) ($r=0.08$, $p<0.05$) and postpartum ovulation interval (POI) ($r=0.21$, $p<0.01$). Excess intake of crude protein (excess to requirements) was lower in animals which expressed oestrus than those which remained anoestrus ($p<0.05$). The difference was marked from one month pre-partum to four months postpartum. Excess CPI delayed the duration of placental expulsion ($r=0.37$, $p<0.01$). The dietary ratio of crude protein/metabolizable energy (g CP/MJ ME) consumed by the buffaloes during the pre-partum and postpartum periods shows that the animals resuming to oestrus had a narrow and almost constant CP/ME ratio (11.9 to 12.2 g/MJ), while the anoestrus animals had a widely fluctuating ratio, ranging from 10.7 to 13.1 g/MJ. CP/ME ratio was related positively with POI ($r=0.15$, $p<0.01$).

In the same study, energy intake showed an overall mean value of 174.5±1.1 MJ/day, ranging from 84.5 to 252.8 MJ/day. ME intake was lower in cows that calved in the NBS than those that calved in LBS ($p<0.01$). Intakes of ME were similar during winter and spring but lower than those in summer or autumn, which was highest ($p<0.01$). Increasing energy intake increased BCS ($r=0.16$) and duration of expulsion of placenta ($r=0.19$) and discharge of lochia ($r=0.24$) but decreased POI ($r=-0.27$, $p<0.01$). Prepartum ME intake was higher in animals observed in oestrous than those remaining anoestrous (177.2 vs 155.9 MJ/day, $p<0.05$). Prepartum metabolizable energy intake above requirement (MEAR) was also higher in animals returning to oestrus than the anoestrus ones ($p<0.01$). Higher MEAR during prepartum period was accompanied by a higher BCS in animals which came into oestrus. The animals coming into estrus within 75 days postpartum showed a moderate intake of ME as compared to those coming into estrus after 75 days postpartum, which showed either deficiency or excess of ME intake ($p<0.01$).

5. Body condition score

Body condition score (BCS) reflects the overall energy status of the body, depending upon the intake of nutrients and their utilization for milk yield, growth and maintenance. Osoro and Wright (1992) and De Rouen et al. (1994), concluded that BCS at calving significantly affected postpartum reproductive performance in cows. O'Rourke et al. (1991) reported that cows with BCS of ≥8 had a conception rate 33% higher than those with score ≤5 (scale 3-9). Buffaloes in poor BCS had inactive ovaries and long postpartum anoestrus periods (Jainudeen and Wahab, 1987). Bhalaru et al. (1987) reported that conception rates were significantly higher (88.3%) for buffaloes with moderate BCS (2.5 to 3.5) than for females scoring 1 to 2 (65.8%) or 4 to 5 (70.8%). The reason for low reproductive performance in the animals with low BCS was perhaps the non-availability of nutrients for reproduction, being the third candidate in partitioning of nutrients, after health and milk production. In the fat animals the low reproductive performance was perhaps due to abnormal physiological functions during the estrous cycle.

The BCS of the 51 buffaloes varied from 1.0 to 4.0`during the late prepartum and early postpartum periods (Qureshi, 2002). The buffaloes were grouped into three categories i.e. poor (BCS 1.0 to 2.0), moderate (BCS 2.5) and good (3.0 to 4.0). None of the buffaloes in the NBS calving group had poor BCS. Conversely, none of the LBS calving buffaloes had good BCS, which is consistent with the higher intake of metabolizable energy ($p<0.01$) during summer and autumn. BCS was significantly affected by the period of calving and season of the year. Animals calving during the NBS, had significantly higher BCS as compared to those calving during the LBS (2.82 vs 2.60), which is the probable cause of their better reproductive efficiency (animals coming into estrus within 45 days had higher BCS than those coming into estrus after 45 days). Body condition score was higher (2.97) prepartum than during the first two months postpartum (2.65, $p<0.01$). Placenta expulsion duration ($r=-0.17$, $p<0.05$) and PEI ($r=-0.20$) negatively correlated with BCS. In buffaloes resuming estrus, BCS was consistently higher than in those failing to resume oestrous activity.

6. Post-conception milk yield decline and progesterone stress

The decline in milk production of buffaloes after conception was investigated in a series of studies (Qureshi et al., 2007; Khan et al., 2009). The experimental buffaloes were selected in North-West Frontier Province (NWFP) of Pakistan. Complete milk yield records for 48 weeks of lactation were obtained for 465 pregnant and 179 non-pregnant buffaloes. Three different models were used to identify factors affecting milk yield reduction due to pregnancy.

Model-1, involved gestation stage in months was fitted using all the 30912 records. Then a reduced model-2 was fitted excluding gestation stage. The reduction in milk yield due to pregnancy was worked out relative to their non-pregnant counterparts. Only the data for lactation weeks after conception were analyzed to find out the milk reduction. Model 3 was used to analyze the factors affecting milk yield reduction due to pregnancy:

$$Y = L + P + LxP + LW + GM + E \quad (1)$$

$$Y = L + P + LxP + LW + E \quad (2)$$

$$RY = L + CS + P + LW + GM + E \quad (3)$$

Where Y is milk yield, RY is the reduction in milk yield; L is location, P is parity, LW is lactation week, GM is gestation month, CS is conception season E is the residual term associated with the model. The milk records were divided in three subsets: lactation weeks 11-28 (early lactation); 29-36 (mid lactation); and 37-48 (late lactation) and analyzed separately to estimate the effect of pregnancy at different lactation stages.

Model 4 was used to modulate milk yield reduction with the onset of pregnancy at medium sized private farms comprising lactation records of 40 buffaloes. The data indicate that post-conception reduction in milk yield occurred earliest in those that conceived during 29-36 or 37-48 weeks of lactation, respectively. A noticeable reduction in milk yield was found during the 3rd, 5th or 6th month of pregnancy in the animals conceiving at earlier, mid or later stages of lactation. Initially the milk yield in pregnant animals increased up to 2 months post-conception and then decreased at an almost constant rate. The reduction was visible after 5th week post-conception. The decline in milk with advancing pregnancy was slight up to a point which we declared as joining point; thereafter the decline was much greater.

The onset of pregnancy may be associated with hormonal changes leading to the decline in milk yield of buffaloes. To investigate this, forty lactating buffaloes from 1st to 23rd weeks post-conception were selected in a study (Khan et al., 2009). The animals were assigned to three treatments: pregnant with traditional ration, pregnant with supplemented ration, non-pregnant with traditional ration and grouped according to milk yield: HMY, 66 to 75 l/week, n=12; MMY, 56 to 65 l/week, n=16; LMY, 46 to 55 l/week, n=12).

Milk samples (10 ml each) collected from the experimental animals were utilized for composition determination. Milk contents were determined through ultrasonic milk analyzer (model Ekomilk Total Ultrasonic Milk Analyser, Bullteh 2000, Stara Zagora, Bulgharia), using manufacturer's instruction, as already reported (Khan et al., 2007).

Milk progesterone concentrations were measured by enzyme-immunoassay (EIA). Group means were compared and correlation analysis was conducted. Progesterone concentrations increased in almost similar pattern with the advancing weeks post-conception. The high and low yielder showed greater progesterone concentrations in the supplemented than the animals on traditional ration ($P<0.001$) than the moderate yielders. Progesterone concentrations correlated positively with fat (%), negatively with milk yield, protein (%) and lactose (%) with milk fat content and negatively with protein content and lactose content.

The decline in milk yield became drastic when progesterone concentrations rose above 6.44 ng/ml. The pregnant animals on traditional ration exhibited a sharper decline in milk yield with the increasing progesterone concentrations as compared to pregnant animals with supplemented ration. It was concluded that concentrate supplementation induced an increase in progesterone levels. Progesterone concentrations and milk yield showed an inverse relationship.

7. Calf suckling and use of oxytocin

Calf suckling and oxytocin injections are commonly used for pre-milking stimulus in dairy buffaloes under field conditions. A study was conducted to investigate effect of these treatments on reproductive performance (Qureshi and Ahmad, 2008). We found a lower reproductive efficiency of dairy buffaloes under the peri-urban farming system reflected by ovarian cyclicity in 68.63% buffaloes within 150 days postpartum and silent estrus in 51.5% of the cases. Increasing suckling duration and use of oxytocin extended the postpartum ovulation interval (POI), however it was shortest in buffaloes suckled for one month. Fat-corrected milk (FCM) was significantly higher in estrus group as compared to anestrus one, during the first two months postpartum (15.09 versus 13.56 kg/day, $P < 0.01$). The moderate yielders had shortest postpartum uterine involution ($P < 0.01$) and estrus intervals (PEI, $P < 0.05$) and highest conception rate ($P < 0.01$). It was suggested that the high yielding buffaloes also manifested better reproductive cyclicity.

As the calves were allowed to suckle two times daily, it probably resulted in adverse effect on resumption of postpartum ovarian activity and increased PEI and POI. There was also a decrease in the duration of lochia discharge, which might have been due to sustained uterine contractions caused by oxytocin released in response to suckling. In agreement with this study, ovarian cyclicity was re-established earlier in non-suckled than suckled river, as well as swamp, buffaloes (El-Fouly et al., 1976; El-Fadaly, 1980; Jainudeen et al., 1984). In Nili-Ravi buffaloes, Usmani et al. (1985) reported that postpartum intervals to uterine involution, resumption of follicular development, first rise in milk progesterone, first palpable corpus luteum formation and first oestrus were longer for limited-suckled buffaloes than for non- suckled buffaloes.

For stimulation of milk letdown, oxytocin is released in response to tactile teat stimulation. The application of a fixed pre-stimulation of 30 to 60 s before milking has been recommended to ensure immediate and continuous milk flow after the start of milking (Rasmussen et al., 1992). However, recent investigations demonstrated the importance of the udder fill on the course of milk ejection (Dzidic et al., 2004). Therefore, pre-stimulation time according to the degree of udder fill in individual cows may improve the milking performance. According to previous results, no cisternal milk was available when milking started without pre-stimulation at a low udder fill (Bruckmaier and Hilger, 2001). At moderate udder fill, cisternal milk was immediately available for milking (Bruckmaier and Blum, 1996) and the alveolar milk ejection started about 70 s after the start of pre-stimulation, as indicated by the second rise of milk flow (Bruckmaier and Hilger, 2001). In full udders, the amount of cisternal milk was further enhanced (Pfeilsticker et al., 1996) and the lag time until the start of the alveolar milk ejection was further reduced (Bruckmaier and Hilger, 2001).

Milk yield in buffalo is lower than cattle because of the little progress made in its conversion to a specialized dairy animal. So the udder is not full and a stronger pre-milking stimulus is required for milk let down. In the present study, representative of the conventional buffalo farming, the suckling (twice a day for five minutes each time) was used or it was replaced by oxytocin in case of death of the calf. Qureshi and Ahmad (2008) suggested that increasing suckling duration and use of oxytocin delayed POI, however, POI was shortest in buffaloes suckled for one month.

8. Milk fatty acids

Buffaloes usually maintain higher body condition and do not produce milk at the cost of their own body reserves under tropical conditions. The mobilization of body reserves for fulfilling the demands of lactation has been extensively studied in dairy cows while limited work is available on this aspect in dairy buffaloes. Therefore, a study was conducted to examine variations in milk fatty acid profiles with body condition in Nili-Ravi buffaloes (Qureshi et al., 2010). We suggested that Nili-Ravi dairy buffaloes produce similar milk to dairy cows regarding content of cardioprotective fatty acids, with the highest concentration of C18:1 cis-9. Two HCFA (hyper-cholesterimic fatty acids, C12:0 and C14:0) were associated with higher body condition. Buffaloes with moderate body condition yielded milk containing healthier fatty acids (the unsaturated fatty acids).

The HCFA (C12:0, C14:0 and C16:0) found in this study on Nili-Ravi buffaloes were considerably lower and cardioprotective fatty acids (C18:1 and C18:2 and C18:3) level were higher than the Bulgharian Murrah buffaloes as reported by Mihaylova and Peeva (2007). They found that total amount of SFAs (saturated fatty acids) were 72.15% (varying from 64.92 to 77.60%), PUFA (poly unsaturated fatty acids) 3.15% and the HCFA were 43.62%. Our values were in close agreement with Fernandes et al. (2007) who reported that the total SFAs, MUFA (mono unsaturated fatty acids) and PUFA in Murrah buffaloes in Brazil were 65.04%, 31.68% and 3.28% respectively and the HCFA varied from 32.48 to 42.90%. Our values for dairy buffaloes were not much different from dairy cows where the SFAs varied from 60 to 65% and UFAs (unsaturatred fatty acids) 35 to 40% of the total fatty acids (Lock and Shinfield, 2004).

Talpur et al. (2008) compared milk fatty acid composition of Nili-Ravi and Kundi buffaloes in Sindh province of Pakistan. The average SFAs were; 66.96 g/100 g and 69.09 g/100 g; MUFA 27.62 and 25.20 g/100 g; PUFA 2.77 and 2.76 g/100 g and HCFA 42.8 and 46.54 g/100 g, of total fatty acids for Kundi and Nili-Ravi breed respectively. It appears that the cardioprotective quality of milk from Nili-Ravi buffaloes is almost similar to dairy cows and Brazilian and higher than in milk from Bulgharian Murrah buffaloes (Talpur et al., 2008).

The opposite pattern of BCS and UFAs concentration in milk fat (Qureshi, et al., 2010) in dairy buffaloes was probably due to lipolysis. In bovine adipose tissue, C18:1 cis-9, C16:0, and C18:0 account for nearly 90% of fatty acids in molar proportions (Christie, 1981) and body fat mobilization would probably increase direct accumulation of these fatty acids into milk fat. In addition, desaturation of stearic acid occurs in the intestinal epithelium and mammary tissues (Enoch et al., 1976). Some 40-50% of C18:1 cis-9 in milk fat is formed from C18:0 in the mammary gland via desaturase (Chilliard et al., 2000). The net outcome of all these processes is the higher level of UFA and more specifically the C18:1 concentration in milk fat.

9. Drinking water quality

The heavy metal content of human diets can adversely affect health status of the consumers. One source of animal feeds include drinking water. Free access to drinking water favorably affected fertility of buffaloes. A study was therefore conducted to investigate the mineral contents of milk (Qureshi and Khan, 2011). The study concluded that the drinking water was the major source of heavy metal contents (Cr, Cd, Pb) in milk produced in the peri-urban buffalo dairy farms in Peshawar. Peshawar was below the desirable limits of the beneficial inorganic minerals (Mg, Zn and Fe) whereas the toxic heavy metals (Cd, Cr and Pb) content of heavy metals were excessive in drinking water. Levels of the heavy metals Cd, Cr and Pb through milk alone was much more than the total daily intake of these heavy metals from all sources. Free access to drinking water effected milk yield, body condition and fertility favorably. The higher intake of lead was associated with depressed milk in addition to enhanced level of this element in the milk.

The study revealed that drinking water used at urban and peri urban dairy farms in Peshawar are below the maximum allowable intake (MAC) in essential minerals and the heavy metals are higher. The Ca and Mn concentration in drinking water were 63.6% and 40% above the MAC of Pakistan Council of Research on Water Resources (PCRWR). While other essential minerals Mg, Fe, Zn and Cu were 57%, 57%, 99.6% and 98% respectively below the MAC of PCRWR. The heavy metals Cd, Cr and Pb levels were above the MAC of PCRWR (700%, 1800% and 1240% respectively) and were also above the standards fixed for livestock drinking water by NRC (1500%, 850% and 4366.7% respectively). The concentrations of the three heavy metal were far above the standards of WHO (2566.6%, 1800% and 6600%).

Although, food is the major source of mineral nutrients in the diet, drinking water can contribute variable fractions of the total intake (WHO, 2004). The magnesium content of water is variable and depends on the region of its source and its manner of storage. 'Hard' water has a higher concentration of magnesium salts (COMA, 1991). The NIRS (National Inorganic Radionuclide Survey, WHO 2004) study provided data on many cationic inorganic ions in water including calcium and magnesium. They found that mean concentrations (49 mg/L for calcium and 16 mg/L for magnesium) were low compared to their dietary requirements. The 90^{th} percentile values (97 mg/L for calcium and 36 mg/L for magnesium would make more substantial contributions to dietary intake (WHO, 2004). The findings of present study showed a substantial contribution of Ca (327 mg/L) but a low contribution of Mg (24 mg/L) to dietary intake.

Somasundaram et al., (2005) found that technological progress, various industrial activities and increased roadway traffic have caused a significant increase in environmental contamination. Ubiquitous presence of some metal pollutants, especially cadmium (Cd), chromium (Cr) and lead (Pb), facilitates their entry into the animal food chain and thus increases the possibility of inducing toxic effects in humans and animals. Land application of sewage sludge, sewage water and industrial wastes gradually increases the toxic metals in the soil environment which are increasingly taken by plants and subsequently transferred into the food chain potentially causing severe damage to both animal and human health.

Due to lack of any strict legislation or its implementation for the proper disposal of industrial wastes in Pakistan these wastes become mixed with drinking water channels. In the present study the high level of heavy metals in the drinking water may be due to sewage water contamination and industrial pollution of livestock drinking water and the farmers pay no attention for the provision of clean drinking water to the livestock.

A comparison of the daily intake of minerals and heavy metals through milk to the maximum of allowable intake from all sources was done by the Expert group on vitamins and minerals (2003). Based upon the per capita milk consumption in the country calculated on the basis of Economic Survey (2009-10), the daily intakes of Ca, Mg, Fe, Zn, Cu, Mn, Cd, Cr and Pb through milk were 650.67, 78.27, 32.91, 10.42, 0.50, 0.46, 1.64, 30.84 and 9.27 (mg/day) respectively. The contributions of milk in the maximum daily intake of essential minerals were 14.45% (Ca), 5.5% (Mg), 74.79% (Fe), 13.53% (Zn), 4.54% (Cu) and 3.06% (Mn). The daily intake of toxic heavy metals Cd, Cr and Pb through milk were 1952.38%, 3896% and 1865.19% above the maximum allowable intake of heavy metals from all sources fixed by EVM (Expert Group On Vitamins And Minerals 2003). The milk produced in Peshawar contributes a slight amount of essential minerals to the total daily intake but a considerable amount of toxic heavy metals reflecting poor quality of milk.

In the present study iron significantly ($P<0.05$) affected milk yield, body condition score and services per conception. Iron in drinking water is probably the most frequent and important contaminant in dairy cattle. Whereas, iron deficiency in adult cattle is very rare because of abundant iron (Fe^{+3}, ferric iron) in feedstuffs, excess total iron intake can be a problem; especially when drinking water contains high iron concentrations. Iron concentrations in drinking water of greater than 0.3 ppm are considered a risk for human health, and are a concern for dairy cattle health and performance. The first concern is that high iron in drinking water may reduce the palatability (acceptability) and therefore amount and rate of water intake. Also, formation of slime in plumbing by iron-loving bacteria may affect water intake and even the rate and volume of water flow through pipes.

The predominant chemical form of iron in drinking water is the ferric (Fe^{+3}) form. The ferrous form is very soluble in water compared with the highly insoluble ferric (Fe) form present in feed sources. Highly soluble iron can interfere with the absorption of copper and zinc. The ferritin system in cells in the intestinal wall normally helps control the risk of iron toxicity in animals by controlling iron absorption. However, highly soluble ferrous iron can be readily absorbed by passing between cells; thus escaping the normal cellular regulation.

Once in the body, the transferrin and lactoferrin systems normally bind iron in blood and tissues to control its reactivity. These systems also help control risk of toxicity under normal conditions.

However, when excess, highly water-soluble iron in drinking water is absorbed there is an overload systemically within the animal and all can not be bound. Deleterious consequences of excess free iron include abundant and excessive amounts of reactive oxygen species (e.g., peroxides) that cause oxidative stress. Oxidative stress damages cell membrane structure, functions, and perturbs otherwise normal biochemical reactions. Consequences of iron toxicity and heightened oxidative stress that are magnified in transition and fresh cows include: compromised immune function, increased fresh cow mastitis and metritis, greater incidence of retained fetal membranes as well as diarrhea, sub-normal feed intake, decreased growth, and impaired milk yield. Excess iron (greater than 0.3 ppm) in drinking water is much more absorbable and available than iron from feedstuffs, and thus present a greater risk for causing iron toxicity (Beede 2006).

The number of services per conception (SPC) was increased with increasing Mn, showing its adverse effect. Expert Group on Vitamins and Minerals (2003) reported that manganese has low acute toxicity but has neurotoxic efffects on fertility. Amal (2003) concluded that long exposure of animals to lead affect the reproductive efficiency in the form of lower conception rates, as well as increased incidence of still births, SPC and abortions. The mothers exposed to Pb suffered reduced postnatal viability and lower birth weight.

10. Conclusion

Based upon the above review it may be concluded that buffaloes kept under the peri-urban dairy farming in Pakistan face huge challenges of survival due to poor physiological support to productivity and low socio-economic status of the farmers resulting in poor management. The breeding efficiency of buffaloes has been reported to show a persistent downward trend (78.20 to 71.38%) during the last decade which may have occurred due to the effects of inbreeding or a deteriorating management conditions at these farms.

Buffaloes show a seasonal breeding with lower milk progesterone levels and higher rates of silent ovulation during spring and summer. The breeding season commences during autumn with lowering intake of crude protein and increasing intake of metabolizable energy. Calcium and zinc intake is higher and phosphorus, copper and magnesium intake is lower during autumn. The onset of breeding season was found to be associated with increasing intake of metabolizable energy and decreasing intake of crude protein. Post-conception decline has been associated with onset of pregnancy and rising levels of milk progesterone beyond certain levels. However, the decline may be combated through feed supplementation. The traditional use of oxytocin was found to decrease reproductive efficiency of dairy buffaloes under the peri-urban farming system reflected by ovarian cyclicity in 68.63% buffaloes within 150 days postpartum and silent estrus in 51.5% of the cases. Increasing suckling duration and use of oxytocin extended the postpartum ovulation interval (POI), however it was shortest in buffaloes suckled for one month.

Nili-Ravi dairy buffaloes produce similar milk to dairy cows regarding content of cardioprotective fatty acids, with the highest concentration of C18:1 cis-9. Buffaloes with moderate body condition yielded milk containing healthier fatty acids (the unsaturated fatty acids). Drinking water used at urban and peri urban dairy farms in Peshawar are below the maximum allowable intake (MAC) in essential minerals and the heavy metals are higher. The higher intake of lead was associated with depressed milk in addition to enhanced level of this element in the milk.

Author details

M. Subhan Qureshi
Agricultural Unviersity, Peshawar, Pakistan

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