The Journal of Animal and Plant Sciences, 22(2 Suppl.): 2012, Page: 96-101
ISSN: 1018-7081

EFFECT OF QUALITY AND FREQUECY OF DRINKING WATER ON PRODUCTIVITY AND FERTILITY OF DAIRY BUFFALOES

R. Khan, M. S. Qureshi[1], A. Mushtaq[1], Ghufranullah and A. Naveed

Directorate of Livestock Research and Development Khyber Pakhtunkhwa Peshawar Pakistan
Corresponding author: raj_wali23@yahoo.com

ABSTRACT

The present study was conducted to evaluate the mineral and heavy metal content in drinking water and document its effect on productivity performance of dairy buffaloes. Twenty five dairy farms were selected having 10 to 122 buffaloes. Data were collected regarding milk yield, body condition score (BCS) and services per conception (SPC). Representative samples were collected from the water used for the dairy animals. One liter water samples were collected from each of the dairies drinking troughs and analyzed for Ca, Mg, Fe, Zn, Cu, Mn, Cd, Cr, and Pb. Water analysis was performed by atomic absorption spectrophotometry. Milk yield was positively affected by Mn and negatively by Fe, Zn and Pb. BCS was adversely affected by Fe and Mg, and positively by Zn and Cd. Iron in drinking water significantly ($P<0.05$) reduced milk yield, body condition score and increase services per conception. The watering frequency negatively affected milk production and BCS ($P<0.01$) while significantly increasing SPC ($P<0.05$). It is concluded that free access to drinking water positively affected milk yield, body condition and fertility. An increase in body condition was noted with higher Zn intake in the drinking water. The higher intake of lead was associated with depressed milk yield. The present study clearly shows the importance of water quality in dairy animals. For quality food products for human consumption, appropriate legislation are required for drinking water used for livestock rearing and quality monitoring of food products.

Key words: Heavy metals, minerals, drinking water, Buffaloe and BCS.

INTRODUCTION

Livestock plays an important role in the economy of Pakistan. This sector contributed approximately 53.2 percent of the agriculture value added and 11.4 percent to national GDP during 2009-10. Gross value addition of livestock at current cost factor has increased form Rs. 1304.6 billion (2008-09) to Rs. 1537.5 billion (2009-10) showing an increase of 17.8 % (Economic survey of Pakistan 2009-10).

In spite of the huge contribution of the livestock to the national economy, the per head milk production of local dairy animals under existing farm conditions is relatively low. Among dairy buffaloes, 98% are produce less than 10 liters of milk/day, overall higher milk production has resulted from increase in the number of cattle and buffaloes, while yield increase per animal has contributed relatively little to milk production growth. In Pakistan, about 65% of the milk is contributed by buffaloes (Economic survey of Pakistan 2009-10). Milk products constitute very important human diet since their consumption has increased in recent years. These products are also a good source of calcium Bighila *et al.* (2008). Animals need to consume sufficient water all the time to satisfy their respective requirement. However, sufficient water can not take the precedence over good quality water, as the hygienic and physiochemical quality of drinking water plays a key role in ensuring an efficient animal productivity. Previous studies have shown that pathogenic bacteria and excessive chemicals in water supplies can reduce animal production, impair fertility and cause the loss of animals in some extreme cases. Moreover, contaminants in drinking water can leave residues in animal products, i.e. meat, milk and eggs, which adversely affect product sales and transfer health risks to humans (Lili, 2009). Water is the second only to oxygen in importance to sustain life and optimize growth, lactation, and reproduction of dairy cattle. However, unlike the careful and continuous attention paid by dairy producers and nutritionists to other nutrients in the ration, oftentimes the quality and provision of free drinking water does not receive the attention necessary to ensure optimal nutrition and cattle performance. The water requirement per unit of body mass of a high-producing dairy cow is greater than that of any other land-based mammal (Woodford et al., 1985). Urban and peri-urban dairy farming in Khyber Pukhtunkhwa province of Pakistan have been established without considering the environment and marketing needs concerned to farm water supply, drainage and the under managed housing Qureshi *et al.* (1999). The water supply to the farms may affect the productivity of dairy animals. Therefore, keeping in view the importance of water quality and frequency the present study was designed to reveal the prevailing conditions in the area and propose workable recommendations.

MATERIALS AND METHODS

The study was conducted in district Peshawar. Twenty five dairy farms were selected having 10 to 122 buffaloes. Data were collected regarding milk yield and reproductive parameters. Representative samples were collected from the water used for drinking the dairy animals. One liter water sample was collected in a labeled plastic bottle from the water trough. Effect of drinking water on performance of the animals was studied by using the following parameters;

1) Watering frequencies. watering frequency were grouped into four categories 1= Once/day, 2= Twice/day, 3= Thrice/day and 4= Free excess.
2) Milk production level (lit/day).
3) Body condition scores of animals. Body condition score was recorded of the dairy buffaloes in selected dairy farms using the method described by (Peters and Ball, 1987). According to this method the thickness of fat over the lumber and tail head area was estimated and was assigned a score from 0 (very week) to 5 (very fat). The BCS was categorized as: 0, spine very prominent and transverse vertebral process feel sharp with no fat cover; 1, spine prominent and transverse process with little fat cover; 2, transverse process can be felt but are rounded with a thin covering of fat; 3, individual transverse vertebral process can only be felt by firm pressure; 4, the transverse process can not be felt; and 5, the transverse process covered with a thick layer of fat.
4) No of services per conception.

Mineral analysis of water: Atomic absorption spectrophotometer (PerkinElmer 200 USA) was used to quantify the inorganic minerals and heavy toxic metals in the water samples by using the method reported by (Richardson 2003). The following elements were determined in water samples in (mg/l) :Calcium (Ca); Magnesium (Mg); Iron (Fe); Zinc (Zn); Manganese (Mn); Copper (Cu); Cadmium (Cd); Chromium (Cr); and Lead (Pb).

Statistical Analysis: The collected data were maintained in M S Excel files. Mean were compared for various groups through analysis of variance by using Computer software SPSS 12 (2003). Means were further ranked through Duncan's multiple range tests according to (Steel and Torrie, 1980). Correlation among various parameters was determined through Pearson's correlation. Independent parameter was water quality. Dependent parameters were milk yield, BCS and services per conception.

RESULTS AND DISCUSSION

Drinking water quality: The present 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 63.55% 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%). As there is no any strict legislation for the proper disposal of industrial wastes in Pakistan, therefore 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 coming in livestock drinking water and the farmers pay no attention for the provision of clean drinking water to their livestock.

Effect of location: In the present study the drinking water of Peri urban dairy farms contained highest level of Ca and Mg with mean values of 331.24 mg/l and 71.52 mg/l respectively. Ca content of the Danishabad and Akbarpura were above the MCL maximum concentration level (75 mg/l) of US environmental protection agency (1978) Shahida (2006). Mg was below the MAC (150 mg l^{-1}) of PCRWR. Mg in the majority of the water samples of the tube wells of Peshawar were within the permissible limits, however Mg content in the tube wells of Kandi hayat, Gunj, Gulbahar and Hazarkhwani were exceeded the MCL (50 mg l^{-1}) of the USEPA (1978) Shahida (2006). Fe concentration (1.44 mg l^{-1}) was highest in Urban area such as Hussan garhi and nothia area of Peshawar. Iron concentration in the surface and ground water of Peshawar were below the maximum permissible limit except from Hayat abad phase 3 (Shahida, 2006). The heavy metal Cd was above the maximum permissible limit of PCRWR in all areas of Peshawar. The highest value (0.16 mg l^{-1}) was found in the urban area such as Palosi and University area. The lowest concentration was found in the rural areas such as Wadpagga (0.04 mg l^{-1}) followed by Daag and Pajjagi ares (0.05 mg l^{-1}). Cd can be released in drinking water from corrosion of galvanized plumbing and water main pipe material. A significant amount of Cd may be released in the atmosphere from combustion of coal, oil, paper and urban organic trash (Chino and Mori. 1982). This may be due to increase in industrialization in the urban environment.

The Cr concentration was highest in the peri urban areas Pandho, Hazarkhwani (1.121 mg l^{-1}), Palosi university area (0.94 mg l^{-1}) followed by urban area Hassan ghari (1.04 mg l^{-1}) while lowest concentration were recorded in the rural areas such as Wadpagga (0.65 mg l^{-1}) and Dag, Pajjagi area (0.88 mg l^{-1}). The water samples of Landi arbab, Ganj and Urmar bala contained the Cr concentration above the upper limits (Shahida, 2007). The present study was inline with the findings of (Shahida 2006). The Pb concentration was highest (1.10 mg l^{-1}) in Pandho, Hazarkhwani areas followed by hassan ghari and nothia areas (0.84 mg/l). The highest Pb concentration was reported in Gulbahar (71 ug/l) by Shahida (2006).

Minerals in drinking water: Concentration of minerals and heavy metals in drinking water is presented in Table 1. The mean Ca, Mg, Fe, Zn, Cu and Mn were 327.10, 63.56, 0.43, 0.06, 0.02 and 0.07 (mg l^{-1}) respectively. The heavy metals Cd, Cr and Pb were 0.08, 0.95 and 0.67 (mg l^{-1}) respectively. The minerals and heavy metals concentration of water showed a sequence of Ca>Mg>Cr>Pb>Fe>Cd>Mn>Zn>Cu. The results suggest that milk yield was negatively affected by Mn and Pb in drinking water. Milk yield was negatively correlated with Fe(r = -0.194, P > .001) Zn (r = 0.67 P > .001) and Pb (r = -0.362, P > .001), while positively correlated with Mn (r = 0.452, P > .001).

Ogwuegbu and Ijioma (2003) reported the poisoning effects of heavy metals which were due to their interference with the normal body biochemistry in the normal metabolic processes. When ingested, in the acid medium of the stomach, they are converted to their stable oxidation states (Zn^{2+}, Pb^{2+} and Cd^{2+}) and combine with the body's biomolecules such as proteins and enzymes to form strong and stable chemical bonds. The hydrogen atoms or the metal groups in the above case are replaced by the poisoning metal and the enzyme is thus inhibited from functioning, whereas the protein–metal compound acts as a substrate and reacts with a metabolic enzyme (Holum, 1983). As many enzymes are involved in milk synthesis, therefore these heavy metals may interfere with normal continuous process of milk synthesis which probably affecting milk yield.

Interaction with BCS: Body Condition Score was negatively affected by Mg and positively by Zn and Cd. Zinc is a trace element essential for every form of life (Underwood, 1977). Poor growth is a prominent characteristic of Zn deficiency of animal and plant species (Dijkhuizen *et al*. 2001). Zinc is involved in a wide range of functions including the metabolism of carbohydrates, proteins, lipids and nucleic acids (Vallee and Falchuk, 1993). Ananda (2001) reviewed that Zn is needed for DNA replication, RNA transcription, cell division, and cell activation. Apoptosis is potentiated by Zn deficiency and Zn also functions as an antioxidant and can stabilize membranes. In this present study the BCS was favorably affected by Zn. As BCS is an indicator of body energy reserves which is concerned with the body metabolic status. As Zn is necessary for the DNA replication which is an important continuous process of body metabolism and protein synthesis. Therefore if abundant amount of Zn is available the process of metabolism and protein synthesis will be keep on and energy reserves be maintained. Therefore the BCS were positively affected by Zn.

Effect of iron on milk yield: In the present study iron significantly ($P<0.05$) affecting milk yield, body condition score and services per conception (Table 3 and Fig 1). Milk yield was negatively correlated with Fe(r = -0.194). Iron in drinking water is probably the most frequent and important anti-quality consideration for 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, a dark slime formation in plumbing and waterers formed by iron-loving bacteria may affect water intake and even the rate and volume of water flow through pipes (Beede 2006). McCluggage (1991) reported the harmful biotoxic effects of heavy metals to the body when consumed above the bio-recommended limits. Although individual metals exhibit specific signs of their toxicity.

The predominant chemical form of iron in drinking water is the ferrous (Fe +2) 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 sneaking 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).

Effect of minerals and heavy metals on Services per conception: The service per conception (SPC) was increased with increasing Mn showed its adverse effect. Expert Group on Vitamins and Minerals 2003 reviewed that manganese has low acute toxicity but neurotoxic effects. Fertility is reduced by high doses of manganese (Amal 2003) concluded that long exposure of animals to lead affect the reproductive efficiency in the form of lower in percentage of conception rate and increase still birth (%) as well as increased service in period, in addition to abortion. The calves from mothers suffered from reduced postnatal, viability, reduction in birth weight.

The results of the present study were in line with findings of (Amal 2003) and (EVM 2003). All elements are non toxic when these are present below the upper limits some of them are beneficial for normal metabolic functions of the body but all elements become harmful when they are present above the upper limits. As Mn is one of important trace elements in the daily feeding of the animals but it affect the services per conception when it is present in abundant quantity in drinking water or feeding.

Effect of watering frequency on animal's performance: In the present study highest milk production (11.81 kg/day) were observed at farms receiving free excess of water as compared to those maintained at once watering frequency (7.83kg/day), showing a difference of 50.8%. Inadequate provision of water decreases milk production faster and more dramatically than any other nutritional factor. If milk production drops dramatically, particularly during summer, water supply should be evaluated. All too often, dirty water tanks or improper placement of waterers may be the culprit (Beede 1993). Murphy *et al*. (1983) calculated the drinking water requirement through a prediction equation and suggested that intake of drinking water changes 0.90 lb for each 1.0 lb change in MY. They found that cattle consume 0.11 gallon for each lb increase in MY.

Table 1 Instrumental condition for calcium, magnesium, iron, zinc, manganese, copper, cadmium, chromium and lead determination in water by Flame Atomic Absorption Spectrophotometer

Conditions	Calcium	Magnesium	Iron	Zinc	Manganese
Wavelength (nm)	422.7	285.2	248.3	213.9	279.5
Lame type	HCL	HCL	HCL	HCL	HCL
Slit width (nm)	0.7	0.7	0.2	0.7	0.2
Flame	A/A	A/A	A/A	A/A	A/A

Conditions	Copper	Cadmium	Chromium	lead
Wavelength (nm)	324.8	228.8	357.9	244.8
Lame type	HCL	HCL	HCL	HCL
Slit width (nm)	0.7	0.7	0.7	0.2
Flame	A/A	A/A	A/A	A/A

HCL= hollow cathode lamp, A/A= acetylene/air, FAAAS= flame atomic absorption spectrophotometer.

Table 2 Concentration of minerals and heavy metals in drinking water in comparison to MAC of PCRWR, NRC and WHO standards (mg l^{-1}).

Elements	Minimum	Maximum	Mean	S.E	MAC-Pak	MAC-NRC	MAC-WHO
Ca	76.240	728.96	327.10	22.70	200.00	-	50.00
Mg	8.480	96.80	63.56	4.88	150.00	-	50.00
Fe	0.003	6.84	0.43	0.27	1.00	-	-
Zn	0.020	1.00	0.06	0.01	15.00	5.000	3.00
Cu	0.000	0.44	0.02	0.02	1.50	1.000	2.00
Mn	0.000	0.64	0.07	0.01	0.05	0.050	0.05
Cd	0.026	0.57	0.08	0.02	0.01	0.005	0.003
Cr	0.446	1.33	0.95	0.048	0.05	0.100	0.05
Pb	0.000	2.00	0.67	0.07	0.05	0.015	0.01

MAC, Maximum Allowable Concentration; PCRWR, Pakistan Council of Research in Water Resources; NRC, National Research Council; WHO, world Health Organization.

Table 3 Minerals and heavy metals in drinking water in various zones (areas) of Peshawar. (mg l^{-1})

Zones	Ca	Mg	Fe	Zn	Cu	Mn	Cd	Cr	Pb
Rural	325.06	59.47b	0.12b	0.08a	0.01	0.05	0.05b	0.77b	0.41b
Peri urban	331.24	71.52ab	0.2b	0.06ab	0.04	0.10	0.11a	1.07a	0.84a
Urban	322.91	55.80a	1.43a	0.03b	0.00	0.04	0.05ab	1.04a	0.85a
P value	.0.95	0.02	0.001	0.01	0.07	0.12	0.01	0.001	0.001

Table 4 Correlation of water minerals with productivity parameters of dairy buffaloes (Pearson correlation coefficient)

Parameters	Water minerals concentration							
	Fe	Mn	Zn	Ca	Mg	Cr	Pb	Cd
MY	-0.194*	0.452**	-0.67**	0.97	-0.88	0.079	-0.362**	0.4
BCS	-0.209*	0.02	0.316**	-0.209	-0.30*	0.131	NS	0.259*
SPC	NS	0.286**	0.185	0.169	-0.139	-0.152	NS	NS

MY, Milk yield; BCS, Body condition score; SPC, Services per conception

Table 5 Effect of water frequency on milk yield and fertility of dairy buffaloes

Watering Frequency Times/day	Daily Production/animal	BCS(1-5)	SPC	Milk contents		
				Cd	Cr	Pb
Once	7.83c	2.33c	2	2.96b	62.5	30.07b
Twice	8.95b	2.63b	1.68	3.00a	60.6	16.85a
Free access	11.81a	2.91a	1.54	2.48c	49.7	12.95a
P Value	P<0.05	P<0.05	NS	P<0.05	.NS	NS

BCS: Body condition score, SPC: services per conception, Cd: cadmium, Cr: Chromium. Pb lead.

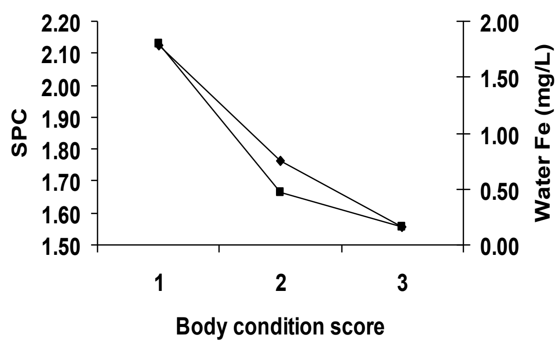

Figure 1 Relationship of body condition score with services per conception (SPC) and water Fe

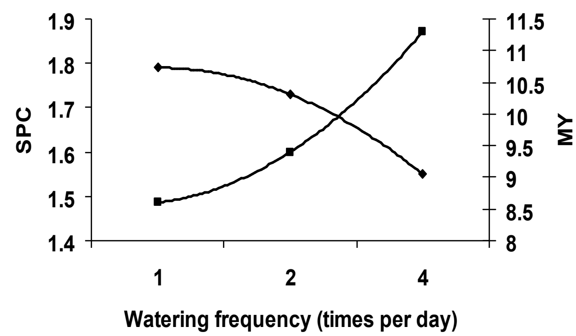

Figure 2 Relationship of watering frequency with milk yield (MY) (♦) and services per conception (SPC) (■)

Most of the dairy farms in the present study lacked facility of free excess to drinking water. The farmers emphasized on feeding management but ignored free excess to drinking water. Pattern of water consumption is associated with feeding pattern (Nocek and Braund, 1985). When four first lactation cows were fed one, two, four or eight times daily, peak hourly water intake was associated with peak times of DMI (dry matter intake). Cows would consumed feed and water at alternate intervals. Given the opportunity, peaks of drinking can be associated with milking. Typically, greater consumption is observed immediately after milking. Therefore, it seems judicious to provide abundant water to cows immediately after milking such as in the return lanes (Beede. 1993).

It is suggested that free excess to drinking water may be ensured at the dairy farms which will lead to an increase in milk yield to the tune of 50.8%. The higher intake of lead through drinking water was associated with depressed milk yield. An increase in body condition was noted with enhanced Zn intake in the drinking water, probably due to the role of this element in protein synthesis leading to tissue building, preventing oxidative stress and apoptosis. However it leads to depressed milk yield, probably through nutritional partitioning or gene regulation towards lipogenesis rather than lactogenesis.

Free access to drinking water effected milk yield, body condition and fertility favorably. The higher intake of iron in drinking water affecting milk yield, body condition score and services per conception adversely. Free excess to drinking water should be encouraged in dairy farms which will lead to better milk yield and composition in addition to improved health status. It is suggested that free excess to drinking water may be ensured at the dairy farms which will lead to an increase in milk yield to the tune of 50.8%. To provide quality food products for human consumption, appropriate legislation are required for drinking water used for livestock rearing and quality monitoring of food products.

REFERENCES

Agriculture Statistics of Pakistan. (2008-09). Ministry of Food, Agriculture and Livestock. (Economic Wing), Government of Pakistan, Islamabad, Pakistan.

Amal, R. and Abdel Hameed. (2003) Clinicopathological studies on the effect of chronic exposure to lead on different reproductive phases in female baladi goats. *Ph. D. Vet. Sci, Fac*. Vet. Med. Cairo Univ.

Ananda, S. P. (2001). Zinc and cell mediated immunity. First International Bio-Minerals Symposium: Trace Elements in Nutrition, Health and Disease (April 19-20, 2001) by Institute Rosell and the International Association of Bioinorganic Scientists (IABS).

Birghila, S, S Dobrinas, G Stansiu and A. Soceanu. (2008). Determination of Major and Minor Elements In Milk Through ICP-AES., *Environmental Engineering and Management Journal* 7 (6), 805-808.

Dijkhuizen M. A., Wieringa Ft, West Ce, S. Martuti Muhilal (2001). Effects of Iron and Zinc supplementation in indonesian infants on micronutrient status and growth. *J. Nutr*. 131: 2860-2865.

Economic Survey of Pakistan, (2009-2010). Government of Pakistan, Finance Division, Economic Advisor's Wing, Islamabad, Pakistan.

Expert Group on Vitamins And Minerals Evm (2003). Safe upper limits for vitamins and minerals. *Crown copyright Published by Food Standards Agency*. ISBN 1-904026-11-7

Holum, J. R. (1983). Elements of General and Biological Chemistry, 6th Edition, John Wiley and Sons, N.Y. pp. 324, 326, 353, 469.

Nocek J. E. and D.G. Braund. (1985). Effect of feeding frequency on diurnal dry matter and water consumption, liquid dilution rate, and milk yield in first lactation. *J. Dairy Sci*. 68:2238.

Lili. (2009). Clean Drinking Water is Crucial in Enhancing Animal Productivity 17th Annual ASAIM SEA Feed Technology and Nutrition Workshop June 15-19, 2009 Imperial Hotel, Hue, Vietnam.

Mccluggage, D. (1991). Heavy Metal Poisoning, NCS Magazine, Published by The Bird Hospital, CO, U.S.A.

Miller, J. K., N. Ramsey and F. C. Madsen. (1988). The trace elements in The Ruminant Animal. Prentice Hall, Englewood Cliffs, NJ. D. C. Church, ed.

Murphy, M. R. C. L. Davis, and G. C. Mccoy. (1983). Factors affecting water consumption by Holstein cows in early lactation. *J. Dairy Sci*. 66:35–38.

National Research Council. (2001). Nutrient Requirements of Dairy Cattle. *7th rev. ed Natl. Acad. Sci*. Washington, D.C.

Ogwuegbu, M. O, and M. A Ijioma., (2003). Effects of Certain Heavy Metals on the Population Due to Mineral Exploitation. In: *International Conference on Scientific and Environmental Issues In The Population, Environment and Sustainable Development in Nigeria*, University of Ado Ekiti, Ekiti State, Nigerian, pp. 8-10.

Qureshi, M. S., H. A. Samad, G. Habib., R. H. Usmani and M.M Siddiqui. (1999). Study on factors leading to seasonality of reproduction in dairy buffaloes. 1. Nutritional factors. *Asian-Aust. J. Anim. Sci, (Korea)* 12 (7): 1019-1024.

Richards, L. A. (1968). Diagnosis and improvement of Saline and Alkaline Soils. 1st. edition. *Agri. Handbook. No. 60. IBH publications Company*. New Delhi. India.

Richardson, S. D. (2003). Water Analysis: Emerging contaminants and current issues, *"Analytical Chemistry,* 75(12): 2831-2857

SPSS 12 for Windows, 2003. Standard version SPSS inc. Chicago IL USA.

Shahida Nasem. (2006). Monitoring of Surface Water Ground Water Air and Soil in Peshawar Basin Against Time The 3rd Dimension, thesis, Centre of Excellence in Geology/ University of Peshawar.

Vallee, B. L. and K. H. Falchuk, (1993). The biochemical basis of zinc physiology. *Physiological Reviews* 73, 70-118.

Woodford, S. T., M. R. Murphy, and C. L. Davis. (1984). Water dynamics of dairy cattle as affected by initiation of lactation and feed intake. J. Dairy Sci. 67:2336– 2343.